IRS
Irish Railway Standards

# Irish Railway Standard IRS-401-A

## Gauging for Vehicles on the Irish 1600mm Rail Network & the related Signs on vehicles

| Issue | Published by | Issue Date |
|---|---|---|
| A | CRR on behalf of the Irish Railway Industry | 31.03.2026 |

# Contents

# 1. Foreword

## 1.1. Irish Railway Standards:

i. cannot replace any Technical Specification for Interoperability (TSI) or other legal requirements which may be applicable to a given project;
ii. are recommended to be chosen as an Alternative Solution in conjunction with a TSI Parameter to demonstrate conformity with the Essential Requirements;
iii. may be called up as a code of practice in conjunction with CSM 402/2013;
iv. may be called up as good industry practice in conjunction with Railway Safety Act 2005;
v. may be called up as a code of practice in conjunction with the safe integration of projects within the Railway System in the Republic of Ireland as defined under 2016/797/EU Art 18 as transposed by S.I. 477 of 2020;
vi. may in parts or in full be called up as a National Rule (NR) for the Republic of Ireland in conjunction with 2016/797/EU as transposed by S.I. 477 of 2020, and 2016/798/EU as transposed by S.I. 476 of 2020.

## 1.2. Where Irish Railway Standards are called up as a NR, in line with 2016/797/EU Art 13(2) as transposed by S.I. 477 of 2020 the reason for its application shall be identified, based on one or more of the following justifications:

i. where the TSIs do not cover, or do not fully cover, certain aspects corresponding to the essential requirements, including open points as referred to in 2016/797 Article 4(6) as transposed by S.I. 477 of 2020;
ii. where non-application of one or more TSIs, or parts of them, has been notified under 2016/797 Article 7 as transposed by S.I. 477 of 2020;
iii. where a specific case requires the application of technical rules not included in the relevant TSI;
iv. national rules used to specify existing systems, limited to the aim of assessing technical compatibility of the vehicle with the network;
v. networks and vehicles not covered by TSIs;
vi. as an urgent temporary preventive measure, in particular following an accident.

# 2. Scope and Application

## 2.1. Scope

This IRS shall serve for a dual use as an Industry Standard and as a National Rule (NR) for the Republic of Ireland.

2.1.1. **Only the sections of this IRS which are indicated in section 2.3 are a National Rule for the Republic of Ireland**

This NR shall apply to all new or modified (including upgrade or renewal) vehicles that are intended to be operated on the Network.

This NR shall also apply in case of an extension of area of use of a vehicle (e.g. where the vehicle's area of use is extended from UK NI to the Network in the Republic of Ireland).

2.1.2. ***Note: All sections of this IRS are an industry standard (with the EXCEPTION of section 2.3)***

*This IRS is highly recommended to be used as good industry practice vehicles that are intended to be operated on the Network. (E.g. for the determination of route compatibility of trains, for operational aspects such as container loading on freight wagons or during the substitution of parts in the framework of vehicle maintenance.)*

2.1.3. **Application of this IRS to Vehicles that were already authorised for operation on the Network before 01.08.2023**

*Note: Gauge calculations for vehicles that were authorised before 01.08.2023 may not have been evaluated against all aspects of this IRS. It is therefore possible that such vehicles do not fully comply with the requirements of this IRS, most notably their Relevant Points may, when re-evaluated against this IRS, actually project into the safety margin around the related Reference Profiles.*

*Furthermore it is known that the historic definition of the Irish gauges has originally been based on large historic vehicle designs, but in the 1980s certain reductions have been applied that caused such historic vehicle designs to be no longer fully compatible with the then defined Irish Gauges. This situation is now not correctable without significant investment into the Fixed Installation's .*

Any modification of such a Vehicle's design which can affect the Vehicle Construction Gauge (VCG) shall either maintain the existing Relevant Mechanical Point (RMP)/ Relevant Pantograph Point (RPP)/ Relevant Electric Point (REP) positions or improve them towards better conformity with this IRS.

2.1.4. ***Note relating to vehicles that do not comply with a gauge of this IRS and require a restricted once-off movement on the Network***

*This may include vehicles that require a once-off transfer operation on the Network, and are not (yet) authorised, or are defective, or carry a special out of gauge load. This shall not be applied for (repeated / normal) operation on the network.*

*SRAC: An Infrastructure Manager that permits such once-off- special movements is expected for its network establish a procedure for operation of any Vehicles that do not comply with this IRS for restricted once off movements.*

## 2.2. General Compliance Date

2.2.1. This Irish Railway Standard comes into force and shall be complied with from its Issue Date (see cover sheet).

## 2.3. NR Provisions

2.3.1. The following table identifies all sections of this IRS which are proposed as Irish NR. The rationale is identified in line with section 1.2.

*Table 1 NR Provisions*

| Section | Rationale (as defined in section 1.2) | | Module |
|---|---|---|---|
| sections 4 to 8 of this IRS (in connection with section2) | where a specific case requires the application of technical rules not included in the relevant TSI | iii | for vehicles: (SB + SD) or (SB + SF) or (SH1) |

2.3.2. In each case where a DeBo assessment is required for a NR it shall be performed by a recognised Irish DeBo employing the Modules stated. The assessment Modules are defined in 2010/713/EC (In this regard, the term NoBo (as used in 2010/713/EU) shall be understood to mean DeBo and references to TSIs shall be understood to mean references to Irish NRs). Note, all NRs to be employed as part of an authorisation require DeBo assessment, NRs originating from the TSI OPE do not require DeBo assessment.

# 3. References

| | |
|---|---|
| EN 50119:2020 | Railway applications - Fixed installations - Electric traction overhead contact lines |
| EN 50206-1:2010 | Railway Applications - Rolling Stock - Pantographs: Characteristics and Tests - Part 1: Pantographs for Main Line Vehicles |
| EN 50367:2020/A2:2025 | Railway applications - Fixed installations and rolling stock - Criteria to achieve technical compatibility between pantographs and overhead contact line |
| EN 15273-1:2013+A1:2016 | Railway applications - Gauges - Part 1: General - Common rules for Rolling Stock and Infrastructure |
| EN 15273-2:2013+A1:2016 | Railway applications - Gauges - Part 2: Rolling Stock |
| EN 15273-3:2013+A1:2016 | Railway applications - Gauges - Part 3: Infrastructure |
| EN 15877-1:2012 | Railway applications – Marking on railway vehicles – Part 1: Freight wagons |
| EN 15877-2:2013 | Railway applications – Marking on railway vehicles – Part 2: External Markings on coaches, motive power units, locomotives and on track machines |
| ERA1209/292 | ERA Clarification Note ERA1209/292 V1.1, Conditions for use of the vehicle and other restrictions |
| (EU) 2010/713 | Commission Decision of 9 November 2010 on modules for the procedures for assessment of conformity, suitability for use and EC verification to be used in the technical specifications for interoperability |
| (EU) 2015/1136 | Commission Implementing Regulation (EU) 2015/1136 of 13 July 2015 amending Implementing Regulation (EU) No 402/2013 on the common safety method for risk evaluation and assessment |
| (EU) 2016/797 | DIRECTIVE (EU) 2016/797 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on the interoperability of the rail system within the European Union |
| (EU) 2016/798 | DIRECTIVE (EU) 2016/798 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on railway safety |
| (EU) 402/2013 | Commission Implementing Regulation (EU) No 402/2013 of 30 April 2013 on the common safety method for risk evaluation and assessment and repealing Regulation (EC) No 352/2009. As amended by 2015/1136. |
| IRS-502 | Gauging for Fixed Installations on the Irish 1600mm Rail Network |

| | |
|---|---|
| UIC 505-1 Ed.10 May 2006 | Railway transport stock - Rolling stock construction gauge |
| UIC 505-5 Ed.3 Oct.2010 | History, justification and commentaries on the elaboration and development of UIC leaflets of the series 505 and 506 on gauges |

# 4. Terms and Definitions

All definitions of terms, symbols and formulae apply generally to all Gauges or Local Restrictions UNLESS a specific term, symbol or formula is defined for a specific case (e.g. a specific Local Restriction). In such a case the specific element shall apply instead of the generic element.

## 4.1. Terms

### 4.1.1. AT Points

See section on Reference Profile.

### 4.1.2. Cant Excess [m]

The amount by which the installed cant ($D_{installed}$) is in excess of the equilibrium cant ($D_{equi}$) at a given combination of velocity and curve radius.

*Note: For a stopped vehicle on canted track the cant excess equals the installed cant ($D_{installed}$).*

### 4.1.3. Comparative Gauging

There are vehicles of old designs existing, which may not fully comply with this IRS, and which may have specific operating conditions attached to them. Such vehicles should over time be modified to become compliant or should become phased out. No additional non-complying vehicles shall be entered into operation on the Network.

Comparative gauging (as defined in EN 15273) based on existing vehicle types is therefore not permitted for gauging of new vehicles or for gauging of alterations to existing vehicles on the Network.

### 4.1.4. Condition and Limits of Use

Refer section 2.1 of clarification note ERA1209/292 and to (EU) 2016/797 for detailed information on this topic.

### 4.1.5. Design Team

The Design Team is the team, that prepares the gauging calculations and the related Gauging Report. It shall consist of one or several experts, who are competent to apply all requirements in this IRS.

### 4.1.6. Electric Reference Profile (RP-E)

For each Gauge and for a Nominal Voltage of the Overhead Line an RP-E is defined which shall ensure that Relevant Electric Points (REPs) remain at a safe distance of $PM_{electric}$ from the MG of that Gauge.

### 4.1.7. Fixed Installation

Combination of all elements of the railway Subsystems INF+ENE+CCT.

### 4.1.8. Gauge

A **Gauge** is a combination of the following:

a) **Mechanical & Electric & Pantograph Reference Profiles (RP-M, RP-E, RP-P))** (These are the virtual references for the respective gauging calculations.);

b) **Associated Definitions** (These are predominantly interface definitions between Vehicles and Fixed Installations and include also safety related application conditions for operation and maintenance of Vehicles and Fixed Installations); and,

c) **Associated Calculation Rules** (These are the precise calculation rules to be used with this gauge).

Using the above it is possible to determine the following in association with that Gauge:

I. The Fixed Installation **Mechanical & Electric & Pantograph NOMINAL GAUGES** (**NG-M, NG-E, NG-P**).
   >The NGs shall be applied when a new Fixed Installation element is placed into service.
   >It should also be applied as far as is practicable when a Fixed Installation is returned to service after maintenance or upgrade or renewal.
II. The Fixed Installation **Mechanical & Electric & Pantograph MAINTENANCE GAUGES** (**MG-M, MG-E, MG-P)** .
   >The MGs shall be applied when a Fixed Installation is returned into service after maintenance or upgrade or renewal.
   >It shall not be applied when a new Fixed Installation element is placed into service.
III. The maximum **Mechanical & Electric & Pantograph VEHICLE CONSTRUCTION GAUGES** (**VCG-M, VCG-E, VCG-P).**
   >The VCGs shall be used when a new Vehicle is placed into service and also when a Vehicle is returned to service after substitution in the framework of maintenance or after upgrade or after renewal.

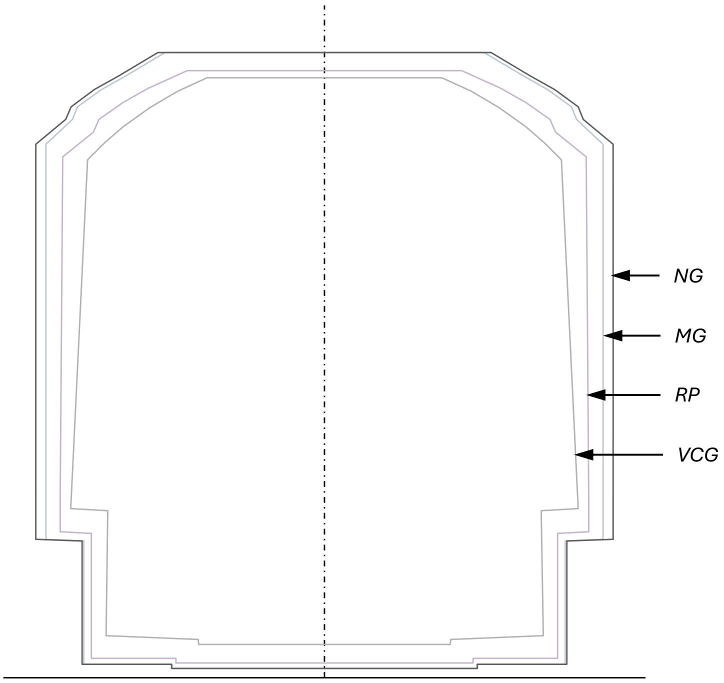



*Figure 1 General concept of a RP and its associated set of VCG, MG, NG*

#### 4.1.9. Global Coordinates

Perpendicular coordinate system based on a theoretical perfect earth surface and a theoretical perfect track centre line.

#### 4.1.10. Guiding Cross-Sections (GCS)

The GCS are those cross sections of the vehicle at which it is guided on the track. This coincides typically:

- with the point of rotation of a bogie.
- with the position of an individual axle mounting.

Figure 1 shows the typical GCSs for the vehicle body gauging (Sections A-A) and the bogie gauging (Sections B-B).

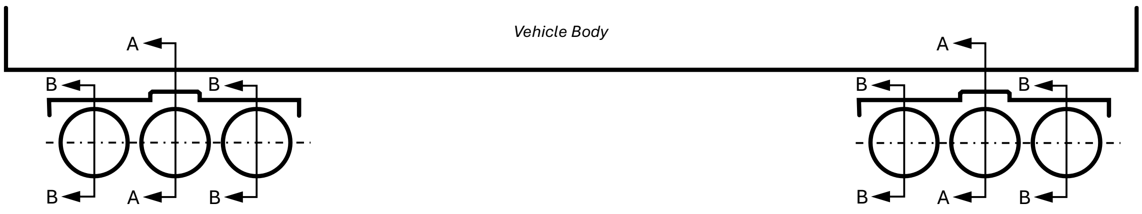



*Figure 2 Guiding Cross Sections*

The point of rotation of a bogie may be a mechanical pin and socket arrangement or it may be a virtual point of rotation.

Often, these cross sections are fixed along the length of a vehicle, but depending on the vehicle design it is possible that their location may vary as a function of R.

*Note: The GCS are often at the outer axles of a vehicle without bogies or, where bogies are present, at the centres of the bogies. Further axles or bogies may exist which do not guide the body.*

4.1.11. **if>0**

The term $(xxx)_{if>0}$ shall mean that the value in the brackets (xxx) shall be set to zero [= 0] if the value becomes negative.

4.1.12. **INNER Point, INNER Relevant Point, INNER RMP, INNER REP, INNER RPP**

INNER Points are all points on a vehicle ON or BETWEEN the GCSs with $n_i$ values between:

**0.000 m =< $n_i$ <= (a/2)**

Not all INNER Points in this area will require gauging calculations. It is sufficient that only INNER Relevant Points are subject to a gauging calculation. Depending on its nature an INNER Relevant Point is either an

> INNER Relevant Mechanical Point (RMP)

> INNER Relevant Electric Point (REP)

> INNER Relevant Pantograph Point (RPP)

*Note: For the avoidance of doubt: Relevant Points ON a GCS require calculation as both: OUTER and INNER Relevant Points.*

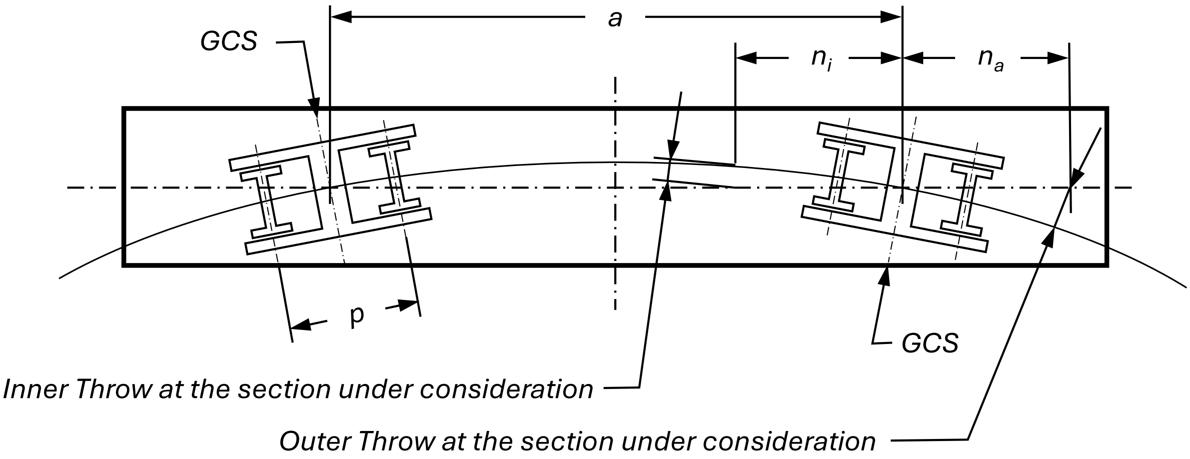



*Figure 3 Curve Overthrow*

4.1.13. **Kinematic Gauge**

All Gauges in this IRS follow the kinematic gauging approach and are therefore Kinematic Gauges.

*Note: This follows the general concept used in the EN 15273 series whereby the Fixed Installations provides an allowance for certain parameters detailed in this standard and any calculated exceedance thereafter shall be borne by the Vehicle (causing a reduction of the Vehicle Construction Gauge).*

4.1.14. **Local Restrictions**

See section 4.1.22.3 on Reference Profile.

4.1.15. **Mechanical Safety Margin around the RP-M**

Each individual RP-M or locally restricted RP-M is surrounded by a Mechanical Safety Margin.

For Fixed Installations the safety margin around the RP is a ‘not to be intruded’ space inside which no part of Fixed Installations is allowed to enter under any operational circumstances, considering all movements, tolerances and maintenance allowances of these Fixed Installations that are included in the fixed installation gauging.

For Vehicles, the safety margin around the RP represents a ‘not to be intruded’ space inside which no part of Vehicles is allowed to enter under any operational circumstances, considering all movements, tolerances and maintenance allowances of these Vehicles that are included in the fixed installation gauging.

The individual dimensions of the Mechanical Safety Margin are case dependent. They depend on whether the NG-M or the MG-M is provided by the Fixed Installations and also on whether there is a direct adjacent track present or not. Direct adjacent track means that the Mechanical Safety Margins of two adjacent tracks are directly touching each other.

*Note: The exact dimension of the Safety Margins are not relevant for Vehicle Gauging.*

4.1.16. **Network**

The Irish 1600 mm network.

4.1.17. **Normal Coordinates**

Perpendicular coordinate system based on a perfect theoretical top of rail and a perfect theoretical track centre line.

*Note: Where no cant is present, Global Coordinates and Normal Coordinates become identical.*

Normal coordinates for points on a vehicle shall be based on that vehicle in perfectly vertical and centred position on the track.

4.1.18. **OUTER Point, OUTER Relevant Point, OUTER RMP, OUTER REP, OUTER RPP**

OUTER Points are points on a vehicle ON or OUTSIDE the GCSs with $n_a$ values of $n_a$ >= 0.000 m.

Not all OUTER Points in these areas will require gauging calculations. It is sufficient that only OUTER Relevant Points are subject to a gauging calculation.

Depending on its nature an OUTER Relevant Point is either an

> OUTER Relevant Mechanical Point (RMP)

> OUTER Relevant Electric Point (REP)

> OUTER Relevant Pantograph Point (RPP)

*Note: For the avoidance of doubt: Relevant Points ON a GCS require calculation as both: OUTER and INNER Relevant Points.*

4.1.19. **PT Points**

See section 4.1.22.2 on Reference Profile.

*Note: This follows the general concept used in the EN 15273 series and UIC 505 series.*

4.1.20. **Pantograph dimensional Outline for 1.5kV**

The following maximum limit dimensions apply under any condition of use or state of maintenance to pantograph heads (including the contact strip) that are intended for use on the Network. Any Pantograph head for 1.5kV DC shall remain within this dimensional outline.

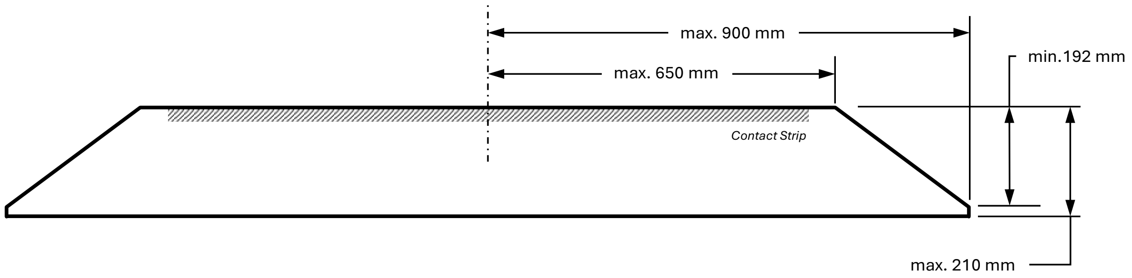



Figure 4 Pantograph Dimensional outline for gauging

*Note: These conditions relate to pantograph gauging. Additional dimensional conditions (e.g. for the contact strip) will apply from other sources and for other reasons.*

4.1.21. **Pantograph dimensional Outline for 25kV**

The following maximum limit dimensions apply under any condition of use or state of maintenance to pantograph heads (including the contact strip) that are intended for use on the Network. Any Pantograph head for 25kV AC shall remain within this dimensional outline.

>>>To be defined in a future issue of this IRS.

*Note: These conditions relate to pantograph gauging. Additional dimensional conditions (e.g. for the contact strip) will apply from other sources and for other reasons.*

4.1.22. **Reference Profile (RP), RP-M, RP-E, RP-P**

For each Gauge one basic

- **Mechanical Reference Profile (RP-M)**

is defined. This is a 'virtual' reference for the gauging calculation for the mechanical VCG of Vehicles to its inside and for the NG and MG of Fixed Installations to its outside.

In addition the RP-M may at certain Gauges be accompanied by further RP-Ms for Local Restrictions.

For all Gauges the RP-M is supported by:

- **at least one Electrical Reference Profile (RP-E)**
- **at least one Pantograph Reference Profile (RP-P)**

**4.1.22.1. AT point(s) on the RP**

The point(s) on the RP which are directly neighbouring the RP of an adjacent track are given the additional index 'AT Point'.

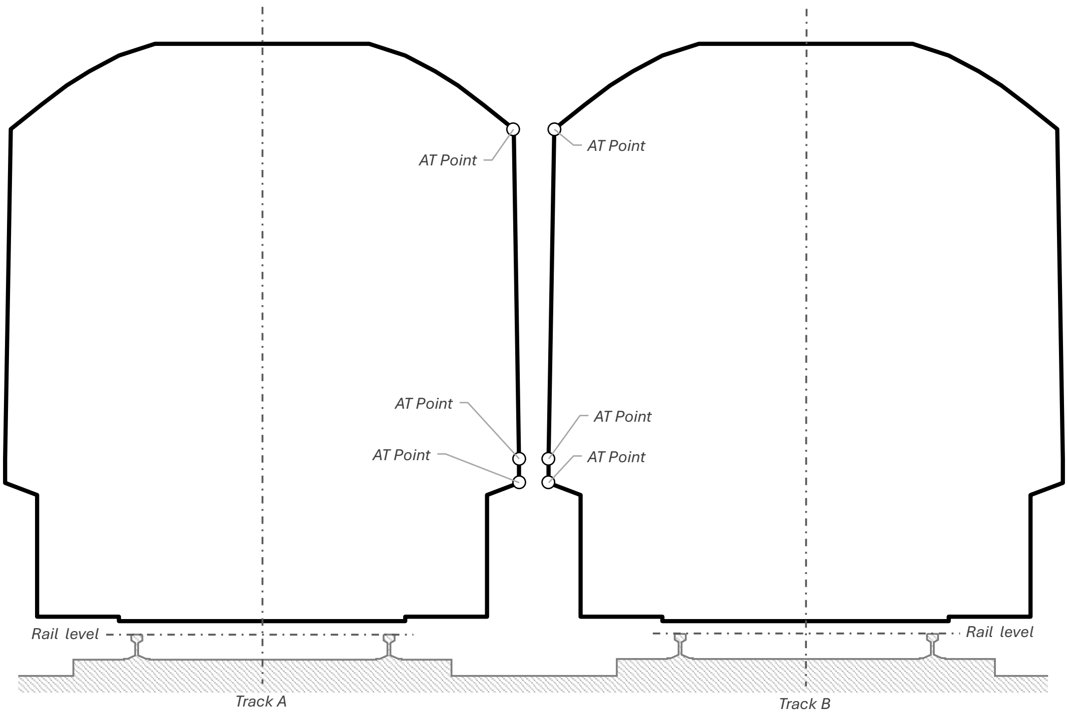



*Figure 5 Reference Profiles with AT Points indicated to present the concept*

*Note: These AT Points are relevant for the determination of the minimum distance between two directly adjacent tracks.*

**4.1.22.2. PT Point(s) on the RP**

The point(s) on the RP which can get relevant upwards shift through vehicle roll are given the additional index 'PT Point'.

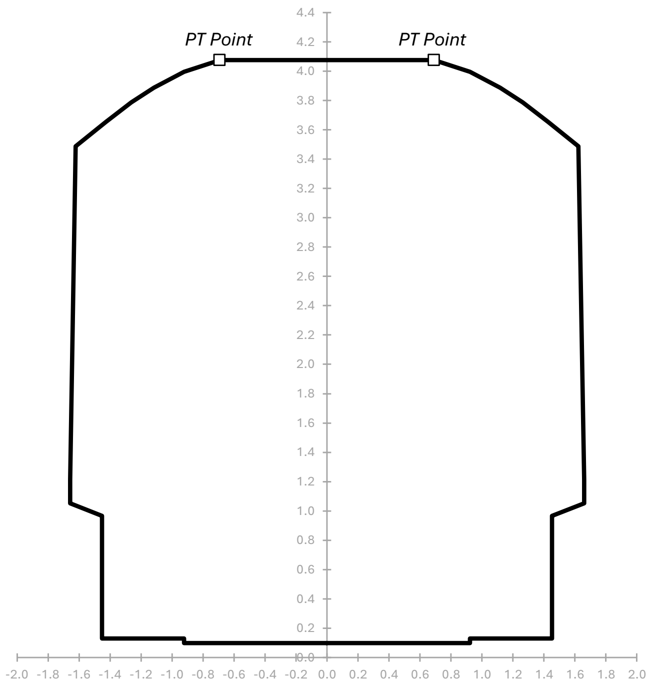



*Figure 6 Reference Profile with PT Points indicated*

*Note: This follows the general concept used in the EN 15273 series.*

Each lateral half of Gauges IRL1, 1D and 1F has one PT point, and each lateral half of Gauge IRL2 has two PT points.

**4.1.22.3. Local Restrictions within a Gauge**

For historic reasons at certain, often central, locations on the Network the basic requirements for the space between two adjacent tracks cannot be fulfilled. As a consequence, the basic RPs of Gauges IRL1, 1D and 1F have additional restricted (i.e. smaller) RPs at these Local Restrictions (LRs).

Again, for historic reasons the basic requirements for vertical track radius cannot be fulfilled at one central location on the existing Network. Also here, as a consequence, the basic RPs of Gauges IRL1, 1D and 1F have additional restricted vertical clearance requirements at this Vertical Local Restriction (vLR).

Based on the above the Gauges IRL1, 1D and 1F require additional gauging calculations to evaluate if a vehicle can operate across all of the associated Local Restrictions or Vertical Local Restrictions.

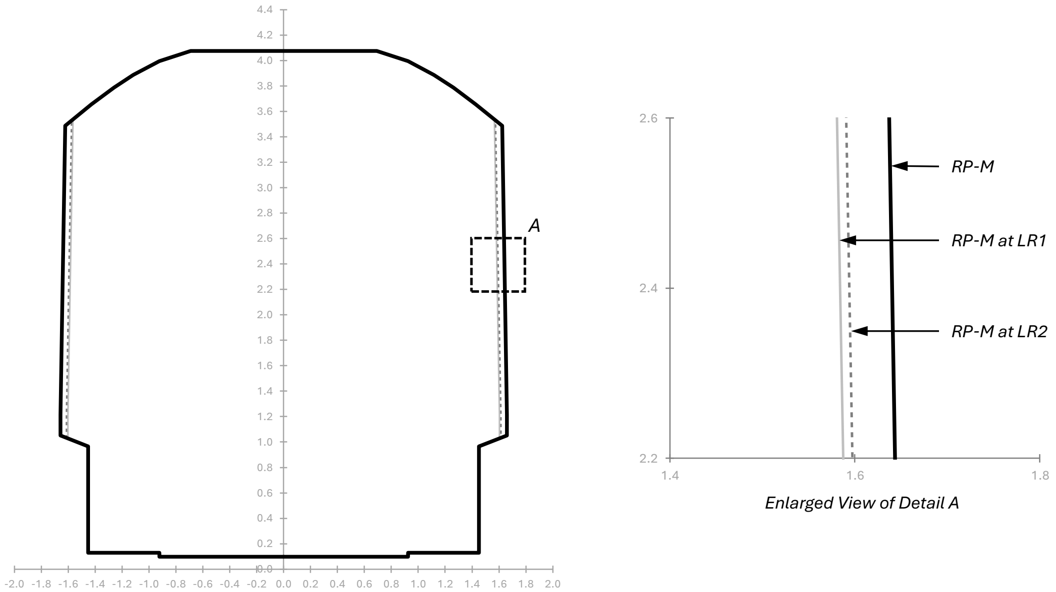



*Figure 7 Indication of the locations of RP-M LR1 and RP-M LR2 versus RP-M*

The Gauge IRL2 has no Local Restrictions or Vertical Local Restrictions.

The Pantograph Gauges for IRL1, IRL1D and IRL2 have no Local Restrictions or Vertical Local Restrictions.

**All LRs and vLRs in detail:**

a) **Local Restriction 1 (LR1)** is present at the track area where the southern extreme of Connolly Station connects with the 'loop line' Liffey Bridge. According to the information obtained from IÉ IM, the complete LR1 area can be represented by the following specific data:

$R_{116\text{-}LR1}$ = 116 m ONLY for gauging of OUTER Relevant Points

$R_{119\text{-}LR1}$ = 119 m ONLY for gauging of INNER Relevant Points

*Note: At the small curve radii present at LR1 it becomes necessary for obtaining correct values to distinguish between the two different radii of the two tracks.*

$D_{max\ R116\text{-}LR1}$ = 0.000 m

$D_{max\ R119\text{-}LR1}$ = 0.000 m

$I_{max\ R116\text{-}LR1}$ = 0.029 m

$I_{max\ R119\text{-}LR1}$ = 0.028 m

This Local Restriction only applies ONLY to RMPs and not to REP or RPPs.

*Note: This Local restriction only affects those Relevant Points whose resulting height $h_{shift}$, after adjusting the nominal height $h_{nom}$ for the relevant upwards or downwards shift $k_{xx}$, falls into the following range:*

***$h_{LR1\ MIN} <= h_{shift} <= h_{LR1\ MAX}$***

*Relevant Points whose $h_{shift}$ falls OUTSIDE of the above range are not affected by this local restriction.*

b) **Local Restriction 2 (LR2)** is present at the track area inside the Phoenix Park tunnel and in the cutting at Sandycove.

*Note: The conditions at Phoenix Park tunnel are also representative for the track area in the cutting at Sandycove (which itself has only slightly less demanding conditions).*

According to the information obtained from IÉ IM, the complete LR2 can be represented by the following specific data:

$R_{280\text{-}LR2}$ = 280 m

*Note: This track radius is representative for the whole Local Restriction.*

Maximum Civil Line Speed = 32 km/h

$D_{max\ R280\text{-}LR2}$ = 0.044 m

$I_{max\ R280\text{-}LR2}$ = 0.000 m

This Local Restriction ONLY applies to RMPs and not to REP or RPPs.

This Local restriction only applies to those Relevant Points whose resulting height $h_{shift}$, after adjusting the nominal height $h_{nom}$ for the relevant upwards or downwards shift $k_{xx}$, falls into the following range:

$\mathbf{h_{LR2\ MIN} <= h_{shift} <= h_{LR2\ MAX}}$

Relevant Points whose $h_{shift}$ falls OUTSIDE of the above range are not affected by this Local Restriction.

c) **Vertical Local Restriction 1 (vLR1)** is present at the track area around the Royal Canal lifting bridge north of Connolly Station. According to the information obtained from IÉ IM, that complete vLR can be represented by the following specific data:

$R_{98\text{-}vLR1}$ = 98 m

*Note: This track radius is representative for the whole vLR.*

Maximum Civil Line Speed = 16 km/h

$D_{max\ R98\text{-}vLR1}$ = 0.010 m

$I_{max\ R98\text{-}vLR1}$ = 0.013 m

$vR_{min\text{-}vLR1}$ = 700 m

This vertical Local Restriction ONLY applies to RMPs and REPs, but not to RPPs.

#### 4.1.23. Relevant Electric Point (REP)

These are the Relevant Points on non-insulated parts of a vehicle, including any stored pantograph (!), which can be under electric tension.

*Note: Such non-insulated parts of a vehicle include e.g. the stored pantograph, connection-lines between pantographs or feeder lines to the main circuit breaker.*

For the avoidance of doubt: It is not permitted to store a pantograph that is under electric tension if it is not within the Electric Reference Profile (RP-E), even if the pantograph in that position is compatible with the Pantograph Reference Profile (RP-P). Any electrically live point on a stored pantograph must be compatible with both: the Electric Reference Profile (RP-E) and the Pantograph Reference Profile (RP-P))!

This definition excludes Relevant Points on the raised pantograph as all Relevant Points on **a raised pantograph** are captured under the requirements for Relevant Pantograph Points (RPPs).

The set of REPs to be included within the gauging calculations shall be all the INNER and OUTER REPs which have the potential to shift statically or dynamically within 0.5 m of the RP-E and which are closer to the RP-E than adjacent points around them.

4.1.24. **Relevant Mechanical Point (RMP)**

These are the Relevant Points on a mechanical part of a vehicle.

The set of RMPs to be included within the gauging calculations shall be all the INNER and OUTER RMPs which have the potential to shift statically or dynamically within 0.5 m of the RP-M and which are closer to the RP-M than adjacent points around them.

*Note for the avoidance of doubt: Any Relevant Points on*

- *a stored pantograph that may be under electric tension*
- *a non-insulated part on a vehicle that may be under electric tension (e.g. the feed into the main circuit braker)*

*shall be treated as an REP.*

4.1.25. **Relevant Pantograph Point (RPP)**

Relevant Pantograph Points shall be defined for the full range of pantograph reach heights between $Ph_{stored}$ and $Ph_{max\ wire}$. Across this range a pantograph shall be considered to have the same electric tension that is in the overhead line.

*Note: For the gauging of a pantograph in the stored position refer additionally to the definition of REPs.*

The following Relevant Pantograph Points RPP1 to RPP5 shall be subject to a gauging calculation. The associated $n_a$ and/ or $n_i$ values shall be derived from the specific pantograph design (considering the $n_a$ and $n_i$ values for the longitudinal dimensions of the pantograph head).

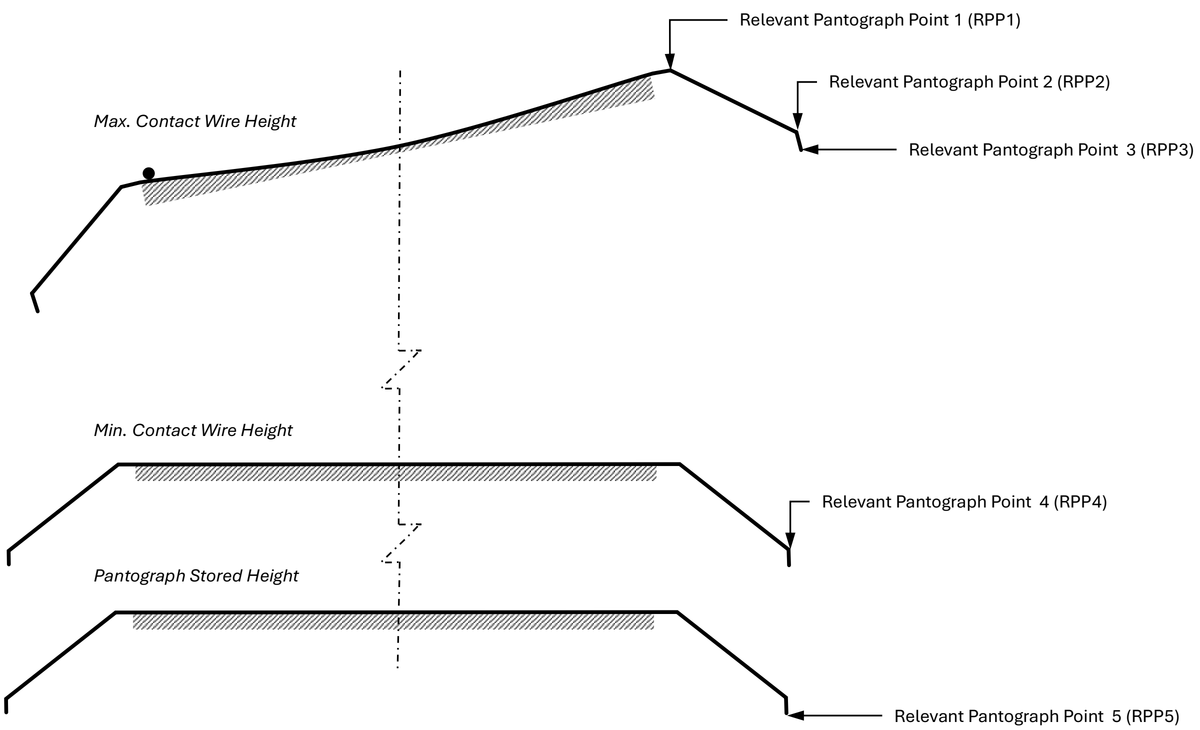



Figure 8 Overview on RPPs to be covered by the gauging calculations

In addition to the five RPP identified above, any other INNER and OUTER RPPs which have the potential to shift statically or dynamically within 0.5 m of the RP-P and which are closer to the RP-P than adjacent points around them shall also become included in the gauging calculations.

4.1.26. **Relevant Point**

Relevant Points are those RMPs, REPs and RPPs which are critical for the gauging of a Vehicle design. At least for these points a gauging calculation shall be performed. The selected set of Relevant Points shall be fully representative for the Vehicle design and no other points shall be more critical in relation to gauging.

4.1.27. **Relevant Radius**

Whenever the gauging calculation formulae contain discontinuities in a function that depends on R, the associated values of R become a Relevant Radius.

Several of such discontinuities are caused by the definitions of the formulae in this IRS, and additional discontinuities can be caused by the specific vehicle design.

The gauging calculations shall be performed for any Relevant Radius.

**SUMMARY of Relevant Radii:**

The straight track (∞ Radius= $R_0$) and the minimum permitted track Radius $R_{80}$ are both a Relevant Radius.

*Note: In the gauging calculations 1/∞ shall be taken as =0.*

The definition of $D_{max\,f(R)}$ [m] (permitted Design Cant for gauging) includes discontinuities and establishes Relevant Radii at (80 m or $R_{min\,vehicle}$), 250.4 m, 2000 m and ∞.

The definition of $I_{max\,f(R)}$ [m] (permitted Cant Deficiency for gauging) includes discontinuities and establishes Relevant Radii at (80 m or $R_{min\,vehicle}$), 2000m and ∞.

The definition of $S_{0xx}$ [m] includes discontinuities and establishes a Relevant Radius at (80 m or $R_{min\,vehicle}$), 150 m and ∞.

Further to the definition of $S_{0xx}$ [m], the definition of $S_{0i}$ includes an additional discontinuity and establishes a Relevant Radius at 900 m (ONLY for INNER Relevant Points) and at 150 m (for INNER and OUTER Relevant Points).

Where the specific vehicle design causes further discontinuities, e.g. in functions $a_{f(R)}$, $w_{a\,f(R)}$, $w_{i\,f(R)}$, etc. any related additional Relevant Radii shall be defined and used during the gauging calculations:

$R_{add1}$

$R_{add2}$

etc.

4.1.28. **Running Surface**

Virtual plane coplanar with the tops of the rails.

4.1.29. **SRAC – Safety Related Application Condition**

Depending on its content a SRAC may

- apply to the installation/modification of equipment
- require to establish/update operating rules,
- require the need to establish/update maintenance rules.

4.1.30. **Subsystem CCO**

This includes all elements of the command control and signalling onboard subsystems as defined by the Interoperability Directive (EU) 2016/797.

4.1.31. **Subsystem CCT**

This includes all elements of the command control and signalling trackside subsystems as defined by the Interoperability Directive (EU) 2016/797.

4.1.32. **Subsystem ENE**

This includes all elements of the energy subsystems as defined by the Interoperability Directive (EU) 2016/797.

4.1.33. **Subsystem INF**

This includes all elements of the infrastructure subsystems as defined by the Interoperability Directive (EU) 2016/797.

4.1.34. **Subsystem RST**

This includes all elements of the rolling stock subsystems as defined by the Interoperability Directive (EU) 2016/797.

4.1.35. **Vehicle**

Combination of all elements of the Subsystems RST+CCO. This includes e.g. locomotives, railcars, coaches, wagons, special vehicles and any on-board signalling and telecommunication equipment.

4.1.36. **Vehicle Construction Gauge (VCG), VCG-M, VCG-E, VCG-P**

Each Gauge has associated Mechanical, Electrical and Pantograph Vehicle Construction Gauges.

The VCG is in all cases the space inside which the Mechanical, Electrical, or Pantograph Relevant Points of an individual vehicle cross section can be built.

As the displacements at each of the individual vehicle cross sections are different, the associated VCGs for the different Vehicle cross sections are likely also different.

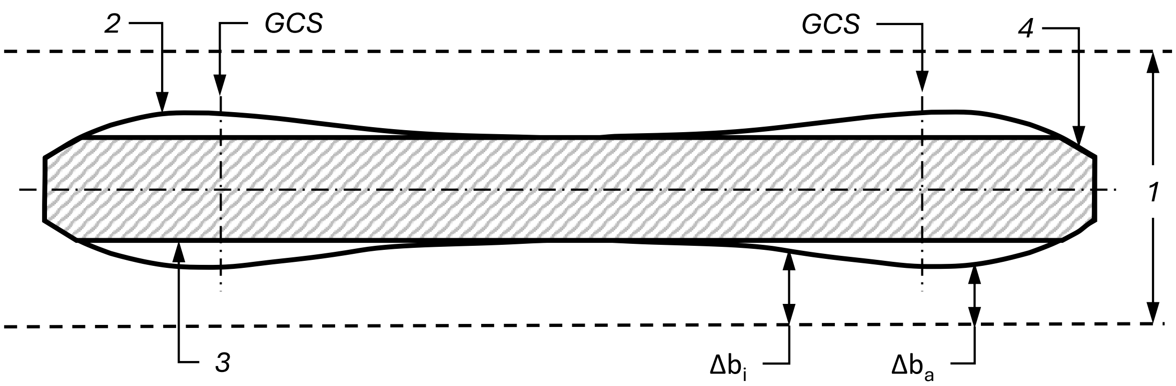



*Figure 9 Typical variation of the VCG width along the length of a vehicle – top view*

Key

1 RP width

2 VCG width

3 Effective Vehicle outline that was selected by the design/maintenance team

4 Tapering at the vehicle ends is a typical solution to make the Vehicle width conform with the VCG

5 $\Delta b_a$ – refer to section 5.215

6 $\Delta b_i$ – refer to section 5.216

4.1.37. **Vehicle Gauging Parameter Set**

This is the set of all parameters which are required for the gauging calculations of an individual Vehicle design. It shall only be used in a gauging calculation, if:

a) The set of parameters for a vehicle design was developed by a member of the design/maintenance team that is competent to apply all the requirements of this IRS.

b) The set of parameters was reviewed and confirmed as complete and as correctly developed by a second person that is organisationally independent from the vehicle design/maintenance team and that is competent to apply all requirements of this IRS.

c) The steps a) and b) shall be repeated until step b) ends with a positive result.

'Organisationally Independent' requires that the second person is not involved in step a) or line managed by the same manager that manages step a). Further the second person shall not be subject to any pressure that could affect its ability to make an independent review and an independent judgement.

4.1.38. **Vertical Local Restriction**

See entry on "Local Restrictions".

# 5. Definitions of Symbols and Formulae [with their related units]

## 5.1. a [m] – Fixed distance between the GCSs

The distance between the GCSs is very often a fixed value and independent of the track radius.

"a" shall be replaced by "$a_{f(R)}$" where the value of "a" is a function of the track radius R.

As example: A variable value of "a" can be present, where articulated Vehicle body connections are part of the vehicle design, and where such connections do not coincide with the GCSs.

Additionally, where the specific vehicle design causes discontinuities in the function of $a_{f(R)}$, all related additional Relevant Radii and all $a_{R\ addx}$ values shall also be defined and used in the gauging calculations:

$a_{R\ add1}$

$a_{R\ add2}$

etc.

*Note: Where "a" is a function of R, it can be expected that the values of $n_a$ and $n_i$ will in turn also become functions of R: $n_{a\ Rxx}$ and $n_{i\ Rxx}$.*

## 5.2. $A_{xx}$ - General symbol for various coefficients of displacement for gauging

*Note: These coefficients are included within the gauging calculations. Depending on the design of Vehicles these coefficients take into account the orientation and position of wheelsets, bogies and Vehicle bodies with respect to the theoretically perfect track centre line.*

*The following tables summarise the various applicable coefficients for general information. The following subsections of this IRS provide further details on the different $A_{xx}$ terms.*

| Coefficients of displacement for gauging of OUTER Relevant Points RMP,REP,RPP | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Track Type | Vehicle Type | Topic to which the coefficient applies | | | | | | |
| | | *Bogie Throw* | *Rail-wheelset interface* | | *Wheelset-bogie or wheelset-body interface* | *Bogie-body interface (where bogies are present)* | | |
| | | $A_{a\ bogie}$ | $A_{a\ track}$ | $A_{a\ track\ (special)}$ | $A_{a\ q}$ | $A_{a\ wR0\ straight}$ | $A_{a\ wi\ curve}$ | $A_{a\ wa\ curve}$ |
| Straight | Any vehicle design | | $(2 * n_a + a) / a$ | | $(2 * n_a + a) / a$ | $(2 * n_a + a) / a$ | | |
| Curved | Any vehicle design | 1 | $(2 * n_a + a) / a$ | | $(2 * n_a + a) / a$ | | $(n_a / a)$ | $(n_a + a) / a$ |
| | with two trailer bogies [(a)] | 1 | | $(n_a + a) / a$ | $(2 * n_a + a) / a$ | | $(n_a / a)$ | $(n_a + a) / a$ |
| [(a)] Application of the $A_{a\ track\ (special)}$ coefficient is not mandatory and may only be selected for vehicle designs that have exactly two non-motorised trailer bogies (=no single axles, no driven bogies or driven axles irrespective of their rated tractive power) | | | | | | | | |

| Coefficients of displacement for gauging of INNER Relevant Points RMP,REP,RPP | | | | | | |
|---|---|---|---|---|---|---|
| Track Type | Vehicle Type | Term to which the coefficient applies | | | | |
| | | *Bogie Throw* | *Rail-wheelset interface* | | *Wheel-bogie interface or wheelset-body interface* | *Bogie-body interface (where bogies are present)* |
| | | $A_{i\ bogie}$ | $A_{i\ track}$ | $A_{i\ track\ (special)}$ | $A_{i\ q}$ | $A_{i\ wi}$ |
| Straight | Any vehicle design | | 1 | | 1 | 1 |
| Curved | Any vehicle design | 1 | 1 | | 1 | 1 |
| | with two trailer bogies [a] | 1 | | 0 | 1 | 1 |
| [a] Application of the $A_{i\ track\ (special)}$ coefficient is not mandatory and may only be selected for vehicle designs that have exactly two non-motorised trailer bogies (=no single axles, no driven bogies or driven axles irrespective of their rated tractive power) | | | | | | |

*Figure 10 Overview Tables of coefficients of displacement*

## 5.3. $A_{a\ xx}$ - General symbol for various coefficients of displacement for gauging of OUTER Relevant Points RMP,REP,RPP

Depending on the design of Vehicles these coefficients take into account the orientation and position of wheelsets, bogies and Vehicle bodies with respect to the theoretically perfect track centre line.

*Note: Unlike the definitions within the EN 15273 series and UIC 505 series of standards, the status of an axle being a driven or undriven axle is not relevant for the calculation rules in this IRS except when the special case $A_{a\ track\ (special)}$ is claimed to be applicable by the vehicle design/maintenance team.*

## 5.4. $A_{a\ bogie}$ - Coefficient of displacement for bogie term

**+ for OUTER Relevant Points RMP,REP,RPP**
**+ only for CURVED track gauging**
**+ for any Vehicle design**

**$A_{a\ bogie} = 1$**

*Notes:*

*In case of no bogie: p will be 0.000 m and thus the term $[p^2 / 4 * A_{a\ bogie}]$ will become 0.000 m.*

*On straight track the term $Dpl_{a\ vehicle}$ disappears (resulting from division by $R = \infty$) and therefore $A_{a\ bogie}$ is not relevant for straight track gauging.*

## 5.5. $A_{a\ q}$ - Coefficient of displacement for q

**+ for OUTER Relevant Points RMP,REP,RPP**
**+ for BOTH CURVED and STRAIGHT track gauging**
**+ for any vehicle design**

**$A_{a\ q} = (2 * n_a + a) / a$**

## 5.6. $A_{a\ track}$ - Coefficient of displacement for track term

**+ for OUTER Relevant Points RMP,REP,RPP**
**+ for BOTH CURVED and STRAIGHT track gauging**
**+ for any Vehicle design (unless $A_{a\ track\ (special)}$ was instead selected for CURVED track gauging)**

**$A_{a\ track}$ = (2 * $n_a$ + a) / a**

## 5.7. $A_{a\ track\ (special)}$ - Special case for coefficient of displacement for track term

**+ for OUTER Relevant Points RMP,REP,RPP**
**+ only for CURVED track gauging**
**+ may only be selected for vehicle designs that have exactly two non-motorised trailer bogies**
**(=no single axles, no driven bogies or driven axles irrespective of their rated tractive power)**

**$A_{a\ track\ (special)}$ = ($n_a$ + a) / a**

*Note: The use of this special coefficient follows an approach that is included in the UIC 505 series and EN 15273 series of standards for the mentioned vehicle design concept.*

*The special coefficient is based on the assumption that with this particular vehicle design the bogie centres typically remain above the track centre line when a vehicle operates on curved track.*

*The application of this special coefficient is not mandatory. Its application may provide benefits to the permitted body width of a vehicle.*

## 5.8. $A_{a\ wa\ curve}$ - Coefficient of displacement for $w_a$

**+ for OUTER Relevant Points RMP,REP,RPP**
**+ only for CURVED track gauging**
**+ for any Vehicle design**

**$A_{a\ wa\ curve}$ = ($n_a$ + a) / a**

*Note: In case of no bogie $w_a$ will be 0.000 m and thus the term [$w_{a\ f(R)}$ * $A_{a\ wa\ curve}$] will also become 0.000 m.*

## 5.9. $A_{a\ wi\ curve}$ - Coefficient of displacement for $w_i$

**+ for OUTER Relevant Points RMP,REP,RPP**
**+ only for CURVED track gauging**
**+ for any Vehicle design**

**$A_{a\ wi\ curve}$ = ($n_a$) / a**

*Note: in case of no bogie $w_i$ will be 0.000 m and thus the term [$w_{i\ f(R)}$ * $A_{a\ wi\ curve}$] will also become 0.000 m.*

## 5.10. $A_{a\ wR0\ straight}$ - Coefficient of displacement for $w_{R0}$

**+ for OUTER Relevant Points RMP,REP,RPP**
**+ only for STRAIGHT track gauging**
**+ for any Vehicle design**

**$A_{a\ wR0\ straight}$ = (2 * $n_a$ + a) / a**

*Note: in case of no bogie, $w_{R0}$ will be 0.000 m and thus the term [$w_{R0}$ * $A_{a\ wR0\ straight}$] will also become 0.000 m.*

## 5.11. $A_{i\ xx}$ - General symbol for various coefficients of displacement for gauging of INNER Relevant Points RMP,REP,RPP

Depending on the design of Vehicles these coefficients take into account the orientation and position of wheelsets, bogies and vehicle bodies with respect to the theoretically perfect track centre line.

*Note: Unlike the definitions within the EN 15273 series and UIC 505 series of standards, the status of an axle being a driven or undriven axle is not relevant for the calculation rules in this IRS except when the special case $A_{i\ track\ (special)}$ is claimed to be applicable by the vehicle design/maintenance team.*

## 5.12. $A_{i\ bogie}$ - Coefficient of displacement for bogie term

**+ for INNER Relevant Points RMP,REP,RPP**
**+ only for CURVED track gauging**
**+ for any Vehicle design**

**$A_{i\ bogie}$ = 1**

*Note: in case of no bogie p will be 0.00 m and thus the term [$p^2 / 4*A_{i\ bogie}$] will become 0.000 m.*

*On straight track the term $Dpl_i$ disappears (resulting from division by R = ∞) and therefore $A_{i\ bogie}$ is not relevant for straight track gauging.*

## 5.13. $A_{i\ q}$ - Coefficient of displacement for q

**+ for INNER Relevant Points RMP,REP,RPP**
**+ for BOTH CURVED and STRAIGHT track gauging**
**+ for any Vehicle design**

**$A_{i\ q}$ = 1**

## 5.14. $A_{i\ track}$ - Coefficient of displacement for track term

**+ for INNER Relevant Points RMP,REP,RPP**
**+ for BOTH CURVED and STRAIGHT track gauging**
**+ for any vehicle design (unless $A_{i\ track\ (special)}$ was instead selected for CURVED track gauging)**

**$A_{i\ track}$** = 1

## 5.15. $A_{i\ track\ (special)}$ - Special case for coefficient of displacement for track term

**+ for INNER Relevant Points RMP,REP,RPP**
**+ only for CURVED track gauging**
**+ may only be selected for <u>Vehicle designs that have exactly two non-motorised trailer bogies</u>**
**(=no single axles, no driven bogies or driven axles irrespective of their rated tractive power, etc.)**

**$A_{i\ track\ (special)}$ = 0**

*Note: The use of this special coefficient follows an approach that is included in the UIC 505 series and EN 15273 series of standards for the mentioned vehicle design concept.*

*The special coefficient is based on the assumption that with this particular vehicle design the bogie centres typically remain above the track centre line when a vehicle operates on curved track.*

*The application of this special coefficient is not mandatory. Its application may provide benefits to the permitted body width of a vehicle.*

## 5.16. $A_{i\ wi}$ - Coefficient of displacement for $w_i$

**+ for INNER Relevant Points RMP,REP,RPP**
**+ for BOTH CURVED and STRAIGHT track gauging**
**+ for any Vehicle design**

**$A_{i\ wi}$ = 1**

*Note: in case of no bogie $w_i$ will be 0.000 m and thus the term [$w_i * A_{i\ wi}$] will also become 0.000 m.*

## 5.17. $b_1$ [m] – 1/2 width between primary suspensions in Normal Coordinates

## 5.18. $b_2$ [m] – 1/2 width between secondary suspensions in Normal Coordinates

Use the primary suspension value ($b_1$) where no secondary suspension is present.

## 5.19. $b_G$ [m] – 1/2 width between side bearers in Normal Coordinates

Set this to same value as ($b_2$) if no side bearers are present.

## 5.20. $b_{nom}$ [m] – Nominal lateral distance of a Relevant Point RMP, REP to the vehicle centreline in Normal Coordinates

EXCEPT for RPPs, any critical lateral offset of a Relevant Point RMP, REP that may be caused by build tolerances vs. the theoretically perfect position of the same point shall be included in $b_{nom}$.

*Note: A value of $b_{nom}$= 1.345m +/-10 mm build tolerance will require that $b_{nom}$ shall be taken as at least 1.355m.*

*This requirement does not apply to Relevant Pantograph Points RPP, as there this tolerance is considered by other means.*

## 5.21. $b_{RP}$ [m] – 1/2 width of a point on RP-M, RP-E, RP-P in Normal Coordinates, EXCEPT for LR1 / LR2

## 5.22. $b_{RP\text{-}LR1}$ [m] – ONLY for LR1: 1/2 width of a point on RP-M in Normal Coordinates

## 5.23. $b_{RP\text{-}LR2}$ [m] – ONLY for LR2: 1/2 width of a point on RP-M in Normal Coordinates

## 5.24. $d_{min}$ [m]- Minimum permitted outer face to face distance of the flanges of a wheelset

This is the minimum permitted distance between the outer faces of the flanges (= fully worn wheels/ flanges). It is to be measured at 10mm below the wheel-rail contact circles of the wheelset.

