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2nd edition, January 2008

Translation

OR

Rules governing application of the enlarged GA, GB, GB1, GB2, GC and GI3 gauges

Règles pour l'application des gabarits agrandis GA, GB, GB1, GB2, GC et GI3
Regeln für die Anwendung der erweiterten Begrenzungslinien GA, GB, GB1, GB2, GC und GI3

UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

Leaflet to be classified in Volume :

V - Transport stock

Application :

With effect from 1 January 2008
All members of the International Union of Railways

This leaflet applies to standard gauge lines

Record of updates

1st edition, January 1987	Initial version
2nd edition, January 2008	Overhaul of leaflet. New GI3 gauge, amended GB2 gauge. New point 5.3.

The person responsible for this leaflet is named in the UIC Code

Contents

Summary **1**

1 - General **2**

2 - Scope of application **3**

3 - GA, GB and GC static gauges (Loading gauges) **4**

3.1 - Reference profiles 4

3.2 - Rules for static reference profiles 5

4 - GA, GB and GC kinematic gauges **7**

4.1 - Reference profiles 7

4.2 - Rules associated with the kinematic reference profiles for calculating the maximum vehicle profile 8

5 - GA, GB and GC structure gauges and centre-to-centre distances between tracks **20**

5.1 - Structure gauges 20

5.2 - Centre-to-centre distance between tracks 21

5.3 - GC gauge for nominal positioning of obstructions for the high speed interoperable network 21

6 - GI3 kinematic gauge **23**

6.1 - Reference profile 23

6.2 - Rules associated with the kinematic reference profile for determining the maximum vehicle profile 24

6.3 - GI3 structure gauge 32

Appendix A - GC gauge - Examples of structure gauge and centre-to-centre calculations **33**

Appendix B - Remarks **39**

Appendix C - Hypothetical bases for bi- or multi-lateral agreements covering application of GB1 and GB2 enlarged gauges **47**

Bibliography **55**

Summary

By comparison with *UIC Leaflet 505-1 and 505-4*, this leaflet defines the rules for gauges GA, GB, GC, GB1 and GB2 which are larger in the upper part and gauge GI3 which is larger in the lower part.

For each gauge this leaflet enables:

- maximum construction gauges for rolling stock to be determined,

- the examination of the structure gauges and track centre distances which must be achieved and maintained.

1 - General

By comparison with the gauge common to *UIC Leaflet 505-1 and 505-4* (see Bibliography - page 55), GA, GB and GC vehicle gauges are larger in the upper part and consequently correspond to the application principles set out in point 2 - page 3.

Since GA, GB and GC vehicle gauges were designed initially to meet loading needs by derogation from *UIC Leaflet 505-1*, the present leaflet first of all defines the rules for static gauges.

NB : The standard loads used for defining GA, GB and GC gauges are given in Appendix B - page 39.

To enable rail vehicles built to the GA, GB and GC enlarged gauges, the leaflet also defines the corresponding kinematic gauges in the same way as in *UIC Leaflet 505-1*.

Loads and vehicles conforming to the GA, GB and GC enlarged gauges shall only be allowed on lines widened to these gauges. The lines concerned are listed in *RIV, Annex 2* (see Bibliography - page 55). Train movements on lines not listed in this Annex shall be treated as special traffic.

Wagons and coaches built to the GA, GB and GC gauges shall be identified by a marking as provided for in the *CUU* (see Bibliography - page 55) and *RIC*.

By comparison with the gauge common to *UIC Leaflet 505-1 and 505-4*, gauge GI3 is larger in the upper part.

Gauge GI3 has been included in the present leaflet on account of its non-obligatory status.

Gauge GI3 was initially defined to enable optimum use to be made of infrastructure, in conjunction with gauge GB1, to enable the transport of semi-trailers on well wagons derogating from the gauge in *UIC Leaflet 505-1*. However, it can be used in conjunction with all other gauges.

Vehicles conforming to the enlarged GI3 gauge shall only be allowed on lines whose lower parts have been enlarged accordingly; routing of such vehicles calls for bi- or multi-lateral agreements.

Vehicles built to gauge GI3 cannot bear the *CUU* or *RIC* markings.

2 - Scope of application

The GA gauge may be implemented in the more or less long term on all railway lines.

The GB gauge, which incorporates the GA gauge, is relevant for short or medium-term projects involving a maximum number of lines in order to develop a cohesive network over a relatively extensive area.

The GC gauge, which incorporates the GA and GB gauges, is relevant for new lines and major rebuilding projects (for example: tunnels) on specially-targeted existing lines.

For the GA and GB gauges, a transitional phase may be allowed during which the standard loads defined in Appendix B - page 39 may be routed under the responsibility of the railway concerned, which should then ascertain, through appropriate calculations, that there exists maximum structure clearance.

NB : Lines accepting such loads may be called GAO and GBO.

The GI3 gauge may be used on existing or future lines. It can be achieved at a lower cost than the gauges for lower parts defined in *UIC Leaflet 505-4* since it primarily encounters occasional obstructions without consequence for larger obstacles such as platforms and structures.

The GB1 and GB2 gauges shown in Appendix C - page 47 are options that involve the upgrading of specific lines when the GB gauge is not appropriate. The GB2 gauge incorporates the GB1 gauge, which in turn incorporates the GB gauge.

3 - GA, GB and GC static gauges (Loading gauges)

3.1 - Reference profiles

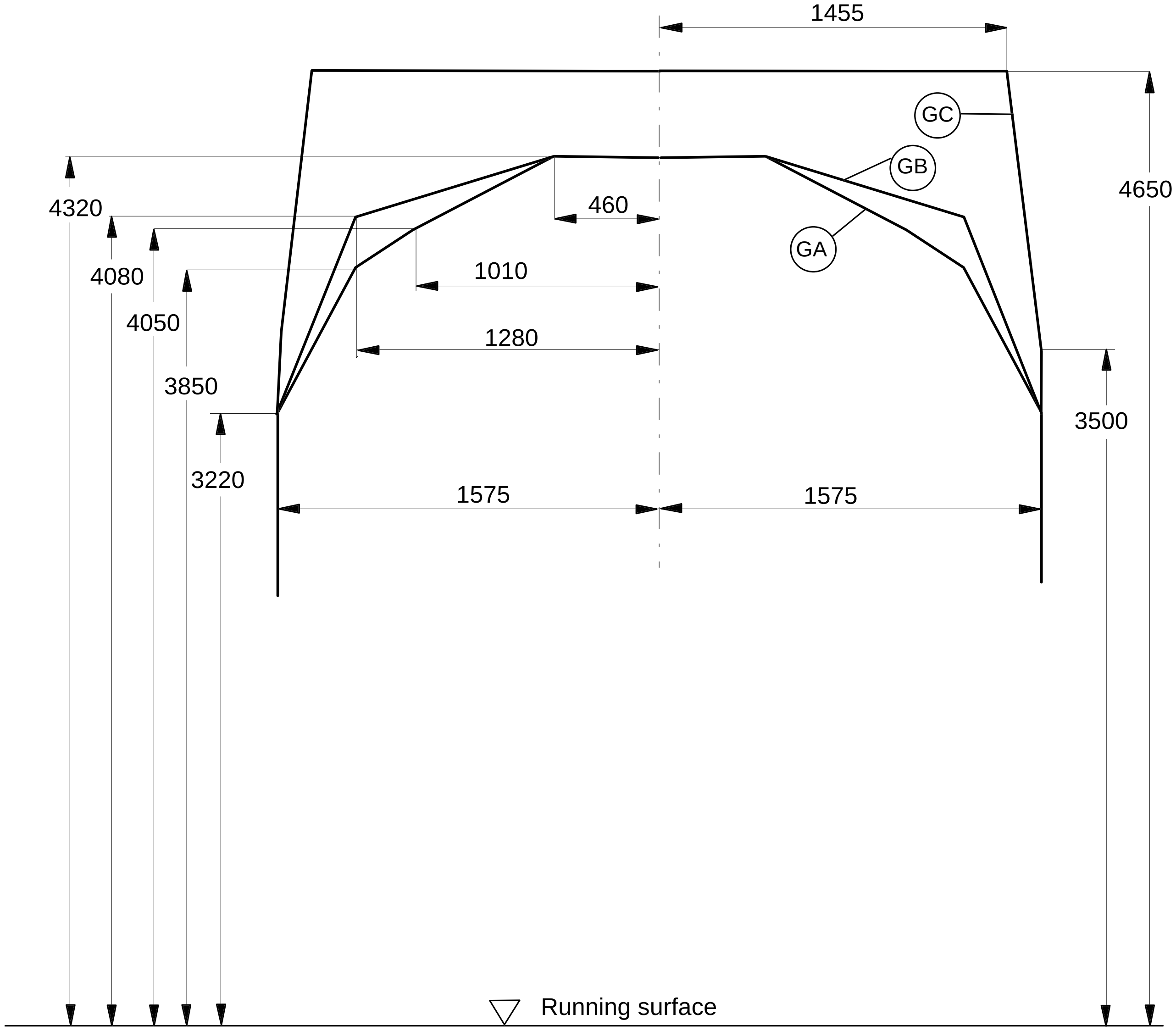

Fig. 1 - Reference profile

NB : Up to a height of 3 220 mm, the static reference profile of the GA, GB and GC gauges is identical to that of the static gauge G1 in *UIC Leaflet 505-5*.

3.2 - Rules for static reference profiles

These rules are applicable solely for calculating maximum load profile. They shall be valid only in cases where the coefficient of flexibility of the wagon + load combination is not greater than that of the standard loads shown in point B.1 - page 39.

The rules for the kinematic calculations, arising from point 4.2.4 - page 17 may be applied to clearly-defined loads.

The term "clearly-defined loads" in this context shall be understood to mean transferrable unit loads with known geometric parameters, for example containers and swap bodies loaded on carrier wagons fitted with load positioning and securing devices, and semi-trailers with deflated air suspension or mechanical suspension (with a known roll flexibility coefficient[1]) conveyed on recess wagons.

Under these conditions, the wagon + load combination can be treated as a normal single wagon.

To allow for tolerances on centring, the half-widths should be at most equal to those of the reference profiles shown in Fig. 1 - page 4 reduced by the following values of E_i and E_a.

3.2.1 - GA and GB static gauges

- **Height h ≤ 3,22 m**. The formulae applicable are those relating to the static gauge (see *UIC Leaflet 505-5*, *Appendix H*).

- **Height h > 3,22 m**. The formulae applicable are as set out below[2]:

1. *For the sections between bogie pivots or between end-axles of vehicles not mounted on bogies*

   - Where:

$$\left(an - n^2 + \frac{p^2}{4}\right) \leq 7,5 + 32,5k \qquad \Delta_i = 7,5 + 32,5k$$

   - Where:

$$\left(an - n^2 + \frac{p^2}{4}\right) > 7,5 + 32,5k \qquad \Delta_i = an - n^2 + \frac{p^2}{4}$$

$$E_i = \left[\frac{\Delta_i}{500} + \frac{1,465 - d}{2} + q + w + [x_i]_{>0} - 0,075 - 0,065k\right]_{>0} \qquad (601)$$

with:

$$x_i = \frac{1}{750}\left(an - n^2 + \frac{p^2}{4} - 100\right) \;;$$

k (see Table 1 - page 6)

1. These provisions do not affect characteristics of wagons of UIC Leaflet 596-6.
2. With the exception of k, the symbols used are those already applied in UIC Leaflet 505-1.

2. *For sections beyond bogie pivots or end-axles of vehicles not mounted on bogies*

- Where:

$$\left(an + n^2 - \frac{p^2}{4}\right) \leq 7,5 + 32,5k, \qquad \Delta_a = 7,5 + 32,5k$$

- Where:

$$\left(an + n^2 - \frac{p^2}{4}\right) > 7,5 + 32,5k, \qquad \Delta_a = an + n^2 - \frac{p^2}{4}$$

$$E_a = \left[\frac{\Delta_a}{500} + \left(\frac{1,465 - d}{2} + q + w\right)\frac{2n + a}{a} + [x_a]_{>0} - 0,075 - 0,065\,k\right]_{>0} \qquad (602)$$

with:

$$x_a = \frac{1}{750}\left(an + n^2 - \frac{p^2}{4} - 100\right) \;;$$

k (see Table 1)

Table 1 :

GA gauge	GB gauge
Where 3,22 < h < 3,85 m, $k = \frac{h - 3,22}{0,63}$	Where 3,22 < h <4,08 m, $k = \frac{h - 3,22}{0,86}$
Where h ≥ 3,85 m, k = 1	Where h ≥ 4,08 m, k = 1

NB : Explanations justifying the reduction formulae and k are given in Appendix B - page 39.

3.2.2 - GC static gauge

The reduction formulae applicable are those valid for the *UIC Leaflet 505-5* static gauge.

