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Translation

OR

Brakes - Regulations concerning the manufacture of brake components - Self-adjusting load-proportional braking system and automatic "empty-loaded" control device

Frein - Prescriptions concernant la construction des différents organes de frein - Appareil de freinage autovariable en fonction de la charge et dispositif de commande automatique de l'appareil "vide-chargé"
Bremse - Vorschriften für den Bau der verschiedenen Bremsteile - Automatische Lastabbremsung und automatische Lastwechseleinrichtung "leer - beladen"

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1st edition, July 1992	First issue and 3 amendments (No. 1 dated 1.7.94, No. 2 dated 1.7.95 and No. 3 dated 1.1.97).
2nd edition, July 2004	Addition of points 2.1.4 and 4.8, amendment to point 5, addition of appendices D and F. Update of table in Appendix C (II-Pneumatic) following the conclusions of the Study Group 04 (January 2003)
3rd edition, November 2006	Reissue with publication of the Appendices C, D and E on the UIC website

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

Contents

Summary

This leaflet contains regulations and minimum requirements to be met by self-adjusting load-proportional braking systems and automatic "empty-loaded" control devices to be used in international service. Additional regulations and guidelines for different braking systems and their individual component parts are set out in other leaflets of the 54 series.

1 - General characteristics of self-adjusting load-proportional braking equipment

1.1 - By adjusting braking forces automatically and gradually to vehicle loads, self-adjusting load-proportional brakes are able to offer braked weight percentages which remain virtually constant up to the maximum weight on rail allowed by the braking system involved. Appendix A - page 13 charts the pattern of characteristic percentage curves for self-adjusting load-proportional braking. In the case of vehicles with axle-loads lower than the value specified, self-adjusting load-proportional braking must guarantee compliance with the braking percentages.

1.2 - Compressed-air brakes incorporating a self-adjusting load-proportional system must fulfil the conditions defined in *UIC Leaflet 540, point 1* (see Bibliography - page 19). The value of the maximum brake-cylinder pressure must be 3,8 bar ± 0,1, in line with the provisions of *UIC Leaflet 540, point 1.7*. For older-type equipment, the value of 4,0 bar is accepted. Minimum permissible brake-cylinder pressure ... (to be completed later).

1.3 - The extra components required for the self-adjusting load-proportional equipment must not alter the characteristics of already-approved air brakes. This applies both to brakes used in conjunction solely with the main brake-pipe and those used also in conjunction with the main air-supply pipe.

1.4 - Brake force adjustment must be performed rapidly, automatically and progressively in relation to the load. Impacts and short-lasting load variations withstood by the axles must not be allowed to affect adjustment of this load in any significant way.

1.5 - The air consumption of the weight-recording system used to ascertain the load during running must be minimal and must not interfere with normal braking performance.

2 - Types of self-adjusting load-proportional braking system

2.1 - Self-adjusting load-proportional braking for wagons worked under SS conditions

O **2.1.1 -** The self-adjusting load-proportional braking equipment for wagons worked under SS conditions must provide an approximately constant braked weight of 100% as per *UIC Leaflet 543, point 1.3.6* (see Bibliography - page 19).

O **2.1.2 -** For wagons with tread brakes only, the value of λ = 100% is allowed solely up to an axle-load of 18 t. For additional loading, the value of λ decreases progressively down to 90% for a 20 t axle-load (maximum permissible axle-load).

O **2.1.3 -** In order to obtain a value of λ = 100% for an axle-load of over 18 t, additional braking equipment (for example: disc brakes) must be provided.

R **2.1.4 -** It is recommended that modified relay valve combinations be fitted on tread-braked wagons suitable for working under SS conditions, for instance a relay valve with a supplementary integrated valve, a relay valve with an additional fitting or a combination of relay valves of a different design.

In the case of moderate service braking (P_{MBP} = 4,6 – 4,2 bar), the reference curve produced by the valve combination should lower the braking force of an SS wagon to that of an S wagon.

In the case of heavy service braking (P_{MBP} = 4,2 – 3,8 bar), the level of braking force should rise again continuously when the brakes are applied at over $P_{MBP} \leq$ 3,8 bar to match that of an SS wagon.

By using such relay valve combinations, wheels can be protected from overheating, in particular on long downhill runs.

