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Translation

OR

Coaches, vans and wagons - Dimensions of buffer heads - Track layout on S-curves

Voitures, fourgons et wagons - Dimensions des plateaux de tampons - Tracé des courbes en S
Reisezug-, Gepäck- und Güterwagen - Abmessungen der Pufferteller - Linienführung der S-Bogen

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

Leaflet to be classified in Volumes:

V - Rolling Stock

VII - Way and Works

Application:

With effect from 1 April 2005
All members of the International Union of Railways

Record of updates

1st edition, January 1965	First issue
2nd edition, January 1981	with 4 Amendments
3rd edition, April 2005	Overhaul of Leaflet

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

Contents

Summary

This leaflet applies to the wagons, coaches, vans and motive power units of UIC member European Railway Undertakings for standard gauge track as well as for larger track gauges in Spain and in Finland.

It specifies boundary dimensions and the calculations of the width of buffer heads as well as the rules governing track layout on S curves enabling operation of vehicles without the need for special regulations.

1 - Dimensions of buffer heads

1.1 - Boundary dimensions

Buffer heads must not exceed the following limits, shown in Appendix A - page 8:

1.1.1 - Towards the outside, the limit of the construction gauge defined, for the vehicle concerned, in the *UIC Leaflet 505* and *UIC Leaflet 506 series*.

1.1.2 - Towards the vehicle centreline:

1.1.2.1 - For wagons, a vertical line situated 600 mm from the vehicle centreline. This limit ensures, generally, the observance of the space to be kept free for the shunter, as defined in *UIC Leaflet 521*;

1.1.2.2 - For coaches and vans, a vertical line situated 540 mm from the vehicle centreline. This limit ensures, generally, the observance of the space to be left free for the shunter, as defined in *UIC Leaflet 521*;

1.1.2.3 - For vehicles with interconnecting gangways, in addition to the vertical line mentioned in point 1.1.2.2, a line sloping at 60° towards the outside and passing at the level of the horizontal centreline of the buffers at a point 615 mm from the vehicle centreline.

1.1.3 - Towards the ground, a horizontal line situated 250 mm below the centreline of the buffers.

1.2 - Calculation of the dimensions of buffer heads

1.2.1 - The buffer heads must completely cover the minimum working surface as shown in Appendix A - page 8.

The curved edges of the buffer heads, the radius of which must not exceed 7 mm (see point 1.4.8 - page 4), may be accepted as forming a part of the minimum working surface.

1.2.2 - The width Δ of the minimum working surface of the buffer heads shall be calculated on the basis of one of the formulae given in Appendix B - page 9, with the vertical symmetry axis of this working surface at a distance of 875 mm from the vehicle centreline.

1.2.3 - The minimum working surface defined in points 1.2.1 and 1.2.2 above must be observed even if, for special design reasons, the distance between the centrelines of the buffer casings is other than 1 750 mm (e.g. in the case of vehicles accepted for running in transit between France and Spain, or between Finland and standard-gauge RUs).

1.3 - General requirements for buffer head materials

Buffers must comply with the requirements set out in appendix D - page 13.

1.3.1 - The roughness value Ra for the surface condition of buffer heads expressed by the mean arithmetic deviation must be ≤ 25. The hardness value HV of the working surfaces measured at a depth of 0.5 mm must be ≥ 160. These provisions apply only to buffer heads made of steel.

1.3.2 - Buffer head materials must be compatible with each other and with all buffer heads currently used in service. The list of materials used is given in Appendix E - page 16 and on the UIC Website (http://www.uic.asso.fr/)

1.3.3 - The function of buffer head materials must be guaranteed in the temperature range of -40 °C/ +50°C. e.

1.3.4 - Friction conditions between buffer heads and with other materials must not be poorer than with the steel-on-steel combination.

1.3.5 - Buffer head materials must withstand grease, oil, wagon cleaning products and other surrounding influences (e.g. ultra-violet rays).

1.3.6 - Operating safety must be guaranteed with buffer head materials other than steel.

1.3.7 - If the entire surface of the buffer head is not made of the same material, it must be ensured that the transition zone between the two materials does not jeopardise safety.

o 1.4 - Special aspects concerning wagons

1.4.1 - Buffer heads must be convex and the radius of curvature of their spherical working surfaces must be:

- 1 500 mm ± 100 for wagons built before 31.12.1993 ;
- 2 750 mm ± 100 for wagons built after 01.01.1994.