4 - GA, GB and GC kinematic gauges

4.1 - Reference profiles

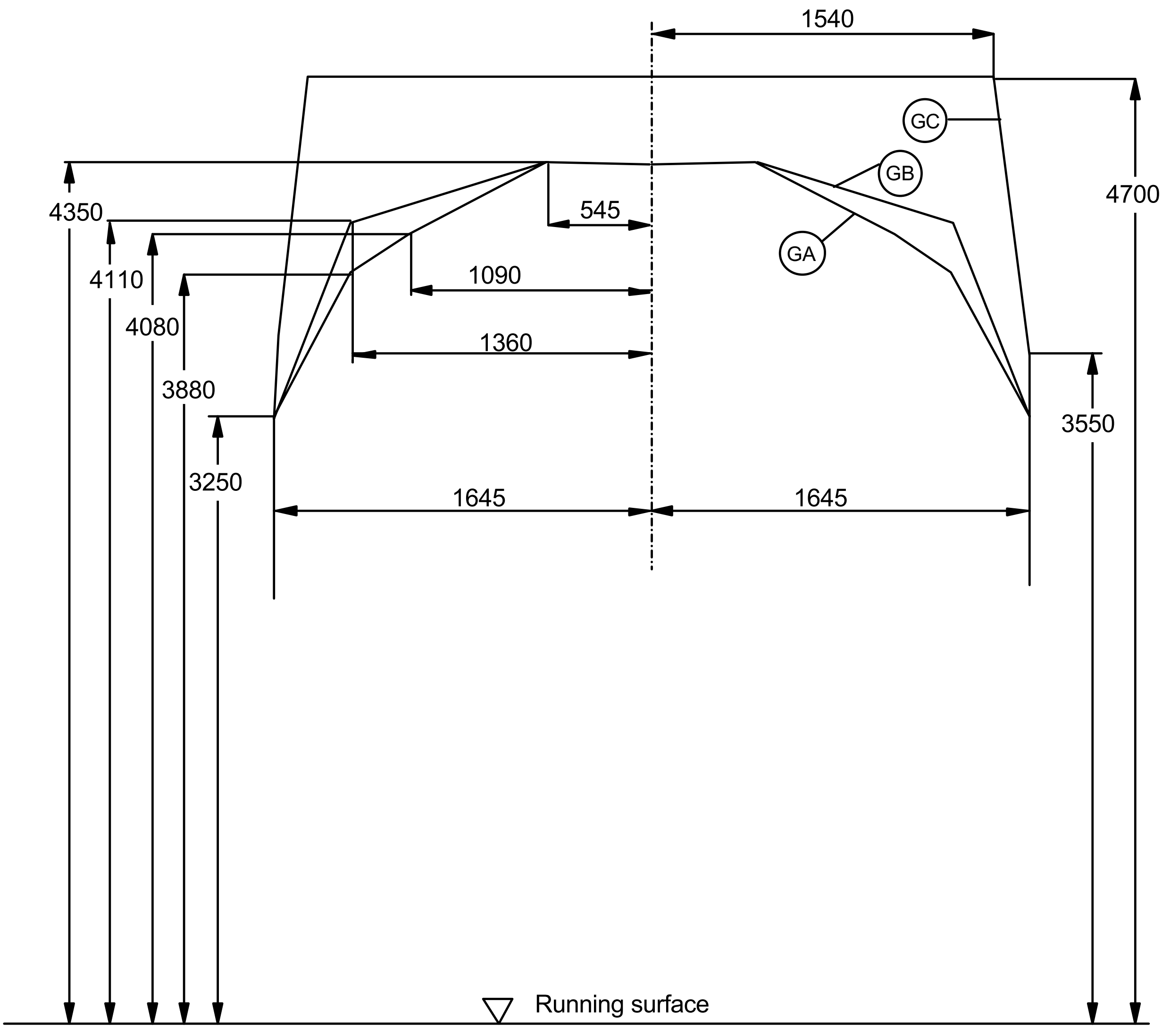

Fig. 2 - Reference profile

NB : For heights between 400 and 3 250 mm, the reference profile of GA, GB and GC gauges is identical to that given in *UIC Leaflet 505-1 and 505-4*.
For heights ≤ 0,4 m, the reference profile is that associated with the gauge applicable to lower parts.

4.2 - Rules associated with the kinematic reference profiles for calculating the maximum vehicle profile

4.2.1 - Tractive units (except railcars)

4.2.1.1 - GA and GB kinematic gauges

- **Height h ≤ 0,4 m**. The rules applicable are those associated with the gauge for lower parts.
- **Height 0,4 < h ≤ 3,25 m**. The rules applicable are those given in *UIC Leaflet 505-1*.
- **Height h > 3,25 m**. The rules applicable are those given in *UIC Leaflet 505-1*, with the exception of the following formulae[1]:

4.2.1.1.1 - Vehicles for which play w is independent of the curve radius or varies in linear fashion by reference to the curvature

1. *For sections between bogie pivots or between end-axles of vehicles not mounted on bogies*

- Where: $an - n^2 + \frac{p^2}{4} - 500(w_\infty - w_{i(250)}) \leq 7,5 + 32,5k$

$$E_i = \frac{1,465 - d}{2} + q + w_\infty + z - 0,015 \qquad (603)$$

- Where: $an - n^2 + \frac{p^2}{4} - 500(w_\infty - w_{i(250)}) > 7,5 + 32,5k$

$$E_i = \frac{an - n^2 + \frac{p^2}{4}}{500} + \frac{1,465 - d}{2} + q + w_{i(250)} + z + [x_i]_{>0} - 0,030 - 0,065k \qquad (604)$$

with:

$$x_i = \frac{1}{750}\left(an - n^2 + \frac{p^2}{4} - 100\right) + w_{i(150)} - w_{i(250)}$$

k and z (see Table 2 - page 11)

1. With the exception of k, the symbols used are those applied in UIC Leaflet 505-1.

2. *For sections beyond bogie pivots or end-axles of vehicles not mounted on bogies*

- Where:

$$an + n^2 - \frac{p^2}{4} - 500\left[(w_\infty - w_{i(250)})\frac{n}{a} + (w_\infty - w_{i(250)})\frac{n+a}{a}\right] \leq 7,5 + 32,5k$$

$$E_a = \left(\frac{1,465 - d}{2} + q + w_\infty\right)\frac{2n+a}{a} + z - 0,015 \qquad (605)$$

- Where:

$$an + n^2 - \frac{p^2}{4} - 500\left[(w_\infty - w_{i(250)})\frac{n}{a} + (w_\infty - w_{i(250)})\frac{n+a}{a}\right] > 7,5 + 32,5k$$

$$E_a = \frac{an + n^2 - \frac{p^2}{4}}{500} + \left(\frac{1,465 - d}{2} + q\right)\frac{2n+a}{a} + w_{i(250)}\frac{n}{a} + w_{a(250)}\frac{n+a}{a} + z + [x_a]_{>0} - 0,030 - 0,065k \qquad (606)$$

with: $$x_a = \frac{1}{750}\left(an + n^2 - \frac{p^2}{4} - (120 - 20k)\right) + (w_{i(150)} - w_{i(250)})\frac{n}{a} + (w_{a(150)} - w_{a(250)})\frac{n+a}{a}$$

k and z (see Table 2 - page 11)

4.2.1.1.2 - Vehicles for which play w varies in non-linear fashion by reference to the curvature

1. *For sections between bogie pivots or end-axles of vehicles not mounted on bogies*

   For each point on the vehicle, the value of E_i to be taken is the highest obtained from application of:

   - formula (603) above,
   - formulae (607) and (608) below in which the value of R to be taken maximises the portion between coupling hooks.

$$E_i = \left[\frac{an - n^2 + \frac{p^2}{4} - (7,5 + 32,5k)}{2R} + w_{i(R)}\right] + \frac{1,465 - d}{2} + q + z - 0,015 \qquad (607)$$

with: $\infty > R \geq 250$ m

$$E_i = \left[\frac{an - n^2 + \frac{p^2}{4} - 100}{2R} + w_{i(R)}\right] + \frac{1,465 - d}{2} + q + z - 0,170 - 0,065k \qquad (608)$$

with: $250 > R \geq 150$ m

k and z (see Table 2 - page 11)

2. *For sections beyond bogie pivots or end-axles of vehicles not mounted on bogies*

   For each point on the vehicle, the value of E_a to be taken is the highest obtained from application of:

   - formula (605) above,
   - formulae (609) and (610) below in which the value of R to be taken maximises the portion between coupling hooks.

   for: $\infty > R \geq 250$ m

$$E_a = \left[\frac{an + n^2 - \frac{p^2}{4} - (7,5 + 32,5k)}{2R} + w_{i(R)}\frac{n}{a} + w_{a(R)}\frac{n+a}{a}\right] + \left(\frac{1,465 - d}{2} + q\right)\frac{2n+a}{a} + z - 0,015 \qquad (609)$$

for: $250 > R \geq 150$ m

$$E_a = \left[\frac{an + n^2 - \frac{p^2}{4} - (120 - 20k)}{2R} + w_{i(R)}\frac{n}{a} + w_{a(R)}\frac{n+a}{a}\right] + \left(\frac{1,465 - d}{2} + q\right)\frac{2n+a}{a} + z + 0,210 - 0,105k \qquad (610)$$

k and z (see Table 2)

Table 2 :

GA gauge	GB gauge
Where 3,25 < h < 3,88 m, $k = \frac{h - 3,25}{0,63}$ Where h ≥ 3,88 m, k = 1	Where 3,25 < h < 4,11 m, $k = \frac{h - 3,25}{0,86}$ Where h ≥ 4,11 m, k = 1
$z = \left[\frac{s}{30} + \tan(\eta_0 - 1°)_{>0}\right](h - h_c) + \left[\frac{s}{10}(h - h_c) - (0,04 - 0,01k)(h - 0,5)\right]_{>0}$	

NB : Explanations justifying reduction formulae and k are given in Appendix B - page 39.

4.2.1.2 - GC kinematic gauge

- **Height h ≤ 0,4 m**. The rules applicable are those associated with the gauge for lower parts.
- **Height > 0,4 m**. The rules applicable are those given in *UIC Leaflet 505-1*, irrespective of the value of height h.

4.2.2 - Railcars

NB : The gauge characteristics of railcars, whose bogies can be considered to be motor or carrying bogies, are described in *UIC Leaflet 505-1*.

4.2.2.1 - GA and GB kinematic gauges

- **Height h ≤ 0,4 m**. The rules applicable are those associated with the gauge for lower parts.
- **Height 0,4 < h ≤ 3, 25 m**. The rules applicable are those given in *UIC Leaflet 505-1*.
- **Height h > 3,25 m**. The rules applicable are those given in *UIC Leaflet 505-1* with the exception of the following formulae[1]:
  - railcars all with motor bogies: the formulae are those given in point 4.2.1.1 - page 8 (Power cars);
  - railcars all with carrying bogies: the formulae are those given in point 4.2.3.1 - page 13 (Coaches and vans);
  - railcars with motor bogie and carrying bogie: the reduction formulae given in point 4.2.1.1 - page 8 may either be applied as they stand, or replaced with the following formulae which offer manufacturers a slight advantage in the centre-part and at the ends of the vehicle body.

1. With the exception of k, the symbols used are those applied in UIC Leaflet 505-1.

1. *Between pivots* [1] *:*

$$E_i = \frac{1,465 - d}{2} + q + w_\infty \frac{a - n_\mu}{a} + w'_\infty \frac{n_\mu}{a} + z - 0,015 \qquad (603a)$$

$$E_i = \frac{an_\mu - n_\mu^2 + \frac{p^2}{4}\frac{a - n_\mu}{a} + \frac{p'^2}{4}\frac{n_\mu}{a}}{500} + \frac{1,465 - d}{2} \cdot \frac{a - n_\mu}{a} + q + w_{i(250)}\frac{a - n_\mu}{a} + w'_{i(250)}\frac{n_\mu}{a} + z + [x_i]_{>0} - 0,015 - 0,015\frac{a - n_\mu}{a} - 0,065k \qquad (604a)$$

with: $$x_i = \frac{1}{750}\left(an_\mu - n_\mu^2 + \frac{p^2}{4} \cdot \frac{a - n_\mu}{a} + \frac{p'^2}{4} \cdot \frac{n_\mu}{a} - 100\right) + (w_{i(150)} - w_{i(250)})\frac{a - n_\mu}{a} + (w'_{i(250)} - w'_{i(150)})\frac{n_\mu}{a}$$

k and z (see Table 2 - page 11)

2. *Beyond pivots on motor-bogie side* [2]

$$E_a = \left(\frac{1,465 - d}{2} + q + w_\infty\right)\frac{2n + a}{a} + z - 0,015 \qquad (605b)$$

$$E_a = \frac{an + n^2 - \frac{p^2}{4} \cdot \frac{n + a}{a} + \frac{p'^2}{4} \cdot \frac{n}{a}}{500} + \frac{1,465 - d}{2} \cdot \frac{n + a}{a} + q \cdot \frac{2n + a}{a} + w'_{i(250)}\frac{n}{a} + w_{a(250)}\frac{n + a}{a} + z + [x_a]_{>0} - 0,030 - 0,065k \qquad (606b)$$

with: $$x_a = \frac{1}{750}\left(an + n^2 - \frac{p^2}{4}\frac{n + a}{a} + \frac{p'^2}{4}\frac{n}{a} - (120 - 20k)\right) + (w'_{i(150)} - w'_{i(250)})\frac{n}{a} + (w_{a(150)} - w_{a(250)})\frac{n + a}{a}$$

k and z (see Table 2 - page 11)

1. The reduction applicable for the same value of n is the highest obtained with formulae (603a) and (604a).
2. The reduction applicable for the same value of n is the highest obtained with formulae (605b) and (606b).

3. *Beyond pivots on carrying-bogie side*[1]

$$E_a = \left(\frac{1,465 - d}{2} + q\right)\frac{2n + a}{a} + w_{\infty}\frac{n}{a} + w'_{\infty}\frac{n + a}{a} + z - 0,015 \qquad (605c)$$

$$E_a = \frac{an + n^2 + \frac{p^2}{4} \cdot \frac{n}{a} - \frac{p'^2}{4} \cdot \frac{n + a}{a}}{500} + \left(\frac{1,465 - d}{2} + q\right) \cdot \frac{2n + a}{a} + w_{i(250)}\frac{n}{a} + w'_{a(250)}\frac{n + a}{a} + z + [x_a]_{>0} - 0,030 - 0,065k \qquad (606c)$$

with: $$x_a = \frac{1}{750}\left(an + n^2 + \frac{p^2}{4}\frac{n}{a} - \frac{p'^2}{4}\frac{n + a}{a} - (120 - 20k)\right) + (w_{i150} - w_{i(250)})\frac{n}{a} + (w'_{a(150)} - w'_{a(250)})\frac{n + a}{a}$$

k and z (see Table 2 - page 11)

4.2.2.2 - GC kinematic gauge

- **Height h ≤ 0,4 m**. The rules applicable are those associated with the gauge for lower parts.

- **Height > 0,4 m**. The rules applicable are those given in *UIC Leaflet 505-1*, irrespective of the value of height h.

4.2.3 - Coaches and vans

4.2.3.1 - GA and GB kinematic gauges

- **Height h ≤ 0,4 m**. The rules applicable are those associated with the gauge for lower parts.

- **Height 0,4 < h ≤ 3, 25 m**. The rules applicable are those given in *UIC Leaflet 505-1*.