The technical approval test for relay valve combinations is set out in point 4.8 - page 7.

The features of the modified relay valve combination must not impact upon the specific features of the compressed air brake (e. g. pilot pressure, graduation).

o 2.2 - Automatic load-proportional braking for wagons worked under S conditions

2.2.1 - The automatic load-controlled equipment of wagons worked under S conditions must provide a maximum braked weight of λ = 100%[1], up to a load limit equal to 65% of the maximum permissible wagon weight.

2.2.2 - When an extra load is placed on wagons, the braked weight percentage may decrease continuously to reach the minimum λ value of 65%.

2.2.3 - For wagons with brake blocks of cast iron only, the braked mass for each axle shall not exceed 18 t.

o 2.3 - Automatic load-proportional braking for vehicles fitted with high performance brakes

This braking equipment - whether used under the G, RIC or R systems and irrespective of load conditions - must provide a constant braked weight percentage λ up to the braked-weight value stipulated in each case. However, the design characteristics of such vehicle may require application of specific conditions.

1. Corresponding to a 14,5 t axle-load for wagons designed for 22,5 t axle-loads.

3 - Design characteristics of self-adjusting load-proportional braking equipment

3.1 - Braking force can be adapted to the overall weight of vehicles either mechanically through variation of the brake-rigging amplification ratio, or pneumatically through variation of the air pressure in one or several brake cylinders, or again through a combination of these arrangements.

O **3.2 -** Graduated braking is an absolute requirement irrespective of the pneumatic or mechanical operating method used. Moreover it must be possible to obtain maximum braking by going through a sufficiently large number of brake application notches (even for braking the vehicle in unladen state, the number of notches must be a minimum of 5).

3.3 - Transmission to the control system of the vehicle-exerted load

3.3.1 - The vehicle-exerted load can be transmitted to the control system (weighing devices) either through mechanical means exclusively, or mecanopneumatically, or oleopneumatically, or again elastopneumatically.

O **3.3.2 -** Account must not be taken of play in the suspension in the calculations.

O **3.4 -** In case of pneumatic transmission, the control pressure produced by the weighing mechanism with the vehicle under full load must not exceed 4,6 bar.

3.4.1 - Three types of load-weigh valves shall be used. The control pressure T in bars depends on the load on the valve in kN as follows:

- type 1: 0,8 bar/10 kN,
- type 2: 0,88 bar/10 kN,
- type 3: 1,0 bar/10 kN.

The characteristics of the load-weigh valves are described in Appendix B - page 14.

3.4.2 - New bogies and bogies on which a major overhaul has been carried out must bear a plate on the outer surface of the frame, if possible close to the load-weigh valve, showing its type number and specifications, either stamped or in relief. An example of the inscription is given in Appendix B.

An equivalent inscription shall be placed near the relevant pneumatic relay.

O **3.5 -** However, possible control-pressure variations occurring during brake application must not be allowed to alter the value of braking forces produced by such application.

4 - Tests to be carried out for acceptance of self-adjusting load-proportional braking equipment in international traffic

4.1 - Compliance with the stipulations of points 1 - page 2, 2.1 - page 3, 2.2 and 2.3 - page 4 must be checked by means of tests carried out on a randomly-selected vehicle. These tests shall be chosen from among those stipulated in *UIC Leaflet 547* (see Bibliography - page 19). The mandatory application and release times must be observed in the entire load area.

4.2 - The accuracy of weighing devices, the brake-block forces and - depending on the self-adjusting load-proportional braking system used - the cylinder pressures or the equalising-bar amplification ratios, must be checked under different load conditions in both increasing and decreasing order. To this end, allowance must be made for a tare equal to a 5 t axle-load, for the load limit stipulated for λ = 100% (c) and for the maximum load (d) of the particular type of vehicle. When the check is performed on a fixed rig, the vehicle under test must be moved between each different loading.

4.3 - For guidance purposes, the time or distance at the end of which cylinder pressures, amplification ratios and brake-block forces are determined must be measured each time there is a loading variation.

4.4 - The lack of sensitivity of the equipment to random load variations occurring while the vehicle is on the move shall also be checked.