*Note: In the TSIs this value may alternatively be called $S_r$.*

According to the current TSI L&P and TSI WAG the theoretical permitted range for the Network is
1.573 m <= $d_{min}$ =< 1.592 m.

*Note: In most cases of Vehicle design $d_{min}$ = 1.573 m is used, as this provides the maximum tolerance for vehicle maintenance.*

*For individual vehicle designs, a higher value than 1.573 m may be selected within the permitted interval. This would reduce the horizontal sway of the vehicle and may thus enable a wider Vehicle body. But this will in turn very likely cause higher wheelset maintenance costs for that Vehicle design.*

5.24.1. SRAC: A value $d_{min}$>1.573 m from the permitted range may only be used, if a Safety Related Application Condition is defined within the maintenance manual of the Vehicle to ensure that this $d_{min}$ value will be maintained under all operating conditions (as otherwise the compatibility with the selected Gauge may be lost).

## 5.25. $D_{xx}$ – General symbol for Cant

The difference in height of the tops of the two rails of a track in Global Coordinates.

## 5.26. $D_{equi}$ [m] - Equilibrium Cant

The theoretical cant for which the centrifugal acceleration in a curve of radius R is balanced by the gravitational acceleration (g) so that the resulting acceleration on the vehicle body (and any passengers within) becomes perpendicular to the plane of rails at a given velocity (v).

$$D_{equi} [m] = v^2 [m^2/s^2] / R [m] * L [m] / g [m/s^2]$$

*Note: For the Network the above formula can be alternatively expressed as:*

$$D_{equi}[mm] = 13.116 * v^2[km/h]^2 / R[m]$$

## 5.27. $D_{installed}$ –Installed Cant

The actually installed cant at a point on the Network.

$D_{installed}$ shall always follow the rule: **$D_{installed}$ =< $D_{max\ f(R)}$**.

## 5.28. $D_{max\ f(R)}$ [m]– maximum permitted Design Cant

*Note: It is normal practice that the Design Cant is less than the Equilibrium Cant.*

The maximum permitted Design Cant for IRL1, 1D, 1F and 2 Gauges is a function of R and must therefore be determined separately for each individual Relevant Radius.

WITH THE EXCEPTION of the Local Restrictions and Vertical Local Restrictions $D_{max\ f(R)}$ shall be:

a) for the interval 80 m <= R < 250.4 m:

**$D_{max\ f(R)}$ = (R – 50 m) * 1.235 m / 1500 m**

*Note: This linear function is based on the historic definition in the internal standard CCE-TMS-340 of IÉ-IM for maximum design cant in small radius curves.*

b) for the interval 250.4 m =< R <= 2000 m:

**$D_{max\ f(R)}$ = 0.165 m**

*Note: This term is based on the historic definition in the internal standard CCE-TMS-340 of IÉ-IM for maximum design cant in curves within the stated radius range.*

*The current TSI INF defines a higher value, but this TSI INF value may not be used for the IRL1, 1D, 1F and 2 Gauges.*

*It may become applicable for future Gauges that are not yet defined within this IRS.*

c) for the interval 2000 m < R <= ∞:

**$D_{max\ f(R)}$ =0.165 m*2000 m/R**

*Note: Between the curve radius $R_{2000}$=2000 m and $R_0$ = ∞ = straight track the cant shall be gradually reduced from 0.165 m to 0.000 m. This reciprocal function has been established following a survey by IÉ-IM on the current (in 2024) installed Cant values in the Network.*

The following $D_{max\ f(R)}$ values relate to the Relevant Radii defined in this IRS:

$D_{max\ R0}$ (for $R_0$ straight track) = 0.000 m

$D_{max\ R2000}$ (for $R_{2000}$) = 0.165 m

$D_{max\ R900}$ (for $R_{900}$) = 0.165 m (this value is only relevant for gauging of OUTER Points)

$D_{max\ R250.4}$ (for $R_{250.4}$) = 0.165 m

$D_{max\ R150}$ (for $R_{150}$) = 0.082 m

$D_{max\ R80}$ (for $R_{80}$) = 0.025 m

At the Local Restrictions and Vertical Local Restriction the individual $D_{max\ f(R)}$ values are:

*Note: These values where provided by IÉ-IM after a survey (2024) and are representative for a complete individual (vertical) Local Restriction.*

$D_{max\ R116\text{-}LR1}$ (for $R_{116\text{-}LR1}$) = 0.000 m (this value is only relevant at LR1)

$D_{max\ R119\text{-}LR1}$ (for $R_{119\text{-}LR1}$) = 0.000 m (this value is only relevant at LR1)

$D_{max\ R280\text{-}LR2}$ (for $R_{280\text{-}LR2}$) =0.044m (this value is only relevant at LR2)

$D_{max\ R98\text{-}vLR1}$ (for $R_{98\text{-}vLR1}$) = 0.010m (this value is only relevant at vLR1)

If a specific vehicle design causes additional Relevant Radii, the related values must also be defined:

$D_{max\ Radd1}$

$D_{max\ Radd2}$

etc.

## 5.29. $Dpl_{a\ curve}$ [m] – Lateral displacement of OUTER Relevant Points RMP, REP for CURVED track gauging

a) EXCEPT for LR1/LR2/vLR1:
$Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track} * (A_{a\ track} \text{ or } A_{a\ track\ (special)}) + q * A_{a\ q} + w_{a\ f(R)} * A_{a\ wa\ curve} + w_{i\ f(R)} * A_{a\ wi\ curve} + z_a$

b) ONLY for LR1:
$Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track\text{-}LR1} * (A_{a\ track} \text{ or } A_{a\ track\ (special)}) + q * A_{a\ q} + w_{a\ f(R)} * A_{a\ wa\ curve} + w_{i\ f(R)} * A_{a\ wi\ curve} + z_a$

c) ONLY for LR2:
$Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track\ \text{-}LR2} * (A_{a\ track} \text{ or } A_{a\ track\ (special)}) + q * A_{a\ q} + w_{a\ f(R)} * A_{a\ wa\ curve} + w_{i\ f(R)} * A_{a\ wi\ curve} + z_a$

d) ONLY for vLR1:
$Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track\text{-}vLR1} * (A_{a\ track} \text{ or } A_{a\ track\ (special)}) + q * A_{a\ q} + w_{a\ f(R)} * A_{a\ wa\ curve} + w_{i\ f(R)} * A_{a\ wi\ curve} + z_a$

## 5.30. $Dpl_{a\ straight}$ [m] – Lateral displacement of OUTER Relevant Points RMP, REP for STRAIGHT track gauging

$Dpl_{a\ straight} = Dpl_{a\ track} * A_{a\ track} + q * A_{a\ q} + w_{R0} * A_{a\ wR0\ straight} + z_a$

## 5.31. $Dpl_{a\ track}$ [m] – Track related lateral displacement of OUTER Relevant Points RMP, REP for CURVED track gauging – EXCEPT for the gauging of the Local Restrictions and Vertical Local Restrictions

$Dpl_{a\ track} = (\ell_{max} – d_{min}) / 2$

## 5.32. $Dpl_{a\ track\text{-}LR1}$ [m] – SPECIFIC for LR1: Track related lateral displacement of OUTER Relevant Points RMP for CURVED track gauging

$Dpl_{a\ track\text{-}LR1} = (\ell_{max\text{-}LR1} – d_{min}) / 2$

## 5.33. $Dpl_{a\ track\text{-}LR2}$ [m] – SPECIFIC for LR2: Track related lateral displacement of OUTER Relevant Points RMP for CURVED track gauging

$Dpl_{a\ track\text{-}LR2} = (\ell_{max\text{-}LR2} – d_{min}) / 2$

## 5.34. $Dpl_{a\ track\text{-}vLR1}$ [m] – SPECIFIC for vLR1: Track related lateral displacement of OUTER Relevant Points RMP, REP for CURVED track gauging

$Dpl_{a\ track\text{-}vLR1} = (\ell_{max\text{-}vLR1} – d_{min}) / 2$

### 5.35. $Dpl_{a\ vehicle}$ [m] – Vehicle related lateral displacement of OUTER Relevant Points RMP, REP, RPP for CURVED track gauging

$Dpl_{a\ vehicle} = (a * n_a + n_a^2 – (A_{a\ bogie} * p^2) / 4) / (2R)$

*Note: Background information on the development of this formula can be found in Section 8.2 of UIC 505-5 (2010). This term is sometimes referred to as "lateral end throw".*

### 5.36. $Dpl_{i\ curve}$ [m] – Lateral displacement of INNER Relevant Points RMP, REP for CURVED track gauging

a) EXCEPT for LR1/LR2/vLR1:
$Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track} * (A_{i\ track}$ or $A_{i\ track\ (special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$

b) ONLY for LR1:
$Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track\text{-}LR1} * (A_{i\ track}$ or $A_{i\ track\ (special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$

c) ONLY for LR2:
$Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track\text{-}LR2} * (A_{i\ track}$ or $A_{i\ track\ (special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$

d) ONLY for vLR1:
$Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track\text{-}vLR1} * (A_{i\ track}$ or $A_{i\ track\ (special)}) +q * A_{i\ q} +w_{i\ f(R)} * A_{i\ wi} + z_i$

### 5.37. $Dpl_{i\ straight}$ [m] – Lateral displacement of INNER Relevant Points RMP, REP for STRAIGHT track gauging

$Dpl_{i\ straight} = Dpl_{i\ track} * A_{i\ track} + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$

### 5.38. $Dpl_{i\ track}$ [m] – Track related lateral displacement of INNER Relevant Points RMP, REP for CURVED track gauging – EXCEPT for the gauging of the (Vertical) Local Restrictions

$Dpl_{i\ track} = (\ell_{max} – d_{min}) / 2$

### 5.39. $Dpl_{i\ track\text{-}LR1}$ [m] – SPECIFIC for LR1: Track related lateral displacement of INNER Relevant Points RMP for CURVED track gauging

$Dpl_{i\ track\text{-}LR1} = (\ell_{max\text{-}LR1} – d_{min}) / 2$

### 5.40. $Dpl_{i\ track\text{-}LR2}$ [m] – Specific for LR2: Track related lateral displacement of INNER Relevant Points RMP for CURVED track gauging

$Dpl_{i\ track\text{-}LR2} = (\ell_{max\text{-}LR2} – d_{min}) / 2$

### 5.41. $Dpl_{i\ track\text{-}vLR1}$ [m] – Specific for vLR1: Track related lateral displacement of INNER Relevant Points RMP, REP for CURVED track gauging

$Dpl_{i\ track\text{-}vLR1} =(\ell_{max\text{-}vLR1} – d_{min}) / 2$

### 5.42. $Dpl_{i\ vehicle}$ [m] – Vehicle related lateral displacement of INNER Relevant Points RMP, REP, RPP for CURVED track gauging

$Dpl_{i\ vehicle} = (a * n_i – n_i^2 + (A_{i\ bogie} * p^2) / 4) / (2R)$

*Note: Background information on the development of this formula can be found in Section 8.2 of UIC 505-5 (2010). This term is sometimes referred to as "lateral inner throw".*

### 5.43. g [m/s²] – Gravitational acceleration constant

$g = 9.80665\ m/s^2$

## 5.44. $h_c$ [m] – Height of roll centre of this vehicle design in Normal Coordinates

This value shall be measured according to EN 14363 or calculated (where such a calculation is permitted).

*Note: Some legal requirements for vehicle design or authorisation for placing on the market may not permit the option to calculate this value.*

$h_c$ may be dependent on load and suspension conditions of the vehicle (Example: For a vehicle with air suspension different $h_c$ values may apply to operation with inflated and deflated air suspension; primary suspended Relevant Points may have a different $h_c$ than secondary suspended points). For each relevant value of $h_c$ a separate gauge calculation shall be performed.

## 5.45. $h_{c0}$ [m] – Height of roll centre of reference vehicle in Normal Coordinates

For IRL1, 1D, 1F and 2 Gauges this is set to 0.500 m.

**$h_{c0}$ = 0.500 m**

## 5.46. $h_{LR1\ MAX}$ [m] – SPECIFIC for LR1: UPPER limit height in Normal Coordinates for gauging calculations at this Local Restriction

The gauging calculations for LR1 shall apply ONLY IF $h_{shift}$ is between $h_{LR1\ MIN}$ and $h_{LR1\ MAX}$.

Where it applies, this value is provided together with the Reference Profile of a Gauge.

## 5.47. $h_{LR1\ MIN}$ [m] – SPECIFIC for LR1: LOWER limit height in Normal Coordinates for gauging calculations at this Local Restriction

The gauging calculations for LR1 shall apply ONLY IF $h_{shift}$ is between $h_{LR1\ MIN}$ and $h_{LR1\ MAX}$.

Where it applies, this value is provided together with the Reference Profile of a Gauge.

## 5.48. $h_{LR2\ MAX}$ [m] – SPECIFIC for LR2: UPPER limit height in Normal Coordinates for gauging calculations at this Local Restriction

The gauging calculations for LR2 shall apply ONLY IF $h_{shift}$ is between $h_{LR2\ MIN}$ and $h_{LR2\ MAX}$.

Where it applies, this value is provided together with the Reference Profile of a Gauge.

## 5.49. $h_{LR2\ MIN}$ [m] – SPECIFIC for LR2: LOWER limit height in Normal Coordinates for gauging calculations at this Local Restriction

The gauging calculations for LR2 shall apply ONLY IF $h_{shift}$ is between $h_{LR2\ MIN}$ and $h_{LR2\ MAX}$.

Where it applies, this value is provided together with the Reference Profile of a Gauge.

## 5.50. $h_{nom}$ [m] – Nominal height of a Relevant Point in Normal Coordinates

Any vertical tolerance of a Relevant Point caused by build tolerances vs. the theoretical perfect position of the same point shall be included in the value of $h_{nom}$.

The most relevant height shall be taken.

*Note: This is for Relevant Points close to the upper section of a Reference Gauge often the upper tolerance and for Relevant Points close to the lower section of a Reference Gauge often the lower tolerance.*

*A Relevant Point with a design height of 3.100m +0.010m/-0.000m build tolerance shall have a $h_{nom}$ = 3.110 m. Another Relevant Point with a design height of 0.500m +0.005m/-0.005m build tolerance shall have a $h_{nom}$ = 0.495 m.*

If in doubt both values upper and lower values shall be used and two Relevant Points shall be determined.

*Note: This may be necessary for Relevant Points in the middle section of a Reference Gauge. A point on th e Vehicle outline at 1.100 m +0.010m/-0.010m may thus be required to become two Relevant Points an $h_{nom}$ = 1.110 m and $h_{nom}$ = 1.090 m.*

### 5.51. $h_{RP}$ [m] –Height of a Point on a reference profile RP-M, RP-E, RP-P in Normal Coordinates, EXCEPT for LR1 / LR2

### 5.52. $h_{RP-LR1}$ [m] – ONLY for LR1: Height of a Point on a reference profile RP-M, RP-E, RP-P in Normal Coordinates

### 5.53. $h_{RP-LR2}$ [m] – ONLY for LR2: Height of a Point on a reference profile RP-M, RP-E, RP-P in Normal Coordinates

### 5.54. $h_{S0i\ reduction\ MIN}$ [m] – ONLY for IRL1 / 1D / 1F: LOWER limit height for the application of $S_{0i\ reduction}$ in Normal Coordinates, EXCEPT for LR1 and LR2

Where it applies, this value is provided together with the Reference Profile of a Gauge.

*Note: For the avoidance of doubt: This value does also apply when gauging for vLR1.*

### 5.55. $h_{S0i\ reduction\ MAX}$ [m] – ONLY for IRL1 / 1D / 1F: UPPER limit height for the application of $S_{0i\ reduction}$ in Normal Coordinates, EXCEPT for LR1 and LR2

Where it applies, this value is provided together with the Reference Profile of a Gauge.

*Note: For the avoidance of doubt: This value does also apply when gauging for vLR1.*

### 5.56. $h_{S0i\ LR1\ reduction\ MAX}$ [m] – UPPER limit height for the application of $S_{0i\ reduction}$ in Normal Coordinates, ONLY for gauging at the lateral Local Restriction LR1

Where it applies, this value is provided together with the Reference Profile of a Gauge.

### 5.57. $h_{S0i\ LR1\ reduction\ MIN}$ [m] – LOWER limit height for the application of $S_{0i\ reduction}$ in Normal Coordinates, ONLY for gauging at the lateral Local Restriction LR1

Where it applies, this value is provided together with the Reference Profile of a Gauge.

### 5.58. $h_{S0i\ LR2\ reduction\ MAX}$ [m] – UPPER limit height for the application of $S_{0i\ reduction}$ in Normal Coordinates, ONLY for gauging at the lateral Local Restriction LR2

Where it applies, this value is provided together with the Reference Profile of a Gauge.

### 5.59. $h_{S0i\ LR2\ reduction\ MIN}$ [m] – LOWER limit height for the application of $S_{0i\ reduction}$ in Normal Coordinates, ONLY for gauging at the lateral Local Restriction LR2

Where it applies, this value is provided together with the Reference Profile of a Gauge.

## 5.60. $h_{shift}$ [m] – EXCEPT for vLR1: Resulting height of a Relevant Point RMP, REP in Normal Coordinates, after adjusting its nominal height $h_{nom}$ for the relevant upwards or downwards shift elements $k_{xx}$

*Notes:*

*The distinction between $h_{shift}$ OR $h_{shift\text{-}vLR1}$ is required due to the different vertical radius $vR_{700}$ that applies only at vLR1 ($vR_{1000}$ applies to all other gauging calculations).*

*The definitions of $h_{shift}$ do not apply to RPPs, as the resulting height is for these determined in a different way.*

$h_{shift}$ shall be individually determined for each set of gauging calculations according to the following definitions. Within each set $h_{shift}$ shall apply EXCEPT for vLR1.

a) For **Set1, Set7** of the gauging calculations for the **INNER Relevant Points in their UPWARDS shifted positions** the following shall apply EXCEPT for vLR1:
$h_{shift} = h_{nom} + k_{U1i} + k_{U2}$

b) For **Set2, Set8** of the gauging calculations for the **INNER Relevant Points in their DOWNWARDS shifted positions** the following shall apply EXCEPT for vLR1:
$h_{shift} = h_{nom} - k_{L1i} - k_{L2} - k_{L3} - k_{L4} - k_{L5}$

c) For **Set3, Set9** of the gauging calculations for **OUTER Relevant Points in their UPWARDS shifted positions** EXCEPT for vLR1:
$h_{shift} = h_{nom} + k_{U1a} + k_{U2}$

d) For **Set4, Set10** of the gauging calculations for the **OUTER Relevant Points in their DOWNWARDS shifted positions** EXCEPT for vLR1:
$h_{shift} = h_{nom} - k_{L1a} - k_{L2} - k_{L3} - k_{L4} - k_{L5}$

## 5.61. $h_{shift\text{-}vLR1}$ [m] – ONLY for vLR1: Resulting height of a Relevant Point RMP, REP in Normal Coordinates, after adjusting its nominal height $h_{nom}$ for the relevant upwards or downwards shift elements $k_{xx}$

*Notes:*

*The distinction between $h_{shift}$ OR $h_{shift\text{-}vLR1}$ is required due to the different vertical radius $vR_{700}$ that applies only at vLR1 ($vR_{1000}$ applies to all other gauging calculations).*

*The definitions of $h_{shift\text{-}vLR1}$ do not apply to RPPs, as the resulting height is for these determined in a different way.*

$h_{shift}$ shall be individually determined for each set of gauging calculations according to the following definitions. Within each set $h_{shift\text{-}vLR1}$ shall apply ONLY for vLR1.

The below mentioned sets of the gauging calculations - Set1 to Set10 - are defined in sections 7.2.9 to 7.2.20 of this IRS.

a. For **Set1, Set7** of the gauging calculations for the **INNER Relevant Points in their UPWARDS shifted positions** the following shall apply ONLY for vLR1:
$h_{shift\text{-}vLR1} = h_{nom} + k_{U1i\text{-}vLR1} + k_{U2}$

b. For **Set2, Set8** of the gauging calculations for the **INNER Relevant Points in their DOWNWARDS shifted positions** the following shall apply ONLY for vLR1:
$h_{shift\text{-}vLR1} = h_{nom} - k_{L1i\text{-}vLR1} - k_{L2} - k_{L3} - k_{L4} - k_{L5}$

c. For **Set3, Set9** of the gauging calculations for **OUTER Relevant Points in their UPWARDS shifted positions** ONLY for vLR1:
$h_{shift\text{-}vLR1} = h_{nom} + k_{U1a\text{-}vLR1} + k_{U2}$

d. For **Set4, Set10** of the gauging calculations for the **OUTER Relevant Points in their DOWNWARDS shifted positions** ONLY for vLR1:
$\mathbf{h_{shift\text{-}vLR1} = h_{nom} - k_{L1a\text{-}vLR1} - k_{L2} - k_{L3} - k_{L4} - k_{L5}}$

## 5.62. $I_{xx}$ [m] – General symbol for Cant Deficiency

The amount of cant by which the installed cant $D_{installed}$ would have to be increased in order to provide equilibrium cant for a point on the track with its given combination of line speed and horizontal curve radius.

$\mathbf{I = D_{equi} - D_{installed}}$

## 5.63. $I_{max\ f(R)}$ [m] – Maximum Permitted Cant Deficiency

The maximum permitted cant deficiency for IRL1, 1D, 1F and 2 Gauges is a function of R.

With the EXCEPTION of the Local Restrictions and the Vertical Local Restrictions, $I_{max\ f(R)}$ shall be:

a) for the interval **80 m <= R <= 2000 m**:

$\mathbf{I_{max\ f(R)} = 0.110m}$

*Note: This term is based on the historic definition in the internal standard CCE-TMS-340 of IÉ-IM for the maximum permitted cant deficiency that can be present in curves with the stated radius range on the Network.*

b) for the interval **2000 m < R <= ∞**:

$\mathbf{I_{max\ f(R)} = 0.110\ m * 2000\ m / R}$

*Note: Between the curve radius $R_{2000}$ = 2000 m and $R_0$ = ∞ = straight track the cant deficiency shall be gradually reduced from 0.110 m to 0.000 m. This reciprocal function has been established after a survey by IÉ-IM of the currently (in 2023) applied cant deficiency values on the Network.*

The following $I_{max}$ values relate to the Relevant Radii defined in this IRS:

$I_{max\ R0}$ (for $R_0$ straight track) = 0.000 m
$I_{max\ R2000}$ (for $R_{2000}$) = 0.110 m
$I_{max\ R900}$ (for $R_{900}$) = 0.110 m (this value is only relevant for gauging of OUTER Points)
$I_{max\ R250.4}$ (for $R_{250.4}$) = 0.110 m
$I_{max\ R150}$ (for $R_{150}$) = 0.110 m
$I_{max\ R80}$ (for $R_{80}$) = 0.110 m

At the (vertical) Local Restrictions the individual $I_{max}$ values are:

*Note: These values where provided by IÉ-IM and are representative for a complete individual Local Restriction or vertical Local Restriction.*

$I_{max\ R116\text{-}LR1}$ (for $R_{116\text{-}LR1}$) = 0.029 m (this value is only relevant at LR1)

$I_{max\ R119\text{-}LR1}$ (for $R_{119\text{-}LR1}$) = 0.028 m (this value is only relevant at LR1)

$I_{max\ R280\text{-}LR2}$ (for $R_{280\text{-}LR2}$) = 0.006 m(this value is only relevant at LR2)

$I_{max\ R98\text{-}vLR1}$ (for $R_{98\text{-}vLR1}$) = 0.034 m (this value is only relevant at vLR1)

If a specific vehicle design causes additional Relevant Radii, the related values must also be defined:

$l_{max\ Radd1}$

$l_{max\ Radd2}$

etc.

## 5.64. J [m] – Maximum side bearer play

Nominal vertical free travel in the side bearers (in the theoretical static and perfectly centred position of the vehicle).

This vehicle design specific value shall include the maximum permitted maintenance tolerance.

If no side bearers are present set this value to **J= 0.000 m**.

## 5.65. $J_0$ [m] – Side bearer play of the Reference Vehicle 1

For IRL1, 1D, 1F and 2 Gauges a value of $J_0 = 0.005$ m has been defined.

**$J_0 = 0.005$ m**

*Note: This value is an element relating to an allowance which is provided by the Fixed Installations.*

*Based on a concept used in the EN 15273 series and in the UIC 505 series of standards, this value is already included within the Fixed Installation allowance for roll of vehicle body that is caused by $\eta_{0r}$.*

## 5.66. $k_{xx}$ – General symbol for the UPPER or LOWER vertical shifts of Relevant Points RMPs, REPs from their nominal height ($h_{nom}$) to a resulting height ($h_{shift}$ OR $h_{shift\text{-}vLR1}$) in Normal Coordinates

Several static or random movements of the vehicle cause a vertical shift of the Relevant Points RMP, REP.

The vertical shift is in some cases the combination of a vertical shift ($vDpl_{xx}$) reduced by an associated allowance ($vS_{0xx}$) (where such an allowance is provided by the Fixed Installation).

The definitions of $k_{xx}$ apply to all gauges and Local Restrictions of this IRS,
EXCEPT $k_{L1x\ vLR1}$ and $k_{U1x\text{-}vLR1}$, which apply exclusively for Local Restriction vLR1 instead of $k_{L1x}$ and $k_{U1x}$.

*Note: This concept of $k_{xx}$ does NOT apply to RPPs.*

## 5.67. $k_{L1xx}$ – General symbol for the LOWER vertical STATIC shift for Relevant Points RMP, REP caused by Fixed Installations

## 5.68. $k_{L1a}$ [m] – LOWER vertical STATIC shift for OUTER Relevant Points RMP, REP caused by Fixed Installations on a DIP with $vR_{min} = vR_{1000}$, EXCEPT for vLR1 gauging

$k_{L1a} = (vDpl_{a1000} - vS_{0a\ geometric1000})_{if>0}$

## 5.69. $k_{L1a\text{-}vLR1}$ [m] – ONLY for vLR1 gauging: LOWER vertical STATIC shift for OUTER Relevant Points RMP, REP caused by Fixed Installations on a DIP with $vR_{min\text{-}vLR1} = vR_{700}$

$k_{L1a\text{-}vLR1} = (vDpl_{a700} - vS_{0a\ geometric700})_{if>0}$

## 5.70. $k_{L1i}$ [m] – LOWER vertical STATIC shift for INNER Relevant Points RMP, REP caused by Fixed Installations on a HILL with $R_{v\ min} = vR_{1000}$, EXCEPT for vLR1

$k_{L1i} = (vDpl_{i1000} - vS_{0i\ geometric1000})_{if>0}$

## 5.71. $k_{L1i\text{-}vLR1}$ [m] – ONLY for vLR1 gauging: LOWER vertical STATIC shift for INNER Relevant Points RMP, REP caused by Fixed Installations on a HILL with $vR_{min\text{-}vLR1} = vR_{700}$

$k_{L1i\text{-}vLR1} = (vDpl_{i700} - vS_{0i\ geometric700})_{if > 0}$

## 5.72. $k_{L2}$ [m] – Sum of the vehicle related LOWER vertical STATIC shift aspects of Relevant Points RMP, REP

$k_{L2} = k_{L2.1} + k_{L2.2} + k_{L2.3}$

## 5.73. $k_{L2.1}$ [m] – Vertical STATIC shift of Relevant Points RMP, REP caused by wheel wear

= maximum permitted wheel wear of this vehicle design.

## 5.74. $k_{L2.2}$ [m] – Vertical STATIC shift of Relevant Points RMP, REP caused by relevant wear – other than wheel wear

Apart from wheel wear, this shall include the maximum permitted vertical wear of all relevant parts of the vehicle (e.g. centre pivot wear between bogie and body)

- wear in the axle boxes may be ignored for all vehicle designs

## 5.75. $k_{L2.3}$ [m] – Vertical STATIC shift of Relevant Points RMP, REP caused by deflection under STATIC load

= Sum of:

- Suspension sag
- For freight wagons (and special vehicles of similar design): The static vertical deflection of Relevant Points on the body structure under 100% (=maximum) static load that will be present during operation.
- For vehicle designs other than freight wagons (and special vehicles of similar design): The static vertical deflections of Relevant Points on the body structure may be ignored.
- Vertical deflection of Relevant Points caused by the deflection of wheelsets under static load may be ignored for any vehicle design.
- Vertical deflection of Relevant Points caused by the deflection of bogies under load may be ignored for any vehicle design.

*Note: This approach is based on the concepts included in EN 15273-2 and in UIC 505-1 (points 6.1.1.2, 6.1.1.2.1 and 6.1.1.2.2) and*
*ERRI B12/DT135.*

## 5.76. $k_{L3}$ [m] – Vertical STATIC shift of Relevant Points RMP, REP caused by suspension deflection from empty/tare to 100% load condition under STATIC load

= Static suspension deflection between empty/tare and 100% (=maximum) load condition of this vehicle design.

Where air suspension is present: The value shall be established with empty air suspension and include the deflection of any back-up suspension.

## 5.77. $k_{L4}$ [m] – Sum of the vehicle related LOWER vertical DYNAMIC shift aspects of Relevant Points RMP, REP

$k_{L4} = k_{L4.1} + k_{L4.2}$

This represents the additional dynamic shift that is caused by the dynamic loads during operation.

## 5.78. $k_{L4.1}$ [m] – Vertical DYNAMIC shift of Relevant Points RMP, REP under DYNAMIC forces during operation

This shall for freight wagons (and special vehicles of similar design) consider the random dynamic deflections of the body(frame) under 100% (=maximum) load that will be present during operation. This deflection shall be represented by the additional vertical static shift of the vehicle structure that would be caused by an overloading from 100% to 130% of the maximum load.

For vehicle designs other than freight wagons (and special vehicles of similar design) the random dynamic deflections of the body(frame) during operation may be ignored.

The deflection caused by torsion of the vehicle structure on twisted track may be ignored for any vehicle design.

*Note: this approach is based on the concepts included in UIC 505-1 (points 6.1.1.2, 6.1.1.2.1 and 6.1.1.2.2) and ERRI B12/DT135.*

## 5.79. $k_{L4.2}$ [m] – Vertical DYNAMIC shift of Relevant Points RMP, REP caused by the DYNAMIC forces on the suspension during operation

Where air suspension is present: All below values shall be established with empty air suspension and include the deflection of any back-up suspension.

For freight wagons (and special vehicles of similar design) the random dynamic suspension deflection shall be represented by an additional deflection from 100% maximum load case down to the bump stops (bottoming out).

For vehicle designs other than freight wagons (and special vehicles of similar design) the random dynamic suspension deflections shall be represented by an additional static deflection from:

a) 100% load condition to 130% load condition; or,

b) 100% load condition to the bump stops (bottoming out)

*Note: In case of subpoint a) with linear suspension:* $k_{L4.2} = 0.3 * k_{L3}$

## 5.80. $k_{L5x}$ [m] – Additional LOWER STATIC shift of Relevant Points RMP, REP due to roll and pitch of the vehicle

This shall include roll and pitch caused by

- possible (partial) suspension defects,
- the permitted differential wheel wear on the same axle,
- the permitted differential wheel wear within the same vehicle
- the clearance in the side bearers.

This shift is differentiated into 4 Zones (Zone A has the size ($a * 2b_2$) and is placed between the GCSs).

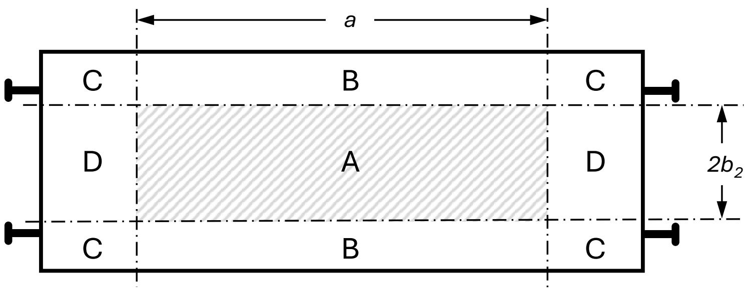



*Figure 11 Body Zones influencing Displacements*

For each individual Relevant Point one zone applies.

Zone A includes all Relevant Points with $b_{nom}$ =< $b_2$ and $n_i$ >= 0.000 m.
Zone B includes all Relevant Points with $b_{nom}$ > $b_2$ and $n_i$ >= 0.000 m.
Zone C includes all Relevant Points with $b_{nom}$ >$b_2$ and $n_a$ > 0.000 m.
Zone D includes all Relevant Points with $b_{nom}$ =< $b_2$ and $n_a$ > 0.000 m.

In Zone A:

**$k_{L5A}$[m] = 0.000m**

In Zone B:

**$k_{L5B}$[m]**

= (roll caused by possible suspension defects)
+ (roll caused by the permitted differential wheel wear on the same axle)
+ (roll caused by the permitted side bearer clearance)

= $(k_{L3} + k_{L4}) * (b_{nom} - b_2) / (2 * b_2)$
+ $\Delta k_{L2.2axle} * (b_{nom} - b_2) / (2 * b_2)$
+ $(J * b_{nom} / b_G)$

**= $(k_{L3} + k_{L4} + \Delta k_{L2.2axle}) * (b_{nom} - b_2) / (2 * b_2) + (J * b_{nom} / b_G)$**

In Zone C:

**$k_{L5C}$[m]**

= (roll and pitch caused by possible suspension defects)
+ (roll caused by the permitted differential wheel wear on the same axle)
+ (roll caused by the permitted side bearer clearance)
+ (pitch caused by the permitted differential wheel wear across the vehicle)

**= $(k_{L3} + k_{L4}) * [n_a^2 + (b_{nom} - b_2)^2]^{0.5} / [a^2 + 4b_2^2]^{0.5}$**
**+ $\Delta k_{L2.2axle} * (b_{nom} - b_2) / (2 * b_2)$**
**+ $(J * b_{nom} / b_G)$**
**+ $\Delta k_{L2.2vehicle} * (n_a / a)$**

In Zone D:

**$k_{L5D}$[m]**

= (pitch caused by suspension defects)
+ (pitch caused by the permitted differential wheel wear across the vehicle)

= $(k_{L3} + k_{L4}) * (n_a / a))$
+ $\Delta k_{L2.2vehicle} * (n_a / a))$

**= $(k_{L3} + k_{L4} + \Delta k_{L2.2vehicle}) * (n_a / a)$**

### 5.81. $k_{U1xx}$ [m] – General symbol for the UPPER vertical STATIC shift of Relevant Points RMP, REP caused by Fixed Installations

### 5.82. $k_{U1a}$ [m] –UPPER vertical STATIC shift for OUTER Relevant Points RMP, REP caused by Fixed Installations on a HILL with $vR_{min} = vR_{1000}$, EXCEPT for vLR1 gauging

$k_{U1a} = (vDpl_{a1000} - vS_{0a\ geometric1000})_{if>0}$

### 5.83. $k_{U1a\text{-}vLR1}$ [m] –ONLY for vLR1 gauging: UPPER vertical STATIC shift for OUTER Relevant Points RMP, REP caused by Fixed Installations on a HILL with $vR_{min\text{-}vLR1} = vR_{700}$

$k_{U1a\ vLR1} = (vDpl_{a700} - vS_{0a\ geometric700})_{if>0}$

### 5.84. $k_{U1i}$ [m] –UPPER vertical STATIC shift for INNER Relevant Points RMP, REP caused by Fixed Installations on a DIP with $vR_{min} = vR_{1000}$, EXCEPT for vLR1 gauging

$k_{U1i} = (vDpl_{i1000} - vS_{0i\ geometric1000})_{if>0}$

### 5.85. $k_{U1i\text{-}vLR1}$ [m] –ONLY for vLR1 gauging: UPPER vertical STATIC shift for INNER Relevant Points RMP, REP caused by Fixed Installations on a DIP with $vR_{min\text{-}vLR1} = vR_{700}$

$k_{U1i\text{-}vLR1} = (vDpl_{i700} - vS_{0i\ geometric700})_{if>0}$

### 5.86. $k_{U2}$ [m] – Vertical DYNAMIC shift of Relevant Points RMP, REP caused by the DYNAMIC forces on the suspension during operation

$k_{U2}$ = 0.010 m per suspension stage

*Note: 0.010 m for vehicles with only primary suspension and 0.020 m for vehicles with primary and secondary suspension.*

*This approach has been defined based on the concept included in EN 15273-2, A.3.4.2.2, first sentence.*

### 5.87. $\ell_{max}$ [m] – Maximum track gauge – EXCEPT for the Local Restrictions and the Vertical Local Restriction

For IRL1, 1D, 1F and 2 Gauges the permitted maximum value is **$\ell_{max}$ = 1.630 m**.

Where a section of the Network is stated to be compatible with IRL1 or 1D or 1F or 2 Gauges no higher value may be used by Fixed Installations, even if a higher value for use on the Network is published in a TSI.

*Note: Based on review of the current (in 2024) Network, IÉ-IM have advised, that $\ell_{max}$ shall be 1.630 m.*

### 5.88. $\ell_{max\text{-}LR1}$ [m] – Only for LR1: Maximum track gauge present on track at LR1

For IRL1, 1D, 1F Gauges the permitted maximum value is **$\ell_{max\text{-}LR1}$ = 1.612 m**.

Where a section of the Network is stated to be compatible with IRL1 or 1D or 1F Gauges no higher value may be used at LR2 by Fixed Installations, even if a higher value for use on the Network is published in a TSI.

### 5.89. $\ell_{max\text{-}LR2}$ [m] – Only for LR2: Maximum track gauge present on track at LR2

For IRL1, 1D, 1F Gauges the permitted maximum value is **$\ell_{max\ LR2}$ = 1.612 m**.

Where a section of the Network is stated to be compatible with IRL1 or 1D or 1F Gauges no higher value may be used at LR2 by Fixed Installations, even if a higher value for use on the Network is published in a TSI.

## 5.90. $\ell_{max\text{-}vLR1}$ [m] – Only for vLR1: Maximum track gauge present on track at vLR1

For IRL1, 1D, 1F Gauges the permitted maximum value is $\ell_{max\text{-}vLR1}$ **= 1.630 m**.

Where a section of the Network is stated to be compatible with IRL1 or 1D or 1F Gauges no higher value may be used at vLR1 by Fixed Installations, even if a higher value for use on the Network is published in a TSI.

## 5.91. $\ell_{nom}$ [m] – Nominal track gauge

$\ell_{nom}$ **= 1.602 m**

*Note: IÉ-IM have provided the information that the commonly used 'Irish 1600 mm network' terminology originates from the conversion of the historical 5'3" track gauge into metric units. Whilst 1600 mm track gauge is still present on the Network at points and crossings and at some plain line locations, the widespread introduction of rails inclined at 1 in 40 on concrete sleepers has resulted in 1602 mm becoming by far the dominant track gauge on the Network and it should therefore be used as the value for this parameter.*

## 5.92. L [m] – Nominal distance between wheel-rail interface points

This distance is defined as nominal track gauge $\ell_{nom}$ + 0.065 m.

**L = 1.667 m**

*Note: The value for L is 1.667 m, which is determined by adding 0.065 m to the nominal track gauge $\ell_{nom}$ = 1.602 m. It represents the distance between the nominal wheel-rail contact points.*

*The differential of 0.065 m is defined in analogy to various EN and UIC standards that define L = 1.500 m for the nominal track gauge 1.435 m.*

## 5.93. $n_a$ [m] – Nominal longitudinal distance between an OUTER Relevant Point RMP, REP, RPP and the nearest GCS in Normal Coordinates

Any longitudinal offset of a Relevant Point RMP, REP, RPP caused by build tolerances vs. the theoretical position of the same point shall be included in $n_a$.

*Note: A design value of $n_a$ = 2.540 m +10 mm/-0mm build tolerance will require that $n_a$ shall be taken as at least 2.550 m.*
*Note: A non-fixed distance between the GCSs (which causes the value of "a" to become a function of R) will in most cases also effect the values of $n_a$ and cause them in turn also to become a function of R: $n_{a\,Rxx} = f(R)$.*

## 5.94. $n_i$ [m] – Nominal longitudinal distance between an INNER Relevant Point RMP, REP, RPP and the nearest GCS in Normal Coordinates

A longitudinal offset of a Relevant Point RMP, REP, RPP caused by build tolerances vs. the theoretical position of the same point shall be included in $n_i$.

*Note: A design value of $n_i$ = 5.670 m +10mm/-0mm build tolerance will require that $n_i$ shall be taken as at least 5.680 m.*

*Note: A non-fixed distance between the GCSs (which causes the value of "a" to become a function of R) will in most cases also effect the values of $n_i$ and cause them in turn also to become a function of R: $n_{i\,Rxx} = f(R)$.*

## 5.95. p [m] – Distance between a bogie's GCSs in Normal Coordinates

Set this to 0.000 m for vehicles that are not fitted with bogies.

## 5.96. $P1.5b_{nom}$ [m] – Nominal lateral distance from a Relevant Pantograph Point RPP to the vehicle centre line in Normal Coordinates for 1.5kV

## 5.97. $P1.5b_{w}$ [m] – maximum 1/2 width of pantograph head in normal coordinates for 1.5kV

Half value of the overall width including the pantograph horns.

The maximum permitted value is 0.900m.

## 5.98. $P1.5f_{s}$ [m] – Permitted static and dynamic contact wire uplift for 1.5kV

The IM that manages the fixed installation shall ensure that the maximum uplift caused by the static or dynamic uplift forces for the 1.5kV DC system is ≤ 110 mm when assessed in accordance with Clause 9.2.1 (Assessment of overhead contact line design) of EN50367.This shall apply for all gauges IRL 1+1D+1F+2.

## 5.99. $P1.5f_{wa}$ [m] – Upwards shift of a Relevant Pantograph Point RPP caused by the maximum permitted pantograph wear or flex at this vehicle/ pantograph design for 1.5kV

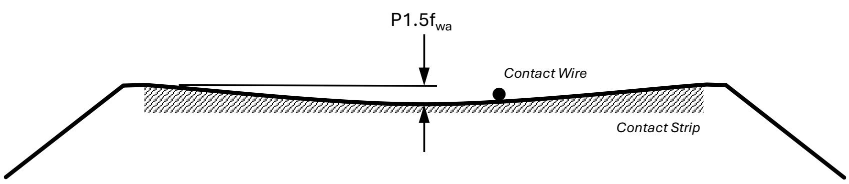



*Figure 12 wear causing upwards Shift of RPP*

5.99.1. This value shall be measured through testing with a static force that that represents the worst of the static and dynamic forces that will be present at the operation of the vehicle design. The contact wire position shall be selected to provide the largest vertical shift.

5.99.2. SRAC: A value $P1.5f_{wa}$ from the permitted range which is smaller than $P1.5f_{wa\ max}$ may only be selected, if a Safety Related Application Condition is defined within the maintenance manual of the Vehicle to ensure that this $P1.5f_{wa}$ value will be maintained under all operating conditions (as otherwise the compatibility with the selected Gauge may be lost).

## 5.100. $P1.5f_{wa\ max}$ [m] – Absolute permitted maximum upwards shift of a Relevant Pantograph Point RPP caused by pantograph wear or flex for pantograph gauging for 1.5kV

The absolute permitted maximum value to maintain compliance with the Gauges IRL 1+1D+1F+2 is:

**$P1.5f_{wa\ max} = 0.028$ m**

*Note: Higher values of $P1.5f_{wa}$ could interfere with the available free space and electrical safety margin provided by the Fixed Installations and are therefore not acceptable for the mentioned Gauges.*

## 5.101. $P1.5f_{ws}$ [m] – Upwards offset of a Relevant Pantograph Point RPP caused by roll of the pantograph head at this vehicle/ pantograph design for 1.5kV

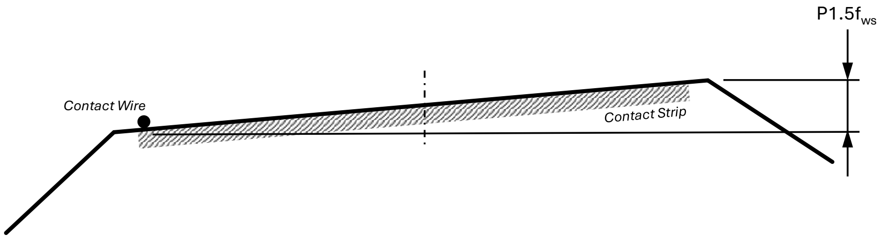



Figure 13 Pantograph Upwards Offset caused by roll

5.101.1. This value shall be measured through testing with a static force that that represents the worst of the static and dynamic forces that will be present at the operation of the vehicle design. The contact wire position shall be selected to be at a wire stagger (wire offset from pantograph centre line) of at least 550mm.

5.101.2. SRAC: A value $P1.5f_{ws}$ from the permitted range which is smaller than $P1.5f_{ws\ max}$ may only be selected, if a Safety Related Application Condition is defined within the maintenance manual of the Vehicle to ensure that this $P1.5f_{ws}$ value will be maintained under all operating conditions (as otherwise the compatibility with the selected Gauge may be lost).

## 5.102. $P1.5f_{ws\ max}$ [m] – Absolute permitted maximum of STATIC upwards offset of a Relevant Pantograph Point RPP caused by roll of the pantograph head for 1.5kV

The permitted maximum value to maintain compliance with the gauges IRL 1+1D+1F+2 is:

**$P1.5f_{ws\ max}$ = 0.067 m**

*Note: Higher values of $Pf_{ws}$ could interfere with the available free space and electrical safety margin provided by the Fixed Installations and are therefore not acceptable for the mentioned Gauges.*

## 5.103. $P1.5h_{max\ wire}$ [m] – Maximum permitted contact wire height in normal coordinates for 1.5kV

This is the maximum permitted height of the contact wire across all weather conditions (including e.g. tensioning caused by cold ambient temperatures), including the maximum uplift of the contact wire system (as caused by a static or passing pantograph), including the maximum contact wire wear and including the maximum rail wear on the Network.

The value shall apply between the top of rail (at any state of rail wear) and the bottom of the contact wire.

For IRL 1+1D+1F+2 this value is **$P1.5h_{max\ wire}$ = 5.714 m**

*Note: This is based on a reference 1.5kV contact wire system with:*

- *maximum permitted undisturbed contact wire height above the top of rails = 5.575 m*
- *maximum permitted vertical alignment error of track $T_N$=0.025m*
- *maximum permitted contact wire wear = 0.004 m*
- *maximum permitted uplift of the contact wire system = 0.110 m*

## 5.104. $P1.5h_{min\ wire}$ [m] – Minimum height of the contact wire in Normal Coordinates for 1.5kV

This is the minimum permitted height of the contact wire across all weather conditions (including e.g. a drop caused by icing).
The value shall apply between the top of rail (at any state of rail wear) and the bottom of the contact wire.

For IRL 1+1D+1F+2 this value is **$P1.5h_{min\ wire}$ = 4.190 m**

## 5.105. $P1.5h_{shift}$ [m] – General Symbol for reference height of a Relevant Pantograph Point RPP on the raised pantograph in Normal Coordinates, after adjusting the nominal height for the relevant UPWARDS or DOWNWARDS shifts for 1.5kV:

The following values shall be used:

a) **For RPP1: $P1.5h_{shift} = P1.5h_{max\ wire} + (P1.5f_{wa}^2 + P1.5f_{ws}^2)^{0.5}$**

b) **For RPP2: $P1.5h_{shift} = P1.5h_{max\ wire} + (P1.5f_{wa}^2 + P1.5f_{ws}^2)^{0.5} - 0.192$ m**

c) **For RPP3: $P1.5h_{shift} = P1.5h_{max\ wire} + (P1.5f_{wa}^2 + P1.5f_{ws}^2)^{0.5} - 0.210$ m**

d) **For RPP4: $P1.5h_{shift} = P1.5h_{min\ wire} - 0.192$ m**

e) **For RPP5: $P1.5h_{shift} = P1.5h_{stored} - 0.210$ m**

*Note: In the above the term $(P1.5f_{wa}^2 + P1.5f_{ws}^2)^{0.5}$ has been defined on the background that it would be too conservative to apply the full sum of $(P1.5f_{wa} + P1.5f_{ws})$.*

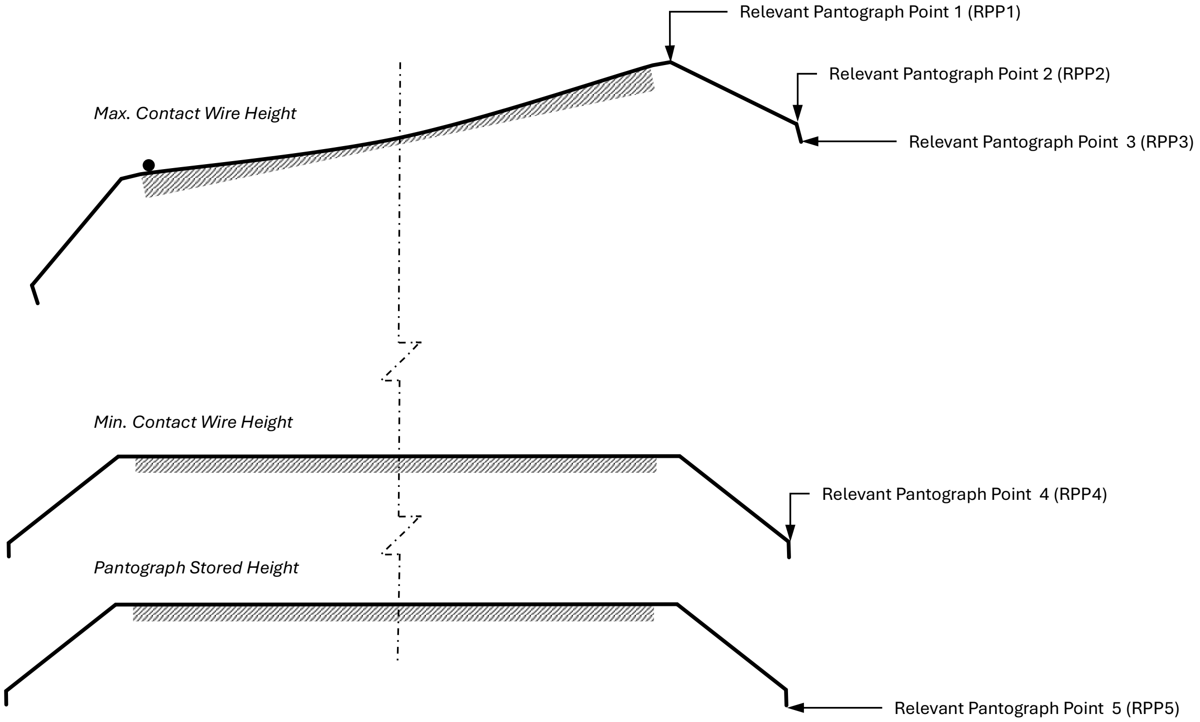



*Figure 14 Pantograph Upwards Offset*

## 5.106. $P1.5h_{stored}$ [m] – Nominal height of the top of a 1.5 kV pantograph in the stored position in Normal Coordinates

## 5.107. $P1.5h_t$ [m] – Nominal height of the rotation centre of a 1,5kV pantograph's lower hinge in Normal Coordinates

The relevant lower hinge is that hinge around which the moveable upper part of the pantograph rotates.

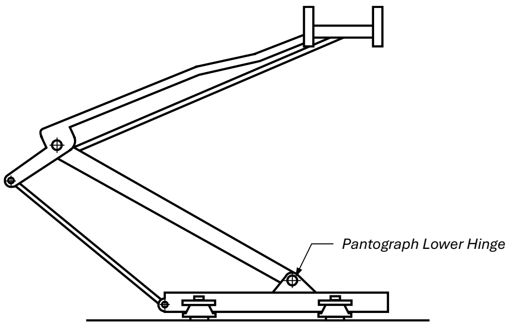



*Figure 15 Pantograph – Nominal Installation Height of lower hinge*

## 5.108. P1.5$M_{electric}$ [m] – Minimum static electric safety margin for 1.5kV

For IRL1, 1D, 1F and 2 Gauges this value is:

**P1.5$M_{electric}$ = 0.100 m**

*Note: This value has been taken from EN 50119 for 1.5kV nominal voltage.*

## 5.109. P1.5$s_{0\ random}$ [no unit] – Coefficient of flexibility of reference vehicle for random vehicle roll effects for pantograph gauging for 1.5kV

For IRL1, 1D, 1F and 2 Gauges this value is:

**P1.5$s_{0\ random}$ = 0.000**

*Note: Historically all effects caused by random DYNAMIC vehicle roll were assigned only to the Vehicles and no allowance is provided by the Fixed Installations.*

*Therefore, P1.5$s_{0\ random}$ is defined as 0.000 m for IRL1, 1D, 1F and 2 Gauges.*

*For additional Gauges that may become defined in a future version of this IRS, such an allowance may be present and P1.5$s_{0\ random}$ may get a value > 0.000.*

## 5.110. P1.5$s_{0\ static}$ [no unit] – Coefficient of flexibility of reference vehicle for quasi-static vehicle roll effects for pantograph gauging for 1.5kV

For IRL1, 1D, 1F and 2 Gauges: **P1.5$s_{0\ static}$ = 0.000**

*Note: Historically all effects caused by STATIC vehicle roll were assigned only to the Vehicles and no allowance is provided by the Fixed Installations.*

*Therefore, P1.5$s_{0\ static}$ is defined as 0.000 m for IRL1, 1D, 1F and 2 Gauges.*

*For additional Gauges that may become defined in a future version of this IRS, such an allowance may be present and P1.5$s_{0\ static}$ may get a value > 0.000.*

## 5.111. P1.5$S_{0a}$ [m] – Allowance for OUTER Pantograph Relevant Points Overthrow for 1.5kV

For any curve radius between straight track = R∞ and R = 80 m:

For IRL1, 1D, 1F and 2 Gauges this value is:

**P1.5$S_{0a}$ = 0.000 m**

*Note: This value relates to the overthrow effect that shall be included within the pantograph gauging.*

*Unlike for the vehicle body overthrow $S_{0a}$ to which an allowance is provided by the Fixed Installations, historically all such throw effects for the pantograph gauging were assigned only to the Vehicle and no* *equivalent allowance is provided by the Fixed Installations. (It was apparently assumed, that a pantograph would always be positioned above or very near to a GCS.)*

*Therefore, P1.5$S_{0a}$ is defined as 0.000 m for IRL1, 1D, 1F and 2 Gauges.*

*For additional Gauges that may become defined in a future version of this IRS, such an allowance may be present and P1.5$S_{0a}$ may get a value >0.000m.*

### 5.112. P1.5$S_{0i}$ [m] – Allowance for INNER pantograph Relevant Points Overthrow for 1.5kV

For any curve radius between straight track = R∞ and R = 80 m:

For IRL1, 1D, 1F and 2 Gauges, **P1.5$S_{0i}$ = 0.000 m**

*Note: Historically for pantograph gauging all effects caused by static vehicle body overthrow were assigned only to the Vehicle and no allowance is provided by the Fixed Installations.*

*Therefore, P1.5$S_{0i}$ is defined as 0.000 m for IRL1, 1D, 1F and 2 Gauges.*

### 5.113. P1.5t [m] - Lateral displacement of a 1.5kV pantograph

Lateral displacement of the pantograph at its maximum working height when subjected to a static lateral force of 300 N (Refer to Clause 6.6 (Transverse rigidity test (type test)) of EN 50206).

5.113.1. SRAC: A value P1.5t> P1.5$t_{max}$ from the permitted range may only be used, if a Safety Related Application Condition is defined within the maintenance manual of the Vehicle to ensure that this Pt value will be maintained under all operating conditions (as otherwise the compatibility with the selected Gauge may be lost).