- **Height h > 3,25 m**. The rules applicable are those given in *UIC Leaflet 505-1* with the exception of the following formulae[2]:

1. The reduction applicable for the same value of n is the highest obtained with formulae (605c) and (606c).
2. With the exception of k, the symbols used are those applied in UIC Leaflet 505-1.

4.2.3.1.1 - Vehicles for which play w is independent of the curve radius or varies in linear fashion in relation to curvature

1. *For sections between bogie pivots*

- Where:

$$an - n^2 + \frac{p^2}{4} - 500(w_\infty - w_{i(250)}) \leq 250(1,465 - d) + 32,5k$$

$$E_i = \frac{1,465 - d}{2} + q + w + z - 0,015 \qquad (611)$$

- Where:

$$an - n^2 + \frac{p^2}{4} - 500(w_\infty - w_{i(250)}) > 250(1,465 - d) + 32,5k$$

$$E_i = \frac{an - n^2 + \frac{p^2}{4}}{500} + q + w_{i(250)} + z + [x_i]_{>0} - 0,015 - 0,065k \qquad (612)$$

with: $x_i = \frac{1}{750}\left(an - n^2 + \frac{p^2}{4} - 100\right) + w_{i(150)} - w_{i(250)}$

k and z (see Table 3 - page 16)

2. *For sections beyond bogie pivots*

- Where:

$$an + n^2 - \frac{p^2}{4} - 500\left[(w_\infty - w_{i(250)})\frac{n}{a} + (w_\infty - w_{i(250)})\frac{n+a}{a}\right] \leq 250(1,465 - d)\frac{n}{a} + (7,5 + 32,5k)$$

$$E_a = \left(\frac{1,465 - d}{2} + q + w\right)\frac{2n + a}{a} + z - 0,015 \qquad (613)$$

- Where:

$$an + n^2 - \frac{p^2}{4} - 500\left[(w_\infty - w_{i(250)})\frac{n}{a} + (w_\infty - w_{a(250)})\frac{n+a}{a}\right] > 250(1,465 - d)\frac{n}{a} + (7,5 + 32,5k)$$

$$E_a = \frac{an + n^2 - \frac{p^2}{4}}{500} + \frac{1,465 - d}{2} \cdot \frac{n+a}{a} + q \cdot \frac{2n+a}{a} + w_{i(250)}\frac{n}{a} + w_{a(250)}\frac{n+a}{a} + z + [x_a]_{>0} - 0,030 - 0,065k \qquad (614)$$

with: $$x_a = \frac{1}{750}\left(an + n^2 - \frac{p^2}{4} - (120 - 20k)\right) + (w_{i(150)} - w_{i(250)})\frac{n}{a} + (w_{a(150)} - w_{a(250)})\frac{n+a}{a}$$

k and z (see Table 3 - page 16)

4.2.3.1.2 - Vehicles for which play w varies in non-linear fashion in relation to curvature

1. *For sections between bogie pivots*

For each point on the vehicle, the value of E_i to be taken is the highest obtained from application of:

- formula (611) above,
- formulae (615) and (616) below in which the value of R to be taken maximises the portion between coupling hooks.

for: $\infty > R \geq 250$ m

$$E_i = \left[\frac{an - n^2 + \frac{p^2}{4} - (7,5 + 32,5k)}{2R} + w_{i(R)}\right] + q + z \qquad (615)$$

for: $250 > R \geq 150$ m

$$E_i = \left[\frac{an - n^2 + \frac{p^2}{4} - 100}{2R} + w_{i(R)}\right] + q + z + 0,185 - 0,065k \qquad (616)$$

k and z = (see Table 3 - page 16)

2. *For sections beyond bogie pivots*

For each point on the vehicle, the value of E_a to be taken is the highest obtained from application of:

- formula (613) above,
- formulae (617) and (618) below in which the value of R to be taken maximises the portion between coupling hooks.

with: $\infty > R \geq 250$ m

$$E_a = \left[\frac{an + n^2 - \frac{p^2}{4} - (7,5 + 32,5k)}{2R} + w_{i(R)}\frac{n}{a} + w_{a(R)}\frac{n+a}{a}\right] + \left(\frac{1,465 - d}{2} \cdot \frac{n+a}{a}\right) + q \cdot \frac{2n+a}{a} + z - 0,015 \quad (617)$$

with: $250 > R \geq 150$ m

$$E_a = \left[\frac{an + n^2 - \frac{p^2}{4} - (120 - 20k)}{2R} + w_{i(R)}\frac{n}{a} + w_{a(R)}\frac{n+a}{a}\right] + \left(\frac{1,465 - d}{2} \cdot \frac{n+a}{a}\right) + q \cdot \frac{2n+a}{a} + z + 0,210 - 0,105k \quad (618)$$

k and z (see Table 3)

Table 3 :

GA gauge	GB gauge
Where 3,25 < h < 3,88 m, $k = \frac{h - 3,25}{0,63}$	Where 3,25 < h < 4,11 m, $k = \frac{h - 3,25}{0,86}$
Where h ≥ 3,88 m, k = 1	Where h ≥ 4,11 m, k = 1
$z = \left[\frac{s}{30} + \tan(\eta_0 - 1°)_{>0}\right](h - h_c) + \left[\frac{s}{10}(h - h_c) - (0,04 - 0,01k)(h - 0,5)\right]_{>0}$	

NB : - Explanations justifying reduction formulae and k are given in Appendix B - page 39.
- The formulae in point 4.2.1 - page 8 are applicable to axle coaches and vans.

4.2.3.2 - GC kinematic gauge

- **Height h ≤ 0,4 m**. The rules applicable are those associated with the gauge for lower parts.
- **Height > 0,4 m**. The rules applicable are those given in *UIC Leaflet 505-1*, irrespective of the value of height h.

4.2.4 - Wagons

4.2.4.1 - GA and GB kinematic gauges

- **Height h $\le$ 0,4 m**. The rules applicable are those associated with the gauge for lower parts.
- **Height 0,4 < h $\le$ 3, 25 m**. The rules applicable are those given in *UIC Leaflet 505-1*.
- **Height h > 3,25 m**. The rules applicable are those given in *UIC Leaflet 505-1* with the exception of the following formulae[1]:

4.2.4.1.1 - Vehicles not mounted on bogies

1. *For sections between end-axles*

- Where: $an - n^2 \le 7,5 + 32,5k$

$$E_i = \frac{1,465 - d}{2} + q + w + z - 0,015 \qquad (619)$$

- Where: $an - n^2 > 7,5 + 32,5k$

$$E_i = \frac{an - n^2}{500} + \frac{1,465 - d}{2} + q + w + z - 0,030 - 0,065k \qquad (620)$$

k and z (see Table 4 - page 19)

2. *For sections beyond end-axles*

- Where: $an - n^2 \le 7,5 + 32,5k$

$$E_a = \left(\frac{1,465 - d}{2} + q + w\right)\frac{2n + a}{a} + z - 0,015 \qquad (621)$$

1. With the exception of k, the symbols used are those applied in UIC Leaflet 505-1.

- Where: $an + n^2 > 7,5 + 32,5k$

$$E_a = \frac{an + n^2}{500} + \left(\frac{1,465 - d}{2} + q + w\right)\frac{2n + a}{a} + z - 0,030 - 0,065k \qquad (622)$$

k and z (see Table 4 - page 19)

4.2.4.1.2 - Bogies vehicles

1. *For vehicles between end-axles*

- Where: $an - n^2 + \frac{p^2}{4} \leq 250(1,465 - d) + 32,5k$

$$E_i = \frac{1,465 - d}{2} + q + w + z - 0,015 \qquad (623)$$

- Where: $an - n^2 + \frac{p^2}{4} > 250(1,465 - d) + 32,5k$

$$E_i = \frac{an - n^2 + \frac{p^2}{4}}{500} + q + w + z + [x_i]_{>0} - 0,015 - 0,065k \qquad (624)$$

with: $x_i = \frac{1}{750}\left(an - n^2 + \frac{p^2}{4} - 100\right)$

k and z (see Table 4 - page 19)

2. *For sections beyond bogie pivots*

- Where: $an + n^2 - \frac{p^2}{4} \leq 250(1,465 - d)\frac{n}{a} + (7,5 + 32,5k)$

$$E_a = \left(\frac{1,465 - d}{2} + q + w\right)\frac{2n + a}{a} + z - 0,015 \qquad (625)$$

- Where: $$an + n^2 - \frac{p^2}{4} > 250(1,465 - d)\frac{n}{a} + (7,5 + 32,5k)$$

$$E_a = \frac{an + n^2 - \frac{p^2}{4}}{500} + \frac{1,465 - d}{2} \cdot \frac{n + a}{a} + (q + w) \cdot \frac{2n + a}{a} + z + [x_a]_{>0} - 0,030 - 0,065k \qquad (626)$$

with: $$x_a = \frac{1}{750}\left(an + n^2 - \frac{p^2}{4} - (120 - 20k)\right)$$

k and z (see Table 4)

Table 4 :

GA gauge	GB gauge
Where 3,25 < h < 3,88 m, $k = \frac{h - 3,25}{0,63}$ Where h ≥ 3,88 m, k = 1	Where 3,25 < h < 4,11 m, $k = \frac{h - 3,25}{0,86}$ Where h ≥ 4,11 m, k = 1
$z = \left\{\frac{s}{30} + \tan\left[\eta_0 + \left(\arctan\frac{(J - 0,005)_{>0}}{b_G}\right) \cdot (1 + s) - 1°\right]_{>0}\right\}(h - h_C) + \left[\frac{s}{10}(h - h_C) - (0,04 - 0,01k)(h - 0,5)\right]_{>0}$	

NB : Explanations justifying reduction formulae and k are given in Appendix B - page 39.

4.2.4.2 - CG kinematic gauge

- **Height h ≤ 0,4 m**. The rules applicable are those associated with the gauge for lower parts.
- **Height > 0,4 m**. The rules applicable are those given in *UIC Leaflet 505-1*, irrespective of the value of height h.

5 - GA, GB and GC structure gauges and centre-to-centre distances between tracks

5.1 - Structure gauges

5.1.1 - Reference profiles

GA , GB and GC structure gauges are calculated from the reference profiles given in Fig. 2 - page 7.

5.1.2 - Associated rules

5.1.2.1 - GA and GB gauges

- **Height h ≤ 0,4 m**. The rules applicable are those associated with the gauge for lower parts.
- **Height 0,4 < h ≤ 3, 25 m**. The rules applicable are those given in *UIC Leaflet 505-4*.
- **Height h ≥ 3, 88 m** (GA gauge) and **Height h ≥ 4,11 m** (GB gauge). The rules applicable are those given in *UIC Leaflet 505-4*, with the exception of:
    - The formulae for projections. The following should be taken:

      For: ∞ > R ≥ 250 m

      $$S_i \text{ or } S_a = \frac{20}{R} + \frac{\ell - 1,435}{2} \quad \text{(in mm)}$$

      For: 250 > R ≥ 150 m

      $$S_i \text{ or } S_a = \frac{50}{R} - 0,120 + \frac{\ell - 1,435}{2} \quad \text{(in mm)}$$

    - The coefficient of flexibility. s = 0,3 should be taken instead of s = 0,4 in all cases where this coefficient occurs.

Between 3,25 m and 3,88 m or 4,11 m, the points obtained are connected by a straight line.

5.1.2.2 - GC gauge

- **Height h ≤ 0,4 m**. The rules applicable are those associated with the gauge for lower parts.
- **Height > 0,4 m**. The rules applicable are those given in *UIC Leaflet 505-4*, irrespective of the value of height h.

As regards determining the height of the structure gauge, because of the considerable width and rectangular shape of its upper part, allowance should be made for increments that might result from quasi-static tilt and track defects (see point B.3 - page 44) additionally to the $\frac{50000}{R[m]}$ increase for the connections between gradients.

NB : In cases where railways should insist on a basic radius of 4000 m in respect of the GC gauge so that larger vehicles can be worked immediately or at some future date, the projection formulae to be envisaged should be as follows:

- For $R \geq 4000$ m : S_i or S_a $= \frac{4}{R} + \frac{\ell - 1,435}{2}$ (in m)

- For $R < 4000$ m : S_i or S_a $= \frac{50}{R} - 0,0115 + \frac{\ell - 1,435}{2}$ (in m)

5.2 - Centre-to-centre distance between tracks

The rules applicable are those given in *UIC Leaflet 505-4*.

The height h of the point which conditions centre-to-centre distance calculations is:

- GA and GB gauges: h = 3,25 m,

- GC gauge: h = 3,55 m.

The result is that for GC gauge in formulae (433) to (436) of *UIC Leaflet 505-4* used for calculating centre-to-centre distances at a height of 3,25 m, the following formula applies for gauge convergence:

$$\frac{3,55}{1,5} \cdot (D_a - D_i) \approx 2,4 \cdot (D_a - D_i)$$

instead of 2,2 . (D_a - D_i), which is the value maintained for GA and GB gauges.

NB : Examples of structure gauge GC and track centre-to-centre distance calculations are given in Appendix A - page 33.

5.3 - GC gauge for nominal positioning of obstructions for the high speed interoperable network

The gauge for nominal positioning of obstructions shown in Fig. 3 - page 22, results from the application of the *UIC Leaflet 505-4* (see Bibliography - page 55) and this Leaflet, with the following parameters:

- basis radius of 250 m,

- cant and cant deficiency of 150 mm,

- vehicle flexibility coefficient s = 0,4

- track gauge of 1,465 m.

The gauge must be chosen for new high speed lines and lines subject to major modifications.

The gauge does not take account of the margins in relation with aerodynamic phenomenon.