4.5 - It must also be ascertained that, even when the vehicle is empty, maximum application can be obtained through at least 5 gradual stages, while measuring piston-rod force variations (pneumatic systems), and exit-link force variations (mechanical systems) in the self-adjusting load-proportional braking equipment, as well as variations between brake-blocks and wheels or between pads and discs.

4.6 - In accordance with *UIC Leaflet 544-1* (see Bibliography - page 19), braking power shall be determined on the line when the vehicle is empty (a), half-loaded (b), under maximum load corresponding to λ = 100% (c), and under full load (d). In this regard the value of λ must not exceed 125% irrespective of load status. The value must never exceed 105% during tests on wagons as per point 2.1.2 - page 3 under the maximum load (c) specified for λ = 100%.

4.7 - It must be ensured that the weighing mechanism does not cause excessive air consumption during running. To this end, the test described below shall be conducted:

The wagon brake is neutralised, and the air cylinders - which are usually connected to the weighing mechanism - are continuously resupplied at 5,0 bar by means of the main brake pipe through a holding valve and an aperture with a diameter of 0,7 mm. Cylinder pressure is monitored during running and any pressure drop below 5,0 bar will indicate excessive air consumption by the weighing mechanism. The test shall be performed using a partially-loaded trailing vehicle worked at 100 km/h on a route section with multiple curves.

O 4.8 - Relay valve combinations with inflected curve for SS wagons

4.8.1 - To reduce braking force in cases of moderate service braking, the following are allowed: a relay valve with a supplementary integrated valve (inflected-curve valve), a relay valve with an additional fitting or a combination of relay valves of a different design.

4.8.2 - These relay valve combinations require international approval in accordance with points 4 - page 6 and 5 - page 10.

In the case of a relay valve combination associated with an internationally-approved self-adjusting load-proportional brake listed in Appendix C - page 15 which is only supplemented with the characteristic inflected curve, only the supplementary tests stipulated in points 4.8.3 and 4.8.4 - page 9 are necessary for technical approval to be granted.

4.8.3 - The following series of tests shall be conducted with the **relay valve for SS wagons** to prove the reduction in braking force:

1. **No inflected-curve valve integrated or ineffective curve inflection:**

   The reference curve $C = f(P_{MBP})$ through to C_{max} shall be determined by brake applications with the following pressures in the main brake pipe:

   $$5 \rightarrow 4{,}9 \rightarrow 4{,}8 \rightarrow 4{,}7 \rightarrow \ldots \text{etc.} \ldots \rightarrow 3{,}6 \rightarrow 3{,}5 \rightarrow 3{,}4 \rightarrow 3{,}3 \rightarrow 0 \text{ bar}$$

   and in the opposite direction:

   $$0 \rightarrow 3{,}3 \rightarrow 3{,}4 \rightarrow 3{,}5 \rightarrow 3{,}6 \rightarrow \ldots \text{etc.} \ldots \rightarrow 4{,}7 \rightarrow 4{,}8 \rightarrow 4{,}9 \rightarrow 5 \text{ bar}$$

   The main brake pipe values shall be set at 0,1 bar and read to 0,01 bar.

   A mean curve shall be plotted based on the results.

   The curves measured may not deviate by more than 0,2 bar from the mean curve.

   a. with 18 t axle load (corresponding to a T pressure of ca. 3,3 bar in a type 1 load-proportional valve) through to $C_{max} = 3{,}8$ bar ,
   b. with 14,5 t axle load (T pressure ca. 2,6 bar (type 1 load-proportional valve)),
   c. with 10 t axle load (T pressure ca. 1,7 bar (type 1 load-proportional valve)).

2. **Inflected-curve valve integrated or effective curve inflection:**

The reference curve $C = f(P_{MBP})$ to C_{max} is determined by brake applications with the following pressures in the main brake pipe:

$$5 \rightarrow 4{,}9 \rightarrow 4{,}8 \rightarrow 4{,}7 \rightarrow \ldots \text{etc.} \ldots \rightarrow 3{,}6 \rightarrow 3{,}5 \rightarrow 3{,}4 \rightarrow 3{,}3 \rightarrow 0 \text{ bar}$$

and in the opposite direction:

$$0 \rightarrow 3{,}3 \rightarrow 3{,}4 \rightarrow 3{,}5 \rightarrow 3{,}6 \rightarrow \ldots \text{etc.} \ldots \rightarrow 4{,}7 \rightarrow 4{,}8 \rightarrow 4{,}9 \rightarrow 5 \text{ bar}$$

The main brake pipe values shall be set at 0,1 bar and read at 0,01 bar.