1.4.2 - The working surface of buffer heads on new wagons must be symmetrical to the vertical plane passing through the centre-line of the buffer casing and the width of the casing must be chosen from among the standard values given in the tables in points 1.4.3 - page 3 to 1.4.6 - page 4.

1.4.3 - Standard widths of the buffer heads of standard gauge wagons (distance between buffers: 1 750 mm):

Value Δ calculated according to Appendix B	**Corresponding standard width**
$\Delta \leq 400$ mm	450 mm
$400 < \Delta \leq 550$ mm	550 mm

1.4.4 - Standard widths of buffer heads on wagons accepted for traffic with Spain and complying with the provisions of *UIC Leaflet 430-1* (see Bibliography - page 17) (distance between buffer centres: 1 850 mm): the minimum width Δ' of buffer heads of these wagons must be 100 mm more than the width Δ calculated in accordance with Appendix B - page 9.

Value Δ' $\Delta' = \Delta + 100$ mm	Corresponding standard width
$\Delta' \leq 500$ mm	550 mm
$500 < \Delta' \leq 650$ mm	650 mm

1.4.5 - Standard widths of buffer heads on wagons accepted for traffic with Finland and complying with the provisions of *UIC Leaflet 430-3* (see Bibliography - page 17) (distance between buffer centres: 1 790 mm): the minimum width Δ'' of buffer heads of these wagons must be 40 mm more than the width Δ calculated in accordance with Appendix B.

Value Δ'' $\Delta'' = \Delta + 40$ mm	Corresponding standard width
$\Delta'' \leq 400$ mm	450 mm
$400 < \Delta'' \leq 550$ mm	550 mm

1.4.6 - Standard widths of buffer heads on wagons accepted for traffic with both Spain and Finland: in this case, the provisions of point 1.4.4 above apply.

1.4.7 - The standard height of buffer heads shall be 340 mm, i.e. 170 mm on either side of the centre-line of the casing.

1.4.8 - The buffer heads shall not have any irregularities that might pose problems for shunting staff. The edges of their working surfaces must be rounded with a radius of at least 50 mm and the edge of the buffer head must have a curvature of 5 mm $^{+2}_{0}$.

NB : Document DT 85 compiled by ERRI Experts Committee B 12 defines the profiles of buffer heads with widths of 450, 550 and 650 mm meeting these conditions.

1.4.9 - For buffer heads with widths of 550 or 650 mm, with application of the curvature values specified in point 1.4.8 above, it is no longer possible to comply strictly with the minimum working surface when the calculated value Δ (or Δ' or Δ'') exceeds 524 or 624 mm respectively. The resulting slight reduction in the working surface shall be accepted.

1.5 - Special prescriptions concerning coaches

O **1.5.1 -** Buffer heads must be convex and the radius of curvature of their spherical working surface must be equal to 1500 mm ± 100 mm.

R **1.5.2 -** In order to limit the transversal displacements of the buffers on coaches fitted with bogies with a large transversal play (> 40 mm), it is recommended that a device be provided on these coaches limiting the transversal play between vehicle and axle towards the outside of the curve, on small-radius curves (between 150 and 250 m).

R **1.5.3 -** However, if it is found necessary, for special design reasons, to retain a large transversal play (> 40 mm) between vehicle and axle on small-radius curves, it is recommended that buffers be used with buffer heads whose width exceeds the minimum value stipulated in this Leaflet

R **1.5.4 -** It is also recommended that long coaches (length exceeding 25 m) be fitted with buffers with a minimum buffer head width of Δ = 635 mm.

2 - Track layout on S-curves

The regulations relating to the layout of S-curves (length of straight section that may be necessary between a curve and a reverse curve) resulting from the dimensioning of the buffer heads (see point 1 - page 2) and allowing for the running of vehicles without special precautions, are given in Appendix C - page 10.

3 - Comments on the preparation of the formulae in Appendices B and C

3.1 - The formulae applicable, which are shown in Appendices B - page 9 and C - page 10, are based on the studies of the Working Party for Dimensions of buffer heads (see Appendix 5 to the minutes of the Joint Meeting of the 5th and 7th Committees in Bern in May 1964).