### 5.114. P1.5$t_0$ [m] – Allowance for lateral displacement of any Relevant Pantograph Point RPP for 1.5kV

For IRL1, 1D, 1F and 2 Gauges this value is:

**P1.5$t_0$ = 0.000 m**

*Note: Historically all effects caused by lateral displacement of a pantograph were assigned only to the Vehicle and no allowance is provided by the Fixed Installations.*

*Therefore, P1.5$t_0$ is defined as 0.000 m for IRL1, 1D, 1F and 2 Gauges.*

*For additional Gauges that may become defined in a future version of this IRS, such an allowance may be present and P1.5$t_0$ may get a value >0.000m.*

### 5.115. P1.5$t_{max}$ [m] – Maximum permitted lateral displacement of any Relevant Pantograph Point RPP for 1.5kV

The maximum permitted P1.5t value for IRL1, 1D, 1F and 2 Gauges is:

**P1.5$t_{max}$ = 0.030 m**

### 5.116. P1.5$\eta_{0r}$[°] – Reference value for vehicle dissymmetry ONLY for pantograph gauging for 1.5kV

P$\eta_{0r}$ relates to an allowance that could be provided by the Fixed Installations

**P1.5$\eta_{0r}$ = 0°**

*Note: Historically no allowance has been provided for this value at IRL1, 1D, 1F and 2 Gauges.*

*All effects caused by Vehicle di and installation tolerances of a pantograph were assigned only to the Vehicle and no allowance is provided by the Fixed Installations.*

*Therefore, P1.5 $\eta_{0r}$ is defined as 0° for IRL1, 1D, 1F and 2 Gauges.*

*For additional Gauges that may become defined in a future version of this IRS, such an allowance may be present and P1.5 $\eta_{0r}$ may get a value >0°.*

### 5.117. $P1.5\tau$ [m] – Lateral construction and installation tolerance of any Relevant Pantograph Point RPP for 1.5kV

5.117.1. SRAC: A value $P1.5\tau < P1.5\tau_{max}$ from the permitted range may only be used, if a Safety Related Application Condition is defined within the maintenance manual of the Vehicle to ensure that this $P1.5\tau$ value will be maintained under all operating conditions (as otherwise the compatibility with the selected Gauge may be lost).

### 5.118. $P1.5\tau_0$ [m] – Allowance for lateral installation tolerance of any Relevant Pantograph Point for 1.5kV

For IRL1, 1D, 1F and 2 Gauges this value is:

**$P1.5\tau_0 = 0.000$ m**

*Note: Historically all effects caused by lateral construction and installation tolerances of a pantograph were assigned only to the Vehicle and no allowance is provided by the Fixed Installations.*

*Therefore, $P1.5\tau_0$ is defined as 0.000 m for IRL1, 1D, 1F and 2 Gauges.*

*For additional Gauges that may become defined in a future version of this IRS, such an allowance may be present and $P1.5\tau_0$ may get a value >0.000m.*

### 5.119. $P1.5\tau_{max}$ [m] – Maximum permitted lateral construction and installation tolerance of any Relevant Pantograph Point RPP for 1.5kV

For IRL1, 1D, 1F and 2 Gauges, the maximum permitted value is:

**$P1.5\tau_{max} = 0.010$ m**

Pantographs with $P1.5\tau > 10$mm are not permitted to be operated on parts of the Network with IRL1, 1D, 1F and 2 Gauges.

### 5.120. $P25b_{nom}$ [m] – Nominal lateral distance from a Relevant Pantograph Point RPP to the vehicle centre line in Normal Coordinates for 25kV

### 5.121. $P25b_w$ [m] – maximum 1/2 width of pantograph head in normal coordinates for 25kV

Half value of the overall width including the pantograph horns.

The maximum permitted value shall be defined within a future version of this standard.

### 5.122. $P25f_s$ [m] – Permitted static and dynamic contact wire uplift for 25kV

To be defined in a future version of this IRS.

### 5.123. $P25f_{wa}$ [m] – Upwards shift of a Relevant Pantograph Point RPP caused by the maximum permitted pantograph wear or flex at this vehicle/ pantograph design for 25kV

To be defined in a future issue of this IRS.

### 5.124. $P25f_{wa\,max}$ [m] – Absolute permitted maximum upwards shift of a Relevant Pantograph Point RPP caused by pantograph wear or flex for pantograph gauging for 25kV

To be defined in a future issue of this IRS.

## 5.125. $P25f_{ws}$ [m] – Upwards offset of a Relevant Pantograph Point RPP caused by roll of the pantograph head at this vehicle/ pantograph design for 25kV

To be defined in a future issue of this IRS.

## 5.126. $P25f_{ws\ max}$ [m] – Absolute permitted maximum of STATIC upwards offset of a Relevant Pantograph Point RPP caused by roll of the pantograph head for 25kV

To be defined in a future issue of this IRS.

## 5.127. $P25h_{max\ wire}$ [m] – Maximum permitted contact wire height in normal coordinates for 25kV

This is the maximum permitted height of the contact wire across all weather conditions (including e.g. tensioning caused by cold ambient temperatures), including the maximum uplift of the contact wire system (as caused by a static or passing pantograph), including the maximum contact wire wear and including the maximum rail wear on the Network.

The value shall apply between the top of rail (at any state of rail wear) and the bottom of the contact wire.

For IRL 1+1D+1F+2 this value is **$P25h_{max\ wire}$ = to be defined within a future version of this standard**

## 5.128. $P25h_{min\ wire}$ [m] – Minimum height of the contact wire in Normal Coordinates for 25kV

This is the minimum permitted height of the contact wire across all weather conditions (including e.g. a drop caused by icing).
The value shall apply between the top of rail (at any state of rail wear) and the bottom of the contact wire.

For IRL 1+1D+1F+2 this value is **$Ph_{min\ wire}$ = to be defined within a future version of this standard**

## 5.129. $P25h_{shift}$ [m] – General Symbol for reference height of a Relevant Pantograph Point RPP on the raised pantograph in Normal Coordinates, after adjusting the nominal height for the relevant UPWARDS or DOWNWARDS shifts for 25kV

To be defined in a future issue of this IRS.

## 5.130. $P25h_t$ [m] – Nominal height of the rotation centre of a 25kV pantograph's lower hinge in Normal Coordinates

The relevant lower hinge is that hinge around which the moveable upper part of the pantograph rotates.

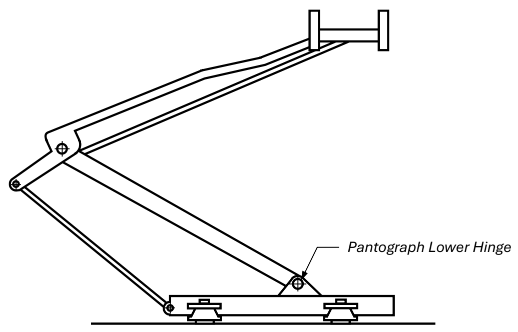



*Figure 16 Pantograph – Nominal Installation Height of lower hinge*

### 5.131. $P25M_{electric}$ [m] – Minimum static electric safety margin for 25kV

For IRL1, 1D, 1F and 2 Gauges this value is:

**$P25M_{electric}$ = 0.270 m**

*Note: This value has been taken from EN 50119 for 25kV nominal voltage.*

### 5.132. $P25s_{0\ random}$ [no unit] – Coefficient of flexibility of reference vehicle for random vehicle roll effects for pantograph gauging for 25kV

For IRL1, 1D, 1F and 2 Gauges this value is:

**$P25s_{0\ random}$ = 0.000**

*Note: Historically all effects caused by random DYNAMIC vehicle roll were assigned only to the Vehicles and no allowance is provided by the Fixed Installations.*

*Therefore, $P25s_{0\ random}$ is defined as 0.000 m for IRL1, 1D, 1F and 2 Gauges.*

*For additional Gauges that may become defined in a future version of this IRS, such an allowance may be present and $P25s_{0\ random}$ may get a value > 0.000.*

### 5.133. $P25s_{0\ static}$ [no unit] – Coefficient of flexibility of reference vehicle for quasi-static vehicle roll effects for pantograph gauging for 25kV

To be defined in a future issue of this IRS.

### 5.134. $P25S_{0a}$ [m] – Allowance for OUTER Pantograph Relevant Points Overthrow for 25kV

To be defined in a future issue of this IRS.

### 5.135. $P25S_{0i}$ [m] – Allowance for INNER pantograph Relevant Points Overthrow for 25kV

To be defined in a future issue of this IRS.

### 5.136. P25t [m] - Lateral displacement of a 25kV pantograph

To be defined in a future issue of this IRS.

### 5.137. $P25t_0$ [m] – Allowance for lateral displacement of any Relevant Pantograph Point RPP for 25kV

To be defined in a future issue of this IRS.

### 5.138. $P25t_{max}$ [m] – Maximum permitted lateral displacement of any Relevant Pantograph Point RPP for 25kV

To be defined in a future issue of this IRS.

### 5.139. $P25\eta_{0r}$[°] – Reference value for vehicle dissymmetry ONLY for pantograph gauging for 25kV

To be defined in a future issue of this IRS.

### 5.140. $P25\tau$ [m] – Lateral construction and installation tolerance of any Relevant Pantograph Point RPP for 25kV

To be defined in a future issue of this IRS.

### 5.141. $P25\tau_0$ [m] – Allowance for lateral installation tolerance of any Relevant Pantograph Point for 25kV

To be defined in a future issue of this IRS.

### 5.142. $P25\tau_{max}$ [m] – Maximum permitted lateral construction and installation tolerance of any Relevant Pantograph Point RPP for 25kV

To be defined in a future issue of this IRS.

### 5.143. $Pb_{RP}$ [m] – 1/2 width of a point at $Pxxh_{shift}$ on a Pantograph Reference Profile RP-P

The relevant value shall be selected as appropriate from either RP-$P_{1.5kV}$ or RP-$P_{25kV}$.

### 5.144. $PDpl_{a\ curve}$ [m] – Lateral displacement of OUTER Relevant Pantograph Points RPP for CURVED track gauging

$PDpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track} * (A_{a\ track}$ or $A_{a\ track\ (special)}) + q*A_{a\ q} + w_{a\ f(R)} * A_{a\ wa\ curve} + w_{i\ f(R)} * A_{a\ wi\ curve} + Pz_a$

*Note: In this formula $A_{a\ track\ (special)}$ may be present.*

### 5.145. $PDpl_{a\ straight}$ [m] – Lateral displacement of OUTER Relevant Pantograph Points RPP for STRAIGHT track gauging

$PDpl_{a\ straight} = Dpl_{a\ track} * A_{a\ track} + q * A_{a\ q} + w_{R0} * A_{a\ wR0\ straight} + Pz_a$

### 5.146. $PDpl_{i\ curve}$ [m] – Lateral displacement of INNER Relevant Pantograph Points RPP for CURVED track gauging

$PDpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track} * (A_{i\ track}$ or $A_{i\ track\ (special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + Pz_i$

*Note: In this formula $A_{i\ track\ (special)}$ may be present.*

### 5.147. $PDpl_{i\ straight}$ [m] – Lateral displacement of INNER Relevant Pantograph Points RPP for STRAIGHT track gauging

$PDpl_{i\ straight} = Dpl_{i\ track} * A_{i\ track} + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ w} + Pz_i$

### 5.148. $Pxxh_{shift}$ [m] – General Symbol for reference height of a Relevant Pantograph Point RPP on the raised pantograph in Normal Coordinates, after adjusting the nominal height for the relevant UPWARDS or DOWNWARDS shifts

$Pxxh_{shift}$ is used in this IRS to improve readability of the formulae. It shall be replaced as appropriate by either $P1.5h_{shift}$ or $P25h_{shift}$.

### 5.149. $Pz_{xx}$ [m] – General symbol for lateral displacement of Relevant Pantograph Points RPP due to roll of the Vehicle & due to effects caused by Pxxt and $Pxx\tau$ & as reduced by any associated allowances provided by the Fixed Installations

Pxxt and $Pxx\tau$ are used in this IRS to improve readability of the formulae. They shall be replaced as appropriate by either P1.5t, P25t and $P1.5\tau$, $P25\tau$.

*Note: The use of the root-sum-square (RSS) element in $Pz_{xx}$ follows an approach that is included in the UIC 505 series and the EN 15273 series of standards for the pantograph gauging.*

*The RSS element has in this IRS also been applied for RPP1 and RPP2 at the highest wire position.*

*The RSS element is limited to the random elements Pz1 term; Pz2 term; Pz3 term; Pz4 term which are technically independent from each other.*

*The static element ($Pz5.1_{a\ term} - Pz5.2_{a\ term}$) cannot be included within the RSS calculation.*

a) for OUTER Relevant Points RPP:

**$Pz_a$ [m] = $[(Pz1\ term)^2 + (Pz2\ term)^2 + (Pz3\ term)^2 + (Pz4\ term)^2]^{0.5} + [Pz5.1_a\ term - Pz5.2_a\ term]$**

*Note: The result of this formula may become negative.*

b) for INNER Relevant Points RPP:

**$Pz_i$ [m] = $[(Pz1\ term)^2 + (Pz2\ term)^2 + (Pz3\ term)^2 + (Pz4\ term)^2]^{0.5} + [Pz5.1_i\ term - Pz5.2_i\ term]$**

*Note: The result of this formula may become negative.*

**5.150. Pz1 term [m] = $[s * T_D / L * |Pxxh_{shift} - h_c|] - [Pxxs_{0\ random} * T_D / L * |Pxxh_{shift} - h_{c0}|]$**

*Note: This term includes:*

a) *the roll of a pantograph caused by the vehicle - to which the pantograph is fitted - operating on straight or curved track with the maximum permitted cross level error $T_D$: $[s * T_D / L * |Pxxh_{shift} - h_c|]$*

b) *and the associated allowance provided by the Fixed Installations: $[Pxxs_{0\ random} * T_D / L * |Pxxh_{shift} - h_{c0}|]$*

*Note: Use for $Pxxs_{0\ random}$ as appropriate either $P1.5s_{0\ random}$ or $P25s_{0\ random}$.*

**5.151. Pz2 term [m] = $\{[(\tan \eta_0 + \tan \alpha_J) * (1 + s) * |Pxxh_{shift} - h_c|]$**
**$- [\tan(Pxx\eta_{0r}) * (1 + Pxxs_{0\ random}) * |Pxxh_{shift} - h_{c0}|]\}_{if>0}$**

$Pxx\eta_{0r}$ is used in this IRS to improve readability of the formulae. It shall be replaced as appropriate by either $P1.5\eta_{0r}$ or $P25\eta_{0r}$ .

$Pxxs_{0\ random}$ is used in this IRS to improve readability of the formulae. It shall be replaced as appropriate by either $P1.5s_{0\ random}$ or $P25s_{0\ random}$.

*Note: This term includes:*

a) *the roll of a pantograph that is caused during operating on straight or curved track by the vehicle's dissymmetry and the vehicle's side bearer clearance: $[(\tan \eta_0 + \tan \alpha_J) * (1 + s) * |Pxxh_{shift} - h_c|]$*

b) *and the associated allowance provided by the Fixed Installations: $[\tan(Pxx\eta_{0r}) * (1 + Pxxs_{0\ random}) * |Pxxh_{shift} - h_{c0}|]$*

**5.152. Pz3 term [m] = $\{[Pxxt * (Pxxh_{shift} - Pxxh_t) / (Pxxh_{max\ wire} - Pxxh_t)]$**
**$- [Pxxt_0 * (Pxxh_{shift} - Pxxh_t) / (Pxxh_{max\ wire} - Pxxh_t)]\}_{if>0}$**

*Note: This term includes:*

a) *the random dynamic lateral displacement of the Relevant Pantograph Points RPP caused by roll of the pantograph around its lowest hinge on straight and curved track: $[Pxxt * (Pxxh_{shift} - Pxxh_t) / (Pxxh_{max\ wire} - Pxxh_t)]$*

b) *and the associated allowance provided by the Fixed Installations: $[Pxxt_0 * (Pxxh_{shift} - Pxxh_t) / (Pxxh_{max\ wire} - Pxxh_t)]$*

*c) Use for Pxxt as appropriate either P1.5t or P25t*

*d) Use for $Pxxt_0$ as appropriate either $P1.5t_0$ or $P25t_0$*

*e) Use for $Pxxh_t$ as appropriate either $P1.5h_t$ or $P25h_t$*

*f) Use for $Pxxh_{max\ wire}$ as appropriate either $P1.5h_{max\ wire}$ or $P25h_{max\ wire}$*

## 5.153. Pz4 term [m] = $(Pxx\tau - Pxx\tau_0)_{if>0}$

*Note:*

*a) This term includes the random static lateral displacement of the Relevant Pantograph Points RPP caused by $P\tau$ and the associated allowance $P\tau_0$ provided by the Fixed Installations.*

*b) Use for $Pxx\tau$ as appropriate $P1.5\tau$ or $P25\tau$*

*c) Use for $Pxx\tau_0$ as appropriate $P1.5\tau_0$ or $P25\tau_0$*

## 5.154. $Pz5.1_a$ term [m] – ONLY for OUTER Relevant Points RPP

This term includes the roll of the Vehicle and its pantograph that is caused during operation on straight or curved track by the vehicle's reaction to Cant and Cant Deficiency to OUTER Relevant Pantograph Points:

*Note: These formulae are case dependent and relate to $Pxxh_{shift}$ and $h_c$ !*

a) IF $Pxxh_{shift} > h_c$ : **$Pz5.1_a$ term = $s * I_{max\ f(R)} / L * (Pxxh_{shift} - h_c)$**

OR

b) IF $Pxxh_{shift} = h_c$: **$Pz5.1_a$ term = 0.000m**

OR

c) IF $Pxxh_{shift\ x} < h_c$: **$Pz5.1_a$ term = $s * D_{max\ f(R)} / L * (h_c - Pxxh_{shift})$**

## 5.155. $Pz5.1_i$ term [m] – ONLY for INNER Relevant Points RPP

This term includes the roll of the Vehicle and its pantograph that is caused during operation on straight or curved track by the vehicle's reaction to Cant and Cant Deficiency to INNER Relevant Pantograph Points:

*Note: These formulae are case dependent and relate to $Pxxh_{shift}$ and $h_c$ !*

a) IF $Pxxh_{shift} > h_c$ : **$Pz5.1_i$ term = $s * D_{max\ f(R)} / L * (Pxxh_{shift} - h_c)$**

OR

b) IF $Pxxh_{shift} = h_c$: **$Pz5.1_i$ term = 0.000m**

OR

c) IF $Pxxh_{shift} < h_c$ : **$Pz5.1_i$ term = $s * I_{max\ f(R)} / L * (h_c - Pxxh_{shift})$**

## 5.156. $Pz5.2_a$ term [m] – ONLY for OUTER Relevant Points RPP

This term includes the allowance that is provided by the Fixed Installations associated with $Pz5.1_a$ term.

*Note: These formulae are case dependent and relate to $Pxxh_{shift}$ and $h_{c0}$ !*

a) IF $Pxxh_{shift} > h_{c0}$: **$Pz5.2_a$ term = $Ps_{0\ static} * I_{max\ f(R)} / L * (Pxxh_{shift} - h_{c0})$**

OR

b) IF $Pxxh_{shift} = h_{c0}$: **$Pz5.2_a$ term = 0.000m**

OR

c) IF $Pxxh_{shift} =< h_{c0}$: **$Pz5.2_a$ term = $Ps_{0\ static}$ * $D_{max\ f(R)}$ / L * ($h_{c0}$ – $Pxxh_{shift}$)**

## 5.157. $Pz5.2_i$ term [m] – ONLY for INNER Relevant Points RPP

This term includes the allowance that is provided by the Fixed Installations associated with $Pz5.1_i$ term.

*Note: These formulae are case dependent and relate to $Pxxh_{shift}$ and $h_{c0}$ !*

a) IF $Pxxh_{shift} > h_{c0}$ : **$Pz5.2_i$ term = $Ps_{0\ static}$ * $D_{max\ f(R)}$ / L * ($Pxxh_{shift}$ – $h_{c0}$)**

OR

b) IF $Pxxh_{shift} = h_{c0}$: **$Pz5.1_i$ term = 0.000m**

OR

c) IF $Pxxh_{shift} < h_{c0}$ : **$Pz5.2_i$ term = $Ps_{0\ static}$ * $I_{max\ f(R)}$ / L * ($h_{c0}$ – $Pxxh_{shift}$)**

## 5.158. q [m] – Lateral play between wheelset and bogie frame or between wheelset and vehicle body at vehicle designs not fitted with bogies

## 5.159. R [m] – General symbol for horizontal track radius

## 5.160. $R_{absolute\ min\ Network}$ [m] – ABSOLUTE minimum horizontal track radius on the Network

**$R_{absolute\ min\ Network}$= $R_{80}$ = 80 m**

*Note: On the Network the normal minimum track radius on mainline track is 150 m.*

*But mainline track at the following Local Restrictions and vertical Local Restrictions have tighter track Radii:*

*$R_{116-LR1}$ = 116 m*

*$R_{119-LR1}$ = 119 m*

*$R_{98-vLR1}$ = 98 m*

*Also for all Gauges in this IRS and for the complete Network the value of $R_{nominal\ min\ Network}$ = 95 m was defined.*

*On sidings or in depots the minimum track radius may be $R_{min}$ = $R_{80}$ = 80 m.*

*Note: For operation in sidings or depots below* $R_{nominal\ min\ Network}$ = 95 m *it may be required to adjust the coupling between vehicles (e.g. by lengthening the screw couplings).*

*Additionally it is permitted to apply a Condition and Limit of Use for a Vehicle design, if this Vehicle design shall not be operated below $R_{min\ vehicle}$.*

## 5.161. $R_{nominal\ min\ Network}$[m] – NOMINAL minimum horizontal track radius on the Network

The Minimum horizontal track radius that can be operated by the Vehicle shall for all Gauges in this IRS be at least $R_{nominal\ min\ Network}$ =95 m.

## 5.162. $R_{min\ vehicle}$[m] – Minimum track radius of the Vehicle design

The value of $R_{min\ vehicle}$ shall be between $R_{absolute\ min\ Network}$ <= $R_{min\ vehicle}$ <=$R_{nominal\ min\ Network}$. Therefore:

**80 m <= $R_{min\ vehicle}$ <= 95 m**

SRAC: Where $R_{min\ vehicle}$ > 80 m, the related signs 'MINIMUM RADIUS HORIZONTAL CURVE' according to EN15877series shall be applied to the vehicle according to section 8.2. An RU shall not operate the vehicle on parts of the network where the actual curve radius is below $R_{min\ vehicle}$.

*Note: For operation in sidings or depots below 95m curve radius it may be required to adjust the coupling between vehicles (e.g. by lengthening the screw couplings).*

## 5.163. $R_{xx}$ [m] – Set of all horizontal track Relevant Radii that shall be subject to a gauging calculation

For any Vehicle design, as an absolute minimum, all the following set of radii shall be subject to gauge calculations:

$R_0$ (for straight track)

$R_{2000}$ (for R = 2000 m)

$R_{900}$ (for R = 900 m), only relevant for gauging of INNER relevant points.

$R_{250.4}$ (for R = 250.4 m)

$R_{150}$ (for R = 150 m)

$R_{80}$ (for R = 80 m)

$R_{116\text{-}LR1}$ (for R = 116 m, relevant for LR1)

$R_{119\text{-}LR1}$ (for R = 119 m, relevant for LR1)

$R_{280\text{-}LR2}$ (for R = 280 m, relevant for LR2)

$R_{98\text{-}vLR1}$ (for R = 98 m, relevant for vLR1)

Depending on the individual Vehicle design additional $R_{xx}$ values may also become Relevant Radii. For instance, where any of the input values ($n_a$, $n_i$, w, q, a, etc.) of the Vehicle design depend on curvature 1/R as a function = f(1/R) and where this function has discontinuities (local minima and maxima as well as local non-linearities) for Relevant Radii that are not already included in the above list, the associated $R_{xx}$ values shall be taken as additional Relevant Radii. These shall also become subject to gauging calculations.

## 5.164. s [no unit] – Coefficient of flexibility of the gauged vehicle design

The coefficient of flexibility is a measure of a Vehicle's flexibility in roll.

Whenever a stationary Vehicle is placed on a canted track whose running surface lies at an angle δ to the horizontal, its body leans on its suspensions and forms an angle η with the perpendicular to the rail level. The vehicle flexibility coefficient "s" is defined by the ratio:

**$s = \eta / \delta$**

More details of this coefficient and determining its value can be found in the EN 15273 series of standards, EN 14363 and the UIC 505 series.

This value shall either:

- be measured (e.g. according to EN14363),
- be calculated, unless an applicable legal requirement for vehicle design does not permit the option to calculate this value.

“s” may be dependent on load and suspension conditions of the vehicle. All relevant values of “s” shall be subject to gauging calculations.

### 5.165. $s_{0\ random}$ [no unit] – Coefficient of flexibility of the reference vehicle for random DYNAMIC vehicle roll effects

For IRL1, 1D, 1F and 2 Gauges this value is:

**$s_{0\ random}$ = 0.25.**

*Note: This value relates to an allowance for Vehicle DYNAMIC roll that that is provided by the Fixed Installations.*

### 5.166. $s_{0\ static}$ [no unit] – Coefficient of flexibility of reference vehicle for the STATIC vehicle roll effects

For IRL1, 1D, 1F and 2 Gauges, **$s_{0static}$ = 0.00**

*Note: Historically all effects caused by STATIC vehicle roll were assigned only to the Vehicles and no allowance is provided by the Fixed Installations.*

*Therefore, $s_{0\ static}$ is defined as 0.000 m for IRL1, 1D, 1F and 2 Gauges.*

*For additional Gauges that may become defined in a future version of this IRS, such an allowance may be present and $s_{0\ static}$ may get a value >0.000.*

### 5.167. $S_{0x}$ [m] – Various elements related to allowed overthrow

In curves the RP is widened by an allowed inner and an allowed outer overthrow. This allowance is provided by the Fixed Installations. The allowed inner or allowed outer overthrow is embedded within the calculation rules for the VCG (and also within those for NG and MG).

*Note: The allowed inner or allowed outer overthrows for the Network have in the past been defined based a combination of parameters:*

***a) Geometric Overthrow***

*The Fixed Installation shall keep free the geometric inner and outer overthrows which are required by the Irish Reference Vehicle 1 for horizontal overthrows.*

*This reference vehicle is a virtual vehicle that is influenced by certain dimensions of the historic CIE 'Park Royal' and other dimensions of the CIE 'Laminated' coach types. It has:*

- *an overall body length of = 18.745 m;*
- *a distance between the GCSs of $a_0$ = 13.411 m;*
- *a $n_{a0\ max}$ = (18.745 m-13.411 m)/2 = 2.667 m;*
- *a $n_{i0\ max} = a_0 / 2$;*
- *a maximum body width of 3.098 m between the GCSs (based on the Park Royal type);*
- *a maximum body width of 3.048 m outside the GCSs (based on the Laminated type);*
- *a $s_0$ = 0.25,*
- *a $h_{c0}$ = 0.5 m,*
- *a $q_0$ = 0.0 m.*

*Due to a historic decision for which the reason is not known, the allowed overthrows became defined by ignoring the effect of bogie throw. Therefore $p_0$ = 0 m and $w_{i0f(R)} = w_{a0f(R)}$ = 0 m. Thus, the Irish Reference Vehicle was defined as a virtual two axle coach with a wheelset distance of 13.411 m.*

*Furthermore, no allowance was made for q and therefore $q_0$ = 0.0 m.*

*Since the 1980s significant sections of the network have been maintained or modified to these allowed overthrows.*

*This has since caused operational restrictions for still existing historic 'Park Royal' and 'Laminated' coaches as these vehicles have in reality clearly values for p, $w_{if(R)}$, $w_{af(R)}$, q that are all >0 m which causes these vehicles to require a wider gauge than that which is actually provided since the introduction of the new gauging rules in the 1980s. Until these vehicles are completely removed from operation, special operational restrictions apply to them.*

*New vehicles or modifications to existing vehicles may not use these special operational restrictions to ensure interoperability on the Network.*

*The values of $S_{0i\ geometric}$ and $S_{0a\ geometric}$ are functions f(R) of the track curvature (1 / R):*

$S_{0a\ geometric\ f(R)}$ = ($a_0$ * $n_{a0max}$ + $n_{a0max}$^2 - ($A_{a\ bogie}$ *$p_0$^2) / 4) / (2R) = 21.440 [m²] * (1 / R)

$S_{0i\ geometric\ f(R)}$ = ($a_0$ * $n_{i0max}$ - $n_{i0max}$^2 + ($A_{i\ bogie}$ * $p_0$^2) / 4) / (2R) = 22.482 [m²] * (1 / R)

**b) Reduction of INNER Overthrow at IRL 1/1D/1F**

*(This reduction is NOT defined for Gauge IRL 2.)*

*The allowed **INNER** overthrow $S_{0i\ geometric\ f(R)}$ in curves has historically become reduced by an additional reduction $S_{0i\ reduction}$ = 25mm **between two adjacent tracks** with the additional condition that ($S_{0i\ geometric}$ - $S_{0i\ reduction}$) shall never come negative.*

*Therefore:*

$(S_{0i\ geometric} - S_{0i\ reduction})_{if>0}$

*The reason for the historic introduction of this additional reduction is not known. (It is possible, that it was originally intended to be applied to OUTER points, to encourage the tapering of the extreme ends of long coaches, but in the largest currently operating fleet on the network (IÉ-RU 22000 DMUs, since 2007) this reduction has been applied to the INNER points which can now not be ignored.)*

*This reduction causes a non-linearity for the **INNER points** gauging and thus a Relevant Radius at $R_{900}$ = 900 m.*

*This additional reduction only affects points on a RP that may come close to another RP on an adjacent line. It affects therefore only such INNER points on a vehicle design which can reach with their height $h_{shift}$ a value between*

*b.1) EXCEPT for gauging at LR1 of LR2:*

$h_{S0i\ reduction\ MIN}$ = < $h_{shift}$ <= $h_{S0i\ reduction\ MAX}$

*b.2) ONLY for gauging at LR1:*

$h_{S0i\ LR1\ reduction\ MIN}$ = < $h_{shift}$ <= $h_{S0i\ LR1\ reduction\ MAX}$

*b.3) ONLY for gauging at LR2:*

$h_{S0i\ LR2\ reduction\ MIN}$ = < $h_{shift}$ <= $h_{S0i\ LR2\ reduction\ MAX}$

*These heights are determined by the intersections of the RP and a line parallel to its outer lateral face with a horizontal offset of 25mm.*

*The values for $h_{S0i\ reduction}$ xx are provided together with the RPs.*

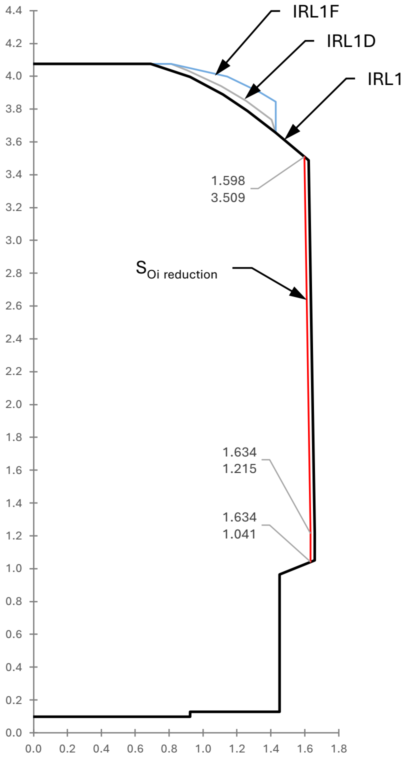



*Figure 17 $S_{0i\ reduction}$ for IRL1, IRL1D and IRL1F, EXCEPT for gauging at the Local Restrictions LR1 and LR2*

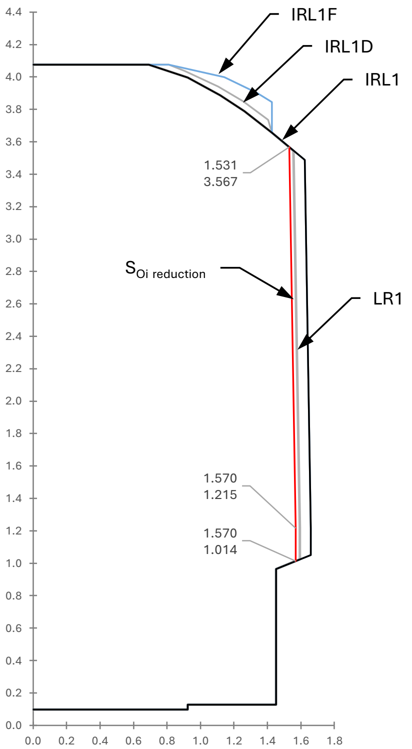



*Figure 18 $S_{0i\ reduction}$ for gauging at Local Restriction LR1*

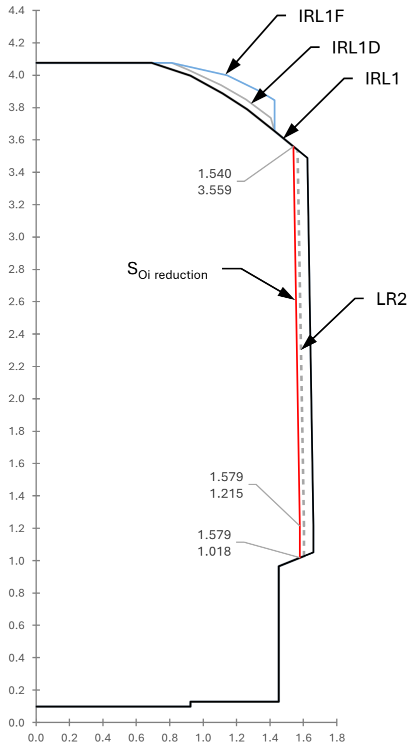



*Figure 19 $S_{0i\ reduction}$ for gauging at Local Restriction 2*

**c) *Overthrow Enlargements***

*In tight curves with radii 150 m > R >= 80 m an additional allowance for inner and outer overthrows is required to avoid unacceptable reductions to the width of vehicles with longer wheelbases than the reference vehicle.*

*This applies to all Gauges IRL 1/1D/1F/2.*

*The additional enlargements provided by the Fixed Installations are:*

$S_{0a\ enlargement} = (15\ m^2 * (1 / R) - 0.1\ m)_{if>0}$

$S_{0i\ enlargement} = (15\ m^2 * (1 / R) - 0.1\ m)_{if>0}$

*These additional enlargements cause a non-linearity for gauging of INNER points and OUTER points at the Relevant Radius $R_{150}$ = 150 m.*

## 5.168. $S_{0a}$ [m] – Allowance for the overthrow of OUTER Relevant Points RMP, REP

For any curve radius between straight track $R_0$ and $R_{80}$ = 80 m:

$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$

## 5.169. $S_{0a\ enlargement}$ [m] – Enlargement of OUTER overthrow for R<150 m

$S_{0a\ enlargement} = (15\ m^2 * (1 / R) - 0.1\ m)_{if>0}$

## 5.170. $S_{0a\ geometric}$ [m] – Geometric OUTER overthrow of Reference Vehicle

Permitted allowance for OUTER overthrow representing the reference vehicle.

This applies to all Gauges IRL 1/1D/1F/2.

$S_{0a\ geometric} = 21.440\ m^2 * (1 / R)$

## 5.171. $S_{0i}$ [m] – Allowance for the overthrow of INNER Relevant Points RMP, REP

**a) at IRL 1/1D/1F:**

For any curve radius between straight track $R_0$ and $R_{80}$ = 80 m:

$S_{0i} = (S_{0i\ geometric} - S_{0i\ reduction})_{if>0} + S_{0i\ enlargement}$

*Note: The formula element 'if > 0' causes a non-linearity of this function at $R_{900}$. $R_{900}$ is therefore a Relevant Radius.*

**b) at IRL 2:**

For any curve radius between straight track $R_0$ and $R_{80}$ = 80 m:

$S_{0i} = S_{0i\ geometric} + S_{0i\ enlargement}$

## 5.172. $S_{0i\ enlargement}$ [m] – Enlargement of INNER overthrow for R<150 m

$S_{0i\ enlargement} = (15\ m^2 * (1 / R)) - 0.1\ m)_{if>0}$

*Note: As this formula only applies for R < 150 m, it creates a Relevant Radius at $R_{150}$.*

## 5.173. $S_{0i\ geometric}$ [m] – Geometric INNER overthrow of Reference Vehicle

Permitted allowance for INNER overthrow representing the reference vehicle.

This applies to all Gauges IRL 1/1D/1F/2.

$S_{0i\ geometric} = 22.482\ m^2 * (1 / R)$

## 5.174. $S_{0i\ reduction}$ [m] - Reduction of INNER overthrow ONLY for IRL1/1D/1F

Reduction within the Allowed Inner Overthrow. This value is case dependent and depends on $h_{shift}$ of a Relevant Point:

a) EXCEPT for LR1 and LR2:
IF $h_{S0i\ reduction\ MIN} =< h_{shift} <= h_{S0i\ reduction\ MAX}$ : $S_{0i\ reduction} = 0.025\ m$

ELSE: $S_{0i\ reduction} = 0.000\ m$

b) ONLY for LR1:
IF $h_{S0i\ LR1\ reduction\ MIN} =< h_{shift} <= h_{S0i\ LR1\ reduction\ MAX}$ : $S_{0i\ reduction} = 0.025\ m$

ELSE: $S_{0i\ reduction} = 0.000\ m$

c) ONLY for LR2:
IF $h_{S0i\ LR2\ reduction\ MIN} =< h_{shift} <= h_{S0i\ LR2\ reduction\ MAX}$ : $S_{0i\ reduction} = 0.025\ m$

ELSE: $S_{0i\ reduction} = 0.000\ m$

d) ONLY for vLR1:
IF $h_{S0i\ reduction\ MIN} =< h_{shift\text{-}vLR1} <= h_{S0i\ reduction\ MAX}$ : $S_{0i\ reduction} = 0.025\ m$

ELSE: **$S_{0i\ reduction}$ = 0.000 m**

### 5.175. $T_D$ [m] - Maximum permitted random cross level error of the track expressed as cant

For IRL1, 1D, 1F and 2 Gauges this value is:

**$T_D$ = 0.020 m**

### 5.176. $T_N$ [m] - Maximum permitted vertical alignment error of the track in normal coordinates

For IRL1, 1D, 1F and 2 Gauges this value is:

**$T_N$ = 0.025 m**

### 5.177. $T_{osc\ xx}$ [m] – General symbol for allowance for vehicle roll due to random imperfections within wheel-rail contact.

This element is expressed as an additional cross level error or cant.

### 5.178. $T_{osc\ straight\&oc\ NTQ}$ [m] – For Fixed Installations next to straight track or next to the outside of curves.

For normal track quality = this shall be assigned to any track other than slab track with normal track quality.

For IRL1, 1D, 1F and 2 Gauges this value is:

**$T_{osc\ straight\&oc\ NTQ}$ = 0.065 m**

### 5.179. $T_{osc\ straight\&oc\ VGTQ}$ [m] - For Fixed Installations next to straight track or next to the outside of curves.

For very good track quality = this may be assigned to slab track of very good track quality.

For IRL1, 1D, 1F and 2 Gauges this value is:

**$T_{osc\ straight\&oc\ VGTQ}$ = 0.039 m**

### 5.180. $T_{osc\ straight\&oc\ LR1}$ [m] - For Fixed Installations next to straight track or next to the outside of curves.

For LR1 where the dynamic roll is reduced by a civil line speed of 16 km/h.

For IRL1, 1D, 1F and 2 Gauges this value is:

**$T_{osc\ straight\&oc\ LR1}$ = 0.039 m**

### 5.181. $T_{osc\ straight\&oc\ LR2}$ [m] - For Fix Installations next to straight track or next to the outside of curves.

For LR2 where the dynamic roll is reduced by a civil line speed of 32 km/h.

For IRL1, 1D, 1F and 2 Gauges this value is:

**$T_{osc\ straight\&oc\ LR2}$ = 0.039 m**

### 5.182. $T_{osc\ ic\ NTQ}$ [m] - For Fixed Installations next to the inside of curves.

For normal track quality = this shall be assigned to any track other than slab track with normal quality.

For IRL1, 1D, 1F and 2 Gauges this value is:

**$T_{osc\ ic\ NTQ}$ = 0.013 m**

**5.183. $T_{osc\ straight\&oc\ VGTQ}$ [m] - For Fixed Installations next to the inside of curves.**

For very good track quality = this may be assigned to slab track of very good track quality.

For IRL1, 1D, 1F and 2 Gauges this value is:

**$T_{osc\ ic\ VGTQ}$ = 0.007 m**

**5.184. $T_{osc\ straight\&oc\ LR1}$ [m] - For Fixed Installations next to the inside of curves.**

For LR1 where the dynamic roll is reduced by a civil line speed of 16 km/h.

For IRL1, 1D and 1F Gauges this value is:

**$T_{osc\ ic\ LR1}$ = 0.007 m**

**5.185. $T_{osc\ straight\&oc\ LR2}$ [m] - For Fixed Installations next to the inside of curves.**

For LR2 where the dynamic roll is reduced by a civil line speed of 32 km/h.

For IRL1, 1D and 1F Gauges this value is:

**$T_{osc\ ic\ LR2}$ = 0.007m**

**5.186. $T_{susp}$ [°] - Allowance for vehicle roll due to a dissymmetry caused by a random uneven suspension setup within the reference vehicle.**

For IRL1, 1D, 1F and 2 Gauges this value is:

**$T_{susp}$ = 0.77°**

**5.187. $T_{track}$ [m] - Allowance for the permitted lateral alignment error of the track centre line, EXCEPT for LR1 & LR2**

For IRL1, 1D, 1F and 2 Gauges this value is:

**$T_{track}$ = 0.025m**

**5.188. $T_{track-LR1}$ [m] – ONLY for LR1: Allowance for the permitted lateral alignment error of the track centre line**

For IRL1, 1D and 1F Gauges this value is:

**$T_{track-LR1}$ = 0.025m**

**5.189. $T_{track-LR2}$ [m] - ONLY for LR2: Allowance for the permitted lateral alignment error of the track centre line**

For IRL1, 1D and 1F Gauges this value is:

**$T_{track-LR2}$ = 0.025m**

**5.190. $v_{max-LR1}$ [m] - Maximum permitted civil line speed at LR 1**

For IRL1, 1D and 1F Gauges this value is:

**$v_{max-LR1}$ = 16 km/h**

**5.191. $v_{max-LR2}$ [m] - Maximum permitted civil line speed at LR 2**

For IRL1, 1D and 1F Gauges this value is:

**$v_{max-LR1}$ = 32 km/h**

**5.192. $v_{max-vLR1}$ [m] - Maximum permitted civil line speed at vLR 1**

For IRL1, 1D and 1F Gauges this value is:

**$v_{max-vLR1}$ = 16 km/h**

**5.193. $vDpl_{a700}$[m] – Only for vLR1 gauging: Term for vehicle related VERTICAL displacement on vertical track radius $vR_{700}$ for OUTER Relevant Points RMP / REP**

$vDpl_{a700} = (a * n_a + n_a^2 – (p^2 / 4)) / (2 * vR_{700})$

*Note: Background information on the development of this formula can be found in of UIC 505-5 (2010). This term is sometimes referred to as “vertical end throw”.*

**5.194. $vDpl_{a1000}$ [m] – Term for vehicle related VERTICAL displacement on vertical track radius $vR_{1000}$for OUTER Relevant Points RMP / REP**

$vDpl_{a1000} = (a * n_a + n_a^2 – (p^2 / 4)) / (2 * vR_{1000})$

*Note: Background information on the development of this formula can be found in of UIC 505-5 (2010). This term is sometimes referred to as “vertical end throw”.*

**5.195. $vDpl_{i700}$ [m] – Only for vLR1 gauging: Term for vehicle related VERTICAL displacement on vertical track radius $vR_{700}$ for INNER Relevant Points RMP / REP**

$vDpl_{i700} = (a * n_i – n_i^2 + (p^2 / 4)) / (2 * vR_{700})$

*Note: Background information on the development of this formula can be found in of UIC 505-5 (2010). This term is sometimes referred to as “vertical inner throw”.*

**5.196. $vDpl_{i1000}$ [m] – Term for vehicle related VERTICAL displacement on vertical track radius $vR_{1000}$for INNER Relevant Points RMP / REP**

$vDpl_{i1000} = (a * n_i – n_i^2 + (p^2 / 4)) / (2 * vR_{1000})$

*Note: Background information on the development of this formula can be found in of UIC 505-5 (2010). This term is sometimes referred to as “vertical inner throw”.*

**5.197. $vR_{1000}$ [m] (= $vR_{min)}$ – Minimum VERTICAL track radius (for dip or hill) for any gauging calculation, EXCEPT for vLR1.**

For IRL1, 1D, 1F and 2 Gauges $vR_{1000}$ =1000 m.

**5.198. $vR_{700}$ [m] (= $vR_{min-vLR1}$) – ONLY for vLR1 gauging: Minimum VERTICAL track radius at vLR1 (for dip or hill).**

For IRL1, 1D and 1F Gauges - NOT for IRL2 Gauge: $vR_{min-vLR1} = vR_{700}$ = 700 m.

**5.199. $vS_{0xx}$ – General symbol for Geometric VERTICAL shift allowance provided by the Fixed Installations**

*Note: Due to historic definitions this is based on a 2-axle reference vehicle 2 with:*

- *a = 16.000 m*

- *$p = 0.000$ m*
- *$n_{amax} = 3.314$ m*

**5.200. $vS_{0a\ geometric700}$ [m] – ONLY for vLR1: Geometric OUTER VERTICAL shift allowance provided by the Fixed Installations**

$vS_{0a\ geometric\ 700} = (32\ [m^2] * (1 / vR_{700})) + 0.016\ [m] = 0.062m$

*Note: This includes an additional allowance of 0.016 m that is provided by the Fixed Installations at vLR1.*

**5.201. $vS_{0a\ geometric1000}$ [m] – Geometric OUTER Relevant Points VERTICAL shift allowance provided by the Fixed Installations, EXCEPT for vLR1**

$vS_{0a\ geometric1000} = 32\ m^2 * (1 / vR_{1000}) = 0.032m$

**5.202. $vS_{0i\ geometric700}$ [m] – ONLY for vLR1: Geometric OUTER VERTICAL shift allowance provided by the Fixed Installations**

$vS_{0i\ geometric\ 700} = (32\ m^2 * (1 / vR_{700})) + 0.016\ m = 0.062\ m$

*Note: This includes an additional allowance of 0.016 m that is provided by the Fixed Installations at vLR1.*

**5.203. $vS_{0i\ geometric1000}$ [m] – Geometric OUTER VERTICAL shift allowance provided by the Fixed Installations, EXCEPT for vLR1**

$vS_{0i\ geometric} = 32\ m^2 * (1 / vR_{1000}) = 0.032\ m$

**5.204. $w_{R0}$ or $w_{a\ f(R)}$ or $w_{i\ f(R)}$ [m] – Various values for lateral play between bogie and vehicle body**

$w_{R0}$ applies for straight track. This value is symmetrical to both sides of the Vehicle and does not differentiate between $w_a$ and $w_i$.

Depending on the vehicle design, $w_i$ and $w_a$ can be 0.00 m or >0m, both can depend on curvature (1/R) and both can have different values for the same Radius. Examples:

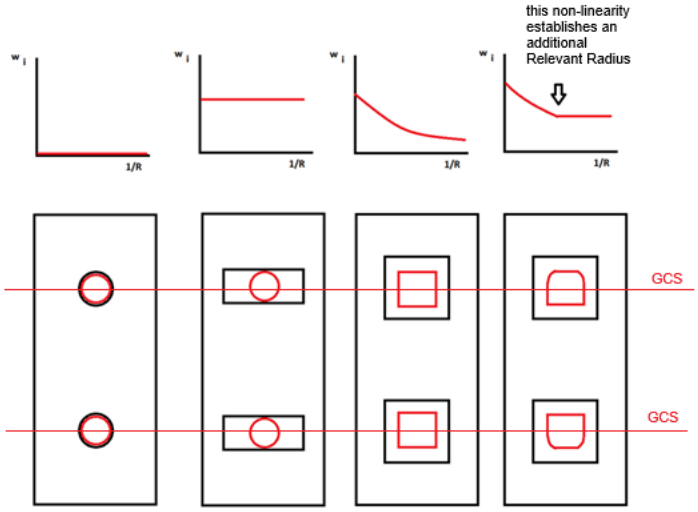



*Figure 20 Examples for different lateral play behaviours between bogie and vehicle body.*

Top view on bogie (black) with centre pivot/plunger (red).

Define the following values for the actual vehicle:

Set all values to $w_{xx}$ = 0.000 m if no bogie is present.

$w_{R0}$

$w_{a\ R2000}$

$w_{a\ R900}$

$w_{a\ R250.4}$

$w_{a\ R150}$

$w_{a\ R80}$

$w_{a\ R116-LR1}$

$w_{aR119-LR1}$

$w_{a\ R280-LR2}$

$w_{a\ R98-vLR1}$

$w_{a\ Radd1}$

$w_{i\ R2000}$

$w_{i\ R900}$

$w_{i\ R250.4}$

$w_{i\ R150}$

$w_{i\ R80}$

$w_{i\ R116-LR1}$

$w_{i\ R119-LR1}$

$w_{i\ R280-LR2}$

$w_{i\ R98-vLR1}$

$w_{i\ Radd1}$

$w_{i\ Radd2}$

...

## 5.205. $z_{xx}$ [m] – General symbol for lateral displacement caused to Relevant Points RMP, REP by roll of the vehicle and as reduced by any associated allowances provided by the Fixed Installations

## 5.206. $z_a$ [m] –Lateral displacement caused to OUTER Relevant Points RMP, REP by roll of the vehicle and as reduced by any associated allowances provided by the Fixed Installations

For OUTER Relevant Points RMP, REP:

**$z_a$ [m] = (z1 term) + (z2 term) + (z3.1$_a$ term - z3.2$_a$ term)**

*Note: The result of this formula may become negative.*

## 5.207. $z_i$ [m] –Lateral displacement caused to INNER Relevant Points RMP, REP by roll of the vehicle and as reduced by any associated allowances provided by the Fixed Installations

For INNER Relevant Points RMP, REP:

**$z_i$ [m] = (z1 term) + (z2 term) + ($z3.1_i$ term – $z3.2_i$ term)**

*Note: The result of this formula may become negative.*

## 5.208. z1 term

a) EXCEPT for gauging at vLR1:

$z1\ term = [s * T_D / L * |h_{nom} - h_c|] - [s_{0\ random} * T_D / L * |h_{shift} - h_{c0}|]$

*Note: This term includes:*

*b) the roll of the Vehicle that is caused by the vehicle operating on straight or curved track with the maximum permitted cross level error $T_D$: $[s * T_D / L * |h_{nom} - h_c|]$*

*c) and the associated allowance provided by the Fixed Installations: $[s_{0\ random} * T_D / L * |h_{shift} - h_{c0}|)]$*

d) ONLY for gauging at vLR1:

$z1\ term = [s * T_D / L * |h_{nom} - h_c|] - [s_{0\ random} * T_D / L * |h_{shift\text{-}vLR1} - h_{c0}|]$

## 5.209. z2 term

a) EXCEPT for gauging at vLR1:

$z2\ term = \{[(\tan \eta_0 + \tan \alpha_J) * (1 + s) * |h_{nom} - h_c|] - [\tan \eta_{0r} * (1 + s_{0\ random}) * |h_{shift} - h_{c0}|]\}_{if>0}$

b) ONLY for gauging at vLR1:

$z2\ term = \{[(\tan \eta_0 + \tan \alpha_J) * (1 + s) * |h_{nom} - h_c|] - [\tan \eta_{0r} * (1 + s_{0\ random}) * |h_{shift\text{-}vLR1} - h_{c0}|]\}_{if>0}$

*Note: This term includes:*

*a) the roll of the Vehicle body that is caused during operating on straight or curved track by the vehicle's dissymmetry and the Vehicles side bearer clearance: $[(\tan \eta_0 + \tan \alpha_J) * (1 + s) * |h_{nom} - h_c|]$*

*b) and the associated allowance provided by the Fixed Installations: $[\tan \eta_{0r} * (1 + s_{0\ random}) * |h_{shift} - h_{c0}|]$*

*Note: The element '$\{...\}_{if>0}$' ensures, that no vehicle to be operated on the Network can become systematically enlarged through the application of a very low value for $\eta_0$.*

## 5.210. $z3.1_a$ term – ONLY for OUTER Relevant Points RMP, REP

This term includes the roll of the Vehicle that is caused during operation on straight or curved track by the Vehicle's reaction to Cant and Cant Deficiency at OUTER Relevant Points RMP, REP:

*Note: These formulae are case dependent and relate to $h_{nom}$ and $h_c$!*

a) IF $h_{nom} > h_c$: **$z3.1_a\ term = s * I_{max\ f(R)} / L * (h_{nom} - h_c)$**

OR

b) IF $h_{nom} = h_c$: **$z3.1_a$ term = 0.000 m**

OR

c) IF $h_{nom}<h_c$: **$z3.1_a$ term = $s * D_{max\ f(R)} / L * (h_c - h_{nom})$**

## 5.211. $z3.2_a$ term – ONLY for OUTER Relevant Points RMP, REP

This term includes the allowance that is provided by the Fixed Installations in association with the z3.1a term.

When gauging at a vertical Local Restriction, $h_{shift}$ shall in all cases below become replaced by $h_{shift-vLR1}$.

*Note: These formulae are case dependent and relate to $h_{shift}$ and $h_{c0}$!*

EXCEPT for gauging at vLR1, the terms a), b) or c) apply:

a) IF $h_{shift} > h_{c0}$: **$z3.2_a$ term = $s_{0\ static} * I_{max\ f(R)} / L * (h_{shift} - h_{c0})$**

OR

b) IF $h_{shift} = h_{c0}$: **$z3.2_a$ term = 0.000 m**

OR

c) IF $h_{shift} < h_{c0}$: **$z3.2_a$ term = $s_{0\ static} * D_{max\ f(R)} / L * (h_{c0} - h_{shift})$**

ONLY for gauging at vLR1, the terms d), e) or f) apply:

d) IF $h_{shift-vLR1} > h_{c0}$: **$z3.2_a$ term = $s_{0\ static} * I_{max\ f(R)} / L * (h_{shift-vLR1} - h_{c0})$**

OR

e) IF $h_{shift-vLR1} = h_{c0}$: **$z3.2_a$ term = 0.000 m**

OR

f) IF $h_{shift-vLR1} < h_{c0}$: **$z3.2_a$ term = $s_{0\ static} * D_{max\ f(R)} / L * (h_{c0} - h_{shift-vLR1})$**

## 5.212. $z3.1_i$ term – ONLY for INNER Relevant Points RMP, REP

This term includes the roll of the Vehicle that is caused during operation on straight or curved track by the Vehicle's reaction to Cant and Cant Deficiency at INNER Relevant Points RMP, REP:

*Note: These formulae are case dependent and relate to $h_{nom}$ and $h_c$!*

a) IF $h_{nom} > h_c$: **$z3.1_i$ term = $s * D_{max\ f(R)} / L * (h_{nom} - h_c)$**

OR

b) IF $h_{nom} = h_c$: **$z3.1_i$ term = 0.000 m**

OR

c) IF $h_{nom} < h_c$: **$z3.1_i$ term = $s * I_{max\ f(R)} / L * (h_c - h_{nom})$**

## 5.213. $z3.2_i$ term – ONLY for INNER Relevant Points RMP, REP

This term includes the allowance that is provided by the Fixed Installations in association with the $z3.1_i$ term.

When gauging at a vertical Local Restriction, $h_{shift}$ shall in all cases below become replaced by $h_{shift-vLR1}$.

*Note: These formulae are case dependent and relate to $h_{shift}$ and $h_{c0}$!*

EXCEPT for gauging at vLR1, the terms a), b) or c) apply:

a) IF $h_{shift} > h_{c0}$: **$z3.2_i$ term = $s_{0\ static} * D_{max\ f(R)} / L * (h_{shift} - h_{c0})$**

OR

b) IF $h_{shift} = h_{c0}$: **$z3.2_i$ term = 0.000 m**

OR

c) IF $h_{shift} < h_{c0}$: **$z3.2_i$ term = $s_{0\ static} * I_{max\ f(R)} / L * (h_{c0} - h_{shift})$**

ONLY for gauging at vLR1, the terms d), e) or f) apply:

d) IF $h_{shift-vLR1} > h_{c0}$: **$z3.2_i$ term = $s_{0\ static} * D_{max\ f(R)} / L * (h_{shift-vLR1} - h_{c0})$**

OR

e) IF $h_{shift-vLR1} = h_{c0}$: **$z3.2_i$ term = 0.000 m**

OR

f) IF $h_{shift-vLR1} < h_{c0}$: **$z3.2_i$ term = $s_{0\ static} * I_{max\ f(R)} / L * (h_{c0} - h_{shift-vLR1})$**

**5.214. $\alpha_j$ [m] – Additional vehicle body roll angle caused where the side bearer gap J is greater than $J_0$.**

*Note: The roll effect caused by a side bearer gap up to $J_0$ is included within $\eta_{0r}$.*

**$= \arctan((J - J_0)_{if>0} / b_G)$**

**5.215. $\Delta b_a$ [m] – Lateral distance in Normal Coordinates between $b_{nom}$ of an individual OUTER Relevant Point RMP, REP at a given height and the VCG for that same Relevant Point**

$\Delta b_a$ = (allowance provided by the Fixed Installations for that Relevant Point) – (width required by the Vehicle for that Relevant Point)

a) ONLY for straight track gauging:

**$\Delta b_a = (b_{RP} + S_{0a}) - (b_{nom} + Dpl_{a\ straight})$**

b) ONLY for curved track gauging:

**$\Delta b_a = (b_{RP} + S_{0a}) - (b_{nom} + Dpl_{a\ curve})$**

A value >= 0.000 m indicates that the vehicle design is compatible with the selected Gauge.

