Commission Decision of 28 July 2006 concerning the technical specification of interoperability relating to the subsystem 'rolling stock — freight wagons' of the trans-European conventional rail system (notified under document number C(2006) 3345) (Text with EEA relevance) (2006/861/EC) (repealed)

ANNEX

Technical Specification for Interoperability relating to the subsystem Rolling Stock — Freight Wagons

ANNEX C

VEHICLE TRACK INTERACTION AND GAUGING

Kinematic Gauge

C.3. GAUGE G1

In 1991 the decision was taken that the regulations for static gauge should no longer be used for the construction of wagons.

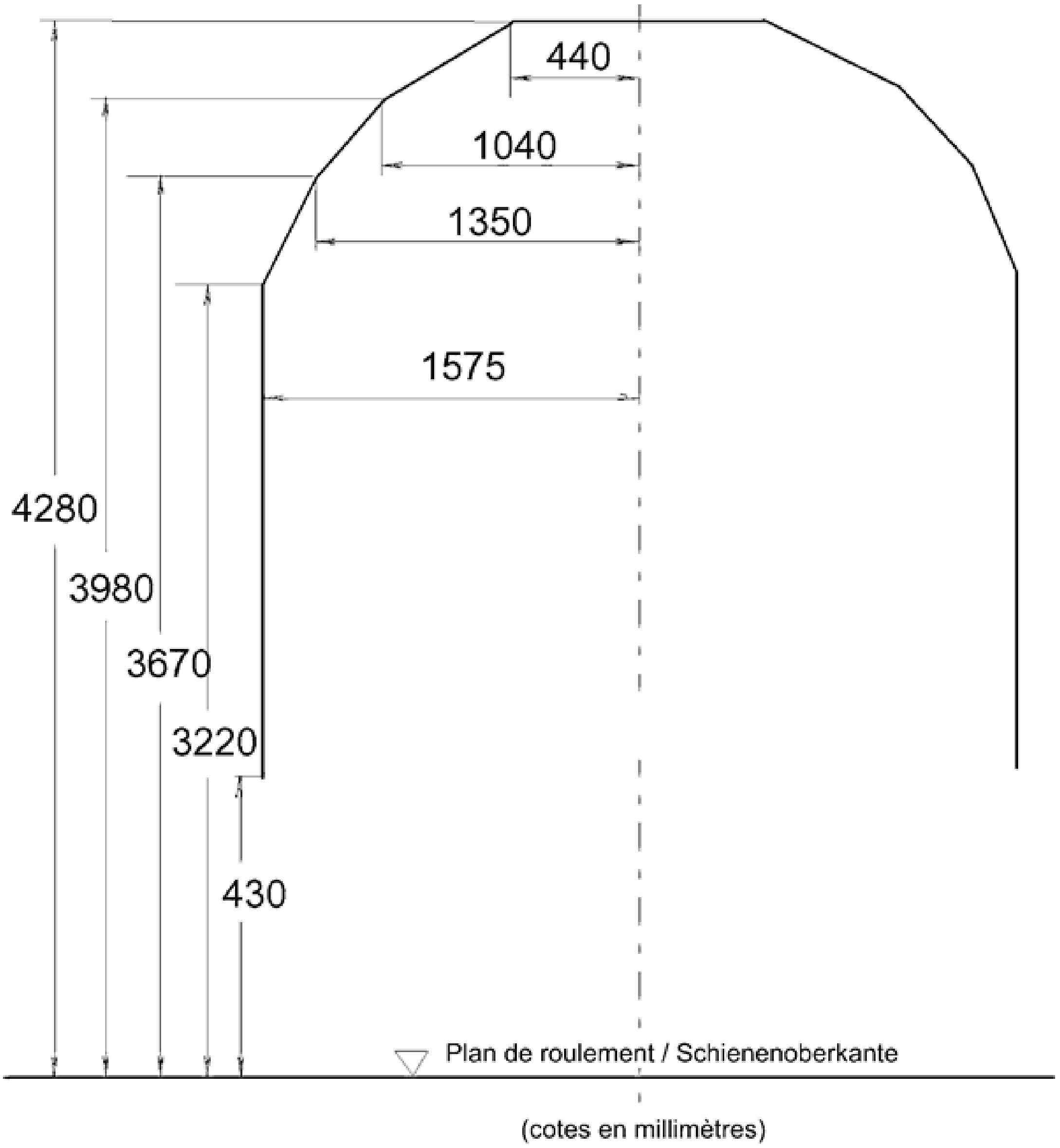
The static gauge regulations therefore remain applicable only to the gauges specially defined for loads, which was the case for example with gauges GA, GB, GB1,GB2 and GC.

Static gauge regulations mentioned below include:

1. a reference profile (upper sections),

2. reduction formulae linked with this profile.

C.3.1. Reference profile for static gauge G1
Fig. C14



C.3.1.1. Reduction formulae

Sections between the end axles or the bogie pivots

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

with:

