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Translation

O R

Wagons - Running safety

Wagons - Sécurité de circulation
Güterwagen - Fahrsicherheit

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5th edition, May 2006	Overhaul of Leaflet according to modifications and conclusions of the Sub-Commission 2 "Technical Freight" of the 18th June 2004.

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

Contents

Summary

UIC Leaflet 530-2 defines conditions that must be complied with by wagons from a running safety point of view, irrespective of their type of coupling. Running safety is taken to mean negotiating twisted track and the longitudinal compressive forces generated during braking or propelling movements.

By defining the technical features of current and new wagons, the relevant safety requirements can be met when such wagons are deployed in operations.

For wagons of conventional design as well as operations with the automatic buffing and draw coupler, running safety can be assessed by using a series of diagrams.

For two-axle wagons equipped with screw couplers and side buffers and which have defined technical characteristics, running safety can be checked through a diagram specially designed for that purpose. Furthermore, for some two-axle bogie wagons, there are technical conditions which, to show compliance, do not require propelling tests to be carried out to justify the permissible longitudinal compressive forces. For other wagons, running safety must be demonstrated by the carrying out of propelling tests. The conditions for carrying out and analysing the propelling tests are set out in the appendices to this leaflet.

Depending on the length over buffers and the bogie pivot pitch (wheelbase for two-axle wagons), it is also possible to use diagrams to establish whether there is compliance with the coupling conditions.

1 - General

1.1 - The provisions of this leaflet shall apply to all new wagons without exception, regardless of the type of coupler fitted.

1.2 - The running safety criteria relate to:

- running on twisted track;
- the impact of longitudinal forces.

1.3 - The running safety criteria were established on the basis of:

- *ORE report B55/RP8* (see Bibliography - page 45),
- *ORE reports B125/RP5 and RP6* [1] [2],
- *ORE report B12/RP40*,
- *ORE reports B12/RP69 and RP70*.

1. The criteria were established on the basis of the characteristics of ordinary types of wagons.The inclusion, in trains, of wagons which do not comply with the coupling conditions of the automatic coupler on account of their length or overhang, may be subject to special operating restrictions.
2. The bases used by the CE to prepare these reports are covered by an agreement between UIC and OSJD.

2 - General basic conditions

2.1 - Basic conditions for wagons irrespective of their type of coupling

2.1.1 - The wheel diameter and flange angle used in the calculations in the *ORE report B55/RP8* (see Bibliography - page 45) and *ORE reports B125 RP5 and RP6* are 920 mm and 70° respectively.

2.1.2 - These provisions shall apply to wheels whose nominal diameter is situated between 740 mm and 1 000 mm, the diameter does not have a major impact on running safety for this range.

O **2.1.3 -** In order to assess derailment safety when negotiating twisted track, it is important, for new wagons, for the representative point of the design characteristics on the diagrams set out in Appendices A - page 17, B - page 18 and C - page 19, to be above the A-A line (compliance with the criterion for running on twisted track in the "permissible area")[1]. When the A-A curves are not shown on the diagram there is no restriction on the torsional stiffness c_t*.

For wagons with design characteristics that do not match those set out in Appendices A, B and C, derailment safety when running on twisted track must be demonstrated by carrying out the calculations and test set out in *ORE report B55/RP8*.

2.1.4 - For existing wagons it is recommended that the provisions of point 2.1.3 be fulfilled.

2.2 - Basic conditions for wagons equipped with screw couplings and side buffers

This leaflet also covers the specific conditions to be fulfilled by long two-axle wagons $(14{,}1\ \text{m} \le \text{Lob} \le 15{,}5\ \text{m})$ fitted with screw couplings and side buffers, in accordance with *ORE report B12/RP40*.

2.3 - Basic conditions for wagons equipped with screw couplings and without side buffers

2.3.1 - The conditions to be complied with are set out in the form of diagrams contained in Appendices A, B and C, which indicate:

- the permissible combinations between the values of the design characteristics of the wagons,

- the maximum longitudinal compressive force (F_L) which a wagon can withstand in relation to its constructional characteristics, when fitted with the automatic coupler.

O **2.3.2 -** The design characteristics of new wagons as well as those of existing wagons designed to be fitted with the automatic coupler, should be such that the maximum longitudinal force (F_L) is as high as possible and in any case greater than 500 kN. *ORE reports B125/RP5 and RP6* describe the UIC and OSJD harmonised calculation procedures for determining the permissible longitudinal compressive force for the operation of wagons equipped with the automatic coupler with centre buffer.

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1. This criterion is based on the studies of ORE Committee B55.

2.3.3 - Regarding new wagons, it is recommended that the maximum longitudinal force (F_L) be greater than 600 kN. Proof can be brought by using the calculation method described in *ORE reports B125/RP5 and RP6*.

2.3.4 - When assessing wagons for operation with the automatic coupler, it is assumed, inter alia, that the maximum side travel of the axle relative to the wagon underframe - or bogie frame - is equal to 35 mm for two-axle wagons, 25 mm for bogie wagons with long suspension, and 12 mm for bogie wagons with short suspension.

3 - Conditions specific to two-axle wagons

3.1 - Conditions to be met by existing two-axle wagons equipped with screw coupling and side buffers or with the automatic coupler without side buffers

O **3.1.1 -** Existing wagons built before 1/7/1984 should comply with the following conditions:

- the wheelbase (2a*) should be between $4{,}5\ \text{m} \leq 2a^* \leq 9\ \text{m}$,
- the tare weight should be at least 9 t for wagons equipped with side buffers and at least 9,5 t for wagons fitted with the automatic coupler and without side buffers.

The permissible longitudinal compressive forces[1] for two-axle wagons fitted with side buffers and the screw coupling should be at least 150 kN in accordance with the conditions governing the propelling tests set out in point G.1 - page 35.

O **3.1.2 -** Existing wagons fitted with side buffers and the screw coupling, built between 1/7/1984 and 1/7/1992 shall comply with the conditions set out in point 3.2, although the permissible longitudinal compressive forces should be greater than 180 kN.

O **3.1.3 -** Wagons fitted with side buffers and screw coupling, built after 1/7/1992 shall comply with the conditions set out in point 3.2, although the permissible longitudinal compressive forces should be greater than 200 kN.

O 3.2 - Assessment of the running safety of two-axle wagons equipped with screw coupling and side buffers

3.2.1 - Their length over buffers (Lob) should be less than or equal to 17.3 m.

3.2.2 - Depending on the Lob, the following wheelbases should be used:

- Lob < 14,1 m:	$6\ \text{m} \leq 2a^* \leq 9\ \text{m}$
- 14,1 m ≤ Lob ≤ 15,75 m:	$9\ \text{m} \leq 2a^* \leq 10\ \text{m}$
- Lob > 15,75 m:	$2a^* = 10\ \text{m}$

1. Determination of the permissible longitudinal compressive forces through propelling tests or approximate determination based on DT 388.

3.2.3 - Point E.5 - page 32 sets out the conditions in points 3.2.1 and 3.2.2 - page 5. Furthermore, the diagram includes the limit curves for the conditions underpinning suitability for coupling in accordance with *UIC Leaflets 522 and 530-1* (see Bibliography - page 45). The basis for determining these limit curves is summed up in point E.1 - page 27. The diagram shows the non-permissible combined areas between the length over buffers Lob and the wheelbase 2a*.

3.2.3.1 - For wagons whose characteristics are described by :

- Lob > 15,75 m and wheelbase = 10 m or

- Lob < 14,1 m and wheelbase < 9 m or

propelling tests should be carried out in line with point G.1 - page 35 in order to demonstrate that the permissible longitudinal compressive forces are at least 200 kN.

The results of these tests whose characteristics are located in the areas demarcated by points A, B, C as well as D to F in point E.5 should be communicated to the UIC SG 2 by using the form provided for in point G.2 - page 41.

3.2.3.2 - The use in service of wagons whose characteristics comply with the areas demarcated by points E and F is subject to a preliminary test as well as the agreement of UIC SG 2 (see point 3.4 - page 11).

3.2.4 - Wagons should be equipped with axle guards whose lateral stiffness must comply with the conditions set out in *UIC Leaflet 517, Appendices L2 and L3* (see Bibliography - page 45).

The provisions of *UIC Leaflet 517, point 3.1* shall apply for the determination of the lateral elastic properties and the design of axle guards.

3.2.5 - The torsional stiffness (c_t*) of the body of the wagon should comply with the condition $c_t^* > 0{,}5 \times 10^{10}$ kNmm^2/rad . Proof of the actual c_t* value for a wagon or wagon category should be furnished by means of a torsional test[1].

3.2.6 - The tare weight of wagons with screw couplers and side buffers with:

- Lob < 14,1 m shall be equal to or greater than 11,5 t,

- 14,1 m ≤ Lob ≤ 15,5 m shall be at least equal to the value indicated in Appendix F - page 34, as a function of the torsional stiffness c_t*.

1. ERRI - Document DT 135, 1.5.0 (1995) (see Bibliography).

3.2.7 - The scope of validity for Appendix F - page 34 is specified in point E.5 - page 32.

This covers the sector:

- $14{,}1 \text{ m} \leq Lob \leq 15{,}5 \text{ m}$ and $9 \text{ m} \leq 2a^* \leq 10 \text{ m}$ for wagons with or without a crossover walkway,

- $15{,}5 \text{ m} < Lob \leq 15{,}75 \text{ m}$ et $9 \text{ m} \leq 2a^* \leq 10 \text{ m}$ for wagons equipped with a crossover walkway in accordance with *UIC Leaflet 535-2, point 2.4* (see Bibliography - page 45).

3.2.7.1 - If the tare weight of wagons fitted with side buffers is at least equal to the value obtained for the intersecting point (Lob_i / c_{ti}*) of the wagon to be assessed in Appendix F, then propelling tests are not required to provide proof that the permissible longitudinal compressive forces are 200 kN.

3.2.7.2 - In the case of wagons with $15{,}5 \text{ m} < Lob < 15{,}75 \text{ m}$ and $9 \text{ m} < 2a^* < 10 \text{ m}$ and fitted with a crossover walkway in accordance with *UIC Leaflet 532-2, point 2.4*, the minimum tare must be at least 250 kg more than the minimum tare weight of the same wagon without a crossover walkway as specified in Appendix F.

3.2.7.3 - Regarding the wagons covered by points 3.2.7.1 and 3.2.7.2, whose tare weight is below the required amount indicated in Appendix F propelling tests need to be carried out as per point G.1 - page 35 to provide proof that the permissible longitudinal compressive forces are at least 200 kN. The results of these tests should be communicated to UIC SG 2 using the form specified in point G.2 - page 41.

3.3 - Assessment of the ride safety of two-axle wagons equipped with the AACT and without side buffers

O **3.3.1 -** When assessing the ride safety of a two-axle wagon, account should be taken of the following constructional characteristics:

- Wagon length (length outside the coupling centres),

- wheelbase (2a*),

- wheel load with the wagon empty (Q_0)[1]

- Torsional stiffness of the wagon body (c_t*),

- Mean stiffness of the suspension springs (c_z).

1. In case of wagons fitted with suspension springs with progressive characteristic curves, account should also be taken of partial loads; see footnote for point 3.3.3.

