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Translation

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Technical specification for the supply of wheelsets for tractive and trailing stock - Tolerances and assembly

Spécifications techniques pour la fourniture d'essieux montés des matériels roulants moteur et remorqué - Tolérances et montage
Technische Lieferbedingungen - Radsätze für Triebfahrzeuge und Wagen - Toleranzen und Montage

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

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Contents

Summary

A wheelset is an assembly consisting of an axle with two complete wheels together with other component parts such as brake discs, gear wheels, etc.

This UIC leaflet defines the characteristics of press-shrunk or hot-shrunk assembly of solid-core wheels, wheel plates, tyred wheels and other component parts on axles.

It also specifies assembly tolerances as well as inspection and delivery conditions.

1 - Subject and field of application

1.1 - This technical specification defines conditions for the mounting, on wheelsets, by pressed-on or shrunk-on fitting (under the effect of heat), of solid-core wheels, wheel centres, tyred wheels, axle-mounted brake discs, generator pulleys, gear wheels, chain wheels and other components specified by the purchasing railway for wheelset assemblies[1].

It also stipulates assembly tolerances as well as inspection and delivery conditions.

1.2 - This technical specification defines the characteristics for wheelsets for tractive and trailing stock; it applies to the following wheelset elements:

- Axle types:
  - inner or outer axle journals,
  - cylindrical or conical[2] wheel seats,
  - straight axles or axles with seats for gear wheels, chain wheels, generator pulleys, brake discs, traction-motor suspension bearings, etc.
- Wheel types:
  - solid-core wheels, forged and rolled,
  - tyred wheels with rolled tyres and forged or cast wheel centres.
- Axle-box type:
  - plain bearing or roller bearing.
- Traction-motor bearing type:
  - plain bearing or roller bearing.

These characteristics are based on *ISO Standard 1005/7* (see Bibliography - page 33).

1. A wheelset is defined to be the whole assembly consisting of an axle with two complete wheels together with gear wheels, generator pulleys, chain wheels, brake discs as required by the purchasing railway.
2. Axles with conical wheel seats are the subject of special provisions in derogation of this technical specification. These provisions must be indicated in the purchase order or its associated documents.

2 - Literature references

(see - Bibliography - page 33):

- *ISO 286*: ISO System of limits and fits - Part 1: Bases of tolerances, deviations and fits
- *UIC Leaflet 510-2*: Trailing stock - Conditions concerning the use of wheels of various diameters with running gear of different types
- *UIC Leaflet 810-1*: Technical specification for the supply of rough rolled non-alloy steel tyres for tractive and trailing stock
- *UIC Leaflet 810-2*: Technical specification for the supply of rough tyres for tractive and trailing stock - Tolerances
- *UIC Leaflet 810-3*: Technical specification for the supply of non-alloy flat and sectional steel for tyre retention spring rings
- *UIC Leaflet 811-1*: Technical specification for the supply of axles for tractive and trailing stock
- *UIC Leaflet 811-2*: Technical specification for the supply of axles for tractive and trailing stock - Tolerances
- *UIC Leaflet 812-1*: Technical specification for the supply of rolled or forged wheel centres for tyred wheels for trailing stock - Quality requirements
- *UIC Leaflet 812-2*: Solid wheels for tractive and trailing stock - Tolerances
- *UIC Leaflet 812-3*: Technical specification for the supply of solid wheels in rolled non-alloy steel for tractive and trailing stock
- *UIC Leaflet 812-4*: Technical specification for the supply of tyred wheels for tractive and trailing stock - Type fitting and tolerances
- *UIC Leaflet 812-5*: Technical specification for the supply of rolled or forged steel wheel centres for tractive and trailing stock - Tolerances and surface roughness

3 - Information to be supplied by the purchasing railway

The following information must be supplied by the purchasing railway when calling for tenders and placing an order:

3.1 - The number of this technical specification.

3.2 - Wheelset type:

1. driving wheelset,
2. carrying wheelset for tractive vehicle,
3. carrying wheelset for passenger trailing stock,
4. carrying wheelset for freight trailing stock.

3.3 - Maximum speed range of use:

	V	≤ 100 km/h
100 km/h	< V	≤ 120 km/h
120 km/h	< V	≤ 160 km/h
160 km/h	< V	≤ 200 km/h
	V	> 200 km/h

3.4 - Types of other components to be fitted to the wheelset (see points 1.2 - page 2 and 4.1.1 - page 6), fitting methods and any specific technical specifications to be applied.

3.5 - Mechanical burnishing, if any, to be applied to certain seats indicated on the axle drawing. Burnishing of certain seats should be limited to axle seats made of A1 steel governed by *UIC Leaflet 811-1* (see Bibliography - page 33).

3.6 - Chemical burnishing, if any, to be applied to the journals or the suspension seats of traction motors, if the axle is to be provided with plain-bearing axle-boxes or motor suspensions.

3.7 - Method of fitting wheels, wheel centres or wheel centres with tyres to the axle (see point 5.2.3.2 - page 9).

3.7.1 - If pressed-on fitting is specified:

Tightening range between seat and bore (see point 4.1.2 - page 6), range of pressure P_F (see point 5.2.3.3.5 - page 10) and type of lubricant.

3.7.2 - If shrunk-on fitting (under the effect of heating) is specified:

3.7.2.1 - Tightening range between seat and bore (see point 4.1.2) and value of counter-pressure P_p (see point 6.4.3.1 - page 14).

3.7.2.2 - Indicate whether the counter-pressure test does not need to be carried out at all or only on part of the wheelset batch (see Table 4, Footnote d - page 26).

3.8 - In the case of tyred wheels, indicate the method of marking any displacement of the wheel centre in relation to the tyre (see point 5.3 - page 12).

3.9 - Indicate whether machining of the running surfaces is required (see point 5.5 - page 12).

3.10 - Identification markings to be applied (see point 4.2.5.1, items 1 - page 7, 5 - page 8 and 6 - page 8 and their location (see point 4.2.5.2 - page 8).

3.11 - Indicate who is to be responsible for inspections (see point 6.1 - page 13 and Table 4 - page 26, Column 5).

3.12 - Indicate whether the electrical resistance is to be measured (see point 4.2.2 - page 6 and Table 4).

3.13 - When out-of-balance needs to be corrected (see points 4.2.3 - page 7, 5.6 - page 12 and Table 4), and if applicable, indicate the permitted value for out-of-balance (see points 4.2.3.2 - page 7 and 4.2.3.3 - page 7).

3.14 - Specify additional dimensional tolerances or those differing from tolerances given in Table 3 - page 25, (see point 4.2.4 - page 7).

3.15 - If a final coat of paint or permanent protection against corrosion is required, details must be specified (see points 5.4 - page 12 and 5.8 - page 12).

4 - Classification

4.1 - Components

4.1.1 - General

In the "ready for fitting" state the components must fulfil all conditions required for sound behaviour of the wheelsets in service. The corresponding characteristics must be determined by reference to the appropriate technical specifications set out in Table 1 - page 23.

4.1.2 - Tightening between wheel seats and wheel bores

As regards the tightening between wheel seats and bores, a range shall be specified by agreement between the purchasing railway and the manufacturer. Unless agreed otherwise, this range shall be such that, with the fitting conditions indicated in point 5.2 - page 9, the requirements of the counter-pressure test shall be fulfilled (see point 4.2.1 - page 6, Table 4 - page 26 and point 6.4.3.1 - page 14), and that the margin selected shall lie between the limiting curves of Figs. 1 - page 19 and 2 - page 20.

4.1.3 - Tightening between seats and bores of other ancillary components

The tightening between seats and bores of other ancillary components of the wheelset shall be specified in the purchase order or its associated documents. In the absence of special provisions their values shall be selected from a range between the limiting curves of Figs. 1 and 2.

Notes:

1. In Figs. 1 and 2 certain tolerance levels and deviations are shown, in accordance with *ISO R 286* (see Bibliography - page 33) and satisfy the necessary conditions shown in point 4.1.2 - page 6. The values are listed in Table 2 - page 24.