$\Delta_i = 7{,}5$

if

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

$\Delta_i = \left(an - n^2 + \frac{p^2}{4}\right)$

if this quantity > 7,5

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

Sections situated beyond the end axles or the bogie pivots

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

with

$$\Delta_a = 7{,}5$$

if

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

$$\Delta_a = \left(an + n^2 - \frac{p^2}{4}\right)$$

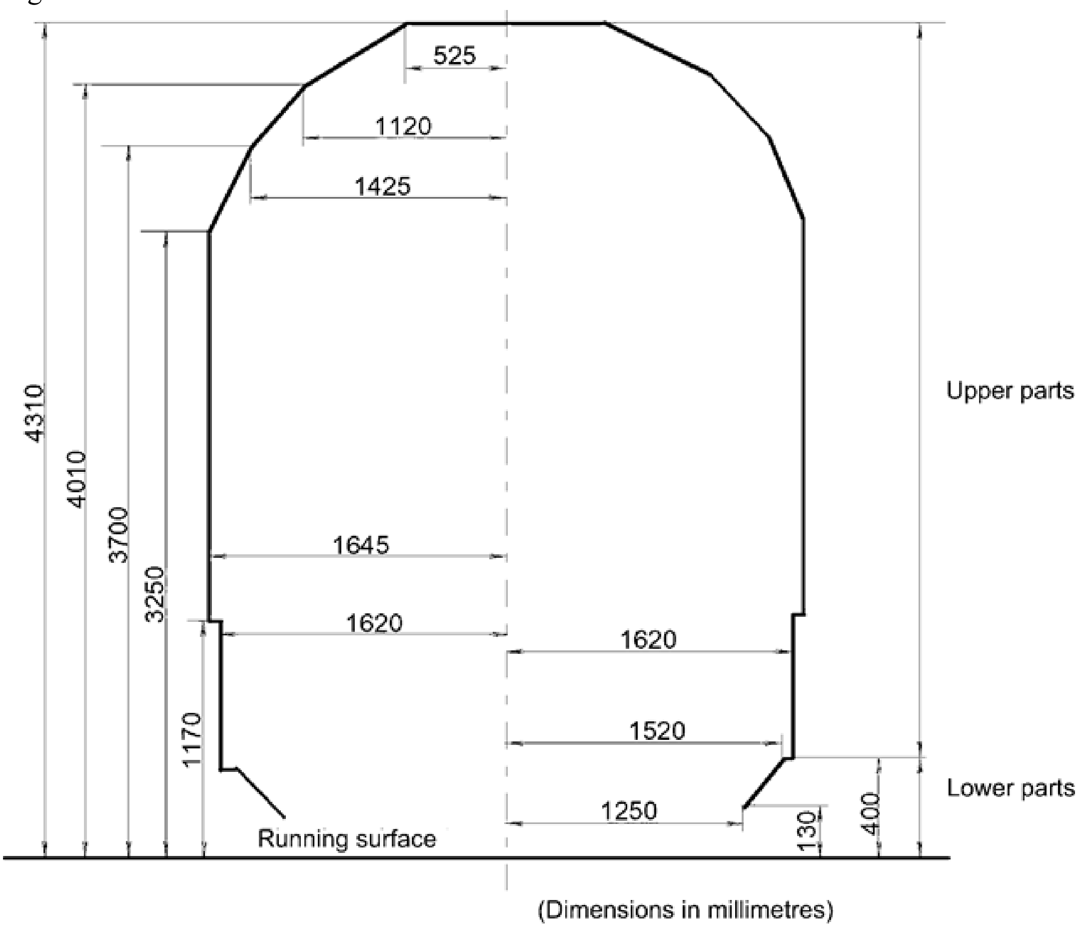
if this quantity is > 7,5

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

C.3.2. Reference profile for kinematic gauge G1

C.3.2.1. Part common to all vehicles

Fig. C15



The G1 kinematic reference profile takes into account the most restrictive lineside structure positions and track centre distances in Continental Europe.

It is divided into 2 parts as follows, one being above and the other below the 400 mm height that is also the limit for the calculation of projections:

— an upper part defined as being above a plane located 400 mm above the running surface, common to all vehicles,
— a lower part defined as being located at or below the plane located 400 mm above the running surface and which differs according to whether the vehicles must pass over shunting bumps, rail brakes and other activated shunting and stopping devices (part lower than 130 mm) or not.

The part below 130 mm differs according to vehicle type.

Loaded coaches must respect the provisions of paragraph C.3.2.2 when on a track without vertical curvature.

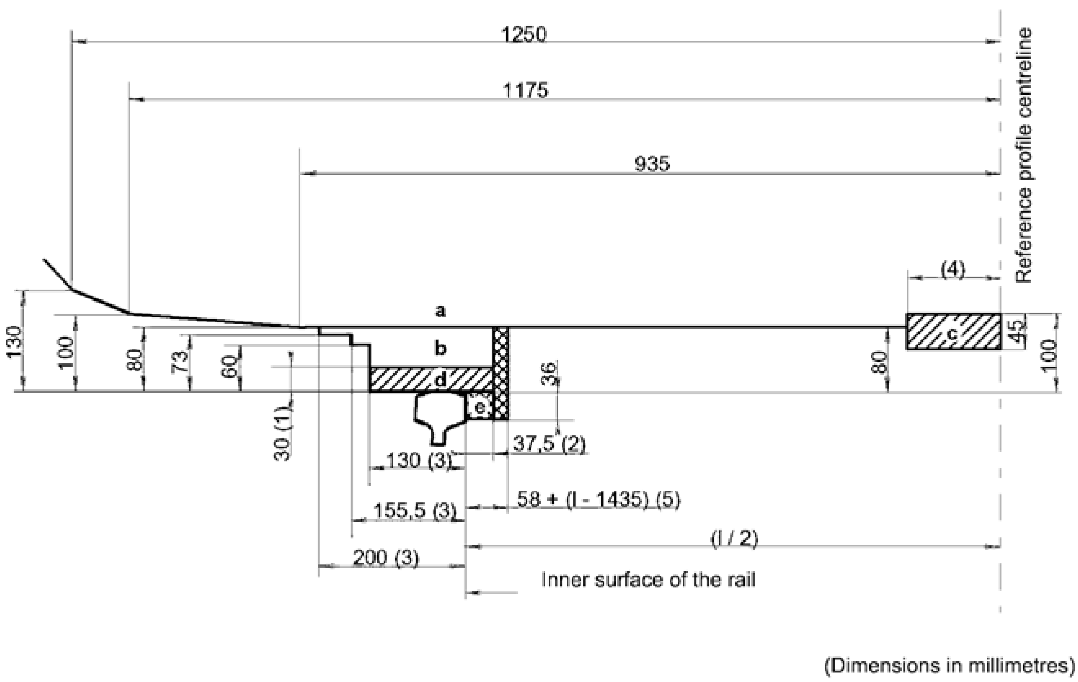
Vans and wagons, whether empty or loaded, except for well-wagons and certain combined transport wagons, must satisfy paragraph C.3.2.3.

In the case of wagons intended to run in transit on the Finnish network, the elements of the lower parts must respect the gauge in accordance with the specific standards.

Wagons which must not pass over shunting humps with a curvature radius of 250 m or track brakes and other shunting and stopping devices:
— shall not be allowed to carry the RIV sign, unless otherwise expressly specified in the standards
— are required to bear the inscription to that effect.