Theorical definition:

- The torsional stiffness c_t* is the torsional elastic stiffness of the wagon body, which for an angular displacement φ, corresponds to the torsional moment F x 2b*. The following interdependency exists between the torsional stiffness, the angular displacement and the torsional moment:

$$C_t^* = \frac{2a^* \times 2b^* \times F}{\varphi}$$ (see Document ERRI DT135, A.5.0 (1995))

with 2b* = lateral distance (mm) between the bearers on which the F forces are exerted

2a* = wheelbase in the case of two-axle wagons; distance between pins in the case of bogie wagons (mm)

φ = angular displacement (rad)

F = vertical force (kN)

- When assessing ride safety, account must taken of the mean spring stiffness (c_z), which is determined in case of a spring suspension arrangement (general double-link suspension). The value c_z is the inverse value of the flexibility C_z (mm/kN).
  The specific flexibility is expressed as C_{z1} to represent certain springs with linear characteristic curves and as C_{z1} and C_{z2} for progressive stiffness curves.
  La *UIC Leaflet 517, Appendix H* (see Bibliography - page 45), describes flexibility and how it is determined.
  F_{cz} = force (kN) of the spring characterising the transition point (transition from C_{z1} to C_{z2}) on the diagram showing the deflection of progressive stiffness springs);
  Z_c = stroke of the spring corresponding to the load F_{cz}.

O **3.3.2 -** The design characteristics of a two-axle wagon as specified in point 3.3.1 - page 7, which should be factored in to fulfil the conditions mentioned in points 2.1.3, 2.1.4 - page 3 as well as points 2.3.2 and 2.3.3 - page 4, are set out in the diagrams

- in Appendix A - page 17 for wagons incorporating leaf springs with linear characteristic curves (c_z),

- in Appendix B - page 18 for wagons incorporating leaf springs with progressive characteristic curves (c_{z1} and c_{z2}).

Points D.1 - page 20 to D.5 - page 25 illustrate the application procedure for these diagrams, point.

3.3.3 - The diagrams were plotted for the following characteristics:

- Wagon length over buffers (Lob),

- wheelbase (2a*),

- stiffness of suspension springs:
  - c_z for springs of constant stiffness,
  - c_{z1} et c_{z2} for springs of progressive stiffness, the transition point being defined by F_{cz} et z_c.

- wheel load difference due to the vehicle ($\Delta_{\bar{q}}$) according to the provisions of point D.3 - page 22.

These diagrams define the permissible maximum longitudinal compressive force (F_L) in relation to the torsional stiffness of the body of the wagon (c_t*) and the wheel load with the wagon empty (Q_0). The calculation basis for plotting the diagrams is described in *ERRI report B12/RP49* (see Bibliography - page 45).

To enable the characteristics required for complying with the conditions set out in points 2.1.2, 2.1.3 and 2.1.4 - page 3 to be determined, the diagrams include the A-A line. The curves plotted for each value of the wheel load (Q_0)[1] fare continuous line curves above the A-A line and broken line curves below the A-A line. The conditions to be observed are explained in point D.2 - page 21.

3.3.4 - The following tables show the values relating to the lengths over buffers, the wheelbases, the types of suspension springs, the areas of torsional stiffness of the bodies, and the wheel loads used for plotting the diagrams.

3.3.4.1 - Characteristics of linear stiffness suspension spring wagons as defined in Appendix A - page 17.

Length over buffers [mm]	Wheelbase [mm]								
9 500	5 500	6 000							
10 000	5 500	6 000	6 500						
10 500	5 500	6 000	6 500						
11 000		6 000	6 500	7 000					
11 500			6 500	7 000	7 500				
12 000			6 500	7 000		8 000			
12 500				7 000	7 500	8 000			
13 000					7 500	8 000		9 000	
13 500						8 000	8 500	9 000	
14 000						8 000	8 500	9 000	
14 500						8 000	8 500	9 000	
15 000								9 000	10 000
15 500								9 000	10 000
16 000									10 000
16 500									10 000
17 000									10 000
17 300									10 000

Types of linear stiffness suspension spring in accordance with *UIC Leaflet 517*:

8 leaves/1 400 mm: c_z = 0,86 kN/mm (Appendix B - page 18)
9 leaves/1 400 mm: c_z = 0,97 kN/mm (Appendix A, type A)
8 leaves/1 200 mm: c_z = 1,37 kN/mm (Appendix A, type B).

1. In the case of suspension spring wagons with progressive characteristic curves, when determining the points for the A-A line, account has also been taken of all the different Q wheel loads that could result from partial loads; the procedure is documented in ERRI report B12/RP49 (1991) (see Bibliography).

Torsional stiffness of the body:

c_t*: 0,40 x 10^{10} up to 8,40 x 10^{10} kN mm^2/rad
with a pitch of 0,50 x 10^{10} kN mm^2/rad

Wheel load:

Q_o: 22,5 - 25 - 27,5 - 30 - 32,5 et 35 kN pour Lob ≤ 12 000 mm
Q_o: 25 - 27,5 - 30 - 32,5 - 35 - 37,5 et 40 kN pour Lob > 12 000 mm

3.3.4.2 - Characteristics of progressive stiffness suspension spring wagons as defined in Appendix B - page 18.

Length over buffers [mm]	**Wheelbase (mm)**								
9 500	5 500	6 000							
10 000	5 500		6 500						
10 500	5 500		6 500						
11 000		6 000		7 000					
12 000				7 000		8 000			
13 000				7 000		8 000			
14 000						8 000		9 000	
14 500						8 000		9 000	
15 000								9 000	10 000
15 500								9 000	10 000
16 000									10 000 [a]
16 500									10 000 [a]
17 000									10 000 [a]
17 300									10 000 [a]

a. The diagrams do not include the trapezoidal spring suitable for 20 t (UIC Leaflet 517, Appendices I1 et I3)

Types of progressive stiffness suspension spring in accordance with *UIC Leaflet 517, Appendices I1 and I3*:

Trapezoidal springs suitable for 20 t/axle

c_{z1} = 1,14 kN/mm
c_{z2} = 2,08 kN/mm
F_{cz} = 40,5 kN
Z_c = 35,5 mm

Parabolic springs suitable for 20 t/axle

c_{z1} = 0,55 kN/mm
c_{z2} = 1,69 kN/mm
F_{cz} = 37,9 kN
Z_c = 69,8 mm

	c_{z1}	= 0,65 kN/mm
Parabolic springs	c_{z2}	= 1,82 kN/mm
suitable for 22,5 t/axle	F_{cz}	= 41,1 kN
	Z_c	= 62,9 mm

Torsional stiffness of the body:

c_t*: 0,4 x 10^{10} up to 10,4 x 10^{10} KN mm^2/rad, with a pitch of 1 x 10^{10} kN mm^2/rad.

Wheel load:

Q_o: 22,5 - 25 - 27,5 - 30 - 32,5 - 35 - 37,5 et 40 kN for all lenghts over buffers.

O **3.3.5 - Use of diagrams**

For lengths over buffers (Lob), wheelbases (2a*) and wheel loads (Q_0), between the values specified, linear interpolations can be made between the values provided by the diagrams.

An interpolation may also be made between the various types of suspension springs with constant stiffness (value c_z).

Conversely, an interpolation may not be made between the results provided by the diagrams for the two types of springs with progressive stiffness examined, or for other types of springs with progressive stiffness.

For the $Q_{o'}$ values, the interpolation can easily be made on the diagrams themselves.

Point D.4 - page 23 contains examples of interpolation for Lob, 2a* and c_z.

O **3.3.6 -** For the operation of wagons equipped with automatic couplers without side buffers, the tare should be chosen so that the conditions in point 2.3.2 - page 3 are met.

3.3.7 - When calculating the permissible longitudinal compressive forces using the diagrams set out in Appendices A - page 17 and B - page 18, the length over buffers to take into account for each wagon should correspond to:

- the effective length over buffers, when the wagons have the same overhang;

- for wagons with unequal overhangs, the length to be adopted is equal to the sum of the wheelbase plus twice the maximum overhang. However, where the overhang is unequal owing to the presence of an end walkway and does not exceed 250 mm, the actual length over buffers of the wagon may be used.

3.4 - Exemptions regarding horizontal coupling of 2-axle wagons

Exemptions relating to the maximum Lob length of wagons may, on request, be granted by UIC SG 2 provided these wagons are restricted by the conditions governing horizontal coupling when operating with automatic couplers (see point E.5 - page 32). Point E.6 - page 33 contains the list of exemptions granted by UIC SG 2.

4 - Conditions specific to wagons with two-axle bogies

4.1 - Conditions to be met by existing two-axle bogie wagons equipped with screw coupling and side buffers, or with the automatic coupler without side buffers

o **4.1.1 -** The bogie pins shall be at least 5 m apart.

4.1.2 - It is recommended that the distance between bogie pins be greater than 6,5 m.

o **4.1.3 -** The distance between bogie pins and overhang (measured from bogie pin to buffer heads) should meet the conditions stipulated in points E.2 - page 30 and E.3 - page 31.

4.1.4 - It is recommended that wherever constructional features of the wagon permit, the overhang should be:

- 2,520 m between bogie pins and buffer heads, or 2,545 m between bogie pins and the coupling plane of the automatic coupler, for wagon ends without a crossover walkway or a footboard,
- 2,770 m between bogie pins and buffer heads, or 2,795 m between bogie pins and the coupling plane of the automatic coupler, for wagon ends with a crossover walkway or a footboard.

o 4.2 - Assessment of the running safety of two-axle wagons equipped with screw coupling and side buffers

Wagons with screw coupling and side buffers will be required to demonstrate permissible longitudinal compressive forces of 240 kN, by carrying out propelling tests in accordance with the conditions laid down in point G.1 - page 35.

An exemption from these tests is allowed for wagons meeting the following conditions[1 2]:

- Tare (T) $\geq$ 16 t;
- Ratio T/Lob $\geq$ 1,0 t/m;
- Overhang located within the permissible areas defined by points E.2 and E.3.

1. ERRI report B12/RP69 (1998) (see Bibliography)
2. ERRI report B12/RP70 (1999)

4.3 - Assessment of the ride safety of two-axle bogie wagons equipped with the automatic buffing and draw coupling and without side buffers

O **4.3.1 -** To assess running safety, the following design characteristics should be taken on board:

- length-over-buffers (Lob) in mm,
- distance between bogie pins (2a*) in mm,
- wheel load (Q_0) in kN of the wagon when empty[1],
- torsional stiffness of the wagon body (c_t*)[1] in kN mm^2/rad (see theoretical definition in point 3.3.1 - page 7),
- bogie type used, with the following main characteristics:

$2a^+$ = bogie wheelbase in mm,

c_z = mean stiffness (in kN/mm), of the suspension springs corresponding to each axle box. This value applies to the suspension when mounted. For suspensions with progressive stiffness, the stiffness value of the 1st stage (c_{z1}) and 2nd stage (c_{z2}) shall be taken into consideration.

F_{cz} = force of the spring(s) in kN which denotes the changeover point of progressive suspension (transfer from c_{Z1} à c_{Z2}),

Z_c = stroke of the spring corresponding to the load F_{cz},

c_t+ = torsional stiffness of bogie frame in kN/mm^2/rad (see theoretical definition in point 3.3.1),

d_{zG} = side-bearer gap (on either side of bogie) in mm,

c_{zG} = stiffness of springs of each side-bearer in kN/mm (only for elastic side-bearers),

q2 = lateral clearance between axle box and bogie frame.