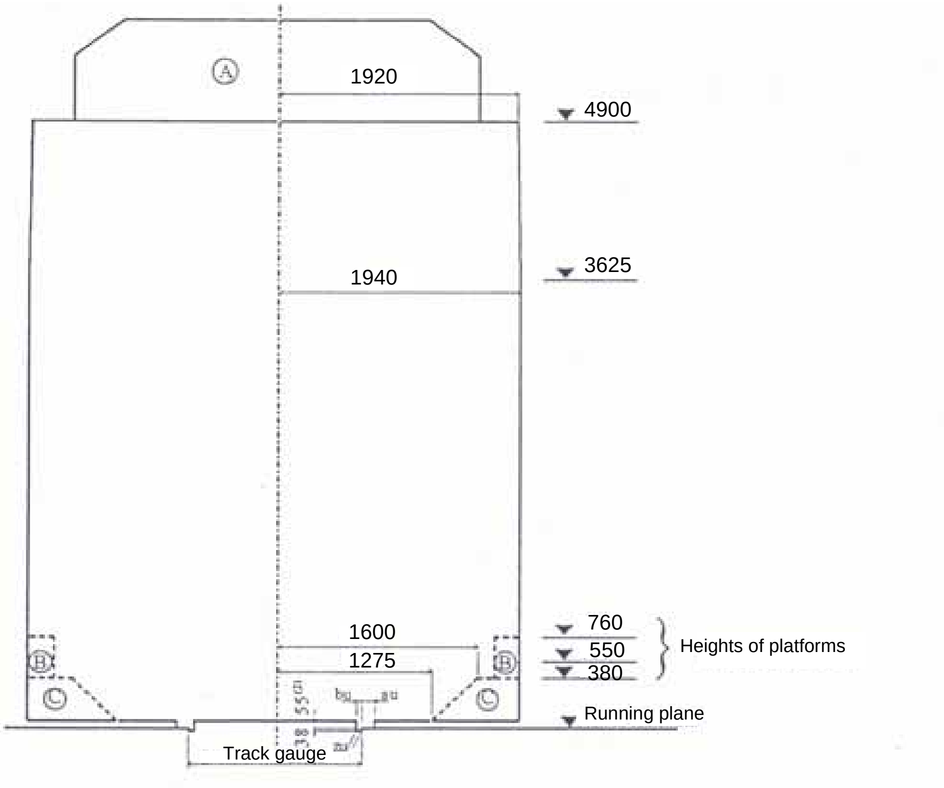

Fig. 3 - GC gauge

NB : For gradient transition curves with R > 2 000 m

A area = clearance for pantographs
B area = clearance for platform positioning following *UIC Leaflet 505-4*, for v ≤ 200 km/h
C area = possibility of clearance reservation for low platforms and specific installations

a_u ≥ 150 mm for non fixed to the rail devices
a_u ≥ 135 mm for fixed to the rail devices
b_u = 41 mm minimum for axle-guidance on internal face
b_u ≥ 70 mm for all the other situations
z_u = area with possible curved edges

For speeds ≤ 160 km/h, in case of difficult local conditions, the limit position of the *UIC Leaflet 505-4* may be used, the superior angles of the gauge may be reduced as mentioned on the plan.

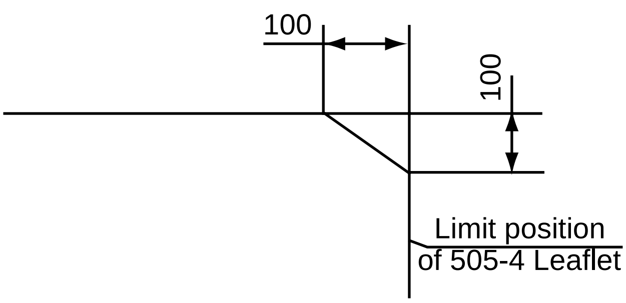

Fig. 4 -

6 - GI3 kinematic gauge

6.1 - Reference profile

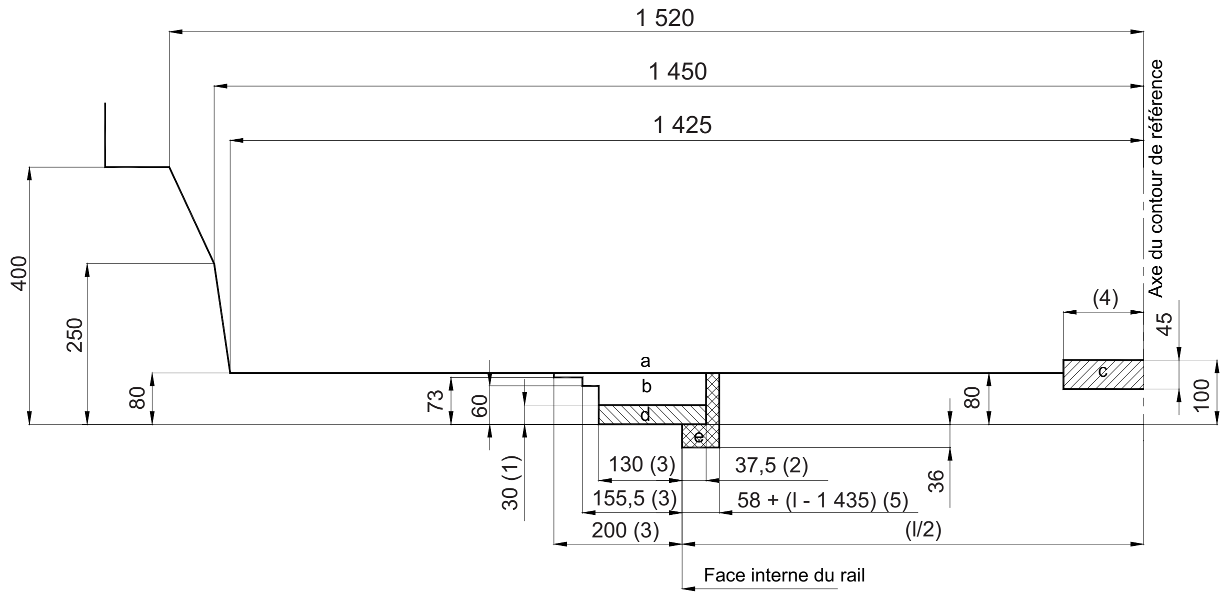

Fig. 5 - Reference profile

a	zone for equipment away from wheels
b	zone for equipment in immediate proximity of wheels
c	zone for contact ramp brushes
d	zone for wheels and other parts coming into contact with the rails
e	zone occupied exclusively by the wheels
(1)	Limit for parts located outside the axle ends (guard irons, sanders, etc.) not to be exceeded for running over detonators. The limit may however be disregarded for parts located between the wheels, provided these parts remain within the wheel track.
(2)	Maximum theoretical width of the flange profile in the case of check-rails (*UIC Leaflet 505-5*).
(3)	Effective limit position of the outside surface of the wheel and of the parts associated with this wheel. Lower parts: see *UIC Leaflet 505-5*.
(4)	When the vehicle is in any position whatsoever on a curve of radius R = 250 m (minimum radius for contact ramp installation) and a track width of 1 465 mm, no part of the vehicle likely to descend to less than 100 mm from the running surface, except for the contact brush, should be less than 125 mm from the track centre. For parts located inside the bogies, this dimension is 150 mm.
(5)	Effective limit position of the internal surface of the wheel when the axle is against the opposite rail. This dimension varies with gauge widening.

NB : Account should also be taken of point 6.1.1.3.2 of *UIC Leaflet 505-1*

6.2 - Rules associated with the kinematic reference profile for determining the maximum vehicle profile

- **Height h > 0,4 m** regarding upper parts: the rules applicable are those given in *UIC Leaflet 505-1* and the present leaflet.

- **Height h = 0,4 m** regarding lower parts: the rules applicable are those given in *UIC Leaflet 505-1*.

- **Height h ≤ 0,25 m**. The rules applicable are those in *UIC Leaflet 505-1* with the exception of the following formulae.

- **Height 0,4 m < h < 0,25 m**. The points obtained at 0,25 m and 0,4 m are linked by a straight line.

6.2.1 - Tractive Units (except railcars)

6.2.1.1 - Vehicles for which play w is independent of the track position or varies linearly depending on the curvature

1. *Sections between the bogie pivots or between the end axles of vehicles not fitted with bogies*

- When: $an - n^2 + \frac{p^2}{4} - 500(w_\infty - w_{i(250)}) \le 5$

$$E_i = \frac{1,465 - d}{2} + q + w_\infty + z - 0,015 \qquad (701)$$

- When: $an - n^2 + \frac{p^2}{4} - 500(w_\infty - w_{i(250)}) > 5$

$$E_i = \frac{an - n^2 + \frac{p^2}{4}}{500} + \frac{1,465 - d}{2} + q + w_{i(250)} + z + [x_i]_{>0} - 0,025 \qquad (702)$$

with: $x_i = \frac{1}{750}\left(an - n^2 + \frac{p^2}{4} - 75\right) + w_{i(150)} - w_{i(250)}$

2. *Sections beyond bogie pivots or between the end axles of vehicles not fitted with bogies*

- When: $an + n^2 - \frac{p^2}{4} - 500\left[(w_\infty - w_{i(250)})\frac{n}{a} + (w_\infty - w_{a(250)})\frac{n+a}{a}\right] \leq 0$

$$E_a = \left(\frac{1,465 - d}{2} + q + w_\infty\right)\frac{2n + a}{a} + z - 0,015 \qquad (703)$$

- When: $an + n^2 - \frac{p^2}{4} - 500\left[(w_\infty - w_{i(250)})\frac{n}{a} + (w_\infty - w_{a(250)})\frac{n+a}{a}\right] > 0$

$$E_a = \frac{an + n^2 - \frac{p^2}{4}}{500} + \left(\frac{1,465 - d}{2} + q\right)\frac{2n + a}{a} + w_{i(250)}\frac{n}{a} + w_{a(250)}\frac{n+a}{a} + z + [x_a]_{>0} - 0,015 \qquad (704)$$

with: $x_a = \frac{1}{750}\left(an + n^2 - \frac{p^2}{4} - 80\right) + (w_{i(150)} - w_{i(250)})\frac{n}{a} + (w_{a(150)} - w_{a(250)})\frac{n+a}{a}$

6.2.1.2 - Vehicles for which the play w varies non-linearly depending on the curvature

1. *Sections between the bogie pivots or between the end axles of vehicles not fitted with bogies.*

For each section of the vehicle, the reduction E_i to be taken is the greatest of those obtained from the application of:

- the formula (701) above,
- the formulae (705) and (706) below, in which the value R to be used is that which gives the highest value for the part between square brackets.

For: $\infty > R \geq 250$ m

$$E_i = \left[\frac{an - n^2 + \frac{p^2}{4} - 5}{2R} + w_{i(R)}\right] + \frac{1,465 - d}{2} + q + z - 0,015 \qquad (705)$$

For: $250 > R \geq 150$ m

$$E_i = \left[\frac{an - n^2 + \frac{p^2}{4} - 75}{2R} + w_{i(R)}\right] + \frac{1,465 - d}{2} + q + z + 0,125 \qquad (706)$$

2. *Sections beyond bogie pivots or between the end axles of vehicles not fitted with bogies.*

For each section of the vehicle, the reduction E_a to be taken is the greatest of those obtained from the application of:

- the formula (703) above,
- the formulae (707) and (708) below, in which the value R to be used is that which gives the highest value for the part between square brackets.

For: $\infty > R \geq 250$ m

$$E_a = \left[\frac{an + n^2 - \frac{p^2}{4}}{2R} + w_{i(R)}\frac{n}{a} + w_{a(R)}\frac{n+a}{a}\right] + \left(\frac{1,465 - d}{2} + q\right)\frac{2n + a}{a} + z - 0,015 \qquad (707)$$

For: $250 > R \geq 150$ m

$$E_a = \left[\frac{an + n^2 - \frac{p^2}{4} - 80}{2R} + w_{i(R)}\frac{n}{a} + w_{a(R)}\frac{n+a}{a}\right] + \left(\frac{1,465 - d}{2} + q\right)\frac{2n + a}{a} + z + 0,145 \qquad (708)$$

6.2.2 - Railcars

NB : The particular features of railcars whose bogies can be considered as motor or trailer bogies are set out in *UIC Leaflet 505-1*.

- Railcars fitted entirely with motor bogies: the applicable formulae are those under "Tractive Units" (see point 6.2.1 - page 24),
- Railcars fitted entirely with trailer bogies: the applicable formulae are those under "Coaches and vans" (see point 6.2.3 - page 28),
- Railcars fitted with one motor bogie and one trailer bogie: the reduction formulae may either be used as they stand, or replaced by the formulae below which give manufacturers a slight advantage in the centre and at the end of the vehicle body.

1. *Between the pivots* [1]

$$E_i = \frac{1,465 - d}{2} + q + w_\infty + \frac{a - n_\mu}{a} + w'_\infty \frac{n_\mu}{a} + z - 0,015 \qquad (701a)$$

$$E_i = \frac{an_\mu - n_\mu^2 + \frac{p^2}{4}\frac{a - n_\mu}{a} + \frac{p'^2}{4}\frac{n_\mu}{a}}{500} + \frac{1,465 - d}{2}\frac{a - n_\mu}{a} + q + w_{i(250)}\frac{a - n_\mu}{a} + w'_{i(250)}\frac{n_\mu}{a} + z + [x_i]_{>0} - 0,01 - 0,015\frac{a - n_\mu}{a} \qquad (702a)$$

with: $$x_i = \frac{1}{750}\left(an_\mu - n_\mu^2 + \frac{p^2}{4}\frac{a - n_\mu}{a} + \frac{p'^2}{4}\frac{n_\mu}{a} - 75\right) + (w_{i(150)} - w_{i(250)})\frac{a - n_\mu}{a} + (w'_{i(150)} - w'_{i(250)})\frac{n_\mu}{a}$$

2. *Beyond the pivots, motor bogie sides* [2]

$$E_a = \left(\frac{1,465 - d}{2} + q\right)\frac{2n + a}{a} + w_\infty \frac{n + a}{a} + w'_\infty \frac{n}{a} + z - 0,015 \qquad (703a)$$

$$E_a = \frac{an + n^2 - \frac{p^2}{4}\frac{n + a}{a} + \frac{p'^2}{4}\frac{n}{a}}{500} + \frac{1,465 - d}{2}\frac{n + a}{a} + q\frac{2n + a}{a} + w'_{i(250)}\frac{n}{a} + w_{a(250)}\frac{n + a}{a} + z + [x_a]_{>0} - 0,015 \qquad (704a)$$

with: $$x_a = \frac{1}{750}\left(an + n^2 - \frac{p^2}{4}\frac{n + a}{a} + \frac{p'^2}{4}\frac{n}{a} - 80\right) + (w'_{i(150)} - w'_{i(250)})\frac{n}{a} + (w_{a(150)} - w_{a(250)})\frac{n + a}{a}$$

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1. The reduction applicable in case of the same value of n is the greatest of those resulting from formulae (701a) and (702a).
2. The reduction applicable in case of the same value of n is the greatest of those resulting from forumlae (703a) and (704a).