C.3.2.2. Part below 130 mm on vehicles which must not pass over shunting humps or negotiate rail brakes and other activated shunting and stopping devices

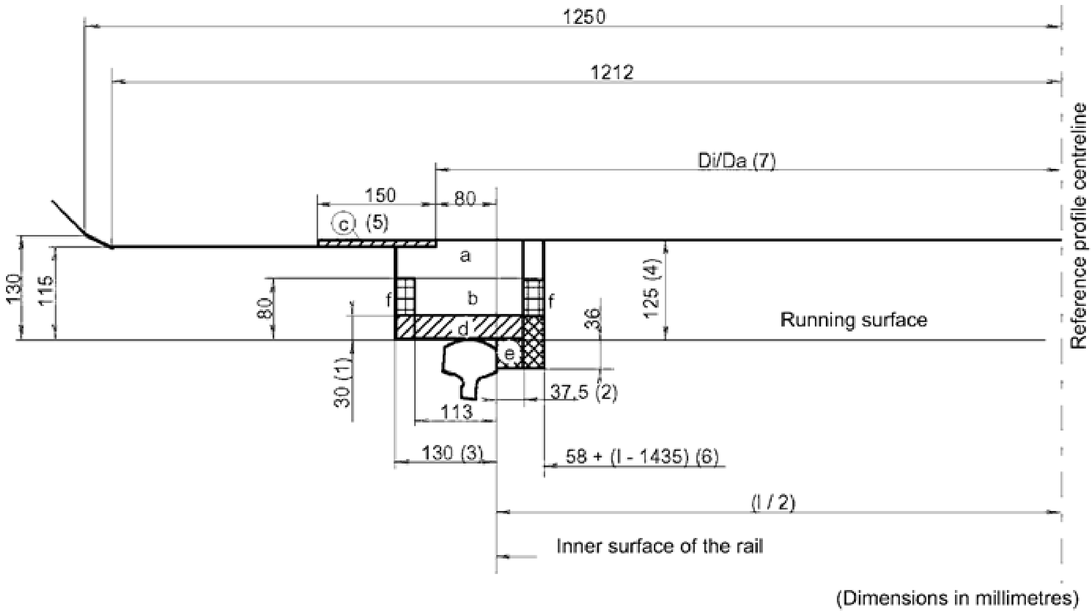
Certain gauge restrictions must be observed at right angles to the axles when vehicles are placed on an under-floor wheel lathe for wheel reprofiling.
Fig. C16



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. This 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.
3)	Effective limit position of the outside surface of the wheel and of the parts associated with this wheel.
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.

C.3.2.3. Part below 130 mm for vehicles able to pass over shunting humps and negotiate rail brakes and other activated shunting and stopping devices

Fig. C17

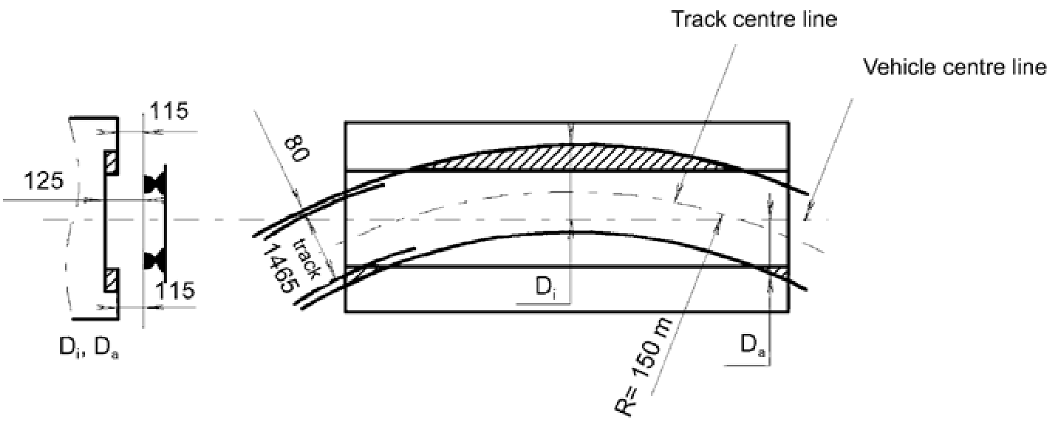


a)	zone for equipment away from wheels
b)	zone for equipment in immediate proximity of wheels
c)	zone for ejection of standardised drag shoes
d)	zone for wheels and other equipment coming into contact with the rails
e)	zone occupied exclusively by the wheels
f)	zone for rail brakes in released position

(1)	Limit for parts located outside the axle ends (guard-irons, sanders, etc) not to be exceeded for running over detonators.
(2)	Maximum fictional width of the flange profiles in the case of check rails.
(3)	Effective limit position of the wheel external surface and of the parts associated with the wheel.
(4)	This dimension also shows the maximum height of standard drag shoes used for scotching or slowing down the rolling stock.
(5)	No rolling stock equipment should penetrate into this area.
(6)	Effective limit position of the wheel internal surface when the axle is against the opposite rail. This dimension varies with gauge widening.
(7)	See paragraph on 'Use of shunting devices on curved track section'.

C.3.2.3.1.*Use of shunting devices on curved track sections*

Rail brakes and other shunting and stopping devices which, when activated, can reach the dimensions 115 or 125 mm, in particular drag shoes 125 mm high, may be placed on curves of radius R ≥ 150 m.
Fig. C18



(unless otherwise indicated, dimensions are in millimetres)

It follows that the application limit for the 115 or 125 mm dimensions, which is at a constant distance from the inner edge of the rail (80 mm), is at a variable distance D from the centreline of the vehicle, as shown in figure 17 above.

Take the following: (1) (values given in metres)

$$D_i = 0{,}008+1{,}465-\frac{1{,}410}{2}+\frac{an-n^2+\frac{p^2}{4}}{300} = 0{,}840+\frac{an-n^2+\frac{p^2}{4}}{300}$$

$$D_a = 0{,}008+1{,}465-\frac{1{,}410}{2}+\frac{an-n^2-\frac{p^2}{4}}{300} = 0{,}840+\frac{an+n^2-\frac{p^2}{4}}{300}$$

NOTE: (1) In the particular case involving the use of shunting devices, the influence of plays q + w may be considered negligible.