2. The choice of a suitable tightening value from the ranges given in Figs. 1 and 2 to meet conditions set for the fitting-on pressure depends partly on the yield limits of the two assembled materials, the lubricant used, the design of the assembled components, the roughness of contact faces, the press-fitting speed, etc. The specification of tighter tolerance ranges for both the tightening and the fitting-on pressure can cause difficulties in assembly.

4.2 - Wheelset

4.2.1 - Mechanical characteristics

In the counter-pressure test (see table 4 - page 26) the wheels must not incur any displacement on the axle.

4.2.2 - Electrical resistance

The electrical resistance of each wheelset shall not exceed 0,01 Ω.

4.2.3 - Out-of-balance

4.2.3.1 - The dynamic out-of-balance of carrying wheelsets in each equilibrium plane must be less than the values indicated in the table below, following *UIC Leaflet 510-2* (see Bibliography - page 33).

Maximum permitted wheelset speed km/h	Maximum dynamic out-of-balance gm
100 < V ≤120	125[a]
120 < V ≤ 200	75 (all vehicles)
V > 200	50 (all vehicles)

a. If laid down in the purchase order.

4.2.3.2 - For driving wheelsets, values for the dynamic out-of-balance can be agreed when calling for tenders and placing the purchase order.

4.2.3.3 - Values for the static out-of-balance can also be agreed when calling for tenders and placing the purchase order. However, for carrying wheelsets the value for the static out-of-balance of the wheelset shall not exceed twice the amount of the values shown in point 4.2.3.1 - page 7.

4.2.4 - Dimensions

The dimensions of the wheelsets must satisfy the specifications of the purchase order and its associated documents.

Tolerances are specified in Table 3 - page 25.

4.2.5 - Manufacturing markings

4.2.5.1 - The components of the wheelset shall bear the manufacturing markings indicated in the particular specification for the component. The markings below shall be cold-punched with stamps with rounded edges bearing characters 5 to 10 mm high to provide the following information:

1. the serial number:

   The purchasing railway or else the manufacturer shall define the type of serial number to be used and shall allocate groups of numbers for this purpose.

2. the date of acceptance:

   Two digits for the month (e.g. 02 = February) and the last two digits of the year of acceptance shall be punched. However, marking of the acceptance date may be omitted when the month and year of acceptance are the same as the month and year of manufacture of the axle shown on its end faces.

3. the inspection mark,

4. the mark of the manufacturer or special workshop where the wheelset was assembled,

and if required:

5. the symbol or number of the wheelset type,

6. the identification mark of the railway.

4.2.5.2 - Unless otherwise agreed, these markings shall be affixed to the end face of the axle bearing the marking of the manufacturer.

If insufficient space is available on the end face (for example in the case of wheelsets with roller bearing axle-boxes), the markings may, with the agreement of the purchasing railway, be punched into a steel band placed round the axle.

5 - Manufacture

5.1 - General

The manufacturer shall inform the purchasing railway of the production method to be used. He shall notify the purchasing railway of any changes in this method which might affect quality, asking for its approval.

5.2 - Fitting of wheelset components

5.2.1 - Preparatory operations

Before being fitted, components shall be prepared and checked in accordance with the provisions of point 6.2 - page 13.

5.2.2 - Fitting of ancillary components

Unless otherwise specified in the purchasing order or its associated documents, fitting of the ancillary components, such as gear wheels, brake discs, generator pulleys, etc., shall be carried out under the same conditions as for solid-core wheels, tyred wheels or wheel centres.

5.2.3 - Fitting of wheels or wheel centres

5.2.3.1 - Location of out-of-balance

After fitting, the residual out-of-balance of each of the two wheels of the same wheelset must lie in the same diametrical plane and on the same side of the centre-line of the axle.

The residual out-of-balance of the brake discs must lie in the same diametrical plane as the out-of-balance of the wheels and be opposite in relation to the centre-line of the axle.

5.2.3.2 - Fitting methods

Only pressed-on fitting (see point 5.2.3.3 - page 9) and shrunk-on fitting under the effect of heating (see point 5.2.3.4 - page 11) are provided for in this technical specification.

Other methods for fitting wheelset components to the axle may be authorised, in accordance with the regulations of the purchasing railway.

5.2.3.3 - Assembly by pressed-on fitting

5.2.3.3.1 - At the time of fitting-on, the solid-core or tyred wheels, or the wheel centres, shall have the same ambient temperature as the axle.

5.2.3.3.2 - The bore of the wheel or wheel centre and the corresponding seat on the axle shall be coated with a lubricant film. This lubricant should preferably be one of the following:

1. pure tallow,

2. vegetable oil (linseed oil, rapeseed oil, colza oil),

3. vegetable oil + tallow,

4. molybdenum disulphide.

The type of lubricant to be used shall be specified by the purchasing railway.

5.2.3.3.3 - Fitting of the wheel, wheel centre or tyred wheel must be carried out gradually with a hydraulic press, taking all suitable precautions to prevent deformation of the components and damage to the machined parts, especially the journals.

The fitting speed depends on the wheelset type, the lubricant used and the press used. It should be slow enough to satisfy the conditions of point 5.2.3.3.4 (typical value 0,5 to 5 mm/s).

The press should be equipped with a properly calibrated recording pressure gauge, making it possible to draw the diagram of the fitting pressure as a function of the position of the wheel in relation to the seat on the axle during the operation. This diagram shall be drawn with indelible ink and to a sufficiently large scale to permit precise measurement of the fitting-on pressure at any point of the curve.

Before applying the fitting pressure, the recorder shall be set at zero.

5.2.3.3.4 - The fitting-on pressure diagram shall satisfy the following conditions:

1. the pressure shall begin to rise before the movement of the wheel or wheel centre on the seat has reached 20 mm;

2. the fitting-on pressure shall increase steadily and continuously in relation to the movement;

3. a decrease in fitting-on pressure in the vicinity of an oil relief groove is permitted;

4. the final fitting-on pressure shall not be less than the value of minimum fitting-on pressure P_{Fmin} nor exceed maximum press fitting force P_{Fmax} (see point 5.2.3.3.5 - page 10).

   However, maximum fitting-on pressure P_{Fmax} may be exceeded by up to 10% if a satisfactory counter-pressure test is carried out (see point 6.4.3.1 - page 14);

5. a reduction of the fitting-on pressure by up to 50 kN is permitted in the last 25 mm of movement;

6. at any point of the diagram the fitting-on pressure shall not exceed 1,1 times the value of maximum fitting-on pressure P_{Fmax}.

   The provisions are shown in appendix C - page 27 in schematic form.

5.2.3.3.5 - Permitted values P_F = a.D kN for the fitting-on pressure specified by the purchasing railway in tender invitations or purchase orders for pressed-on fitting of wheels to axles.

- D = nominal diameter of the hub seat in mm,

- a = coefficient in the table below,

- L = length of the hub seat in mm.

"a" coefficients

Wheel type	1	2	3
	Lubricant		
	Oil	Tallow	Mo^{S}_{2}
Wheel centres without tyres Trailing stock	3,5 to 5,0	3,0 to 4,5	3,0 to 4,5
Solid-core wheels Tyred wheels Trailing stock	4,0 to 6,0	3,0 to 5,5	3,5 to 5,5
Solid-core wheels Tyred wheels Tractive stock	4,5 to 6,5	3,0 to 6,0	3,5 to 6,0

1. The values above are valid for $\frac{L}{D}$ = 0,8 to 1,1.

   For a different $\frac{L}{D}$ ratio, the value of the coefficient shall be set by the purchasing railway.

2. For a mixture of tallow + oil, the average values of columns 1 and 2 shall be applied.

5.2.3.3.6 - A counter-pressure test shall be carried out in the presence of a representative from the purchasing railway if:

- examination of the fitting-on diagram gives rise to doubt;
- final fitting-on pressure P_F achieved exceeds the maximum P_{Fmax} value laid down, but not by more than 10% (see point 5.2.3.3.4 - page 10).