A value < 0.000 m indicates that the vehicle design is not compatible with the selected Gauge.

**5.216. $\Delta b_i$ [m] – Lateral distance in Normal Coordinates between $b_{nom}$ of an individual INNER Relevant Point RMP, REP and the VCG for that same Relevant Point**

$\Delta b_i$ = (allowance provided by the Fixed Installations for that Relevant Point) – (width required by the Vehicle for that Relevant Point)

a) ONLY for straight track gauging:

**$\Delta b_i = (b_{RP} + S_{0i}) - (b_{nom} + Dpl_{i\ straight})$**

b) ONLY for curved track gauging:

**$\Delta b_i = (b_{RP} + S_{0i}) - (b_{nom} + Dpl_{i\ curve})$**

A value >= 0.000 m indicates that the vehicle design is compatible with the selected Gauge.

A value < 0.000 m indicates that the vehicle design is not compatible with the selected Gauge.

## 5.217. $\Delta k_{L2.2axle}$ [m] – Maximum permitted differential vertical wheel wear at the same axle

$\Delta k_{L2.2axle}$ shall be taken from the maintenance manual of the vehicle.

However, it shall at least be >=2mm.

## 5.218. $\Delta k_{L2.2vehicle}$ [m] – Maximum permitted differential vertical wheel wear at the same vehicle

$\Delta k_{L2.2vehicle}$ shall be taken from the maintenance manual of the vehicle.

However, it shall at least be >=5mm.

## 5.219. $\Delta Pb_a$ [m] – Lateral distance in Normal Coordinates between $Pb_{nom}$ of an individual OUTER Relevant Point RPP at a given height and the VCG for that same Relevant Pantograph Point RPP

$\Delta Pb_a$ = (allowance provided by the Fixed Installations for that Relevant pantograph Point) – (width required by the vehicle's pantograph for that Relevant pantograph Point)

a) ONLY for straight track gauging:

$$\Delta Pb_a = (Pb_{RP} + PxxS_{0a}) - (Pb_{nom} + PDpl_{a\ straight})$$

b) ONLY for curved track gauging:

$$\Delta Pb_a = (Pb_{RP} + PxxS_{0a}) - (Pb_{nom} + PDpl_{a\ curve})$$

$PxxS_{0a}$ is used in this IRS to improve readability of the formulae. It shall be replaced as appropriate by either $P1.5S_{0a\ RPPx}$ or $P25S_{0a}$ .

A value >= 0.000 m indicates that the vehicle design is compatible with the selected Gauge.

A value < 0.000 m indicates that the vehicle design is not compatible with the selected Gauge.

## 5.220. $\Delta Pb_i$ [m] – Lateral distance in Normal Coordinates between $b_{nom}$ of an individual INNER Relevant Point RPP at a given height and the VCG for that same Relevant Pantograph Point RPP

$\Delta Pb_i$ = (allowance provided by the Fixed Installations for that Relevant pantograph Point) – (width required by the vehicle's pantograph for that Relevant pantograph Point)

a) ONLY for straight track gauging:

$$\Delta Pb_i = (Pb_{RP} + PxxS_{0i}) - (Pb_{nom} + PDpl_{i\ straight})$$

b) ONLY for curved track gauging:

$$\Delta Pb_i = (Pb_{RP} + PxxS_{0i}) - (Pb_{nom} + PDpl_{i\ curve})$$

$PxxS_{0i}$ is used in this IRS to improve readability of the formulae. It shall be replaced as appropriate by either $P1.5S_{0i\ RPPx}$ or $P25S_{0i}$ .

A value >= 0.000 m indicates that the vehicle design is compatible with the selected gauge.

A value <0.000 m indicates that the vehicle design is not compatible with the selected gauge.

## 5.221. $\eta_0$[°] – Actual value of the vehicle design's dissymmetry

Angle of dissymmetry of the actual vehicle design against the theoretical vehicle centre line as caused by construction tolerances, suspension imperfections and unequal vehicle mass / load distribution. Dissymmetry shall either:

- be measured; or
- be calculated.

## 5.222. $\eta_{0r}$[°] – Reference value for vehicle dissymmetry

**$\eta_{0r}$ =1°** is taken into account by the Fixed Installation for IRL1, 1D, 1F and 2 Gauges.

# 6. Reference Profiles

*The figure below provides an informative overview of:*

- *the RP-M for IRL1 (with LR1 and LR2)*
- *the RP-M for IRL1D (with LR1 and LR2)*
- *the RP-M for IRL1F (with LR1 and LR2)*
- *the RP-M for IRL2*

*and*

- *the RP-P for IRL1, 1D, 1F, 2*

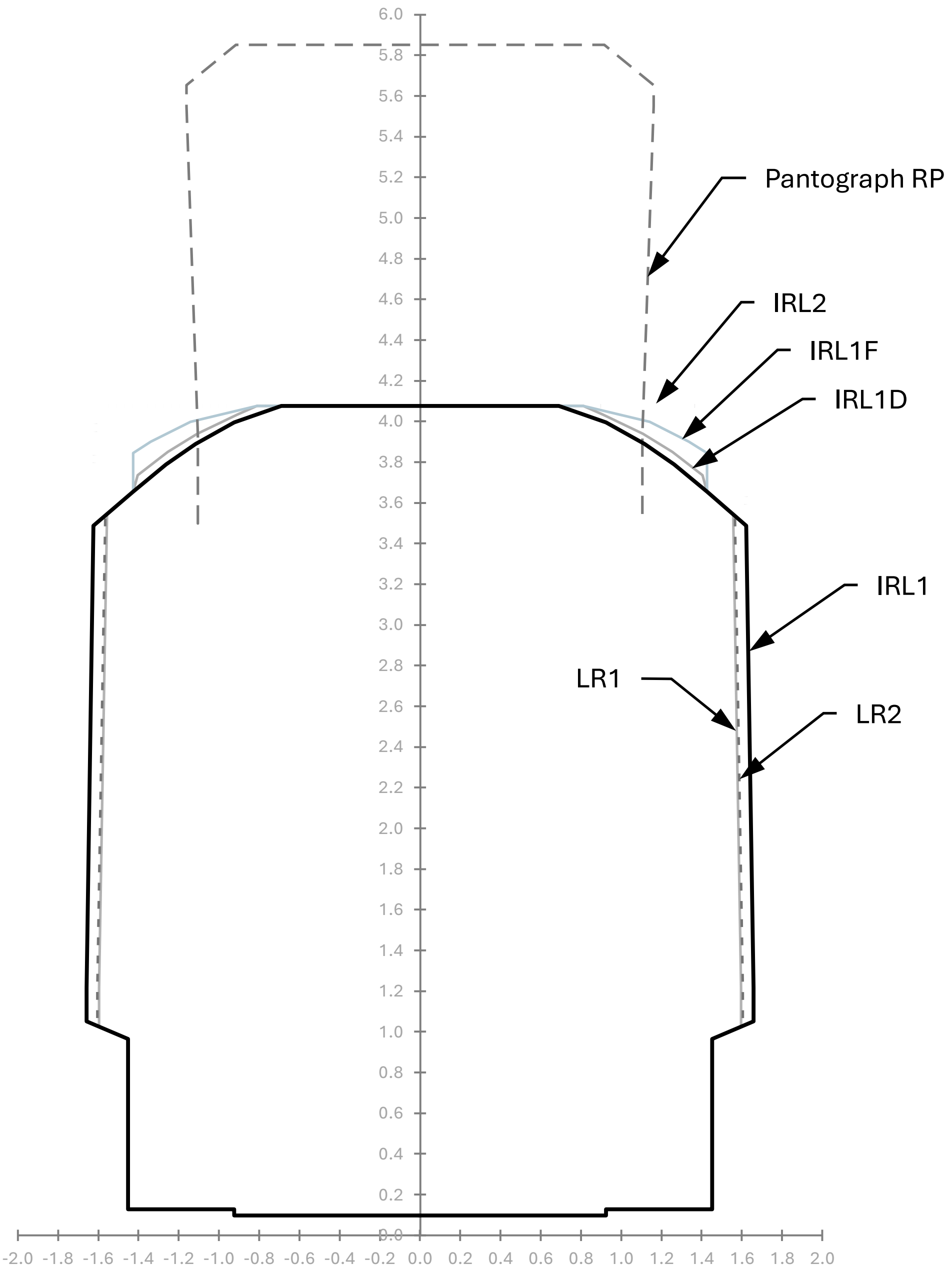



*Figure 21 Overview on RP-Ms and RP-P$_{1.5kV}$*

## 6.1. Mechanical Reference Profiles RP-Ms for IRL1

*Note: IRL1 Gauge is the smallest gauge defined in this IRS and is according to an information obtained from IÉ-IM (in 2024) available on the complete Network.*

All values are given in Normal Coordinates in the unit [m]. All RMPs shall be gauged against the RP-M shown below.

A vehicle that complies with the IRL1 Gauge, also complies with the IRL1D, IRL1F and IRL2 Gauges.

| IRL1 Reference Profile | | | IRL1 Reference Profile for LR1 | | IRL1 Reference Profile for LR2 | |
|---|---|---|---|---|---|---|
| **Point** | **$h_{RP}$ (m)** | **$b_{RP}$ (m)** | **$h_{RP}$ (m)** | **$b_{RP}$ (m)** | **$h_{RP}$ (m)** | **$b_{RP}$ (m)** |
| P1 | 0.094 | 0.000 | 0.094 | 0.000 | 0.094 | 0.000 |
| P2 | 0.094 | 0.936 | 0.094 | 0.936 | 0.094 | 0.936 |
| P3 | 0.127 | 0.936 | 0.127 | 0.936 | 0.127 | 0.936 |
| P4 | 0.127 | 1.452 | 0.127 | 1.452 | 0.127 | 1.452 |
| P5 | 0.965 | 1.452 | 0.965 | 1.452 | 0.965 | 1.452 |
| P6 (AT point) | 1.051 | 1.659 | 1.024 | 1.595 | 1.028 | 1.604 |
| P7 (AT point) | 1.215 | 1.659 | 1.215 | 1.595 | 1.215 | 1.604 |
| P8 (AT point) | 3.488 | 1.623 | 3.545 | 1.556 | 3.538 | 1.565 |
| P9 | 3.655 | 1.428 | 3.655 | 1.428 | 3.655 | 1.428 |
| P10 | 3.789 | 1.262 | 3.789 | 1.262 | 3.789 | 1.262 |
| P11 | 3.888 | 1.117 | 3.888 | 1.117 | 3.888 | 1.117 |
| P12 | 3.996 | 0.924 | 3.996 | 0.924 | 3.996 | 0.924 |
| P13 (PT point) | 4.076 | 0.691 | 4.076 | 0.691 | 4.076 | 0.691 |
| P14 | 4.076 | 0.000 | 4.076 | 0.000 | 4.076 | 0.000 |

IRL1 Gauge has the Local Restrictions LR1, LR2 and the vertical Local Restriction vLR1 which shall be considered during the gauging calculations.

*Note: The following heights define by MINIMAL and MAXIMAL heights the interval in which the gauging calculations shall include Local Restrictions LR1, LR2. (Refer to section 4.1.22.3 for further details.)*

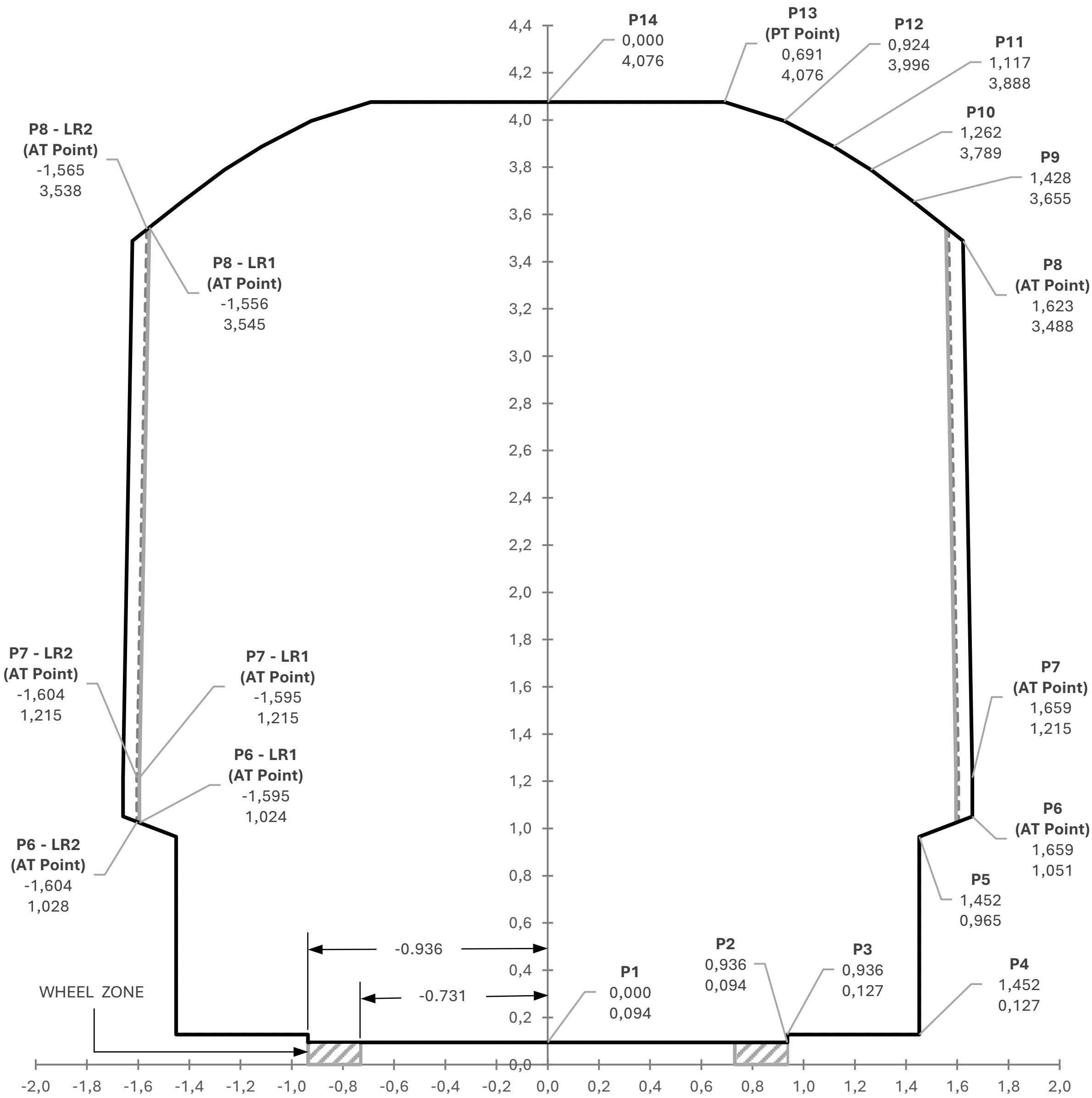
| *$h_{LR1}$ MIN* | *$h_{LR1}$ MAX* | *$h_{LR2}$ MIN* | *$h_{LR2}$ MAX* |
|---|---|---|---|
| *1.024* | *3.545* | *1.028* | *3.538* |

$S_{0i\ reduction}$ applies at this Gauge.

The following dimensions define by MINIMAL and MAXIMAL heights the interval in which the gauging calculations shall include $S_{0i\ reduction}$.

| $h_{S0i}$ reduction MIN | $h_{S0i}$ reduction MAX | $h_{S0i\ LR1}$ reduction MIN | $h_{S0i\ LR1}$ reduction MAX | $h_{S0i\ LR2}$ reduction MIN | $h_{S0i\ LR2}$ reduction MAX |
|---|---|---|---|---|---|
| 1.041 | 3.509 | 1.014 | 3.567 | 1.018 | 3.559 |

*Note: Refer to section 5.167 for further details.*




The WHEEL ZONE may only be used for the wheels or for Relevant Mechanical Points of equipment that is for technical reasons required to be in close proximity to the wheels and near to the rail (e.g. items such as sandpipes). Such equipment shall remain within the swept profile of the wheels and may not protrude laterally or downwards outside of the WHEEL ZONE at any horizontal or vertical curve radius and at any track gauge up to $\ell_{max}$ =1.630m.

*Figure 22 RP-Ms for IRL1, IRL1 LR1 and IRL1 LR2*

## 6.2. Mechanical Reference Profiles RP-Ms for IRL1D

*Note: IRL1D Gauge is based on IRL1 and has been enlarged in the upper section to permit the operation of modern multiple unit vehicles with extensive roof top equipment. IRL1D Gauge is only available on certain parts of the Network.*

All values are given in Normal Coordinates in the unit [m]. All RMPs shall be gauged against the RP-M shown below.

A vehicle that complies with the IRL1D Gauge, also complies also with the IRL1F and IRL2 Gauges.

| IRL1D Reference Profile | | | IRL1D Reference Profile for LR1 | | IRL1D Reference Profile for LR2 | |
|---|---|---|---|---|---|---|
| **Point** | **$h_{RP}$ (m)** | **$b_{RP}$ (m)** | **$h_{RP}$ (m)** | **$b_{RP}$ (m)** | **$h_{RP}$ (m)** | **$b_{RP}$ (m)** |
| P1 | 0.094 | 0.000 | 0.094 | 0.000 | 0.094 | 0.000 |
| P2 | 0.094 | 0.936 | 0.094 | 0.936 | 0.094 | 0.936 |
| P3 | 0.127 | 0.936 | 0.127 | 0.936 | 0.127 | 0.936 |
| P4 | 0.127 | 1.452 | 0.127 | 1.452 | 0.127 | 1.452 |
| P5 | 0.965 | 1.452 | 0.965 | 1.452 | 0.965 | 1.452 |
| P6 (AT point) | 1.051 | 1.659 | 1.024 | 1.595 | 1.028 | 1.604 |
| P7 (AT point) | 1.215 | 1.659 | 1.215 | 1.595 | 1.215 | 1.604 |
| P8 (AT point) | 3.488 | 1.623 | 3.545 | 1.556 | 3.538 | 1.565 |
| P9 | 3.655 | 1.428 | 3.655 | 1.428 | 3.655 | 1.428 |
| P10 | 3.736 | 1.405 | 3.736 | 1.405 | 3.736 | 1.405 |
| P11 | 3.850 | 1.255 | 3.850 | 1.255 | 3.850 | 1.255 |
| P12 | 3.940 | 1.107 | 3.940 | 1.107 | 3.940 | 1.107 |
| P13 | 4.035 | 0.908 | 4.035 | 0.908 | 4.035 | 0.908 |
| P14 (PT point) | 4.076 | 0.812 | 4.076 | 0.812 | 4.076 | 0.812 |
| P15 | 4.076 | 0.000 | 4.076 | 0.000 | 4.076 | 0.000 |

IRL1D Gauge has the Local Restrictions LR1, LR2 and the vertical Local Restriction vLR1 which shall be considered during the gauging calculations.

*Note: The following heights define by MINIMAL and MAXIMAL heights the interval in which the gauging calculations shall include Local Restrictions LR1, LR2. (Refer to section 4.1.22.3 for further details.)*

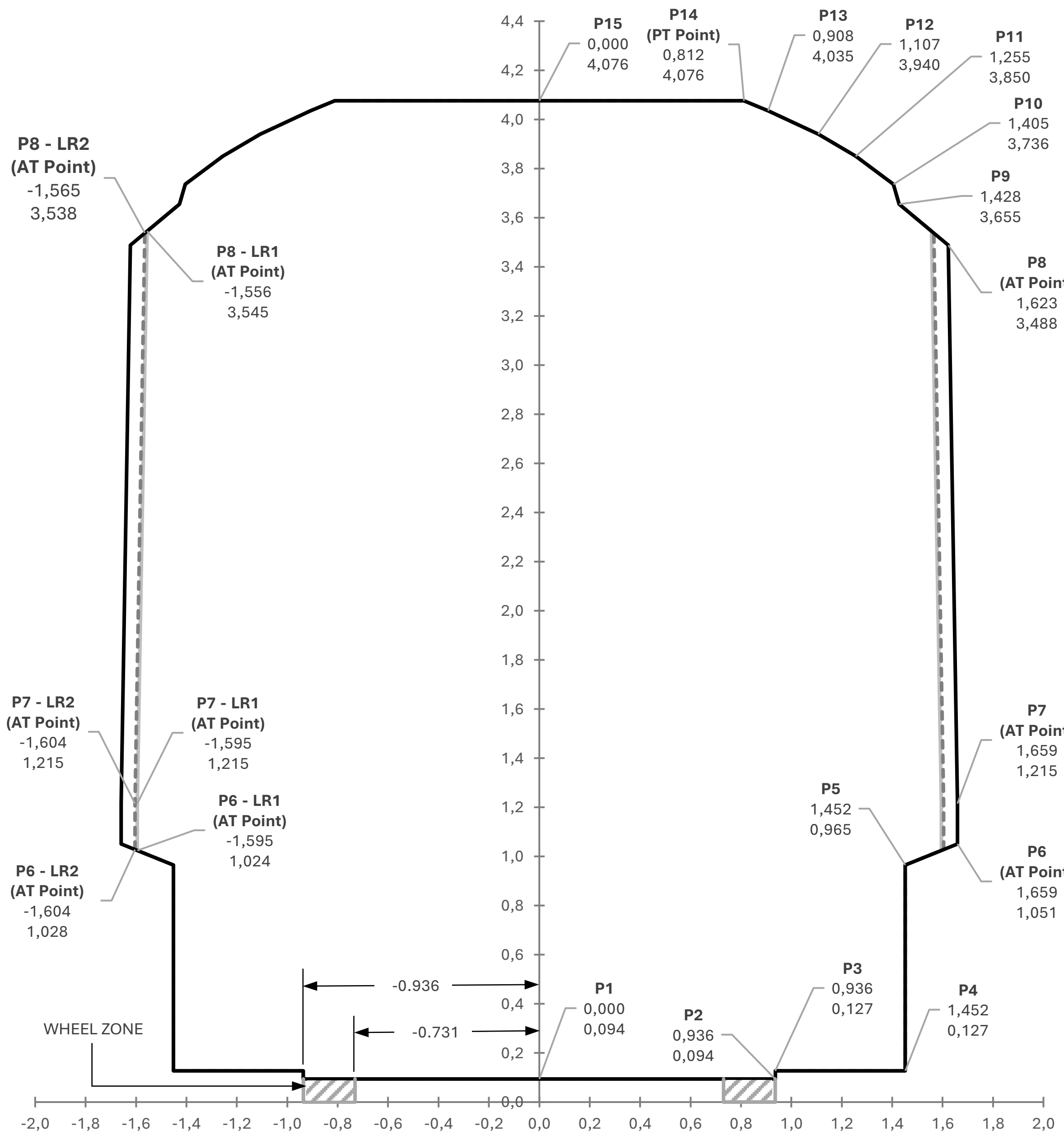
| $h_{LR1}$ MIN | $h_{LR1}$ MAX | $h_{LR2}$ MIN | $h_{LR2}$ MAX |
|---|---|---|---|
| *1.024* | *3.545* | *1.028* | *3.538* |

$S_{0i\ reduction}$ applies at this Gauge.

The following dimensions define by MINIMAL and MAXIMAL heights the interval in which the gauging calculations shall include $S_{0i\ reduction}$.

| $h_{S0i}$ reduction MIN | $h_{S0i}$ reduction MAX | $h_{S0i\ LR1}$ reduction MIN | $h_{S0i\ LR1}$ reduction MAX | $h_{S0i\ LR2}$ reduction MIN | $h_{S0i\ LR2}$ reduction MAX |
|---|---|---|---|---|---|
| 1.041 | 3.509 | 1.014 | 3.567 | 1.018 | 3.559 |

*Note: Refer to section 5.167 for further details.*




The WHEEL ZONE may only be used for the wheels or for Relevant Mechanical Points of equipment that is for technical reasons required to be in close proximity to the wheels and near to the rail (e.g. items such as sandpipes). Such equipment shall remain within the swept profile of the wheels and may not protrude laterally or downwards outside of the WHEEL ZONE at any horizontal or vertical curve radius and at any track gauge up to $\ell_{max}$ =1.630m.

*Figure 23 RP-Ms for IRL1D, IRL1D LR1 and IRL1D LR2*

## 6.3. Mechanical Reference Profiles RP-Ms for IRL1F

*Note: IRL1F Gauge is based on IRL1 and has the upper section enlarged to permit the operation of certain multi-modal container and vehicle combinations. The IRL1F Gauge is only available on certain parts of the Network.*

All values are given in Normal Coordinates in the unit [m]. All RMPs shall be gauged against the RP-M shown below.

A vehicle that complies with the IRL1F Gauge, also complies also with the IRL2 Gauge.

| IRL1F Reference Profile | | | IRL1F Reference Profile for LR1 | | IRL1F Reference Profile for LR2 | |
|---|---|---|---|---|---|---|
| **Point** | **$h_{RP}$ (m)** | **$b_{RP}$ (m)** | **$h_{RP}$ (m)** | **$b_{RP}$ (m)** | **$h_{RP}$ (m)** | **$b_{RP}$ (m)** |
| P1 | 0.094 | 0.000 | 0.094 | 0.000 | 0.094 | 0.000 |
| P2 | 0.094 | 0.936 | 0.094 | 0.936 | 0.094 | 0.936 |
| P3 | 0.127 | 0.936 | 0.127 | 0.936 | 0.127 | 0.936 |
| P4 | 0.127 | 1.452 | 0.127 | 1.452 | 0.127 | 1.452 |
| P5 | 0.965 | 1.452 | 0.965 | 1.452 | 0.965 | 1.452 |
| P6 (AT point) | 1.051 | 1.659 | 1.024 | 1.595 | 1.028 | 1.604 |
| P7 (AT point) | 1.215 | 1.659 | 1.215 | 1.595 | 1.215 | 1.604 |
| P8 (AT point) | 3.488 | 1.623 | 3.545 | 1.556 | 3.538 | 1.565 |
| P9 | 3.655 | 1.428 | 3.655 | 1.428 | 3.655 | 1.428 |
| P10 | 3.845 | 1.428 | 3.845 | 1.428 | 3.845 | 1.428 |
| P11 | 3.901 | 1.338 | 3.901 | 1.338 | 3.901 | 1.338 |
| P12 | 3.999 | 1.143 | 3.999 | 1.143 | 3.999 | 1.143 |
| P13(PT point) | 4.076 | 0.812 | 4.076 | 0.812 | 4.076 | 0.812 |
| P14 | 4.076 | 0.000 | 4.076 | 0.000 | 4.076 | 0.000 |

IRL1F Gauge has the Local Restrictions LR1, LR2 and the vertical Local Restriction vLR1 which shall be considered during the gauging calculations.

*Note: The following heights define by MINIMAL and MAXIMAL heights the interval in which the gauging calculations shall include Local Restrictions LR1, LR2. (Refer to section 4.1.22.3for further details.)*

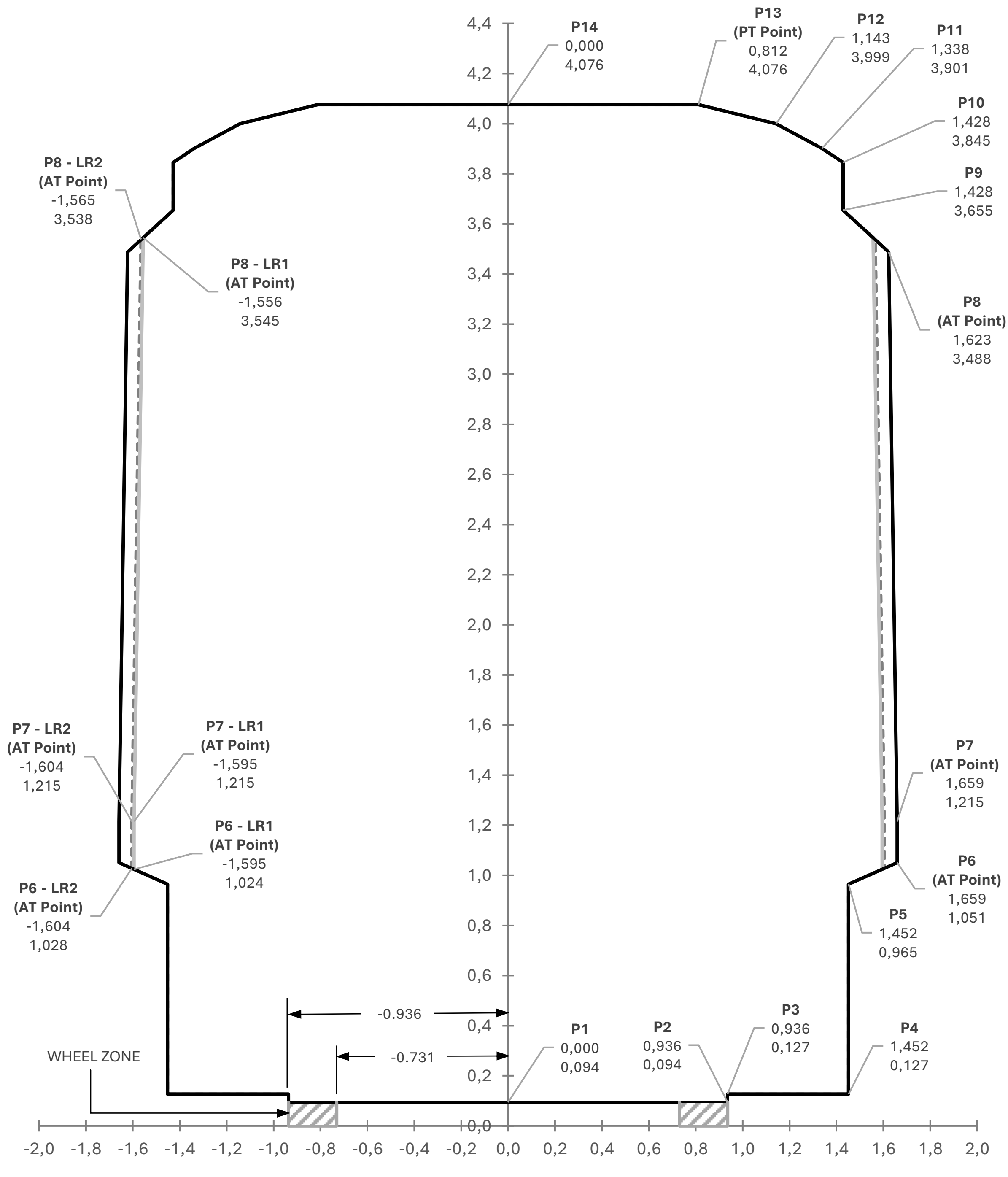
| *$h_{LR1}$ MIN* | *$h_{LR1}$ MAX* | *$h_{LR2}$ MIN* | *$h_{LR2}$ MAX* |
|---|---|---|---|
| *1.024* | *3.545* | *1.028* | *3.538* |

$S_{0i\ reduction}$ applies at this Gauge.

The following dimensions define by MINIMAL and MAXIMAL heights the interval in which the gauging calculations shall include $S_{0i\ reduction}$.

| $h_{S0i}$ reduction MIN | $h_{S0i}$ reduction MAX | $h_{S0i\ LR1}$ reduction MIN | $h_{S0i\ LR1}$ reduction MAX | $h_{S0i\ LR2}$ reduction MIN | $h_{S0i\ LR2}$ reduction MAX |
|---|---|---|---|---|---|
| 1.041 | 3.509 | 1.014 | 3.567 | 1.018 | 3.559 |

*Note: Refer to section 5.167 for further details.*




The WHEEL ZONE may only be used for the wheels or for Relevant Mechanical Points of equipment that is for technical reasons required to be in close proximity to the wheels and near to the rail (e.g. items such as sandpipes). Such equipment shall remain within the swept profile of the wheels and may not protrude laterally or downwards outside of the WHEEL ZONE at any horizontal or vertical curve radius and at any track gauge up to $\ell_{max}$ =1.630m.

*Figure 24 RP-Ms for IRL1F, IRL1F LR1 and IRL1F LR2*

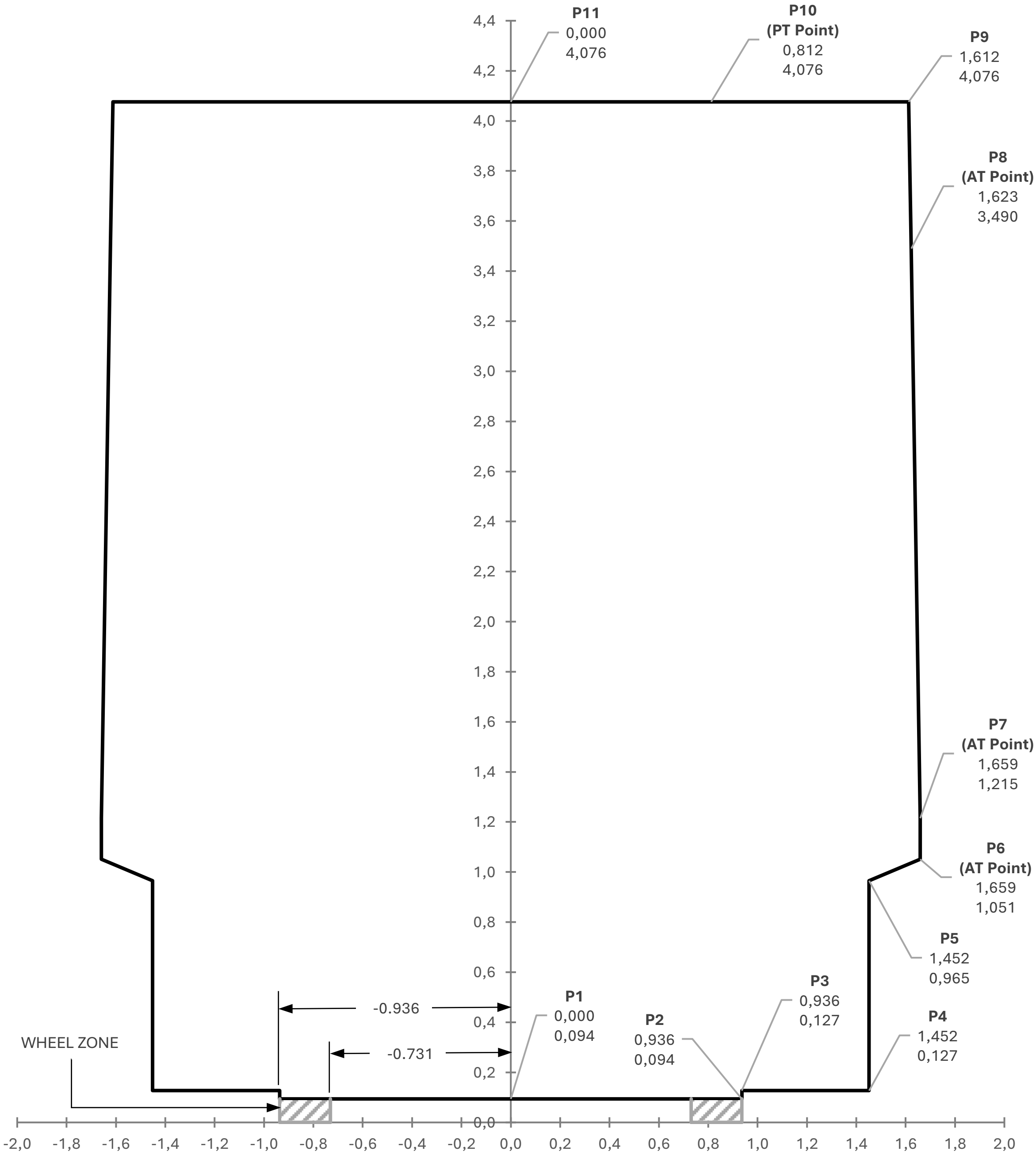
## 6.4. Mechanical Reference Profile RP-M for IRL2

*Note: The IRL2 Gauge is based on IRL1 and has been enlarged in the upper section to permit taller vehicles and larger combinations of vehicles and multi-modal containers to operate. The IRL2 Gauge is not yet made systematically available on the Network.*

All values are given in Normal Coordinates in the unit [m]. All RMPs shall be gauged against the RP-M shown below.

| IRL2 Reference Profile | | |
|---|---|---|
| **Point** | **$h_{RP}$ (m)** | **$b_{RP}$ (m)** |
| P1 | 0.094 | 0.000 |
| P2 | 0.094 | 0.936 |
| P3 | 0.127 | 0.936 |
| P4 | 0.127 | 1.452 |
| P5 | 0.965 | 1.452 |
| P6 (AT point) | 1.051 | 1.659 |
| P7 (AT point) | 1.215 | 1.659 |
| P8 (AT point) | 3.488 | 1.623 |
| P9 (AT & PT point) | 4.073 | 1.610 |
| P10 (PT point) | 4.076 | 0.812 |
| P11 | 4.076 | 0.000 |

*Note: As neither (vertical) Local Restrictions nor $S_{0i\,reduction}$ apply to this Gauge, neither LOWER and UPPER limit heights for the lateral Local Restrictions nor for $S_{0i\,reduction}$ apply.*




The WHEEL ZONE may only be used for the wheels or for Relevant Mechanical Points of equipment that is for technical reasons required to be in close proximity to the wheels and near to the rail (e.g. items such as sandpipes). Such equipment shall remain within the swept profile of the wheels and may not protrude laterally or downwards outside of the WHEEL ZONE at any horizontal or vertical curve radius and at any track gauge up to $\ell_{max}$ =1.630m.

*Figure 25 Reference Profile for IRL2 Gauge*

## 6.5. Pantograph Reference Profile RP-$P_{1.5kV}$ for IRL 1, 1D, 1F, 2 for 1.5 kV DC nominal voltage

*Note: The Combined Pantograph Reference Profile for IRL 1, 1D, 1F, 2 for 1.5 kV DC nominal voltage is only available at certain parts of the Network. Only in these parts it is permitted to raise Vehicle pantographs.*

The following dimensions define the Pantograph Reference Profile. These are given in Normal Coordinates in the unit [m]. All RPPs shall be gauged against the RP-P shown below.

| RP-$P_{1.5kV}$ for IRL 1, 1D, 1F, 2 for 1.5 kV DC nominal voltage | | |
|---|---|---|
| **Point** | **$h_{RP}$ (m)** | **$b_{RP}$ (m)** |
| P1 | 3.547 | 0.000 |
| P2 | 3.547 | 1.112 |
| P3 | 3.930 | 1.112 |
| P4 | 5.550 | 1.161 |
| P5 | 5.652 | 1.161 |
| P6 | 5.852 | 0.916 |
| P7 | 5.852 | 0.000 |

*Note: Albeit the Local Restrictions apply to IRL1, IRL1D and IRL1F, the Local Restrictions have no effect on the RPPs, as they apply only at heights below the RP-$P_{1.5kV}$.*

*Likewise, $S_{0i\ reduction}$ has no effect on the RPPs, as it applies only at heights below the RP-$E_{1.5kV}$.*

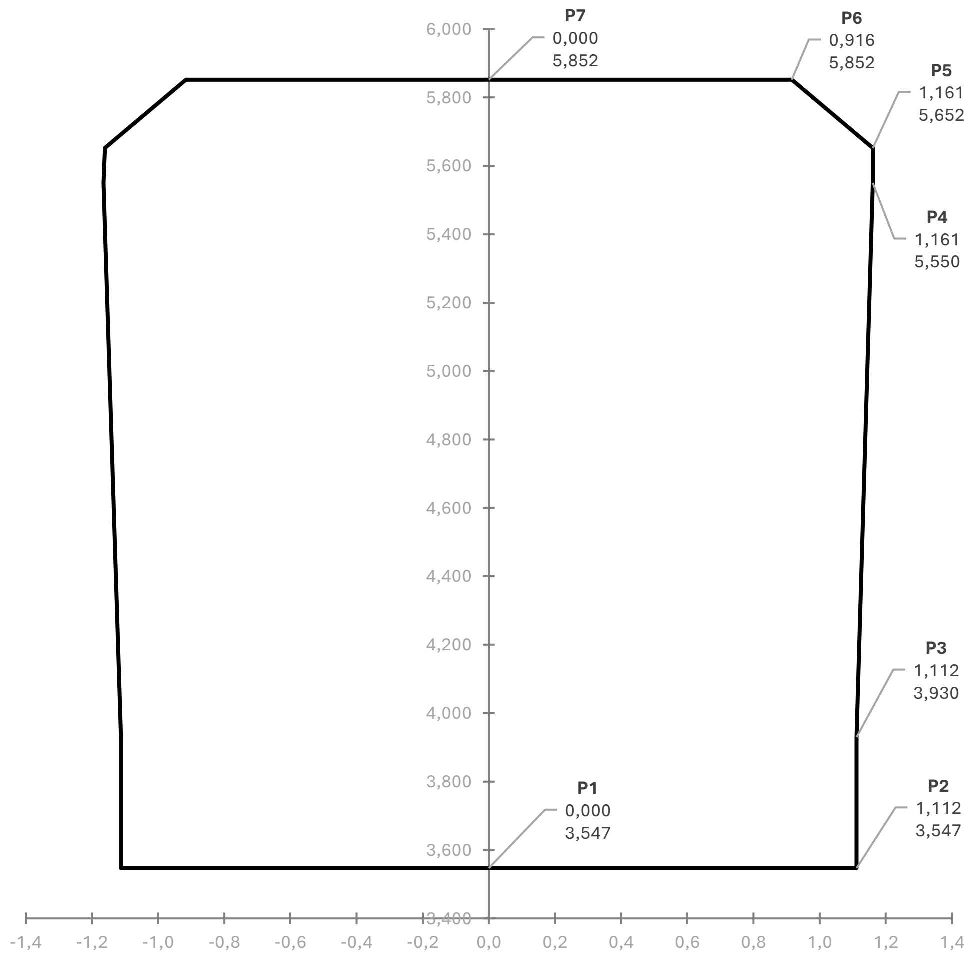



*Figure 26 RP-P for 1.5 kV DC nominal voltage*

## 6.6. Pantograph Reference Profile RP-$P_{25kV}$ for IRL 1, 1D, 1F, 2 for 25 kV AC nominal voltage

Vehicles for operation on the Network are prohibited to be fitted with pantographs for operation under 25 kV AC until a Combined Pantograph Reference Profile for IRL 1, 1D, 1F, 2 for 25 kV AC nominal voltage has been defined in a future update of this IRS.

*Note: The Combined Pantograph Reference Profile for IRL 1, 1D, 1F, 2 for 25 kV AC nominal voltage is at the time of publication of this IRS still subject to conceptual studies and design review.*

*The Combined Pantograph Reference Profile for IRL 1, 1D, 1F, 2 for 25 kV AC nominal voltage will be defined in a future update of this IRS.*

## 6.7. Electrical Reference Profile RP-$E_{1.5kV}$ for IRL1 and for 1.5 kV DC nominal voltage

All exposed electrical points, including any stored pantograph (!), that are capable of being live shall be gauged against the RP-E shown below.

| **RP-$E_{1.5kV}$ for IRL1 and for 1.5 kV DC nominal voltage** | | |
|---|---|---|
| **Point** | **$h_{RP}$ (m)** | **$b_{RP}$ (m)** |
| P1 | 3.547 | 0.000 |
| P2 | 3.547 | 1.336 |
| P3 | 3.691 | 1.336 |
| P4 | 3.765 | 1.244 |
| P5 | 3.862 | 1.101 |
| P6 | 3.969 | 0.912 |
| P7 | 4.046 | 0.686 |
| P8 | 4.046 | 0.000 |

*Note: Albeit the Local Restrictions apply to IRL1D and IRL1F, the Local Restrictions have no effect on the REPs, as they apply only at heights below the RP-$E_{1.5kV}$.*

*Likewise, $S_{0i\ reduction}$ has no effect on the REPs, as it applies only at heights below the RP-$E_{1.5kV}$.*

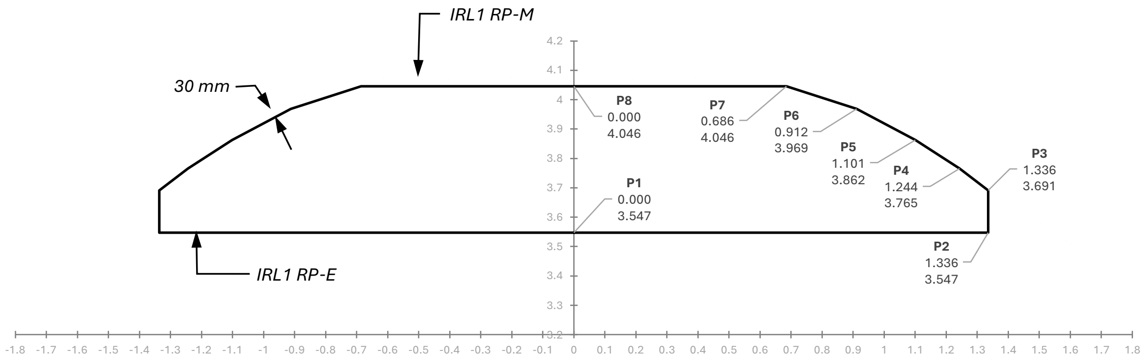



***Figure** 27 RP-$E_{1.5kV}$ for IRL1 and for 1.5 kV DC nominal voltage*

## 6.8. Electrical Reference Profile RP-$E_{25kV}$ for IRL1 and for 25 kV AC nominal voltage

All exposed electrical points, including any stored pantograph (!), that are capable of being live shall be gauged against the RP-E shown below.

**>>>To be defined in a future issue of this IRS.**

## 6.9. Electrical Reference Profile RP-$E_{1.5kV}$ for IRL1D & IRL1F and for 1.5 kV DC nominal voltage

All exposed electrical points, including any stored pantograph (!), that are capable of being live shall be gauged against the RP-E shown below.

| RP-$E_{1.5kV}$ for IRL1D & IRL1F and for 1.5 kV DC nominal voltage | | |
|---|---|---|
| **Point** | **$h_{RP}$ (m)** | **$b_{RP}$ (m)** |
| P1 | 3.547 | 0.000 |
| P2 | 3.547 | 1.336 |
| P3 | 3.751 | 1.336 |
| P4 | 3.825 | 1.238 |
| P5 | 3.914 | 1.093 |
| P6 | 4.008 | 0.896 |
| P7 | 4.046 | 0.806 |
| P8 | 4.046 | 0.000 |

*Note: Albeit the Local Restrictions apply to IRL1D and IRL1F, the Local Restrictions have no effect on the REPs, as they apply only at heights below the RP-$E_{1.5kV}$.*

*Likewise, $S_{0i\ reduction}$ has no effect on the REPs, as it applies only at heights below the RP-$E_{1.5kV}$.*

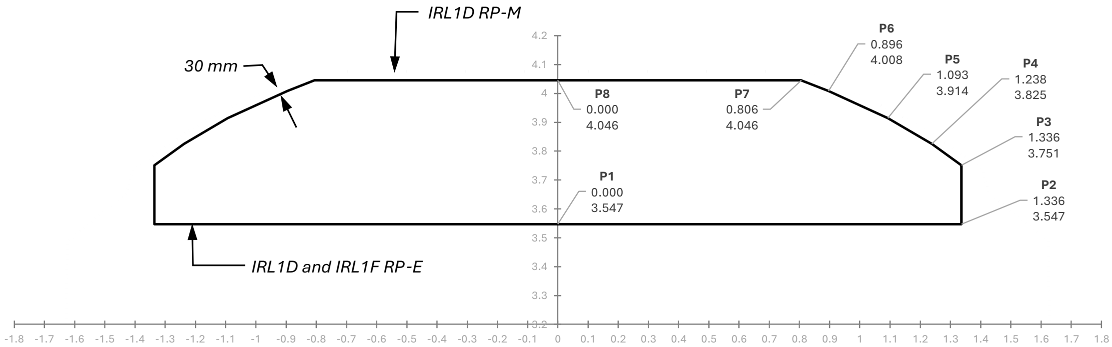



***Figure** 28 RP-$E_{1.5kV}$ for IRL1D & IRL1F and for 1.5 kV DC nominal voltage*

## 6.10. Electrical Reference Profile RP-$E_{25kV}$ for IRL1D & IRL1F and for 25 kV AC nominal voltage

All exposed electrical points, including any stored pantograph (!), that are capable of being live shall be gauged against the RP-E shown below.

**>>>To be defined in a future issue of this IRS.**

## 6.11. Electrical Reference Profile RP-E$_{1.5kV}$ for IRL2 and for 1.5 kV DC nominal voltage

All exposed electrical points, including any stored pantograph (!), that are capable of being live shall be gauged against the RP-E shown below.

| IRL2 Electrical Reference Gauge for 1.5 kV DC nominal voltage | | |
|---|---|---|
| **Point** | **$h_{RP}$ (m)** | **$b_{RP}$ (m)** |
| P1 | 3.547 | 0.000 |
| P2 | 3.547 | 1.402 |
| P3 | 4.046 | 1.393 |
| P4 | 4.046 | 0.791 |
| P5 | 4.046 | 0.000 |

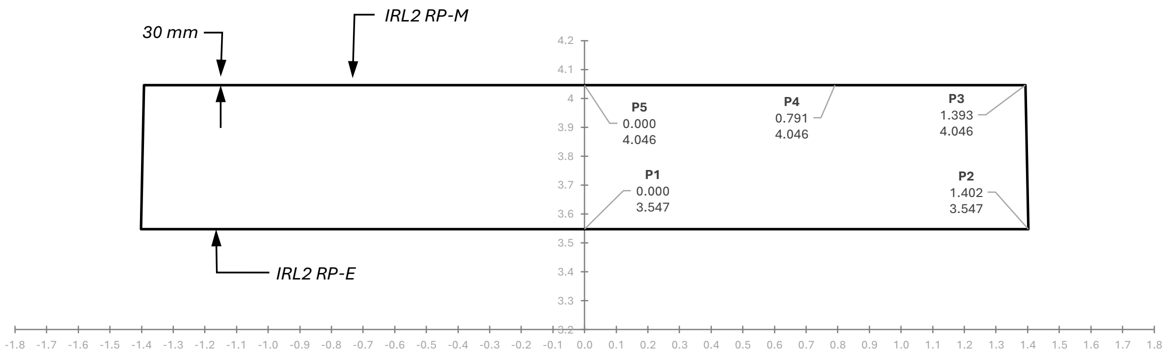



***Figure** 29 **RP-E$_{1.5kV}$ for IRL2 and for 1.5 kV DC nominal voltage***

## 6.12. Electrical Reference Profile RP-$E_{25kV}$ for IRL2 and for 25 kV AC nominal voltage

All exposed electrical points, including any stored pantograph (!), that are capable of being live shall be gauged against the RP-E shown below.

**>>>To be defined in a future issue of this IRS.**

# 7. Process for Vehicle Gauging

## 7.1. General

*Note: The following sections include the process to gauge a Vehicle / Vehicle Design AFTER all its Relevant Points have been defined with the intention to POSITIVELY PROVE (OR NOT) whether this Vehicle/ Vehicle design is compatible with one or more of the Gauges in this IRS. Refer to sections 4.1.23, 4.1.24, 4.1.25 which explain how Relevant Points shall be selected.*

*This process can also be used by competent experts with due care to INITIALLY APPROXIMATE the permitted VCG of individual cross-sections of a planned Vehicle design and in further refinement OPTIMISE these step by step. (As by this approach only an approximation of the VCG is possible, the POSITIVE PROVE is always additionally required.)*

*The requirements of this IRS are expected to be fulfilled by any*

- *Applicant for Authorisation according to IOD or RSA2005 for operation on the Network of*
    - *a new Vehicle or Vehicle Design or*
    - *a modification of an existing Vehicle or Vehicle Design or*
    - *a extension of the area of use of an existing vehicle to the Network.*
- *Keeper that provides Vehicles for operation on the Network.*
- *ECM that maintains a Vehicle for operation on the Network.*
- *Railway Undertaking or Railway Organisation that operates a Vehicle, including its payload/ load/ cargo, on the Network.*

*These requirements are expected to be fulfilled at any time while a vehicle is operated on the Network, except while that vehicle is subject to a special operating movement rule (e.g. a special rule for the operation of a once-off out-of-gauge load on a wagon).*

For each Vehicle design and each Vehicle the conformity to one or more of the kinematic Gauges contained in this IRS shall be demonstrated through following successive steps:

| | |
|---|---|
| **Step 1** | Obtain **all Data-Sets (Data-SetA+B+C) to establish all input data elements** for the gauging calculations (see section 7.2). |
| **Step 2** | Identify for this Vehicle/ Vehicle design **all**<br>• **Relevant Mechanical Points RMPs,**<br>• **Relevant Pantograph Points RPPs,**<br>• **Relevant Electrical Points REPs**<br>and their locations for the gauging calculations (see section 7.2.6). |
| **Step 3** | Perform Set1 of the gauging calculations for **INNER Relevant Mechanical Points RMPs** in their **UPWARDS** shifted positions on R0+R2000+R900+R250.4+R150+R80+Radd1+R119-LR1+R280-LR2+R98-vLR1.<br>Determine from all resulting $\Delta b_i$ values of this set of gauging calculations the smallest value for each RMP (see section 7.2.9). |
| **Step 4** | Perform Set2 of the gauging calculations for **INNER Relevant Mechanical Points RMPs** in their **DOWNWARDS** shifted positions on R0+R2000+R900+R250.4+R150+R80+Radd1 +R119-LR1+R280-LR2+R98-vLR1.<br>Determine from all resulting $\Delta b_i$ values of this set of gauging calculations the smallest value for each RMP (see section 7.2.10). |
| **Step 5** | Perform Set3 of the gauging calculations for **OUTER Relevant Mechanical Points RMPs** in their **UPWARDS** shifted positions on R0+R2000+R250.4+R150+R80+Radd1 +R116-LR1+R280-LR2+R98-vLR1. |

| | |
|---|---|
| | Determine from all resulting $\Delta b_a$ values of this set of gauging calculations the smallest value for each RMP (see section 7.2.11). |
| **Step 6** | Perform Set4 of the gauging calculations for **OUTER Relevant Mechanical Points RMPs** in their **DOWNWARDS** shifted positions on R0+R2000+R250.4+R150+R80+Radd1 +R116-LR1+R280-LR2+R98-vLR1.<br>Determine from all resulting $\Delta b_a$ values of this set of gauging calculations the smallest value for each RMP (see section 7.2.12). |
| **Step 7** | IF a 1.5 kV and/or a 25kV Pantograph is present, perform Set5 of the gauging calculations for **INNER Relevant Pantograph Points RPPs** in their **UPWARDS** shifted positions on R0+R2000+R900+R250.4+R150+R80+Radd1.<br>Determine from all resulting $\Delta b_i$ values of this set of gauging calculations the smallest value for each RPP (see section 7.2.13).<br>Perform separate calculations for 1.5 kV and/or a 25kV Pantographs. |
| **Step 8** | IF a 1.5 kV and/or a 25kV Pantograph is present, perform Set6 of the gauging calculations for **OUTER Relevant Pantograph Points RPPs** in their **UPWARDS** shifted positions on R0+R2000+R250.4+R150+R80+Radd1.<br>Determine from all resulting $\Delta b_a$ values of this set of gauging calculations the smallest value for each RPP (see section 7.2.14).<br>Perform separate calculations for 1.5 kV and/or a 25kV Pantographs. |
| **Step 9** | IF Electric Relevant Points are present, perform Set7 of the gauging calculations for **INNER Relevant Electrical Points REPs** in their **UPWARDS** shifted positions on R0+R2000+R900+R250.4+R150+R80+Radd1 +R119-LR1+R280-LR2+R98-vLR1.<br>Determine from all resulting $\Delta b_i$ values of this set of gauging calculations the smallest value for each REP (see section 7.2.16). |
| **Step 10** | IF Electric Relevant Points are present, perform Set8 of the gauging calculations for **INNER Relevant Electrical Points REPs** in their **DOWNWARDS** shifted positions on R0+R2000+R900+R250.4+R150+R80+Radd1+R119-LR1+R280-LR2+R98-vLR1.<br>Determine from all resulting $\Delta b_i$ values of this set of gauging calculations the smallest value for each REP (see section 7.2.18). |
| **Step 11** | IF Electric Relevant Points are present, perform Set9 of the gauging calculations for **OUTER Relevant Electrical Points REPs** in their **UPWARDS** shifted positions on R0+R2000+R250.4+R150+R80+Radd1+R116-LR1+R280-LR2+R98-vLR1.<br>Determine from all resulting $\Delta b_a$ values of this set of gauging calculations the smallest value for each REP (see section7.2.19). |
| **Step 12** | IF REPs are present, perform Set10 of the gauging calculations for **OUTER Relevant Electrical Points REPs** in their **DOWNWARDS** shifted positions on R0+R2000+R250.4+R150+R80+Radd1+R116-LR1+R280-LR2+R98-vLR1.<br>Determine from all resulting $\Delta b_a$ values of this set of gauging calculations the smallest value for each REP (see section 7.2.20). |
| **Step 13** | Identify for **each** Relevant Point, **if it fulfils the selected Gauge** (see section 7.2.21 |
| **Step 14** | Prepare the **Gauging Report** (see section 7.2.22) |
| **Step 15** | Have the **Independent Gauging Review Report** prepared (see section 7.2.23). |

## 7.2. Steps to be followed during the Gauging Calculations

### 7.2.1. Step1 - Obtain all Data-Sets (Data-SetA+B+C) to get all input data elements for the gauging calculations

7.2.1.1. Be aware on the same Vehicle design:

- a group of Relevant Points which are secondary suspended (e.g. points on a secondary suspended Vehicle body or Vehicle frame),
- a group Relevant Points which are primary suspended (e.g. points on a primary suspended bogie frame or points on a primary suspended Vehicle body or Vehicle frame)
- a group Relevant Points on non-suspended equipment (e.g, on the axle mounted brake disk, gearbox or traction motor)

require individual gauging calculations.