O **4.3.2 -** The design characteristics of a bogie wagon mentioned in point 4.3.1 that must be taken into account to fulfil the conditions of points 2.1.3 and 2.1.4 - page 3 as well as points 2.3.2 and 2.3.3 - page 4, are given

- by the diagrams in Appendix C - page 19, part 1, for wagons fitted with Y25L-type bogies,
- by the diagrams in Appendix C, part 2, for wagons fitted with 65-type bogies[2],
- by the diagrams in Appendix C, part 3, for wagons fitted with 661-type bogies,
- by the diagrams in Appendix C, part 4, for Y25L-type combined transport wagons with side-bearer gap of 9 mm.

Points D.1 - page 20 et D.2 - page 21 illustrate the application procedure for these diagrams.

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1. For intermodal transport vehicles with 9 mm side-bearer gap, the modifications described in Appendix C, (part 4) and resulting from the presence of empty containers or swap bodies, must be taken into consideration when conducting safety checks during transit.
2. Complies with 642 and 652-type bogies.

4.3.3 - The diagrams have been compiled for the following combinations of characteristics:

- length over buffers of the wagon (Lob),
- distance between bogie pins (2a*),
- type of bogie taking account of the wheel load differences specific to the bogie in question (Δ_{q_0}).

These diagrams give the permissible longitudinal compressive force (F_L) for operating with the UIC AACT (without side buffers) in relation to the torsional stiffness of the wagon body (C_t*) and the wheel load when empty (Q_o).

The calculation basis for plotting the diagrams is described in *ERRI report B12/RP49* (see Bibliographie - page 45).

The diagrams include line A-A to assist in determining the characteristics required by wagons for safely negotiating twisted track (points 2.1.3 et 2.1.4 - page 3). The curves plotted for each value of the wheel load (Q_o) are continuous line curves above the A-A line (permissible area) and broken line curves below the A-A line (non-permissible area).

4.3.4 - The following tables give the values for lengths over buffers, for distances between bogie pins, for bogie type, for body torsional-stiffness areas, and for the wheel loads used in connection with the diagrams concerned.

4.3.4.1 - Wagon dimensional characteristics used for compiling the diagrams in Appendix C - page 19:

Overhang (mm)	**2 520**	**2 770**	**2 975**
Distance between bogie pins (mm)		**Lenght over buffers (mm)**	
5 000	10 040	10 540	
6 500	11 540	12 040	12 450
8 000	13 040	13 540	13 950
9 000	14 040	14 540	14 950
10 000	15 040	15 540	15 950
11 000	16 040	16 540	16 950
12 000	17 040	17 540	17 950
13 000	18 040	18 540	18 950
14 000	19 040	19 540	19 950
15 000	20 040	20 540	20 950 [a]
16 000	21 040	21 540	21 950 [a]
17 000	22 040	22 540	22 950 [a]
18 000	23 040	23 540	23 950 [a]
19 300	24 340	24 840	25 250 [a]

a. Unacceptable range as specified in points E.2 - page 30 and E.3 - page 31, see point 4.4 - page 16 for exceptions

4.3.4.2 - Characteristics of bogie types

Characteristics	Bogie Y 25 L	Bogie 661	Bogie 65 [a]
$2a^+$ (mm)	1 800	1 800	1 800
Δq_o	0,20	0,20	0,15
c_{z1} (kN/mm)	1	1,59	0,89
c_{z2} (kN/mm)	2,63	1,59	1,86
F_{cz} (kN)	26,2	-	40
d_{zG} (mm)	12	5	5
c_{zG} (kN/mm)	0,57	0	0
c_t+ (10^{10} kNmm²/rad)	2	0,62	0,65
q2 (mm)	12	25	25
Wheel diameter (mm)	920	920	920

a. Est conforme aux bogies des types 642 et 652.

4.3.4.3 - Torsional stiffness of wagon frame and wheel load

Bogie pitch 2a* in mm	Wheel load Q_o in kN	Torsional stiffness c_t* in 10^{10} kNmm²/rad
$5\,000 \leq 2a^* \leq 10\,000$	17,5 to 35	$0{,}2 \leq c_t^* \leq 25$
$11\,000 \leq 2a^* \leq 15\,000$	20 to 37,5	
$16\,000 \leq 2a^* \leq 19\,300$	25 to 40	

The diagrams have been plotted:

- with a pitch of 2,5 kN for values of Q_0,
- with a pitch of 0,4 x 10^{10} for values of $C_t^* \leq 5 \times 10^{10}$ kNmm²/rad and of 2 x 10^{10} for values of C_t* exceeding 5 x 10^{10} kNmm²/rad.
- for wagons incorporating Y25L-type bogies, and with a side-bearer gap of 12 mm (Appendix C - page 19, part 1),
- for wagons incorporating 65-type bogies, and with a side-bearer gap of 5 mm (Appendix C, part 2),
- for wagons incorporating 661-type bogies, and with a side-bearer gap of 5 mm (Appendix C, part 3),
- for combined-transport wagons incorporating Y25L-type bogies, and with a side-bearer gap reduced to 9 mm, for a bogie pivot pitch of $11\,000 \text{ mm} \leq 2a^* \leq 17\,000$ mm (Appendix C, part 4).

As the overhang only marginally affects the permitted limit value for torsional stiffness C_t* as per *ORE report B55/RP8*, the proposed diagrams only allow for an overhang of 2 975 mm.

For overhangs with lower values, the permitted longitudinal compressive force F_L can be worked out from *ERRI reports B125/RP5 and RP6*, and from the diagrams in Appendix C - page 19, part 1.

O **4.3.5 -** Use of the diagrams

4.3.5.1 - For values relating to the length (Lob) and to the bogie pivot pitch (2a*), comprised between the values adopted in the table given in point 4.3.4.1 - page 14, linear interpolations must be carried out between the results supplied by the diagrams.

Point D.5 - page 25 contains an example of the procedure for effecting these interpolations.

The linear interpolations for values of Q_o can easily be effected from the diagrams.

Interpolations between diagrams designed for different bogie types are not permitted.

4.3.5.2 - The curves relating to wagons:

- fitted with Y25-type bogies are also applicable to wagons incorporating Y25C and Y25R type bogies;

- fitted with 661-type bogies are also applicable to wagons incorporating 664-type bogies;

on account of the small differences between the corresponding curves.

4.4 - Exemptions regarding the horizontal coupling capability of 2-axle bogie wagons

Exemptions relating to the maximum Lob length of wagons may, on request, be granted by UIC SG 2 to the extent that these wagons are restricted by the conditions governing horizontal coupling when operating with automatic couplers (Points E.2 - page 30 et E.3 - page 31). Point E.4 - page 32 contains the list of exemptions granted by UIC SG 2.

Appendix A - Set of diagrams enabling the running safety of two-axle wagons fitted with leaf springs of constant stiffness to be assessed

The diagrams relating to Appendix A are issued in a separate file on the UIC Website http://www.uic.asso.fr/ (see Technical and Research/Products).

Appendix B - Set of diagrams enabling the running safety of two-axle wagons fitted with leaf springs of constant stiffness to be assessed

The diagrams relating to Appendix B are issued in a separate file on the UIC Website http://www.uic.asso.fr/ (see Technical and Research/Products).

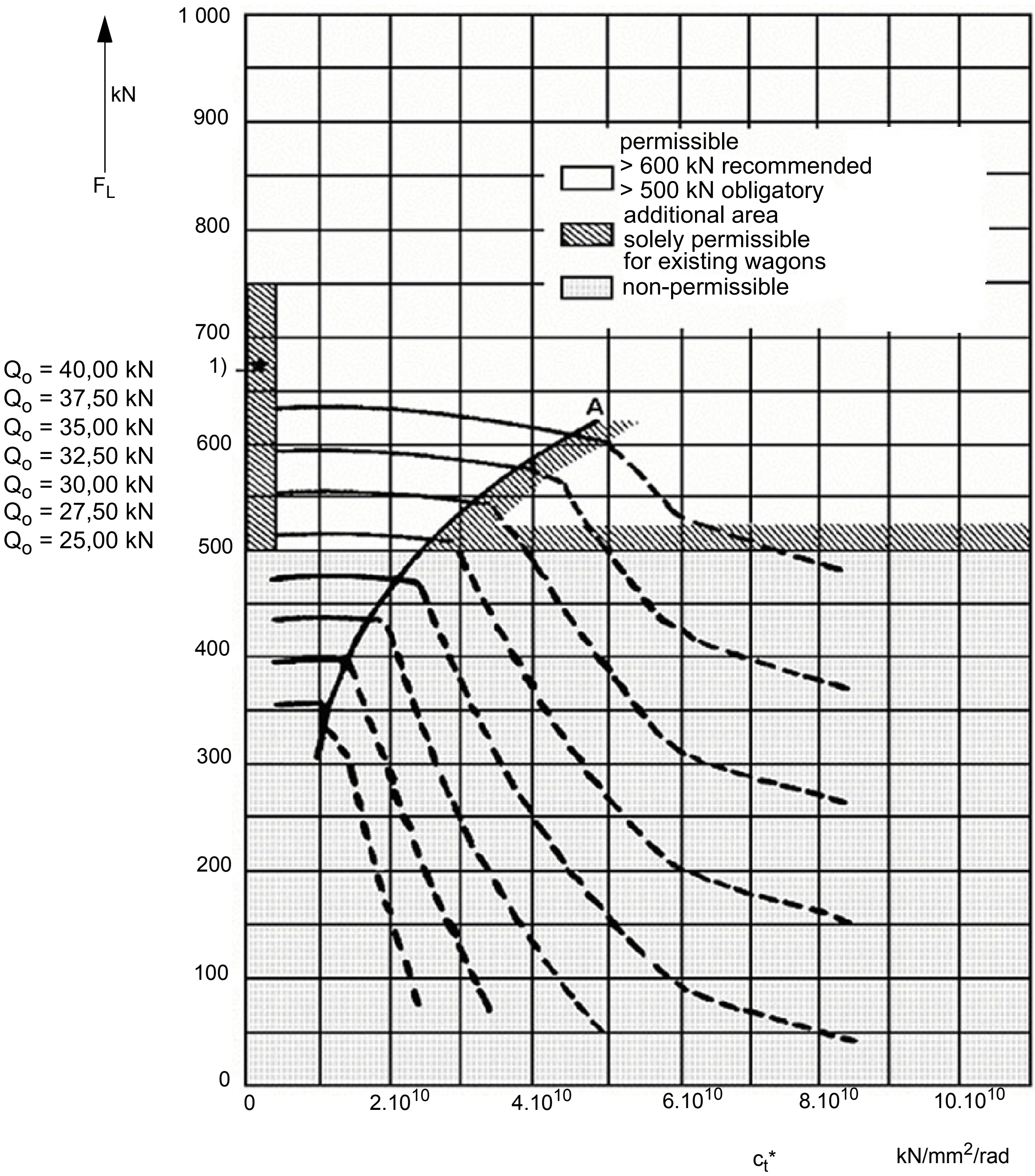
Appendix C - Set of diagrams enabling the running safety of wagons fitted with two 2-axle bogies to be assessed

The diagrams relating to Appendix C are issued in a separate file on the UIC Website http://www.uic.asso.fr/ (see Technical and Research/Products).