3. *Beyond the pivots, trailer bogie side* [1]

$$E_a = \left(\frac{1{,}465 - d}{2} + q\right)\frac{2n + a}{a} + w_\infty \frac{n}{a} + w'_\infty \frac{n + a}{a} + z - 0{,}015 \quad (703b)$$

$$E_a = \frac{an + n^2 + \frac{p^2}{4}\frac{n}{a} - \frac{p'^2}{4}\frac{n + a}{a}}{500} + \left(\frac{1{,}465 - d}{2} + q\right)\frac{2n + a}{a} + w_{i(250)}\frac{n}{a} + w'_{a(250)}\frac{n + a}{a} + z + [x_a]_{>0} - 0{,}015 \quad (704b)$$

with: $x_a = \frac{1}{750}\left(an + n^2 + \frac{p^2}{4}\frac{n}{a} - \frac{p'^2}{4}\frac{n + a}{a} - 80\right) + (w_{i(150)} - w_{i(250)})\frac{n}{a} + (w'_{a(150)} - w'_{a(250)})\frac{n + a}{a}$

6.2.3 - Coaches and vans

6.2.3.1 - Vehicles for which play w is independent of the track position or varies linearly depending on the curvature

1. *Sections between the bogie pivots*

- When: $an - n^2 + \frac{p^2}{4} - 500(w_\infty - w_{i(250)}) \leq 250(1{,}465 - d) + 5$

$$E_i = \frac{1{,}465 - d}{2} + q + w_\infty + z - 0{,}015 \quad (709)$$

- When: $an - n^2 + \frac{p^2}{4} - 500(w_\infty - w_{i(250)}) > 250(1{,}465 - d) + 5$

$$E_i = \frac{an - n^2 + \frac{p^2}{4}}{500} + q + w_{i(250)} + z + [x_i]_{>0} - 0{,}01 \quad (710)$$

with: $x_i = \frac{1}{750}\left(an - n^2 + \frac{p^2}{4} - 75\right) + w_{i(150)} - w_{i(250)}$

1. The reduction applicable in case of the same value of n is the greatest of those resulting from formulae (703b) and (704b)

2. *Sections beyond the bogie pivots*

- When: $an + n^2 - \frac{p^2}{4} - 500\left[(w_\infty - w_{i(250)})\frac{n}{a} + (w_\infty - w_{a(250)})\frac{n+a}{a}\right] \leq 250(1{,}465 - d)\frac{n}{a}$

$$E_a = \left(\frac{1,465 - d}{2} + q + w_\infty\right)\frac{2n + a}{a} + z - 0{,}015 \qquad (711)$$

- When: $an + n^2 - \frac{p^2}{4} - 500\left[(w_\infty - w_{i(250)})\frac{n}{a} + (w_\infty - w_{a(250)})\frac{n+a}{a}\right] > 250(1{,}465 - d)\frac{n}{a}$

$$E_a = \frac{an + n^2 - \frac{p^2}{4}}{500} + \frac{1,465 - d}{2}\frac{n + a}{a} + q\frac{2n + a}{a} + w_{i(250)}\frac{n}{a} + w_{a(250)}\frac{n + a}{a} + z + [x_a]_{> 0} - 0{,}015 \qquad (712)$$

with: $$x_a = \frac{1}{750}\left(an + n^2 - \frac{p^2}{4} - 80\right) + (w_{i(150)} - w_{i(250)})\frac{n}{a} + (w_{a(150)} - w_{a(250)})\frac{n + a}{a}$$

6.2.3.2 - Vehicles for which play w varies non-linearly depending on the curvature

1. *Sections between the bogie pivots*

For each section of the vehicle, the reduction E_i to be taken is the greatest of those obtained from the application of

- the formula (709) above,
- the formulae (713) and (714) below, in which the value of R to be used is that which gives the highest value for the part between square brackets.

For: $\infty > R \geq 250$ m :

$$E_i = \left[\frac{an - n^2 + \frac{p^2}{4} - 5}{2R} + w_{i(R)}\right] + q + z \qquad (713)$$

For: $250 > R \geq 150$ m :

$$E_i = \left[\frac{an - n^2 + \frac{p^2}{4} - 75}{2R} + w_{i(R)}\right] + q + z + 0{,}14 \qquad (714)$$

2. *For sections situated beyond the bogie pivots*

For each section of the vehicle, the reduction E_a to be taken is the greatest of those obtained from the application of

- the formula (711) above,
- the formulae (715) and (716) below, in which the value of R to be used is that which gives the highest value for the part between square brackets.

For: $\infty > R \geq 250$ m :

$$E_a = \left[\frac{an + n^2 - \frac{p^2}{4}}{2R} + w_{i(R)}\frac{n}{a} + w_{a(R)}\frac{n+a}{a}\right] + \frac{1,465 - d}{2}\frac{n+a}{a} + q\frac{2n+a}{a} + z - 0,015 \quad (715)$$

For: $250 > R \geq 150$ m :

$$E_a = \left[\frac{an + n^2 - \frac{p^2}{4} - 80}{2R} + w_{i(R)}\frac{n}{a} + w_{a(R)}\frac{n+a}{a}\right] + \frac{1,465 - d}{2}\frac{n+a}{a} + q\frac{2n+a}{a} + z - 0,145 \quad (716)$$

6.2.4 - Wagons

6.2.4.1 - Vehicles not mounted on bogies

1. *For sections between end-axles:*

- When: $an - n^2 \leq 5$

$$E_i = \frac{1,465 - d}{2} + q + z - 0,015 \quad (717)$$

- When: $an - n^2 > 5$

$$E_i = \frac{an - n^2}{500} + \frac{1,465 - d}{2} + q + z - 0,025 \quad (718)$$

2. *For sections beyond end-axles:*

$$E_a = \frac{an + n^2}{500} + \left(\frac{1,465 - d}{2} + q\right)\frac{2n + a}{a} + z - 0{,}015 \qquad (719)$$

6.2.4.2 - Bogie vehicles

1. *For sections between bogie pivots:*

- When: $an - n^2 + \frac{p^2}{4} \leq 250(1{,}465 - d) + 5$

$$E_i = \frac{1{,}465 - d}{2} + q + w + z - 0,015 \qquad (720)$$

- When: $an - n^2 + \frac{p^2}{4} > 250(1{,}465 - d) + 5$

$$E_i = \frac{an - n^2 + \frac{p^2}{4}}{500} + q + w + z + [x_i]_{>0} - 0,01 \qquad (721)$$

with: $x_i = \frac{1}{750}\left(an - n^2 + \frac{p^2}{4} - 75\right)$

2. *For sections beyond bogie pivots*

- When: $an + n^2 - \frac{p^2}{4} \leq 250(1{,}465 - d)\frac{n}{a}$

$$E_a = \left(\frac{1,465 - d}{2} + q + w\right)\frac{2n + a}{a} + z - 0{,}015 \qquad (722)$$

- When: $an + n^2 - \frac{p^2}{4} > 250(1{,}465 - d)\frac{n}{a}$

$$E_a = \frac{an + n^2 - \frac{p^2}{4}}{500} + \frac{1,465 - d}{2}\frac{n + a}{a} + (q + w)\frac{2n + a}{a} + z + [x_a]_{>0} - 0{,}015 \qquad (723)$$

with: $x_a = \frac{1}{750}\left(an + n^2 - \frac{p^2}{4} - 80\right)$

6.3 - GI3 structure gauge

6.3.1 - Reference profile

The structure gauge is determined based on the reference profile given in point 6.1 - page 23.

6.3.2 - Associated regulations

- **Height h > 0,4 m** regarding upper sections: the rules applicable are those set out in *UIC Leaflet 505-4* and the present leaflet.

- **Height h = 0,4 m** regarding lower sections: the rules applicable are those in *UIC Leaflet 505-4*.

- **Height h ≤ 0,25 m**. The rules applicable are those given in *UIC Leaflet 505-4*, except for rules for projections. The following should be taken:

  - For ∝ > R ≥ 250 m

$$S_i = \frac{2{,}5}{R} + \frac{l - 1{,}435}{2}$$

$$S_a = \frac{l - 1{,}435}{2}$$

  - For 250 m > R ≥ 150 m

$$S_i = \frac{37{,}5}{R} - 0{,}140 + \frac{l - 1{,}435}{2}$$

$$S_a = \frac{40}{R} - 0{,}160 + \frac{l - 1{,}435}{2}$$

Between 0,4 m and 0,25 m, the points obtained are linked by a straight line.

Appendix A - GC gauge - Examples of structure gauge and centre-to-centre calculations

(in accordance with *UIC Leaflet 504-4)*.

A.1 - Example 1

Characteristics of the track		
Track 1 outside	Track 2 inside	Cant deficiency
Radius R = 600 m	Radius R = 600 m	I_i = 0,097 m
Track gauge ℓ = 1,445 m	Track gauge ℓ = 1,445 m	I_a = 0,118 m
Cant D_a = 0,120 m	Cant D_i = 0,100 m	$S_i = S_a$ = 0,011 m
Maximum speed: 110 km/h	Maximum speed: 100 km/h	
Tracks in a state of repair which is not considered as "particularly good"		

A.1.1 - Fixed structures - Minimum position

A.1.1.1 - Outside of curve

	Height above running surface (in m)		
	< 3,55	3,55	4,70
Half-width of reference		1,645	1,540
Projection S_a		0,011	0,011
Additional quasi-static tilt: $\frac{0,4}{1,5}(0,100 - 0,05) \cdot (h - 0,5)$		0,0553	0,0762
Random movements: $\sum'_a$		0,1039	0,139
Minimum distance for siting fixed structures in relation to centre-line of the track	[a]	1,815	1,766

a. The track characteristics taken into consideration are identical to those of Example 3 in UIC Leaflet 505-4 (Appendix). Please refer to this example for details of the values applicable in the case of h < 3,55 m.

NB : The dimensions calculated for the structure gauge are given in Fig. 1 - page 35.

A.1.1.2 - Inside of curve

	Height above running surface (in m)		
	< 3,55	3,55	4,70
Half-width		1,645	1,540
Projection S_i		0,011	0,011
Additional quasi-static tilt: $\frac{0,4}{1,5}(0,100 - 0,05) \cdot (h - 0,5)$		0,0407	0,056
Random movements: $\sum_i'$		0,0833	0,1095
Minimum distance for siting fixed structures in relation to centre-line of the track	[a]	1,780	1,717

a. The track characteristics taken into consideration are identical to those of example 3 in UIC Leaflet 505-4 (Appendix). Please refer to this example for details of the values applicable in the case of h < 3,55 m.

NB : The dimensions calculated for the structure gauge are given in Fig. 1 - page 35.

A.1.2 - Maximum distance between track centres

Height of point on reference profile	3,55 m
Width of reference profile	3,290
Projections: S_i S_a	0,011 0,011
Additional quasi-static tilt: $\frac{0,4}{1,5}(0,120 - 0,05) \cdot (3,55 - 0,5)$ $\frac{0,4}{1,5}(0,097 - 0,05) \cdot (3,55 - 0,5)$	0,0569 0,0382
Cant convergence: 2,4 . (0,120 - 0,100)	0,048
Random movements: $\sqrt{\sum_i'^2 + \sum_a'^2}$	0,1332
Minimum distance between the centre-lines of the two tracks	3,588

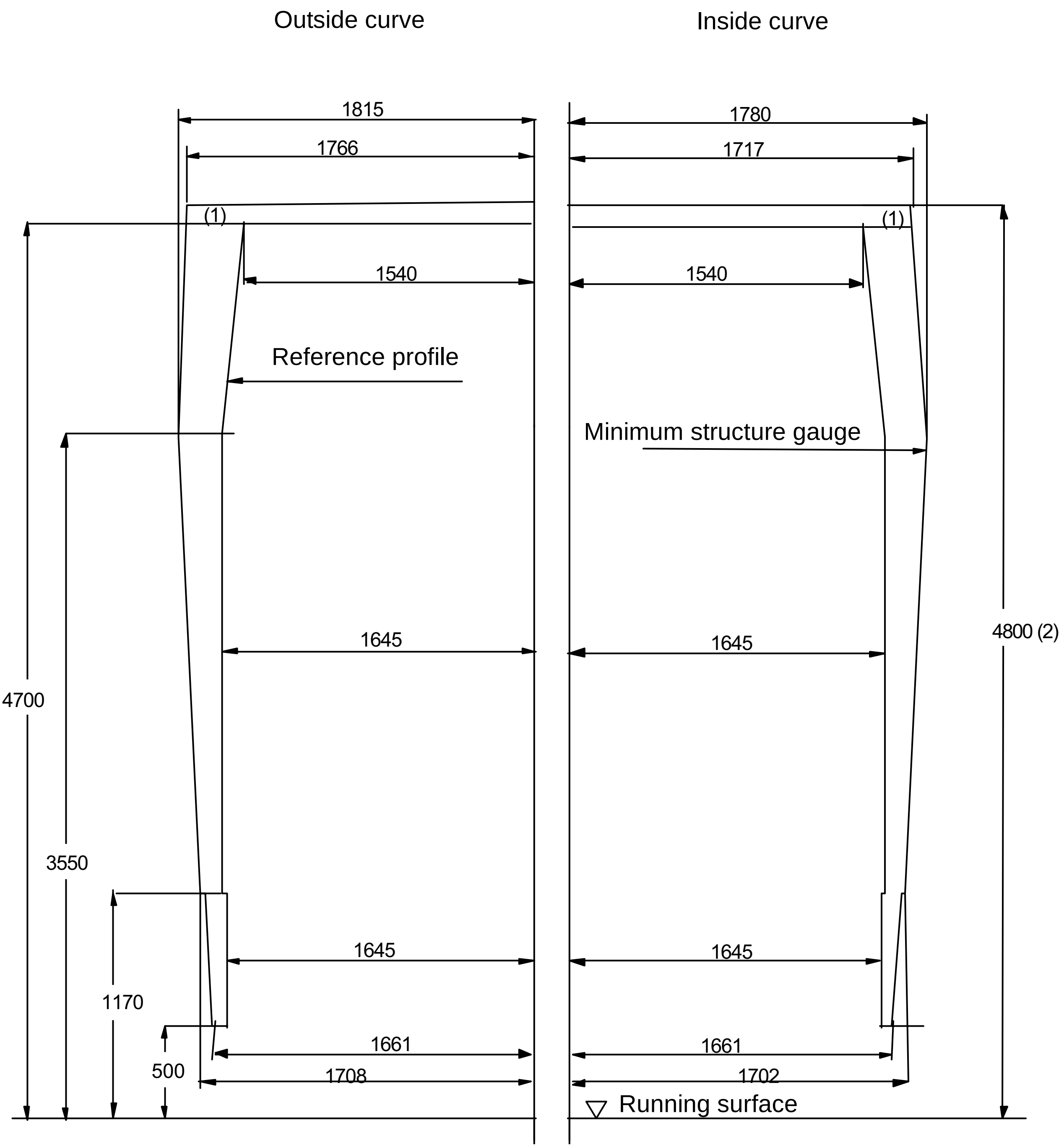

Fig. 1 - GC gauge - Minimum structure gauge (maximum position) - Example 1

(1) In this area, the structure gauge may be reduced to take account of the actual combinations of horizontal and vertical movements.