These Relevant Points cannot be mixed within the same gauging calculation as each of these Relevant Points will require different input data sets. For Example:

- "p" from the gauging of secondary suspended Relevant Points becomes "a" for the calculation for primary suspended Relevant Points on a bogie frame. (The bogie shall effectively be treated like a 'small vehicle'.)
- all kxx values must be adjusted to match the actual suspension stages of the Relevant Points.

7.2.1.2. For the gauging calculations the following sets of input data elements (values, formulae, etc.) shall be obtained:

**a) Input Data Set-A: Vehicle design-SPECIFIC set of input data elements**

This set consists of all data elements from section 5 which **depend** on the specific individual vehicle design that shall be gauged. This set of data elements is identified within section 7.2.5.

**b) Input Data Set-B: Set of Vehicle design-INDEPENDENT input data elements**

This is the set of those data elements from section 5 which are required for the gauging calculation, but **do NOT depend** on the specific individual vehicle design. This includes most of the data elements from section 5, which are NOT identified in section 7.2.5.

**c) Input Data Set-C: Set of all those data elements from Input Data Sets A&B which REQUIRED ADAPTATION to match 'non typical' elements of the specific vehicle design solution**

ONLY where a specific vehicle design to be gauged features 'non-typical' design solutions it will become necessary to adjust certain data elements of Input Data Sets A&B.

*Note: Such design specific adaptations to formulae and vehicle data are not required with 'typical' vehicle design solutions as long as these are compatible with the standard Input Data Sets A&B, i.e. where the vehicle design is compatible with:*

- *a two axle vehicle or*
- *a 4 axle vehicle or a 6 axle vehicle with two bogies of symmetrical design,*
- *each of the values for a, p ,q , $n_a$, $n_i$ being fixed and not dependent on R,*
- *each of the values for p ,q, $w_a$ or $w_{a\,f(R)}$, $w_i$ or $w_{i\,f(R)}$ being identical across all axles, respectively bogies,*
- *the GCS coinciding with the location of the axles, respectively the bogie centres,*
- *the GCS is symmetrically centred at the bogies, respectively axles.*

The design specific adapted calculation formulae are required where a vehicle design is not compatible with Input Data Sets A&B. E.g. where a vehicle design features:

- one more of the values for a, p ,q , $n_a$, $n_i$ being NOT fixed and becoming dependent on R,
- carried on one axle/ bogie at one end and articulated on the other end (see drawing below),
- carried on one bogie at one end and one axle at the other end,
- carried on two bogies which both have different design values for p or $w_a$ or $w_i$ or q,
- the GCS are not coinciding with the location of the axles, respectively the bogie centres,
- on two bogie bolsters with each are carried by two sub-bogies (see drawing below),
- the values of q, $w_a$ or $w_{a\,f(R)}$, $w_i$ or $w_{i\,f(R)}$ not being identical across all axles, respectively bogies,
- the GCS is NOT at p/2 at a bogie.

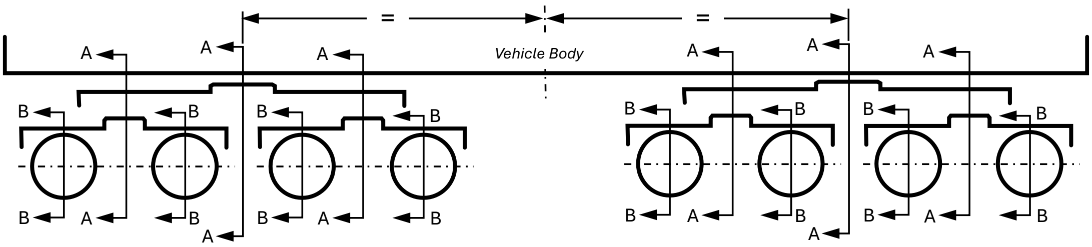



***Figure 30  Example of two bogie bolsters with each carried by two sub-bogies***

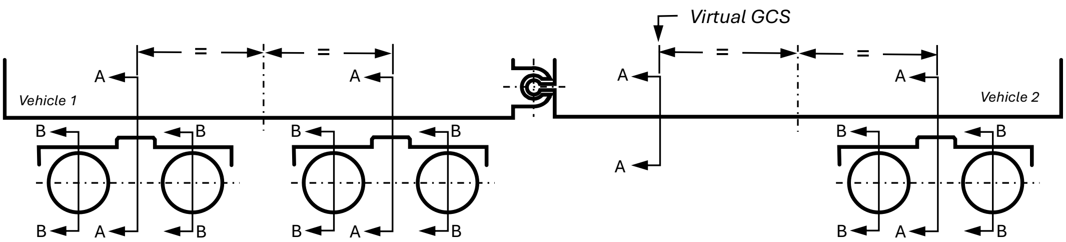



***Figure 31  Example of GCS not at bogies p/2 (Virtual GCS)***

7.2.2. All elements from the input data sets A&B&C shall be presented in the Gauging Report.

7.2.3. Together with each data element of input data set A justifying evidence on the determination of the value shall be provided in the Gauging Report (e.g. relevant drawings, calculations, test reports).

7.2.4. For each data element of input data Set-C the original data element shall be provided in the Gauging Report in red text with strike through font, and it shall be clearly linked to its replacement. The replacement shall be provided in green text. Detailed justifying evidence and argumentation on the determination of the replacement value / formula shall be provided.

Such argumentation shall include a risk assessment according to Annex I of CSM-REA (EU) 402/2013 (as amended) to demonstrate the new residual risk is tolerable.

*Note: It is very important, that such replacements are unambiguously identifiable in the Gauging Report and that they are providing all information for the later validation and independent review. Example:*

| data element | value | unit | description | evidence / justification |
|---|---|---|---|---|
| ~~a~~ | | ~~[m]~~ | ~~Fixed distance between the GCSs~~<br>~~The distance between the GCSs is typically a fixed value independent of the track radius.~~ | At this design “a” is depending on R and therefore replaced by a set of values for all Relevant Radii. “a” is replaced by $a_{f(R)}$ and $a_{Rxx}$ below. |
| $a_{f(R)}$ | | [m] | Variable distance between the GCSs<br>At this design “a” is depending on the track curvature (1/R):<br>**$a_{f(R)}$ = 18m-25[m$^2$]/R**<br>Below the $a_{Rxxx}$ values are provided for all Relevant Radii. | *Drawing xxxx Rev.x*<br>*Technical Description yyyy Rev.y* |
| $a_{R0}$ | 18 | [m] | for straight track | *See references at* $a_{f(R)}$ |
| $a_{R2000}$ | 17.988 | [m] | for $R_{2000}$ | *See references at* $a_{f(R)}$ |
| $a_{R900}$ | 17.972 | [m] | for $R_{900}$, only relevant for gauge calculation of OUTER Relevant (Pantograph) Points | *See references at* $a_{f(R)}$ |
| *etc.* | … | … | … | … |

7.2.5. **Vehicle Gauging Parameter Set**

The following table contains the Vehicle design specific set input parameters which shall be provided by the Design Team.

Where a vehicle includes

- a group of non-suspended Relevant Points,
- a group of secondary suspended Relevant Points,
- a group of primary suspended Relevant Points,
- a group of tertiary suspended Relevant Points,
- etc.,

a separate Data Entry Table shall be prepared for each of these groups of Relevant Points.

| **This Vehicle Gauging Parameter Set is for the Vehicle’s group of Relevant Points,** | | |
|---|---|---|
| **suspended at level:** | *secondary* | [unsuspended / primary / secondary / tertiary /…] |

| | | | | |
|---|---|---|---|---|
| **Data Element** | **Value** | **[Unit]** | **Description** | **Evidence / Justification** (reference to such documents or explanatory text) |
| **Basic properties of the Vehicle design**: | | | | |
| Identify Vehicle design (Bogie design) type / version / variant / configuration | *Note: all data entries in this table are samples to guide the reader* | [text] | *Note: all the data in blue italic text in Steps 3 to 12 are based on the sample data in this table* | *Note: In a real project, the Evidence / Justification shall be entered into this column* |
| Intended Gauge: IRL | *1D* | [1/1D/1F/2] | | |
| Is this vehicle design a Locomotive / a Railcar/ a self-propelled (in transit) special vehicle? | *yes* | [yes/no] | | |
| Is this vehicle design a Passenger Coach/ a Baggage Van/ a Railcar Trailer/ a hauled special vehicle of similar design to the afore mentioned? | *no* | [yes/no] | | |
| Is this vehicle design a Freight wagon / a hauled special vehicle of similar design to a freight wagon? | *no* | [yes/no] | | |
| Do the special coefficients $A_{a\ track\ (special)}$ or $A_{i\ track\ (special)}$ apply (as there are EXACTLY two TRAILER BOGIES present in the running gear of this vehicle design)? | *no* | [yes/no] | | |
| | | | | |
| Is the 1.5kV pantograph width $2*P1.5b_w$ =< 1.800m? | *yes* | [no 1.5kV pantograph / yes / no] | [no 1.5kV pantograph] if the vehicle has no 1.5kV pantograph<br><br>[yes] only if: (width of | |

| | | | | |
|---|---|---|---|---|
| | | | pantograph head) =< 2*P1.5$b_w$ = 1.800m<br><br>[no] if: (width of pantograph head) > 2*P1.5$b_w$ = 1.800m<br>The answer [no] indicates that the vehicle is NOT COMPATIBLE with any of the Gauges IRL1+1D+1F+2! | |
| Is the pantograph value P1.5t =< 0.030m? | *yes* | [no 1.5kV pantograph / yes / no] | [no 1.5kV pantograph] if the vehicle has no 1.5kV pantograph<br><br>[yes] only if: P1.5t =< P1.5$t_{max}$ with P1.5$t_{max}$= 0.030m<br><br>[no] if: P1.5t > P1.5$t_{max}$ with P1.5$t_{max}$= 0.030m<br>The answer [no] indicates that the vehicle is NOT COMPATIBLE with any of the Gauges IRL1+1D+1F+2! | |
| Is the pantograph value P1.5τ =< 0.010m? | *yes* | [no 1.5kV pantograph / yes / no] | [no 1.5kV pantograph] if the vehicle has no 1.5kV pantograph<br><br>[yes] only if: P1.5τ =< P1.5$\tau_{max}$ with P$\tau_{max}$= 0.010m<br><br>[no] if: P1.5τ > P1.5$\tau_{max}$ with P1.5$\tau_{max}$= 0.010m<br>The answer [no] indicates that the vehicle is NOT COMPATIBLE with any of the Gauges IRL1+1D+1F+2! | |
| Is the pantograph value P1.5$f_{wa}$ =< 0.028m? | *yes* | [no 1.5kV pantograph / yes / no] | [no 1.5kV pantograph] if the vehicle has no 1.5kV pantograph<br><br>[yes] only if: P1.5$f_{wa}$ =< P1.5$f_{wa\ max}$ with P1.5$f_{wa\ max}$ = 0.028m<br><br>[no] if: P1.5$f_{wa}$ =< P1.5$f_{wa\ max}$ with P1.5$f_{wa\ max}$ = 0.028m<br>The answer [no] indicates that the vehicle is NOT COMPATIBLE with any of the Gauges IRL1+1D+1F+2! | |
| Is the pantograph value P$f_{ws}$ =< 0.067m? | *yes* | [no 1.5kV pantograph / yes / no] | [no 1.5kV pantograph] if the vehicle has no 1.5kV pantograph<br><br>[yes] only if: P1.5$f_{ws}$ =< P1.5$f_{ws\ max}$ with P1.5$f_{ws\ max}$ = 0.067m | |

| | | | | |
|---|---|---|---|---|
| | | | [no] only if: $P1.5f_{ws}$ =< $P1.5f_{ws\ max}$ with $P1.5f_{ws\ max}$ = 0.065m The answer [no] indicates that the vehicle is NOT COMPATIBLE with any of the Gauges IRL1+1D+1F+2! | |
| | | | | |
| Is the 25kV pantograph width $2*P1.5b_w$ =< 1.800m? | *yes* | [no 25kV pantograph / yes / no] | *Note: To be defined in a future issue of this IRS.* | |
| Is the pantograph value P25t =< 0.030m? | *yes* | [no 25kV pantograph / yes / no] | *Note: To be defined in a future issue of this IRS.* | |
| Is the pantograph value $P25\tau$ =< 0.010m? | *yes* | [no 25kV pantograph / yes / no] | *Note: To be defined in a future issue of this IRS.* | |
| Is the pantograph value $P25f_{wa}$ =< 0.028m? | *yes* | [no 25kV pantograph / yes / no] | *Note: To be defined in a future issue of this IRS.* | |
| Is the pantograph value $P25f_{ws}$ =< 0.067m? | *yes* | [no 25kV pantograph / yes / no] | *Note: To be defined in a future issue of this IRS.* | |
| | | | | |
| Is the value of $d_{min}$ documented as a Safety Related Application Condition in the maintenance manual of this Vehicle design? | *yes* | [yes / no] | | |
| Is the value for $\Delta k_{L2.2axle}$ documented as a Safety Related Application Condition in the maintenance manual of this Vehicle design? | *yes* | [yes / no] | | |
| Is the value for $\Delta k_{L2.2vehicle}$ documented as a Safety Related Application Condition in the maintenance | *yes* | [yes / no] | | |

| | | | | |
|---|---|---|---|---|
| manual of this Vehicle design? | | | | |
| | | | | |
| **Vehicle design specific values:** | | | | |
| a | *13,700* | m | Distance between guiding cross sections. May be a fixed value independent of R or be a function f(R). | |
| $b_1$ | *0,925* | m | 1/2 width between primary suspensions. | |
| $b_2$ | *0,925* | m | 1/2 width between secondary suspensions. (Take primary suspension value, where no secondary suspension is present.) | |
| $b_G$ | *0,925* | m | 1/2 width between side bearers, set this to same value as $b_2$ in case of no side bearers present. | |
| $d_{min}$ | *1,573* | m | minimum permitted outer face to face value of the flanges in a wheelset To be measured 10mm below top of rail, assuming the wheelset is centred on a perfect track with the distance between the tops of rails being equal to L. Permitted range from TSI L&P & TSI WAG is 1.573m =< $d_{min}$ =< 1.592m. A value >1.573m requires an SRAC in the maintenance manual. | |
| $h_c$ | *0,450* | m | height of roll centre of this vehicle in normal coordinates | |
| J | *0,000* | m | side bearer play Set to J= 0.000 m, if no side bearers are present | |
| $k_{L2.1}$ | *0,035* | m | Wheel wear: *max permitted wheel wear | |
| $k_{L2.2}$ | *0,002* | m | Sum of relevant wear – other than wheel wear: *max permitted vertical wear of all relevant parts of the vehicle (e.g. centre pivot wear limit between bogie and body) *wear in the axlebox may be ignored | |
| $k_{L2.3}$ | *0,000* | m | Sum of static deflections of body(frame) structure: *suspension sag (permitted permanent loss of suspension deflection height) *vertical deflection of the | |

| | | | | |
|---|---|---|---|---|
| | | | vehicle structure between empty/tare and maximum static load<br>*vertical deflection of wheelsets under static load may be ignored<br>*vertical deflection of bogies under load may be ignored | |
| $k_{L3}$ | *0,022* | m | Static suspension deflection:<br>*vertical deflection between empty/tare and 100% max static load | |
| $k_{L4.1}$ | *0,000* | m | Random dynamic deflections of body(frame) structure:<br>*vertical deflection of body(frame) under dynamic load may be ignored, except for freight wagons/ special vehicles of similar design<br>*for freight wagons/ special vehicles of similar design the vertical dynamic deflection of the body(frame) shall be represented by an additional static deflection from 100% to 130% max static load | |
| $k_{L4.2}$ | *0,063* | m | Random dynamic suspension deflection:<br>For all vehicles except freight wagons/ special vehicles of similar design dynamic suspension deflection shall be represented by either<br>*additional suspension deflection from 100% to 130% max static load<br>or<br>*suspension deflection from 100% max static load to bottoming out<br><br>For freight wagons/ special vehicles of similar design:<br>*suspension deflection from 100% max static load to bottoming out<br><br>Where air suspension is present: All above values shall be with empty air suspension and with deflected back-up suspension | |
| $k_{U2}$ | *0,020* | m | upper vertical reduction for random vertical deflection of the vehicle of 10mm per suspension stage (as per | |

| | | | | |
|---|---|---|---|---|
| | | | EN15273-1 A.3.4.2.2 first sentence) | |
| p | *2,3* | m | distance between guiding cross sections on a bogie. Set this to 0m for vehicles that are not fitted with bogies. | |
| $P1.5f_{wa}$ | *0,0224* | m | STATIC upwards shift of a Relevant Pantograph Point RPP caused by the maximum permitted pantograph wear at this vehicle/ pantograph design.<br>The permitted maximum is 28mm. | |
| $P1.5f_{ws}$ | *0,067* | m | STATIC upwards offset of a Relevant Pantograph Point RPP caused by roll of the pantograph head at this vehicle/ pantograph design. The value shall be measured at the fully extended pantograph with a wire stagger (wire offset from pantograph centre line) of at least 550mm.<br>The permitted maximum is 67mm. | |
| $P1.5h_{stored}$ | *3,986* | m | height of top of pantograph head in stored position | |
| $P1.5h_t$ | *3,815* | m | height of the pantograph's lowest hinge | |
| P1.5t | *0,030* | m | Lateral displacement of the pantograph at its maximum working height when subjected to a static lateral force of 300N (Refer to EN 50206). The maximum permitted Pt value is Pt=30mm. Pantographs with Pt>30mm are not permitted to be operated in IRL1+1D+1F+2. | |
| $P1.5\tau$ | *0,010* | m | Lateral installation tolerance of reference vehicle for pantograph gauging calculation.<br>The maximum permitted $P\tau$ value is $P\tau$=10mm.<br>Pantographs with $P\tau$>10mm are not permitted to be operated in IRL1+1D+1F+2. | |
| $P25f_{wa}$ | | m | *Note: To be defined in a future issue of this IRS.* | |

| | | | | |
|---|---|---|---|---|
| $P25f_{ws}$ | | m | *Note: To be defined in a future issue of this IRS.* | |
| $P25h_{stored}$ | | m | *Note: To be defined in a future issue of this IRS.* | |
| $P25h_t$ | | m | *Note: To be defined in a future issue of this IRS.* | |
| P25t | | m | *Note: To be defined in a future issue of this IRS.* | |
| $P25\tau$ | | m | *Note: To be defined in a future issue of this IRS.* | |
| q | *0,005* | m | lateral play between wheelset and bogie frame or between wheelset and body at vehicles not fitted with bogies | |
| $R_{add1}$ | *80* | m | Enter value if necessary or leave at 80m.<br>*Note: Depending on the vehicle design, some of the parameters (e.g. a+wi+wa) may depend on curvature (1/R) or not).*<br>*In cases where a parameter depends on curvature, the graph of the parameter as a function of (1/R) shall be identified and analysed for discontinuities (local minima & maxima as well as for local non-linearities) in the range R=infinite to R=80m. If such elements are present, any related R values shall be identified in this section.* | |
| s | *0,235* | | coefficient of flexibility | |
| $w_{R0}$ | *0,050* | m | Lateral play between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $w_{a\ R2000}$ | *0,050* | m | Lateral play to OUTSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $w_{a\ R900}$ | *0,050* | m | Lateral play to OUTSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $w_{a\ R250.4}$ | *0,050* | m | Lateral play to OUTSIDE of a curve between bogie and body at $R_{xx}$. | |

| | | | | |
|---|---|---|---|---|
| | | | Set to 0m if no bogie is present. | |
| $W_{a\ R150}$ | 0,050 | m | Lateral play to OUTSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $W_{a\ R80}$ | 0,050 | m | Lateral play to OUTSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $W_{a\ Radd1}$ | 0,050 | m | Lateral play to OUTSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $W_{a\ R116\text{-}LR1}$ | 0,050 | m | Lateral play to OUTSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $W_{a\ R119\text{-}LR1}$ | 0,050 | m | Lateral play to OUTSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $W_{a\ R280\text{-}LR2}$ | 0,050 | m | Lateral play to OUTSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $W_{a\ R98\text{-}vLR1}$ | 0,050 | m | Lateral play to OUTSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $W_{i\ R2000}$ | 0,050 | m | Lateral play to INSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $W_{i\ R900}$ | 0,050 | m | Lateral play to INSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $W_{i\ R250.4}$ | 0,050 | m | Lateral play to INSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $W_{i\ R150}$ | 0,050 | m | Lateral play to INSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |

| | | | | |
|---|---|---|---|---|
| $w_{i\ R80}$ | *0,050* | m | Lateral play to INSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $w_{i\ Radd1}$ | *0,050* | m | Lateral play to INSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $w_{i\ R116\text{-}LR1}$ | *0,050* | m | Lateral play to INSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $w_{i\ R119\text{-}LR1}$ | *0,050* | m | Lateral play to INSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $w_{i\ R280\text{-}LR2}$ | *0,050* | m | Lateral play to INSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $w_{i\ R98\text{-}vLR1}$ | *0,050* | m | Lateral play to INSIDE of a curve between bogie and body at $R_{xx}$.<br>Set to 0m if no bogie is present. | |
| $\Delta k_{L2.2axle}$ | *0,002* | m | Maximum permitted differential vertical wheel wear at the same axle | |
| $\Delta k_{L2.2vehicle}$ | *0,035* | m | Maximum permitted differential vertical wheel wear across the same vehicle | |
| $\eta_0$ | *0,250* | ° | Actual value of the vehicle dissymmetry. Either measured according to UIC505-5 or take as conservative value 1°. | |

7.2.6. **Step 2 - Identify all RMPs / RPPs/ REPs and their locations for the gauging calculations**

7.2.7. It is highly recommended to include

- all intended multi-modal container types to be carried by the vehicle design
- all detachable equipment of a vehicle design

within the identification of the RMPs / RPPs / REPs of a vehicle design.

As explained at the related definition of $b_{nom}$, $h_{nom}$, $n_a$, $n_i$ their values shall include all applicable build tolerances. In the case of multi-modal containers or detachable equipment this shall also include any positioning tolerances.

*Note: E.g. a value of a container for $b_{nom}$= 1.250m +/-5 mm build tolerance and +/- 13mm positioning tolerance of the container on the vehicle will require that $b_{nom}$ shall be taken as at least 1.268m.*

7.2.8. All RMPs / RPPs / REPs of a vehicle design shall be identified for the gauging calculation with their values in Normal Coordinates combining:

- point ID
- $n_a$ respectively $n_i$
- $b_{nom}$ respectively $Pb_{nom}$
- $h_{nom}$ respectively $Ph_{shift}$

The set of all RMPs / RPPs / REPs for a vehicle design shall be proposed by a member of the vehicle design team that is competent to apply all requirements of this IRS.

*Note: Blue values are examples for information.*

| INNER RMPs | | | | |
|---|---|---|---|---|
| Point ID | ni | hnom | bnom | |
| | [m] | [m] | [m] | |
| iA | 2.070 | 4.022 | 0.000 | |
| iB | 2.070 | 4.022 | 0.727 | |

| OUTER RMPs | | | | |
|---|---|---|---|---|
| Point ID | na | hnom | bnom | |
| | [m] | [m] | [m] | |
| aA | 2.500 | 3.970 | 0.000 | |
| aB | 2.500 | 3.970 | 0.155 | |

| INNER RPPs | | | | |
|---|---|---|---|---|
| Point ID | ni | P1.5h shift RPPx | P1.5b nom | |
| | [m] | [m] | [m] | |
| iRPP1 (1.5kV) | 0.290 | 5.786 | 0.650 | |
| iRPP2 (1.5kV) | 0.290 | 5.594 | 0.900 | |

| OUTER RPPs | | | | |
|---|---|---|---|---|
| Point ID | na | P1.5h shift RPPx | P1.5b nom | |
| | [m] | [m] | [m] | |
| aRPP1 (1.5kV) | 0.240 | 5.786 | 0.650 | |
| aRPP2 (1.5kV) | 0.240 | 5.594 | 0.900 | |

| INNER REPs | | | | |
|---|---|---|---|---|
| Point ID | ni | hnom | bnom | |
| | [m] | [m] | [m] | |
| iL01 (1.5kV) | 0.290 | 3.986 | 0.000 | |
| iL02 (1.5kV) | 0.290 | 3.986 | 0.660 | |

| OUTER REPs | | | | |
|---|---|---|---|---|
| Point ID | na | hnom | bnom | |
| | [m] | [m] | [m] | |
| aL01 (1.5kV) | 0.240 | 3.986 | 0.000 | |
| aL02 (1.5kV) | 0.240 | 3.986 | 0.660 | |

### 7.2.9. Step 3- Perform Set1 of the gauging calculations for INNER Relevant Mechanical Points RMPs in their UPWARDS shifted positions on R0+R2000+R900+R250.4+R150+R80+Radd1+R119-LR1+R280-LR2+R98-vLR1

7.2.9.1. Determine for each RMP the following basic values which are independent of the horizontal track radius:

*Note: Blue values are examples for information.*

| Point ID | $n_i$ | $h_{nom}$ | $b_{nom}$ | $k_{U1i}$ + $k_{U2}$ upwards shift of this Relevant Point | $k_{U1i\text{-}vLR1}$ + $k_{U2}$ upwards shift of this Relevant Point at vLR1 | **$h_{shift}$ = $h_{nom}$ + $k_{U1i}$ + $k_{U2}$** | **$h_{shift\text{-}vLR1}$ = $h_{nom}$ + $k_{U1i\text{-}vLR1}$ + $k_{U2}$** |
|---|---|---|---|---|---|---|---|
| | **[m]** | **[m]** | **[m]** | [m] | [m] | **[m]** | **[m]** |
| **iA** | **2.070** | **4.022** | **0.000** | 0.020 | 0.020 | **4.042** | **4.042** |
| **iB** | **2.070** | **4.022** | **0.727** | 0.020 | 0.020 | **4.042** | **4.042** |

7.2.9.2. Determine for each RMP the following values for straight track:

*Note: Blue values are examples for information.*

**INNER Relevant Mechanical Points RMPs, UPWARDS shifted, R0(=straight)**

| $R_0$ (no value for straight) | $D_{max\ R0}$ | $l_{max\ R0}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP}$ = $h_{shift}$** | $Dpl_{i\ vehicle}$ (not applicable for straight track) | $Dpl_{i\ track}$ | $A_{i\ track}$ | q | $A_{i\ q}$ | $w_{R0}$ | $A_{i\ wi}$ | z1 term =[s*$T_D$/L*│$h_{nom}$-$h_c$│]-[$s_{0random}$*$T_D$/L*│$h_{shift}$-$h_{c0}$│] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}$-$h_c$)$^2$)$^{0.5}$] -[tan$\eta 0_r$ *(1+$s_{0random}$) *(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1i term, if $h_{nom}$>$h_c$: =s*$D_{max\ f(R)}$/L*($h_{nom}$-$h_c$) or if $h_{nom}$=hc: =0.000m or if $h_{nom}$<$h_c$: =s*$l_{max\ f(R)}$/L*($h_c$-$h_{nom}$) | z3.2i term if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$D_{max\ f(R)}$/L*($h_{shift}$-$h_{c0}$) or if $h_{shift}$=$h_{c0}$: =0.000m or if $h_{shift}$<$h_{c0}$: =$s_{0\ static}$*$l_{max\ f(R)}$/L*($h_{c0}$-$h_{shift}$) | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **$Dpl_{i\ straight}$ = $Dpl_{i\ track}$ * $A_{i\ track}$ + q * $A_{i\ q}$ + $w_{i\ f(R)}$ * $A_{i\ wi}$ + $z_i$** | $S_{0i\ geometric}$ (no value for straight track) | $S_{0i\ reduction}$ (no value for straight track) | $S_{0i\ enlargement}$ (no value for straight track) | **$S_{0i}$ (no value for straight track)** | **$\Delta b_i$= ($b_{RP}$+$S_{0i}$) - ($b_{nom}$ +$Dpl_{i\ straight}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| | 0.000 | 0.000 | **0.893** | | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.000 | 0.000 | -0.001 | **0.083** | | | | | **0.810** |
| | 0.000 | 0.000 | **0.893** | | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.000 | 0.000 | -0.001 | **0.083** | | | | | **0.083** |

7.2.9.3. Determine for each RMP the following values for R2000 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Mechanical Points RMPs, UPWARDS shifted, R2000**

| $R_{2000}$ | $D_{max\ R2000}$ | $l_{max\ R2000}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP}$ = $h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ R2000}$ | $A_{i\ wi}$ | z1 term =[s*$T_D$/L*│$h_{nom}$-$h_c$│]-[$s_{0random}$*$T_D$/L*│$h_{shift}$-$h_{c0}$│] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}$-$h_c$)$^2$)$^{0.5}$] -[tan$\eta 0_r$ *(1+$s_{0random}$) *(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1i term, if $h_{nom}$>$h_c$: =s*$D_{max\ f(R)}$/L*($h_{nom}$-$h_c$) or if $h_{nom}$=hc: =0.000m or if $h_{nom}$<$h_c$: =s*$l_{max\ f(R)}$/L*($h_c$-$h_{nom}$) | z3.2i term if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$D_{max\ f(R)}$/L*($h_{shift}$-$h_{c0}$) or if $h_{shift}$=$h_{c0}$: =0.000m or if $h_{shift}$<$h_{c0}$: =$s_{0\ static}$*$l_{max\ f(R)}$/L*($h_{c0}$-$h_{shift}$) | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **$Dpl_{i\ curve}$ = $Dpl_{i\ vehicle}$ + $Dpl_{i\ track}$ * ($A_{i\ track}$ or $A_{i\ track(special)}$) + q * $A_{i\ q}$ + $w_{i\ f(R)}$ * $A_{i\ wi}$ + $z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ reduction}$ IF $h_{S0i\ reduction\ MIN}$ =< $h_{shift}$ <= $h_{S0i\ reduction\ MAX}$ : = 0.025 m ELSE:= 0.000 m | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0$i IF for gauges IRL 1/1D/1F: = ($S_{0i\ geometric}$ – $S_{0i\ reduction}$)$_{if>0}$ + $S_{0i\ enlargement}$ IF for gauges IRL 2: = $S_{0i\ geometric}$ + $S_{0i\ enlargement}$** | **$\Delta b_i$= ($b_{RP}$+$S_{0i}$) -($b_{nom}$ +$Dpl_{i\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| 2000.0 | 0.165 | 0.110 | **0.893** | 0.006 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.083 | 0.000 | 0.083 | **0.172** | **0.011** | **0.000** | **0.000** | **0.011** | **0.732** |
| 2000.0 | 0.165 | 0.110 | **0.893** | 0.006 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.083 | 0.000 | 0.083 | **0.172** | **0.011** | **0.000** | **0.000** | **0.011** | **0.005** |

7.2.9.4. Determine for each RMP the following values for R900 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Mechanical Points RMPs, UPWARDS shifted, R900**

| $R_{900}$ | $D_{max\ R900}$ | $l_{max\ R900}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ R900}$ | $A_{i\ wi}$ | z1 term =[s*$T_D$/L*\| $h_{nom}$-$h_c$\| ]-[$s_{0random}$*$T_D$/L*\| $h_{shift}$-$h_{c0}$\| ] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}$-$h_c$)$^2$)$^{0.5}$] -[tan$\eta 0_r$ *(1+$s_{0random}$) *(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1i term, if $h_{nom}$>$h_c$: =s*$D_{max\ f(R)}$/L*($h_{nom}$-$h_c$) or if $h_{nom}$=hc: =0.000m or if $h_{nom}$<$h_c$: =s*$l_{max\ f(R)}$/L*($h_c$-$h_{nom}$) | z3.2i term if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$D_{max\ f(R)}$/L*($h_{shift}$-$h_{c0}$) or if $h_{shift}$=$h_{c0}$: =0.000m or if $h_{shift}$<$h_{c0}$: =$s_{0\ static}$*$l_{max\ f(R)}$/L*($h_{c0}$-$h_{shift}$) | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **$Dpl_{i\ curve}$ = $Dpl_{i\ vehicle}$ + $Dpl_{i\ track}$ * ($A_{i\ track}$ or $A_{i\ track(special)}$) + q * $A_{i\ q}$ + $w_{i\ f(R)}$ * $A_{i\ wi}$ + $z_i$** | $S_{0i\ geometric}$ = 22.482 $m^2$ * (1 / R) | $S_{0i\ reduction}$ IF $h_{S0i\ reduction\ MIN}$ =< $h_{shift}$ <= $h_{S0i\ reduction\ MAX}$ : = 0.025 m ELSE:= 0.000 m | $S_{0i\ enlargement}$ = (15 $m^2$ * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0$i IF for gauges IRL 1/1D/1F: = ($S_{0i\ geometric}$ – $S_{0i\ reduction}$)$_{if>0}$ + $S_{0i\ enlargement}$ IF for gauges IRL 2: = $S_{0i\ geometric}$ + $S_{0i\ enlargement}$** | **Δbi= ($b_{RP}$+$S_{0i}$) -($b_{nom}$ +$Dpl_i$ curve)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| 900.0 | 0.165 | 0.110 | **0.893** | 0.014 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.083 | 0.000 | 0.083 | **0.180** | **0.025** | **0.000** | **0.000** | **0.025** | **0.738** |
| 900.0 | 0.165 | 0.110 | **0.893** | 0.014 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.083 | 0.000 | 0.083 | **0.180** | **0.025** | **0.000** | **0.000** | **0.025** | **0.011** |

7.2.9.5. Determine for each RMP the following values for R250.4 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Mechanical Points RMPs, UPWARDS shifted, R250.4**

| $R_{250.4}$ | $D_{max\ R250.4}$ | $l_{max\ R250.4}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ R250.4}$ | $A_{i\ wi}$ | z1 term =[s*$T_D$/L*\| $h_{nom}$-$h_c$\| ]-[$s_{0random}$*$T_D$/L*\| $h_{shift}$-$h_{c0}$\| ] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}$-$h_c$)$^2$)$^{0.5}$] -[tan$\eta 0_r$ *(1+$s_{0random}$) *(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1i term, if $h_{nom}$>$h_c$: =s*$D_{max\ f(R)}$/L*($h_{nom}$-$h_c$) or if $h_{nom}$=hc: =0.000m or if $h_{nom}$<$h_c$: =s*$l_{max\ f(R)}$/L*($h_c$-$h_{nom}$) | z3.2i term if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$D_{max\ f(R)}$/L*($h_{shift}$-$h_{c0}$) or if $h_{shift}$=$h_{c0}$: =0.000m or if $h_{shift}$<$h_{c0}$: =$s_{0\ static}$*$l_{max\ f(R)}$/L*($h_{c0}$-$h_{shift}$) | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **$Dpl_{i\ curve}$ = $Dpl_{i\ vehicle}$ + $Dpl_{i\ track}$ * ($A_{i\ track}$ or $A_{i\ track(special)}$) + q * $A_{i\ q}$ + $w_{i\ f(R)}$ * $A_{i\ wi}$ + $z_i$** | $S_{0i\ geometric}$ = 22.482 $m^2$ * (1 / R) | $S_{0i\ reduction}$ IF $h_{S0i\ reduction\ MIN}$ =< $h_{shift}$ <= $h_{S0i\ reduction\ MAX}$ : = 0.025 m ELSE:= 0.000 m | $S_{0i\ enlargement}$ = (15 $m^2$ * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0$i IF for gauges IRL 1/1D/1F: = ($S_{0i\ geometric}$ – $S_{0i\ reduction}$)$_{if>0}$ + $S_{0i\ enlargement}$ IF for gauges IRL 2: = $S_{0i\ geometric}$ + $S_{0i\ enlargement}$** | **Δbi= ($b_{RP}$+$S_{0i}$) -($b_{nom}$ +$Dpl_i$ curve)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| 250.4 | 0.165 | 0.110 | **0.893** | 0.051 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.083 | 0.000 | 0.083 | **0.217** | **0.090** | **0.000** | **0.000** | **0.090** | **0.766** |
| 250.4 | 0.165 | 0.110 | **0.893** | 0.051 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.083 | 0.000 | 0.083 | **0.217** | **0.090** | **0.000** | **0.000** | **0.090** | **0.039** |

7.2.9.6. Determine for each Relevant Point the following values for R150 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Mechanical Points RMPs, UPWARDS shifted, R150**

| $R_{150}$ | $D_{max\ R150}$ | $l_{max\ R150}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{iR150}$ | $A_{i\ wi}$ | z1 term =[s*$T_D$/L*\| $h_{nom}$ -$h_c$\| ]-[$s_{0random}$*$T_D$/L*\| $h_{shift}$-$h_{c0}$\| ] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}$-$h_c$)$^2$)$^{0.5}$] -[tan$\eta 0_r$ *(1+$s_{0random}$) *(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1i term, if $h_{nom}$>$h_c$: =s*$D_{max\ f(R)}$/L*($h_{nom}$-$h_c$) or if $h_{nom}$=hc: =0.000m or if $h_{nom}$<$h_c$: =s*$l_{max\ f(R)}$/L*($h_c$-$h_{nom}$) | z3.2i term if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$D_{max\ f(R)}$/L*($h_{shift}$-$h_{c0}$) or if $h_{shift}$=$h_{c0}$: =0.000m or if $h_{shift}$<$h_{c0}$: =$s_{0\ static}$*$l_{max\ f(R)}$/L*($h_{c0}$-$h_{shift}$) | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **$Dpl_{i\ curve}$ = $Dpl_{i\ vehicle}$ + $Dpl_{i\ track}$ * ($A_{i\ track}$ or $A_{i\ track(special)}$) + q * $A_{i\ q}$ + $w_{i\ f(R)}$ * $A_{i\ wi}$ + $z_i$** | $S_{0i\ geometric}$ = 22.482 $m^2$ * (1 / R) | $S_{0i\ reduction}$ IF $h_{S0i\ reduction\ MIN}$ =< $h_{shift}$ <= $h_{S0i\ reduction\ MAX}$ : = 0.025 m ELSE:= 0.000 m | $S_{0i\ enlargement}$ = (15 $m^2$ * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0$i IF for gauges IRL 1/1D/1F: = ($S_{0i\ geometric}$ – $S_{0i\ reduction}$)$_{if>0}$ + $S_{0i\ enlargement}$ IF for gauges IRL 2: = $S_{0i\ geometric}$ + $S_{0i\ enlargement}$** | **Δbi= ($b_{RP}$+$S_{0i}$) -($b_{nom}$ +$Dpl_i$ curve)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| 150 | 0.082 | 0.110 | **0.893** | 0.085 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.041 | 0.000 | 0.041 | **0.209** | **0.150** | **0.000** | **0.000** | **0.150** | **0.834** |
| 150 | 0.082 | 0.110 | **0.893** | 0.085 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.041 | 0.000 | 0.041 | **0.209** | **0.150** | **0.000** | **0.000** | **0.150** | **0.107** |

7.2.9.7. Determine for each RMP the following values for R80 track radius:

*Note: Blue values are examples for information.*

| INNER Relevant Mechanical Points RMPs, UPWARDS shifted, R80 | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{80}$ | $D_{max\ R80}$ | $l_{max\ R80}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{iR80}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*\vert h_{nom}-h_c\vert]-[s_{0random}*T_D/L*\vert h_{shift}-h_{c0}\vert]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **$Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track}*(A_{i\ track}$ or $A_{i\ track(special)}) + q*A_{i\ q} + w_{i\ f(R)}*A_{i\ wi} + z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ reduction}$ IF $h_{S0i\ reduction\ MIN} =< h_{shift} <= h_{S0i\ reduction\ MAX}$ : = 0.025 m ELSE:= 0.000 m | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0i$ IF for gauges IRL 1/1D/1F: $= (S_{0i\ geometric} - S_{0i\ reduction})_{if>0} + S_{0i\ enlargement}$ IF for gauges IRL 2: $= S_{0i\ geometric} + S_{0i\ enlargement}$** | **$\Delta b_i = (b_{RP}+S_{0i}) - (b_{nom} + Dpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| 80 | 0.025 | 0.110 | **0.893** | 0.159 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.012 | 0.000 | 0.012 | **0.254** | **0.281** | **0.000** | **0.088** | **0.369** | **1.007** |
| 80 | 0.025 | 0.110 | **0.893** | 0.159 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.012 | 0.000 | 0.012 | **0.254** | **0.281** | **0.000** | **0.088** | **0.369** | **0.280** |

7.2.9.8. Where an additional Relevant Radius $R_{add1}$ is present: Determine for each RMP the following values for $R_{add1}$ track radius:

*Note: Blue values are examples for information.*

| INNER Relevant Mechanical Points RMPs, UPWARDS shifted, Radd1 | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{add1}$ | $D_{max\ Radd1}$ | $l_{max\ Radd1}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ Radd1}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*\vert h_{nom}-h_c\vert]-[s_{0random}*T_D/L*\vert h_{shift}-h_{c0}\vert]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **$Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track}*(A_{i\ track}$ or $A_{i\ track(special)}) + q*A_{i\ q} + w_{i\ f(R)}*A_{i\ wi} + z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ reduction}$ IF $h_{S0i\ reduction\ MIN} =< h_{shift} <= h_{S0i\ reduction\ MAX}$ : = 0.025 m ELSE:= 0.000 m | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0i$ IF for gauges IRL 1/1D/1F: $= (S_{0i\ geometric} - S_{0i\ reduction})_{if>0} + S_{0i\ enlargement}$ IF for gauges IRL 2: $= S_{0i\ geometric} + S_{0i\ enlargement}$** | **$\Delta b_i = (b_{RP}+S_{0i}) - (b_{nom} + Dpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| 80 | 0.025 | 0.110 | **0.893** | 0.159 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.012 | 0.000 | 0.012 | **0.254** | **0.281** | **0.000** | **0.088** | **0.369** | **1.007** |
| 80 | 0.025 | 0.110 | **0.893** | 0.159 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.012 | 0.000 | 0.012 | **0.254** | **0.281** | **0.000** | **0.088** | **0.369** | **0.280** |

7.2.9.9. Determine for each RMP the following values for R119 track radius.

*Note: Blue values are examples for information.*

LR1 is not present at IRL2 and shall accordingly not be calculated for IRL2.

| **only applicable for IRL1+1D+1F:** INNER Relevant Points RMPs, UPWARDS shifted, R119 LR1 | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{119-LR1}$ | $D_{max\ R119-LR1}$ | $l_{max\ R119-LR1}$ | **$b_{RP-LR1}$ =1/2 width of Reference Profile at $h_{RP-LR1} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track-LR1}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ R119-LR1}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*\vert h_{nom}-h_c\vert]-[s_{0random}*T_D/L*\vert h_{shift}-h_{c0}\vert]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **ONLY for LR1: $Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track-LR1}*(A_{i\ track}$ or $A_{i\ track\ (special)}) + q*A_{i\ q} + w_{i\ f(R)}*A_{i\ wi} + z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ reduction}$ ONLY for LR1: IF $h_{S0i\ LR1\ reduction\ MIN} =< h_{shift} <= h_{S0i\ LR1\ reduction\ MAX}$ : = 0.025 m ELSE: = 0.000 m | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **ONLY for gauges IRL 1/1D/1F $S_{0i} = (S_{0i\ geometric} - S_{0i\ reduction})_{if>0} + S_{0i\ enlargement}$** | **ONLY for gauges IRL1/1D/1F and ONLY IF $h_{shift}$ is between $h_{LR1\ MIN}$ and $h_{LR1\ MAX}$: $\Delta b_i = (b_{RP\ LR1}+S_{0i}) - (b_{nom} + Dpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| 119 | 0.000 | 0.028 | **0.893** | 0.107 | 0.020 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.000 | 0.000 | -0.001 | **0.181** | **0.189** | **0.000** | **0.026** | **0.215** | **n.a.** |
| 119 | 0.000 | 0.028 | **0.893** | 0.107 | 0.020 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.000 | 0.000 | -0.001 | **0.181** | **0.189** | **0.000** | **0.026** | **0.215** | **n.a.** |

7.2.9.10. Determine for each RMP the following values for R280 track radius.

*Note: Blue values are examples for information.*

LR2 is not present at IRL2 and shall accordingly not be calculated for IRL2.

**only applicable for IRL1+1D+1F:**
**INNER Relevant Points RMPs, UPWARDS shifted, R280 LR2**

| $R_{280\text{-}LR2}$ | $D_{max\ R280\text{-}LR2}$ | $l_{max\ R280\text{-}LR2}$ | **$b_{RP\text{-}LR2}$ =1/2 width of Reference Profile at $h_{RP\text{-}LR2}$ = $h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track\text{-}LR2}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{iR280\text{-}LR2}$ | $A_{i\ wi}$ | z1 term =[$s*T_D/L*\|h_{nom}-h_c\|$]-[$s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|$] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}-h_c)^2)^{0.5}$] -[tan$\eta 0_r$ *(1+$s_{0random}$) *(($h_{shift}-h_{c0})^2)^{0.5}$]}$_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: =$s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: =$s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: =$s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: =$s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **ONLY for LR2: $Dpl_{i\ curve}$ = $Dpl_{i\ vehicle}$ + $Dpl_{i\ track\text{-}LR2}$ * ($A_{i\ track}$ or $A_{i\ track\ (special)}$) + q * $A_{i\ q}$ + $w_{i\ f(R)}$ * $A_{i\ wi}$ + $z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ reduction}$ ONLY for LR2: IF $h_{S0i\ LR2\ reduction\ MIN}$ =< $h_{shift}$ <= $h_{S0i\ LR2\ reduction\ MAX}$ : = 0.025 m ELSE: = 0.000 m | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **ONLY for gauges IRL 1/1D/1F $S_{0i}$ = ($S_{0i\ geometric}$ – $S_{0i\ reduction}$)$_{if>0}$ + $S_{0i\ enlargement}$** | **ONLY for gauges IRL1/1D/1F and ONLY IF $h_{shift}$ is between $h_{LR2\ MIN}$ and $h_{LR2\ MAX}$: $\Delta b_i$= ($b_{RP}$+$S_{0i}$) -($b_{nom}$ +$Dpl_{i\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| 280 | 0.044 | 0.006 | **0.893** | 0.045 | 0.020 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.022 | 0.000 | 0.022 | **0.141** | **0.080** | **0.000** | **0.000** | **0.080** | **n.a.** |
| 280 | 0.044 | 0.006 | **0.893** | 0.045 | 0.020 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.022 | 0.000 | 0.022 | **0.141** | **0.080** | **0.000** | **0.000** | **0.080** | **n.a.** |

7.2.9.11. Determine for each RMP the following values for R98-vLR1 track radius.

*Note: Blue values are examples for information.*

vLR1 is not present at IRL2 and shall accordingly not be calculated for IRL2.

**only applicable for IRL1+1D+1F:**
**INNER Relevant Points RMPs, UPWARDS shifted, R98 vLR1**

| $R_{98\text{-}vLR1}$ | $D_{max\ R98\text{-}vLR1}$ | $l_{max\ R98\text{-}vLR1}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP}$ = $h_{shift\text{-}vLR1}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track\text{-}vLR1}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{iR98\text{-}vLR1}$ | $A_{i\ wi}$ | z1 term =[$s*T_D/L*\|h_{nom}-h_c\|$]-[$s_{0random}*T_D/L*\|h_{shift\text{-}vLR1}-h_{c0}\|$] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}-h_c)^2)^{0.5}$] -[tan$\eta 0_r$ *(1+$s_{0random}$) *(($h_{shift\text{-}vLR1}-h_{c0})^2)^{0.5}$]}$_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: =$s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: =$s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | ONLY for vLR1: z3.2i term if $h_{shift\text{-}vLR1}>h_{c0}$: =$s_{0\ static}*D_{max\ f(R)}/L*(h_{shift\text{-}vLR1}-h_{c0})$ or if $h_{shift\text{-}vLR1}=h_{c0}$: =0.000m or if $h_{shift\text{-}vLR1}<h_{c0}$: =$s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift\text{-}vLR1})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **ONLY for vLR1: $Dpl_{i\ curve}$ = $Dpl_{i\ vehicle}$ + $Dpl_{i\ track\text{-}vLR1}$ * ($A_{i\ track}$ or $A_{i\ track\ (special)}$) +q * $A_{i\ q}$ +$w_{i\ f(R)}$ * $A_{i\ wi}$ + $z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ reduction}$ IF $h_{S0i\ reduction\ MIN}$ =< $h_{shift\text{-}vLR1}$ <= $h_{S0i\ reduction\ MAX}$ : = 0.025 m ELSE:= 0.000 m | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_{0i}$ = ($S_{0i\ geometric}$ – $S_{0i\ reduction}$)$_{if>0}$ + $S_{0i\ enlargement}$** | **ONLY for gauges IRL1/1D/1F $\Delta b_i$= ($b_{RP}$+$S_{0i}$) -($b_{nom}$ +$Dpl_{i\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| 98 | 0.010 | 0.034 | **0.893** | 0.130 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.005 | 0.000 | 0.004 | **0.218** | **0.229** | **0.000** | **0.053** | **0.282** | **0.958** |
| 98 | 0.010 | 0.034 | **0.893** | 0.130 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.005 | 0.000 | 0.004 | **0.218** | **0.229** | **0.000** | **0.053** | **0.282** | **0.231** |

7.2.9.12. Determine from all resulting $\Delta b_i$ values of this set of gauging calculations the smallest value for each RMP.

*Note: Blue value is an example for information*

| **$\Delta b_i$ min across all calculations of this set** |
|---|
| **[m]** |
| **0.732** |
| **0.005** |

+ A positive value or 0.000m indicates that the vehicle design is compatible with the selected gauge(s)

- A negative value indicates that the vehicle design is not compatible with the selected gauge(s)

7.2.9.13. Determine also, if for this Set any RMPs are present in the WHEEL ZONE and evaluate if these RMPs fulfil the related requirements defined for the selected RP-M in section 6.