Appendix D - Explanations on how to use the diagrams in Appendices A, B and C

D.1 - Example of interpreting a diagram

Example of interpreting a diagram for a 2-axle wagon or a 2-axle 2-bogie wagon (see additional explanations in on points D.2 - page 21 and D.3 - page 22).



1) Limit value $c_t^* > 0{,}4.10^{-10}$ $kN/mm^2/rad$ only applies to 2-axle wagons.

D.2 - Application procedure

D.2.1 - Two-axle wagons or two 2-axle bogie wagons fitted with screw couplings and side buffers

The diagram should be selected on the basis of the characteristic values of the wagons:

- length (Lob),
- wheelbase (2a*) or the distance between bogie pins (2a*),
- type of suspension spring (for a two-axle wagon) or bogie type.

The representative point of the wagon is defined by the values of C_t* and Q_o on the appropriate diagram.

D.2.2 - Two-axle wagons or wagons two 2-axle bogies designed for fitting with the automatic coupler (AA) without side buffers

With a view to the introduction of the AA, a second representative point on the wagon should be deduced from the above mentioned point, using the same diagram sheet. For this purpose, the value of Q_o should be increased by 1,25 kN for two-axle wagons and 0,625 kN for bogie wagons. (It is estimated that the tare weight is increased by 0,5 t as a result of the introduction of the AA).

D.2.3 - Conditions to be observed

For new wagons:

- the representative point of the wagon with screw coupling shall be above the A-A line (even if the force F_L is less than 500 kN),
- the representative point of the wagon with AA should be in the permissible area defined by point D.1 - page 20 (F_L > 500 kN).

For existing wagons intended for fitting with the AA, the representative point of the wagon with AA should be in the permissible area or in the additional area (only permissible for existing wagons) defined in point D.1.

For long two-axle wagons (14,1 m ≤ Lob ≤ 15,5 m) fitted with screw couplers and side buffers, the minimum tare conditions specified in point 3.1.1 - page 5 and Appendix F - page 34 should also be observed.

D.3 - Comments on the wheel load difference $\Delta\bar{q}$ due to the vehicle, for 2-axle wagons

When determining the limit values of the torsional stiffness c_t*, allowance was made for wheel load differences due to the vehicle $\Delta_{\bar{q}} = F(c_t^*)$.

D.3.1 - Two-axle wagons fitted with single-stage trapezoidal springs

The wheel load differences due to the vehicle are determined from the regression equation = $\Delta_{\bar{q}} = 0{,}0151\ c_t^* \times 10^{-10} + 0{,}143$ [1] within the following limits: $0{,}15 \le \Delta_{\bar{q}o} \le 0{,}23$ [1].

Only the case of unloaded wagons needs to be examined.

D.3.2 - Two-axle wagons fitted with double-stage suspension springs

The limit value of the torsional stiffness c_t* should be determined on the basis of the most unfavourable load condition of the wagon. For this purpose, the calculation is made in stages from unloaded wagon to fully-loaded wagon. The specific wheel load difference taken into account: $\Delta_{\bar{q}}$

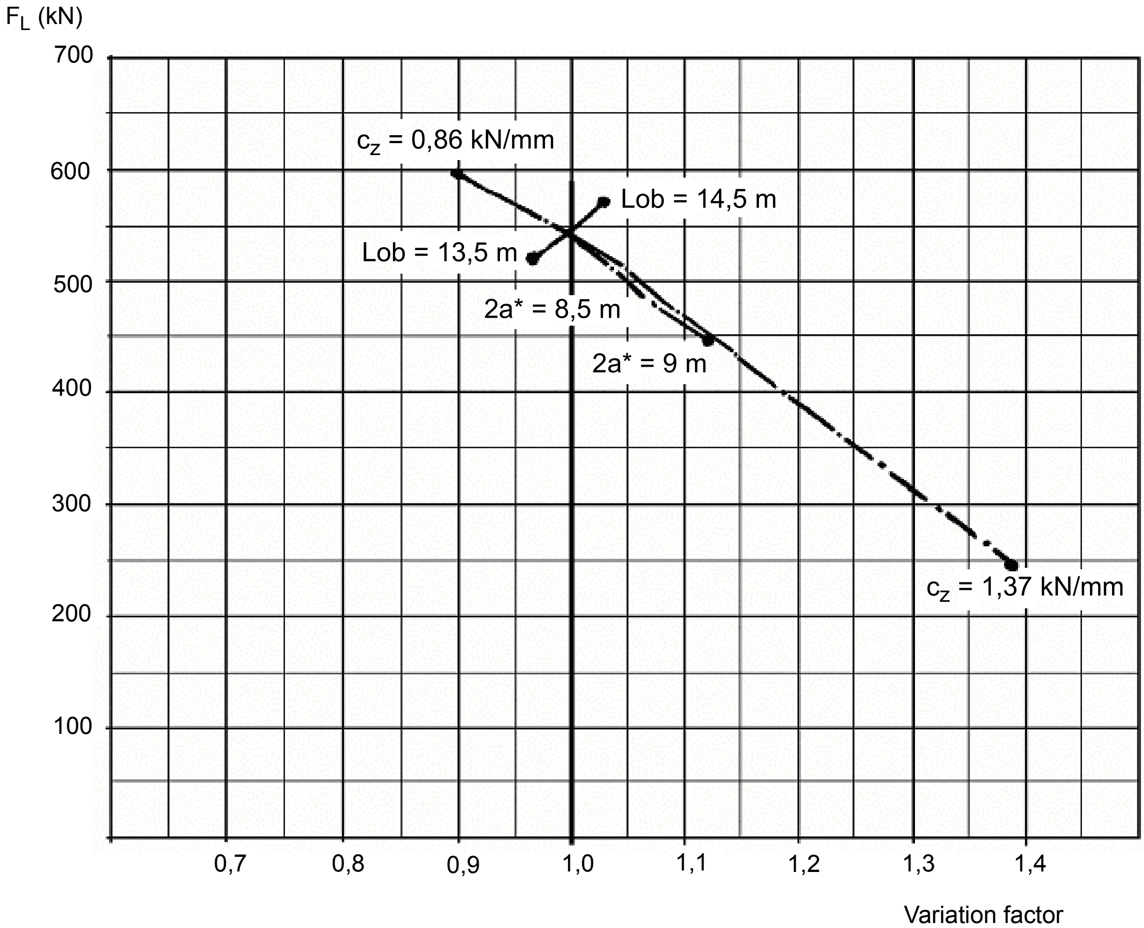
- for the parabolic spring defined in *UIC Leaflet 517* (see Bibliography - page 45) was $\Delta_{\bar{q}} = 0{,}15$ [1],
- for the two-stage trapezoidal spring according to *UIC Leaflet 517* and falling within the range $0{,}15 \le \Delta_{\bar{q}o} \le 0{,}23$, was determined using the following regression equation: $\Delta_{\bar{q}} = 0{,}0151\ c_t^* \times 10^{-10} + 0{,}143$ [1].

In the case of calculations on loaded vehicles, the wheel load difference due to the vehicle $\Delta_{\bar{q}}$ should be subdivided into a component independent of load k_o and a component proportional to the load k_μ. For calculations on double-stage suspension springs, the subdivision adopted is as follows:

- parabolic springs: $k_o = 0{,}07$[1]; $k_\mu = 0{,}08$[1]
- trapezoidal springs: $k_o = 0{,}07$[1]; $k_\mu = \Delta_{\bar{q}} - k_o$[1]

1. The hypotheses adopted in the calculations are based on the result of measurements taken with two-axle wagons. $\Delta_{\bar{q}o}$ is the value of $\Delta_{\bar{q}}$ when the wagon is not loaded.

D.4 - Example of interpolation for determining the longitudinal compressive force F_L on the basis of results supplied by the set of diagrams for Lob, 2a* and C_z characteristics in the case of two-axle bogie wagons



For determining the longitudinal compressive force F_L by interpolation between the results provided by the set of diagrams, a graph can be plotted as indicated in the example presented previously. The use of this interpolation method is justified in particular by the studies carried out on the impact of characteristics Lob, 2a* and c_z.

Comments on the example given by the graph

1 - Basic data

Lob = 14 m

2a* = 8 m

c_z = 0,97 kN/mm

Q_o = 35 kN

c_t^* = 3,9 x 1010 kN mm^2/rad

F_L = 544 kN

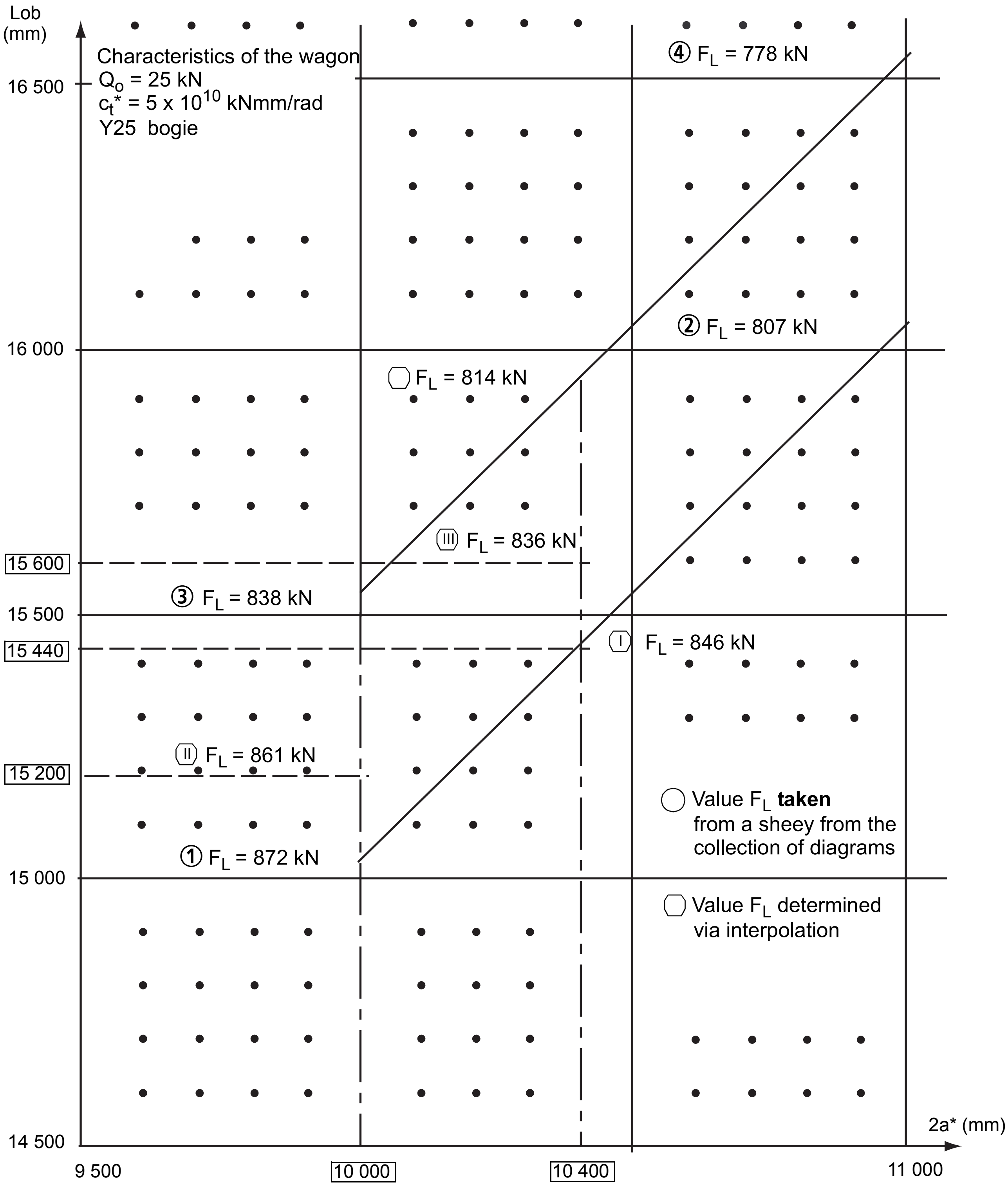
2 - Plotting of the graph

Main	Values	Variation factor	Longitudinal compressive force F_L (kN)
Lob	13,5 m 14,5 m	0,964 1,036	529 574
2a*	8,5 m 9,0 m	1,063 1,125	494 450
c_z	0,86 kN/mm 1,37 kN/mm	0,887 1,412	600 248

3 - Application

A linear interpolation can be made between the values indicated for each diagram. For example, the longitudinal compressive force F_L drops from 544 kN to 504 kN when the wheelbase is increased from 8 m to 8,4 m (variation factor: 1,05).