The purpose of these studies was twofold:

- to define a method of calculating the width of buffer heads so that the overlap of the buffers of any two vehicles running on a given track circuit is not less than that of the buffers of two so-called "basic" vehicles running under the same conditions;

- to draw up, subsequently, regulations for the layout of S-curves which, in relation to the track gauge and the radii of the curves, shall determine the length of straight track required to comply with the buffer head dimensions defined above.

O **3.2 - Basic conditions**

3.2.1 - Track

- Sheer S-curve with a radius of 190 m without intermediate straight section - Track gauge: 1,458 m

- S-curve with a radius of 150 m with intermediate straight section of at least 6 m - Track gauge: 1,470 m

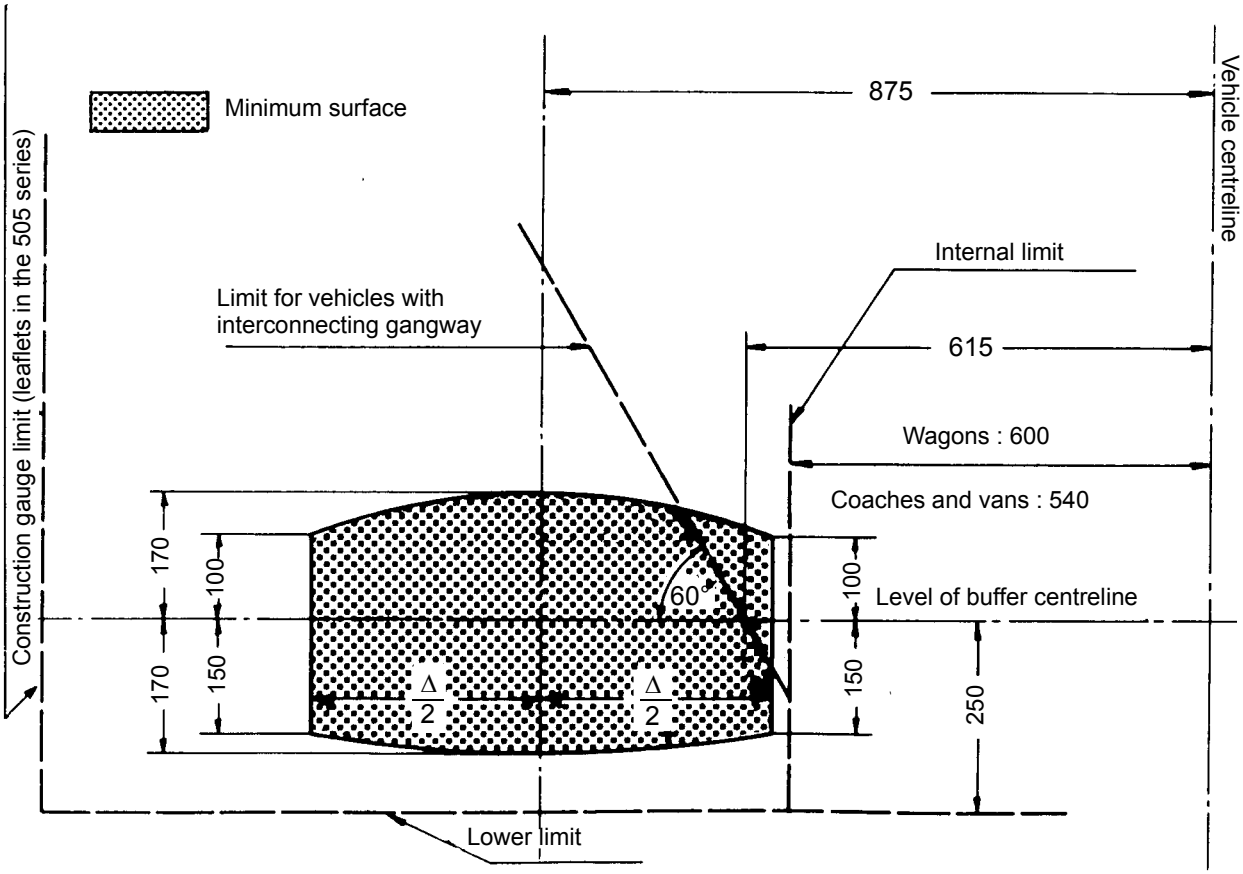
3.2.2 - Vehicle

- Minimum horizontal overlap of 25 mm of two buffer heads in contact, with vehicles running on tracks, as defined in point 3.2.1.