A mean curve shall be plotted based on the results.

The curves measured may not deviate by more than 0,2 bar from the mean curve.

a. with 18 t axle load (T pressure ca. 3,3 bar (type 1 load-proportional valve) through to $C_{max} = 3{,}8$ bar,
b. with 10 t axle load (T pressure ca. 1,7 bar (type 1 load-proportional valve).

3. **Conditions for technical approval**

Checks must be conducted to establish whether:

a. reference curve 2a) largely coincides with the reference curve of a wagon with a 14,5 t axle load (reference curve 1b) in the case of moderate service braking ($P_{MBP} = 4{,}6 - 4{,}2$ bar). A tolerance of +0,1/-0,2 bar is allowed,
b. reference curve 2a) gradually aligns on reference curve 1a (no sudden jump) in the case of heavier service braking ($P_{MBP} = 4{,}2$ to 3,8 bar),
c. reference curve 2a) coincides well with the reference curve for SS wagons with an 18 t axle load (reference curve 1b) in the range $P_{MBP} = 3{,}8 - 3{,}5$ bar. A tolerance of $\pm 0{,}1$ bar is allowed,
d. reference curves 1c) and 2b) run identically and are not affected by inflection. A tolerance of $\pm 0{,}1$ bar is allowed.

(permissible tolerance $P_{MBP} = \pm 0{,}1$ bar).

Appendix F - page 18 specifies the requisite reference curves for the above-mentioned relay valve combinations.

4.8.4 - To prove that the modified relay valve combination does not influence the basic functioning of the compressed-air brake, checks shall be made on graduation and pilot pressure as follows:

4.8.4.1 - Graduation shall be checked as stipulated in *UIC Leaflet Leaflet 540, point 1.13.1*.

4.8.4.2 - Pilot pressure shall be checked as stipulated in *UIC Leaflet Leaflet 540, point 1.18*. The reference value for the maximum brake block force shall be:

- the maximum based on reference curve 1a, when an inflected-curve valve is used,

- the maximum based on reference curve 1b, when an inflected-curve valve is not used.

5 - Acceptance of self-adjusting load-proportional braking equipment for international traffic

Acceptance of a self-adjusting load-proportional braking system for international traffic shall be granted by the UIC Study Group 5 "Braking" based on successful completion of the necessary tests.

The self-adjusting load-proportional braking systems approved for international traffic are listed in Appendices C - page 15 and D - page 16.

6 - Provisions covering the technical characteristics and testing of automatic "empty-loaded" control mechanisms

6.1 - Technical characteristics of the automatic "empty-loaded" control mechanisms

o **6.1.1 -** The automatic mechanism for changeover from "empty" to "loaded" position must automatically perform the changeover as soon as the weight drops below or exceeds the critical weight.

o **6.1.2 -** Compressed-air brakes fitted with an automatic "empty-loaded" control mechanism must comply with the stipulations in *UIC Leaflet 540, point 1*.

o **6.1.3 -** The extra components forming part of the "empty-loaded" control mechanism must not alter the technical features of already-approved air brakes.

6.1.4 - Transmission of the load exerted on the vehicle to the control mechanism (weighing device) can either be fully mechanical, mecanopneumatic, oleopneumatic or elastopneumatic.

o **6.1.5 -** When the load is pneumatically transmitted, a minimum pressure of 3 bar[1] must ensure continuous and reliable working of the mechanism in "loaded" mode.

o **6.1.6 -** The automatic changeover mechanisms must, in all cases, supply the braked weights (tolerance margin for automatic changeover: ±5% of the transition weight)[2]. They must be designed and fitted to the wagon in such a way as to ensure that outside influences in no way affect their effective working. Impacts or jolts must be without consequence.

o 6.2 - Acceptance testing for international traffic

6.2.1 - Compliance with the conditions in points 6.1.2 and 6.1.3 must be monitored on an isolated vehicle, using for this purpose tests selected from among those stipulated in *UIC Leaflet 547*.