D.5 - Example of interpolation for determining the longitudinal compressive force F_L on the basis of results supplied by the set of diagrams for Lob and 2a* characteristics in the case of two-axle 2-bogie wagons



This Fig. shows how, through interpolation, the longitudinal compressive force F_L can be determined for bogie wagons with a length over buffers or a distance between bogie pins comprised within the values given in the Table set out in point 4.3.4.1 - page 14. The interpolation method is limited to the study of the influence of the distance between bogie pins (2a*) and of the length over buffers on the level of the longitudinal compressive force.

Three application cases have been presented:

1. Determination of the longitudinal compressive force F_L of a bogie wagon where the distance between bogie pins (2a*) has not been taken into consideration in the set of diagrams. However, a notional overhang has been given to the wagon corresponding to one of the 3 overhangs specified in point .

   Example: Bogie wagon with a length over buffers of 15 400 mm and 2a* = 10 400 mm

   The data for points ① and ② is taken from the set of diagrams. The longitudinal compressive force F_L = 846 kN (point I), for the wagon in question is determined by linear interpolation between points ① and ②.

2. Determination of the longitudinal compressive force F_L for a bogie wagon where the overhang is located between the values given in point 4.3.4.1. The distance between the bogie pins of the wagon (2a*) in question can be deduced from the set of diagrams.

   Example: Bogie wagon with a length over buffers of 15 200 mm and 2a* = 10 000 mm

   The data in points ① and ③ is deduced from the set of diagrams. Linear interpolation between points ① and ③ gives a longitudinal compressive force F_L = 861 kN (point II) for the wagon in question.

3. Determination of the longitudinal compressive force F_L of a bogie wagon with different overhangs to those mentioned in point 4.3.4.1, and where the distance between bogie pins is not taken into consideration in the set of diagrams.

   Example: Bogie wagon with a length over buffers of 15 600 mm and 2a* = 10 400 mm

   The data for points ① and ④ is taken from the set of diagrams. The longitudinal compressive force of the wagon in question is obtained through triple interpolation: F_L = 836 kN (point III).

NB : For bogie wagons with unequal overhang, the largest overhang shall be taken into consideration for determining the longitudinal compressive force.

Appendix E - Provisions relating to wagon coupling

E.1 - Comments on the limit curves for AA

E.1.1 - General information

To prepare for automatic coupler operations, the Lob length and wheelbase or pivot pitch should be chosen so that wagon equipped with the AA can be coupled without outside assistance.

Suitability for horizontal coupling shall be tested by taking into account the lateral field of action (CA) of a coupler, when coupling on a straight line with a radius test curve (R).

E.1.2 - Characteristics of the automatic couplers tested

The UIC code lays down the characteristics of the two types of AA:

- UIC/OSJD AA without side buffers as per *UIC Leaflet 530-1* (see Bibliography - page 45) carrying mandatory status.

- UIC and OSJD modified AA as per *UIC Leaflet 522* (see Bibliography - page 45) carrying recommendatory status.

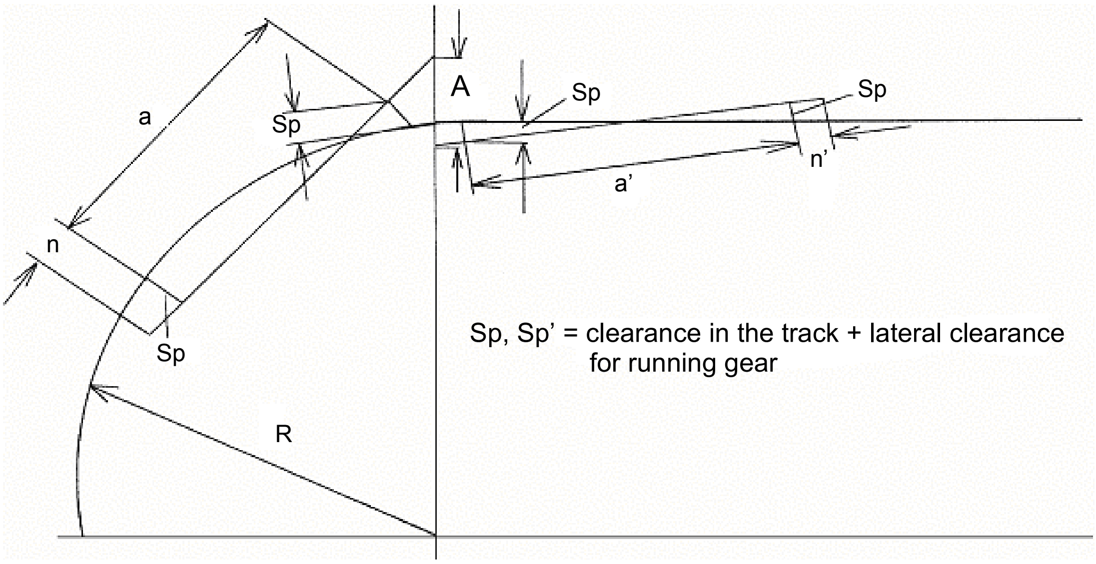
The characteristics and conditions laid down in *UIC Leaflet 530-1* are of crucial importance for checking for the suitability of wagons for coupling.

The table contains the most important criteria to be taken on board for both couplers when checking the coupling capability of a wagon.

Coupling based on UIC Leaflet:	CA (mm)	Test curve with radius of (m)
530-1	220	135
522	190	150

E.1.3 - Test procedures used

The horizontal coupling capability between two wagons shall be tested using the test procedure indicated in *UIC Leaflet 530-1, point 3* in the position portrayed in the figure below on a section between a straight line and a curve.



Parameters a and n refer to wagons to undergo testing, parameters a' and n' to the reference wagon.

A two-axle Tdgs/Fcs gravity unloading standard wagon as specified in *UIC Leaflet 571-3, point 5* (see Bibliography - page 45) was used as reference wagon. The following parameters from the reference wagon were used during the test procedure.

Wheelbase a'	[m]	[m]
Overhang up to the buffer head plane N_p	[m]	1,82
Overhang up to the coupling plane (*UIC Leaflet 530-1*)	[m]	1,845
Overhang up to the coupling plane (*UIC Leaflet 522-2*)	[m]	1,88 [a]
Clearance in the track q' [a]	[m]	0,02
Reduction factor k'	[m]	0,2

a. AAST in the upper position.

The condition applicable to the limit curves drawn in the appendices for horizontal coupling capability is:

Side movement A = CA

Side movement is calculated based on the formula contained in *UIC Leaflet 530-1* (see Bibliography - page 45):

$$A = \frac{an + n^2}{2R} + \frac{2n + a}{a}(q_1 + q_2)k + \frac{2n' + a'}{a'}(q_1' + q_2')k'$$

E.1.4 - Parameters related to the wagon to be assessed

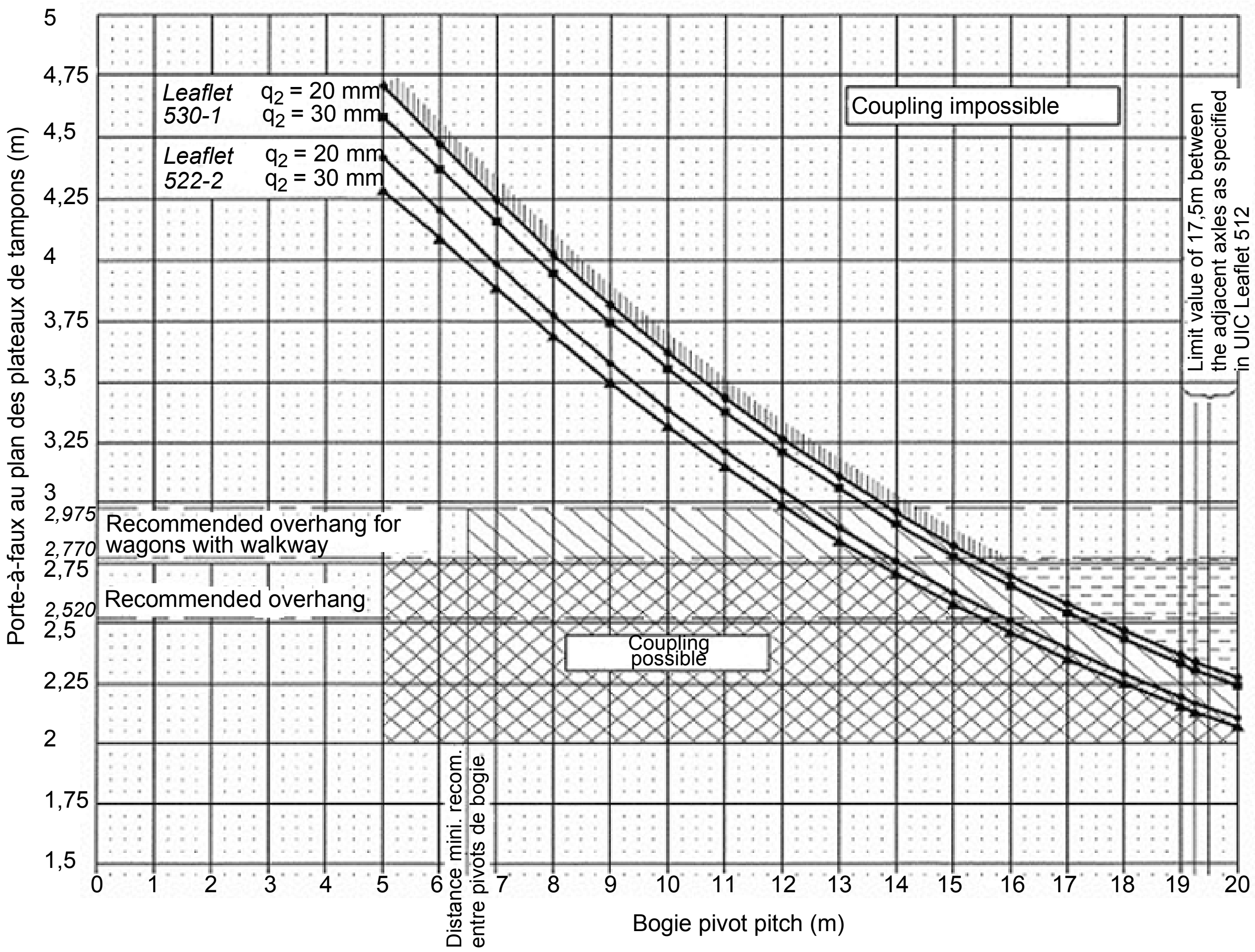
The target value for the calculation-based test procedure for wheelbases examined for two-axle wagons or for bogie pivot pitches for bogie wagons, is represented by the permissible overhang n_p up to the buffer head plane.