- These conditions led a so-called "basic" vehicle to be adopted, with the following characteristics:

  - Distance between end axles or bogie pivots: 12 m
  - Distance between the buffer face and the end axles or bogie pivot: 3 m
  - Own play of the vehicle: 5 mm
  - Play of the axles on a track 1,470 m wide: 30 mm

Appendix A - Boundary dimensions and minimum surface of buffer heads



Appendix B - Calculation of the width of buffer heads

B.1 - Data used in the calculation

a	=	distance, in mm, between end axles or bogie pivots of the vehicle concerned
n_t	=	overhang, in mm, of the buffer face in relation to the end axle or bogie pivot
F	=	ratio $\frac{an_t + n^2_t}{300\,000}$
K	=	ratio $\frac{n_t + a}{a}$ for hauled bogie vehicles ratio $\frac{2n_t + a}{a}$ for all other vehicles

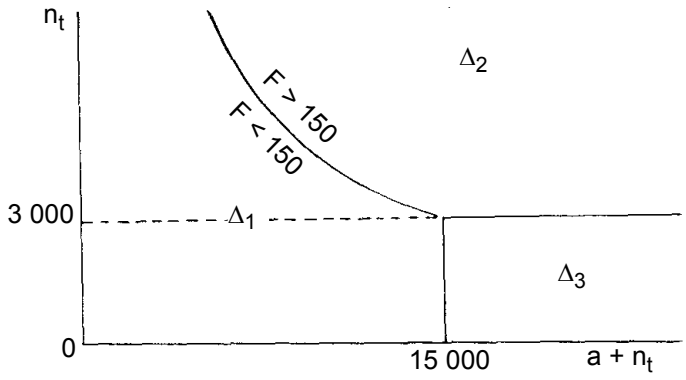
B.2 - Formulae to be applied

The half-width $\frac{\Delta}{2}$ of the buffer heads must not be less than:

$$\frac{\Delta_1}{2} = 30\,k + 130 \qquad \text{when } F \le 150 \text{ and } a + n_t \le 15\,000$$

$$\frac{\Delta_2}{2} = F + 30\,k - 20 \qquad \text{when } F \ge 150 \text{ and } n_t \ge 3\,000$$

$$\frac{\Delta_3}{2} = \frac{\Delta_1}{2} + \frac{(a + n_t - 15\,000)^2}{300\,000\left(\frac{a}{n_t} - 4\right)} = \frac{\Delta_2}{2} + \frac{(3\,000 - n_t)^2\left(\frac{a}{n_t} + 1\right)}{60\,000\left(\frac{a}{n_t} - 4\right)} \qquad \text{when } a + n_t > 15\,000 \text{ and } n_t < 3\,000$$



Appendix C - Regulations relating to the layout of S-curves

(length of straight track likely to be required between a curve and a reverse curve)

C.1 - Data used in the calculation

R_1 and R_2 = radii, in metres, of the curve and reverse curve concerned, with R_1 and $R_2 \geq 150$ m.

L = length, in metres, of straight track likely to be required between curves with radii R_1 and R_2.

I = track gauge, in metres, in the area concerned.

C.2 - Formulae to be applied

1. if $\frac{45}{R_1} + \frac{45}{R_2} - 0{,}45 - 2(1{,}470 - I) \leq 0$ — no straight section is necessary between the curve and reverse curve.

2. if $\frac{45}{R_1} + \frac{45}{R_2} - 0{,}45 - 2(1{,}470 - I) \geq 0$ — the length of the straight section required between the curve and reverse curve is:

$R_1 \leq R_2$	$L_1 = \sqrt{(R_1 + R_2)\left[\frac{45}{R_1} + \frac{45}{R_2} - 0{,}45 - 2(1{,}470 - I)\right]}$ when $\frac{45}{R_1} + 9\frac{4R_2 - R_1}{R_2^2} \leq 0{,}45 + 2(1{,}470 - I)$ $L_2 = 15 - \sqrt{(4R_2 - R_1)\left[0{,}45 + 2(1{,}470 - I) - \frac{45}{R_1}\right]}$ when $\frac{45}{R_1} + 9\frac{4R_2 - R_1}{R_2^2} \geq 0{,}45 + 2(1{,}470 - I)$