6.2.2 - These tests shall be performed on a vehicle which is progressively loaded and unloaded in order to ascertain:

- that the automatic changeover mechanism transfers from "loaded" mode to "empty" mode within the ±5% transition weight range;

- that the mechanism remains unperturbed by random load variations occurring during running of the vehicle.

6.2.3 - It shall be ensured during vehicle running that the pneumatic changeover mechanisms do not result in excessive air consumption (tests as per point 4.7 - page 6).

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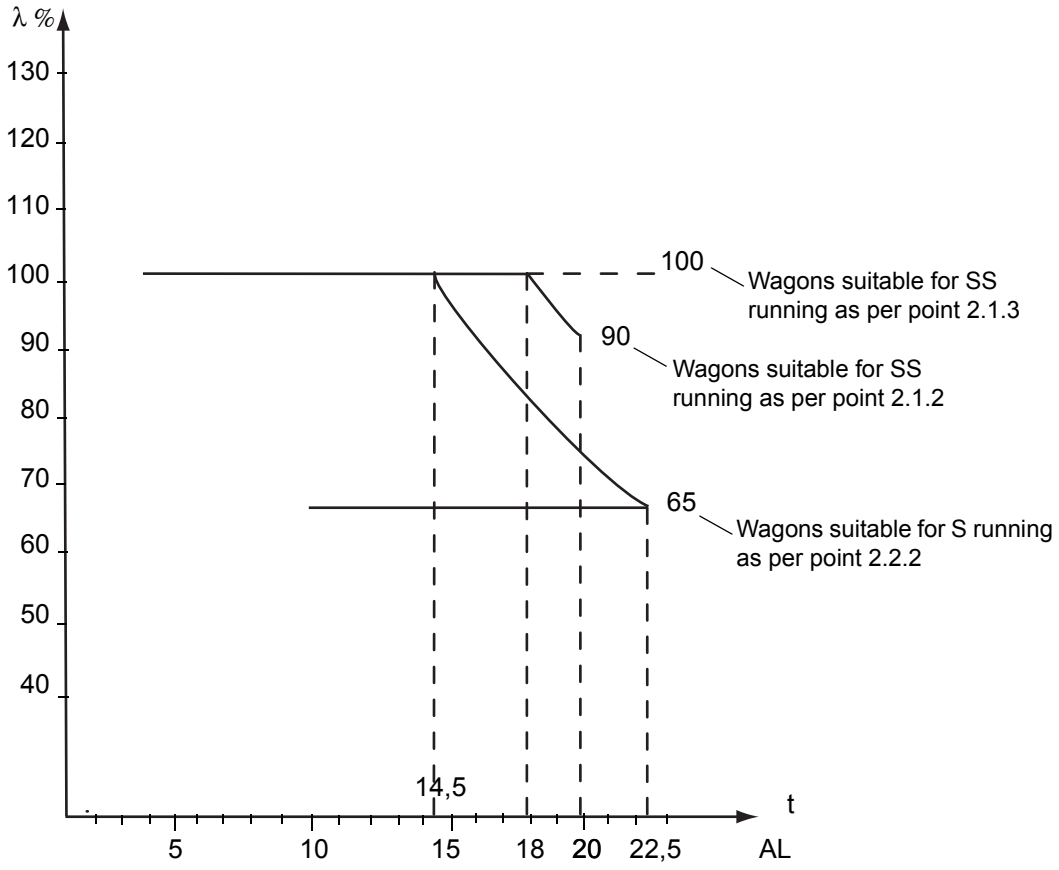
1. A lower pressure can also be applied when weighing valves are used in the automatic mechanisms.
2. Braking equipment that fails to provide this tolerance due to its design or control method, can only be fitted to vehicles running in "empty" or "loaded" mode (in other words without intermediate loads, for example tank wagons).

6.3 - Acceptance in international traffic

Acceptance of an automatic "empty-loaded" control mechanism shall be pronounced once the mechanism has successfully undergone examination by the SG 5.

Those automatic changeover control mechanisms that are accepted in international traffic are listed under Appendix C - page 15.