The following parameters were assumed for calculating the permissible overhangs n_p of the wagons to be assessed.

Parameter	Dimension	2-axle wagons	Bogie wagon, especially bogies of the type	
			65	Y25
Clearance in the track q_1	[m]	0,0275	0,0275	0,0275
Lateral clearance for running gear q_2	[m]	0,02	0,02 and 0,03	0,01 and 0,02
Reduction factor k	-	0,45	0,25	0,4
Overhang for the coupler in front of the buffer head plane for:				
coupling based on *UIC Leaflet 530-1*	[m]	0,025	0,025	0,025
coupling based on *UIC Leaflet 522-2*	[m]	0,06 [a]	0,06 [a]	0,06 [a]

a. AAST in the upper position.

E.2 - Permitted areas and wagon dimensions for horizontal coupling on 2-axle two-bogie wagons (especially for the 65-type bogie)



These curves indicate the potential geometrical limits for horizontal coupling on bogie wagons equipped with AA the characteristics of witch are laid down in *UIC Leaflets 530-1 and 522*.
The principles and parameters used for calculing curves are explained in point E.1 - page 27.

For all areas defined in the diagram as well as for the special cases, it is important that the conditions laid down in points 2.1.3 - page 3 and 2.3.2 - page 4 are met.

Permissible areas; overhangs of more than 2 800 mm are only allowed for wagons equipped with crossover walkways.

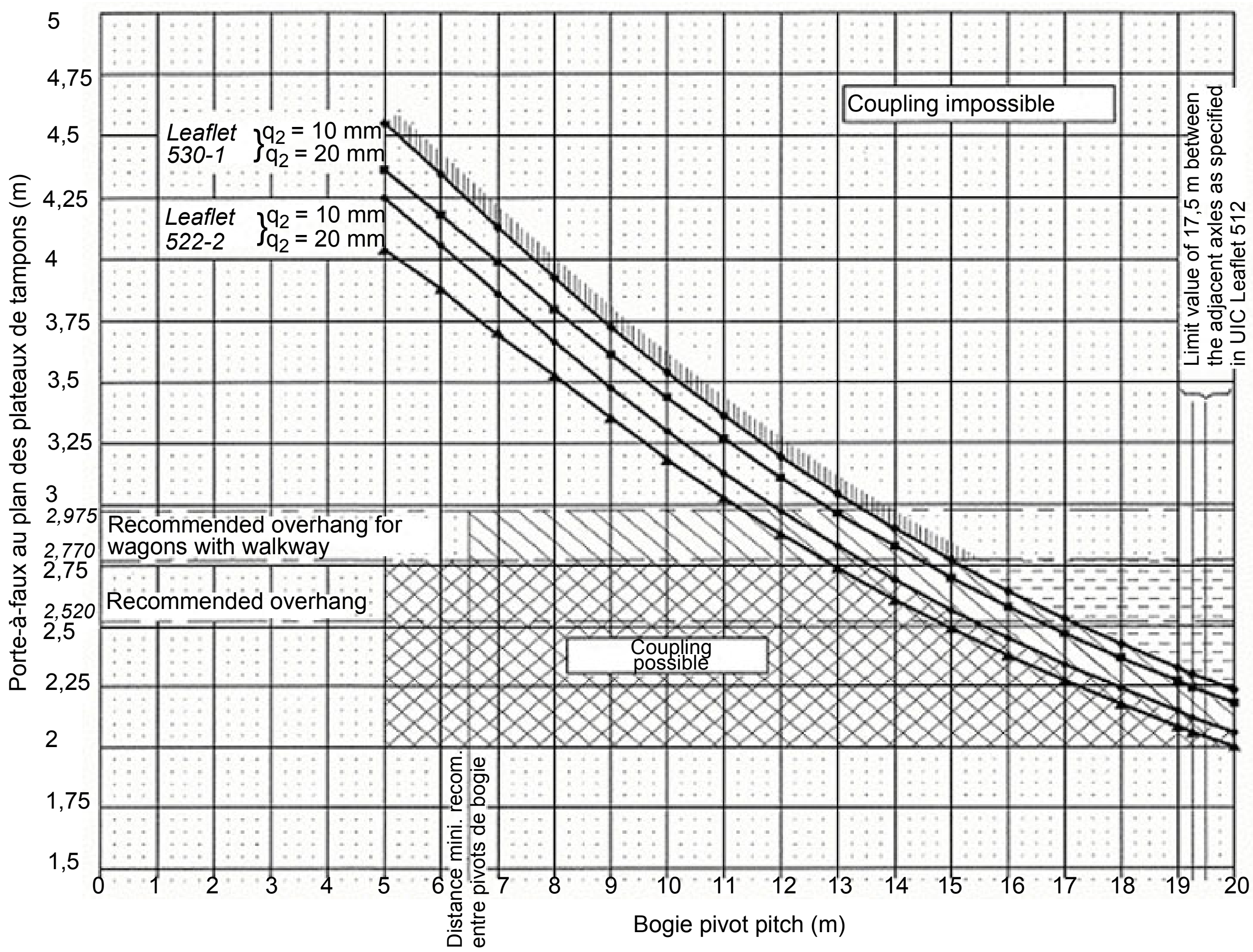
Recommended area.

Permissible area subject to the approval of UIC SG 2.

Specific cases:
If in the diagram, the point defined by the design characteristics of a wagon is located outside both designated permissible areas, approval from UIC SG 2 must also be secured.

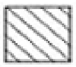
Bogie wagons
with high lateral clearance
(especially type 65)

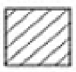
E.3 - Permitted areas and wagon dimensions for horizontal coupling on 2-axle two-bogie wagons (especcially for the Y25-type bogie)

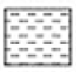


These curves indicate the potential geometrical limits for horizontal coupling on bogie wagons equipped with AA the characteristics of witch are laid down in *UIC Leaflets 530-1 and 522*.
The principles and parameters used for calculating curves are explained in point E.1 - page 27.

For all areas defined in the diagram as well as for the special cases, it is important that the conditions laid down in points 2.1.3 - page 3 and 2.3.2 - page 4 are met.

 Permissible areas; overhangs of more than 2 800 mm are only allowed for wagons equipped with crossover walkways.

 Recommended area.

 Permissible area subject to the approval of UIC SG 2.

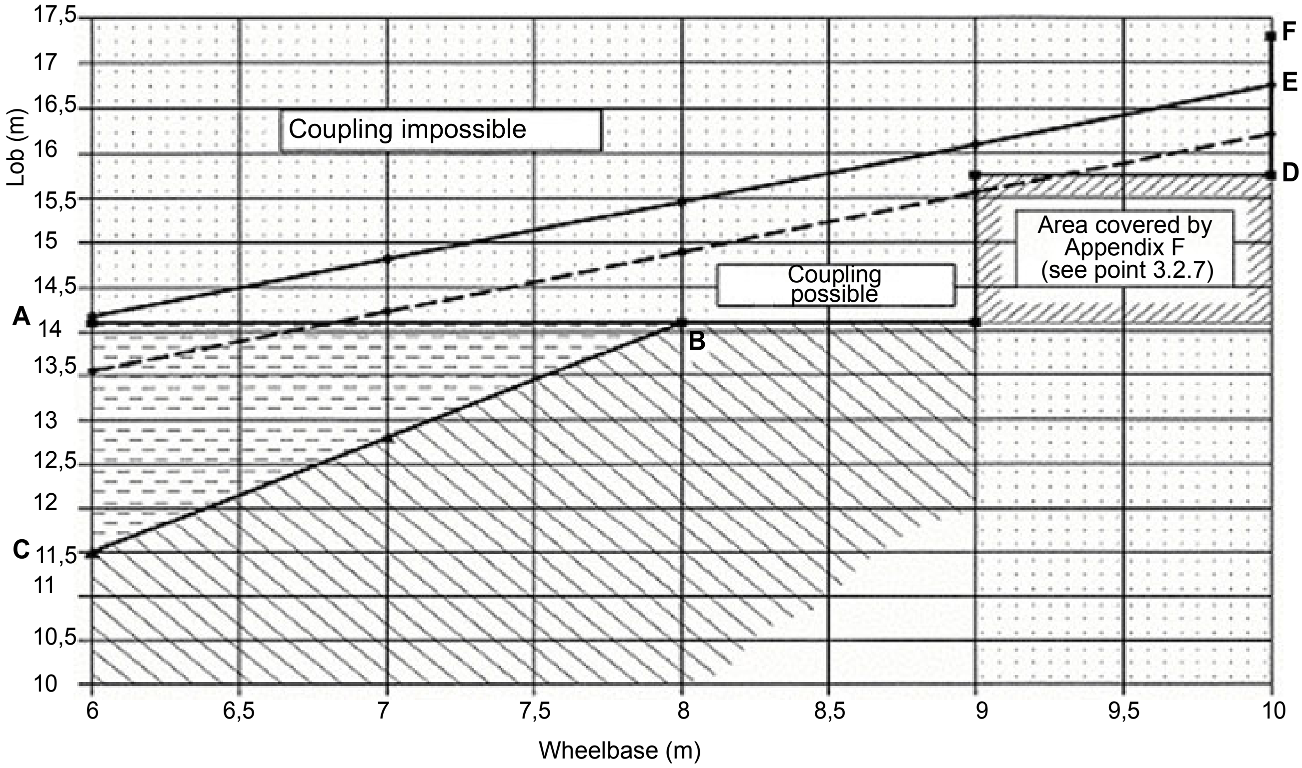
Specific cases:
If in the diagram, the point defined by the design characteristics of a wagon is located outside both designated permissible areas, approval from UIC SG 2 must also be secured.

Bogie wagons
with high lateral clearance
(especially type Y25)

E.4 - List of exemptions from application of regulations for horizontal connection of couplers on 2-axle bogie wagons

The table can be found on the UIC Website: http://www.uic.asso.fr (see Technical and Research /Products).