C.3.3. Permitted projections S_o (S)

The S effective projections must not exceed the S_o values in the table below.

S_O PROJECTION VALUES[0]

Vehicle types	Track	Ei calculation[c]		Ea calculation[c]	
		Sections between the end axles of vehicles not fitted with bogies or between the pivots of bogie vehicles		Sections beyond the end axles of vehicles not fitted with bogies or beyond the pivots of bogie vehicle	
		h ≤ 0,4	h > 0,4	h ≤ 0,4	h > 0,4
All powered or trailing vehicles	straight	0,015	0,015	0,015	0,015
Powered vehicles Trailing axle vehicles Bogie taken individually and their associated parts	on 250 curve	0,025	0,03	0,025	0,03
	on 150 curve	$0{,}025+\frac{100}{750}=0{,}1583$ [b]	$0{,}030+\frac{100}{750}=0{,}1633$ [b]	$0{,}025+\frac{120}{750}=0{,}185$ [b]	$0{,}030+\frac{120}{750}=0{,}190$ [b]
Trailing bogie stock or equivalent	on 250 curve	0,01	0,015	0,025	0,03
	on 150 curve	$0{,}010+\frac{100}{750}=0{,}1433$ [b]	$0{,}015+\frac{100}{750}=0{,}1483$ [b]	$0{,}025+\frac{120}{750}=0{,}185$ [b]	$0{,}030+\frac{120}{750}=0{,}190$ [b]

a These values have been calculated with the l track gauge which leads to the most restrictive E reduction. This value is $L = l_{max.}$ =1,465 m in all cases except for the E_i international reduction for trailing bogie stock or equivalent vehicles for which it is necessary to take lmin = 1,435 m. Furthermore, for powered units and railcars with one designated 'motor' bogie and one trailer bogie or bogie considered as a 'trailer' (see paragraph 7.2.2.1), the width of the track considered in the internal reduction Ei formulae is 1,435 m for the trailer bogie and 1,465 m for the motor bogie. However, for the sake of simplicity in calculating reductions graphically the following values may be taken for both bogies: l = 1,435 m on straight track and 1,465 m on a 250 m curve. In this latter case, the width of the vehicle body is penalised at right angles to the trailer bogie.

b Term x_i or $x_a$in the reduction formulae.

c These values do not apply to the reference profile for parts on the roof.

C.3.4. Reduction formulae

Remark: The formulae below must be used to calculate the gauging of articulated vehicles whose wheelset or bogie pivot centrelines coincide with the articulation centrelines of the their bodies. For other articulated vehicle architectures the formulae must be adapted to the actual geometrical conditions.

C.3.4.1. Reduction formulae applicable to powered vehicles (dimensions in metres)

Powered vehicles for which play w is independent of the track position or varies linearly with the curvature

Internal reductions Ei (where $n = n_i$)

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

When

$an-n^2+\frac{p^2}{4}-500\left(W_\infty-W_{i(250)}\right)\leq|_5^{7,5}$
00

position on straight track preponderant:

$E_i=\frac{1{,}465-d}{2}+q+w_\infty+z-0{,}015$	(101)

when
$an-n^2+\frac{p^2}{4}-500\left(W_\infty-W_{i(250)}\right)>|_5^{7,5}$
00

position on curve preponderant:

$E_i=\frac{an-n^2+\frac{p^2}{4}}{500}+\frac{1{,}465-d}{2}+q+w_{i(250)}+z+[x_i/_{>0}-|_{0{,}025}^{0{,}030}$ **ab**	(102)

a	This value applies to parts located more than 0,4 m above the running surface, with the exception of those covered by footnote (1) above
b	This value applies to those parts no more than 0,4 m above the running surface and those which may descend below this level as a result of wear and vertical movements.

with $x_i=\frac{1}{750}\left(an-n^2+\frac{p^2}{4}-100\right)+w_{i(150)}-w_{i(250)}$	(103)

External reductions E_a (where $n = n_a$)

Sections beyond the end axles of powered vehicles not fitted with bogies or the pivots or powered bogie vehicles.

when
$an+n^2-\frac{p^2}{4}-500\left[\left(w_\infty-w_{i(250)}\right)\frac{n}{a}+\left(w_\infty-w_{a(250)}\right)\frac{n+a}{a}\right]\leq|_5^{7,5}$
00

position on straight track preponderant:

$E_a=\left(\frac{1{,}465-d}{2}+q+w_\infty\right)\frac{2n+a}{a}+z-0{,}015$	(106)

when
$an+n^2-\frac{p^2}{4}-500\left[\left(w_\infty-w_{i(250)}\right)\frac{n}{a}+\left(w_\infty-w_{a(250)}\right)\frac{n+a}{a}\right]>|_5^{7,5}$
00

position on curve preponderant:

$E_a=\frac{an+n^2-\frac{p^2}{4}}{500}+\left(\frac{1{,}465-d}{a}+q\right)\frac{2n+a}{a}+w_{i(250)}\frac{n}{a}+w_{a(250)}\frac{n+a}{a}+z+[x_a/_{>0}-|_{0{,}025(1)}^{0{,}030(2)}$	(107)

with	(108)

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

Powered units for which travel w varies non-linearly depending on the curvature (exceptional case)

— Other than curves of radius R 150 and 250 m for which formulae (104), (105) and (109), (110) are identical to formulae (101), (102) and (106), (107) respectively, formulae (104), (105), (109) and (110) must be applied for the value of R for which the variation of w as a function of

$\frac{1}{R}$

shows a discontinuity; in other words the value of R as from which the variable stops come into play.

— For each section of the powered unit, the reduction to be taken is the greatest of those obtained from the application of the formulae, in which the value of R to be used is that which gives the highest value for the part between square brackets.