5.2.3.4 - Shrunk-on fitting (under the effect of heating)

5.2.3.4.1 - Shrunk-on fitting (under the effect of heat) shall not be used for mounting tyred wheel centres on to axles.

5.2.3.4.2 - To obtain the full advantages of shrunk-on fitting it is essential that oil grooves be provided.

5.2.3.4.3 - When shrunk-on fitting is required by the purchase order, the solid-core wheels or wheel centres shall be heated, using an approved method, to a temperature not exceeding 250 °C in such a manner that this temperature is attained by the whole work-piece, and that the necessary expansion of the bore of the wheel or wheel centre is achieved to permit it to be fitted on to the axle seat. If the wheel or wheel centre is heated in a furnace, special precautions must be taken to prevent oxidation of the surface of the bore.

After removal from the heating area, the wheel or wheel centre must be wiped clean with a lint-free cloth. If heating was carried out in an oil bath, all traces of oil must be removed. The seat must be clean and free from oil or grease. The wheel (or wheel centre) must be properly placed in its final position

on the axle and allowed to cool in still air until the bore has tightened on the axle seat. The second wheel (or wheel centre) is then mounted in the same manner.

As a relatively short period is available before shrunk-on fitting is achieved by contraction, fixtures for holding the wheel (or wheel centre) in its exact position on the axle should be used.

5.2.3.4.4 - In accordance with point 4.2.1 - page 6 shrunk-on fitting must conform with the requirements of the counter-pressure test set out in points 6.4.2.1 - page 14 and 6.4.3.1 - page 14.

5.3 - Shrunk-on fitting of wheel tyres (while heated)

Shrunk-on fitting of wheel tyres, which must conform with the provisions of *UIC Leaflet 812-4* (see Bibliography - page 33), is carried out before or after pressed-on fitting of the wheel centre, or after shrunk-on fitting of the wheel centre under the effect of heating, in accordance with the conditions specified by the purchasing railway in the purchase order or its associated documents.

5.4 - Protection of recesses

Recesses due to overhang of the wheel hub or gear wheel over a relief groove must be sealed with an anti-corrosion product as required by the purchase order or its associated documents.

5.5 - Machining of wheels

The wheel machining tolerances to be observed are laid down in *UIC Leaflet 812-4 and 812-2* (see Bibliography - page 33).

5.6 - Correction of out-of-balance

Any out-of-balance exceeding the value stipulated in point 4.2.3 - page 7 must be reduced to the permitted value by turning or milling each wheel in accordance with the provisions of *UIC Leaflet 812-3 and 812-4* (see Bibliography - page 33).

5.7 - Repairs

5.7.1 - Any repair for the purpose of hiding a fault is prohibited and entails rejection of the supply.

5.7.2 - Repairs to the various components must be carried out in accordance with the technical specifications shown in Table 1 - page 23.

5.7.3 - With the agreement of the purchasing railway, faulty installation of a component may be corrected by its removal and proper refitting of the component.

5.8 - Corrosion protection

The purchasing railway may stipulate provision of a final coating or other type of permanent protection against corrosion in service of some parts of the wheelset (see points 3.15 - page 5 and 5.4 - page 12). The details of this protection shall be agreed when inviting tenders and in the purchase order.

6 - Inspections

6.1 - Responsibilities, type and date of inspections

6.1.1 - The purchasing railway must specify in the purchase order or its associated documents whether inspections shall be carried out:

- by delegating authority to the appropriate department of the manufacturer,

- or in the presence of a representative of the purchasing railway.

Unless otherwise specified in the purchase order or its associated documents the conditions shown in column 5 of Table 4 - page 26 shall apply.

6.1.2 - Delegation of inspection granted by the purchasing railway to the appropriate department of the manufacturer shall not preclude the right of the purchasing railway to verify, possibly on its own test installations, the effectiveness of the manufacturer's inspections together with the effectiveness of the inspection and test methods.

To this end the purchasing railway shall be authorised to attend all tests carried out under the responsibility of the manufacturer or to inspect the recorded results.

6.1.3 - All inspections for which the appropriate department of the manufacturer is responsible must be made before the final inspection by the purchasing railway in a manner complying with the conditions specified in point 6.6 - page 16

6.1.4 - When the inspection is the responsibility of the manufacturer (see point 6.1.1 - page 13), the date for which the inspection is arranged shall be notified in writing. The number of wheelsets to be made available for inspection and the corresponding purchase order number shall be indicated in this notice.

6.2 - Inspection of components

6.2.1 - Before beginning with manufacture of the wheelsets, a check shall be made whether all components have been inspected in accordance with the corresponding technical specifications (see point 4.1 - page 6), whether the results of this inspection satisfy the provisions of the purchase order and its associated documents, and whether they have deteriorated in the meantime.

6.2.2 - When final machining of the wheel seats or bores of the wheel hubs as well as final profiling of the wheel tread form part of the manufacturing process, these operations and their results must be checked in accordance with the provisions of the corresponding technical specifications (see table 1 - page 23).

6.3 - Inspection of production

6.3.1 - Checking of tightening

The tightening between the seat and the bore of each assembly must be checked in ambient temperature. Records of these measurements, numbered to correspond with the serial number of the assembly, shall be made available to the representative of the purchasing railway at the final inspection.

6.3.2 - Checking of fitting-on pressure

In the case of pressed-on fitting, the original or a copy of the fitting-on pressure diagram, recorded in accordance with the provisions of point 5.2.3.3.3 - page 10 and numbered to correspond with the serial number of the assembly, shall be made available to the representative of the purchasing railway at the final inspection.

6.4 - Inspection of wheelset characteristics

6.4.1 - Type and number of tests

Table 4 - page 26 specifies the test types and whether they are obligatory or optional.

6.4.2 - Condition of wheelsets when presented for inspection

6.4.2.1 - When the counter-pressure test is required, it may be carried out before finishing operations, such as machining of the wheel tread, are applied. Normally the wheelsets should not undergo this test earlier than 48 hours after fitting-on; however, the manufacturer is free to reduce this time.

6.4.2.2 - Measurement of the electrical resistance and out-of-balance as well as checking of appearance and dimensions shall be carried out with the wheelsets ready for delivery, but before application of the protective coatings.

6.4.3 - Inspection methods

6.4.3.1 - Counter-pressure test for solid-core tyred wheels and wheel centres

When required (see point 5.2.3.3.6 - page 11) the counter-pressure test must be carried out on a press similar to the one used for pressed-on fitting and equipped with a recording pressure gauge. The counter-pressure must be applied continuously and uniformly to the wheelset.

The direction of the pressure shall be specified by the purchasing railway.

6.4.3.1.1 - In the case of pressed-on solid-core wheels, wheel centres or tyred wheels, counter-pressure P_p shall, if one of the lubricant types mentioned in point 5.2.3.3.2 - page 9 is used, reach 1,2 times the minimum fitting pressure (P_{Fmin}) prescribed by the purchasing railway.

When counter-pressure P_p is reached, the wheel must not be displaced.

6.4.3.1.2 - In the case of shrunk-on wheels or wheel centres fitted-on while heated, the purchasing railway may stipulate a minimum value for counter-pressure P_p, when inviting tenders and placing purchase orders (see point 3.7.2.1 - page 4).

This minimum value shall lie in the following range:

$$3{,}0\ D \leq P_p \leq 7{,}0\ D$$

where:

- P_p is the counter-pressure in kN,
- D is the diameter of the wheel seat in mm.

When no value is stipulated for P_p, the pressure shall be $P_p = 6{,}0\ D$.

6.4.3.2 - Measurement of the electrical resistance

The wheelset shall be insulated against any stray contact and placed on the supports of a calibrated test rig, with which the electrical resistance between the wheel treads of the two wheels can be measured. This rig, or any other test method, must have been approved by the purchasing railway.

6.4.3.3 - Correction of wheelset out-of-balance

6.4.3.3.1 - Measurement of dynamic out-of-balance

Dynamic wheelset out-of-balance shall be measured with equipment previously approved by the purchasing railway.