Appendix A - Change in the braked-weight percentages of self-adjusting load-proportional braking equipment



λ = Braked weight percentage
AL = Axle-load

Appendix B - Reference curves for load-weigh valves and bogie markings

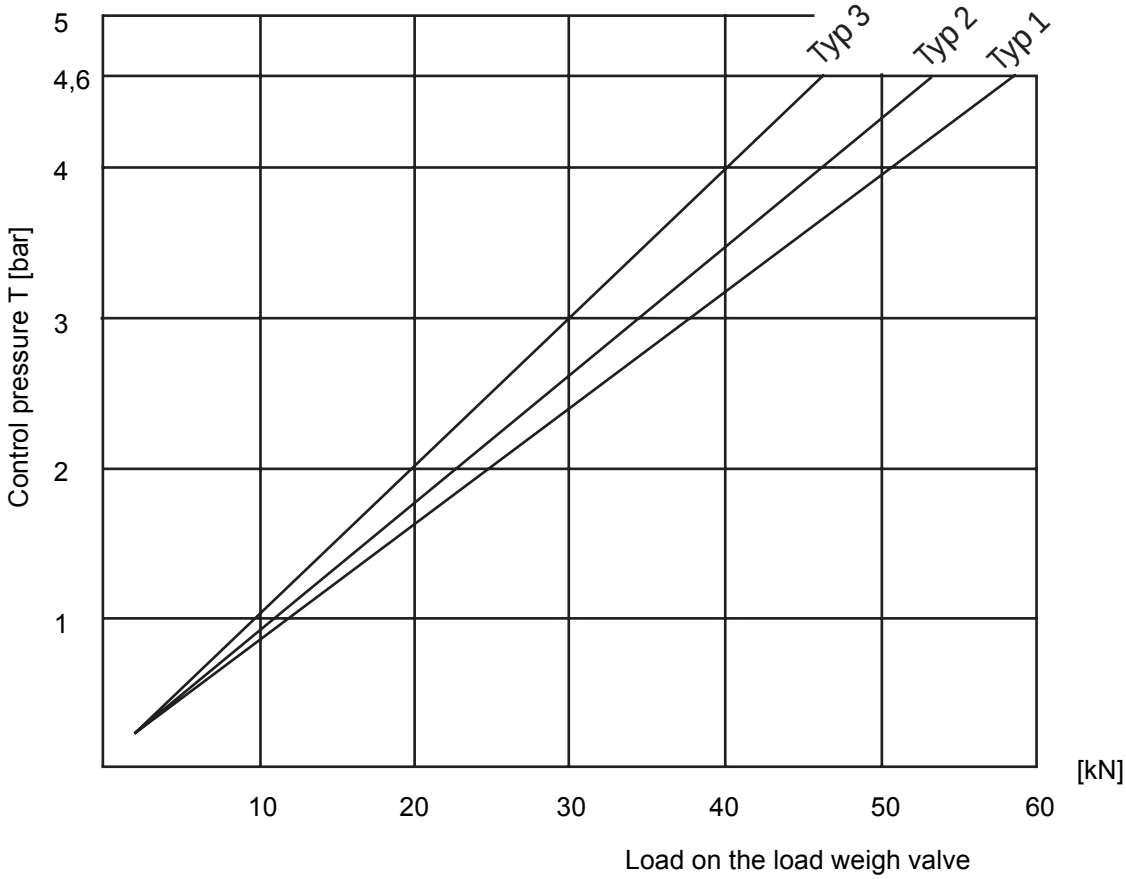


Fig. 1 - Load weigh valve characteristics

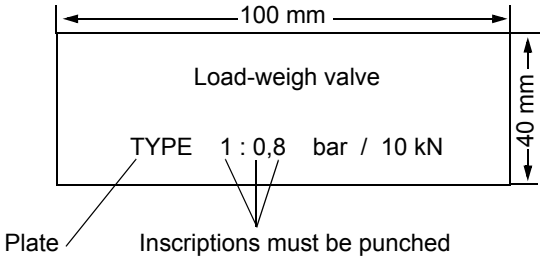


Fig. 2 - Marking on bogies - Example of inscription

Appendix C - Self-adjusting load-proportional braking equipment accepted in international traffic

This table can be consulted on the UIC website:
http://www.uic.asso.fr/ Activities/Technology&Research/Products).