7.2.10. **Step 4- Perform Set2 of the gauging calculations for INNER Relevant Mechanical Points RMPs in their DOWNWARDS shifted positions on R0+R2000+R900+R250.4+R150+R80+Radd1 +R119-LR1+R280-LR2+R98-vLR1**

7.2.10.1. Determine for each RMP the following basic values which are independent of the horizontal track radius:

*Note: Blue values are examples for information.*

| Point ID | $n_i$ | $h_{nom}$ | $b_{nom}$ | Zone (A or B) | $k_{L1i}$ downwards shift of this Relevant Point | $k_{L1i\text{-}vLR1}$ downwards shift of this Relevant Point at vLR1 | $k_{L2}+k_{L3}+k_{L4}$ downwards shift of this Relevant Point | $k_{L5}$ downwards shift of this Relevant Point (depending on Zone: $=k_{L5A}$ oder $=k_{L5B}$) | $h_{shift}=h_{nom}-(k_{L1i}+k_{L2}+k_{L3}+k_{L4}+k_{L5})$ | $h_{shift\text{-}vLR1}=h_{nom}-(k_{L1i\text{-}vLR1}+k_{L2}+k_{L3}+k_{L4}+k_{L5})$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | [m] | [m] | [m] | | [m] | [m] | [m] | [m] | [m] | [m] |
| iA | 2.070 | 4.022 | 0.000 | A | 0.000 | 0.000 | 0.122 | 0.000 | 3.900 | 3.900 |
| iB | 2.070 | 4.022 | 0.727 | A | 0.000 | 0.000 | 0.122 | 0.000 | 3.900 | 3.900 |

7.2.10.2. Determine for each RMP the following values for straight track.

*Note: Blue values are examples for information.*

**INNER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R0(=straight track)**

| $R_0$ (no value for straight) | $D_{max\ R0}$ | $l_{max\ R0}$ | $b_{RP}$ =1/2 width of Reference Profile at $h_{RP}=h_{shift}$ | $Dpl_{i\ vehicle}$ (not applicable for straight track) | $Dpl_{i\ track}$ | $A_{i\ track}$ | q | $A_{i\ q}$ | $w_{R0}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | $Dpl_{i\ straight}=Dpl_{i\ track}*A_{i\ track}+q*A_{i\ q}+w_{i\ f(R)}*A_{i\ wi}+z_i$ | $S_{0i\ geometric}$ (no value for straight track) | $S_{0i\ reduction}$ (no value for straight track) | $S_{0i\ enlargement}$ (no value for straight track) | $S_{0i}$ (no value for straight track) | $\Delta b_i=(b_{RP}+S_{0i})-(b_{nom}+Dpl_{i\ straight})$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | [m] | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] |
| | 0.000 | 0.000 | 1.174 | | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.083 | | | | | 1.090 |
| | 0.000 | 0.000 | 1.174 | | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.083 | | | | | 0.363 |

7.2.10.3. Determine for each RMP the following values for R2000 track radius:

*Note: Blue values are examples for information.*

**INNER Mechanical Relevant Points, DOWNWARDS shifted, R2000**

| $R_{2000}$ | $D_{max\ R2000}$ | $l_{max\ R2000}$ | $b_{RP}$ =1/2 width of Reference Profile at $h_{RP}=h_{shift}$ | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ R2000}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | $Dpl_{i\ curve}=Dpl_{i\ vehicle}+Dpl_{i\ track}*(A_{i\ track}$ or $A_{i\ track(special)})+q*A_{i\ q}+w_{i\ f(R)}*A_{i\ wi}+z_i$ | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ reduction}$ IF $h_{S0i\ reduction\ MIN}=<h_{shift}<=h_{S0i\ reduction\ MAX}$: = 0.025 m ELSE:= 0.000 m | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m$)_{if>0}$ | $S_0i$ IF for gauges IRL 1/1D/1F: $=(S_{0i\ geometric}-S_{0i\ reduction})_{if>0}+S_{0i\ enlargement}$ IF for gauges IRL 2: $=S_{0i\ geometric}+S_{0i\ enlargement}$ | $\Delta b_i=(b_{RP}+S_{0i})-(b_{nom}+Dpl_{i\ curve})$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | [m] | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] |
| 2000.0 | 0.165 | 0.110 | 1.174 | 0.006 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.083 | 0.000 | 0.083 | 0.173 | 0.011 | 0.000 | 0.000 | 0.011 | 1.012 |
| 2000.0 | 0.165 | 0.110 | 1.174 | 0.006 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.083 | 0.000 | 0.083 | 0.173 | 0.011 | 0.000 | 0.000 | 0.011 | 0.285 |

7.2.10.4. Determine for each RMP the following values for R900 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Mechanical Points RMPs, R900, DOWNWARDS shifted, R900**

| $R_{900}$ | $D_{max\ R900}$ | $l_{max\ R900}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ R900}$ | $A_{i\ wi}$ | z1 term =[$s*T_D/L*\|h_{nom}-h_c\|$]-[$s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|$] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *$((h_{nom}-h_c)^2)^{0.5}$] -[tan$\eta\theta_r$ *(1+$s_{0random}$) *$((h_{shift}-h_{c0})^2)^{0.5}$]}$_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: =$s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: =$s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: =$s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: =$s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **$Dpl_{i\ curve}$ = $Dpl_{i\ vehicle}$ + $Dpl_{i\ track}$ * ($A_{i\ track}$ or $A_{i\ track(special)}$) + q * $A_{i\ q}$ + $w_{i\ f(R)}$ * $A_{i\ wi}$ + $z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ reduction}$ IF $h_{S0i\ reduction\ MIN} =< h_{shift} <= h_{S0i\ reduction\ MAX}$ : = 0.025 m ELSE:= 0.000 m | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0$i IF for gauges IRL 1/1D/1F: = ($S_{0i\ geometric}$ – $S_{0i\ reduction}$)$_{if>0}$ + $S_{0i\ enlargement}$ IF for gauges IRL 2: = $S_{0i\ geometric}$ + $S_{0i\ enlargement}$** | **$\Delta b_i$= ($b_{RP}$+$S_{0i}$) -($b_{nom}$ +$Dpl_{i\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | **[m]** | **[m]** |
| 900.0 | 0.165 | 0.110 | **1.174** | 0.014 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.083 | 0.000 | 0.083 | **0.181** | **0.025** | **0.000** | **0.000** | **0.025** | **1.018** |
| 900.0 | 0.165 | 0.110 | **1.174** | 0.014 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.083 | 0.000 | 0.083 | **0.181** | **0.025** | **0.000** | **0.000** | **0.025** | **0.291** |

7.2.10.5. Determine for each RMP the following values for R250.4 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R250.4**

| $R_{250.4}$ | $D_{max\ R250.4}$ | $l_{max\ R250.4}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{iR250.4}$ | $A_{i\ wi}$ | z1 term =[$s*T_D/L*\|h_{nom}-h_c\|$]-[$s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|$] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *$((h_{nom}-h_c)^2)^{0.5}$] -[tan$\eta\theta_r$ *(1+$s_{0random}$) *$((h_{shift}-h_{c0})^2)^{0.5}$]}$_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: =$s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: =$s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: =$s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: =$s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **$Dpl_{i\ curve}$ = $Dpl_{i\ vehicle}$ + $Dpl_{i\ track}$ * ($A_{i\ track}$ or $A_{i\ track(special)}$) + q * $A_{i\ q}$ + $w_{i\ f(R)}$ * $A_{i\ wi}$ + $z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ reduction}$ IF $h_{S0i\ reduction\ MIN} =< h_{shift} <= h_{S0i\ reduction\ MAX}$ : = 0.025 m ELSE:= 0.000 m | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0$i IF for gauges IRL 1/1D/1F: = ($S_{0i\ geometric}$ – $S_{0i\ reduction}$)$_{if>0}$ + $S_{0i\ enlargement}$ IF for gauges IRL 2: = $S_{0i\ geometric}$ + $S_{0i\ enlargement}$** | **$\Delta b_i$= ($b_{RP}$+$S_{0i}$) -($b_{nom}$ +$Dpl_{i\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | **[m]** | **[m]** |
| 250.4 | 0.165 | 0.110 | **1.174** | 0.051 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.083 | 0.000 | 0.083 | **0.217** | **0.090** | **0.000** | **0.000** | **0.090** | **1.046** |
| 250.4 | 0.165 | 0.110 | **1.174** | 0.051 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.083 | 0.000 | 0.083 | **0.217** | **0.090** | **0.000** | **0.000** | **0.090** | **0.319** |

7.2.10.6. Determine for each RMP the following values for R150 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R150**

| $R_{150}$ | $D_{max\ R150}$ | $l_{max\ R150}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{iR150}$ | $A_{i\ wi}$ | z1 term =[$s*T_D/L*\|h_{nom}-h_c\|$]-[$s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|$] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *$((h_{nom}-h_c)^2)^{0.5}$] -[tan$\eta\theta_r$ *(1+$s_{0random}$) *$((h_{shift}-h_{c0})^2)^{0.5}$]}$_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: =$s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: =$s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: =$s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: =$s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **$Dpl_{i\ curve}$ = $Dpl_{i\ vehicle}$ + $Dpl_{i\ track}$ * ($A_{i\ track}$ or $A_{i\ track(special)}$) + q * $A_{i\ q}$ + $w_{i\ f(R)}$ * $A_{i\ wi}$ + $z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ reduction}$ IF $h_{S0i\ reduction\ MIN} =< h_{shift} <= h_{S0i\ reduction\ MAX}$ : = 0.025 m ELSE:= 0.000 m | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0$i IF for gauges IRL 1/1D/1F: = ($S_{0i\ geometric}$ – $S_{0i\ reduction}$)$_{if>0}$ + $S_{0i\ enlargement}$ IF for gauges IRL 2: = $S_{0i\ geometric}$ + $S_{0i\ enlargement}$** | **$\Delta b_i$= ($b_{RP}$+$S_{0i}$) -($b_{nom}$ +$Dpl_{i\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | **[m]** | **[m]** |
| 150 | 0.082 | 0.110 | **1.174** | 0.085 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.041 | 0.000 | 0.041 | **0.209** | **0.150** | **0.000** | **0.000** | **0.150** | **1.114** |
| 150 | 0.082 | 0.110 | **1.174** | 0.085 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.041 | 0.000 | 0.041 | **0.209** | **0.150** | **0.000** | **0.000** | **0.150** | **0.387** |

7.2.10.7. Determine for each RMP the following values for R80 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R80**

| $R_{80}$ | $D_{max\,R80}$ | $l_{max\,R80}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_i$ vehicle | $Dpl_i$ track | $A_{i\,track}$ or $A_{i\,track\,(special)}$ | q | $A_{i\,q}$ | $w_{iR80}$ | $A_{i\,wi}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\,f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=hc$: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\,f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\,static}*D_{max\,f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\,static}*l_{max\,f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **$Dpl_{i\,curve} = Dpl_{i\,vehicle} + Dpl_{i\,track} * (A_{i\,track}$ or $A_{i\,track(special)}) + q * A_{i\,q} + w_{i\,f(R)} * A_{i\,wi} + z_i$** | $S_{0i\,geometric}$ = 22.482 $m^2$ * (1 / R) | $S_{0i\,reduction}$ IF $h_{S0i\,reduction\,MIN} =< h_{shift} <= h_{S0i\,reduction\,MAX}$ : = 0.025 m ELSE:= 0.000 m | $S_{0i\,enlargement}$ $= (15\,m^2 * (1/R)) - 0.1\,m)_{if>0}$ | **$S_0i$ IF for gauges IRL 1/1D/1F: = $(S_{0i\,geometric} - S_{0i\,reduction})_{if>0} + S_{0i\,enlargement}$ IF for gauges IRL 2: = $S_{0i\,geometric} + S_{0i\,enlargement}$** | **$\Delta b_i = (b_{RP}+S_{0i}) - (b_{nom}+Dpl_{i\,curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | **[m]** | **[m]** |
| 80 | 0.025 | 0.110 | **1.174** | 0.159 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.012 | 0.000 | 0.012 | **0.255** | **0.281** | **0.000** | **0.088** | **0.369** | **1.288** |
| 80 | 0.025 | 0.110 | **1.174** | 0.159 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.012 | 0.000 | 0.012 | **0.255** | **0.281** | **0.000** | **0.088** | **0.369** | **0.560** |

7.2.10.8. Where an additional Relevant Radius $R_{add1}$ is present: Determine for each RMP the following values for $R_{add1}$ track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Mechanical Points RMPs, DOWNWARDS shifted, Radd1**

| $R_{add1}$ | $D_{max\,Radd1}$ | $l_{max\,Radd1}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_i$ vehicle | $Dpl_i$ track | $A_{i\,track}$ or $A_{i\,track\,(special)}$ | q | $A_{i\,q}$ | $w_{i\,Radd1}$ | $A_{i\,wi}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\,f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=hc$: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\,f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\,static}*D_{max\,f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\,static}*l_{max\,f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **$Dpl_{i\,curve} = Dpl_{i\,vehicle} + Dpl_{i\,track} * (A_{i\,track}$ or $A_{i\,track(special)}) + q * A_{i\,q} + w_{i\,f(R)} * A_{i\,wi} + z_i$** | $S_{0i\,geometric}$ = 22.482 $m^2$ * (1 / R) | $S_{0i\,reduction}$ IF $h_{S0i\,reduction\,MIN} =< h_{shift} <= h_{S0i\,reduction\,MAX}$ : = 0.025 m ELSE:= 0.000 m | $S_{0i\,enlargement}$ $= (15\,m^2 * (1/R)) - 0.1\,m)_{if>0}$ | **$S_0i$ IF for gauges IRL 1/1D/1F: = $(S_{0i\,geometric} - S_{0i\,reduction})_{if>0} + S_{0i\,enlargement}$ IF for gauges IRL 2: = $S_{0i\,geometric} + S_{0i\,enlargement}$** | **$\Delta b_i = (b_{RP}+S_{0i}) - (b_{nom}+Dpl_{i\,curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | **[m]** | **[m]** |
| 80 | 0.025 | 0.110 | **1.174** | 0.159 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.012 | 0.000 | 0.012 | **0.255** | **0.281** | **0.000** | **0.088** | **0.369** | **1.288** |
| 80 | 0.025 | 0.110 | **1.174** | 0.159 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.012 | 0.000 | 0.012 | **0.255** | **0.281** | **0.000** | **0.088** | **0.369** | **0.560** |

7.2.10.9. Determine for each RMP the following values for R119 track radius:

*Note: Blue values are examples for information.*

LR1 is not present at IRL2 and shall accordingly not be calculated for IRL2.

**only applicable for IRL1+1D+1F:**
**INNER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R119 LR1**

| $R_{119-LR1}$ | $D_{max\,R119-LR1}$ | $l_{max\,R119-LR1}$ | **$b_{RP-LR1}$ =1/2 width of Reference Profile at $h_{RP-LR1} = h_{shift}$** | $Dpl_i$ vehicle | $Dpl_i$ track - LR1 | $A_{i\,track}$ or $A_{i\,track\,(special)}$ | q | $A_{i\,q}$ | $w_{iR119-LR1}$ | $A_{i\,wi}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\,f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=hc$: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\,f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\,static}*D_{max\,f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\,static}*l_{max\,f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **ONLY for LR1: $Dpl_{i\,curve} = Dpl_{i\,vehicle} + Dpl_{i\,track-LR1} * (A_{i\,track}$ or $A_{i\,track\,(special)}) + q * A_{i\,q} + w_{i\,f(R)} * A_{i\,wi} + z_i$** | $S_{0i\,geometric}$ = 22.482 $m^2$ * (1 / R) | $S_{0i\,reduction}$ ONLY for LR1: IF $h_{S0i\,LR1\,reduction\,MIN} =< h_{shift} <= h_{S0i\,LR1\,reduction\,MAX}$ : = 0.025 m ELSE: = 0.000 m | $S_{0i\,enlargement}$ $= (15\,m^2 * (1/R)) - 0.1\,m)_{if>0}$ | **ONLY for gauges IRL 1/1D/1F $S_{0i} = (S_{0i\,geometric} - S_{0i\,reduction})_{if>0} + S_{0i\,enlargement}$** | **ONLY for gauges IRL1/1D/1F and ONLY IF $h_{shift}$ is between $h_{LR1\,MIN}$ and $h_{LR1\,MAX}$: $\Delta b_i = (b_{RP\,LR1}+S_{0i}) - (b_{nom}+Dpl_{i\,curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | **[m]** | **[m]** |
| 119 | 0.000 | 0.028 | **1.174** | 0.107 | 0.020 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | **0.181** | **0.189** | **0.000** | **0.026** | **0.215** | n.a. |
| 119 | 0.000 | 0.028 | **1.174** | 0.107 | 0.020 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | **0.181** | **0.189** | **0.000** | **0.026** | **0.215** | n.a. |

7.2.10.10. Determine for each RMP the following values for R280 track radius:

*Note: Blue values are examples for information.*

LR2 is not present at IRL2 and shall accordingly not be calculated for IRL2.

| only applicable for IRL1+1D+1F: INNER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R280 LR2 | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{280\text{-}LR2}$ | $D_{max\ R280\text{-}LR2}$ | $l_{max\ R280\text{-}LR2}$ | **$b_{RP\text{-}LR2}$ =1/2 width of Reference Profile at $h_{RP\text{-}LR2}$ = $h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track\text{-}LR2}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{iR280\text{-}LR2}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **ONLY for LR2: $Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track\text{-}LR2} * (A_{i\ track}$ or $A_{i\ track\ (special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ reduction}$ ONLY for LR2: IF $h_{S0i\ LR2\ reduction\ MIN} =< h_{shift} <= h_{S0i\ LR2\ reduction\ MAX}$ : = 0.025 m ELSE: = 0.000 m | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **ONLY for gauges IRL 1/1D/1F $S_{0i} = (S_{0i\ geometric} - S_{0i\ reduction})_{if>0} + S_{0i\ enlargement}$** | **ONLY for gauges IRL1/1D/1F and ONLY IF $h_{shift}$ is between $h_{LR1\ MIN}$ and $h_{LR1\ MAX}$: $\Delta b_i = (b_{RP}+S_{0i}) -(b_{nom} + Dpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | **[m]** | **[m]** |
| 280 | 0.044 | 0.006 | **1.174** | 0.045 | 0.020 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.022 | 0.000 | 0.022 | **0.142** | **0.080** | **0.000** | **0.000** | **0.080** | **n.a.** |
| 280 | 0.044 | 0.006 | **1.174** | 0.045 | 0.020 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.022 | 0.000 | 0.022 | **0.142** | **0.080** | **0.000** | **0.000** | **0.080** | **n.a.** |

7.2.10.11. Determine for each RMP the following values for R98-vLR1 track radius:

*Note: Blue values are examples for information.*

vLR1 is not present at IRL2 and shall accordingly not be calculated for IRL2.

| only applicable for IRL1+1D+1F: INNER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R98 vLR1 | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{98\text{-}vLR1}$ | $D_{max\ R98\text{-}vLR1}$ | $l_{max\ R98\text{-}vLR1}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP}$ = $h_{shift\text{-}vLR1}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track\text{-}vLR1}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{iR98\text{-}vLR1}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift\text{-}vLR1}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta0_r*(1+s_{0random})*((h_{shift\text{-}vLR1}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift\text{-}vLR1}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift\text{-}vLR1}-h_{c0})$ or if $h_{shift\text{-}vLR1}=h_{c0}$: =0.000m or if $h_{shift\text{-}vLR1}<h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift\text{-}vLR1})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **ONLY for vLR1: $Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track\text{-}vLR1} * (A_{i\ track}$ or $A_{i\ track\ (special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ reduction}$ IF $h_{S0i\ reduction\ MIN} =< h_{shift\text{-}vLR1} <= h_{S0i\ reduction\ MAX}$ : = 0.025 m ELSE: = 0.000 m | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_{0i} = (S_{0i\ geometric} - S_{0i\ reduction})_{if>0} + S_{0i\ enlargement}$** | **ONLY for gauges IRL1/1D/1F $\Delta b_i = (b_{RP}+S_{0i}) -(b_{nom} + Dpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | **[m]** | **[m]** |
| 98 | 0.010 | 0.034 | **1.174** | 0.130 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.005 | 0.000 | 0.005 | **0.218** | **0.229** | **0.000** | **0.053** | **0.282** | **1.238** |
| 98 | 0.010 | 0.034 | **1.174** | 0.130 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.005 | 0.000 | 0.005 | **0.218** | **0.229** | **0.000** | **0.053** | **0.282** | **0.511** |

7.2.10.12. Determine from all resulting $\Delta b_i$ values of this set of gauging calculations the smallest value for each RMP.

*Note: Blue value is an example for information*

| **$\Delta b_i$ min across all calculations of this set** |
|---|
| **[m]** |
| **1.012** |
| **0.285** |

+ A positive value or 0.000m indicates that the vehicle design is compatible with the selected gauge(s)

- A negative value indicates that the vehicle design is not compatible with the selected gauge(s)

7.2.10.13. Determine also, if for this Set any RMPs are present in the WHEEL ZONE and evaluate if these RMPs fulfil the related requirements defined for the selected RP-M in section 6.

7.2.11. **Step 5 - Perform Set3 of the gauging calculations for OUTER Relevant Mechanical Points RMPs in their UPWARDS shifted positions on R0+R2000+R250.4+R150+R80+Radd1 +R116-LR1+R280-LR2+R98-vLR1**

7.2.11.1. Determine for each Relevant Point the following basic values which are independent of the horizontal track radius:

*Note: Blue values are examples for information.*

| Relevant Point ID | $n_a$ | $h_{nom}$ | $b_{nom}$ | $k_{U1a}+k_{U2}$ upwards shift of this Relevant Point | $k_{U1a\text{-}vLR1}+k_{U2}$ upwards shift of this Relevant Point at vLR1 | $h_{shift}=h_{nom}+k_{U1a}+k_{U2}$ | $h_{shift\ vLR1}=h_{nom}+k_{U1a\text{-}vLR1}+k_{U2}$ |
|---|---|---|---|---|---|---|---|
| | [m] | [m] | [m] | [m] | [m] | [m] | [m] |
| aA | 2.500 | 3.970 | 0.000 | 0.020 | 0.020 | 3.990 | 3.990 |
| aB | 2.500 | 3.970 | 0.155 | 0.020 | 0.020 | 3.990 | 3.990 |

7.2.11.2. Determine for each RMPs the following values for straight track.

*Note: Blue values are examples for information.*

**OUTER Relevant Mechanical Points RMPs, UPWARDS shifted, R0(=straight track)**

| $R_0$ (no value for straight) | $D_{max\ R0}$ | $l_{max\ R0}$ | $b_{RP}$ =1/2 width of Reference Profile at $h_{RP}=h_{shift}$ | $Dpl_{a\ vehicle}$ (not applicable for straight track) | $Dpl_{a\ track}$ | $A_{a\ track}$ | q | $A_{a\ q}$ | $w_{R0}$ | $A_{a\ wR0\ straight}$ | z1 term $=[s*T_D/L*\lvert h_{nom}-h_c\rvert]-[s_{0random}*T_D/L*\lvert h_{shift}-h_{c0}\rvert]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\ f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\ static}*l_{max(fR)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*D_{max(fR)}/L*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term -z3.2a term) | $Dpl_{a\ straight}=Dpl_{a\ track}*A_{a\ track}+q*A_{a\ q}+w_{R0}*A_{a\ wR0\ straight}+z_a$ | $S_{0a\ geometric}$ (no value for straight track) | $S_{0a\ enlargement}$ (no value for straight track) | $S_{0a}$ (no value for straight track) | $\Delta b_a=(b_{RP}+S_{0a})-(b_{nom}+Dpl_{a\ straight})$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | [m] | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] |
| | 0.000 | 0.000 | 1.002 | | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 1.365 | -0.001 | 0.000 | 0.000 | 0.000 | -0.001 | 0.113 | | | | 0.889 |
| | 0.000 | 0.000 | 1.002 | | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 1.365 | -0.001 | 0.000 | 0.000 | 0.000 | -0.001 | 0.113 | | | | 0.734 |

7.2.11.3. Determine for each RMPs the following values for R2000 track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Mechanical Points RMPs, UPWARDS shifted, R2000**

| $R_{2000}$ | $D_{max\ R2000}$ | $l_{max\ R2000}$ | $b_{RP}$ =1/2 width of Reference Profile at $h_{RP}=h_{shift}$ | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R2000}$ | $A_{a\ wi\ curve}$ | $w_{a\ R2000}$ | $A_{a\ wa\ curve}$ | z1 term $=[s*T_D/L*\lvert h_{nom}-h_c\rvert]-[s_{0random}*T_D/L*\lvert h_{shift}-h_{c0}\rvert]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\ f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\ static}*l_{max(fR)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*D_{max(fR)}/L*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | $Dpl_{a\ curve}=Dpl_{a\ vehicle}+Dpl_{a\ track}*(A_{a\ track}$ or $A_{a\ track\ (special)})+q*A_{a\ q}+w_{a\ f(R)}*Aa_{wa\ curve}+w_{i\ f(R)}*A_{a\ wi\ curve}+z_a$ | $S_{0a\ geometric}$ = 21.440 m² * (1 / R) | $S_{0a\ enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | $S_{0a}=S_{0a\ geometric}+S_{0a\ enlargement}$ | $\Delta b_a=(b_{RP}+S_{0a})-(b_{nom}+Dpl_{a\ curve})$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | [m] | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] |
| 2000.000 | 0.165 | 0.110 | 1.002 | 0.010 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | 0.178 | 0.011 | 0.000 | 0.011 | 0.835 |
| 2000.000 | 0.165 | 0.110 | 1.002 | 0.010 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | 0.178 | 0.011 | 0.000 | 0.011 | 0.680 |

7.2.11.4. Determine for each RMP the following values for R250.4 track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Mechanical Points RMPs, UPWARDS shifted, R250.4**

| $R_{250.4}$ | $D_{max\ R250.4}$ | $l_{max\ R250.4}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R250.4}$ | $A_{a\ wi\ curve}$ | $w_{a\ R250.4}$ | $A_{a\ wa\ curve}$ | z1 term $=[s \cdot T_D/L \cdot \lvert h_{nom}-h_c \rvert]-[s_{0random} \cdot T_D/L \cdot \lvert h_{shift}-h_{c0} \rvert]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J) \cdot (1+s) \cdot ((h_{nom}-h_c)^2)^{0.5}] - [\tan\eta 0_r \cdot (1+s_{0random}) \cdot ((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s \cdot l_{max\ f(R)}/L \cdot (h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s \cdot D_{max\ f(R)}/L \cdot (hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\ static} \cdot l_{max(fR)}/L \cdot (h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static} \cdot D_{max(fR)}/L \cdot (h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | **$Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track} \cdot (A_{a\ track}$ or $A_{a\ track\ (special)}) + q \cdot A_{a\ q} + w_{a\ f(R)} \cdot Aa_{wa\ curve} + w_{i\ f(R)} \cdot A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric}$ = 21.440 m² * (1 / R) | $S_{0a\ enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **$\Delta b_a = (b_{RP}+S_{0a}) - (b_{nom} + Dpl_{a\ curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 250.400 | 0.165 | 0.110 | **1.002** | 0.078 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.246** | 0.086 | 0.000 | **0.086** | **0.842** |
| 250.400 | 0.165 | 0.110 | **1.002** | 0.078 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.246** | 0.086 | 0.000 | **0.086** | **0.687** |

7.2.11.5. Determine for each RMP the following values for R150 track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Mechanical Points RMPs, UPWARDS shifted, R150**

| $R_{150}$ | $D_{max\ R150}$ | $l_{max\ R150}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R150}$ | $A_{a\ wi\ curve}$ | $w_{a\ R150}$ | $A_{a\ wa\ curve}$ | z1 term $=[s \cdot T_D/L \cdot \lvert h_{nom}-h_c \rvert]-[s_{0random} \cdot T_D/L \cdot \lvert h_{shift}-h_{c0} \rvert]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J) \cdot (1+s) \cdot ((h_{nom}-h_c)^2)^{0.5}] - [\tan\eta 0_r \cdot (1+s_{0random}) \cdot ((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s \cdot l_{max\ f(R)}/L \cdot (h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s \cdot D_{max\ f(R)}/L \cdot (hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\ static} \cdot l_{max(fR)}/L \cdot (h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static} \cdot D_{max(fR)}/L \cdot (h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | **$Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track} \cdot (A_{a\ track}$ or $A_{a\ track\ (special)}) + q \cdot A_{a\ q} + w_{a\ f(R)} \cdot Aa_{wa\ curve} + w_{i\ f(R)} \cdot A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric}$ = 21.440 m² * (1 / R) | $S_{0a\ enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **$\Delta b_a = (b_{RP}+S_{0a}) - (b_{nom} + Dpl_{a\ curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 150.000 | 0.082 | 0.110 | **1.002** | 0.131 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.299** | 0.143 | 0.000 | **0.143** | **0.847** |
| 150.000 | 0.082 | 0.110 | **1.002** | 0.131 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.299** | 0.143 | 0.000 | **0.143** | **0.691** |

7.2.11.6. Determine for each RMP the following values for R80 track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Mechanical Points RMPs, UPWARDS shifted, R80**

| $R_{80}$ | $D_{max\ R80}$ | $l_{max\ R80}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R80}$ | $A_{a\ wi\ curve}$ | $w_{a\ R80}$ | $A_{a\ wa\ curve}$ | z1 term $=[s \cdot T_D/L \cdot \lvert h_{nom}-h_c \rvert]-[s_{0random} \cdot T_D/L \cdot \lvert h_{shift}-h_{c0} \rvert]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J) \cdot (1+s) \cdot ((h_{nom}-h_c)^2)^{0.5}] - [\tan\eta 0_r \cdot (1+s_{0random}) \cdot ((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s \cdot l_{max\ f(R)}/L \cdot (h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s \cdot D_{max\ f(R)}/L \cdot (hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\ static} \cdot l_{max(fR)}/L \cdot (h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static} \cdot D_{max(fR)}/L \cdot (h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | **$Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track} \cdot (A_{a\ track}$ or $A_{a\ track\ (special)}) + q \cdot A_{a\ q} + w_{a\ f(R)} \cdot Aa_{wa\ curve} + w_{i\ f(R)} \cdot A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric}$ = 21.440 m² * (1 / R) | $S_{0a\ enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **$\Delta b_a = (b_{RP}+S_{0a}) - (b_{nom} + Dpl_{a\ curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 80.000 | 0.025 | 0.110 | **1.002** | 0.245 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.413** | 0.268 | 0.088 | **0.356** | **0.945** |
| 80.000 | 0.025 | 0.110 | **1.002** | 0.245 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.413** | 0.268 | 0.088 | **0.356** | **0.790** |

7.2.11.7. Where an additional Relevant Radius $R_{add1}$ is present: Determine for each RMP the following values for $R_{add1}$ track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Mechanical Points RMPs, UPWARDS shifted, Radd1**

| $R_{add1}$ | $D_{max\ Radd1}$ | $l_{max\ Radd1}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ Radd1}$ | $A_{a\ wi\ curve}$ | $w_{a\ Radd1}$ | $A_{a\ wa\ curve}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\ f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\ static}*l_{max(fR)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*D_{max(fR)}/L*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | **$Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track} * (A_{a\ track}$ or $A_{a\ track\ (special)}) + q * A_{a\ q} + w_{a\ f(R)} * Aa_{wa\ curve} + w_{i\ f(R)} * A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric}$ = 21.440 m² * (1 / R) | $S_{0a\ enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **$\Delta b_a = (b_{RP}+S_{0a}) - (b_{nom} + Dpl_{a\ curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 80.000 | 0.025 | 0.110 | **1.002** | 0.245 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.413** | 0.268 | 0.088 | **0.356** | **0.945** |
| 80.000 | 0.025 | 0.110 | **1.002** | 0.245 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.413** | 0.268 | 0.088 | **0.356** | **0.790** |

7.2.11.8. Determine for each RMP the following values for R116 track radius:

*Note: Blue values are examples for information.*

LR1 is not present at IRL2 and shall accordingly not be calculated for IRL2.

**only applicable for IRL1+1D+1F:**
**OUTER Relevant Mechanical Points RMPs, UPWARDS shifted , R116 LR1**

| $R_{116-LR1}$ | $D_{max\ R116-LR1}$ | $l_{max\ R116-LR1}$ | **$b_{RP-LR1}$ =1/2 width of Reference Profile at $h_{RP-LR1} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track-LR1}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R116-LR1}$ | $A_{a\ wi\ curve}$ | $w_{a\ R116-LR1}$ | $A_{a\ wa\ curve}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\ f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\ static}*l_{max(fR)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*D_{max(fR)}/L*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | **ONLY for LR1: $Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track-LR1} * (A_{a\ track}$ or $A_{a\ track\ (special)}) + q * A_{a\ q} + w_{a\ f(R)} * A_{a\ wa\ curve} + w_{i\ f(R)} * A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric}$ = 21.440 m² * (1 / R) | $S_{0a\ enlargement}$ = (15 m² * (1 / R) – 0.1 m)$_{if>0}$ | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **ONLY for gauges IRL1/1D/1F and ONLY IF $h_{shift}$ is between $h_{LR1\ MIN}$ and $h_{LR1\ MAX}$: $\Delta ba = (b_{RP-LR1}+S_{0a}) - (b_{nom} + Dpla_{curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 116.000 | 0.000 | 0.029 | **1.002** | 0.169 | 0.020 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.014 | 0.000 | 0.014 | **0.284** | 0.185 | 0.029 | **0.214** | **n.a.** |
| 116.000 | 0.000 | 0.029 | **1.002** | 0.169 | 0.020 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.014 | 0.000 | 0.014 | **0.284** | 0.185 | 0.029 | **0.214** | **n.a.** |

7.2.11.9. Determine for each RMP the following values for R280 track radius:

*Note: Blue values are examples for information.*

LR2 is not present at IRL2 and shall accordingly not be calculated for IRL2.

**only applicable for IRL1+1D+1F:**
**OUTER Relevant Mechanical Points RMPs, UPWARDS shifted, R280 LR2**

| $R_{280-LR2}$ | $D_{max\ R280-LR2}$ | $l_{max\ R280-LR2}$ | **$b_{RP-LR2}$ =1/2 width of Reference Profile at $h_{RP-LR2} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track-LR2}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R280-LR2}$ | $A_{a\ wi\ curve}$ | $w_{a\ R280-LR2}$ | $A_{a\ wa\ curve}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\ f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\ static}*l_{max(fR)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*D_{max(fR)}/L*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | **ONLY for LR2: $Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track-LR2} * (A_{a\ track}$ or $A_{a\ track\ (special)}) + q * A_{a\ q} + w_{a\ f(R)} * A_{a\ wa\ curve} + w_{i\ f(R)} * A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric}$ = 21.440 m² * (1 / R) | $S_{0a\ enlargement}$ = (15 m² * (1 / R) – 0.1 m)$_{if>0}$ | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **ONLY for gauges IRL1/1D/1F and ONLY IF $h_{shift}$ is between $h_{LR2\ MIN}$ and $h_{LR2\ MAX}$: $\Delta ba = (b_{RP-LR2}+S_{0a}) - (b_{nom} + Dpla_{curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 280.000 | 0.044 | 0.006 | **1.002** | 0.070 | 0.020 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.003 | 0.000 | 0.002 | **0.174** | 0.077 | 0.000 | **0.077** | **n.a.** |
| 280.000 | 0.044 | 0.006 | **1.002** | 0.070 | 0.020 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.003 | 0.000 | 0.002 | **0.174** | 0.077 | 0.000 | **0.077** | **n.a.** |

7.2.11.10. Determine for each RMP the following values for R98-vLR1 track radius:

*Note: Blue values are examples for information.*

vLR1 is not present at IRL2 and shall accordingly not be calculated for IRL2.

**only applicable for IRL1+1D+1F:**

**OUTER Relevant Mechanical Points RMPs, UPWARDS shifted, R98 vLR1**

| $R_{98\text{-}vLR1}$ | $D_{max\ R98\text{-}vLR1}$ | $l_{max\ R98\text{-}vLR1}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift\text{-}vLR1}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track\text{-}vLR1}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R98\text{-}vLR1}$ | $A_{a\ wi\ curve}$ | $w_{a\ R98\text{-}vLR1}$ | $A_{awa\ curve}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift\text{-}vLR1}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift\text{-}vLR1}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\ f(R)}/L*(hc-h_{nom})$ | ONLY for vLR1: z3.2a term if $h_{shift\text{-}vLR1}>h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{shift\text{-}vLR1}-h_{c0})$ or if $h_{shift\text{-}vLR1}$ = hc0: = 0.000 m or if $h_{shift\text{-}vLR1}<h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{c0}-h_{shift\text{-}vLR1})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | **ONLY for vLR1: $Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track\text{-}vLR1} * (A_{a\ track}$ or $A_{a\ track\ (special)}) + q * A_{a\ q} + w_{a\ f(R)} * A_{a\ wa\ curve} + w_{i\ f(R)} * A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric}$ = 21.440 $m^2$ * (1 / R) | $S_{0a\ enlargement}$ = (15 $m^2$ * (1 / R) – 0.1 m)$_{if>0}$ | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **ONLY for gauges IRL1/1D/1F $\Delta ba=(b_{RP}+S_{0a})-(b_{nom}+Dpla_{curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 98.000 | 0.010 | 0.034 | **1.002** | 0.200 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.017 | 0.000 | 0.016 | **0.330** | 0.219 | 0.053 | **0.272** | **0.944** |
| 98.000 | 0.010 | 0.034 | **1.002** | 0.200 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | -0.001 | 0.000 | 0.017 | 0.000 | 0.016 | **0.330** | 0.219 | 0.053 | **0.272** | **0.789** |

7.2.11.11. Determine from all resulting $\Delta b_a$ values of this set of gauging calculations the smallest value for each RMP.

*Note: Blue value is an example for information.*

| **$\Delta b_a$ min across all calculations of this set** |
|---|
| **[m]** |
| **0.835** |
| **0.680** |

+ A positive value or 0.000m indicates that the vehicle design is compatible with the selected gauge(s)

- A negative value indicates that the vehicle design is not compatible with the selected gauge(s)

7.2.11.12. Determine also, if for this Set any RMPs are present in the WHEEL ZONE and evaluate if these RMPs fulfil the related requirements defined for the selected RP-M in section 6.

### 7.2.12. Step 6 - Perform Set4 of the gauging calculations for OUTER Relevant Mechanical Points RMPs in their DOWNWARDS shifted positions on R0+R2000+R250.4+R150+R80+Radd1 +R116-LR1+R280-LR2+R98-vLR1

7.2.12.1. Determine for each RMP the following basic values which are independent of the horizontal track radius:

*Note: Blue values are examples for information.*

| Point ID | $n_a$ | $h_{nom}$ | $b_{nom}$ | Zone (C or D) | $k_{L1a}$ down-wards shift of this Relevant Point | $k_{L1a\text{-}vLR1}$ down-wards shift of this Relevant Point at vLR1 | $k_{L2}$ +$k_{L3}$ +$k_{L4}$ down-wards shift of this Relevant Point | $k_{L5}$ down-wards shift of this Relevant Point (depending on Zone: =$k_{L5C}$ oder =$k_{L5D}$) | $h_{shift}$ =$h_{nom}$ -($k_{L1a}$ +$k_{L2}$ +$k_{L3}$ +$k_{L4}$ + $k_{L5}$) | $h_{shift\text{-}vLR1}$ =$h_{nom}$ -($k_{L1a\text{-}vLR1}$ +$k_{L2}$ +$k_{L3}$ +$k_{L4}$ +$k_{L5}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | [m] | [m] | [m] | | [m] | [m] | [m] | [m] | [m] | [m] |
| aA | 2.500 | 3.970 | 0.000 | D | 0.000 | 0.000 | 0.122 | 0.022 | 3.826 | 3.826 |
| aB | 2.500 | 3.970 | 0.155 | D | 0.000 | 0.000 | 0.122 | 0.022 | 3.826 | 3.826 |

7.2.12.2. Determine for each RMP the following values for straight track.

*Note: Blue values are examples for information.*

**OUTER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R0(=straight track)**

| $R_0$ (no value for straight) | $D_{max\ R0}$ | $l_{max\ R0}$ | $b_{RP}$ =1/2 width of Reference Profile at $h_{RP}$ = $h_{shift}$ | $Dpl_{a\ vehicle}$ (not applicable for straight track) | $Dpl_{a\ track}$ | $A_{a\ track}$ | q | $A_{a\ q}$ | $w_{R0}$ | $A_{a\ wR0\ straight}$ | z1 term =[s*$T_D$/L*\|$h_{nom}$-$h_c$\|]-[$s_{0random}$*$T_D$/L*\|$h_{shift}$-$h_{c0}$\|] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}$-$h_c$)$^2$)$^{0.5}$] -[tan$\eta 0_r$ *(1+$s_{0random}$) *(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1a term, if $h_{nom}$>$h_c$: =s*$l_{max\ f(R)}$/L*($h_{nom}$-$h_c$) or if $h_{nom}$=$h_c$: =0.000m or if $h_{nom}$<$h_c$: =s*$D_{max\ f(R)}$/L*(hc-$h_{nom}$) | z3.2a term if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$l_{max(fR)}$/L*($h_{shift}$-$h_{c0}$) or if $h_{shift}$=$h_{c0}$: =0.000m or if $h_{shift}$<$h_{c0}$: =$s_{0\ static}$*$D_{max(fR)}$/L*($h_{c0}$-$h_{shift}$) | $z_a$ =(z1 term) +(z2 term) +(z3.1a term -z3.2a term) | $Dpl_{a\ straight}$ = $Dpl_{a\ track}$ * $A_{a\ track}$ + q * $A_{a\ q}$ + $w_{R0}$ * $A_{a\ wR0\ straight}$ + $z_a$ | $S_{0a\ geometric}$ (no value for straight track) | $S_{0a\ enlargement}$ (no value for straight track) | $S_{0a}$ (no value for straight track) | $\Delta b_a$= ($b_{RP}$+$S_{0a}$) -($b_{nom}$ +$Dpl_{a\ straight}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | [m] | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] |
| | 0.000 | 0.000 | 1.286 | | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 1.365 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.114 | | | | 1.173 |
| | 0.000 | 0.000 | 1.286 | | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 1.365 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.114 | | | | 1.017 |

7.2.12.3. Determine for each RMP the following values for R2000 track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R2000**

| $R_{2000}$ | $D_{max\ R2000}$ | $l_{max\ R2000}$ | $b_{RP}$ =1/2 width of Reference Profile at $h_{RP}$ = $h_{shift}$ | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R2000}$ | $A_{a\ wi\ curve}$ | $w_{a\ R2000}$ | $A_{a\ wa\ curve}$ | z1 term =[s*$T_D$/L*\|$h_{nom}$-$h_c$\|]-[$s_{0random}$*$T_D$/L*\|$h_{shift}$-$h_{c0}$\|] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}$-$h_c$)$^2$)$^{0.5}$] -[tan$\eta 0_r$ *(1+$s_{0random}$) *(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1a term, if $h_{nom}$>$h_c$: =s*$l_{max\ f(R)}$/L*($h_{nom}$-$h_c$) or if $h_{nom}$=$h_c$: =0.000m or if $h_{nom}$<$h_c$: =s*$D_{max\ f(R)}$/L*(hc-$h_{nom}$) | z3.2a term if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$l_{max(fR)}$/L*($h_{shift}$-$h_{c0}$) or if $h_{shift}$=$h_{c0}$: =0.000m or if $h_{shift}$<$h_{c0}$: =$s_{0\ static}$*$D_{max(fR)}$/L*($h_{c0}$-$h_{shift}$) | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | $Dpl_{a\ curve}$ = $Dpl_{a\ vehicle}$ + $Dpl_{a\ track}$ * ($A_{a\ track}$ or $A_{a\ track\ (special)}$) + q * $A_{a\ q}$ + $w_{a\ f(R)}$ * $Aa_{wa\ curve}$ + $w_{i\ f(R)}$ * $A_{a\ wi\ curve}$ + $z_a$ | $S_{0a\ geometric}$ = 21.440 m² * (1 / R) | $S_{0a\ enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | $S_{0a}$ = $S_{0a\ geometric}$ + $S_{0a\ enlargement}$ | $\Delta b_a$= ($b_{RP}$+$S_{0a}$) - ($b_{nom}$ +$Dpl_{a\ curve}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | [m] | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | | [m] |
| 2000.000 | 0.165 | 0.110 | 1.286 | 0.010 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | 0.178 | 0.011 | 0.000 | 0.011 | 1.119 |
| 2000.000 | 0.165 | 0.110 | 1.286 | 0.010 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | 0.178 | 0.011 | 0.000 | 0.011 | 0.964 |

7.2.12.4. Determine for each RMP the following values for R250.4 track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R250.4**

| $R_{250.4}$ | $D_{max\ R250.4}$ | $l_{max\ R250.4}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R250.4}$ | $A_{a\ wi\ curve}$ | $w_{a\ R250.4}$ | $A_{a\ wa\ curve}$ | z1 term<br>=[s*$T_D$/L*\|$h_{nom}$-$h_c$\|]-<br>[$s_{0random}$*$T_D$/L*<br>\|$h_{shift}$-$h_{c0}$\|] | z2 term<br>={[(tan $\eta_0$+tan $\alpha_J$) *(1+s)<br>*(($h_{nom}$-$h_c$)$^2$)$^{0.5}$]<br>-[tan$\eta 0_r$<br>*(1+$s_{0random}$)<br>*(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1a term,<br>if $h_{nom}$>$h_c$:<br>=s*$l_{max\ f(R)}$/L*($h_{nom}$-$h_c$)<br>or if $h_{nom}$=$h_c$:<br>=0.000m<br>or if $h_{nom}$<$h_c$:<br>=s*$D_{max\ f(R)}$/L*(hc-$h_{nom}$) | z3.2a term<br>if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$l_{max(fR)}$/L*(<br>$h_{shift}$-$h_{c0}$)<br>or if $h_{shift}$=$h_{c0}$:<br>=0.000m<br>or if $h_{shift}$<$h_{c0}$:<br>=$s_{0\ static}$*$D_{max(fR)}$/L*(<br>$h_{c0}$-$h_{shift}$) | $z_a$<br>=(z1 term)<br>+(z2 term)<br>+(z3.1a term - z3.2a term) | **$Dpl_{a\ curve}$ = $Dpl_{a\ vehicle}$ + $Dpl_{a\ track}$ * ($A_{a\ track}$ or $A_{a\ track\ (special)}$) + q * $A_{a\ q}$ + $w_{a\ f(R)}$ * $Aa_{wa\ curve}$ + $w_{i\ f(R)}$ * $A_{a\ wi\ curve}$ + $z_a$** | $S_{0a\ geometric}$<br>= 21.440 m² * (1 / R) | $S_{0a\ enlargement}$<br>= (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a}$ = $S_{0a\ geometric}$ + $S_{0a\ enlargement}$** | **$\Delta b_a$= ($b_{RP}$+$S_{0a}$) - ($b_{nom}$ +$Dpl_{a\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 250.400 | 0.165 | 0.110 | **1.286** | 0.078 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.247** | 0.086 | 0.000 | **0.086** | **1.125** |
| 250.400 | 0.165 | 0.110 | **1.286** | 0.078 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.247** | 0.086 | 0.000 | **0.086** | **0.970** |

7.2.12.5. Determine for each RMP the following values for R150 track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R150**

| $R_{150}$ | $D_{max\ R150}$ | $l_{max\ R150}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R150}$ | $A_{a\ wi\ curve}$ | $w_{a\ R150}$ | $A_{a\ wa\ curve}$ | z1 term<br>=[s*$T_D$/L*\|$h_{nom}$-$h_c$\|]-<br>[$s_{0random}$*$T_D$/L*<br>\|$h_{shift}$-$h_{c0}$\|] | z2 term<br>={[(tan $\eta_0$+tan $\alpha_J$) *(1+s)<br>*(($h_{nom}$-$h_c$)$^2$)$^{0.5}$]<br>-[tan$\eta 0_r$<br>*(1+$s_{0random}$)<br>*(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1a term,<br>if $h_{nom}$>$h_c$:<br>=s*$l_{max\ f(R)}$/L*($h_{nom}$-$h_c$)<br>or if $h_{nom}$=$h_c$:<br>=0.000m<br>or if $h_{nom}$<$h_c$:<br>=s*$D_{max\ f(R)}$/L*(hc-$h_{nom}$) | z3.2a term<br>if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$l_{max(fR)}$/L*(<br>$h_{shift}$-$h_{c0}$)<br>or if $h_{shift}$=$h_{c0}$:<br>=0.000m<br>or if $h_{shift}$<$h_{c0}$:<br>=$s_{0\ static}$*$D_{max(fR)}$/L*<br>($h_{c0}$-$h_{shift}$) | $z_a$<br>=(z1 term)<br>+(z2 term)<br>+(z3.1a term - z3.2a term) | **$Dpl_{a\ curve}$ = $Dpl_{a\ vehicle}$ + $Dpl_{a\ track}$ * ($A_{a\ track}$ or $A_{a\ track\ (special)}$) + q * $A_{a\ q}$ + $w_{a\ f(R)}$ * $Aa_{wa\ curve}$ + $w_{i\ f(R)}$ * $A_{a\ wi\ curve}$ + $z_a$** | $S_{0a\ geometric}$<br>= 21.440 m² * (1 / R) | $S_{0a\ enlargement}$<br>= (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a}$ = $S_{0a\ geometric}$ + $S_{0a\ enlargement}$** | **$\Delta b_a$= ($b_{RP}$+$S_{0a}$) - ($b_{nom}$ +$Dpl_{a\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 150.000 | 0.082 | 0.110 | **1.286** | 0.131 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.299** | 0.143 | 0.000 | **0.143** | **1.130** |
| 150.000 | 0.082 | 0.110 | **1.286** | 0.131 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.299** | 0.143 | 0.000 | **0.143** | **0.975** |

7.2.12.6. Determine for each RMP the following values for R80 track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R80**

| $R_{80}$ | $D_{max\ R80}$ | $l_{max\ R80}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R80}$ | $A_{a\ wi\ curve}$ | $w_{a\ R80}$ | $A_{a\ wa\ curve}$ | z1 term<br>=[s*$T_D$/L*\|$h_{nom}$<br>-$h_c$\|]-<br>[$s_{0random}$*$T_D$/L*<br>\|$h_{shift}$-$h_{c0}$\|] | z2 term<br>={[(tan $\eta_0$+tan $\alpha_J$) *(1+s)<br>*(($h_{nom}$-$h_c$)$^2$)$^{0.5}$]<br>-[tan$\eta 0_r$<br>*(1+$s_{0random}$)<br>*(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1a term,<br>if $h_{nom}$>$h_c$:<br>=s*$l_{max\ f(R)}$/L*($h_{nom}$-$h_c$)<br>or if $h_{nom}$=$h_c$:<br>=0.000m<br>or if $h_{nom}$<$h_c$:<br>=s*$D_{max\ f(R)}$/L*(hc-$h_{nom}$) | z3.2a term<br>if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$l_{max(fR)}$/L*(<br>$h_{shift}$-$h_{c0}$)<br>or if $h_{shift}$=$h_{c0}$:<br>=0.000m<br>or if $h_{shift}$<$h_{c0}$:<br>=$s_{0\ static}$*$D_{max(fR)}$/L*(<br>$h_{c0}$-$h_{shift}$) | $z_a$<br>=(z1 term)<br>+(z2 term)<br>+(z3.1a term - z3.2a term) | **$Dpl_{a\ curve}$ = $Dpl_{a\ vehicle}$ + $Dpl_{a\ track}$ * ($A_{a\ track}$ or $A_{a\ track\ (special)}$) + q * $A_{a\ q}$ + $w_{a\ f(R)}$ * $Aa_{wa\ curve}$ + $w_{i\ f(R)}$ * $A_{a\ wi\ curve}$ + $z_a$** | $S_{0a\ geometric}$<br>= 21.440 m² * (1 / R) | $S_{0a\ enlargement}$<br>= (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a}$ = $S_{0a\ geometric}$ + $S_{0a\ enlargement}$** | **$\Delta b_a$= ($b_{RP}$+$S_{0a}$) - ($b_{nom}$ +$Dpl_{a\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 80.000 | 0.025 | 0.110 | **1.286** | 0.245 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.413** | 0.268 | 0.088 | **0.356** | **1.229** |
| 80.000 | 0.025 | 0.110 | **1.286** | 0.245 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.413** | 0.268 | 0.088 | **0.356** | **1.073** |

7.2.12.7. Where an additional Relevant Radius $R_{add1}$ is present: Determine for each RMP the following values for $R_{add1}$ track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Mechanical Points RMPs, DOWNWARDS shifted, Radd1**

| $R_{add1}$ | $D_{max\ Radd1}$ | $l_{max\ Radd1}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ Radd1}$ | $A_{a\ wi\ curve}$ | $w_{a\ Radd1}$ | $A_{a\ wa\ curve}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\ f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\ static}*l_{max(fR)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*D_{max(fR)}/L*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | **$Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track}*(A_{a\ track}$ or $A_{a\ track\ (special)}) + q*A_{a\ q} + w_{a\ f(R)}*Aa_{wa\ curve} + w_{i\ f(R)}*A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric}$ = 21.440 $m^2$ * (1 / R) | $S_{0a\ enlargement}$ = (15 $m^2$ * (1 / R) – 0.1 m)if>0 | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **$\Delta b_a = (b_{RP}+S_{0a}) - (b_{nom}+Dpl_{a\ curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 80.000 | 0.025 | 0.110 | **1.286** | 0.245 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.413** | 0.268 | 0.088 | **0.356** | **1.229** |
| 80.000 | 0.025 | 0.110 | **1.286** | 0.245 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.413** | 0.268 | 0.088 | **0.356** | **1.073** |

7.2.12.8. Determine for each RMP the following values for R116 track radius:

*Note: Blue values are examples for information.*

LR1 is not present at IRL2 and shall accordingly not be calculated for IRL2.

**only applicable for IRL1+1D+1F:**
**OUTER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R116 LR1**

| $R_{116\text{-}LR1}$ | $D_{max\ R116\text{-}LR1}$ | $l_{max\ R116\text{-}LR1}$ | **$b_{RP\text{-}LR1}$ =1/2 width of Reference Profile at $h_{RP\text{-}LR1} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track\text{-}LR1}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R116\text{-}LR1}$ | $A_{a\ wi\ curve}$ | $w_{a\ R116\text{-}LR1}$ | $A_{a\ wa\ curve}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\ f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\ static}*l_{max(fR)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*D_{max(fR)}/L*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | **$Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track\text{-}LR1}*(A_{a\ track}$ or $A_{a\ track\ (special)}) + q*A_{a\ q} + w_{a\ f(R)}*Aa_{wa\ curve} + w_{i\ f(R)}*A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric}$ = 21.440 $m^2$ * (1 / R) | $S_{0a\ enlargement}$ = (15 $m^2$ * (1 / R) – 0.1 m)$_{if>0}$ | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **ONLY for gauges IRL1/1D/1F and ONLY IF $h_{shift}$ is between $h_{LR1\ MIN}$ and $h_{LR1\ MAX}$: $\Delta ba = (b_{RP\ LR1}+S_{0a}) - (b_{nom}+Dpla_{curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 116.000 | 0.000 | 0.029 | **1.286** | 0.169 | 0.020 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.014 | 0.000 | 0.014 | **0.285** | 0.185 | 0.029 | **0.214** | **n.a.** |
| 116.000 | 0.000 | 0.029 | **1.286** | 0.169 | 0.020 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.014 | 0.000 | 0.014 | **0.285** | 0.185 | 0.029 | **0.214** | **n.a.** |

7.2.12.9. Determine for each RMP the following values for R280 track radius:

*Note: Blue values are examples for information.*

LR2 is not present at IRL2 and shall accordingly not be calculated for IRL2.

**only applicable for IRL1+1D+1F:**
**OUTER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R280 LR2**

| $R_{280\text{-}LR2}$ | $D_{max\ R280\text{-}LR2}$ | $l_{max\ R280\text{-}LR2}$ | **$b_{RP\text{-}LR2}$ =1/2 width of Reference Profile at $h_{RP\text{-}LR2} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track\text{-}LR2}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R280\text{-}LR2}$ | $A_{a\ wi\ curve}$ | $w_{a\ R280\text{-}LR2}$ | $A_{a\ wa\ curve}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\ f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\ static}*l_{max(fR)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*D_{max(fR)}/L*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | **$Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track\text{-}LR2}*(A_{a\ track}$ or $A_{a\ track\ (special)}) + q*A_{a\ q} + w_{a\ f(R)}*Aa_{wa\ curve} + w_{i\ f(R)}*A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric}$ = 21.440 $m^2$ * (1 / R) | $S_{0a\ enlargement}$ = (15 $m^2$ * (1 / R) – 0.1 m)$_{if>0}$ | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **ONLY for gauges IRL1/1D/1F and ONLY IF $h_{shift}$ is between $h_{LR2\ MIN}$ and $h_{LR2\ MAX}$: $\Delta ba = (b_{RP\ LR2}+S_{0a}) - (b_{nom}+Dpla_{curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 280.000 | 0.044 | 0.006 | **1.286** | 0.070 | 0.020 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.003 | 0.000 | 0.003 | **0.175** | 0.077 | 0.000 | **0.077** | **n.a.** |
| 280.000 | 0.044 | 0.006 | **1.286** | 0.070 | 0.020 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.003 | 0.000 | 0.003 | **0.175** | 0.077 | 0.000 | **0.077** | **n.a.** |

7.2.12.10. Determine for each RMP the following values for R98-vLR1 track radius:

*Note: Blue values are examples for information.*

vLR1 is not present at IRL2 and shall accordingly not be calculated for IRL2.

| only applicable for IRL1+1D+1F: OUTER Relevant Mechanical Points RMPs, DOWNWARDS shifted, R98 vLR1 | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{98\text{-}vLR1}$ | $D_{max\ R98\text{-}vLR1}$ | $l_{max\ R98\text{-}vLR1}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift\text{-}vLR1}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track\text{-}vLR1}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R98\text{-}vLR1}$ | $A_{a\ wi\ curve}$ | $w_{a\ R98\text{-}vLR1}$ | $A_{awa\ curve}$ | z1 term $=[s*T_D/L*\|h_{nom}-h_c\|]-[s_{0random}*T_D/L*\|h_{shift\text{-}vLR1}-h_{c0}\|]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift\text{-}vLR1}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\ f(R)}/L*(hc-h_{nom})$ | ONLY for vLR1: z3.2a term if $h_{shift\text{-}vLR1}>h_{c0}$: $=s_{0\ static}*l_{max(fR)}/L*(h_{shift\text{-}vLR1}-h_{c0})$ or if $h_{shift\text{-}vLR1}=h_{c0}$: =0.000m or if $h_{shift\text{-}vLR1}<h_{c0}$: $=s_{0\ static}*D_{max(fR)}/L*(h_{c0}-h_{shift\text{-}vLR1})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | **ONLY for vLR1: $Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track\text{-}vLR1} * (A_{a\ track}$ or $A_{a\ track\ (special)}) + q * A_{a\ q} + w_{a\ f(R)} * Aa_{wa\ curve} + w_{i\ f(R)} * A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric} = 21.440\ m^2 * (1 / R)$ | $S_{0a\ enlargement} = (15\ m^2 * (1 / R) – 0.1\ m)_{if>0}$ | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **ONLY for gauges IRL1/1D/1F $\Delta ba = (b_{RP}+S_{0a}) - (b_{nom} + Dpla_{curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 98.000 | 0.010 | 0.034 | **1.286** | 0.200 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.017 | 0.000 | 0.017 | **0.331** | 0.219 | 0.053 | **0.272** | **1.228** |
| 98.000 | 0.010 | 0.034 | **1.286** | 0.200 | 0.029 | 1.365 | 0.005 | 1.365 | 0.050 | 0.182 | 0.050 | 1.182 | 0.000 | 0.000 | 0.017 | 0.000 | 0.017 | **0.331** | 0.219 | 0.053 | **0.272** | **1.073** |

7.2.12.11. Determine from all resulting $\Delta b_a$ values of this set of gauging calculations the smallest value for each RMP.

*Note: Blue value is an example for information.*

| **$\Delta b_a$ min across all calculations of this set** |
|---|
| **[m]** |
| **1.119** |
| **0.964** |

+ A positive value or 0.000m indicates that the vehicle design is compatible with the selected gauge(s)

- A negative value indicates that the vehicle design is not compatible with the selected gauge(s)

7.2.12.12. Determine also, if for this Set any RMPs are present in the WHEEL ZONE and evaluate if these RMPs fulfil the related requirements defined for the selected RP-M in section 6.