Internal reduction Ei (where n = n_i)

when ∞ > R ≥ 250

$E_i = \left[\frac{\mathrm{an}\text{-}\mathrm{n}^2+\frac{p^2}{4}\text{-}\left\{\begin{smallmatrix}7{,}5(2)\\5(1)\end{smallmatrix}\right.}{2R}+w_{i(R)}\right]+\frac{1{,}465\text{-}d}{2}+q+z\text{-}0{,}015$	(104)

when 250 > R ≥ 150

$E_i = \left[\frac{\mathrm{an}\text{-}\mathrm{n}^2+\frac{p^2}{4}\text{-}100}{2R}+w_{i(R)}\right]+\frac{1{,}465\text{-}d}{2}+q+z+\left\vert\begin{smallmatrix}0{,}170\\0{,}175\end{smallmatrix}\right.$ **ab**	(105)[0]
a This value applies to parts located more than 0,4 m above the running surface, with the exception of those covered by footnote (1) above.	
b This value applies to those parts no more than 0,4 m above the running surface and those which may descend below this level as a result of wear and vertical movements assessed.	

External reduction Ea (where n = na)

when ∞ > R ≥ 250

$E_a = \left[\frac{\mathrm{an}+\mathrm{n}^2\text{-}\frac{p^2}{4}\text{-}\left\{\begin{smallmatrix}7{,}5(2)\\5(1)\end{smallmatrix}\right.}{2R}+w_{i(R)}\frac{n}{a}+w_{a(R)}\frac{n+a}{a}\right]+\left(\frac{1{,}465\text{-}d}{2}+q\right)\frac{2n+a}{a}+z\text{-}0{,}015$	(109)

when 250> R ≥ 150

$E_a = \left[\frac{\mathrm{an}+\mathrm{n}^2\text{-}\frac{p^2}{4}\text{-}120}{2R}+w_{i(R)}\frac{n}{a}+w_{a(R)}\frac{n+a}{a}\right]+\left(\frac{1{,}465\text{-}d}{2}+q\right)\frac{2n+a}{a}+z+\left\vert\begin{smallmatrix}0{,}210(2)\\0{,}215(1)\end{smallmatrix}\right.$	(110)[a]
a In practice, formulae (105) and (110) are without effect, since variation of travel w takes effect when R > 250 through the effect of variable stops.	

C.3.4.2. Reduction formulae applicable to multiple units (dimensions in metres)

For multiple units with one motor bogie and one trailer bogie (see table below)

Multiple units fitted with :	Values of μ for each of the bogies	Running positions § 2.4.2.2	Reduction formulae
2 motor bogies	μ ≥ 0,2	cases 2 and 5	§ 3.4.1
2 bogies considered as 'trailer' bogies	0 < μ < 0,2	cases 2 and 7	§ 3.4.3
one bogie considered as 'trailer' bogie and one trailer bogie	0 < μ < 0,2 μ = 0		
one motor bogie and one trailer bogie or considered as 'trailer' bogie	μ ≥ 0,2 μ = 0 0 < μ < 0,2	cases 3 and 6	§ 3.4.2[a] or § 3.4.1[a]

a The results of the formulae in paragraphs 3.4.1 and 3.4.2 are very similar; as a result, the formulae in paragraph 2.4.1 are generally employed, those of paragraph 3.4.2 being reserved for cases where the increased reduction obtained on the half-width of the maximum construction gauge is particularly significant (0 to 12,5 mm according to the vehicle section considered).

Internal reductions E_i[(1)]

Sections between bogie pivots

$E_i = \frac{1,465-d}{2} + q + w_\infty \frac{a-n_\mu}{a} + w'_\infty \frac{n_\mu}{a} + z - 0,015$	(101a)
$E_i = \frac{an_\mu - n_2^\mu + \frac{p^2}{4} \cdot \frac{a-n_\mu}{a} + \frac{p^2}{4} \cdot \frac{n_\mu}{a}}{500} + \frac{1,465-d}{2} \cdot \frac{a-n_\mu}{a} + q + w_{i(250)} \frac{a-n_\mu}{a} + w'_{i(250)} \frac{n_\mu}{a} + z + [x_i]_{>0} - \left\| \begin{matrix} 0,015(2) \\ 0,010(1) \end{matrix} \right. - 0,015 \frac{a-n_\mu}{a}$	(102a)
with $x_i = \frac{1}{750}\left[an_\mu - n_2^\mu - \frac{p^2}{4} \cdot \frac{a-n_\mu}{a} + \frac{p'^2}{4} \cdot \frac{n_\mu}{a} - 100\right] + \left(w_{i(150)} - w_{i(250)}\right)\frac{a-n_\mu}{a} + \left(w'_{i(150)} - w'_{i(250)}\right)\frac{n_\mu}{a}$	(103a)

External reductions E_a[(2)] motor bogie end (at the front in the running direction)

Sections beyond the bogie pivots (where $n = n_a$)

$E_a = \left[\frac{1,465-d}{2} + q\right] \frac{2n+a}{a} + w_\infty \frac{n+a}{a} + w'_\infty \frac{n}{a} + z - 0,015$	(106a)

$E_a = \frac{an + n^2 - \frac{p^2}{4} \cdot \frac{n+a}{a} + \frac{p'^2}{4} \cdot \frac{n}{a}}{500} + \frac{1,465-d}{2} \cdot \frac{n+a}{a} + q \frac{2n+a}{a} + w'_{i(250)} \frac{n}{a} + w_{a(250)} \frac{n+a}{a} + z + [x_a]_{>0} - \left\| \begin{matrix} 0,030 \\ 0,025 \end{matrix} \right.$ 00	(107a)

with $x_a = \frac{1}{750}\left[an + n^2 - \frac{p^2}{4} \cdot \frac{n+a}{a} + \frac{p'^2}{4} \cdot \frac{n}{a} - 120\right] + \left(w'_{i(150)} - w'_{i(250)}\right)\frac{n}{a} + \left(w_{a(150)} - w_{a(250)}\right)\frac{n+a}{a}$	(108a)

External reductions Ea[(2)] trailer bogie end (at the front in the running direction)

Sections beyond the bogie pivots (where n = n_a)

$E_a = \left[\frac{1,465-d}{2}+q\right]\frac{2n+a}{a}+w_\infty\frac{n}{a}+w'_\infty\frac{n+a}{a}+z-0,015$	(106b)

