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

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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:

- *report B55/RP8* ,
- *reports B125/RP5 and RP6* ^{1 2},
- *report B12/RP40*,
- *reports B12/RP69 and RP70* (see Bibliography - page 46).

-
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 *reports B55/RP8, B125 RP5 and RP6* (see [Bibliography - page 46](#)) 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.

- **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 18](#), [B - page 19](#) and [C - page 20](#), 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 *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 ($14,1 \text{ m} \leq L_{ob} \leq 15,5 \text{ m}$) 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.

- **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. *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.

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 *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

- **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 forces¹ 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 in S-curves set out in point [G.1 - page 36](#).

- **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.
- **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.
- **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 (L_{ob}) should be less than or equal to 17.3 m.

3.2.2 - Depending on the L_{ob} , the following wheelbases should be used:

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

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 33 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 46). The basis for determining these limit curves is summed up in point **E.1** - page 28. The diagram shows the non-permissible combined areas between the length over buffers L_{ob} and the wheelbase $2a^*$.

3.2.3.1 - For wagons whose characteristics are described by :

- $L_{ob} > 15,75$ m and wheelbase = 10 m or
- $L_{ob} < 14,1$ m and wheelbase < 9 m or

propelling tests in S-curves should be carried out in line with point **G.1** - page 36 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 Technical and Research Platform (PTR) by using the form provided for in point **G.2** - page 42.

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 the PTR (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 46).

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 $c_t^* > 0,5 \times 10^{10}$ kNmm²/rad. Proof of the actual c_t^* value for a wagon or wagon category should be furnished by means of a torsional test¹.

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

- $L_{ob} < 14,1$ m shall be equal to or greater than 11,5 t,
- $14,1 \text{ m} \leq L_{ob} \leq 15,5$ m shall be at least equal to the value indicated in Appendix **F** - page 35, as a function of the torsional stiffness c_t^* .

1. Document B12/DT 135, 1.5.0 (1995) (see **Bibliography**).

3.2.7 - The scope of validity for Appendix F - page 35 is specified in point E.5 - page 33.

This covers the sector:

- $14,1 \text{ m} \leq L_{ob} \leq 15,5 \text{ m}$ and $9 \text{ m} \leq 2a^* \leq 10 \text{ m}$ for wagons with or without a crossover walkway,
- $15,5 \text{ m} < L_{ob} \leq 15,75 \text{ m}$ 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 46).

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 (L_{ob_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 $15,5 \text{ m} < L_{ob} < 15,75 \text{ m}$ 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 prescribed by Appendix F propelling tests in S-curves need to be carried out as per point G.1 - page 36 to provide proof that the permissible longitudinal compressive forces are at least 200 kN. The results of these tests should be communicated to the PTR using the form specified in point G.2 - page 42.

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

○ **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.

Theoretical 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 $F \times 2b^*$. The following interdependency exists between the torsional stiffness, the angular displacement and the torsional moment:

$$C_t^* = \frac{2a^* \times 2b^* \times F}{\varphi} \quad (\text{see Document B12/DT135})$$

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 be 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 46](#)), 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} .

- 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 18](#) for wagons incorporating leaf springs with linear characteristic curves (c_z),
- in Appendix [B - page 19](#) for wagons incorporating leaf springs with progressive characteristic curves (c_{z1} and c_{z2}).

Points [D.1 - page 21](#) to [D.5 - page 26](#) illustrate the application procedure for these diagrams, point.

3.3.3 - The diagrams were plotted for the following characteristics:

- Wagon length over buffers (L_{ob}),
- 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 (Δq) according to the provisions of point [D.3 - page 23](#).

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 *report B12/RP49* (see *Bibliography - page 46*).

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 are 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 22.

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 18.

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 19)

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 report B12/RP49 (see Bibliography).

Torsional stiffness of the body:

c_t^* : $0,40 \times 10^{10}$ up to $8,40 \times 10^{10}$ kN mm²/rad
with a pitch of $0,50 \times 10^{10}$ kN mm²/rad

Wheel load:

Q_0 : 22,5 - 25 - 27,5 - 30 - 32,5 et 35 kN pour $L_{ob} \leq 12\,000$ mm

Q_0 : 25 - 27,5 - 30 - 32,5 - 35 - 37,5 et 40 kN pour $L_{ob} > 12\,000$ mm

3.3.4.2 - Characteristics of progressive stiffness suspension spring wagons as defined in Appendix B - page 19.

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^* : $0,4 \times 10^{10}$ up to $10,4 \times 10^{10}$ KN mm²/rad, with a pitch of 1×10^{10} KN mm²/rad.

Wheel load:

Q_0 : 22,5 - 25 - 27,5 - 30 - 32,5 - 35 - 37,5 et 40 kN for all lengths over buffers.

○ 3.3.5 - Use of diagrams

For lengths over buffers (L_{ob}), 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_0 values, the interpolation can easily be made on the diagrams themselves.

Point [D.4 - page 24](#) contains examples of interpolation for L_{ob} , $2a^*$ and c_z .

○ 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 18](#) and [B - page 19](#), 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 L_{ob} length of wagons may, on request, be granted by the PTR provided these wagons are restricted by the conditions governing horizontal coupling when operating with automatic couplers ([see point E.5 - page 33](#)). Point [E.6 - page 34](#) contains the list of exemptions granted by the PTR.

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

- 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.
- 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 31](#) and [E.3 - page 32](#).
- 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.
- 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 S-curves in accordance with the conditions laid down in point [G.1 - page 36](#).

An exemption from these tests is allowed for wagons meeting the following conditions¹:

- 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. Reports B12/RP69 and B12/RP70 (see Bibliography)