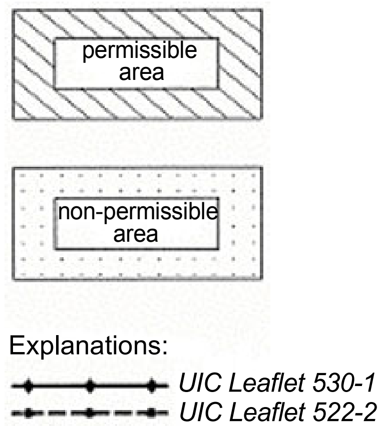
E.5 - Permissible Lob areas for two-axle wagons with double-link suspension



Propelling tests required for wagons whose characteristics are described by the areas located between the points:
- Lob < 14,1 m and 2a* < 9 m
- D to F

(see point 3.2.3.1 - page 6)

Areas E to F:
subject to the approval of UIC SG 2
(see point 3.2.3.2 - page 6)



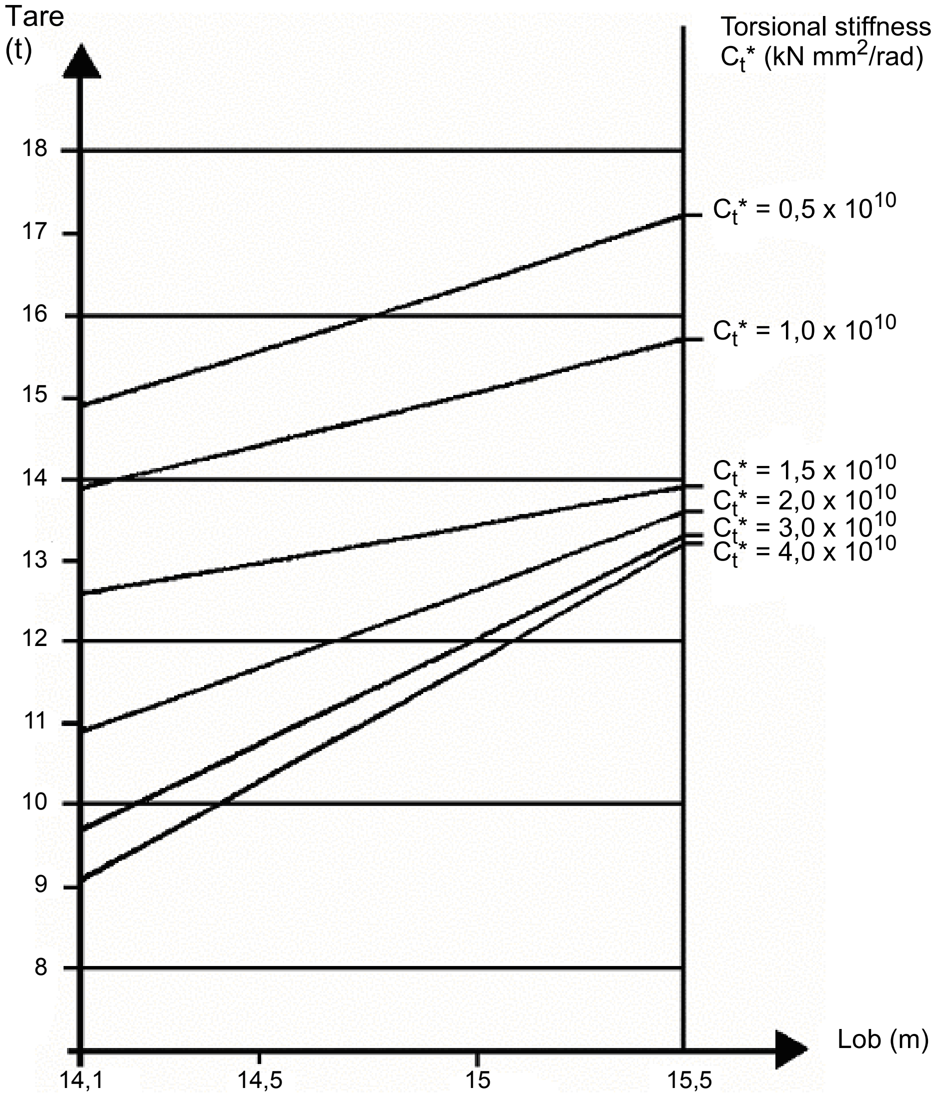
E.6 - List of exemptions from application of regulations for horizontal connection of couplers on 2-axle bogie wagons

The Table can be found on the UIC Website: http://www.uic.asso.fr (see Technical and Research /Products).

Appendix F - Minimum tare of 2-axle long wagons with side buffers and screw coupling

Scope of application of the diagram:

Length over buffers:	14,1 m ≤ Lob ≤ 15,5 m
Wheelbase:	9,0 m ≤ 2a* ≤ 10 m
Buffer head perimeter:	R = 2 750 mm
Axle guards:	Axle guards with progressive stiffness (*UIC Leaflet 517, Appendix L.3*) or with reinforced type constant stiffness (*UIC Leaflet 517, Appendix L.2*)



If the framework conditions specified above are met in relation to the Lob, c_t^* and tare based on the above diagram, the expected permissible longitudinal compressive force is ≥ 200 kN[1].

1. ERRI report B12/RP55 (see Bibliography).

Appendix G - Demonstration of the permissible longitudinal compressive force via propelling tests

G.1 - Conditions related to the carrying out and analysis of propelling tests to determine the permissible longitudinal compressive force for wagons with side buffers

G.1.1 - General information

If the criteria defined in points 2 or 3 - page 5 of this leaflet specify that the permissible longitudinal compressive forces for wagons should be established by carrying out propelling tests, the latter should be carried out in the conditions set out below ensuring at the least the set of measurements indicated in this Appendix are carried out.

G.1.2 - Test conditions

G.1.2.1 - Test track

The test track shall comprise a curve and a reverse curve of R = 150 m separated by a section of straight track measuring 6 m in length.

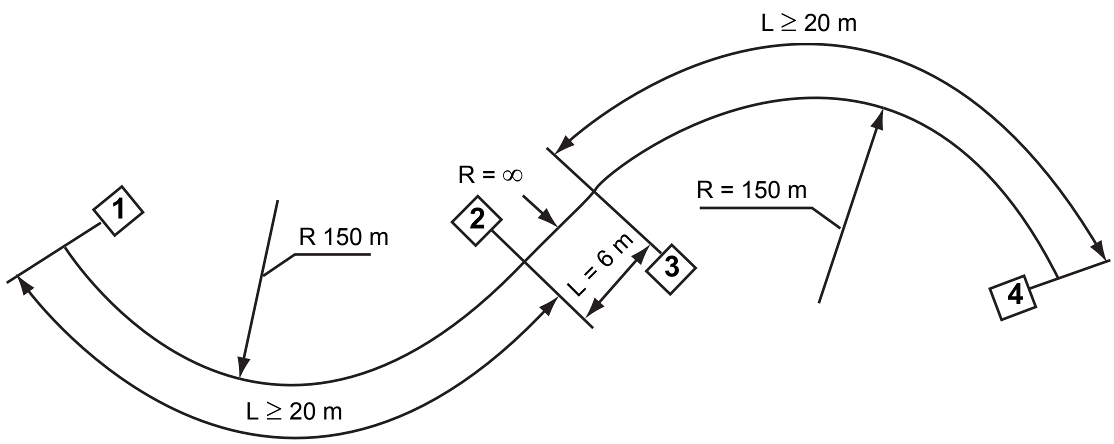


Fig. 1 - Test track

The test track may shall have no cant. The average track gauge shall be between 1 450 and 1 465 mm.

G.1.2.2 - Test train

G.1.2.2.1 - Standard configuration

The barrier wagons defined below should be used:

- Leading wagon:
  - Wagon type : Fcs or Tds
  - Length over buffers : 9,64 m
  - Wheelbase : 6,00 m

- Trailing wagon:
  - Wagon type : Rs
  - Length over buffers : 19,90 m
  - Distance between bogie pivots : 13,00 m

Fig. 2 shows an example of a standard configuration test train.

G.1.2.2.2 - Additional configuration

Use for long 2-axle wagons with Lob ≥ 15,75 m.

An additional variant should be studied. For the study the barrier wagons in the test train should have the same geometrical characteristics (Lob and wheelbase) as the wagon being tested.

G.1.2.2.3 - Loading

For both train configurations:

- the barrier wagons should be loaded,
- The test wagon is empty.

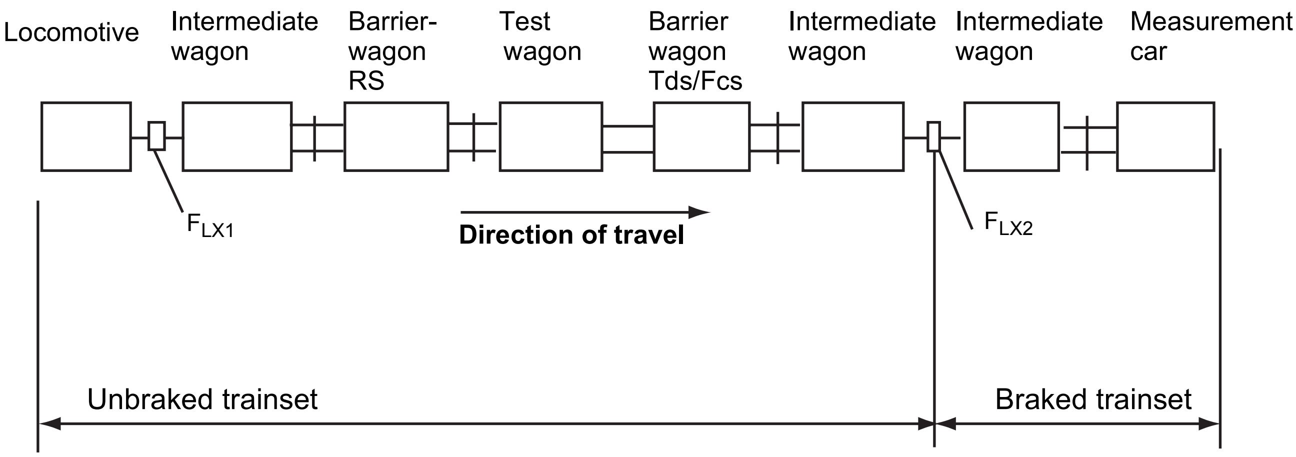


Fig. 2 - Example of test train in standard configuration

To calculate the longitudinal compressive force, use shall be made of 2 or 4 axle intermediate wagons equipped at one end with a central-buffer coupling (incorporating a stress recorder)[1].

1. Other measuring systems giving the same results may also be used.

G.1.2.3 - Type of buffer

The barrier wagons shall be fitted with Category A non-pivoting buffers (590 kN end-stroke force) which have already been used in revenue service. The buffers on the barrier wagons shall have spherical bearing surfaces of R = 1 500 mm. The test wagon shall be fitted with the same buffer type as the model to be used in its future operating.

At the beginning of the tests, the buffer bearing surfaces should show no obvious signs of wear.

G.1.2.4 - Execution of the tests

The screw couplings between the test wagon and the barrier wagons are to be tightened in such a way that when on straight track the buffer plates come into contact without over-tensioning.

The difference in buffer head height should be approximately 80 mm[1] between the test wagon and barrier wagons.

The buffer head surfaces should be slightly lubricated for the propelling tests. Any damage to the buffer head surface caused during a test run should be removed before the next one. Buffer heads with grooved or damaged surfaces should be replaced if the results of the test runs carried out with these surfaces are substantially different to those obtained during previous test runs.

The test train should be propelled into an S-shaped curve at a speed of 4 to 8 km/h with a longitudinal compressive force that remains virtually constant. The longitudinal compressive force will be generated by the propelling forces exerted by the locomotive and the braking of the wagons located at the front of the test train. The longitudinal compressive force should be increased in increments until one of the assessment criteria laid down in point G.1.4 - page 39 is reached or exceeded. If a longitudinal compressive force of 280 kN has been reached and none of the assessment criteria exceeded, there is no need to increase the force any further.