$E_a = \frac{an+n^2+\frac{p^2}{4}\cdot\frac{n}{a}\cdot\frac{p^2}{4}\cdot\frac{n+a}{a}}{500}+\left(\frac{1,465-d}{2}+q\right)\frac{2n+a}{a}+w_{i(250)}\frac{n}{a}+w'_{a(250)}\frac{n+a}{a}+z+[x_a/_{>0}-\vert^{0,030}_{0,025}$ **ab**	(107b)

a	This value applies to parts located more than 0,4 m above the running surface, with the exception of those covered by footnote (1) above.
b	This value applies to those parts no more than 0,4 m above the running surface and those which may descend below this level as a result of wear and vertical movements.

with $x_a = \frac{1}{750}\left[an+n^2+\frac{p^2}{4}\cdot\frac{n}{a}-\frac{p'^2}{4}\cdot\frac{n+a}{a}-120\right]+\left(w_{i(150)}-w_{i(250)}\right)\frac{n}{a}+\left(w'_{a(250)}-w'_{a(250)}\right)\frac{n+a}{a}$	(108b)

C.3.4.3. Reduction formulae applicable to coaches and passenger vehicles (dimensions in metres)

a) For bogie coaches, with the exception of the bogies themselves and their associated parts

Coaches for which the play w is independent of the track position radius or varies linearly with the track curvature

Note: The formulae below must also be used to calculate the gauging of axle coaches.

Internal reductions E_i

Sections **between** bogie pivots (where n = ni)

When

$an-n^2+\frac{p^2}{4}-500\left(w_\infty-w_{i(250)}\right)\leq 250(1,465-d)-\vert^{0}_{2,5}$

(3)(4)

the position on straight track is preponderant:

$E_i = \frac{1,465-d}{2}+q+w_\infty+z-0,015$	(201)

When

$an-n^2+\frac{p^2}{4}-500\left(w_\infty-w_{i(250)}\right)>250(1,465-d)-\vert^{0(2)}_{2,5(1)}$

the position on curved track is preponderant:

$E_i = \frac{an-n^2+\frac{p^2}{4}}{500}+q+w_{i(250)}+z+[x_i/_{>0}-\vert^{0,015(2)}_{0,010(1)}$	(202)

with	(203)

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

External reductions Ea

Sections **beyond** bogie pivots (where n = na)

When

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

(5)(6)

the position on straight track is preponderant:

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

When

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

the position on curved track is preponderant:

$$E_a=\frac{an+n^2-\frac{p^2}{4}}{500}+\frac{1{,}465-d}{2}\cdot\frac{n+a}{a}+q\frac{2n+a}{a}+w_{i(250)}\frac{n}{a}+w_{a(250)}\frac{n+a}{a}+z+[x_a]_{>0}-\Big|_{0{,}025(1)}^{0{,}030(2)}$$

with:

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

Coaches for which the play w varies non-linearly with the curvature

On straight track the reductions are calculated using formulae 201 and 206.

On curves, the reductions are calculated for R = 150 m and R = 250 m using formulae (204), (205), (209) and (210).

It should be noted that for a radius of R = 250 m, formulae (204) and (209) are identical, respectively, to formulae (202) and (207).

Furthermore, formulae (204), (205) and (209), (210) must be applied for values of R for which the variation of w, as a function of

$\frac{1}{R}$

, presents a discontinuity (a step change), i.e. the value of R from which the variable stops come into play.

For each section of the coach, the reduction to be taken is the greatest of those resulting from the application of the above-mentioned formulae, in which the value of R to be used is that which gives the highest value for the part between square brackets.

Internal reductions Ei (where n = ni)

When ∞ > R ≥ 250

$E_i=\left[\frac{an-n^2+\frac{p^2}{4}-\Big|_{5(1)}^{7{,}5(2)}}{2R}+w_{i(R)}\right]+q+z$	(204)

When 250 > R ≥ 150

$E_i = \left[\frac{an - n^2 + \frac{p^2}{4} - 100}{2R} + w_{i(R)} \right] + q + z + \Big|_{0,190}^{0,185}$ 00	(205)[0]

External reductions Ea (where n = na)

When ∞ > R ≥ 250

$E_a = \left[\frac{an + n^2 - \frac{p^2}{4} - \Big|_{5(1)}^{7,5(2)}}{2R} + w_{i(R)} \frac{n}{a} + w_{a(R)} \frac{n+a}{a} \right] + \frac{1,465 - d}{2} \cdot \frac{n+a}{a} + q \frac{2n+a}{a} + z - 0,015$	(209)

When 250 > R ≥ 150

$E_a = \left[\frac{an + n^2 - \frac{p^2}{4} - 120}{2R} + w_{i(R)} \frac{n}{a} + w_{a(R)} \frac{n+a}{a} \right] + \frac{1,465 - d}{2} \cdot \frac{n+a}{a} + q \frac{2n+a}{a} + z + \Big|_{0,215}^{0,210}$ ab	(210)[c]

a	This value applies to parts located more than 0,4 m above the running surface, with the exception of those covered by footnote (1) above.
b	This value applies to those parts no more than 0,4 m above the running surface and those which may descend below this level as a result of wear and vertical movements.
c	In practice, formulae (205) and (210) have no effect, since the variation in play w, resulting from the variable stops taking effect, begins only when R>250.

b) For bogies and their associated parts

The reduction formulae to be applied are those given in § 4.2.1.8.2. Nonetheless, the distance between the end axles of the bogies is in most cases such that formulae (201) and (206) opposite, identical to formulae (101) and (106), are applicable.

C.3.4.4. Reduction formulae applicable to wagons (dimensions in metres)

a) For wagons with independent axles and the bogies themselves and their associated parts (w = 0)

For 2-axle wagons, and only for those parts located below 1,17 m above the running surface, term Z in formulae (301) to (307) may be reduced by 0,005 m when (z-0,005) > 0. It shall be considered nil when (z-0,005) ≤ 0.