Appendix D - Self-adjusting load-proportional braking systems with a characteristic inflected curve approved for international traffic

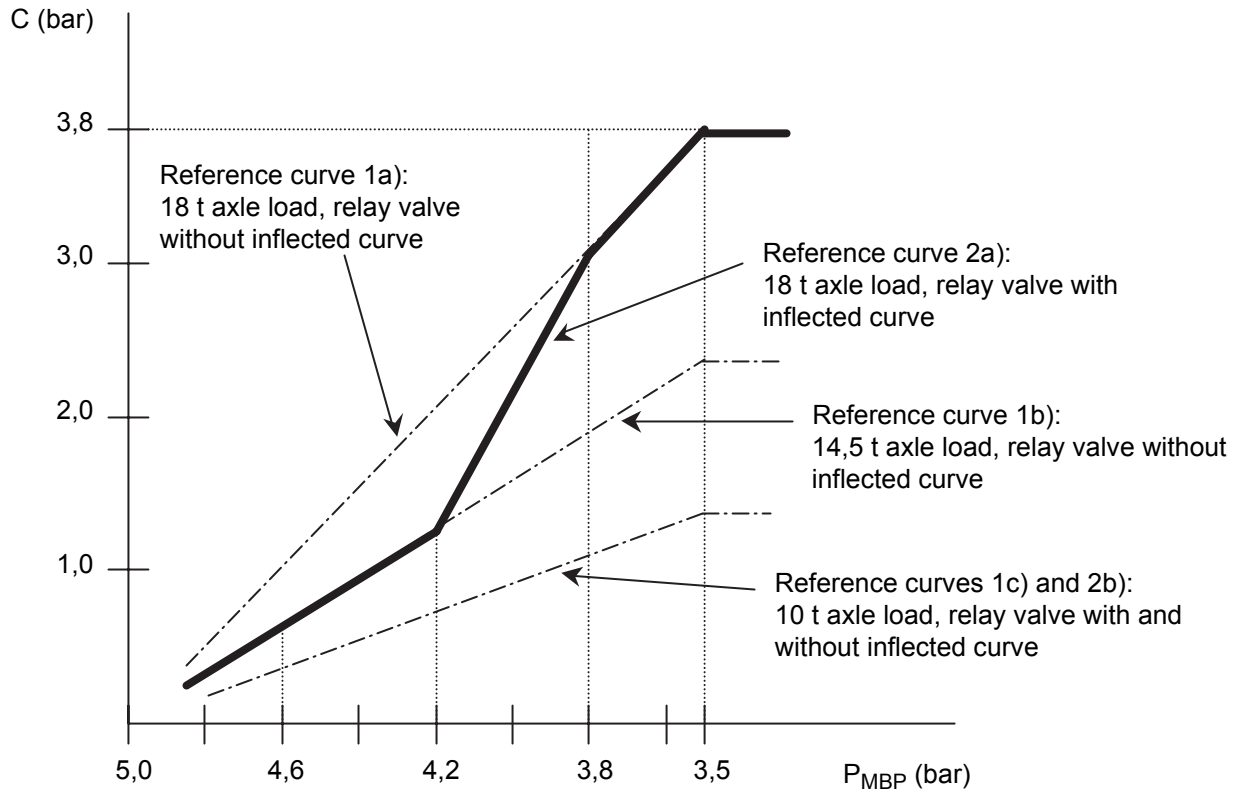
This table can be consulted on the UIC website:
http://www.uic.asso.fr/ Activities/Technology&Research/Products).

Appendix E - Automatic "empty-loaded" control mechanisms accepted in international traffic

This table can be consulted on the UIC website:
http://www.uic.asso.fr/ Activities/Technology&Research/Products).

Appendix F - Theoretical reference curve C = f(P_{MBP})

Characteristic inflection for self-adjusting load-proportional braking



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2. Minutes of meetings

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Traction & Rolling Stock Committee (Question additional to the programme - Examination of the possibility of equipping wagons to be built in future with a self-adjusting load-proportional braking system - Decision: For operating safety reasons, braked weight to be restricted to 18 t per axle (max.) for wagons with shoe brakes (SS braking)), June 1990

Sub-Committee for Braking (Question 5/T/FIC - Revision of UIC Leaflets - Approval of new Leaflet No. 541-04), January 1992

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Study Group 5 "Braking" - Amendment to UIC Leaflet 541-04, Mai 2005

Warning

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