(2) See Appendix B - page 39 for explanations justifying this dimension.

A.2 - Example 2

Characteristics of the track		
Track 1 outside	Track 2 inside	Cant deficiency
Radius R = 250 m	Radius R = 250 m	I_i = 0,110 m
Track gauge ℓ = 1,445 m	Track gauge ℓ = 1,445 m	I_a = 0,110 m
Cant D_a = 0,060 m	Cant D_i = 0,060 m	$S_i = S_a$ = 0,025 m
Maximum speed: 60 km/h	Maximum speed: 60 km/h	

A.2.1 - Fixed structures - Minimum position

A.2.1.1 - Outside curve

	Height above running surface (in m)		
	1,17	3,55	4,70
Half-width of reference profile	1,645	1,645	1,540
Projection S_a	0,025	0,025	0,025
Additional quasi-static tilt: $\frac{0,4}{1,5}(0,110 - 0,05) \cdot (h - 0,5)$	0,0107	0,0488	0,0672
Random movements: $\sum_a'$	0,0418	0,1154	0,1544
Minimum distance for siting fixed structures in relation to centre-line of the track	1,723	1,834	1,787

A.2.1.2 - Inside curve

	Height above running surface (in m)		
	1,17	3,55	4,70
Half-width of reference profile	1,645	1,645	1,540
Projection S_i	0,025	0,011	0,011
Additional quasi-static tilt: $\frac{0,4}{1,5}(0,060 - 0,05) \cdot (h - 0,5)$	0,0018	0,081	0,0112
Random movements: $\sum_i'$	0,0395	0,0973	0,1285
Minimum distance for siting fixed structures in relation to centre-line of the track	1,711	1,755	1,705

A.2.2 - Minimum distance between track centres

Width of reference profile	3,290
Projections: S_i S_a	0,025 0,025
Additional quasi-static tilt: $\frac{0,4}{1,5}(0,060 - 0,05) \cdot (3,55 - 0,5)$ $\frac{0,4}{1,5}(0,110 - 0,05) \cdot (3,55 - 0,5)$	 0,0081 0,0488
Cant convergence: 2,4 . (0,120 - 0,100)	0,048
Random movements: $\sqrt{\sum_i'^2 + \sum_a'^2}$	0,1509
Minimum distance between thre centre-lines of the two tracks	3,548

A.3 - Example 3

Characteristics of the track
Straight section: R = ∞, D = 0, I = 0
Track gauge ℓ = 1,435 m
Speed: > 80 km/h
Tracks the state of which is not considered "especially good"

A.3.1 - Fixed structures - Minimum position

	Height above running surface (in m)		
	< 3,55	3,55	4,70
Half-width of reference profile		1,645	1,540
Random movements: $\sum''$		0,052	0,064
Minimum distance for siting fixed structures in relation to centre-line of the track	a	1,697	1,604

a. The track characteristics taken into consideration are identical to those of Example 2 in UIC Leaflet 505-4 (Appendix). Please refer to this example for details of the values applicable in the case of h < 3,55 m.

A.3.2 - Maximum distance between track centres

Width of reference profile	3,290
Random movements: $\sum'' \sqrt{2}$	0,074
Minimum distance between thre centre-lines of the two tracks	3,364

Appendix B - Remarks

B.1 - Standard loads used for determining GA, GB and GC gauges

B.1.1 - GA gauge

- Containers 8' (2,438 m) wide and 8'6 ½ (2,604 m) high, loaded on wagons (tolerance on centring ± 10 mm) with a ≤ 16 m and floor height ≤ 1,246 m.

- Containers 8' (2,438 m) wide and 9'6" (2,896 m) high, loaded on wagons (tolerance on centring ± 10 mm), with a ≤ 16 m and floor height ≤ 0,954 m (block trains).

- Swap bodies 2,50 m wide and 2,60 m high, loaded on wagons (tolerance on centring ± 10 mm), with a ≤ 12,50 m and floor height ≤ 1,246 m.

- Special semi-trailers 2,50 m wide, used in rail-road combined traffic loaded on recess or low-loader wagons (tolerance on centring ± 20 mm) with a ≤ 12,50 m and edge height not exceeding 3,85 m above the running surface

B.1.2 - GB gauge

- Containers 8' (2,438 m) wide and 9'6" (2,896 m) high, loaded on wagons (tolerance on centring ± 10 mm) with a ≤ 16 m and floor height 1,18 m.

B.1.3 - GC gauge

- Containers 8' (2,438 m) wide and 9'6" (2,896 m) high, loaded on any type of standard flat wagon with a ≤ 16m.

- Lorries and semi-trailers (built to road gauge), 2,50 m wide and 4,00 m high, loaded on special wagons (tolerance on centring ± 100 mm) with a ≤ 12,50 m and floor height ≤ 0,65 m.

B.1.4 - All gauges

The wagon + load combinations taken into consideration are those with the following characteristics:

q+w =	0,023 m
p =	1,8 m
d =	1,41 m
J =	0,005 m
η_0 ≤	1°
h_c	0,5 m
s	0,3

vertical oscillations:	0,030 m : GA and GB gauges 0,050 m : GC gauge

B.2 - Explanations justifying the projections and reduction formulae applicable to the upper part of GA and GB gauges

B.2.1 - Foreword

B.2.1.1 - The projections derived from *UIC Leaflet 505*, which are themselves based on those of Technical Unity, correspond to very short vehicles in curves with a radius of ≥ 250 m.

$$\left(\frac{a^2}{8R} = \frac{3,75}{R}, \text{ or } a \approx 5,5 \text{ m}\right)$$

To ensure that longer vehicles - which are now in widespread use - do not require greater accommodation than these reference vehicles in curves, reduction formulae must be applied to their width and the resulting reductions may be significant in relation to the reference profile.

To avoid resources being unnecessarily spent on upgrading of existing lines it was considered more appropriate to suggest rules for projections in respect of the reference profiles, corresponding to the effective projections of vehicle types most commonly used.

In the case, for example, of a transcontainer with a half-width of 1,23 m (including a loading tolerance of 0,01 m) loaded on a wagon with a = 16 m, p = 1,8 m and a centre-line corresponding to that of the track, the distance from track-centre of the furthest point of its middle section in a curve with radius R, is:

$$1,23 + \frac{16^2 + 1,8^2}{8R} = 1,23 + \frac{32,5}{R}$$, i.e. 1,36 m in a curve with R = 250 m.

In the case of a semi-trailer with a half-width (including a loading tolerance of 0,02 m) of 1,27 m loaded on a wagon with a = 12,5 m , p = 1,8 m and a centre-line corresponding to that of the track, the distance from track-centre of the furthest point of its middle section in a curve with R, is:

$$1,27 + \frac{12,5^2 + 1,8^2}{8R} = 1,27 + \frac{20}{R}$$, i.e. 1,35 m in a curve with R = 250 m.

To accommodate these two options, a half-width of 1,28 m has been combined with a projection of $\frac{20}{R} = 0,08$ m (i.e. 1,28 + 0,08 = 1,36 m in a curve with R = 250 m), whereas if the projection values in *UIC Leaflet 505-4* had been maintained $\left(\frac{3,75}{R}\right.$ instead of $\left.\frac{20}{R}\right)$, it would then have been necessary to take a half-width of $1,36 - \frac{3,75}{R} = 1,345$ m instead of 1,28 m.

This latter option would have had an unnecessary adverse effect on the clearance gauge on straight track and in curves with large radius.

B.2.1.2 - It follows from B.2.1.1 that GA and GB gauges have two rules for projections:

- one rule applicable up to a height of h = 3,22 m (static gauges) and h = 3,25 m (kinematic gauges).

- one rule applicable from heights of :
  h = 3,85 m (static) and h = 3,88 m (kinematic) for GA gauge,
  h = 4,08 m (static) and h = 4,11 m (kinematic) for GB gauge

For intermediate heights, the projections are obtained by linear interpolation of the values corresponding to the above rules (introduction of a coefficient k, which is a function of h).

B.2.1.3 - Since the flexibility coefficient selected for the standard loads taken as a basis for calculating the upper (h > 3,25 m) of GA and GB gauges is 0,3 (see point B.1.4 - page 39), the rules for structure gauges should have taken account of this same coefficient for heights of over 3,25 m.

To avoid creating discontinuity in the height of 3,25 m up to which a flexibility coefficient of 0,4 applies, it has been agreed that s should be made to vary in linear fashion from 0,4 (for h = 3,25 m) to 0,3 (for h = 3,88 m) - GA gauge or h = 4,11 m - GB gauge - (see point 5.1.2 - page 20, last paragraph).

In terms of additional reductions applicable when building vehicles with a flexibility coefficient greater than that taken for the structure gauge, account should also be taken of the above-mentioned linear interpolation.

Consequently the corrective formula: $\left[\frac{s}{10}\cdot(h-h_c)-0,03\cdot(h-0,5)\right]_{>0}$ becomes:

$$\left[\frac{s}{10}\cdot(h-h_c)-(0,04-001k)\cdot(h-0,5)\right]_{>0}$$

In this formula, k has the same values as those given for the rules applicable to projections.

B.2.2 - GA and GB static gauges

B.2.2.1 - h ≤ 3,22 m

The reduction formulae are those of Technical Unity, which can be expressed as follows (see *UIC Leaflet 505-1 and 505-5*.

$$E_i = \left[\frac{\Delta_i}{500}+\frac{1,465-d}{2}+q+w+[x_i]_{>0}-0,075\right]_{>0}$$

with:

$$\begin{cases}\Delta_i = 7,5 \text{ si } \left(an-n^2+\frac{p^2}{4}\right)\leq 7,5\\ \Delta_i = \left(an-n^2+\frac{p^2}{4}\right) \quad \text{if this quantity is} > 7,5\end{cases}$$

$$x_i = \frac{1}{750}\left(an - n^2 + \frac{p^2}{4} - 100\right)$$

$$E_a = \left[\frac{\Delta_a}{500} + \left(\frac{1,465 - d}{2} + q + w\right) \cdot \frac{2n + a}{a} + [x_a]_{>0} - 0,075\right]_{>0}$$

with:

$$\begin{cases} \Delta_a = 7,5 \text{ si } \left(an + n^2 - \frac{p^2}{4}\right) \leq 7,5 \\ \Delta_a = \left(an + n^2 - \frac{p^2}{4}\right) \quad \text{if this quantity is} > 7,5 \end{cases}$$

$$x_i = \frac{1}{750}\left(an + n^2 - \frac{p^2}{4} - 120\right)$$

In these formulae:

- a projection of 0,075 is combined with the basic radius of 250 m,
- the condition for running through a straight section of track is reached when Δ_i or $\Delta_a \leq 7{,}5$,
- the terms x_i and x_a correspond to the conditions for curve-taking with R = 150 m, and come into play for the furthest parts of axles on vehicles with very large wheelbase.

B.2.2.2 - h ≥ 3,85 m (GA gauge) - h ≥ 4,08 m (GB gauge)

- The TU (Technical Unity) projection of 0,075 m in R = 250 m is to be increased by $\frac{20}{250} - \frac{3,75}{20} = 0,065\ m$
- Calculations the same as those providing the formula in B.2.2.1 - page 41 show that the condition for running on straight track is reached when Δ_i or $\Delta_a \leq 40$.
- In view of the loads concerned, the same area of application has been taken for terms x_i and x_a, i.e.:

  Δ_i or $\Delta_a > 100$

By taking k=1, which corresponds to h > 3,85 m (GA gauge) and h ≥ 4,08 m (GB gauge) in reduction formulae (601) and (602) in this leaflet, the reduction formulae for the conditions described above can be obtained.

B.2.2.3 - 3,22 < h < 3,85 m (GA gauge) - 3,22 < h < 4,08 m (GB gauge)

Projections vary in proportion to height h, obtained by applying the rules in points B.2.2.1 - page 41 and B.2.2.2 - page 42. This corresponds to:

$$k = \frac{h - 3,22}{3,85 - 3,22} = \frac{h - 3,22}{0,63} \text{ for GA gauge}$$

$$k = \frac{h - 3,22}{4,08 - 3,22} = \frac{h - 3,22}{0,86} \text{ for GB gauge}$$

B.2.3 - GA and GB kinematic gauges

B.2.3.1 - h ≥ 3,25 m

The reduction formulae applicable are those in *UIC Leaflet 505-1*, where the rule for projections is:

$\infty \geq R \geq 250$ m :

$$S_i \text{ or } S_a = \frac{3,75}{R} + \frac{\ell - 1,435}{2}$$

$250 \geq R \geq 150$ m :

$$S_i = \frac{50}{R} - 0,185 + \frac{\ell - 1,435}{2}$$

$$S_a = \frac{60}{R} - 0,225 + \frac{\ell - 1,435}{2}$$

B.2.3.2 - h ≥ 3,88 m (GA gauge) - h ≥ 4,11 m (GB gauge)

The reduction formulae applicable are those given in *UIC Leaflet 505-1*, replacing the projection values of in point B.2.3.1 with the following increased values:

$\infty \geq R \geq 250$ m :

$$S_i \text{ or } S_a = \frac{20}{R} + \frac{\ell - 1,435}{2}$$

$250 \geq R \geq 150$ m :

$$S_i \text{ or } S_a = \frac{50}{R} - 0,120 + \frac{\ell - 1,435}{2}$$

which corresponds to k = 1, in formulae (603) to (626) of this leaflet.