1) Internal reductions Ei — Sections between the end axles (where n = ni)

When
$an - n^2 \leq \Big|_{5(1)}^{7,5(2)}$
the position on straight track is preponderant:

$E_i = \frac{1,465 - d}{2} + q + w_{\infty} + z - 0,015$	(301)

When
$an - n^2 > \Big|_{5}^{7,5}$
00 the position on curved track is preponderant:

$E_i = \frac{an\text{-}n^2}{500} + \frac{1{,}465\text{-}d}{2} + q + z - \Big\|_{0{,}025}^{0{,}030}$ 00	(302)

2) External reductions Ea — Sections beyond the end axles (where n = na)

When
$an + n^2 \leq \Big\|_{5}^{7{,}5}$
00 the position on straight track is preponderant:

$E_a = \left(\frac{1{,}465\text{-}d}{2}\right)\frac{2n+a}{a} + z\text{-}0{,}015$	(306)

When
$an + n^2 > \Big\|_{5}^{7{,}5}$
00 the position on curved track is preponderant:

$E_a = \frac{an+n^2}{500} + \left(\frac{1{,}465\text{-}d}{2} + q\right)\frac{2n+a}{a} + z - \Big\|_{0{,}025}^{0{,}030}$ **ab**	(307)

a	This value applies to parts located more than 0,4 m above the running surface, with the exception of those covered by footnote (1) above.
b	This value applies to those parts no more than 0,4 m above the running surface and those which may descend below this level as a result of wear and vertical movements.

b) For bogie wagons

For bogie wagons whose play is considered to be constant, except for the bogies themselves and their associated parts.

Special remark for calculation of z: see § 1.5.1.3.

1) - Internal reductions Ei — Sections between bogie pivots (where n = ni)

When
$an\text{-}n^2 + \frac{p^2}{4} \leq 250(1{,}465\text{-}d) - \Big\|_{2{,}5}^{0}$
00 the position on straight track is preponderant:

$E_i = \frac{1{,}465\text{-}d}{2} + q + w_{\infty} + z\text{-}0{,}015$	(311)

When
$an\text{-}n^2 + \frac{p^2}{4} > 250(1{,}465\text{-}d) - \Big\|_{2{,}5}^{0}$
00 the position on curved track is preponderant:

$E_i = \frac{an\text{-}n^2 + \frac{p^2}{4}}{500} + q + w + z + [x_i/_{>0} - \Big\|_{0{,}010}^{0{,}015}$ 00	(312)

with $x_i = \frac{1}{750}\left(an - n^2 + \frac{p^2}{4} - 100\right)$	(313)

2) External reductions Ea — Sections beyond bogie pivots (where n = na)

When

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

00 the position on straight track is preponderant:

$E_a = \left(\frac{1{,}465-d}{2} + q + w\right)\frac{2n+a}{a} + z - 0{,}015$	(316)

When

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

00 the position on curved track is preponderant:

$E_a = \frac{an + n^2 - \frac{p^2}{4}}{500} + \frac{1{,}465-d}{2} \cdot \frac{n+a}{a} + (q+w)\frac{2n+a}{a} + z + [x_a]_{>0} + |_{0{,}025}^{0{,}030}$ **ab**	(317)
a This value applies to parts located more than 0,4 m above the running surface, with the exception of those covered by footnote (1) above.	
b This value applies to those parts no more than 0,4 m above the running surface and those which may descend below this level as a result of wear and vertical movements.	

with $x_i = \frac{1}{750}\left(an + n^2 - \frac{p^2}{4} - 120\right)$	(318)

C.3.5. Reference profile for pantographs and non-insulated live parts on the roof

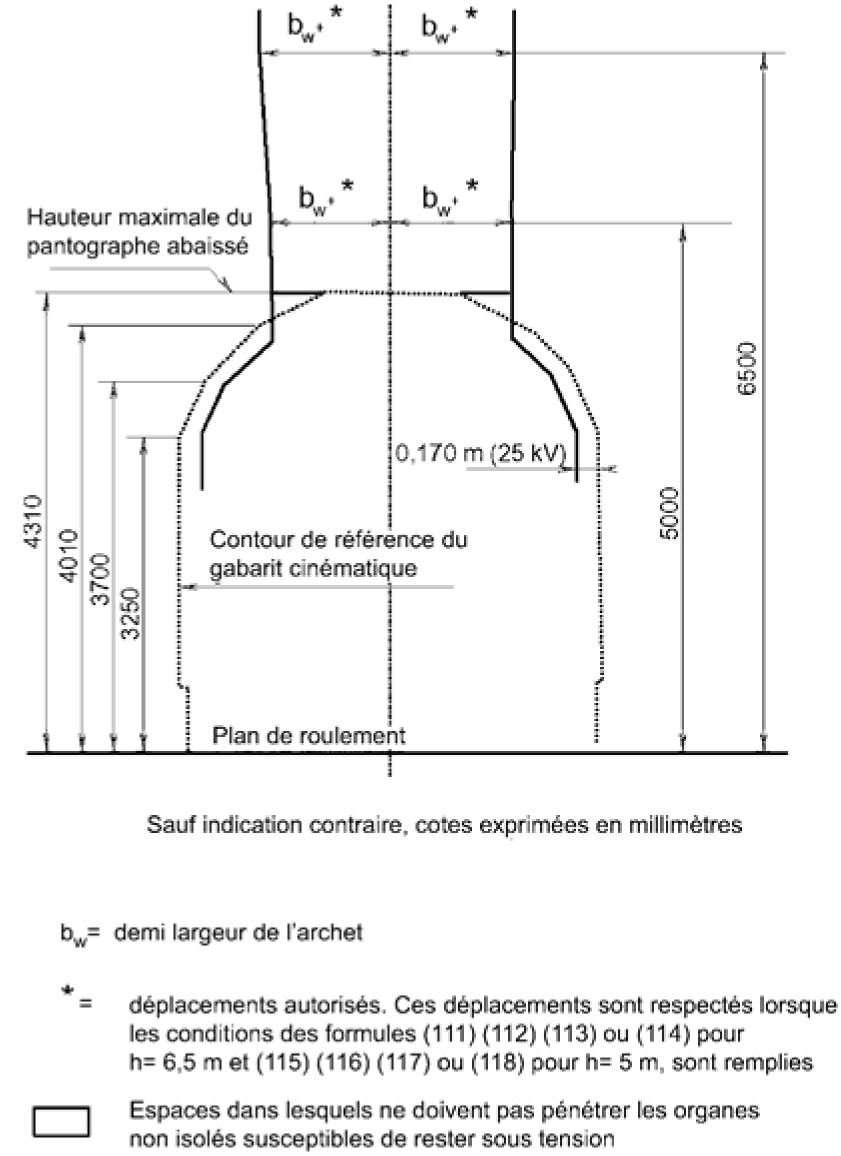


Figure 19

Note: For vehicles worked on electrified lines, the shaded areas may be used for gauging pantograph bows in the down position.