NB: a. When $R_1 = R_2 = R$, these formulae can be simplified as follows:

$$L_1 = \sqrt{180 - R[0{,}90 + 4(1{,}470 - I)]}$$

when $R \geq \frac{72}{0{,}45 + 2(1{,}470 - I)}$

$$L_2 = 15 - \sqrt{R[1{,}35 + 6(1{,}470 - I)] - 135}$$

when $R \leq \frac{72}{0{,}45 + 2(1{,}470 - I)}$

b. The above formulae and the examples set out below assume that the curves and reverse curves are tangent to one another or to the intermediate straight section. The length of the straight section must be increased, when an angle on a turnout (points and crossings) alters the swing movement of the vehicles, in order to offset the additional relative displacement of the buffers resulting therefrom.

C.3 - Working examples

Table 1 : Curve and reverse curve without intermediate straight section
(see point C.2, paragraph 1.)

Track gauge	R_1 =	150	160	170	180	190	200
1,470		300	266,7	242,9	225	211,2	200
1,465		281,3	251,8	230,5	214,3	201,7	191,5
1,460		264,8	238,5	219,2	204,6	193,1	183,7
1,455	$R_2 \geq$	250	226,5	209,1	195,7	185,1	176,5
1,450		236,9	215,6	199,8	187,5	177,8	169,9
1,445		225	205,8	191,3	180	171	163,7
1,440		214,3	196,8	183,5	173,1	164,8	157,9

Table 2 : Minimum straight section between a curve and a reverse curve with the same radii
(see point C.2, paragraph 2.)

Track gauge	$R_1 = R_2 = R$	150	160	170	180	190	200
1,470		6,79	6	5,20	4,25	3	0
1,465		6,52	5,73	4,86	3,80	2,28	0
1,460		6,26	5,44	4,50	3,29	1,19	0
1,455	$L \geq$	6	5,14	4,10	2,69	0	0
1,450		5,75	4,82	3,66	1,90	0	0
1,445		5,48	4,48	3,17	0	0	0
1,440		5,20	4,10	2,57	0	0	0

NB : Up to a maximum track gauge of 1,458 m, a curve and reverse curve of 190 m can follow each other without a straight section.

Appendix D - Test programme requirements for verification of buffer head materials

Against item	Requirements under test	Proof of compliance
1.3	**General requirements for buffer head materials**	Operating trials Prior to definitive international approval of buffer head materials, trials in service over a period of at least one year shall be performed and documented in a report. All studies and trials carried out shall be documented in a concise report sent to UIC together with a declaration of conformity. The UIC shall keep a list of approved buffer head materials.
1.3.1	**Roughness value of the surface condition of buffer heads**	Documentation in a report on measured roughness and hardness values.
1.3.2	**Compatibility of buffer head materials**	Proof of compliance must be provided by theoretical studies or tests where necessary. Study report and information on other materials studied (a list of UIC buffer head materials used by the railways is posted on the UIC website); a declaration of conformity shall be provided. In the case of non-metallic materials, a product description and a materials data sheet shall be provided. Details of proof to be provided
1.3.3 and 1.3.4	**Function of buffer head materials** Friction tests - temperature +50°C - Friction force: in steps 100, 150 and 250 kN without changing the buffer heads - Transverse movement +/-50 mm - 1 cycle: 1000 - Opposite material: same material, steel, all materials contained in the list of UIC materials.	Friction and impact tests performed on buffer heads must not generate any shelling, cracks or delaminations with tempering colours. A sliding motion over the surface of the buffer head with a small smooth object must not result in any jolting movements, because this would indicate the presence of unacceptable sharp-edged surface damage. For metallic materials, proof of compliance via the characteristic values in the EN Standards shall be provided for the metals concerned.