**7.2.13. Step 7(1.5kV) - IF a 1.5kV Pantograph is present, perform Set5 of the gauging calculations for the related INNER Relevant Pantograph Points RPPs in their UPWARDS shifted positions on R0+R2000+R900+R250.4+R150+R80+Radd1**

7.2.13.1. Determine for each RPP the following basic values which are independent of the horizontal track radius:

*Note: Blue values are examples for information.*

| Point ID | $n_i$ | $P1.5h_{shift}$ | $P1.5b_{nom}$ |
|---|---|---|---|
| | [m] | [m] | [m] |
| iRPP1 (1.5kV) | 0.290 | 5.786 | 0.650 |
| iRPP2 (1.5kV) | 0.290 | 5.594 | 0.900 |

7.2.13.2. Determine for each RPP the following values for straight track.

*Note: Blue values are examples for information.*

**INNER Relevant Pantograph Points RPPs, R0(=straight), UPWARDS shifted**

| $R_0$ (no value for straight) | $D_{max\ R0}$ | $l_{max\ R0}$ | **$Pb_{RP}$ =1/2 width of Reference Profile at $P1.5h_{shift}$** | $Dpl_{i\ vehicle}$ (not applicable for straight track) | $Dpl_{i\ track}$ | $A_{i\ track}$ | q | $A_{i\ q}$ | $w_{R0}$ | $A_{i\ wi}$ | Pz1 term $=[s^*T_D/L^*\lvert P1.5h_{shift}-h_c\rvert]-[P1.5s_{0\ random}{}^*T_D/L^*\lvert P1.5h_{shift}-h_{c0}\rvert]$ | Pz2 term $=\{[(\tan\eta_0+\tan\alpha_J)^*(1+s)^*\lvert P1.5h_{shift}-h_c\rvert]-[\tan(P1.5\eta_{0r})^*(1+P1.5s_{0\ random})^*\lvert P1.5h_{shift}-h_{c0}\rvert]\}_{if>0}$ | Pz3 term $=\{[P1.5t^*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)]-[P1.5t_0{}^*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)]\}_{if>0}$ | Pz4 term $=(P1.5\tau-P1.5\tau_0)_{if>0}$ | Pz5.1i term if $P1.5h_{shift}>h_c$: $=s^*D_{max\ f(R)}/L^*(P1.5h_{shift}-h_c)$ of if $P1.5h_{shift}=h_c$: $=0.000m$ or if $P1.5h_{shift}<h_c$: $=s^*l_{max\ f(R)}/L^*(h_c-P1.5h_{shift\ RPPx})$ | Pz5.2i term if $P1.5h_{shift}>h_{c0}$: $=P1.5s_{0\ static}{}^*D_{max\ f(R)}/L^*(P1.5h_{shift}-h_{c0})$ of if $P1.5h_{shift}=h_{c0}$: $=0.000m$ or if $P1.5h_{shift}<h_{c0}$: $=P1.5s_{0\ static}{}^*l_{max\ f(R)}/L^*(h_{c0}-P1.5h_{shift})$ | $Pz_i=[(Pz1\ term)^2+(Pz2\ term)^2+(Pz3\ term)^2+(Pz4\ term)^2]^{0.5}+[Pz5.1_i\ term-Pz5.2_i\ term]$ | **$PDpl_{i\ curve}=Dpl_{i\ vehicle}+Dpl_{i\ track}{}^*(A_{i\ track}$ or $A_{i\ track\ (special)})+q^*A_{i\ q}+w_{i\ f(R)}{}^*A_{i\ wi}+Pz_i$** | **$P1.5S_{0i}$ (not applicable for straight track)** | **$\Delta Pb_i=(Pb_{RP}+P1.5S_{0i})-(P1.5b_{nom}+PDpl_{i\ straight})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** |
| | 0.000 | 0.000 | **0.996** | | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.015 | 0.029 | 0.031 | 0.010 | 0.000 | 0.000 | 0.046 | **0.130** | | **0.217** |
| | 0.000 | 0.000 | **1.161** | | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.015 | 0.028 | 0.028 | 0.010 | 0.000 | 0.000 | 0.043 | **0.127** | | **0.134** |

7.2.13.3. Determine for each RPP the following values for R2000 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Pantograph Points RPPs, R2000, UPWARDS shifted**

| $R_{2000}$ | $D_{max\ R2000}$ | $l_{max\ R2000}$ | **$Pb_{RP}$ =1/2 width of Reference Profile at $P1.5h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ R2000}$ | $A_{i\ wi}$ | Pz1 term $=[s^*T_D/L^*\lvert P1.5h_{shift}-h_c\rvert]-[P1.5s_{0\ random}{}^*T_D/L^*\lvert P1.5h_{shift}-h_{c0}\rvert]$ | Pz2 term $=\{[(\tan\eta_0+\tan\alpha_J)^*(1+s)^*\lvert P1.5h_{shift}-h_c\rvert]-[\tan(P1.5\eta_{0r})^*(1+P1.5s_{0\ random})^*\lvert P1.5h_{shift}-h_{c0}\rvert]\}_{if>0}$ | Pz3 term $=\{[P1.5t^*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)]-[P1.5t_0{}^*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)]\}_{if>0}$ | Pz4 term $=(P1.5\tau-P1.5\tau_0)_{if>0}$ | Pz5.1i term if $P1.5h_{shift}>h_c$: $=s^*D_{max\ f(R)}/L^*(P1.5h_{shift}-h_c)$ of if $P1.5h_{shift}=h_c$: $=0.000m$ or if $P1.5h_{shift}<h_c$: $=s^*l_{max\ f(R)}/L^*(h_c-P1.5h_{shift})$ | Pz5.2i term if $P1.5h_{shift}>h_{c0}$: $=P1.5s_0$ $_{static}{}^*D_{max\ f(R)}/L^*(P1.5h_{shift}-h_{c0})$ of if $P1.5h_{shift}=h_{c0}$: $=0.000m$ or if $P1.5h_{shift}<h_{c0}$: $=P1.5s_{0\ static}{}^*l_{max\ f(R)}/L^*(h_{c0}-P1.5h_{shift})$ | $Pz_i=[(Pz1\ term)^2+(Pz2\ term)^2+(Pz3\ term)^2+(Pz4\ term)^2]^{0.5}+[Pz5.1_i\ term-Pz5.2_i\ term]$ | **$PDpl_{i\ curve}=Dpl_{i\ vehicle}+Dpl_{i\ track}{}^*(A_{i\ track}$ or $A_{i\ track\ (special)})+q^*A_{i\ q}+w_{i\ f(R)}{}^*A_{i\ wi}+Pz_i$** | **$P1.5S_{0i}$ =0.000m** | **$\Delta Pb_i=(Pb_{RP}+P1.5S_{0i})-(P1.5b_{nom}+PDpl_{i\ curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** |
| 2000.000 | 0.165 | 0.110 | **0.996** | 0.001 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.015 | 0.029 | 0.031 | 0.010 | 0.124 | 0.000 | 0.170 | **0.255** | **0.000** | **0.091** |
| 2000.000 | 0.165 | 0.110 | **1.161** | 0.001 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.015 | 0.028 | 0.028 | 0.010 | 0.120 | 0.000 | 0.163 | **0.248** | **0.000** | **0.013** |

7.2.13.4. Determine for each RPP the following values for R900 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Pantograph Points RPPs, R900, UPWARDS shifted**

| $R_{900}$ | $D_{max\ R900}$ | $l_{max\ R900}$ | **$Pb_{RP}$ =1/2 width of Reference Profile at $P1.5h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ R900}$ | $A_{i\ wi}$ | Pz1 term $=[s*T_D/L*\|P1.5h_{shift}-h_c\|] - [P1.5s_{0\ random}*T_D/L*\|P1.5h_{shift}-h_{c0}\|]$ | Pz2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*\|P1.5h_{shift}-h_c\|] - [\tan(P1.5\eta_{0r})*(1+P1.5s_{0\ random})*\|P1.5h_{shift}-h_{c0}\|]\}_{if>0}$ | Pz3 term $=\{[P1.5t*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)] - [P1.5t_0*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)]\}_{if>0}$ | Pz4 term $=(P1.5\tau-P1.5\tau_0)_{if>0}$ | Pz5.1i term if $P1.5h_{shift}>h_c$: $=s*D_{max\ f(R)}/L*(P1.5h_{shift}-h_c)$ of if $P1.5h_{shift}=h_c$: = 0.000m or if $P1.5h_{shift}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-P1.5h_{shift})$ | Pz5.2i term if $P1.5h_{shift}>h_{c0}$: $=P1.5s_{0\ static}*D_{max\ f(R)}/L*(P1.5h_{shift}-h_{c0})$ of if $P1.5h_{shift}=h_{c0}$: = 0.000m or if $P1.5h_{shift}<h_{c0}$: $=P1.5s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-P1.5h_{shift})$ | $Pz_i=[(Pz1\ term)^2+(Pz2\ term)^2+(Pz3\ term)^2+(Pz4\ term)^2]^{0.5}+[Pz5.1_i\ term-Pz5.2_i\ term]$ | **$PDpl_{i\ curve}=Dpl_{i\ vehicle}+Dpl_{i\ track}*(A_{i\ track}$ or $A_{i\ track\ (special)})+q*A_{i\ q}+w_{i\ f(R)}*A_{i\ wi}+Pz_i$** | **$P1.5S_{0i}$ =0.000m** | **$\Delta Pb_i=(Pb_{RP}+P1.5S_{0i})-(P1.5b_{nom}+PDpl_{i\ curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** |
| 900.000 | 0.165 | 0.110 | **0.996** | 0.003 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.015 | 0.029 | 0.031 | 0.010 | 0.124 | 0.000 | 0.170 | **0.257** | **0.000** | **0.090** |
| 900.000 | 0.165 | 0.110 | **1.161** | 0.003 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.015 | 0.028 | 0.028 | 0.010 | 0.120 | 0.000 | 0.163 | **0.249** | **0.000** | **0.012** |

7.2.13.5. Determine for each RPP the following values for R250.4 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Pantograph Points RPPs, R250.4, UPWARDS shifted**

| $R_{250.4}$ | $D_{max\ R250.4}$ | $l_{max\ R250.4}$ | **$Pb_{RP}$ =1/2 width of Reference Profile at $P1.5h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ R250.4}$ | $A_{i\ wi}$ | Pz1 term $=[s*T_D/L*\|P1.5h_{shift}-h_c\|] - [P1.5s_{0\ random}*T_D/L*\|P1.5h_{shift}-h_{c0}\|]$ | Pz2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*\|P1.5h_{shift}-h_c\|] - [\tan(P1.5\eta_{0r})*(1+P1.5s_{0\ random})*\|P1.5h_{shift}-h_{c0}\|]\}_{if>0}$ | Pz3 term $=\{[P1.5t*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)] - [P1.5t_0*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)]\}_{if>0}$ | Pz4 term $=(P1.5\tau-P1.5\tau_0)_{if>0}$ | Pz5.1i term if $P1.5h_{shift}>h_c$: $=s*D_{max\ f(R)}/L*(P1.5h_{shift}-h_c)$ of if $P1.5h_{shift}=h_c$: = 0.000m or if $P1.5h_{shift}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-P1.5h_{shift})$ | Pz5.2i term if $P1.5h_{shift}>h_{c0}$: $=P1.5s_{0\ static}*D_{max\ f(R)}/L*(P1.5h_{shift}-h_{c0})$ of if $P1.5h_{shift}=h_{c0}$: = 0.000m or if $P1.5h_{shift}<h_{c0}$: $=P1.5s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-P1.5h_{shift})$ | $Pz_i=[(Pz1\ term)^2+(Pz2\ term)^2+(Pz3\ term)^2+(Pz4\ term)^2]^{0.5}+[Pz5.1_i\ term-Pz5.2_i\ term]$ | **$PDpl_{i\ curve}=Dpl_{i\ vehicle}+Dpl_{i\ track}*(A_{i\ track}$ or $A_{i\ track\ (special)})+q*A_{i\ q}+w_{i\ f(R)}*A_{i\ wi}+Pz_i$** | **$P1.5S_{0i}$ =0.000m** | **$\Delta Pb_i=(Pb_{RP}+P1.5S_{0i})-(P1.5b_{nom}+PDpl_{i\ curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** |
| 250.400 | 0.165 | 0.110 | **0.996** | 0.010 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.015 | 0.029 | 0.031 | 0.010 | 0.124 | 0.000 | 0.170 | **0.264** | **0.000** | **0.082** |
| 250.400 | 0.165 | 0.110 | **1.161** | 0.010 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.015 | 0.028 | 0.028 | 0.010 | 0.120 | 0.000 | 0.163 | **0.257** | **0.000** | **0.004** |

7.2.13.6. Determine for each RPP the following values for R150 track radius:

*Note: Blue values are examples for information.*

| INNER Relevant Pantograph Points RPPs, R150, UPWARDS shifted | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{150}$ | $D_{max\ R150}$ | $l_{max\ R150}$ | **$Pb_{RP}$ =1/2 width of Reference Profile at $P1.5h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ R150}$ | $A_{i\ wi}$ | Pz1 term $=[s*T_D/L*\|P1.5h_{shift}-h_c\|] - [P1.5s_{0\ random}*T_D/L*\|P1.5h_{shift}-h_{c0}\|]$ | Pz2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*\|P1.5h_{shift}-h_c\|] - [\tan(P1.5\eta_{0r})*(1+P1.5s_{0\ random})*\|P1.5h_{shift}-h_{c0}\|]\}_{if>0}$ | Pz3 term $=\{[P1.5t*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)] - [P1.5t_0*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)]\}_{if>0}$ | Pz4 term $=(P1.5\tau-P1.5\tau_0)_{if>0}$ | Pz5.1i term if $P1.5h_{shift}>h_c$: $= s*D_{max\ f(R)}/L*(P1.5h_{shift}-h_c)$ of if $P1.5h_{shift}=h_c$: = 0.000m or if $P1.5h_{shift}<h_c$: $= s*l_{max\ f(R)}/L*(h_c-P1.5h_{shift})$ | Pz5.2i term if $P1.5h_{shift}>h_{c0}$: $= P1.5s_{0\ static}*D_{max\ f(R)}/L*(P1.5h_{shift}-h_{c0})$ of if $P1.5h_{shift}=h_{c0}$: = 0.000m or if $P1.5h_{shift}<h_{c0}$: $=P1.5s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-P1.5h_{shift})$ | $Pz_i= [(Pz1\ term)^2+(Pz2\ term)^2+(Pz3\ term)^2+(Pz4\ term)^2]^{0.5}+[Pz5.1_i\ term - Pz5.2_i\ term]$ | **$PDpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track}*(A_{i\ track}$ or $A_{i\ track\ (special)}) + q*A_{i\ q} + w_{i\ f(R)}*A_{i\ wi} + Pz_i$** | **$P1.5S_{0i}$ =0.000m** | **$\Delta Pb_i=(Pb_{RP}+P1.5S_{0i})-(P1.5b_{nom}+PDpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** |
| 150.000 | 0.082 | 0.110 | **0.996** | 0.017 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.015 | 0.029 | 0.031 | 0.010 | 0.062 | 0.000 | 0.108 | **0.209** | **0.000** | **0.137** |
| 150.000 | 0.082 | 0.110 | **1.161** | 0.017 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.015 | 0.028 | 0.028 | 0.010 | 0.060 | 0.000 | 0.103 | **0.204** | **0.000** | **0.057** |

7.2.13.7. Determine for each RPP the following values for R80 track radius:

*Note: Blue values are examples for information.*

| INNER Relevant Pantograph Points RPPs, R80, UPWARDS shifted | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{80}$ | $D_{max\ R80}$ | $l_{max\ R80}$ | **$Pb_{RP}$ =1/2 width of Reference Profile at $P1.5h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ R80}$ | $A_{i\ wi}$ | Pz1 term $=[s*T_D/L*\|P1.5h_{shift}-h_c\|] - [P1.5s_{0\ random}*T_D/L*\|P1.5h_{shift}-h_{c0}\|]$ | Pz2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*\|P1.5h_{shift}-h_c\|] - [\tan(P1.5\eta_{0r})*(1+P1.5s_{0\ random})*\|P1.5h_{shift}-h_{c0}\|]\}_{if>0}$ | Pz3 term $=\{[P1.5t*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)] - [P1.5t_0*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)]\}_{if>0}$ | Pz4 term $=(P1.5\tau-P1.5\tau_0)_{if>0}$ | Pz5.1i term if $P1.5h_{shift}>h_c$: $= s*D_{max\ f(R)}/L*(P1.5h_{shift}-h_c)$ of if $P1.5h_{shift}=h_c$: = 0.000m or if $P1.5h_{shift}<h_c$: $= s*l_{max\ f(R)}/L*(h_c-P1.5h_{shift})$ | Pz5.2i term if $P1.5h_{shift}>h_{c0}$: $= P1.5s_{0\ static}*D_{max\ f(R)}/L*(P1.5h_{shift}-h_{c0})$ of if $P1.5h_{shift}=h_{c0}$: = 0.000m or if $P1.5h_{shift}<h_{c0}$: $=P1.5s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-P1.5h_{shift})$ | $Pz_i= [(Pz1\ term)^2+(Pz2\ term)^2+(Pz3\ term)^2+(Pz4\ term)^2]^{0.5}+[Pz5.1_i\ term - Pz5.2_i\ term]$ | **$PDpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track}*(A_{i\ track}$ or $A_{i\ track\ (special)}) + q*A_{i\ q} + w_{i\ f(R)}*A_{i\ wi} + Pz_i$** | **$P1.5S_{0i}$ =0.000m** | **$\Delta Pb_i=(Pb_{RP}+P1.5S_{0i})-(P1.5b_{nom}+PDpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** |
| 80.000 | 0.025 | 0.110 | **0.996** | 0.033 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.015 | 0.029 | 0.031 | 0.010 | 0.019 | 0.000 | 0.065 | **0.181** | **0.000** | **0.166** |
| 80.000 | 0.025 | 0.110 | **1.161** | 0.033 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.015 | 0.028 | 0.028 | 0.010 | 0.018 | 0.000 | 0.061 | **0.177** | **0.000** | **0.084** |

7.2.13.8. Where an additional Relevant Radius $R_{add1}$ is present: Determine for each RPP the following values for $R_{add1}$ track radius:

*Note: Blue values are examples for information.*

| **INNER Relevant Pantograph Points RPPs, Radd1, UPWARDS shifted** | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{add1}$ | $D_{max\ Radd1}$ | $l_{max\ Radd1}$ | **$Pb_{RP}$ =1/2 width of Reference Profile at $P1.5h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ Radd1}$ | $A_{i\ wi}$ | Pz1 term $=[s*T_D/L*\lvert P1.5h_{shift}-h_c\rvert]-[P1.5s_{0\ random}*T_D/L*\lvert P1.5h_{shift}-h_{c0}\rvert]$ | Pz2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*\lvert P1.5h_{shift}-h_c\rvert]-[\tan(P1.5\eta_{0r})*(1+P1.5s_{0\ random})*\lvert P1.5h_{shift}-h_{c0}\rvert]\}_{if>0}$ | Pz3 term $=\{[P1.5t*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)]-[P1.5t_0*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)]\}_{if>0}$ | Pz4 term $=(P1.5\tau-P1.5\tau_0)_{if>0}$ | Pz5.1i term if $P1.5h_{shift}>h_c$: $=s*D_{max\ f(R)}/L*(P1.5h_{shift}-h_c)$ of if $P1.5h_{shift}=h_c$: = 0.000m or if $P1.5h_{shift}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-P1.5h_{shift})$ | Pz5.2i term if $P1.5h_{shift}>h_{c0}$: $=P1.5s_{0\ static}*D_{max\ f(R)}/L*(P1.5h_{shift}-h_{c0})$ of if $P1.5h_{shift}=h_{c0}$: = 0.000m or if $P1.5h_{shift}<h_{c0}$: $=P1.5s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-P1.5h_{shift})$ | $Pz_i=[(Pz1\ term)^2+(Pz2\ term)^2+(Pz3\ term)^2+(Pz4\ term)^2]^{0.5}+[Pz5.1_i\ term-Pz5.2_i\ term]$ | **$PDpl_{i\ curve}=Dpl_{i\ vehicle}+Dpl_{i\ track}*(A_{i\ track}$ or $A_{i\ track\ (special)})+q*A_{i\ q}+w_{i\ f(R)}*A_{i\ wi}+Pz_i$** | **$P1.5S_{0i}$ =0.000m** | **$\Delta Pb_i=(Pb_{RP}+P1.5S_{0i})-(P1.5b_{nom}+PDpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** |
| 80 | 0.025 | 0.110 | **0.996** | 0.033 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.015 | 0.029 | 0.031 | 0.010 | 0.019 | 0.000 | 0.065 | **0.181** | **0.000** | **0.166** |
| 80 | 0.025 | 0.110 | **1.161** | 0.033 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.015 | 0.028 | 0.028 | 0.010 | 0.018 | 0.000 | 0.061 | **0.177** | **0.000** | **0.084** |

7.2.13.9. Determine from all resulting $\Delta b_i$ values of this set of gauging calculations the smallest value for each RPP.

*Note: Blue value is example for information.*

| **$\Delta Pb_i$ min across all calculations** |
|---|
| **[m]** |
| **0.082** |
| **0.004** |

+ A positive value or 0.000m indicates that the vehicle design is compatible with the selected gauge(s)

- A negative value indicates that the vehicle design is not compatible with the selected gauge(s)

7.2.14. **Step 7(25kV) - IF a 25kV Pantograph is present, perform Set5 of the gauging calculations for the related INNER Relevant Pantograph Points RPPs in their UPWARDS shifted positions on R0+R2000+R900+R250.4+R150+R80+Radd1**

Details to be included in a future issue of this IRS.

7.2.15. **Step 8(1.5kV) - IF a 1.5kV Pantograph is present, perform Set6 of the gauging calculations for the related OUTER Relevant Pantograph Points RPPs in their UPWARDS shifted positions on R0+R2000+R250.4+R150+R80+Radd1**

7.2.15.1. Determine for each RPP the following basic values which are independent of the horizontal track radius:

*Note: Blue values are examples for information.*

| Point ID | $n_a$ | P1.5$h_{shift}$ | P1.5$b_{nom}$ |
|---|---|---|---|
| | [m] | [m] | [m] |
| aRPP1 (1.5kV) | 0.240 | 5.786 | 0.650 |
| aRPP2 (1.5kV) | 0.240 | 5.594 | 0.900 |

7.2.15.2. Determine for each RPP the following values for straight track.

*Note: Blue values are examples for information.*

**OUTER Relevant Pantograph Points RPPs, UPWARDS shifted, R0(=straight track)**

| $R_0$ (no value for straight) | $D_{max\ R0}$ | $l_{max\ R0}$ | **$Pb_{RP}$ =1/2 width of Reference Profile at P1.5$h_{shift}$** | $Dpl_{i\ vehicle}$ (not applicable for straight track) | $Dpl_{a\ track}$ | $A_{a\ track}$ | q | $A_{a\ q}$ | $w_{R0}$ | $A_{a\ wR0\ straight}$ | Pz1 term =[s*$T_D$/L*│P1.5$h_{shift}$-$h_c$│] - [P1.5$s_{0\ random}$*$T_D$/L*│P1.5$h_{shift}$-$h_{c0}$│] | Pz2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *│P1.5$h_{shift}$-$h_c$│] - [tan(P1.5$\eta_{0r}$) *(1+P1.5$s_{0\ random}$) *│P1.5$h_{shift}$-$h_{c0}$│]}$_{if>0}$ | Pz3 term = {[P1.5t*(P1.5$h_{shift}$ - P1.5$h_t$) /(P1.5$h_{max\ wire}$ - P1.5$h_t$)] - [P1.5$t_0$*(P1.5$h_{shift}$ -P1.5$h_t$) /(P1.5$h_{max\ wire}$ - P1.5$h_t$)]}$_{if>0}$ | Pz4 term = $(P\tau-P\tau_0)_{if>0}$ | Pz5.1$_a$ term if P1.5$h_{shift}$>$h_c$: =s*$l_{max\ f(R)}$/L*(P1.5$h_{shift}$-$h_c$) or if P1.5hshift=hc: = 0.000m or if P1.5$h_{shift}$<$h_c$: =s*$D_{max}$ f(R)/L*($h_c$-P1.5$h_{shift}$) | Pz5.2$_a$ term if P1.5$h_{shift}$>$h_{c0}$: = P1.5$s_{0\ static}$*$l_{max\ f(R)}$/L*(P1.5$h_{shift}$-$h_{c0}$) or if P1.5$h_{shift}$=$h_{c0}$: = 0.000m or if P1.5$h_{shift}$<$h_{c0}$: = P1.5$s_{0\ static}$*$D_{max\ f(R)}$/L*($h_{c0}$-P1.5$h_{shift}$) | $Pz_a$ = [(Pz1 term)$^2$+(Pz2 term)$^2$+(Pz3 term)$^2$+(Pz4 term)$^2$]$^{0.5}$ +[Pz5.1a term -Pz5.2a term] | **$PDpl_{a\ straight}$ = $Dpl_{a\ track}$ * $A_{a\ track}$ +q * $A_{a\ q}$ + $w_{R0}$ * $A_{a\ wR0\ straight}$ + $Pz_a$** | **P1.5$S_{0a}$ (not applicable for straight track)** | **$\Delta Pb_a$= ($Pb_{RP}$+P1.5$S_{0a}$) -(P1.5$b_{nom}$ +$PDpl_{a\ straight}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** |
| | 0.000 | 0.000 | **0.996** | | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 1.035 | 0.015 | 0.029 | 0.031 | 0.010 | 0.000 | 0.000 | 0.046 | **0.133** | | **0.214** |
| | 0.000 | 0.000 | **1.161** | | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 1.035 | 0.015 | 0.028 | 0.028 | 0.010 | 0.000 | 0.000 | 0.043 | **0.130** | | **0.131** |

7.2.15.3. Determine for each RPP the following values for R2000 track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Pantograph Points RPPs, UPWARDS shifted, R2000**

| $R_{2000}$ | $D_{max\ R2000}$ | $l_{max\ R2000}$ | **$Pb_{RP}$ =1/2 width of Reference Profile at P1.5$h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R2000}$ | $A_{a\ wi\ curve}$ | $w_{a\ R2000}$ | $A_{a\ wa\ curve}$ | Pz1 term =[s*$T_D$/L*│P1.5$h_{shift}$-$h_c$│] - [P1.5$s_{0\ random}$*$T_D$/L*│P1.5$h_{shift}$-$h_{c0}$│] | Pz2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *│P1.5$h_{shift}$-$h_c$│] - [tan(P1.5$\eta_{0r}$) *(1+P1.5$s_{0\ random}$) *│P1.5$h_{shift}$-$h_{c0}$│]}$_{if>0}$ | Pz3 term = {[P1.5t*(P1.5$h_{shift}$ - P1.5$h_t$) /(P1.5$h_{max\ wire}$ -P1.5$h_t$)] - [P1.5$t_0$*(P1.5$h_{shift}$ -P1.5$h_t$) /(P1.5$h_{max\ wire}$ -P1.5$h_t$)]}$_{if>0}$ | Pz4 term = $(P1.5\tau-P1.5\tau_0)_{if>0}$ | Pz5.1$_a$ term if P1.5$h_{shift}$>$h_c$: =s*$l_{max\ f(R)}$/L*(P1.5$h_{shift}$-$h_c$) or if P1.5hshift=hc : = 0.000m or if P1.5$h_{shift}$<$h_c$: =s*$D_{max}$ f(R)/L*($h_c$-P1.5$h_{shift}$) | Pz5.2$_a$ term if P1.5$h_{shift}$>$h_{c0}$: = P1.5$s_{0\ static}$*$l_{max\ f(R)}$/L*(P1.5$h_{shift}$-$h_{c0}$) or if P1.5$h_{shift}$=$h_{c0}$: = 0.000m or if P1.5$h_{shift}$<$h_{c0}$: = P1.5$s_{0\ static}$*$D_{max\ f(R)}$/L*($h_{c0}$-P1.5$h_{shift}$) | $Pz_a$ = [(Pz1 term)$^2$+(Pz2 term)$^2$+(Pz3 term)$^2$+(Pz4 term)$^2$]$^{0.5}$ +[Pz5.1a term -Pz5.2a term] | **$PDpl_{a\ curve}$ = $Dpl_{a\ vehicle}$ + $Dpl_{a\ track}$ * ($A_{a\ track}$ or $A_{a\ track\ (special)}$) + q*$A_{a\ q}$ + $w_{a\ f(R)}$ * $A_{a\ wa\ curve}$ + $w_{i\ f(R)}$ * $A_{a\ wi\ curve}$ + $Pz_a$** | **P1.5$S_{0a}$ =0.000m** | **$\Delta Pb_a$= ($Pb_{RP}$+P1.5$S_{0a}$) -(P1.5$b_{nom}$ +$PDpl_{a\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** |
| 2000.000 | 0.165 | 0.110 | **0.996** | 0.001 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.015 | 0.029 | 0.031 | 0.010 | 0.083 | 0.000 | 0.129 | **0.216** | **0.000** | **0.131** |
| 2000.000 | 0.165 | 0.110 | **1.161** | 0.001 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.015 | 0.028 | 0.028 | 0.010 | 0.080 | 0.000 | 0.123 | **0.210** | **0.000** | **0.051** |

7.2.15.4. Determine for each RPP the following values for R250.4 track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Pantograph Points RPPs, UPWARDS shifted, R250.4**

| $R_{250.4}$ | $D_{max\ R250.4}$ | $l_{max\ R250.4}$ | **$Pb_{RP}$ =1/2 width of Reference Profile at $P1.5h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R250.4}$ | $Aa_{wi\ curve}$ | $w_{a\ R250.4}$ | $A_{a\ wa\ curve}$ | Pz1 term =[s*$T_D$/L*│P1.5$h_{shift}$-$h_c$│] - [P1.5$s_{0\ random}$*$T_D$/L*│P1.5$h_{shift}$-$h_{c0}$│] | Pz2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *│P1.5$h_{shift}$-$h_c$│] - [tan(P1.5$\eta_{0r}$) *(1+P1.5$s_{0\ random}$) *│P1.5$h_{shift}$-$h_{c0}$│]}$_{if>0}$ | Pz3 term = {[P1.5t*(P1.5$h_{shift}$ - P1.5$h_t$) /(P1.5$h_{max\ wire}$ - P1.5$h_t$)] - [P1.5$t_0$*(P1.5$h_{shift}$ -P1.5$h_t$) /(P1.5$h_{max\ wire}$ - P1.5$h_t$)]}$_{if>0}$ | Pz4 term = (P1.5$\tau$- P1.5$\tau_0$)$_{if>0}$ | Pz5.1$_a$ term if P1.5$h_{shift}$>$h_c$: =s*$l_{max\ f(R)}$/L*(P1.5$h_{shift}$-$h_c$) or if P1.5hshift=hc : = 0.000m or if P1.5$h_{shift}$<$h_c$: =s*$D_{max}$ f(R)/L*($h_c$-P1.5$h_{shift}$) | Pz5.2$_a$ term if P1.5$h_{shift}$>$h_{c0}$: = P1.5$s_{0\ static}$*$l_{max\ f(R)}$/L*(P1.5$h_{shift}$-$h_{c0}$) or if P1.5$h_{shift}$=$h_{c0}$: = 0.000m or if P1.5$h_{shift}$<$h_{c0}$: = P1.5$s_{0\ static}$*$D_{max\ f(R)}$/L*($h_{c0}$-P1.5$h_{shift}$) | $Pz_a$ = [(Pz1 term)$^2$+(Pz2 term)$^2$+(Pz3 term)$^2$+(Pz4 term)$^2$]$^{0.5}$ +[Pz5.1a term -Pz5.2a term] | **$PDpl_{a\ curve}$ = $Dpl_{a\ vehicle}$ + $Dpl_{a\ track}$ * ($A_{a\ track}$ or $A_{a\ track\ (special)}$) + q*$A_{a\ q}$ + $w_{a\ f(R)}$ * $A_{a\ wa\ curve}$ + $w_{i\ f(R)}$ * $A_{a\ wi\ curve}$ + $Pz_a$** | **$P1.5S_{0a}$ =0.000m** | **$\Delta Pb_a$= ($Pb_{RP}$+P1.5$S_{0a}$) -(P1.5$b_{nom}$ +$PDpl_{a\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** |
| 250.400 | 0.165 | 0.110 | **0.996** | 0.004 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.015 | 0.029 | 0.031 | 0.010 | 0.083 | 0.000 | 0.129 | **0.219** | **0.000** | **0.127** |
| 250.400 | 0.165 | 0.110 | **1.161** | 0.004 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.015 | 0.028 | 0.028 | 0.010 | 0.080 | 0.000 | 0.123 | **0.213** | **0.000** | **0.048** |

7.2.15.5. Determine for each RPP the following values for R150 track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Pantograph Points RPPs, UPWARDS shifted, R150**

| $R_{150}$ | $D_{max\ R150}$ | $l_{max\ R150}$ | **$Pb_{RP}$ =1/2 width of Reference Profile at $P1.5h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R150}$ | $Aa_{wi\ curve}$ | $w_{a\ R150}$ | $A_{a\ wa\ curve}$ | Pz1 term =[s*$T_D$/L*│P1.5$h_{shift}$-$h_c$│] - [P1.5$s_{0\ random}$*$T_D$/L*│P1.5$h_{shift}$-$h_{c0}$│] | Pz2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *│P1.5$h_{shift}$-$h_c$│] - [tan(P1.5$\eta_{0r}$) *(1+P1.5$s_{0\ random}$) *│P1.5$h_{shift}$-$h_{c0}$│]}$_{if>0}$ | Pz3 term = {[P1.5t*(P1.5$h_{shift}$ - P1.5$h_t$) /(P1.5$h_{max\ wire}$ - P1.5$h_t$)] - [P1.5$t_0$*(P1.5$h_{shift}$ -P1.5$h_t$) /(P1.5$h_{max\ wire}$ - P1.5$h_t$)]}$_{if>0}$ | Pz4 term = (P1.5$\tau$- P1.5$\tau_0$)$_{if>0}$ | Pz5.1$_a$ term if P1.5$h_{shift}$>$h_c$: =s*$l_{max\ f(R)}$/L*(P1.5$h_{shift}$-$h_c$) or if P1.5hshift=hc : = 0.000m or if P1.5$h_{shift}$<$h_c$: =s*$D_{max}$ f(R)/L*($h_c$-P1.5$h_{shift}$) | Pz5.2$_a$ term if P1.5$h_{shift}$>$h_{c0}$: = P1.5$s_{0\ static}$*$l_{max\ f(R)}$/L*(P1.5$h_{shift}$-$h_{c0}$) or if P1.5$h_{shift}$=$h_{c0}$: = 0.000m or if P1.5$h_{shift}$<$h_{c0}$: = P1.5$s_{0\ static}$*$D_{max\ f(R)}$/L*($h_{c0}$-P1.5$h_{shift}$) | $Pz_a$ = [(Pz1 term)$^2$+(Pz2 term)$^2$+(Pz3 term)$^2$+(Pz4 term)$^2$]$^{0.5}$ +[Pz5.1a term -Pz5.2a term] | **$PDpl_{a\ curve}$ = $Dpl_{a\ vehicle}$ + $Dpl_{a\ track}$ * ($A_{a\ track}$ or $A_{a\ track\ (special)}$) + q*$A_{a\ q}$ + $w_{a\ f(R)}$ * $A_{a\ wa\ curve}$ + $w_{i\ f(R)}$ * $A_{a\ wi\ curve}$ + $Pz_a$** | **$P1.5S_{0a}$ =0.000m** | **$\Delta Pb_a$= ($Pb_{RP}$+P1.5$S_{0a}$) -(P1.5$b_{nom}$ +$PDpl_{a\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** |
| 150.000 | 0.082 | 0.110 | **0.996** | 0.007 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.015 | 0.029 | 0.031 | 0.010 | 0.083 | 0.000 | 0.129 | **0.222** | **0.000** | **0.124** |
| 150.000 | 0.082 | 0.110 | **1.161** | 0.007 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.015 | 0.028 | 0.028 | 0.010 | 0.080 | 0.000 | 0.123 | **0.216** | **0.000** | **0.045** |

7.2.15.6. Determine for each RPP the following values for R80 track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Pantograph Points RPPs, UPWARDS shifted, R80**

| $R_{80}$ | $D_{max\ R80}$ | $l_{max\ R80}$ | **$Pb_{RP}$ =1/2 width of Reference Profile at $P1.5h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R80}$ | $Aa_{wi\ curve}$ | $w_{a\ R80}$ | $A_{a\ wa\ curve}$ | Pz1 term $=[s*T_D/L*\mid P1.5h_{shift}-h_c\mid]-[P1.5s_{0\ random}*T_D/L*\mid P1.5h_{shift}-h_{c0}\mid]$ | Pz2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*\mid P1.5h_{shift}-h_c\mid]-[\tan(P1.5\eta_{0r})*(1+P1.5s_{0\ random})*\mid P1.5h_{shift}-h_{c0}\mid]\}_{if>0}$ | Pz3 term $=\{[P1.5t*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)]-[P1.5t_0*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)]\}_{if>0}$ | Pz4 term $=(P1.5\tau-P1.5\tau_0)_{if>0}$ | $Pz5.1_a$ term if $P1.5h_{shift}>h_c$: $=s*l_{max\ f(R)}/L*(P1.5h_{shift}-h_c)$ or if P1.5hshift=hc: = 0.000m or if $P1.5h_{shift}<h_c$: $=s*D_{max}\ f(R)/L*(h_c-P1.5h_{shift})$ | $Pz5.2_a$ term if $P1.5h_{shift}>h_{c0}$: $=P1.5s_{0\ static}*l_{max\ f(R)}/L*(P1.5h_{shift}-h_{c0})$ or if $P1.5h_{shift}=h_{c0}$: = 0.000m or if $P1.5h_{shift}<h_{c0}$: $=P1.5s_{0\ static}*D_{max\ f(R)}/L*(h_{c0}-P1.5h_{shift})$ | $Pz_a=[(Pz1\ term)^2+(Pz2\ term)^2+(Pz3\ term)^2+(Pz4\ term)^2]^{0.5}+[Pz5.1a\ term-Pz5.2a\ term]$ | **$PDpl_{a\ curve}=Dpl_{a\ vehicle}+Dpl_{a\ track}*(A_{a\ track}$ or $A_{a\ track\ (special)})+q*A_{a\ q}+w_{a\ f(R)}*A_{a\ wa\ curve}+w_{i\ f(R)}*A_{a\ wi\ curve}+Pz_a$** | **$P1.5S_{0a}$ =0.000m** | **$\Delta Pb_a=(Pb_{RP}+P1.5S_{0a})-(P1.5b_{nom}+PDpl_{a\ curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** |
| 80.000 | 0.025 | 0.110 | **0.996** | 0.013 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.015 | 0.029 | 0.031 | 0.010 | 0.083 | 0.000 | 0.129 | **0.228** | **0.000** | **0.118** |
| 80.000 | 0.025 | 0.110 | **1.161** | 0.013 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.015 | 0.028 | 0.028 | 0.010 | 0.080 | 0.000 | 0.123 | **0.222** | **0.000** | **0.039** |

7.2.15.7. Where an additional Relevant Radius $R_{add1}$ is present: Determine for each RPP the following values for $R_{add1}$ track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Pantograph Points RPPs, UPWARDS shifted, Radd1**

| $R_{add1}$ | $D_{max\ Radd1}$ | $l_{max\ Radd1}$ | **$Pb_{RP}$ =1/2 width of Reference Profile at $P1.5h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ Radd1}$ | $Aa_{wi\ curve}$ | $w_{a\ Radd1}$ | $A_{a\ wa\ curve}$ | Pz1 term $=[s*T_D/L*\mid P1.5h_{shift}-h_c\mid]-[P1.5s_{0\ random}*T_D/L*\mid P1.5h_{shift}-h_{c0}\mid]$ | Pz2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*\mid P1.5h_{shift}-h_c\mid]-[\tan(P1.5\eta_{0r})*(1+P1.5s_{0\ random})*\mid P1.5h_{shift}-h_{c0}\mid]\}_{if>0}$ | Pz3 term $=\{[P1.5t*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)]-[P1.5t_0*(P1.5h_{shift}-P1.5h_t)/(P1.5h_{max\ wire}-P1.5h_t)]\}_{if>0}$ | Pz4 term $=(P1.5\tau-P1.5\tau_0)_{if>0}$ | $Pz5.1_a$ term if $P1.5h_{shift}>h_c$: $=s*l_{max\ f(R)}/L*(P1.5h_{shift}-h_c)$ or if P1.5hshift=hc: = 0.000m or if $P1.5h_{shift}<h_c$: $=s*D_{max}\ f(R)/L*(h_c-P1.5h_{shift})$ | $Pz5.2_a$ term if $P1.5h_{shift}>h_{c0}$: $=P1.5s_{0\ static}*l_{max\ f(R)}/L*(P1.5h_{shift}-h_{c0})$ or if $P1.5h_{shift}=h_{c0}$: = 0.000m or if $P1.5h_{shift}<h_{c0}$: $=P1.5s_{0\ static}*D_{max\ f(R)}/L*(h_{c0}-P1.5h_{shift})$ | $Pz_a=[(Pz1\ term)^2+(Pz2\ term)^2+(Pz3\ term)^2+(Pz4\ term)^2]^{0.5}+[Pz5.1a\ term-Pz5.2a\ term]$ | **$PDpl_{a\ curve}=Dpl_{a\ vehicle}+Dpl_{a\ track}*(A_{a\ track}$ or $A_{a\ track\ (special)})+q*A_{a\ q}+w_{a\ f(R)}*A_{a\ wa\ curve}+w_{i\ f(R)}*A_{a\ wi\ curve}+Pz_a$** | **$P1.5S_{0a}$ =0.000m** | **$\Delta Pb_a=(Pb_{RP}+P1.5S_{0a})-(P1.5b_{nom}+PDpl_{a\ curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** |
| 80 | 0.025 | 0.110 | **0.996** | 0.013 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.015 | 0.029 | 0.031 | 0.010 | 0.083 | 0.000 | 0.129 | **0.228** | **0.000** | **0.118** |
| 80 | 0.025 | 0.110 | **1.161** | 0.013 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.015 | 0.028 | 0.028 | 0.010 | 0.080 | 0.000 | 0.123 | **0.222** | **0.000** | **0.039** |

7.2.15.8. Determine from all resulting $\Delta b_a$ values of this set of gauging calculations the smallest value for each RPP.

*Note: Blue value is an example for information.*

| **$\Delta Pb_a$ min across all calculations** |
|---|
| **[m]** |
| **0.118** |
| **0.039** |

+ A positive value or 0.000m indicates that the vehicle design is compatible with the selected gauge(s)

- A negative value indicates that the vehicle design is not compatible with the selected gauge(s)

7.2.16. **Step 8(25kV) - IF a 25kV Pantograph is present, perform Set6 of the gauging calculations for the related OUTER Relevant Pantograph Points RPPs in their UPWARDS shifted positions on R0+R2000+R250.4+R150+R80+Radd1**

Details to be included in a future issue of this IRS.

**7.2.17. Step 9 - IF Electric Relevant Points are present, perform Set7 of the gauging calculations for INNER Relevant Electrical Points REPs in their UPWARDS shifted positions on R0+R2000+R900+R250.4+R150+R80+Radd1 +R119-LR1+R280-LR2+R98-vLR1**

7.2.17.1. Determine for each REP the following basic values which are independent of the horizontal track radius:

*Note: Blue values are examples for information.*

| Point ID | $n_i$ | $h_{nom}$ | $b_{nom}$ | $k_{U1i}+k_{U2}$ up-wards shift of this Relevant Point | $k_{U1i\text{-}vLR1}+k_{U2}$ up-wards shift of this Relevant Point at vLR1 | $h_{shift} = h_{nom}+k_{U1i}+k_{U2}$ | $h_{shift\text{-}vLR1} = h_{nom}+k_{U1i\text{-}vLR1}+k_{U2}$ |
|---|---|---|---|---|---|---|---|
| | [m] | [m] | [m] | [m] | [m] | [m] | [m] |
| iL01 (1.5kV) | 0.290 | 3.986 | 0.000 | 0.020 | 0.020 | 4.006 | 4.006 |
| iL02 (1.5kV) | 0.290 | 3.986 | 0.660 | 0.020 | 0.020 | 4.006 | 4.006 |

7.2.17.2. Determine for each REP the following values for straight track.

*Note: Blue values are examples for information.*

**INNER Relevant Electrical Points REPs, UPWARDS shifted, R0(=straight)**

| $R_0$ (no value for straight) | $D_{max\ R0}$ | $l_{max\ R0}$ | $b_{RP}$ =1/2 width of Reference Profile at $h_{RP}=h_{shift}$ | $Dpl_{i\ vehicle}$ (not applicable for straight track) | $Dpl_{i\ track}$ | $A_{i\ track}$ | q | $A_{i\ q}$ | $w_{R0}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5}]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5}]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | $Dpl_{i\ straight} = Dpl_{i\ track}*A_{i\ track}+q*A_{i\ q}+w_{i\ f(R)}*A_{i\ wi}+z_i$ | $S_{0i\ geometric}$ (no value for straight track) | $S_{0i\ enlargement}$ (no value for straight track) | $S_{0i}$ (no value for straight track) | $\Delta b_i=(b_{RP}+S_{0i})-(b_{nom}+Dpl_{i\ straight})$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | [m] | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] |
| | 0.000 | 0.000 | 0.900 | | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.000 | 0.000 | -0.001 | 0.083 | | | | 0.817 |
| | 0.000 | 0.000 | 0.900 | | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.000 | 0.000 | -0.001 | 0.083 | | | | 0.157 |

**7.2.17.3.** Determine for each REP the following values for R2000 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Electrical Points REPs, UPWARDS shifted, R2000**

| $R_{2000}$ | $D_{max\ R2000}$ | $l_{max\ R2000}$ | $b_{RP}$ =1/2 width of Reference Profile at $h_{RP}=h_{shift}$ | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ R2000}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5}]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5}]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term -z3.2i term) | $Dpl_{i\ curve} = Dpl_{i\ vehicle}+Dpl_{i\ track}*(A_{i\ track}$ or $A_{i\ track(special)})+q*A_{i\ q}+w_{i\ f(R)}*A_{i\ wi}+z_i$ | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | $S_{0}i = S_{0i\ geometric}+S_{0i\ enlargement}$ | $\Delta b_i=(b_{RP}+S_{0i})-(b_{nom}+Dpl_{i\ curve})$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | [m] | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] |
| 2000.0 | 0.165 | 0.110 | 0.900 | 0.001 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.082 | 0.000 | 0.082 | 0.167 | 0.011 | 0.000 | 0.011 | 0.745 |
| 2000.0 | 0.165 | 0.110 | 0.900 | 0.001 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.082 | 0.000 | 0.082 | 0.167 | 0.011 | 0.000 | 0.011 | 0.085 |

7.2.17.4. Determine for each REP the following values for R900 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Electrical Points REPs, UPWARDS shifted, R900**

| $R_{900}$ | $D_{max\ R900}$ | $l_{max\ R900}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ R900}$ | $A_{i\ wi}$ | z1 term =[s*$T_D$/L*(($h_{nom}$-$h_c$)$^2$)$^{0.5}$]-[$s_{0random}$*$T_D$/L*(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$)] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}$-$h_c$)$^2$)$^{0.5}$] -[tan$\eta$0$_r$ *(1+$s_{0random}$) *(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1i term, if $h_{nom}$>$h_c$: =s*$D_{max\ f(R)}$/L*($h_{nom}$-$h_c$) or if $h_{nom}$=hc: =0.000m or if $h_{nom}$<$h_c$: =s*$l_{max\ f(R)}$/L*($h_c$-$h_{nom}$) | z3.2i term if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$D_{max\ f(R)}$/L*($h_{shift}$-$h_{c0}$) or if $h_{shift}$=$h_{c0}$: =0.000m or if $h_{shift}$<$h_{c0}$: =$s_{0\ static}$*$l_{max\ f(R)}$/L*($h_{c0}$-$h_{shift}$) | $z_i$ =(z1 term) +(z2 term) +(z3.1i term -z3.2i term) | **$Dpl_{i\ curve}$ = $Dpl_{i\ vehicle}$ + $Dpl_{i\ track}$ * ($A_{i\ track}$ or $A_{i\ track(special)}$) + q * $A_{i\ q}$ + $w_{i\ f(R)}$ * $A_{i\ wi}$ + $z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0i$ = $S_{0i\ geometric}$ + $S_{0i\ enlargement}$** | **$\Delta b_i$= ($b_{RP}$+$S_{0i}$) - ($b_{nom}$ +$Dpl_{i\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| 900.0 | 0.165 | 0.110 | **0.900** | 0.003 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.082 | 0.000 | 0.082 | **0.168** | **0.025** | **0.000** | **0.025** | **0.757** |
| 900.0 | 0.165 | 0.110 | **0.900** | 0.003 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.082 | 0.000 | 0.082 | **0.168** | **0.025** | **0.000** | **0.025** | **0.097** |

7.2.17.5. Determine for each REP the following values for R250.4 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Electrical Points REPs, UPWARDS shifted, R250.4**

| $R_{250.4}$ | $D_{max\ R250.4}$ | $l_{max\ R250.4}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{iR250.4}$ | $A_{i\ wi}$ | z1 term =[s*$T_D$/L*(($h_{nom}$-$h_c$)$^2$)$^{0.5}$]-[$s_{0random}$*$T_D$/L*(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$)] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}$-$h_c$)$^2$)$^{0.5}$] -[tan$\eta$0$_r$ *(1+$s_{0random}$) *(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1i term, if $h_{nom}$>$h_c$: =s*$D_{max\ f(R)}$/L*($h_{nom}$-$h_c$) or if $h_{nom}$=hc: =0.000m or if $h_{nom}$<$h_c$: =s*$l_{max\ f(R)}$/L*($h_c$-$h_{nom}$) | z3.2i term if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$D_{max\ f(R)}$/L*($h_{shift}$-$h_{c0}$) or if $h_{shift}$=$h_{c0}$: =0.000m or if $h_{shift}$<$h_{c0}$: =$s_{0\ static}$*$l_{max\ f(R)}$/L*($h_{c0}$-$h_{shift}$) | $z_i$ =(z1 term) +(z2 term) +(z3.1i term -z3.2i term) | **$Dpl_{i\ curve}$ = $Dpl_{i\ vehicle}$ + $Dpl_{i\ track}$ * ($A_{i\ track}$ or $A_{i\ track(special)}$) + q * $A_{i\ q}$ + $w_{i\ f(R)}$ * $A_{i\ wi}$ + $z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0i$ = $S_{0i\ geometric}$ + $S_{0i\ enlargement}$** | **$\Delta b_i$= ($b_{RP}$+$S_{0i}$) - ($b_{nom}$ +$Dpl_{i\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 250.4 | 0.165 | 0.110 | **0.900** | 0.010 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.082 | 0.000 | 0.082 | **0.176** | **0.090** | **0.000** | **0.090** | **0.814** |
| 250.4 | 0.165 | 0.110 | **0.900** | 0.010 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.082 | 0.000 | 0.082 | **0.176** | **0.090** | **0.000** | **0.090** | **0.154** |

7.2.17.6. Determine for each REP the following values for R150 track radius:

*Note: Blue values are examples for information.*

**INNER Relevant Electrical Points REPs, UPWARDS shifted, R150**

| $R_{150}$ | $D_{max\ R150}$ | $l_{max\ R150}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{iR150}$ | $A_{i\ wi}$ | z1 term =[s*$T_D$/L*(($h_{nom}$-$h_c$)$^2$)$^{0.5}$]-[$s_{0random}$*$T_D$/L*(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$)] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}$-$h_c$)$^2$)$^{0.5}$] -[tan$\eta$0$_r$ *(1+$s_{0random}$) *(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1i term, if $h_{nom}$>$h_c$: =s*$D_{max\ f(R)}$/L*($h_{nom}$-$h_c$) or if $h_{nom}$=hc: =0.000m or if $h_{nom}$<$h_c$: =s*$l_{max\ f(R)}$/L*($h_c$-$h_{nom}$) | z3.2i term if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$D_{max\ f(R)}$/L*($h_{shift}$-$h_{c0}$) or if $h_{shift}$=$h_{c0}$: =0.000m or if $h_{shift}$<$h_{c0}$: =$s_{0\ static}$*$l_{max\ f(R)}$/L*($h_{c0}$-$h_{shift}$) | $z_i$ =(z1 term) +(z2 term) +(z3.1i term -z3.2i term) | **$Dpl_{i\ curve}$ = $Dpl_{i\ vehicle}$ + $Dpl_{i\ track}$ * ($A_{i\ track}$ or $A_{i\ track(special)}$) + q * $A_{i\ q}$ + $w_{i\ f(R)}$ * $A_{i\ wi}$ + $z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0i$ = $S_{0i\ geometric}$ + $S_{0i\ enlargement}$** | **$\Delta b_i$= ($b_{RP}$+$S_{0i}$) - ($b_{nom}$ +$Dpl_{i\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| 150 | 0.082 | 0.110 | **0.900** | 0.017 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.041 | 0.000 | 0.040 | **0.141** | **0.150** | **0.000** | **0.150** | **0.909** |
| 150 | 0.082 | 0.110 | **0.900** | 0.017 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.041 | 0.000 | 0.040 | **0.141** | **0.150** | **0.000** | **0.150** | **0.249** |

7.2.17.7. Determine for each REP the following values for R80 track radius:

*Note: Blue values are examples for information.*

| INNER Relevant Electrical Points REPs, UPWARDS shifted, R80 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{80}$ | $D_{max\ R80}$ | $l_{max\ R80}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{iR80}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5)}]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term -z3.2i term) | **$Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track} * (A_{i\ track}$ or $A_{i\ track(special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0i = S_{0i\ geometric} + S_{0i\ enlargement}$** | **$\Delta b_i = (b_{RP}+S_{0i}) - (b_{nom} + Dpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| 80 | 0.025 | 0.110 | **0.900** | 0.033 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.012 | 0.000 | 0.012 | **0.128** | **0.281** | **0.088** | **0.369** | **1.141** |
| 80 | 0.025 | 0.110 | **0.900** | 0.033 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.012 | 0.000 | 0.012 | **0.128** | **0.281** | **0.088** | **0.369** | **0.481** |

7.2.17.8. Where an additional Relevant Radius $R_{add1}$ is present: Determine for each REP the following values for $R_{add1}$ track radius:

*Note: Blue values are examples for information.*

| INNER Relevant Electrical Points REPs, UPWARDS shifted, Radd1 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{add1}$ | $D_{max\ Radd1}$ | $l_{max\ Radd1}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ Radd1}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5)}]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term -z3.2i term) | **$Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track} * (A_{i\ track}$ or $A_{i\ track(special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0i = S_{0i\ geometric} + S_{0i\ enlargement}$** | **$\Delta b_i = (b_{RP}+S_{0i}) - (b_{nom} + Dpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| 80 | 0.025 | 0.110 | **0.900** | 0.033 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.012 | 0.000 | 0.012 | **0.128** | **0.281** | **0.088** | **0.369** | **1.141** |
| 80 | 0.025 | 0.110 | **0.900** | 0.033 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.012 | 0.000 | 0.012 | **0.128** | **0.281** | **0.088** | **0.369** | **0.481** |

7.2.17.9. Determine for each REP the following values for R98-vLR1 track radius:

*Note: Blue values are examples for information.*

vLR1 is not present at IRL2 and shall accordingly not be calculated for IRL2.

| only applicable for IRL1+1D+1F: INNER Relevant Electrical Points REPs, UPWARDS shifted, R98 vLR1 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{98}$ vLR1 | $D_{max}$ R98-vLR1 | $l_{max}$ R98-vLR1 | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift-vLR1}$** | $Dpl_i$ vehicle | $Dpl_i$ track-vLR1 | $A_{i\ track}$ or $A_i$ track (special) | q | $A_{i\ q}$ | $w_{iR98-vLR1}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5})]-[s_{0random}*T_D/L*((h_{shift-vLR1}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta0_r*(1+s_{0random})*((h_{shift-vLR1}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | ONLY for vLR1: z3.2i term if $h_{shift-vLR1}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift-vLR1}-h_{c0})$ or if $h_{shift-vLR1}=h_{c0}$: =0.000m or if $h_{shift-vLR1}<h_{c0}$: $=s_0\ static*l_{max\ f(R)}/L*(h_{c0}-h_{shift-vLR1})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term -z3.2i term) | **ONLY for vLR1: $Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track-vLR1} * (A_{i\ track}$ or $A_{i\ track\ (special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0i = S_{0i\ geometric} + S_{0i\ enlargement}$** | **ONLY for gauges IRL1/1D/1F $\Delta b_i = (b_{RP}+S_{0i}) - (b_{nom} + Dpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| 98 | 0.010 | 0.034 | **0.900** | 0.027 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.005 | 0.000 | 0.004 | **0.115** | **0.229** | **0.053** | **0.282** | **1.068** |
| 98 | 0.010 | 0.034 | **0.900** | 0.027 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | -0.001 | 0.000 | 0.005 | 0.000 | 0.004 | **0.115** | **0.229** | **0.053** | **0.282** | **0.408** |

7.2.17.10. Determine from all resulting $\Delta b_i$ values of this set of gauging calculations the smallest value for each REP.