The sensitivity of this equipment must be sufficient to be able to detect out-of-balance equal to at least 1/5th of the maximum values indicated in point 4.2.3.1 - page 7.

6.4.3.3.2 - Measurement of static out-of-balance

Static wheelset out-of-balance shall be measured with equipment previously approved by the purchasing railway. The wheelset to be tested shall rest with its journals on the smoothed and polished surfaces of the horizontal supports of this machine.

6.4.3.4 - Checking of appearance and dimensions

Appearance and dimensions shall be checked by suitable means to be provided by the manufacturer after prior approval by the purchasing railway. The dimensions in particular must be checked with periodically-calibrated measuring instruments.

6.5 - Conclusions from the inspections

6.5.1 - If the inspections show that the production conditions have differed from those stipulated in the purchasing order and its associated documents, the wheelsets involved may be rejected.

6.5.2 - Any wheelset not complying with the conditions of this technical specification (see table 4 - page 26) is liable to be rejected.

6.5.3 - Rejected wheelsets may be re-presented for inspection when they have been repaired in accordance with point 5.7 - page 12 or another repair method authorised by the purchasing railway.

6.6 - Certification

During the final inspection, or earlier, the manufacturer shall supply a certificate attesting that the provisions of this technical specification have been observed. The results of the tests shall be made available to the purchasing railway.

7 - Delivery

7.1 - Protection against corrosion during shipment

After final inspection, and before storage or shipment, the wheelsets must be protected against corrosion. Special attention shall be paid to all components not yet protected and those whose protection has been removed or damaged during production or handling. The protection method and the areas to be protected shall be agreed when inviting tenders and placing the purchasing order.

7.2 - Protection against mechanical damage during shipment

Before despatch the wheelsets shall be provided with effective protection against mechanical damage.

8 - Guarantee

The terms of guarantee shall be agreed in the purchasing order between manufacturer and purchasing railway. Unless stipulated otherwise in the purchasing order the wheelsets shall be guaranteed by the manufacturer for five years against any defect attributable to production and not detected in the inspection at the works.

This period shall start from the end of the month marked on the wheelset.

In the case of wheelsets installed in new vehicles, the date of delivery of the vehicles in which they are installed shall be considered to be the starting date of the guarantee period.

Wheelsets which during the guarantee period prove to have faults making them unsuitable for service or reducing their service life, shall be rejected.

However, before being rejected definitely, the defective wheelsets may be submitted to an examination in the presence of both parties - purchasing railway and manufacturer - if the latter so requests.

If this examination confirms that the faults can be attributed either to production or to the fact that the protection methods according to points 7.1 - page 17 and 7.2 - page 17 were not observed, the defective wheelsets shall be definitely rejected.

If the results of the examination carried out in the presence of both parties fail to bring agreement between the purchasing railway and the manufacturer, experts recognised by both parties shall be consulted to settle the dispute. The costs shall then be borne by the party adjudged to be responsible.

The rejected wheelsets and wheelset components shall be put at the disposal of the manufacturer to be replaced or reimbursed at the as-new value at the time of withdrawal.

Appendix A - Characteristics, tightening and dimensional tolerances of wheelsets and their components

A.1 - Nominal diameter D of wheel, gear or brake-disc seat in mm

A.1.1 - Tightening between seats and bores from 100 to 300 mm diameter and corresponding tolerance limits for deviation V according to *ISO R 286*

See point 4.1.2 - page 6, figure 3 - page 21 and (see Bibliography - page 33).

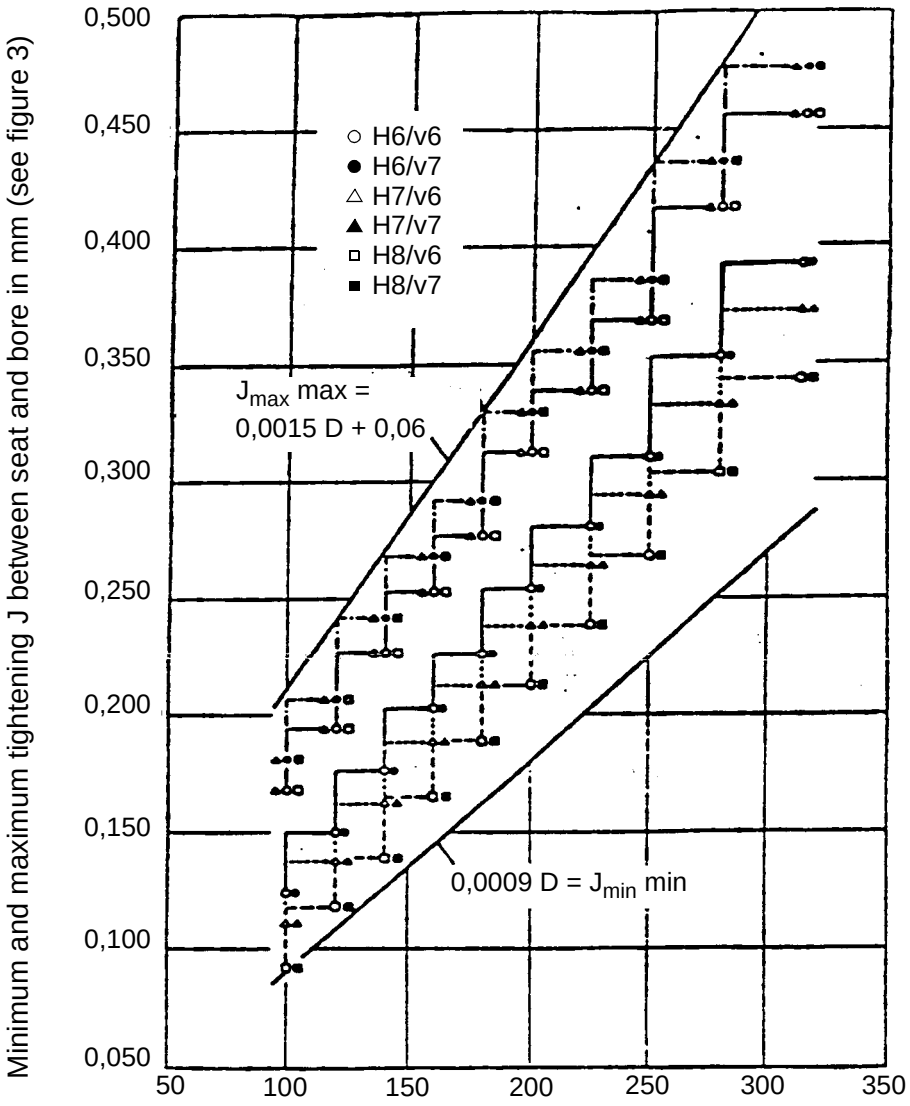


Fig. 1 - Tightening between seats and bores from 100 to 300 mm diameter and corresponding tolerance limits for deviation V according to ISO R 286

A.1.2 - Tightening between seats and bores from 100 to 300 mm diameter and corresponding tolerance limits for deviation U according to *ISO R 286*

See point 4.1.2 - page 6, figure 3 - page 21 and (see Bibliography - page 33).