B.2.3.3 - 3,25 < h < 3,88 m (GA gauge) and 3,25 < h < 4,11 m (GB gauge)

Projections vary in proportion to height h, between the values obtained by applying the rules given in points B.2.3.1 and B.2.3.2, which corresponds to:

$$k = \frac{h - 3,25}{3,88 - 3,25} = \frac{h - 3,25}{0,63} \text{ for GA gauge}$$

$$k = \frac{h - 3,25}{4,11 - 3,25} = \frac{h - 3,25}{0,86} \text{ for GB gauge}$$

B.3 - Calculation of the height of GC structure gauge

B.3.1 - In accordance with the provisions of *UIC Leaflet 505-4*, Permanent Way Departments should increase the vertical dimensions of the upper part of contour of reference $\frac{50000}{R\ [m]}$ between gradients.

B.3.2 - Because of the large width (1 540 mm in relation to centre-line) of the upper horizontal of the gauge, provision must be made for further increments to take account of turning or lifting movements in the upper parts of vehicles or their loads as a result of:

- quasi-static tilt,
- track defects, cant deficiency (in curves) or cross-level deficiencies (in straight sections),
- oscillations caused by dynamic interaction between track and vehicles,
- dissymmetry that may occur due to uneven load distribution and adjustment tolerances.

B.3.2.1 - Effect of quasi-static tilt

In relation to the perpendicular to the running surface, the quasi-static effect reslults in tilt in the vertical axis of vehicles or their loads of:

$s \cdot \frac{E \text{ or } I}{1,5}$ (see *UIC Leaflet 505-5, Appendix C4*)

Rotary movements of similar value also have an effect on the upper line of vehicles or their loads, thus causing the reference profile to be exceeded vertically on the side opposite to the quasi-static tilt. The maximim stage is reached at the upper "horn" and can be determined at[1]:

$$s \cdot \frac{E \text{ or } I}{1,5} \cdot 1,540 \text{, i.e.: } \sim s \text{ . (E or I) = 0,4 (E or I)}$$ [2]

NB : Whereas, for vehicles entirely within the reference profile for E or I = 0,050 m, the excess value to be taken into consideration would ultimately be s (E or I = 0,050), the same does not hold true for loads not subject to vertical reduction. The excess value to be taken into account is indeed 0,4 (E or I).

1. This is a simplified calculation which does not allow for the loss in height due to rotation. In all events, this may be insignificant given the small angles considered. Moreover, the 1,540 dimension (half-width of reference profile) is a deliberate exaggeration since the true half-width of vehicles or their loads is less.
2. En considérant le coefficient de souplesse s = 0,4 du gabarit GC.

B.3.2.2 - Geometric effect of an error in cant or cross-level

A given deficiency in cant t_E (plus) or t_I (minus) in relation to a rail causes rotation of the running surface by reference to its position in accordance with the theoretical cant value, with the centre of rotation being on the opposite rail. The angle of rotation is:

$$\Phi(\text{radians}) = \frac{t_E \text{ or } t_I}{1,5}$$

Rotary movements of similar value also affect the upper line of vehicles or their loads, and cause the reference profile to be exceeded vertically. The maximum stage is reached by the upper "horn" and can be determined at[1]:

Excess in cant

$$t_E : \left(\frac{1,540 + 0,750}{1,5} \approx 1,5 \cdot t_E\right) = 1,5 \cdot (0,015 \text{ or } 0{,}020)^{\;2}$$

Cant deficiency

$$t_I : \left(\frac{1,540 + 0,750}{1,5} \approx 0,5 \cdot t_I\right) = 0,5 \cdot (0,015 \text{ or } 0{,}020)^{\;2}$$

B.3.2.3 - Dynamic effect of a deficiency in cant or cross-level

This effect should be added to the effect of quasi-static tilt as such, and means an increase in the excess values determined in point B.3.2.1 - page 44 (0,015 to 0,020) [2].

B.3.2.4 - Effects of oscillation and dissymetry

These effects may be assimilated to the dynamic effect of a deficiency in cant (see *UIC Leaflet 505-4*). They should also be added to quasi-static tilt values as such and mean an increase in the values in point B.3.2.1 of :

- 0,4 . (0,039 ou 0,065) or 0,4 . (0,07 or 0,013) for oscillations[2],

- 0,4 . (0,065) for dissymetry[2].

1. This is a simplified calculation which does not allow for the loss in height due to rotation. In all events, this may be insignificant given the small angles considered. Moreover, the 1,540 dimension (half-width of reference profile) is a deliberate exaggeration since the true half-width of vehicles or their loads is less.
2. Taking the deficiency values given in UIC Leaflet 505-4.

B.3.2.5 - Recapitulation

The incremental amounts to be allowed by Permanent Way Departments in excess of the 4,700 m dimension in the reference profile of GC gauge are (in metres):

1. Nominal position of fixed structures

   - Outside of curve (and straight track sections)

     0,4 . E + 1,5 . (0,015 or 0,020) + 0,4 . (0,015 or 0,020) + 0,4 . (0,007 or 0,013) + 0,4 . (0,065)

   - Inside of curve

     0,4 . I + 0,5 . (0,015 or 0,020) + 0,4 . (0,015 or 0,020) + 0,4 . (0,039 or 0,065) + 0,4 . (0,065)

2. Minimum position of fixed structures[1]

   - Outside of curve (and straight track sections)

     $$0,4 \cdot E + \sqrt{[1,5 \cdot (0,015 \text{ ou } 0,020) + 0,4 \cdot (0,015 \text{ ou } 0,020)]^2 + [0,4 \cdot (0,007 \text{ ou } 0,013)]^2 + [0,4 \cdot (0,065)]^2}$$

   - Outside inner curve

     $$0,4 \cdot I + \sqrt{[0,5 \cdot (0,015 \text{ ou } 0,020) + 0,4 \cdot (0,015 \text{ ou } 0,020)]^2 + [0,4 \cdot (0,039 \text{ ou } 0,065)]^2 + [0,4 \cdot (0,065)]^2}$$

B.3.2.6 - Application of example 1 of Appendix A

(see point A.1 - page 33)

1. Data in accordance with *UIC Leaflet 505-4*

   Since the maximum speed is > 80 kmh, cant deficiency in this case is taken as ± 0,015 m.

   Since the state of repair of the track is not "especially good", 0,013 m is taken for oscillation and 0,065 for dissymmetry.

   In addition, E = 0,120 m and I = 0,097 m.

2. The extra height to be allowed in respect of the 4,700 m dimension is as follows:

   - Outside of curve, track 1

     $$0,4 \cdot 0,120 + \sqrt{(1,5 \cdot 0,015 + 0,4 \cdot 0,015)^2 + (0,4 \cdot 0,013)^2 + (0,4 \cdot 0,065)^2} = 0,087 \text{ m}$$

   - Inside of curve, track 2

     $$0,4 \cdot 0,097 + \sqrt{(0,5 \cdot 0,015 + 0,4 \cdot 0,015)^2 + (0,4 \cdot 0,065)^2 + (0,4 \cdot 0,065)^2} = 0,078 \text{ m}$$

3. The height of the maximum structure gauge is therefore 4,787 m and 4,778 m respectively. A rounded-off figure of 4,800 m is applied in practice.

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1. Application of the theory of probabilities at point of interface of the different excess values calculated (see UIC Leaflet 505-5, Appendix F).

Appendix C - Hypothetical bases for bi- or multi-lateral agreements covering application of GB1 and GB2 enlarged gauges

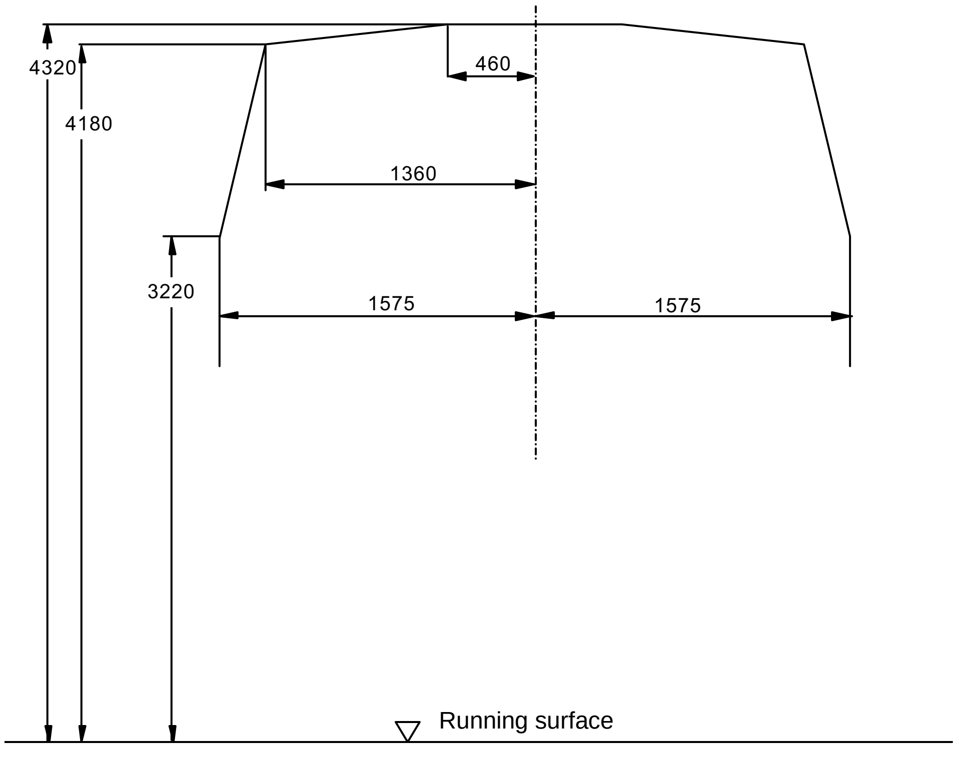
NB : The provisions in this Appendix are given for information.
GB1 : This gauge was originally studied under codename GB + gauge, since changed for the sake of consistency.

GB1 and GB2 gauges were developed on the basis of specific combined-transport requirements that emerged from 1989.

Railways may conclude bi- or multi-lateral agreements covering application of GB1 and GB2 gauges on certain routes.

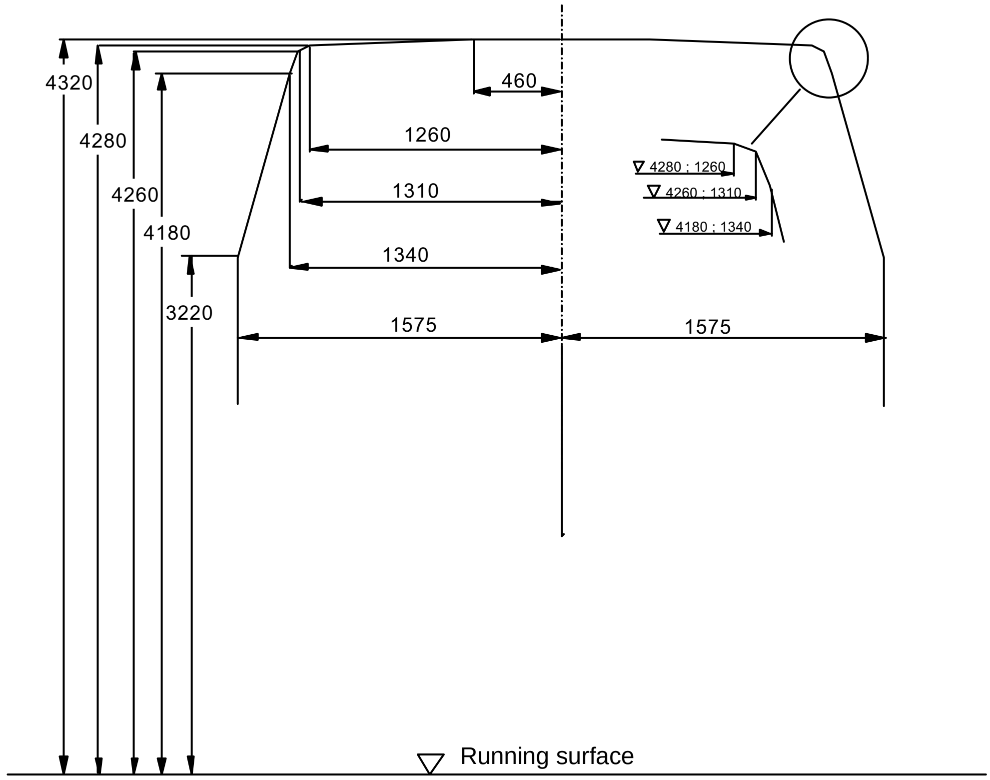
C.1 - GB1 and GB2 static gauges (loading gauges)

C.1.1 - GB1 static gauge



NB : Up to a height of 3 220 mm, the reference profile of GB1 gauge is identical to that of the static gauge shown in *UIC Leaflet 505-5, Appendix H*.

C.1.2 - GB2 static gauge



NB : Up to a height of 3 220 mm, the reference profile of GB1 gauge is identical to that of the static gauge shown in *UIC Leaflet 505-5, Appendix H*.