To determine the linear regression line as per point G.1.5 - page 40, at least 20 valid tests should be carried out with different longitudinal compressive forces. Minimum longitudinal compressive force (two-axle wagons: 200 kN, bogie wagons: 240 kN) which should be exceeded by roughly 10% in at least 10 of the valid tests.

In the series of 20 or more tests, at least 5 consecutive tests should be carried out with the minimum longitudinal compressive force without replacing the buffers or treating the buffer heads and without the assessment criteria in point G.1.4 being exceeded.

1. Differences caused by the wagon type are allowed.

G.1.3 - Scope of measurements

G.1.3.1 - Measurements during the tests

During the test runs, at least the following values should be measured:

- longitudinal compressive force F_{Lxi},
- wheel uplift d_{zij} on all wheels,
- H_{yi} lateral forces on the axle boxes exerted on all the axles,
- deformation of the axle guards d_{yAij}[1] on all wheels,
- lateral movements d_{yp1}, d_{yp2} of the buffers between the barrier wagons and test wagon,
- recording of track markers (see Fig. 1 - page 35),
- distance covered (e.g. 1 m marker).

G.1.3.2 - Other measurements

- Determination of the torsional stiffness c_t* of the wagon body: measurement method as per *ORE report B55 RP8, Chapter 7.1.7*, or document *B12/DT135, Appendix E* (see Bibliography - page 45),
- Calculation of the characteristic static curves on the buffers of the barrier wagons and test wagon,
- Calculation of the track geometry before and after the tests,
- Calculation of the lateral and longitudinal play between the axle box and axle guard on the test wagon before and after the tests,
- Calculation of the buffer height difference between the barrier wagons and test wagon in relation to the upper part of the rail.

1. Only for wagons with axle guards.

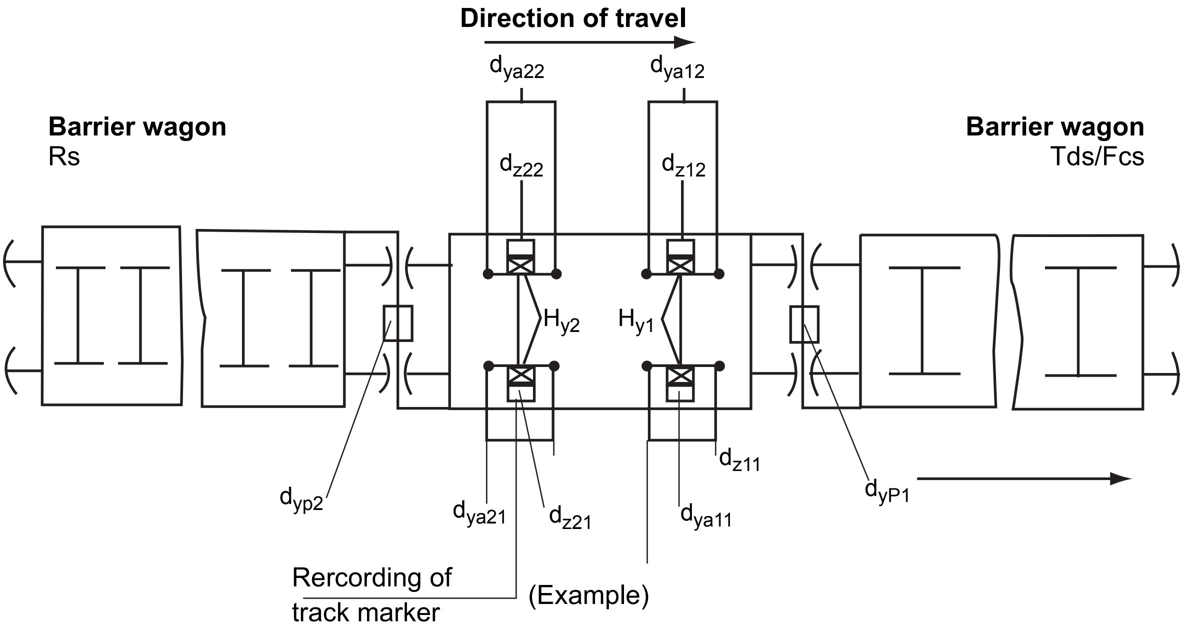


Fig. 3 - Layout of measuring points

G.1.4 - Assessment criteria used to calculate the permissible longitudinal compressive force

The permissible longitudinal compressive force is obtained when one of the following limit values is exceeded:

- Uplift of a non-guide wheel $d_{zij} \geq 50$ mm over a distance of ≥ 2 m.

- Climbing of guide wheels $d_{zij} \geq 5$ mm for wheel forces $Q_{ij} < 0$; in case of 2-axle wagons, the guide wheels are wheels 11 and 22. This criterion should only be checked for additional configuration test trains (see point G.1.2.2.2 - page 36).

- Axle-guard deformation $d_{yAij} \geq 22$ mm[1] measured 380 mm from the lower edge of the sole-bar.

- Stabilised track stress
  H_{lim} (2m) $\geq 25 + 0{,}6 \times 2 \times Q_o$ (kN)
  Q_o = mean force of wheel on rail.

- Minimum horizontal overlap of buffer plates d_{yp1} and $d_{yp2} \leq 25$ mm.

1. Evaluation and analysis solely for wagons with axle guards.

G.1.5 - Analysis

For each test, it is necessary to calculate:

- H_{yi} and d_{zij} as a value for 2 m,
- d_{zij} as elevation of guide wheels, analysed solely for additional configuration test trains (see point G.1.2.2.2 - page 36),
- F_{Lx},
- d_{yAij} [1],
- d_{ypi}

The values calculated shall be presented in graphic form in relation to the longitudinal compressive force F_{Lx}.

In order to calculate the permissible longitudinal compressive force, the straight regression line equations shall be defined for the quantities to be measured d_{zij}, d_{yAij} and H_{yi}.

The permissible longitudinal compressive force shall be defined as the value found on the abscissa for the point of intersection between the straight regression line and the evaluation criterion (see Fig. 4):

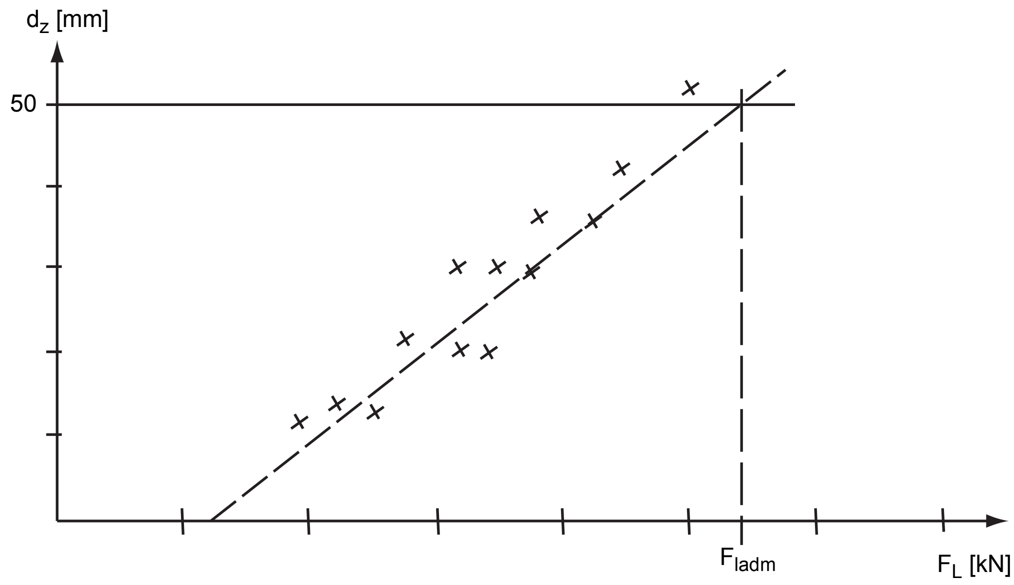


Fig. 4 - Permissible longitudinal compressive forces

The evaluation criterion giving the lowest value for F_{ladm} shall determine the permissible longitudinal compressive force. A report shall be drawn up describing the tests carried out and presenting a summary of the most important data in table form, as per point G.2 - page 41.

1. Evaluation and analysis solely for wagons with axle guards.

G.2 - Presentation of propelling test results

As stated in point 3.2.3.1 - page 6 and 3.2.7.3 - page 7, UIC SG 2 shall be notified of wagons with different characteristics (Lob and 2a*) that are suitable for unrestricted use in international traffic and have passed the tests specified in point G.1 - page 35. Wagon types which have passed the propelling tests the results of which have been passed on to UIC will be entered in point G.3 - page 42.

For the purposes of notification, the relevant information shall be presented as follows:

G.2.1 - Characteristics of the track on which the tests were carried out

- Mean curve radius (m)
- Length of curve (m)
- Mean track gauge (mm)

Length of intermediate track section (m)

Left-hand curve	Right-hand curve	Straight track section

G.2.2 - Characteristics of test wagon

- Length over buffers (m),
- Wheelbase (m),
- Tare (t),
- Torsional stiffness c_t* of the wagon body (kNmm^2/rad),
- Diameter of wheel running tread (mm),
- Wheel profile,
- Type of axle guard,
- Type of spring suspension,
- Type of suspension spring,
- Elastic constant of suspension spring c_{z1} and c_{z2} (kN/mm),
- Type of buffers,
- Buffer plate radius (mm),
- Difference between the heights of the buffer centre-lines on the barrier wagons and test wagon (mm).

G.2.3 - Test results

- Minimum permissible longitudinal compressive force determined as F_{Lperm} (kN)
- What evaluation criterion was used to determine F_{Lperm}?
- Number of tests
- Number of tests with wheel elevations
- Number of tests with wheel elevations > 40 mm
- Was it necessary to replace the buffer pair?
- If so, why?
- Was lateral track displacement recorded?
- If so, by how many mm?

UIC SG 2 and the railway undertaking on which the wagons will operate may ask to be submitted the full test report.

G.3 - Checklist of wagons which have passed the propelling tests

Wagons with Lob $\geq$ 15,5 m and $2a^{*} \leq$ 10 m.

The table can be found on the UIC Website: http://www.uic.asso.fr (see Technical and Research /Products).

Glossary

Longitudinal compressive force

This is the force generated by braking or by a propelling movement and transferred from one vehicle to another via the draw or buffing gear.

Permissible longitudinal compressive forces

This denotes a value, which in given conditions, can still be tolerated by wagons without the defined limit values being exceeded.

Twisted track

Track twist is a constructional feature that occurs on canted track in transition curves. Track twist is also caused by cross-level variations, where the profile of a line deviates from the theoretical geometrical situation. The resulting differences between the inner and outer running rails cause the vehicle to twist and change the distribution of wheel forces.

List of abbreviations

AACT	Automatic buffing and draw coupler
AAST	Draw-only automatic coupler
CA	Field of action of the automatic coupler
CE	Specialist Committee
F_L	Longitudinal compressive force
OR	Mandatory (o) and Recommendatory (R) regulations
ORE/ERRI	Office for Research and Experiments (ORE) of the International Union of Railways Following restructuring in 1992, ORE became the European Rail Research Institute (ERRI)
OSJD	Organisation for the Collaboration between Railways (Eastern Europe, Asia)
UIC-SG2	UIC Study Group 2 - Freight technology (formely Sub-Commission 02, from January 2002 to January 2004 SC 08, previous name: UIC Sub-Committee 25B)

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Warning

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