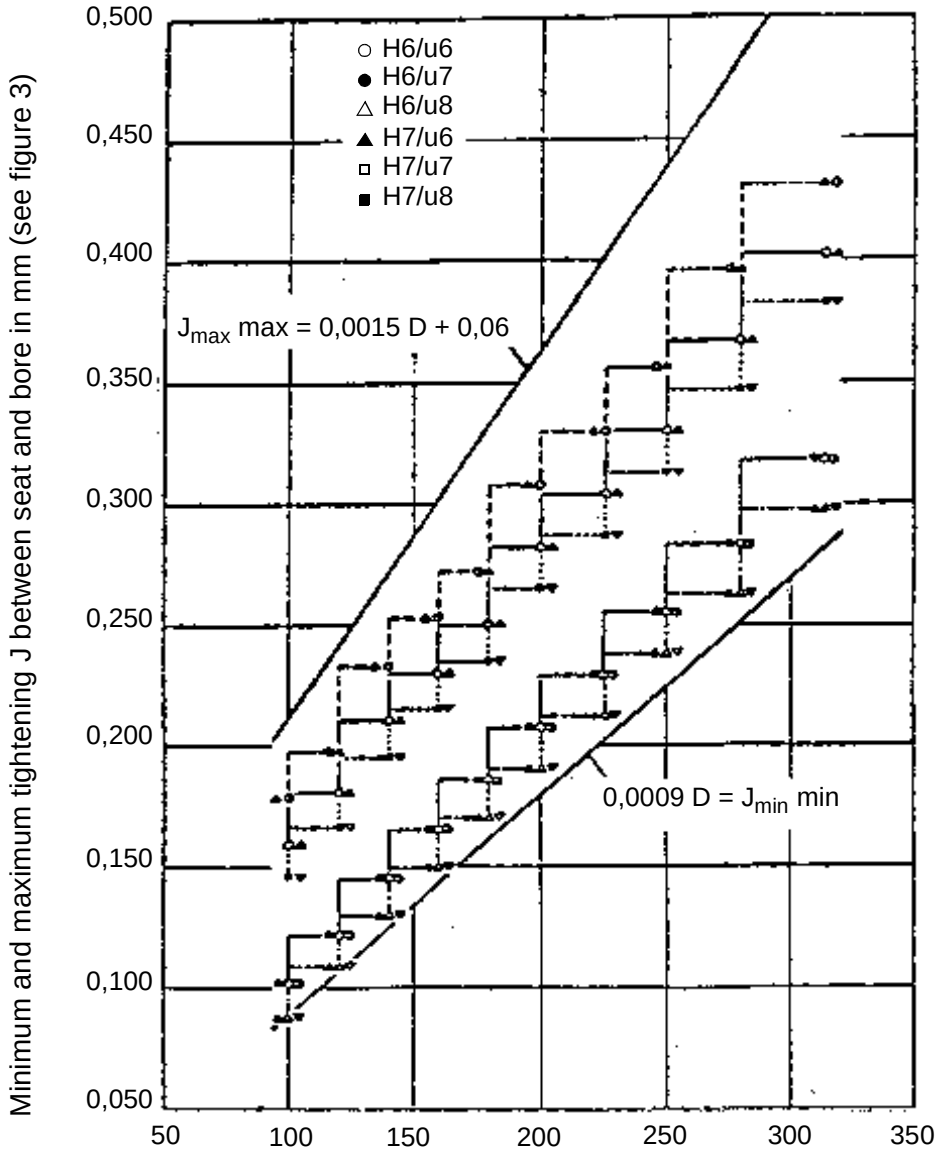


Fig. 2 - Tightening between seats and bores from 100 to 300 mm diameter and corresponding tolerance limits for deviation U according to ISO R 286

A.2 - Explanation of symbols

A.2.1 - Explanation of symbols in table 2 and figures 1 and 2 for the tolerances and tightening between seats and bores

See table 2 - page 24, figures 1 - page 19 and 2 - page 20.

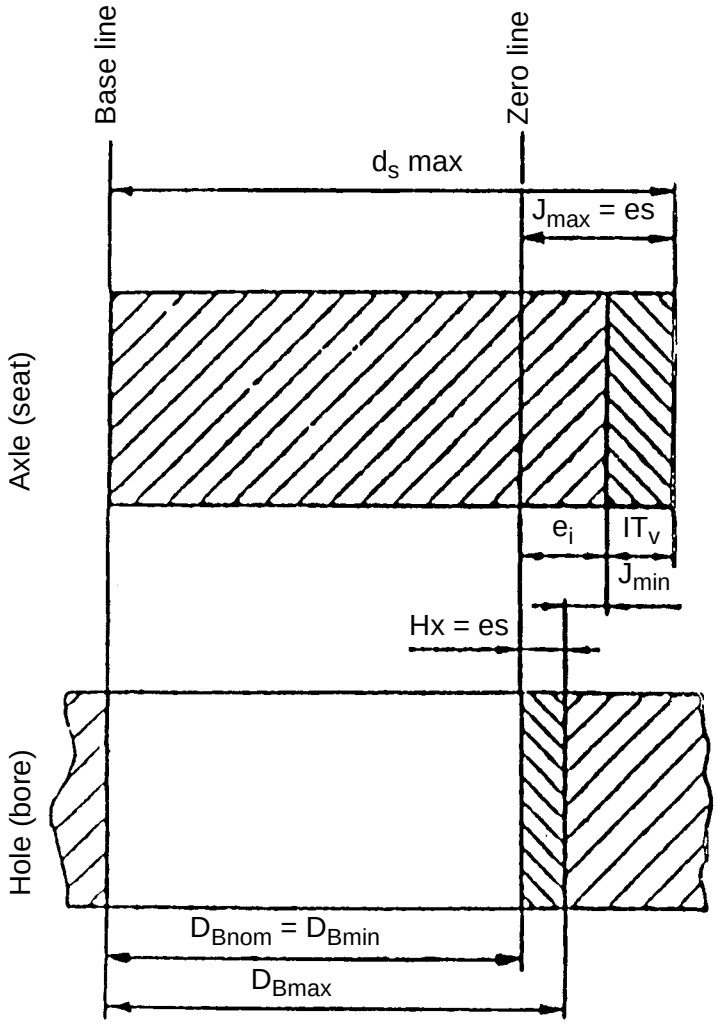


Fig. 3 - Explanation of symbols in table 2 and figures 1 and 2 for the tolerances and tightening between seats and bores

A.2.2 - Explanation of symbols used in table 3 for wheelset tolerances

(see table 3 - page 25).