Against item	Requirements under test	Proof of compliance
1.3.3 and 1.3.4	Impact test - Temperature: -40 und +50°C - Buffing test 90 t against 80 t at 12 km/h using Category A buffers. Alternatively, the test can be carried out on a pendulum rig in equivalent conditions. - Opposite buffer head: Same material and steel. If results are ambiguous, supplementary tests shall be performed with other buffer head materials contained in the list of UIC materials.	For non-metallic materials, proof of compliance shall be provided via the characteristic values and in rig tests (friction tests and impact tests in the given temperature ranges). Documentation of the studies in test reports.
1.3.5	**Strength of buffer head materials** Test "durable strength" The buffer head material under study (with the usual grease, oils and cleaning chemicals applied) is in each case subjected in the open to UV rays and other weather conditions for a period of several weeks.	By means of known characteristic values or appropriate tests. Documentation in study and/or test reports.
1.3.6	**Guaranteed running safety** Running tests: passenger vehicles Running tests shall be performed with the vehicles and operating conditions considered for application of the buffer head materials under test. Measurement of - Transverse buffer displacement - Wheel/rail forces Pushing tests: wagons In accordance with the conditions in *UIC Leaflet 530-2, appendix 7*.	Computer simulations, tests and other means. For wagons, replace running tests by comparative propelling tests in accordance with *UIC Leaflet UIC Leaflet 530-2, Appendix 7*. A long two-axle wagon shall be provided as test vehicle. Documentation in study and/or test reports.

Against item	Requirements under test	Proof of compliance
1.3.6	Tests with opposite buffers from the same material and tests against steel buffers and (possibly) other approved materials from the UIC list. The results (permissible longitudinal compressive force) shall be contrasted to a comparative test with the same combination of vehicles equipped with conventional steel buffer heads.	
1.3.7	**Safety test in the presence of material transitions on the buffer head surface**	Computer simulations and photographs of respective positions. Study report.

Appendix E - Buffer head materials used by UIC Railways Undertaking

See table under http://www.uic.asso.fr/

Bibliography

1. UIC leaflets

International Union of Railways (UIC)
UIC Leaflet 430-1: Conditions with which wagons must comply in order to be accepted for transit between France and Spain with axle changeover at transfer point, 2nd edition of 1.7.81 - Reprint dated 1.7.97

UIC Leaflet 430-3: Freight wagons. Technical conditions for freight wagons capable of running on both standard-gauge and Finnish broad gauge systems, 2nd edition of 1.7.95

UIC Leaflet 505-5: Basic conditions common to Leaflets 505-1, 505-4 and 506 - Notes on the preparation and provisions of these leaflets, 2nd edition of 1.1.77 and 4 amendments

UIC Leaflet 521: Coaches and vans, wagons, tractive stock - Clearance to be provided at vehicle extremities, 1st edition of 1.1.87 and 1 amendment

UIC Leaflet 526-1: Wagons - Buffers with a stroke of 105 mm, 2nd edition of 1.7.98

UIC Leaflet 526-2: Wagons - Buffers with a stroke of 75 mm, 1st edition of 1.1.81 and 2 amendments

UIC Leaflet 526-3 - (under preparation), 2nd edition of 1.7.98

UIC Leaflet 527-2: Coaches, vans and wagons - Dimensions of buffer heads - Rolling stock built before 1-1-65, 2nd edition of 1.1.60 and 3 amendments

UIC Leaflet 528: Buffer gear for coaches, 7th edition of 1.1.91 and Amendment No.1

UIC Leaflet 828: Technical specification for the supply of welded components for buffers, 1st edition of 1.1.60 and 1 amendment

2. Minutes of meetings

International Union of Railways (UIC)
Sub-Committee for Buffing and Draw Gear (Question 5/U/FIC - Revision of and admendment to the leaflets managed by the Sub-Committee),

Traction and Rolling Stock Committee (Revision of Leaflet 527-1 "Dimensions of buffer heads - Track layout on S-curves"), June 1980

Traction and Rolling Stock Committee (Question 5/U/FIC - Amendment to Leaflet 527-1 "Coaches, vans and wagons - Dimensions of buffer heads - Track layout on S-curves"), October 1982

Joint Meeting of the "Operating" and "Traction and Rolling Stock" Committees (Question 45/B/FIC - Revision of leaflets - Approval of amendments to Leaflet 527-1), October 1983

Sub-Committee for Wagons (Question 45/B/FIC - Revision of Leaflet 527-1 "Coaches, vans and wagons - Dimensions of buffer heads - Track layout on S-curves"- Approval of amendments to Leaflet 527-1), January 1987

Traction and Rolling Stock Committee (Point 31.6 - Amendment to Leaflet 527-1), May 1993

3. Miscellaneous

European Rail Research Institute (ERRI)

DT85/B12: Wagons - Allgemein verwendbare Bauteile und Richtlinien für den Bau von Güterwagen, 3. Ausgabe, 1/02/1996 (exists only in german and french)

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