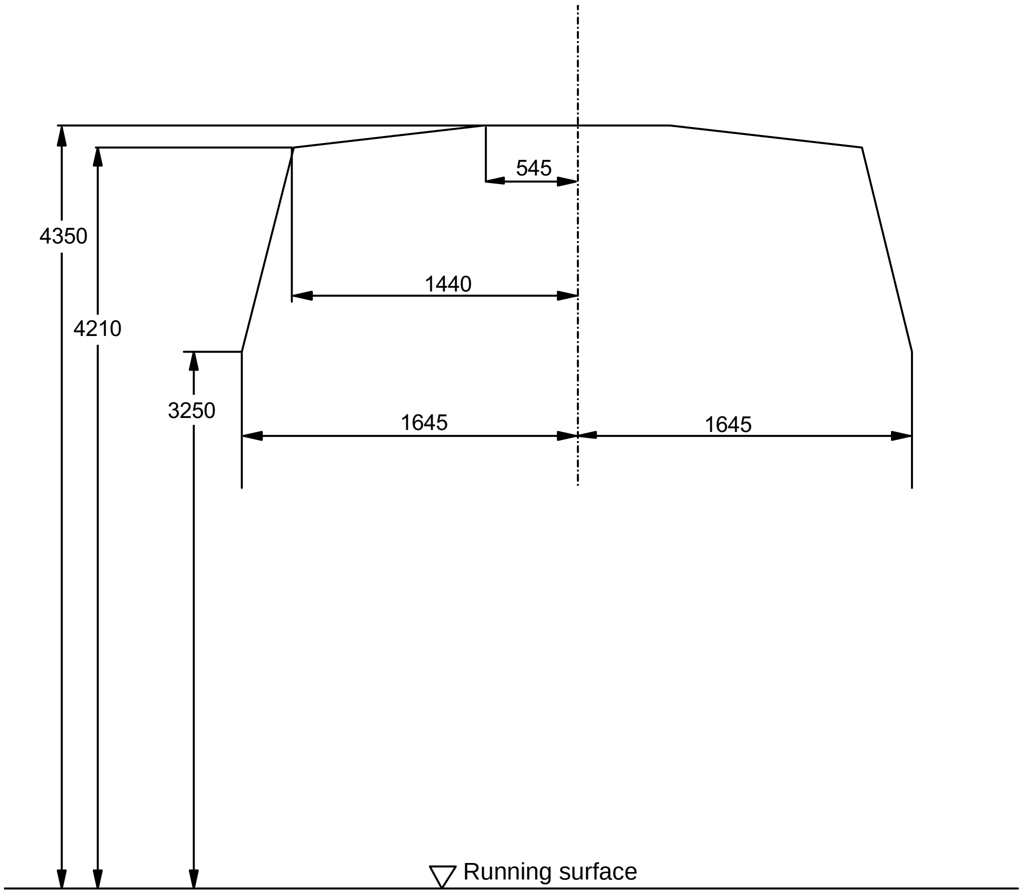
C.1.3 - Rules for static reference profiles GB1 and GB2

The rules aplicable are those for the GB gauge shown in point 3.2 - page 5 of this leaflet, with the exception of coefficien k given in Table 1 - page 6. The coefficient applicable is given in the table below:

GB1 gauge	GB2 gauge
Where 3,22 < h < 4,18 m, $k = \frac{h - 3,22}{0,96}$ Where h ≥ 4,18 m, k = 1	Where 3,22 < h < 4,32 m, $k = \frac{h - 3,22}{1,1}$

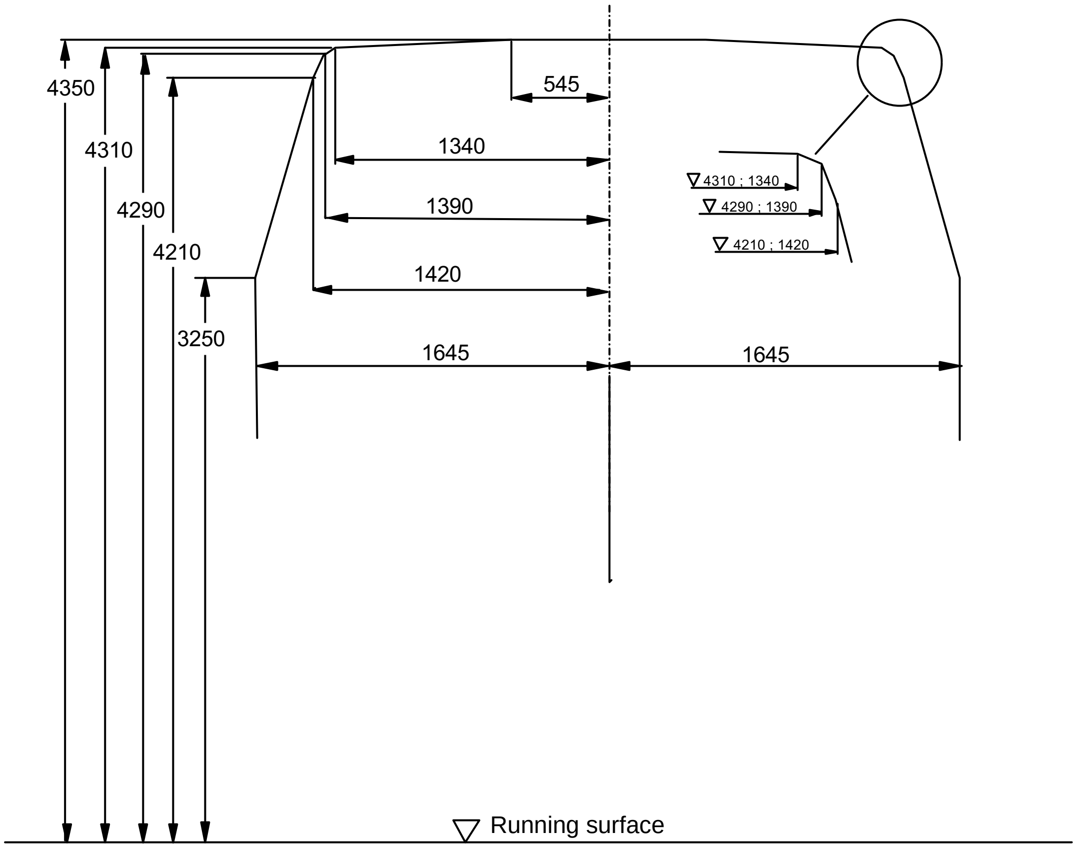
C.2 - GB1 and GB2 kinematic gauges

C.2.1 - GB1 kinematic reference profile



NB : For heights between 400 and 3 250 mm, the reference profile of GA, GB and GC gauge is identical to those given in *UIC Leaflet 505-1 and 505-4*.
For heights ≤ 0,4 m, the reference profile is that associated with the gauge for lower parts.

C.2.2 - GB2 kinematic reference profile



NB : For heights between 400 and 3 250 mm, the reference profile of the GA, GB and GC gauges is identical to that of the gauge given in *UIC Leaflet 505-1 and 505-4*

For heights ≤ 0,4 m, the reference profile is that associated with the gauge for lower parts.

C.2.3 - Rules for kinematic reference profiles GB1 and GB2 to determine the maximum profile for vehicles

The rules applicable are those for GB gauge shown in point 4.2 - page 8 of this leaflet, with the exception of coefficient k given in Tables 2 - page 11, 3 - page 16 and 4 - page 19. The coefficient k applicable is shown in the table below:

GB1 gauge	GB2 gauge
Where 3,25 < h < 4,21 m , $k = \frac{h - 3,25}{0,96}$ Where h ≥ 4,21 m, k = 1	Where 3,25 < h £ 4,35 m , $k = \frac{h - 3,25}{1,1}$

C.2.4 - Rules associated with the GB1 and GB2 kinematic reference profiles for determining the positioning of obstacles

- **Height h ≤ 0,4 m**. The rules applicable are those associated with the gauge for lower sections.
- **Height 0,4 < h ≤ 3,25 m**. The rules applicable are those given in *UIC Leaflet 505-4*.
- **Height h ≥ 4,21 m** (GB1 gauge) and **Height h = 4,35 m** (GB2 gauge).The rules applicable are those given in *UIC Leaflet 505-4*, with the exception of:
  - the formulae for projections. The following should be taken:

    For ∝ > R ≥ 250 m: $S_i \text{ or } S_a = \frac{20}{R} + \frac{\ell - 1,435}{2}$ (in m)

    For 250 > R ≥ 150 m: $S_i \text{ or } S_a = \frac{50}{R} - 0,120 + \frac{\ell - 1,435}{2}$ (in m)
  - the coefficient of flexibility. s = 0,3 should be taken instead of s = 0,4 in all cases where this coefficient occurs.
- Between 3,25 and 4,21 or 4,35 mm, the points obtained are connected by a straight line.

C.3 - Remarks

C.3.1 - Standard loads taken as a basis for determining GB1 and GB2 gauges

C.3.1.1 - GB1 gauge

In conjunction with the gauges for lower parts given in *UIC Leaflet 505-1*.

- Containers 8'6" (2,591 m) wide and 9'6" (2,896 m) high, loaded on wagons (tolerance on centring ± 10 mm) with a ≤ 16 m and floor height 1,18 m.

- Swap bodies 2,60 m wide and 3,00 m high, loaded on wagons (tolerance on centring ± 10 mm) with a ≤ 16 m and floor height 1,18 m.

- Semi-trailers 2,50 m wide, loaded on recess wagons (tolerance on centring ± 20 mm) with a ≤ 12,5 m and height of edges not exceeding 4,18 m above the running surface.

- Semi-trailers 2,60 m wide, loaded on recess wagons (tolerance on centring ± 10 mm) with a ≤ 13,3 m and height of edges not exceeding 4,18 m above the running surface.

In conjunction with GI3 gauge for lower parts - with the general wagon and load characteristics defined for GB2 gauge under point C.3.2 - page 52.

- Semi-trailers with deflated air suspension 2,60 m wide and the height of which does not exceed 3,92 m, loaded on wagons (tolerance on centring ± 70 mm) with a ≤ 14,4 mm and floor height 0,235 m.

C.3.1.2 - GB2 gauge

In conjunction with GI3 gauge for lower parts

- Semi-trailers with deflated spring suspensions 2,60 m wide and not in excess of 4,10 m high, loaded on wagons (tolerance on centring ± 70 mm) with a ≤ 14,4 m and floor height 0,235 m.

C.3.2 - All gauges

The wagons + loads combinations considered have the following characteristics:

	GB1 gauge		GB2 gauge
q+w =	0,023 m	q+w =	0,0115 m
p =	1,8 m	p =	1,8 m
d =	1,410 m	d =	1,410 m
J =	0,005 m (cote nominale)	J =	0,006 m
$\eta_0 \leq$	1°	$\eta_0 \leq$	1°
h_c =	0,5 m	h_c =	0,5 m
s =	0,3	s =	0,3

Vertical oscillations 0,03 m.

C.4 - Definition of the height of the GB2 structure gauge

In accordance with the provisions of *UIC Leaflet 505-4* Permanent Way Departments should increase the vertical dimensions of the upper part of the reference profile by $\frac{50000}{R[m]}$ to take into account curves on gradients.

For the same reasons as for the GC gauge, on account of the large width (1 540 mm in relation to centre-line) of the upper horizontal of the gauge, provision must be made for further increments to the height of 4 350 mm to take account of turning or lifting movements in the upper parts of vehicles or their loads as a result of:

- quasi-static tilt,
- track defects, cant deficiency (in curves) or cross-level deficiencies (in straight sections),
- oscillations caused by dynamic interaction between track and vehicles,
- dissymetry that may occur due to uneven load distribution and adjustment tolerances.

It is to be noted that the flexibility coefficient used for the positioning of GB2 gauge obstacles is 0,3 (0,4 for GC gauge).

Full details relating to the occurrence of these phenomena are given in point B.3.2 - page 44.

C.4.1 - Nominal positioning of obstructions

The additional increments to be provided by Infrastructure Departments to the 4,350 m dimension of the GB2 gauge reference profile are (in m) :

- Outside of the curve and straight sections

$$0{,}3E + 1{,}5 \times (0{,}015 \text{ or } 0{,}020) + 0{,}3 \times (0{,}015 \text{ or } 0{,}020) + 0{,}3 \times (0{,}007 \text{ or } 0{,}013)$$

- Inside of the curve

$$0{,}3I + 0{,}5 \times (0{,}015 \text{ or } 0{,}020) + 0{,}3 \times (0{,}015 \text{ or } 0{,}020) + 0{,}3 \times (0{,}039 \text{ or } 0{,}065) + (0{,}3 \times 0{,}065)$$

C.4.2 - Maximum positioning of obstacles

The additional increments to be provided by Infrastructure Departments to the 4,350 m dimension of the GB2 gauge reference profile are (in m) :

- Outside of the curve (and straight sections)

$$0{,}3E + \sqrt{[1{,}5 \times (0{,}015 \text{ or } 0{,}020) + 0{,}3 \times (0{,}015 \text{ or } 0{,}020)]^2 + [0{,}3 \times (0{,}007 \text{ or } 0{,}013)]^2 + [0{,}3 \times 0{,}065]^2}$$

- Inside of the curve

$$0{,}3I + \sqrt{[0{,}5 \times (0{,}015 \text{ or } 0{,}020) + 0{,}3 \times (0{,}015 \text{ or } 0{,}020)]^2 + [0{,}3 \times (0{,}039 \text{ or } 0{,}065)]^2 + [0{,}3 \times 0{,}065]^2}$$

For example:

For maximum speeds > 80 km/h, cant deficiency of ± 0,015 m is taken.

If the state of repair of the track is not "particularly good", oscillations are taken to be 0,013 m and 0,065 m and dissymmetry 0,065 m.

With cant (E) = 0,120 m and cant deficiency (I) = 0,097 m.

The height increment to be applied to the 4,350 m dimension is:

- Outside of the curve

$$0{,}3 \times 0{,}120 + \sqrt{[1{,}5 \times 0{,}015 + 0{,}3 \times 0{,}015]^2 + [0{,}3 \times 0{,}013]^2 + [0{,}3 \times 0{,}065]^2} \approx 0{,}070 \text{ m}$$

- Inside of the curve

$$0{,}3 \times 0{,}097 + \sqrt{[0{,}5 \times 0{,}015 + 0{,}3 \times 0{,}015]^2 + [0{,}3 \times 0{,}065]^2 + [0{,}3 \times 0{,}065]^2} \approx 0{,}060 \text{ m}$$

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