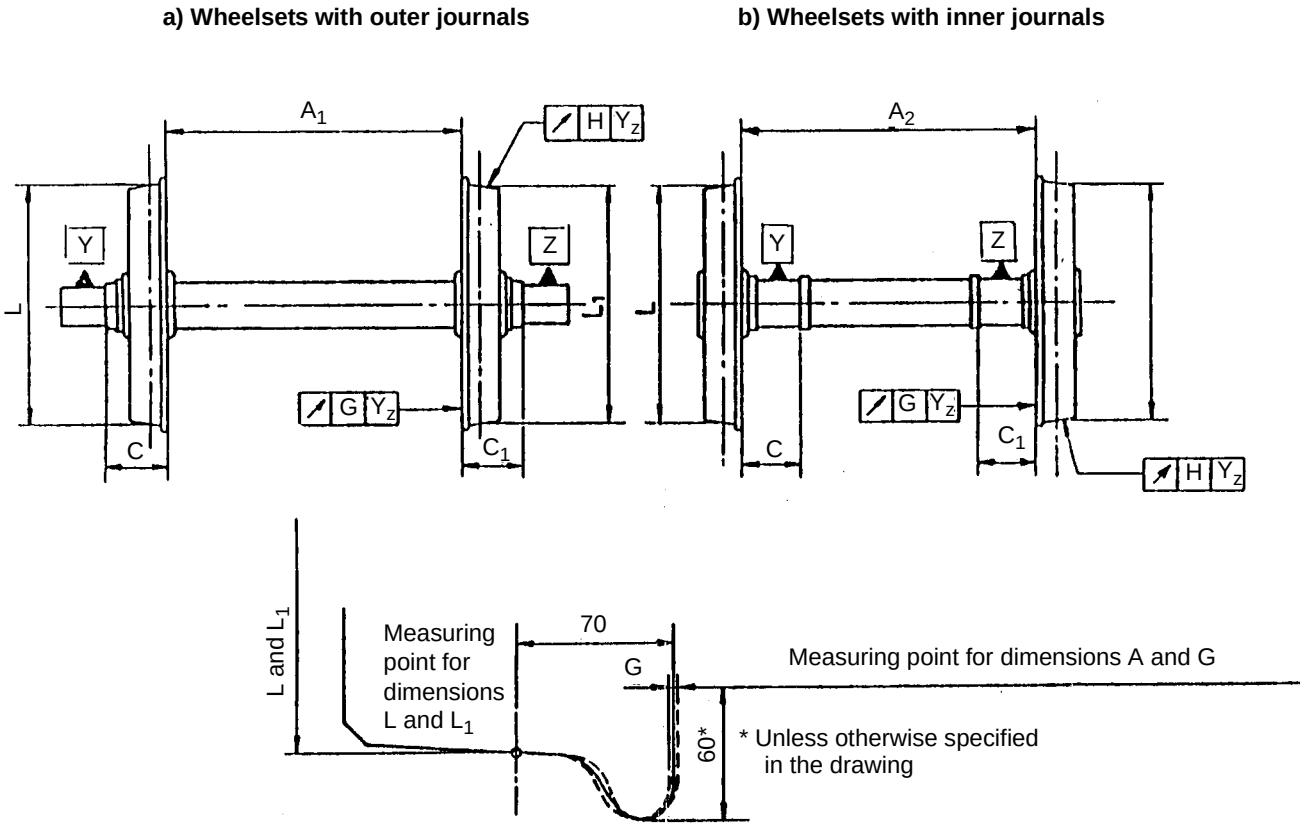


Fig. 4 - Explanation of symbols used in table 3 for wheelset tolerances

A.3 - Tables

A.3.1 - Table 1: Conditions for wheelset components

Table 1: Conditions for wheelset components

Component	Quality conditions	Dimensional conditions for the "ready for assembly" state
	(see Bibliography - page 33)	
Axles	*UIC Leaflet 811-1*	*UIC Leaflet 811-2*
Solid-core wheels	*UIC Leaflet 812-3*	*UIC Leaflet 812-2*
Wheel centres	*UIC Leaflet 812-1*	*UIC Leaflet 812-5*
Wheel tyres	*UIC Leaflet 810-1*	*UIC Leaflet 810-2*
Tyred wheels		*UIC Leaflet 812-4*
Spring rings	*UIC Leaflet 810-3*	

A.3.2 - Table 2 : Limit values of tolerances and tightening for seats and bores

Table 2: Limit values of tolerances and tightening for seats and bores

1	2			3		4					5					6	7	8
Nominal and minimum bore diameters	Maximum bore diameter			Limit of seat diameter[a]							Tightening between bore[a] and seat[a]						Wheel seat diameter[a]	
D_{Bnom}				Lower		Upper					Min.					Max.	Min.	Max.
D_{Bmin}	$D_{Bmax} = D_{Bnom} + ...$			$ei = J_{min} + Hx^d$		$es = J_{max}{}^c$					$J_{min} = ei - H_x{}^d$					$J_{max} = es$	ds_{min}	ds_{max}
mm	H6	H7	H8	u^b	v^b	u6	u7	u8	v6	v7	H6/u^b	H7/u^b	H6/v^b	H7/v^b	H8/v^b			
> 100 to 120	0,022	0,035	0,054	0,144	0,172	0,166	0,179	0,198	0,194	0,207	0,122	0,109	0,150	0,137	0,188	J_{max} = es (see column 4)	$d_{smin} = D_{Bnom}$ + ei (see columns 1 and 3)	$d_{smax} = D_{Bnom}$ + es (see columns 1 and 4)
> 120 to 140	0,025	0,040	0,063	0,170	0,202	0,195	0,210	0,233	0,227	0,242	0,145	0,130	0,177	0,162	0,139			
> 140 to 160	0,025	0,040	0,063	0,190	0,228	0,215	0,230	0,253	0,253	0,268	0,165	0,150	0,203	0,188	0,165			
> 160 to 180	0,025	0,040	0,063	0,210	0,252	0,235	0,250	0,273	0,277	0,292	0,185	0,170	0,227	0,212	0,189			
> 180 to 200	0,029	0,046	0,072	0,236	0,284	0,265	0,282	0,308	0,313	0,330	0,207	0,190	0,255	0,238	0,212			
> 200 to 225	0,029	0,046	0,072	0,258	0,310	0,287	0,304	0,330	0,339	0,356	0,229	0,212	0,281	0,264	0,238			
> 225 to 250	0,029	0,046	0,072	0,284	0,340	0,313	0,330	0,356	0,369	0,386	0,255	0,238	0,311	0,294	0,268			
> 250 to 280	0,032	0,052	0,081	0,315	0,385	0,347	0,367	0,396	0,417	0,437	0,283	0,263	0,353	0,333	0,304			
> 280 to 315	0,032	0,052	0,081	0,350	0,425	0,382	0,402	0,431	0,457	0,477	0,318	0,298	0,393	0,373	0,344			

a. The terms "bore" and "seat" used in this technical specification apply respectively to the wheel, gear and brake-disc bores and the wheel, gear and brake-disc seats.
b. For all tolerance ranges.
c. J_{max} - ei + IT_v (IT_v - international tolerances v, v being equal to 6, 7 or 8; see Fig. 3).
d. v can be equal to 6, 7 or 8 (see Fig. 1, 2 and 3).

A.3.3 - Table 3 : Dimensional tolerances for wheelsets

Table 3: Dimensional tolerances for wheelsets

Designation	Symbol (see Fig. 4 - page 22)	Operating speed in km/h V	Tolerances (in mm)[a]
Distance between the inner surfaces of the two wheels	A1 A2	All	+ 2 0 0 - 2
Difference between the respective distances from the inner surface of a wheel to the outer end of the corresponding journal	(C - C1) or (C1 - C)	All	≤ 1,0
Axle off-centre (runout) of the inner surface of each wheel[b]	G	V ≤ 120 120 < V ≤ 160 160 < V ≤ 200 V > 200	≤ 1,0 ≤ 0,8 ≤ 0,5 c
Radial off-centre (runout) of wheel tread[b]	H	V ≤ 120 120 < V ≤ 200 V > 200	0,5 0,3 c
Difference between wheel tread diameters of the two wheels of the same wheelset	(L - L1) or (L1 - L)	V ≤ 200 V > 200	0,5 c

a. The value specified correspond to UIC Leaflet 510-2.
b. The geometrical concept of "off-centre" (runout) is defined by ISO standard 1101/1.
c. The tolerance value must be agreed when calling for tenders and placing the purchase order.

Appendix B - Type and number of wheelset tests

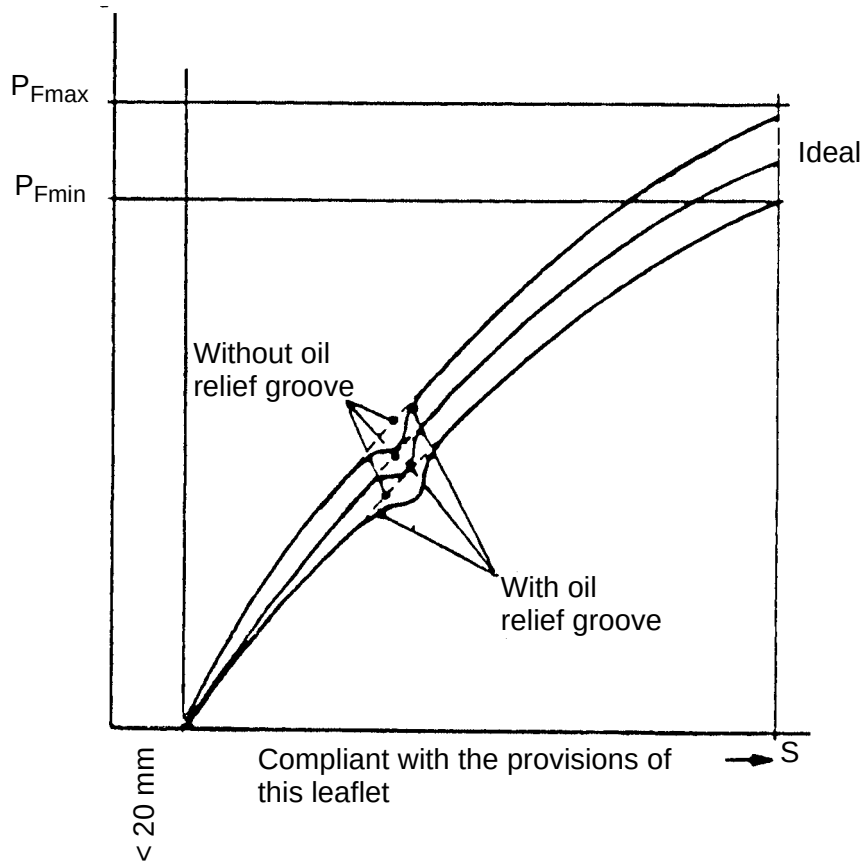
Table 4: Type and number of wheelset tests