*Note: Blue value is an example for information.*

| **$\Delta b_i$ min across all calculations of this set** |
|---|
| **[m]** |
| **0.745** |
| **0.085** |

+ A positive value or 0,000m indicates that the vehicle design is compatible with the selected gauge(s)

- A negative value indicates that the vehicle design is not compatible with the selected gauge(s)

**7.2.18. Step 10 - IF Electric Relevant Points are present, perform Set8 of the gauging calculations for INNER Relevant Electrical Points REPs in their DOWNWARDS shifted positions on R0+R2000+R900+R250.4+R150+R80+Radd1+R119-LR1+R280-LR2+R98-vLR1**

7.2.18.1. Determine for each REP the following basic values which are independent of the horizontal track radius:

*Note: Blue values are examples for information.*

| Point ID | $n_i$ | $h_{nom}$ | $b_{nom}$ | Zone (A or B) | $k_{L1i}$ down-wards shift of this Relevant Point | $k_{L1i\text{-}vLR1}$ down-wards shift of this Relevant Point at vLR1 | $k_{L2}+k_{L3}+k_{L4}$ down-wards shift of this Relevant Point | $k_{L5}$ down-wards shift of this Relevant Point (depending on Zone: $=k_{L5A}$ oder $=k_{L5B}$) | $h_{shift}$ $=h_{nom}-(k_{L1i}+k_{L2}+k_{L3}+k_{L4}+k_{L5})$ | $h_{shift\text{-}vLR1}$ $=h_{nom}-(k_{Lai\text{-}vLR1}+k_{L2}+k_{L3}+k_{L4}+k_{L5})$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | [m] | [m] | [m] | | [m] | [m] | [m] | [m] | [m] | [m] |
| iL01 (1.5kV) | 0.290 | 3.986 | 0.000 | A | 0.000 | 0.000 | 0.122 | 0.000 | 3.864 | 3.864 |
| iL02 (1.5kV) | 0.290 | 3.986 | 0.660 | A | 0.000 | 0.000 | 0.122 | 0.000 | 3.864 | 3.864 |

7.2.18.2. Determine for each REP the following values for straight track.

*Note: Blue values are examples for information.*

**INNER Relevant Electrical Points REPs, DOWNWARDS shifted, R0(=straight track)**

| $R_0$ (no value for straight) | $D_{max\ R0}$ | $l_{max\ R0}$ | $b_{RP}$ =1/2 width of Reference Profile at $h_{RP}=h_{shift}$ | $Dpl_{i\ vehicle}$ (not applicable for straight track) | $Dpl_{i\ track}$ | $A_{i\ track}$ | q | $A_{i\ q}$ | $w_{R0}$ | $A_{i\ wi}$ | z1 term $=[s^*T_D/L^*((h_{nom}-h_c)^2)^{0.5}]-[s_{0random}^*T_D/L^*((h_{shift}-h_{c0})^2)^{0.5}]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)^*(1+s)^*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta_0 {}_r^*(1+s_{0random})^*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s^*D_{max\ f(R)}/L^*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s^*l_{max\ f(R)}/L^*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}^*D_{max\ f(R)}/L^*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}^*l_{max\ f(R)}/L^*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | $Dpl_{i\ straight}=Dpl_{i\ track}*A_{i\ track}+q*A_{i\ q}+w_{i\ f(R)}*A_{i\ wi}+z_i$ | $S_{0i\ geometric}$ (no value for straight track) | $S_{0i\ enlargement}$ (no value for straight track) | $S_{0i}$ (no value for straight track) | $\Delta b_i=(b_{RP}+S_{0i})-(b_{nom}+Dpl_{i\ straight})$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | [m] | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] |
| X | 0.000 | 0.000 | 1.174 | X | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.083 | X | X | X | 1.091 |
| X | 0.000 | 0.000 | 1.174 | X | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.083 | X | X | X | 0.431 |

7.2.18.3. Determine for each REP the following values for R2000.

*Note: Blue values are examples for information.*

**INNER Relevant Electrical Points REPs, DOWNWARDS shifted, R2000**

| $R_{2000}$ | $D_{max\ R2000}$ | $l_{max\ R2000}$ | $b_{RP}$ =1/2 width of Reference Profile at $h_{RP}=h_{shift}$ | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{i\ R2000}$ | $A_{i\ wi}$ | z1 term $=[s^*T_D/L^*((h_{nom}-h_c)^2)^{0.5}]-[s_{0random}^*T_D/L^*((h_{shift}-h_{c0})^2)^{0.5}]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)^*(1+s)^*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta_0 {}_r^*(1+s_{0random})^*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s^*D_{max\ f(R)}/L^*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s^*l_{max\ f(R)}/L^*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}^*D_{max\ f(R)}/L^*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0static}^*l_{max\ f(R)}/L^*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term -z3.2i term) | $Dpl_{i\ curve}=Dpl_{i\ vehicle}+Dpl_{i\ track}*(A_{i\ track}$ or $A_{i\ track(special)})+q*A_{i\ q}+w_{i\ f(R)}*A_{i\ wi}+z_i$ | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | $S_0i=S_{0i\ geometric}+S_{0i\ enlargement}$ | $\Delta b_i=(b_{RP}+S_{0i})-(b_{nom}+Dpl_{i\ curve})$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | [m] | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] |
| 2000.0 | 0.165 | 0.110 | 1.174 | 0.001 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.082 | 0.000 | 0.082 | 0.167 | 0.011 | 0.000 | 0.011 | 1.019 |
| 2000.0 | 0.165 | 0.110 | 1.174 | 0.001 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.082 | 0.000 | 0.082 | 0.167 | 0.011 | 0.000 | 0.011 | 0.359 |

7.2.18.4. Determine for each REP the following values for R900.

*Note: Blue values are examples for information.*

| INNER Relevant Electrical Points REPs, R900, DOWNWARDS shifted, R900 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{900}$ | $D_{max}$ R900 | $I_{max}$ R900 | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_i$ vehicle | $Dpl_i$ track | $A_{i\ track}$ or $A_i$ track (special) | q | $A_{i\ q}$ | $w_i$ R900 | $A_{i\ wi}$ | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5})]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*I_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*I_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term -z3.2i term) | **$Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track} * (A_{i\ track}$ or $A_{i\ track(special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0i = S_{0i\ geometric} + S_{0i\ enlargement}$** | **$\Delta b_i = (b_{RP}+S_{0i}) - (b_{nom}+Dpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 900.0 | 0.165 | 0.110 | **1.174** | 0.003 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.082 | 0.000 | 0.082 | **0.169** | **0.025** | **0.000** | **0.025** | **1.031** |
| 900.0 | 0.165 | 0.110 | **1.174** | 0.003 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.082 | 0.000 | 0.082 | **0.169** | **0.025** | **0.000** | **0.025** | **0.371** |

7.2.18.5. Determine for each REP the following values for R250.4.

*Note: Blue values are examples for information.*

| INNER Relevant Electrical Points REPs, DOWNWARDS shifted, R250.4 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{250.4}$ | $D_{max}$ R250.4 | $I_{max}$ R250.4 | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_i$ vehicle | $Dpl_i$ track | $A_{i\ track}$ or $A_i$ track (special) | q | $A_{i\ q}$ | $w_{iR250.4}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5})]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*I_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*I_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term -z3.2i term) | **$Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track} * (A_{i\ track}$ or $A_{i\ track(special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0i = S_{0i\ geometric} + S_{0i\ enlargement}$** | **$\Delta b_i = (b_{RP}+S_{0i}) - (b_{nom}+Dpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 250.4 | 0.165 | 0.110 | **1.174** | 0.010 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.082 | 0.000 | 0.082 | **0.176** | **0.090** | **0.000** | **0.090** | **1.088** |
| 250.4 | 0.165 | 0.110 | **1.174** | 0.010 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.082 | 0.000 | 0.082 | **0.176** | **0.090** | **0.000** | **0.090** | **0.428** |

7.2.18.6. Determine for each REP the following values for R150.

*Note: Blue values are examples for information.*

| INNER Relevant Electrical Points REPs, DOWNWARDS shifted, R150 | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{150}$ | $D_{max}$ R150 | $I_{max}$ R150 | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_i$ vehicle | $Dpl_i$ track | $A_{i\ track}$ or $A_i$ track (special) | q | $A_{i\ q}$ | $w_{iR150}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5})]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*I_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*I_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term -z3.2i term) | **$Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track} * (A_{i\ track}$ or $A_{i\ track(special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0i = S_{0i\ geometric} + S_{0i\ enlargement}$** | **$\Delta b_i = (b_{RP}+S_{0i}) - (b_{nom}+Dpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 150 | 0.082 | 0.110 | **1.174** | 0.017 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.041 | 0.000 | 0.041 | **0.142** | **0.150** | **0.000** | **0.150** | **1.183** |
| 150 | 0.082 | 0.110 | **1.174** | 0.017 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.041 | 0.000 | 0.041 | **0.142** | **0.150** | **0.000** | **0.150** | **0.523** |

7.2.18.7. Determine for each REP the following values for R80.

*Note: Blue values are examples for information.*

| **INNER Relevant Electrical Points REPs, DOWNWARDS shifted, R80** | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{80}$ | $D_{max\ R80}$ | $l_{max\ R80}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{iR80}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5})]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term -z3.2i term) | **$Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track} * (A_{i\ track}$ or $A_{i\ track(special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0i = S_{0i\ geometric} + S_{0i\ enlargement}$** | **$\Delta b_i = (b_{RP}+S_{0i}) - (b_{nom} + Dpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 80 | 0.025 | 0.110 | **1.174** | 0.033 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.012 | 0.000 | 0.012 | **0.128** | **0.281** | **0.088** | **0.369** | **1.415** |
| 80 | 0.025 | 0.110 | **1.174** | 0.033 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.012 | 0.000 | 0.012 | **0.128** | **0.281** | **0.088** | **0.369** | **0.755** |

7.2.18.8. Where an additional Relevant Radius $R_{add1}$ is present: Determine for each REP the following values for $R_{add1}$ track radius:

*Note: Blue values are examples for information.*

| **INNER Relevant Electrical Points REPs, DOWNWARDS shifted, Radd1** | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{add1}$ | $D_{max\ Radd1}$ | $l_{max\ Radd1}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{iRadd1}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5})]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term -z3.2i term) | **$Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track} * (A_{i\ track}$ or $A_{i\ track(special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0i = S_{0i\ geometric} + S_{0i\ enlargement}$** | **$\Delta b_i = (b_{RP}+S_{0i}) - (b_{nom} + Dpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 80 | 0.025 | 0.110 | **1.174** | 0.033 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.012 | 0.000 | 0.012 | **0.128** | **0.281** | **0.088** | **0.369** | **1.415** |
| 80 | 0.025 | 0.110 | **1.174** | 0.033 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.012 | 0.000 | 0.012 | **0.128** | **0.281** | **0.088** | **0.369** | **0.755** |

7.2.18.9. Determine for each REP the following values for R98-vLR1 track radius:

*Note: Blue values are examples for information.*

vLR1 is not present at IRL2 and shall accordingly not be calculated for IRL2.

| only applicable for IRL1+1D+1F: INNER Relevant Electrical Points REPs, DOWNWARDS shifted, R98 vLR1 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{98-vLR1}$ | $D_{max\ R98-vLR1}$ | $l_{max\ R98-vLR1}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift-vLR1}$** | $Dpl_{i\ vehicle}$ | $Dpl_{i\ track-vLR1}$ | $A_{i\ track}$ or $A_{i\ track\ (special)}$ | q | $A_{i\ q}$ | $w_{iR98-vLR1}$ | $A_{i\ wi}$ | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5}]-[s_{0random}*T_D/L*((h_{shift-vLR1}-h_{c0})^2)^{0.5}]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta_{0r}*(1+s_{0random})*((h_{shift-vLR1}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1i term, if $h_{nom}>h_c$: $=s*D_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}$=hc: =0.000m or if $h_{nom}<h_c$: $=s*l_{max\ f(R)}/L*(h_c-h_{nom})$ | z3.2i term if $h_{shift-vLR1}>h_{c0}$: $=s_{0\ static}*D_{max\ f(R)}/L*(h_{shift-vLR1}-h_{c0})$ or if $h_{shift-vLR1}=h_{c0}$: =0.000m or if $h_{shift-vLR1}<h_{c0}$: $=s_{0\ static}*l_{max\ f(R)}/L*(h_{c0}-h_{shift-vLR1})$ | $z_i$ =(z1 term) +(z2 term) +(z3.1i term - z3.2i term) | **ONLY for vLR1: $Dpl_{i\ curve} = Dpl_{i\ vehicle} + Dpl_{i\ track-vLR1} * (A_{i\ track}$ or $A_{i\ track\ (special)}) + q * A_{i\ q} + w_{i\ f(R)} * A_{i\ wi} + z_i$** | $S_{0i\ geometric}$ = 22.482 m² * (1 / R) | $S_{0i\ enlargement}$ = (15 m² * (1 / R)) – 0.1 m)$_{if>0}$ | **$S_0i = S_{0i\ geometric} + S_{0i\ enlargement}$** | **ONLY for gauges IRL1/1D/1F $\Delta b_i = (b_{RP}+S_{0i}) - (b_{nom} + Dpl_{i\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 98 | 0.010 | 0.034 | **1.174** | 0.027 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.005 | 0.000 | 0.005 | **0.115** | **0.229** | **0.053** | **0.282** | **1.342** |
| 98 | 0.010 | 0.034 | **1.174** | 0.027 | 0.029 | 1.000 | 0.005 | 1.000 | 0.050 | 1.000 | 0.000 | 0.000 | 0.005 | 0.000 | 0.005 | **0.115** | **0.229** | **0.053** | **0.282** | **0.682** |

7.2.18.10. Determine from all resulting $\Delta b_i$ values of this set of gauging calculations the smallest value for each REP.

*Note: Blue value is an example for information.*

| **$\Delta b_i$ min across all calculations of this set** |
|---|
| **[m]** |
| **1.019** |
| **0.359** |

+ A positive value or 0.000m indicates that the vehicle design is compatible with the selected gauge(s)

- A negative value indicates that the vehicle design is not compatible with the selected gauge(s)

7.2.19. **Step 11 - IF Electric Relevant Points are present, perform Set9 of the gauging calculations for OUTER Relevant Electrical Points REPs in their UPWARDS shifted positions on R0+R2000+R250.4+R150+R80+Radd1+R116-LR1+R280-LR2+R98-vLR1**

7.2.19.1. Determine for each REP the following basic values which are independent of the horizontal track radius:

*Note: Blue values are examples for information.*

| Relevant Point ID | $n_a$ | $h_{nom}$ | $b_{nom}$ | $k_{U1a}$ + $k_{U2}$ up-wards shift of this Relevant Point | $k_{U1a-vLR1}$ + $k_{U2}$ up-wards shift of this Relevant Point at vLR1 | $h_{shift}$ = $h_{nom}$ + $k_{U1a}$ + $k_{U2}$ | $h_{shift\ vLR1}$ = $h_{nom}$ + $k_{U1a-vLR1}$ + $k_{U2}$ |
|---|---|---|---|---|---|---|---|
| | **[m]** | **[m]** | **[m]** | [m] | [m] | **[m]** | **[m]** |
| aL01 (1.5kV) | **0.240** | **3.986** | **0.000** | 0.020 | 0.020 | **4.006** | **4.006** |
| aL02 (1.5kV) | **0.240** | **3.986** | **0.660** | 0.020 | 0.020 | **4.006** | **4.006** |

7.2.19.2. Determine for each REP the following values for straight track.

*Note: Blue values are examples for information.*

**OUTER Relevant Electrical Points REPs, UPWARDS shifted, R0(=straight track)**

| $R_0$ (no value for straight) | $D_{max\ R0}$ | $l_{max\ R0}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP}$ = $h_{shift}$** | $Dpl_{a\ vehicle}$ (not applicable for straight track) | $Dpl_{a\ track}$ | $A_{a\ track}$ | q | $A_{a\ q}$ | $w_{R0}$ | $A_{a\ wR0\ straight}$ | z1 term =[s*$T_D$/L*(($h_{nom}$-$h_c$)$^2$)$^{0.5}$]-[$s_{0random}$*$T_D$/L*(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$)] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}$-$h_c$)$^2$)$^{0.5}$] -[tan$\eta 0_r$ *(1+$s_{0random}$) *(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1a term, if $h_{nom}$>$h_c$: =s*$l_{max\ f(R)}$/L*($h_{nom}$-$h_c$) or if $h_{nom}$=$h_c$: =0.000m or if $h_{nom}$<$h_c$: =s*$D_{max\ f(R)}$/L*(hc-$h_{nom}$) | z3.2a term if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$l_{max(fR)}$/L*($h_{shift}$-$h_{c0}$) or if $h_{shift}$=$h_{c0}$: =0.000m or if $h_{shift}$<$h_{c0}$: =$s_{0\ static}$*$D_{max(fR)}$/L*($h_{c0}$-$h_{shift}$) | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | **$Dpl_{a\ straight}$ = $Dpl_{a\ track}$ * $A_{a\ track}$ + q * $A_{a\ q}$ + $w_{R0}$ * $A_{a\ wR0\ straight}$ + $z_a$** | $S_{0a\ geometric}$ (no value for straight track) | $S_{0a\ enlargement}$ (no value for straight track) | **$S_{0a}$ (no value for straight track)** | **$\Delta b_a$= ($b_{RP}$+$S_{0a}$) -($b_{nom}$ +$Dpl_{a\ straight}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| | 0.000 | 0.000 | **0.900** | | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 1.035 | -0.001 | 0.000 | 0.000 | 0.000 | -0.001 | **0.086** | | | | **0.814** |
| | 0.000 | 0.000 | **0.900** | | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 1.035 | -0.001 | 0.000 | 0.000 | 0.000 | -0.001 | **0.086** | | | | **0.154** |

7.2.19.3. Determine for each REP the following values for R2000.

*Note: Blue values are examples for information.*

**OUTER Relevant Electrical Points REPs, UPWARDS shifted, R2000**

| $R_{2000}$ | $D_{max\ R2000}$ | $l_{max\ R2000}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP}$ = $h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R2000}$ | $A_{a\ wi\ curve}$ | $w_{a\ R2000}$ | $A_{a\ wa\ curve}$ | z1 term =[s*$T_D$/L*(($h_{nom}$-$h_c$)$^2$)$^{0.5}$]-[$s_{0random}$*$T_D$/L*(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$)] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}$-$h_c$)$^2$)$^{0.5}$] -[tan$\eta 0_r$ *(1+$s_{0random}$) *(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1a term, if $h_{nom}$>$h_c$: =s*$l_{max\ f(R)}$/L*($h_{nom}$-$h_c$) or if $h_{nom}$=$h_c$: =0.000m or if $h_{nom}$<$h_c$: =s*$D_{max\ f(R)}$/L*(hc-$h_{nom}$) | z3.2a term if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$l_{max(fR)}$/L*($h_{shift}$-$h_{c0}$) or if $h_{shift}$=$h_{c0}$: =0.000m or if $h_{shift}$<$h_{c0}$: =$s_{0\ static}$*$D_{max(fR)}$/L *($h_{c0}$-$h_{shift}$) | $z_a$ =(z1 term) +(z2 term) +(z3.1a term -z3.2a term) | **$Dpl_{a\ curve}$ = $Dpl_{a\ vehicle}$ + $Dpl_{a\ track}$ * ($A_{a\ track}$ or $A_{a\ track\ (special)}$) + q * $A_{a\ q}$ + $w_{a\ f(R)}$ * $Aa_{wa\ curve}$ + $w_{i\ f(R)}$ * $A_{a\ wi\ curve}$ + $z_a$** | $S_{0a\ geometric}$ = 21.440 m² * (1 / R) | $S_{0a\ enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a}$ = $S_{0a\ geometric}$ + $S_{0a\ enlargement}$** | **$\Delta b_a$= ($b_{RP}$+$S_{0a}$) - ($b_{nom}$ +$Dpl_{a\ curve}$)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 2000.000 | 0.165 | 0.110 | **0.900** | 0.001 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.141** | 0.011 | 0.000 | **0.011** | **0.770** |
| 2000.000 | 0.165 | 0.110 | **0.900** | 0.001 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.141** | 0.011 | 0.000 | **0.011** | **0.110** |

7.2.19.4. Determine for each REP the following values for R250.4.

*Note: Blue values are examples for information.*

| OUTER Relevant Electrical Points REPs, UPWARDS shifted, R250.4 | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{250.4}$ | $D_{max\ R250.4}$ | $l_{max\ R250.4}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R250.4}$ | $A_{a\ wi\ curve}$ | $w_{a\ R250.4}$ | $A_{a\ wa\ curve}$ | z1 term $=[s^*T_D/L^*((h_{nom}-h_c)^2)^{0.5})]-[s_{0random}{}^*T_D/L^*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)^*(1+s)^*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r{}^*(1+s_{0random})^*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s^*l_{max\ f(R)}/L^*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s^*D_{max\ f(R)}/L^*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\ static}{}^*l_{max(fR)}/L^*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}{}^*D_{max(fR)}/L^*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term -z3.2a term) | **$Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track}{}^* (A_{a\ track}$ or $A_{a\ track\ (special)}) + q^* A_{a\ q} + w_{a\ f(R)}{}^* Aa_{wa\ curve} + w_{i\ f(R)}{}^* A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric}$ = 21.440 m² * (1 / R) | $S_{0a\ enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **$\Delta b_a = (b_{RP}+S_{0a}) - (b_{nom}+Dpl_{a\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 250.400 | 0.165 | 0.110 | **0.900** | 0.004 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.145** | 0.086 | 0.000 | **0.086** | **0.841** |
| 250.400 | 0.165 | 0.110 | **0.900** | 0.004 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.145** | 0.086 | 0.000 | **0.086** | **0.181** |

7.2.19.5. Determine for each REP the following values for R150.

*Note: Blue values are examples for information.*

| OUTER Relevant Electrical Points REPs, UPWARDS shifted, R150 | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{150}$ | $D_{max\ R150}$ | $l_{max\ R150}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R150}$ | $A_{a\ wi\ curve}$ | $w_{a\ R150}$ | $A_{a\ wa\ curve}$ | z1 term $=[s^*T_D/L^*((h_{nom}-h_c)^2)^{0.5})]-[s_{0random}{}^*T_D/L^*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)^*(1+s)^*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r{}^*(1+s_{0random})^*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s^*l_{max\ f(R)}/L^*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s^*D_{max\ f(R)}/L^*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\ static}{}^*l_{max(fR)}/L^*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}{}^*D_{max(fR)}/L^*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term -z3.2a term) | **$Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track}{}^* (A_{a\ track}$ or $A_{a\ track\ (special)}) + q^* A_{a\ q} + w_{a\ f(R)}{}^* Aa_{wa\ curve} + w_{i\ f(R)}{}^* A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric}$ = 21.440 m² * (1 / R) | $S_{0a\ enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **$\Delta b_a = (b_{RP}+S_{0a}) - (b_{nom}+Dpl_{a\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 150.000 | 0.082 | 0.110 | **0.900** | 0.007 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.147** | 0.143 | 0.000 | **0.143** | **0.896** |
| 150.000 | 0.082 | 0.110 | **0.900** | 0.007 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.147** | 0.143 | 0.000 | **0.143** | **0.236** |

7.2.19.6. Determine for each REP the following values for R80.

*Note: Blue values are examples for information.*

**OUTER Relevant Electrical Points REPs, UPWARDS shifted, R80**

| $R_{80}$ | $D_{max}$ R80 | $l_{max}$ R80 | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_a$ vehicle | $Dpl_a$ track | $A_a$ track or $A_a$ track (special) | q | $A_{a\,q}$ | $w_{i\,R80}$ | $A_{a\,wi}$ curve | $w_{a\,R80}$ | $A_{a\,wa}$ curve | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5}]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5}]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\,f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\,f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\,static}*l_{max(fR)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\,static}*D_{max(fR)}/L*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term -z3.2a term) | **$Dpl_{a\,curve} = Dpl_{a\,vehicle} + Dpl_{a\,track} * (A_{a\,track}$ or $A_{a\,track\,(special)}) + q * A_{a\,q} + w_{a\,f(R)} * Aa_{wa\,curve} + w_{i\,f(R)} * A_{a\,wi\,curve} + z_a$** | $S_{0a\,geometric}$ = 21.440 m² * (1 / R) | $S_{0a\,enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a} = S_{0a\,geometric} + S_{0a\,enlargement}$** | **$\Delta b_a = (b_{RP}+S_{0a}) - (b_{nom} + Dpl_{a\,curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 80.000 | 0.025 | 0.110 | **0.900** | 0.013 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.153** | 0.268 | 0.088 | **0.356** | **1.102** |
| 80.000 | 0.025 | 0.110 | **0.900** | 0.013 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.153** | 0.268 | 0.088 | **0.356** | **0.442** |

7.2.19.7. Where an additional Relevant Radius $R_{add1}$ is present: Determine for each REP the following values for $R_{add1}$ track radius:

*Note: Blue values are examples for information.*

**OUTER Relevant Electrical Points REPs, UPWARDS shifted, Radd1**

| $R_{add1}$ | $D_{max}$ Radd1 | $l_{max}$ Radd1 | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_a$ vehicle | $Dpl_a$ track | $A_a$ track or $A_a$ track (special) | q | $A_{a\,q}$ | $w_i$ Radd1 | $A_{a\,wi}$ curve | $w_a$ Radd1 | $A_{a\,wa}$ curve | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5}]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5}]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\,f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\,f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\,static}*l_{max(fR)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\,static}*D_{max(fR)}/L*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term -z3.2a term) | **$Dpl_{a\,curve} = Dpl_{a\,vehicle} + Dpl_{a\,track} * (A_{a\,track}$ or $A_{a\,track\,(special)}) + q * A_{a\,q} + w_{a\,f(R)} * Aa_{wa\,curve} + w_{i\,f(R)} * A_{a\,wi\,curve} + z_a$** | $S_{0a\,geometric}$ = 21.440 m² * (1 / R) | $S_{0a\,enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a} = S_{0a\,geometric} + S_{0a\,enlargement}$** | **$\Delta b_a = (b_{RP}+S_{0a}) - (b_{nom} + Dpl_{a\,curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 80.000 | 0.025 | 0.110 | **0.900** | 0.013 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.153** | 0.268 | 0.088 | **0.356** | **1.102** |
| 80.000 | 0.025 | 0.110 | **0.900** | 0.013 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | -0.001 | 0.000 | 0.055 | 0.000 | 0.054 | **0.153** | 0.268 | 0.088 | **0.356** | **0.442** |

7.2.19.8. Determine for each REP the following values for R98-vLR1 track radius:

*Note: Blue values are examples for information.*

vLR1 is not present at IRL2 and shall accordingly not be calculated for IRL2.

| only applicable for IRL1+1D+1F: OUTER Relevant Electrical Points REPs, UPWARDS shifted, R98 vLR1 | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{98\text{-}vLR1}$ | $D_{max\ R98\text{-}vLR1}$ | $l_{max\ R98\text{-}vLR1}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift\text{-}vLR1}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track\text{-}vLR1}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R98\text{-}vLR1}$ | $A_{a\ wi\ curve}$ | $w_{a\ R98\text{-}vLR1}$ | $A_{a\ wa\ curve}$ | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5})]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\ f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift\text{-}vLR1}>h_{c0}$: $= s_{0\ static} * l_{max\ f(R)} / L * (h_{shift\text{-}vLR1} - h_{c0})$ or if $h_{shift\text{-}vLR1}$ = hc0: = 0.000 m or if $h_{shift\text{-}vLR1}<h_{c0}$: $= s_{0\ static} * D_{max\ f(R)} / L * (h_{c0}- h_{shift\text{-}vLR1})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term -z3.2a term) | **ONLY for vLR1: $Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track\text{-}vLR1} * (A_{a\ track}$ or $A_{a\ track\ (special)}) + q * A_{a\ q} + w_{a\ f(R)} * A_{a\ wa\ curve} + w_{i\ f(R)} * A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric} = 21.440\ m^2 * (1 / R)$ | $S_{0a\ enlargement} = (15\ m^2 * (1 / R) – 0.1\ m)_{if>0}$ | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **ONLY for gauges IRL1/1D/1F $\Delta ba = (b_{RP}+S_{0a}) - (b_{nom} + Dpla_{curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 98.000 | 0.010 | 0.034 | **0.900** | 0.010 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | -0.001 | 0.000 | 0.017 | 0.000 | 0.016 | **0.113** | 0.219 | 0.053 | **0.272** | **1.059** |
| 98.000 | 0.010 | 0.034 | **0.900** | 0.010 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | -0.001 | 0.000 | 0.017 | 0.000 | 0.016 | **0.113** | 0.219 | 0.053 | **0.272** | **0.399** |

7.2.19.9. Determine from all resulting $\Delta b_a$ values of this set of gauging calculations the smallest value for each REP.

*Note: Blue value is example for information.*

| **$\Delta b_a$ min across all calculations of this set** |
|---|
| **[m]** |
| **0.770** |
| **0.110** |

+ A positive value or 0.000m indicates that the vehicle design is compatible with the selected gauge(s)

- A negative value indicates that the vehicle design is not compatible with the selected gauge(s)

7.2.20. **Step 12 - IF Electric Relevant Points are present, perform Set10 of the gauging calculations for OUTER Relevant Electrical Points REPs in their DOWNWARDS shifted positions on R0+R2000+R250.4+R150+R80+Radd1+R116-LR1+R280-LR2+R98-vLR1**

7.2.20.1. Determine for each REP the following basic values which are independent of the horizontal track radius:

*Note: Blue values are examples for information.*

| **Point ID** | $n_a$ | $h_{nom}$ | $b_{nom}$ | Zone (C or D) | $k_{L1a}$ down-wards shift of this Relevant Point | $k_{L1a\text{-}vLR1}$ down-wards shift of this Relevant Point at vLR1 | $k_{L2}$ +$k_{L3}$ +$k_{L4}$ down-wards shift of this Relevant Point | $k_{L5}$ down-wards shift of this Relevant Point (depending on Zone: =$k_{L5C}$ oder =$k_{L5D}$) | **$h_{shift}$ =$h_{nom}$ -($k_{L1a}$ +$k_{L2}$ +$k_{L3}$ +$k_{L4}$ + $k_{L5}$)** | **$h_{shift\text{-}vLR1}$ =$h_{nom}$ -($k_{L1a\text{-}vLR1}$ +$k_{L2}$ +$k_{L3}$ +$k_{L4}$ +$k_{L5}$)** |
|---|---|---|---|---|---|---|---|---|---|---|
| | **[m]** | **[m]** | **[m]** | | [m] | [m] | [m] | [m] | **[m]** | **[m]** |
| aL01 (1.5kV) | **0.240** | **3.986** | **0.000** | D | 0.000 | 0.000 | 0.122 | 0.002 | **3.862** | **3.862** |
| aL02 (1.5kV) | **0.240** | **3.986** | **0.660** | D | 0.000 | 0.000 | 0.122 | 0.002 | **3.862** | **3.862** |

7.2.20.2. Determine for each REP the following values for straight track.

*Note: Blue values are examples for information.*

| **OUTER Relevant Electrical Points REPs, DOWNWARDS shifted, R0(=straight track)** | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_0$ (no value for straight) | $D_{max\ R0}$ | $l_{max\ R0}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP}$ = $h_{shift}$** | $Dpl_{a\ vehicle}$ (not applicable for straight track) | $Dpl_{a\ track}$ | $A_{a\ track}$ | q | $A_{a\ q}$ | $w_{R0}$ | $A_{a\ wR0\ straight}$ | z1 term =[s*$T_D$/L*(($h_{nom}$-$h_c$)$^2$)$^{0.5}$]-[$s_{0random}$*$T_D$/L*(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$)] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}$-$h_c$)$^2$)$^{0.5}$] -[tan$\eta 0_r$ *(1+$s_{0random}$) *(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1a term, if $h_{nom}$>$h_c$: =s*$l_{max\ f(R)}$/L*($h_{nom}$-$h_c$) or if $h_{nom}$=$h_c$: =0.000m or if $h_{nom}$<$h_c$: =s*$D_{max\ f(R)}$/L*(hc-$h_{nom}$) | z3.2a term if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$l_{max(fR)}$/L*($h_{shift}$-$h_{c0}$) or if $h_{shift}$=$h_{c0}$: =0.000m or if $h_{shift}$<$h_{c0}$: =$s_{0\ static}$*$D_{max(fR)}$/L*($h_{c0}$-$h_{shift}$) | $z_a$ =(z1 term) +(z2 term) +(z3.1a term - z3.2a term) | **$Dpl_{a\ straight}$ = $Dpl_{a\ track}$ * $A_{a\ track}$ + q * $A_{a\ q}$ + $w_{R0}$ * $A_{a\ wR0\ straight}$ + $z_a$** | $S_{0a\ geometric}$ (no value for straight track) | $S_{0a\ enlargement}$ (no value for straight track) | **$S_{0a}$ (no value for straight track)** | **$\Delta b_a$= ($b_{RP}$+$S_{0a}$) - ($b_{nom}$ +$Dpl_{a\ straight}$)** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | **[m]** | **[m]** | **[m]** | **[m]** |
| | 0.000 | 0.000 | **1.178** | | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 1.035 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | **0.086** | | | | **1.092** |
| | 0.000 | 0.000 | **1.178** | | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 1.035 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | **0.086** | | | | **0.432** |

7.2.20.3. Determine for each REP the following values for R2000.

*Note: Blue values are examples for information.*

| **OUTER Relevant Electrical Points REPs, DOWNWARDS shifted, R2000** | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{2000}$ | $D_{max\ R2000}$ | $l_{max\ R2000}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP}$ = $h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R2000}$ | $A_{a\ wi\ curve}$ | $w_{a\ R2000}$ | $A_{a\ wa\ curve}$ | z1 term =[s*$T_D$/L*(($h_{nom}$-$h_c$)$^2$)$^{0.5}$]-[$s_{0random}$*$T_D$/L*(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$)] | z2 term ={[(tan $\eta_0$+tan $\alpha_J$) *(1+s) *(($h_{nom}$-$h_c$)$^2$)$^{0.5}$] -[tan$\eta 0_r$ *(1+$s_{0random}$) *(($h_{shift}$-$h_{c0}$)$^2$)$^{0.5}$]}$_{if>0}$ | z3.1a term, if $h_{nom}$>$h_c$: =s*$l_{max\ f(R)}$/L*($h_{nom}$-$h_c$) or if $h_{nom}$=$h_c$: =0.000m or if $h_{nom}$<$h_c$: =s*$D_{max\ f(R)}$/L*(hc-$h_{nom}$) | z3.2a term if $h_{shift}$>$h_{c0}$: =$s_{0\ static}$*$l_{max(fR)}$/L*($h_{shift}$-$h_{c0}$) or if $h_{shift}$=$h_{c0}$: =0.000m or if $h_{shift}$<$h_{c0}$: =$s_{0\ static}$*$D_{max(fR)}$/L*($h_{c0}$-$h_{shift}$) | $z_a$ =(z1 term) +(z2 term) +(z3.1a term -z3.2a term) | **$Dpl_{a\ curve}$ = $Dpl_{a\ vehicle}$ + $Dpl_{a\ track}$ * ($A_{a\ track}$ or $A_{a\ track\ (special)}$) + q * $A_{a\ q}$ + $w_{a\ f(R)}$ * $A_{a\ wa\ curve}$ + $w_{i\ f(R)}$ * $A_{a\ wi\ curve}$ + $z_a$** | $S_{0a\ geometric}$ = 21.440 m² * (1 / R) | $S_{0a\ enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a}$ = $S_{0a\ geometric}$ + $S_{0a\ enlargement}$** | **$\Delta b_a$= ($b_{RP}$+$S_{0a}$) - ($b_{nom}$ +$Dpl_{a\ curve}$)** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | | **[m]** |
| 2000.000 | 0.165 | 0.110 | **1.178** | 0.001 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.142** | 0.011 | 0.000 | **0.011** | **1.047** |
| 2000.000 | 0.165 | 0.110 | **1.178** | 0.001 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.142** | 0.011 | 0.000 | **0.011** | **0.387** |

7.2.20.4. Determine for each REP the following values for R250.4.

*Note: Blue values are examples for information.*

**OUTER Relevant Electrical Points REPs, DOWNWARDS shifted, R250.4**

| $R_{250.4}$ | $D_{max}$ R250.4 | $l_{max}$ R250.4 | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_a$ vehicle | $Dpl_a$ track | $A_a$ track or $A_a$ track (special) | q | $A_{a\,q}$ | $w_i$ R250.4 | $A_{a\,wi}$ curve | $w_a$ R250.4 | $A_{a\,wa}$ curve | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5})]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\,f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\,f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\,static}*l_{max(fR)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\,static}*D_{max(fR)}/L*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term -z3.2a term) | **$Dpl_{a\,curve} = Dpl_{a\,vehicle} + Dpl_{a\,track} * (A_{a\,track}$ or $A_{a\,track\,(special)}) + q * A_{a\,q} + w_{a\,f(R)} * Aa_{wa\,curve} + w_{i\,f(R)} * A_{a\,wi\,curve} + z_a$** | $S_{0a\,geometric}$ = 21.440 m² * (1 / R) | $S_{0a\,enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a} = S_{0a\,geometric} + S_{0a\,enlargement}$** | **$\Delta b_a = (b_{RP}+S_{0a}) - (b_{nom}+Dpl_{a\,curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 250.400 | 0.165 | 0.110 | **1.178** | 0.004 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.145** | 0.086 | 0.000 | **0.086** | **1.118** |
| 250.400 | 0.165 | 0.110 | **1.178** | 0.004 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.145** | 0.086 | 0.000 | **0.086** | **0.458** |

7.2.20.5. Determine for each REP the following values for R150.

*Note: Blue values are examples for information.*

**OUTER Relevant Electrical Points REPs, DOWNWARDS shifted, R150**

| $R_{150}$ | $D_{max}$ R150 | $l_{max}$ R150 | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_a$ vehicle | $Dpl_a$ track | $A_a$ track or $A_a$ track (special) | q | $A_{a\,q}$ | $w_i$ R150 | $A_{a\,wi}$ curve | $w_a$ R150 | $A_{a\,wa}$ curve | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5})]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\,f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\,f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\,static}*l_{max(fR)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\,static}*D_{max(fR)}/L*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term -z3.2a term) | **$Dpl_{a\,curve} = Dpl_{a\,vehicle} + Dpl_{a\,track} * (A_{a\,track}$ or $A_{a\,track\,(special)}) + q * A_{a\,q} + w_{a\,f(R)} * Aa_{wa\,curve} + w_{i\,f(R)} * A_{a\,wi\,curve} + z_a$** | $S_{0a\,geometric}$ = 21.440 m² * (1 / R) | $S_{0a\,enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a} = S_{0a\,geometric} + S_{0a\,enlargement}$** | **$\Delta b_a = (b_{RP}+S_{0a}) - (b_{nom}+Dpl_{a\,curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 150.000 | 0.082 | 0.110 | **1.178** | 0.007 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.148** | 0.143 | 0.000 | **0.143** | **1.173** |
| 150.000 | 0.082 | 0.110 | **1.178** | 0.007 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.148** | 0.143 | 0.000 | **0.143** | **0.513** |

7.2.20.6. Determine for each REP the following values for R80.

*Note: Blue values are examples for information.*

**OUTER Relevant Electrical Points REPs, DOWNWARDS shifted, R80**

| $R_{80}$ | $D_{max}$ R80 | $l_{max}$ R80 | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_a$ vehicle | $Dpl_a$ track | $A_a$ track or $A_a$ track (special) | q | $A_{a\,q}$ | $w_{i\,R80}$ | $A_{a\,wi}$ curve | $w_{a\,R80}$ | $A_{a\,wa}$ curve | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5})]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\,f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\,f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\,static}*l_{max(fR)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\,static}*D_{max(fR)}/L*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term -z3.2a term) | **$Dpl_{a\,curve} = Dpl_{a\,vehicle} + Dpl_{a\,track} * (A_{a\,track}$ or $A_{a\,track\,(special)}) + q * A_{a\,q} + w_{a\,f(R)} * Aa_{wa\,curve} + w_{i\,f(R)} * A_{a\,wi\,curve} + z_a$** | $S_{0a\,geometric}$ = 21.440 m² * (1 / R) | $S_{0a\,enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a} = S_{0a\,geometric} + S_{0a\,enlargement}$** | **$\Delta b_a = (b_{RP}+S_{0a}) - (b_{nom}+Dpl_{a\,curve})$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 80.000 | 0.025 | 0.110 | **1.178** | 0.013 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.154** | 0.268 | 0.088 | **0.356** | **1.380** |
| 80.000 | 0.025 | 0.110 | **1.178** | 0.013 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.154** | 0.268 | 0.088 | **0.356** | **0.720** |

7.2.20.7. Where an additional Relevant Radius $R_{add1}$ is present: Determine for each REP the following values for $R_{add1}$ track radius:

*Note: Blue values are examples for information.*

| OUTER Relevant Electrical Points REPs, DOWNWARDS shifted, Radd1 | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{add1}$ | $D_{max\ Radd1}$ | $l_{max\ Radd1}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ Radd1}$ | $A_{a\ wi\ curve}$ | $w_{a\ Radd1}$ | $A_{a\ wa\ curve}$ | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5})]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\ f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift}>h_{c0}$: $=s_{0\ static}*l_{max(fR)}/L*(h_{shift}-h_{c0})$ or if $h_{shift}=h_{c0}$: =0.000m or if $h_{shift}<h_{c0}$: $=s_{0\ static}*D_{max(fR)}/L*(h_{c0}-h_{shift})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term -z3.2a term) | **$Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track} * (A_{a\ track}$ or $A_{a\ track\ (special)}) + q * A_{a\ q} + w_{a\ f(R)} * Aa_{wa\ curve} + w_{i\ f(R)} * A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric}$ = 21.440 m² * (1 / R) | $S_{0a\ enlargement}$ = (15 m² * (1 / R) – 0.1 m)if>0 | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **$\Delta b_a = (b_{RP}+S_{0a}) - (b_{nom} + Dpl_{a\ curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 80.000 | 0.025 | 0.110 | **1.178** | 0.013 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.154** | 0.268 | 0.088 | **0.356** | **1.380** |
| 80.000 | 0.025 | 0.110 | **1.178** | 0.013 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.000 | 0.000 | 0.055 | 0.000 | 0.055 | **0.154** | 0.268 | 0.088 | **0.356** | **0.720** |

7.2.20.8. Determine for each REP the following values for R98-vLR1 track radius:

*Note: Blue values are examples for information.*

vLR1 is not present at IRL2 and shall accordingly not be calculated for IRL2.

| only applicable for IRL1+1D+1F: OUTER Relevant Electrical Points REPs, DOWNWARDS shifted, R98 vLR1 | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{98-vLR1}$ | $D_{max\ R98-vLR1}$ | $l_{max\ R98-vLR1}$ | **$b_{RP}$ =1/2 width of Reference Profile at $h_{RP} = h_{shift-vLR1}$** | $Dpl_{a\ vehicle}$ | $Dpl_{a\ track-vLR1}$ | $A_{a\ track}$ or $A_{a\ track\ (special)}$ | q | $A_{a\ q}$ | $w_{i\ R98-vLR1}$ | $A_{a\ wi\ curve}$ | $w_{a\ R98-vLR1}$ | $A_{a\ wa\ curve}$ | z1 term $=[s*T_D/L*((h_{nom}-h_c)^2)^{0.5})]-[s_{0random}*T_D/L*((h_{shift}-h_{c0})^2)^{0.5})]$ | z2 term $=\{[(\tan\eta_0+\tan\alpha_J)*(1+s)*((h_{nom}-h_c)^2)^{0.5}]-[\tan\eta 0_r*(1+s_{0random})*((h_{shift}-h_{c0})^2)^{0.5}]\}_{if>0}$ | z3.1a term, if $h_{nom}>h_c$: $=s*l_{max\ f(R)}/L*(h_{nom}-h_c)$ or if $h_{nom}=h_c$: =0.000m or if $h_{nom}<h_c$: $=s*D_{max\ f(R)}/L*(hc-h_{nom})$ | z3.2a term if $h_{shift-vLR1}>h_{c0}$: $= s_{0\ static} * l_{max\ f(R)} / L * (h_{shift-vLR1} – h_{c0})$ or if $h_{shift-vLR1}$ = hc0: = 0.000 m or if $h_{shift-vLR1}<h_{c0}$: $= s_{0\ static} * D_{max\ f(R)} / L * (h_{c0}– h_{shift-vLR1})$ | $z_a$ =(z1 term) +(z2 term) +(z3.1a term -z3.2a term) | **ONLY for vLR1: $Dpl_{a\ curve} = Dpl_{a\ vehicle} + Dpl_{a\ track-vLR1} * (A_{a\ track}$ or $A_{a\ track\ (special)}) + q * A_{a\ q} + w_{a\ f(R)} * A_{a\ wa\ curve} + w_{i\ f(R)} * A_{a\ wi\ curve} + z_a$** | $S_{0a\ geometric}$ = 21.440 m² * (1 / R) | $S_{0a\ enlargement}$ = (15 m² * (1 / R) – 0.1 m)$_{if>0}$ | **$S_{0a} = S_{0a\ geometric} + S_{0a\ enlargement}$** | **ONLY for gauges IRL1/1D/1F $\Delta ba = (b_{RP}+S_{0a}) - (b_{nom} + Dpla_{curve})$** |
| [m] | [m] | [m] | **[m]** | [m] | [m] | | [m] | | [m] | | [m] | | [m] | [m] | [m] | [m] | [m] | **[m]** | [m] | [m] | **[m]** | **[m]** |
| 98.000 | 0.010 | 0.034 | **1.178** | 0.010 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.000 | 0.000 | 0.017 | 0.000 | 0.017 | **0.114** | 0.219 | 0.053 | **0.272** | **1.336** |
| 98.000 | 0.010 | 0.034 | **1.178** | 0.010 | 0.029 | 1.035 | 0.005 | 1.035 | 0.050 | 0.018 | 0.050 | 1.018 | 0.000 | 0.000 | 0.017 | 0.000 | 0.017 | **0.114** | 0.219 | 0.053 | **0.272** | **0.676** |

7.2.20.9. Determine from all resulting $\Delta b_a$ values of this set of gauging calculations the smallest value for each REP.

*Note: Blue value is an example for information.*

| **$\Delta b_a$ min across all calculations of this set** |
|---|
| **[m]** |
| **1.047** |
| **0.387** |

+ A positive value or 0.000m indicates that the vehicle design is compatible with the selected gauge(s)

- A negative value indicates that the vehicle design is not compatible with the selected gauge(s)

7.2.21. **Step 13 – Identify for each Relevant Point, if it fulfils the selected Gauge**

7.2.21.1. Determine and report for each RMP, RPP, REP the smallest $\Delta b_x$ value from the calculation Sets1 to 10. These shall be documented in a Gauging Report by the Design Team.

*Note: Blue values are examples for information.*

| INNER RMPs | | | | |
|---|---|---|---|---|
| Point ID | $n_i$ | $h_{nom}$ | $b_{nom}$ | $\Delta b_i$ min across all calculations of sets 1 and 2 |
| | [m] | [m] | [m] | [m] |
| iA | 2.070 | 4.022 | 0.000 | 0.732 |
| iB | 2.070 | 4.022 | 0.727 | 0.005 |

| OUTER RMPs | | | | |
|---|---|---|---|---|
| Point ID | $n_a$ | $h_{nom}$ | $b_{nom}$ | $\Delta b_a$ min across all calculations of sets 3 and 4 |
| | [m] | [m] | [m] | [m] |
| aA | 2.500 | 3.970 | 0.000 | 0.835 |
| aB | 2.500 | 3.970 | 0.155 | 0.680 |

| INNER RPPs | | | | |
|---|---|---|---|---|
| Point ID | $n_i$ | $Pxxh_{shift}$ | $Pb_{nom}$ | $\Delta b_i$ min across all calculations of set 5 |
| | [m] | [m] | [m] | [m] |
| iRPP1 (1.5kV) | 0.290 | 5.786 | 0.650 | 0.082 |
| iRPP2 (1.5kV) | 0.290 | 5.594 | 0.900 | 0.004 |

| OUTER RPPs | | | | |
|---|---|---|---|---|
| Point ID | $n_a$ | $Pxxh_{shift}$ | $Pb_{nom}$ | $\Delta b_a$ min across all calculations of set 6 |
| | [m] | [m] | [m] | [m] |
| aRPP1 (1.5kV) | 0.240 | 5.786 | 0.650 | 0.118 |
| aRPP2 (1.5kV) | 0.240 | 5.594 | 0.900 | 0.039 |

| INNER REPs | | | | |
|---|---|---|---|---|
| Point ID | $n_i$ | $h_{nom}$ | $b_{nom}$ | $\Delta b_i$ min across all calculations of sets 7 and 8 |
| | [m] | [m] | [m] | [m] |
| iL01 (1.5kV) | 0.290 | 3.986 | 0.000 | 0.745 |
| iL02 (1.5kV) | 0.290 | 3.986 | 0.660 | 0.085 |

| OUTER REPs | | | | |
|---|---|---|---|---|
| Point ID | $n_a$ | $h_{nom}$ | $b_{nom}$ | $\Delta b_a$ min across all calculations of sets 9 and 10 |
| | [m] | [m] | [m] | [m] |
| aL01 (1.5kV) | 0.240 | 3.986 | 0.000 | 0.770 |
| aL02 (1.5kV) | 0.240 | 3.986 | 0.660 | 0.110 |

7.2.21.2. Determine, if within any of the Sets1 to 4 any RMPs were present in the WHEEL ZONE and evaluate if all of these RMPs fulfil the associated requirements defined for the selected RP-M in section 6.

7.2.22. **Step 14 - Prepare the Gauging Report**

7.2.22.1. The detailed input data, calculations and results of the Steps 1 to 13 shall be documented in a Gauging Report by the Design Team.

7.2.22.2. The supporting evidence shall be attached to the Gauging Report.

7.2.22.3. The Design Team members which have prepared the Gauging Report shall be identified in the Gauging Report and shall sign the report to confirm the correctness of its content.

7.2.22.4. **Any gauging calculation** for an individual vehicle design shall be validated by using an **independent second gauging calculation**.

*Note: The gauging calculation of a Vehicle design is a safety related activity, as:*

- *An incorrect calculation has the potential that Vehicle parts could at high operating speed hit other Vehicles or fixed installations. The resulting debris has a potential to cause serious injuries.*
- *The gauging calculation itself is complex and is depending on the correct processing of a large number of input values using many connected formulae.*
- *Incorrect calculation results may not in all cases be directly obvious to the Design Team or to reviewers. Such incorrect values may only reveal themselves in specific situations of Vehicle and Fixed Installation wear and under specific operational circumstances a long time after the Vehicle commenced operation on the Network.*
- *Depending on the individual Vehicle design, only a sub-set of all calculation formulae may be applied. Each calculation for a relevant point on a vehicle design will employ slightly different combinations of parameters and formulae. It is thus not practical to perform a complete black box testing of a gauge calculation tool across all possible input combinations.*

*It is in this situation good industry practice (based on concepts embedded in ISO 9001, ISO 17020, EN50126-1, (EU) 402/2013) that software tools which are employed for determining dependable safety related gauging calculation results need to be validated!*

An acceptable form of validation is to compare the results of two different calculation tools, as long as these tools have been developed by two different persons/teams. Such an independent development shall ensure with a very high probability that no common cause failures are present between these two different calculation tools.

7.2.22.5. The independent provenance of the first and second calculation tools shall be explained in the Gauging Report in a level of detail that permits to understand that both calculation tools can be used for cross-validation.

7.2.22.6. The result of the validation shall be explained in the Gauging Report.

7.2.23. **Step 15 - Prepare an Independent Gauging Report**

7.2.23.1. The following aspects shall be **inspected and confirmed** by a person/ team that is independent from the Design Team and that is competent to apply all requirements of this IRS:

a) The preparation of a complete Gauging Report by the Design Team.

b) The complete and correct selection of all gauging data input elements of Input Data Sets A+B.

c) IF it was necessary to also define an Input Data Set C: The complete and correct identification and the correct adjustment of all gauging data input elements of set C

d) The complete and correct selection of all Relevant Points RMP, REP, RPP

e) The correct selection of the second calculation tool for validation of the results of the first calculation tool.

f) The complete and positive result of the validation.

7.2.24. To claim a positive validation result:

a) Both tools shall indicate that all Relevant Points are compatible with the selected Gauge,

AND

b) The differences in results between these two calculations shall be less than 2mm for each individual $\Delta b_a$ or $\Delta b_i$ value.

c) The independent provenance of the first and second calculation tool and the coherence of the results shall be documented in the Gauging Review Report.

d) Where a Notified Body (NoBo) or an IE Designated Body (IE-DeBo) / Independent Professional Reviewer (for IPR refer to CRR-G-009) shall inspect conformity of a vehicle design against this IRS, an inspector or lead inspector of the NoBo / IE DeBo / IPR that is independent from the vehicle design team and that is competent to apply all requirements of this IRS may perform this gauging review and prepare the Gauging Review report.

e) The persons which have prepared the Gauging Review Report shall be identified in the Gauging Review Report and by signing the report confirm the correctness of its content.

# 8. Signs on Vehicles related to gauging

## 8.1. 'Gauge Marking' signs on Vehicles

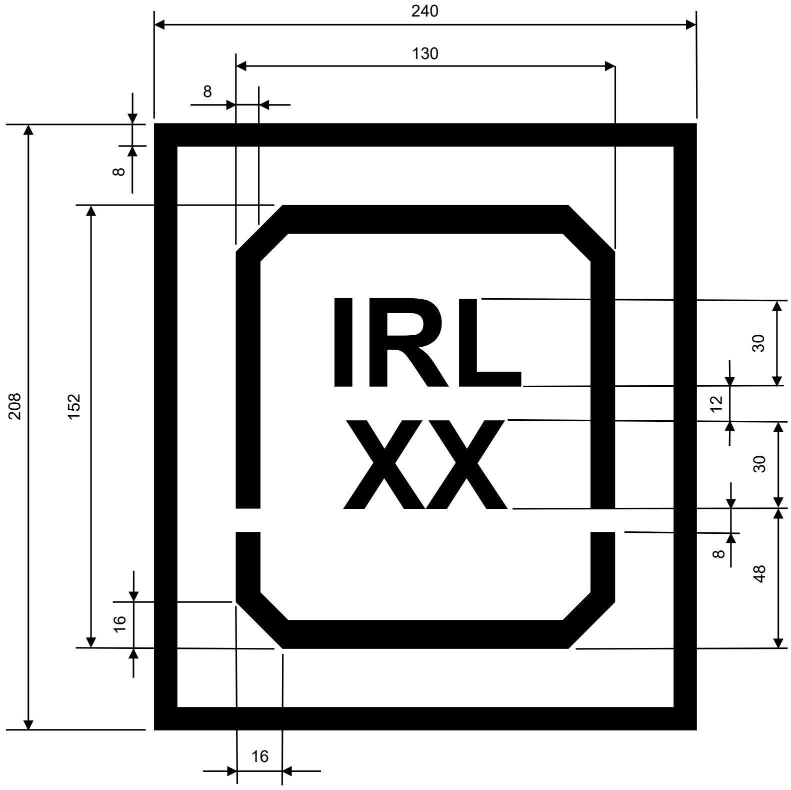
*Note: The standards of the EN 15877series define requirements for the 'Gauge Marking' sign on Vehicles which are compatible with the Gauges G1 or GA or GB or GC or other Gauges that are included in EN 15273-2.*

*These standards are not compatible with the Gauges defined in this IRS and the contained definitions for the 'Gauge Marking' of Vehicles are therefore not applicable to the Gauges defined in this IRS.*

The following definitions shall apply for the 'Gauge Marking' sign on Vehicles that are compatible with the Gauges of this IRS.

The following definitions shall also apply instead to the 'Gauge Marking' as defined in EN 15877series, whenever these standards are referred to or where their application is mandated.

### 8.1.1. Layout of the 'Gauge Marking' sign:




The term "XX" shall be replaced with the relevant IRL-Gauge denomination (i.e. 1 / 1D / 1F / 2).

### 8.1.2. Application on Vehicles

The application on Vehicles that are compatible with IRL1 is optional.

The application on Vehicles that are NOT compatible with IRL1 (i.e. where the vehicle design requires IRL1D, IRL1F or IRL2 to operate) is recommended.

Where these markings are applied, one marking shall be applied on or near the solebar at each longitudinal side of a Vehicle.

At fixed formations it is sufficient to apply the marking at the end-vehicles.

### 8.2. ‘MINIMUM RADIUS HORIZONTAL CURVE’ sign on Vehicles

Where $R_{min\ vehicle}$ > 80 m, the related signs ‘MINIMUM RADIUS HORIZONTAL CURVE’ according to the EN15877series shall be applied on or near the solebar to each longitudinal side of the vehicle.

## 9. Further Clarification

Further clarification on this IRS can be sought from the CRR by email: info@crr.ie.

## 10. List of Participants

The participants for each revision of this IRS are shown in the table below.

*Table 2 List of Participants by Revision*

| Participant Name and Organisation | | Involved in IRS-401-A | | |
|---|---|---|---|---|
| Maik Wuttke | CRR | ✓ | | |
| Lisa Di Vicino | CRR | ✓ | | |
| Gavin Duffy | IÉ-RU | ✓ | | |
| Nick West | IÉ-IM | ✓ | | |
| Niall McNamara | IÉ-IM | ✓ | | |