On non electrified lines, the same possibilities are allowable subject to specific studies by the railways.

C.3.6. Rules for the reference profile for determining the maximum rolling stock construction gauge

C.3.6.1. Powered units fitted with pantographs

Pantograph in current collection position

The present standard is based on the characteristics of pantographs for standard gauge powered units.

In order for powered units with pantographs to respect the limit position resulting from the reference profile, the characteristics of these vehicles (play and coefficient of flexibility of the pantograph-bearing section) and the position of the pantograph in relation to the axles must be such that the quantities E'i and E'a (with pantographs raised to 6,5 m above the running surface) and E''_i and E''_a (pantographs raised to 5 m above the running surface) are negative or nil.

This condition is met if the section in which the pantograph bow is operated is placed close to the transverse centreline of the bogies, i.e. if n is very small or nil.

The limit position is then defined by the reference profile for roof-mounted equipment shown in paragraph 2.5. It corresponds to a maximum geometric overthrow of the pantograph bow of

$$\frac{2,5}{R}$$

.

a) Preliminary calculations

To determine E'_i, E'_a, E''_i and E''_a, the following preliminary calculations are necessary[(7)] 1):

j'i = q + wi - 0,0375[(8)] 2)

$$j'_a = q\frac{2n+a}{a} + w_a\frac{n+a}{a} + w_i\frac{n}{a} - 0,0375$$

(8)

when s ≤ 0,225 (general case)

$$z' = \frac{8}{30}(s-0,225) + (t-0,03) + (\tau-0,01) + 6(\theta-0,005)$$

but if s > 0,225, this implies a value of

$$z' = \frac{8}{10}(s-0,225) + (t-0,03) + (\tau-0,01) + 6(\theta-0,005)$$

when s ≤ 0,225 (general case)

$$z'' = \frac{6}{30}s + \sqrt{\left(t\frac{h-h_t}{6,5-h_t}\right)^2 + \tau^2 + (\theta(h-h_c))^2} - 0,0925$$

but if s > 0,225, this implies a value of

$$z'' = \frac{6}{10}s + \sqrt{\left(t\frac{h-h_t}{6,5-h_t}\right)^2 + \tau^2 + (\theta(h-h_c))^2} - 0,1825$$

b) For sections between the end axles or bogie pivots

Expressions for E'_i and E''_i (where $n = n_i$)

When

$$an - n^2 + \frac{p^2}{4} \leq 5$$

the position on straight track is preponderant:

h = 6,5 m	$E'_i = j'_i + z'$	(111)
h = 5 m	$E''_i = j'_i + z''$	(115)

When

$$an - n^2 + \frac{p^2}{4} > 5$$

the position on curved track is preponderant:

h = 6,5 m	$E'_i = \frac{an - n^2 + \frac{p^2}{4} - 5}{300} + j'_i + z'$	(112)
h = 5 m	$E''_i = \frac{an - n^2 + \frac{p^2}{4} - 5}{300} + j'_i + z''$	(116)

c) For sections beyond the end axles or bogie pivots

Expressions for E'_a and E''_a (where $n = n_a$)

When

$an - n^2 + \frac{p^2}{4} \leq 5$

the position on straight track is preponderant:

h = 6,5 m	$E'_a = j'_a + z' + \frac{1,465 - d}{2} \cdot \frac{2n}{a}$	(113)
h = 5 m	$E''_a = j'_a + z'' + \frac{1,465 - d}{2} \cdot \frac{2n}{a}$	(117)

When

$an - n^2 + \frac{p^2}{4} > 5$

the position on curved track is preponderant:

h = 6,5 m	$E'_a = \frac{an + n^2 - \frac{p^2}{4} - 5}{300} + j'_a + z' + \frac{1,465 - d}{2} \cdot \frac{2n}{a}$	(114)
h = 5 m	$E''_a = \frac{an + n^2 - \frac{p^2}{4} - 5}{300} + j'_a + z'' + \frac{1,465 - d}{2} \cdot \frac{2n}{a}$	(118)

C.3.6.2. Railcars fitted with pantographs

The limit position for pantographs on a railcar with one motor bogie and one trailer bogie shall be determined as if both bogies were identical to the one above which the pantograph is placed.

C.3.6.3. Pantographs in lowered position

Subject, if necessary, to application of the insulation conditions, the lowered pantograph must fall entirely within the gauge defined.

C.3.6.4. Insulation clearance margin for 25kV

On vehicles which may use a 25 kV power supply, all non-insulated parts likely to remain live must be arranged so as to fall well within the 0,17 m reference profile.

(**1**) The reduction to apply for a given value of n is the greatest reduction obtained from the following formulae:
- (101 a) or (102 a) and (103 a);
- (106 a) or (107 a) and (108 a);
- (106 b) or (107 b) and (108 b).

(**2**) The reduction to apply for a given value of n is the greatest reduction obtained from the following formulae:
- (101 a) or (102 a) and (103 a);
- (106 a) or (107 a) and (108 a);
- (106 b) or (107 b) and (108 b).

(**3**) This value applies to parts located more than 0,4 m above the running surface, with the exception of those covered by footnote (1) above.

(**4**) This value applies to those parts no more than 0,4 m above the running surface and those which may descend below this level as a result of wear and vertical movements.

(**5**) This value applies to parts located more than 0,4 m above the running surface, with the exception of those covered by footnote (1) above.

(**6**) This value applies to those parts no more than 0,4 m above the running surface and those which may descend below this level as a result of wear and vertical movements.

(**7**) For powered units without fixed bogie pivots, see note in § 1.1.

(**8**) If the play varies according to the track position radius, the maximum value of wi at pivot level (actual or theoretical) shall be taken from j'i, and the maximum value of wa and the corresponding value of wi taken from j'a.