1	2	3	4	5	6
	Inspection of	**Type of test or inspection**	**Observations**		**Number of wheelsets to be checked**
			a	b	
1	Component	See points 6.2 - page 13 and 6.6 - page 16			
2	Manufacture	Tightening between seats and bores (see point 4.1.2 - page 6)	m	1)	All
3		Pressure diagram for pressed-on wheels (see points 5.2.3.3.3 - page 10 and 5.2.3.3.6 - page 11)	m	1)	All
4	Characteristics	Counter-pressure test (see point 6.4.3.1 - page 14):			
		- for pressed-on wheels	c	2)	c
		- for shrunk-on wheels (while heated)	m	2)	d
5		Electrical resistance (see point 4.2.2 - page 6):			
		- tyred wheels	m	1)	All
		- solid-core wheels	o	1)	d
6		Out-of-balance of wheelset (see point 4.2.3 - page 7):			
6a		Dynamic			
		- carrying wheelset V ≤ 120 km/h	o	1)	d
		- carrying wheelset V > 120 km/h	o[e]	1)	d
		- driving wheelset	o[f]	1)	d
6b		Static	o[g]	1)	All
7		Appearance and dimensions (see point 4.2.4 - page 7)	m	2)	All

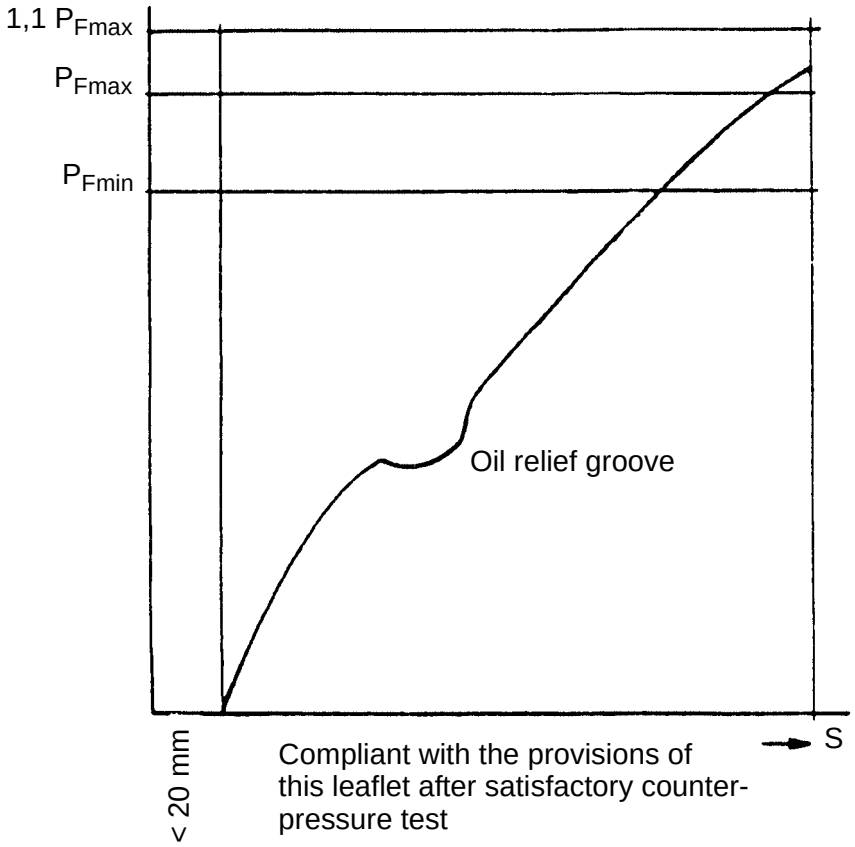
a. m = obligatory test.
o = optional test (i.e. tests need only be carried out when specified in the purchase order or its associated documents).
b. Unless otherwise agreed (see point 6.1), the tests shall be carried out:
1) either by the competent service of the manufacturer, or
2) in the presence of a representative of the purchasing railway.
c. See point 5.2.3.3.6.
d. The purchasing railway shall specify the number of wheelsets to be inspected per batch; if not specified, all wheelsets are inspected.
e. The manufacturer must satisfy the purchasing railway that the manufacturing methods guarantee compliance with the regulations concerning dynamic balancing.
f. See points 4.2.3.2 and 6.4.3.3.1.
g. See points 4.2.3.3 and 6.4.3.3.2.

Appendix C - Schematic representation of the fitting-on diagram

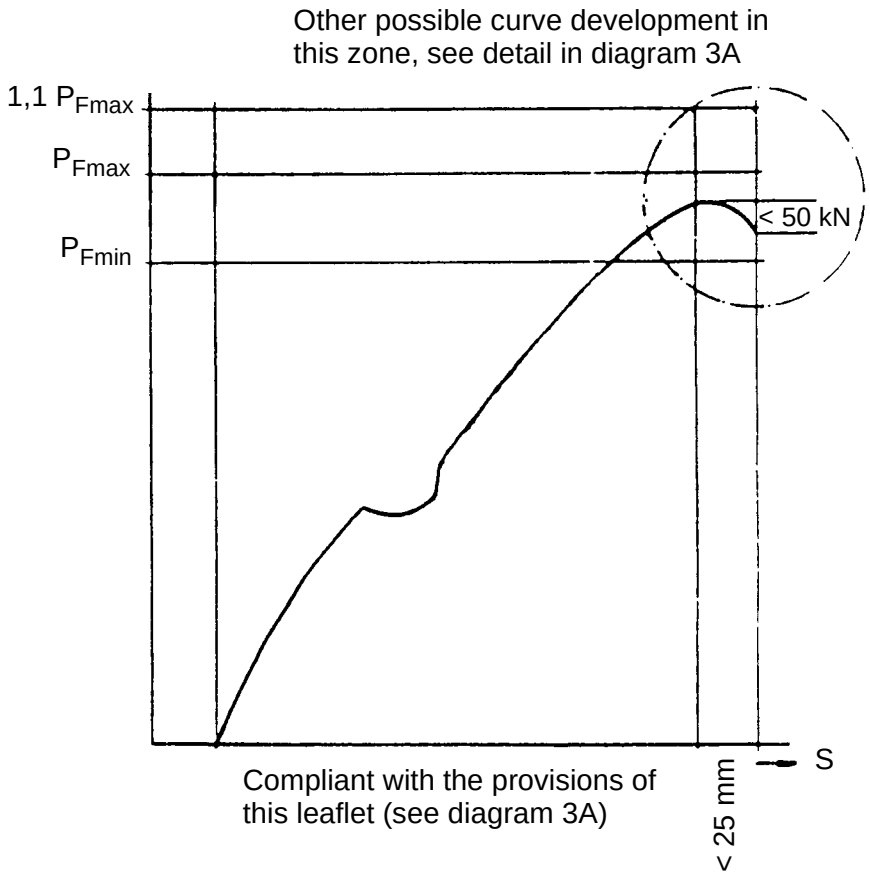
C.1 - Diagram 1



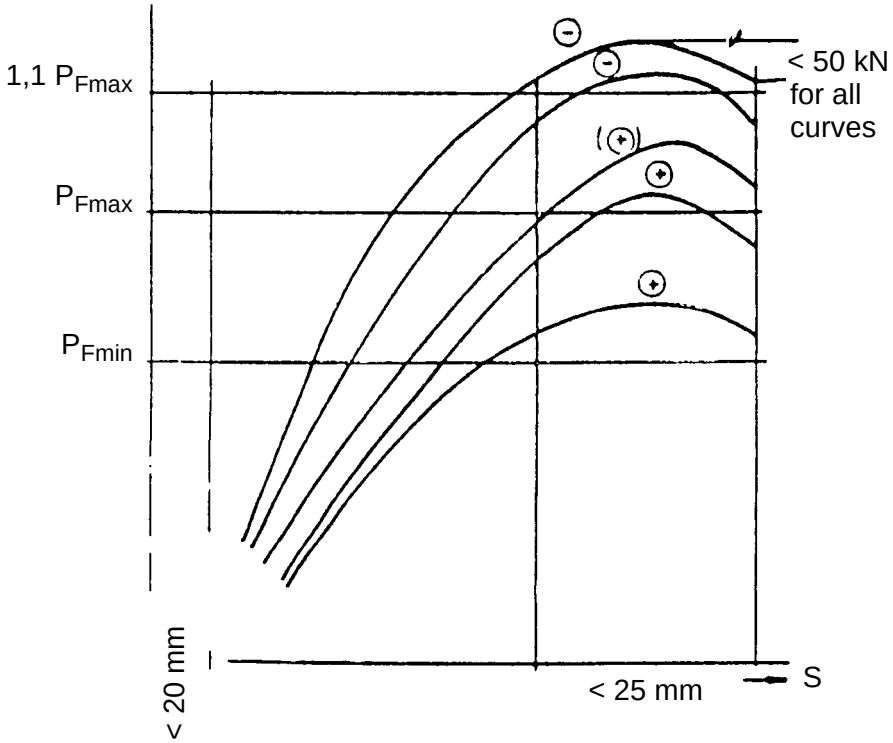
C.2 - Diagram 2


1,1 P_{Fmax}
P_{Fmax}
P_{Fmin}
Oil relief groove
S
< 20 mm
Compliant with the provisions of this leaflet after satisfactory counter-pressure test

C.3 - Diagram 3


Other possible curve development in this zone, see detail in diagram 3A
1,1 P_{Fmax}
P_{Fmax}
P_{Fmin}
< 50 kN
S
Compliant with the provisions of this leaflet (see diagram 3A)
< 25 mm

C.4 - Diagram 3A

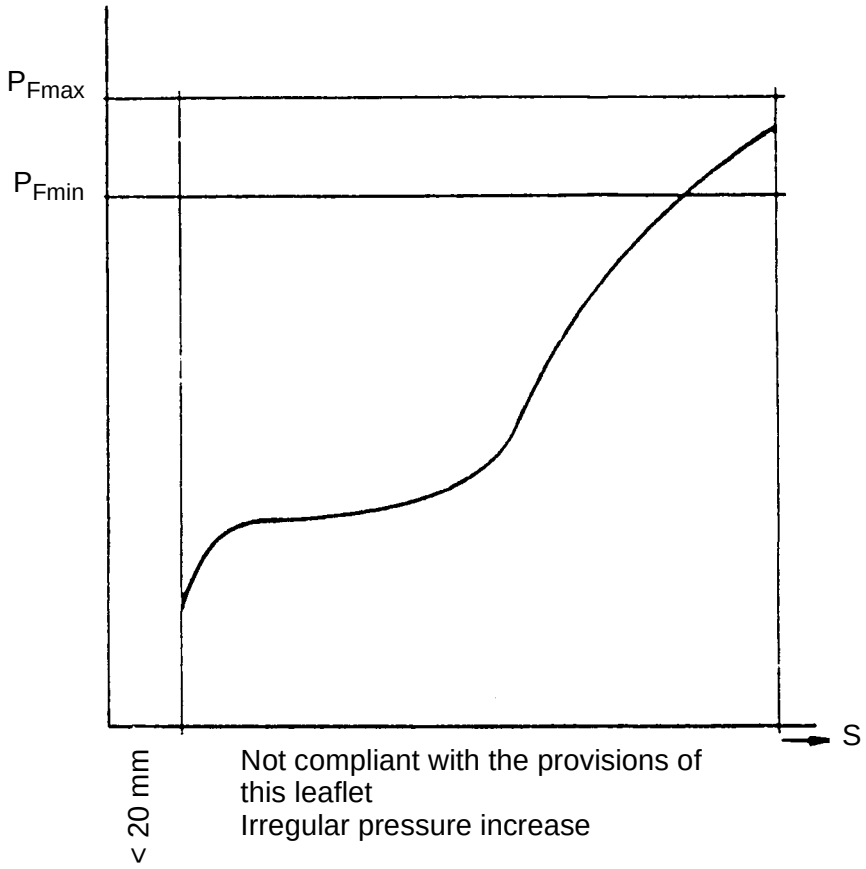


⊖ Not compliant with the provisions of this leaflet

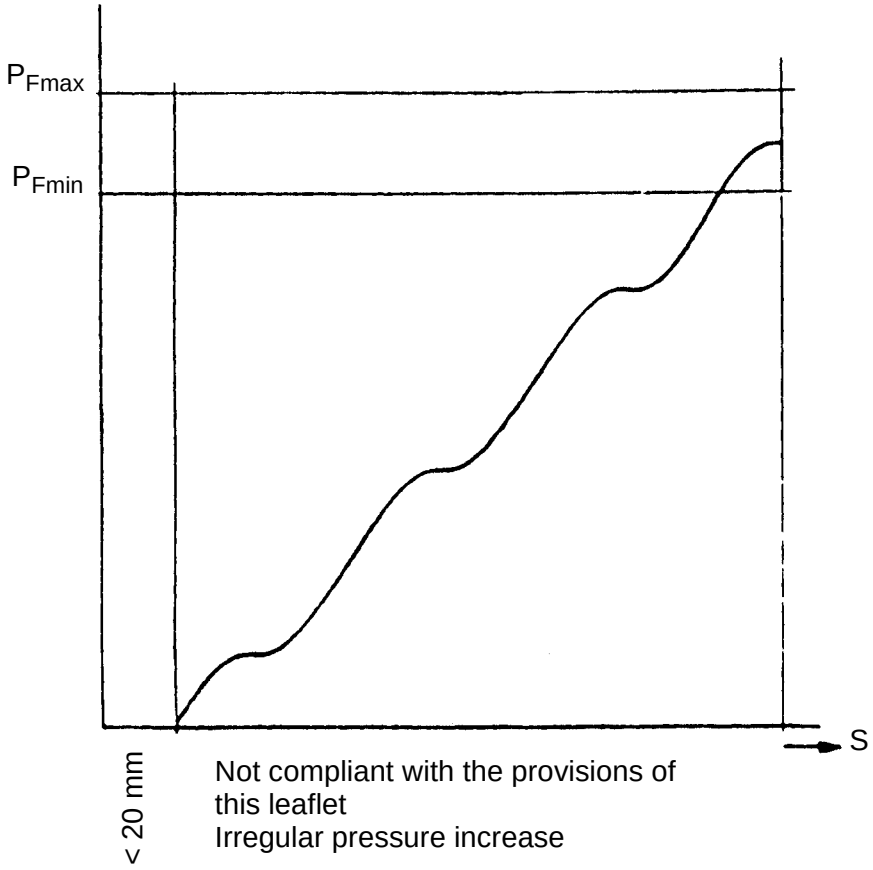
(⊕) Compliant with the provisions of this leaflet after satisfactory counter-pressure test

⊕ Compliant with the provisions of this leaflet

C.5 - Diagram 4


P_{Fmax}
P_{Fmin}
S
< 20 mm
Not compliant with the provisions of this leaflet
Irregular pressure increase

C.6 - Diagram 5


P Fmax
P Fmin
S
< 20 mm
Not compliant with the provisions of this leaflet
Irregular pressure increase

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2. Minutes of meetings

International Union of Railways (UIC)
Sub-Committee for Specifications (Question 5/SA/FIC - UIC Leaflet 813 "Technical specification for the supply of wheelsets for tractive and trailing stock"), January 1988

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