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Translation

O

Technical specification for the supply of brake-shoes made from phosphoric iron for tractive and trailing stock

Spécification technique pour la fourniture de semelles de frein en fonte phosphoreuse pour le matériel moteur et remorqué

Technische Lieferbedingungen für Bremsklotzsohlen aus Phosphorgußeisen für Triebfahrzeuge und Wagen



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VI - Traction

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Summary

This specification governs the supply of brake-shoes made from phosphoric iron for tractive and trailing stock as specified in *UIC Leaflet 542* for international services. These brake-shoes belong to the category identified as P10.

1 - Purpose and scope

This specification governs the supply of brake-shoes made from phosphoric iron for tractive and trailing stock as specified in *UIC Leaflet 542* (see [Bibliography - page 23](#)) for international services. These brake-shoes belong to the category identified as P10. Brake-shoes in category P14, defined in [Appendix C - page 21](#), may continue to be used by Railways which have been granted an exemption by UIC for a limited period of time.

This specification defines requirements covering brake-shoe manufacture and inspection conditions.

Any other type of brake-shoe used by each individual Railway in domestic traffic must be the subject of a special agreement between the purchasing Railway and the supplier.

2 - Reference documents

In this specification, reference is made to the following documents:

- *UIC Leaflet 542*,
- ISO Standards: 945, 6506-1, 7438, 7799 and 9002 (see Bibliography - page 23).

3 - Chemical properties of the product

3.1 - Brake-shoes made of cast iron grade P10

The phosphorus content of the iron must be between:

$$0,80\% \text{ and } 1,10\%$$

The manganese content of the iron must be such that:

$$(1,72 \text{ S } \% + 0,30) < \text{Mn } \% < 1,00 \%,$$

where S % is the sulphur content of the iron.

The recommended total carbon and silicon contents are:

$$2,90 \% < \text{TC } \% < 3,30 \% \text{ and } 1,20 \% < \text{Si } \% < 2,00 \%$$

3.2 - Steel support

The carbon, sulphur and phosphorus contents of the constituent steel of the brake-shoe support shall be such that:

- C % < 0,13 %,
- S % < 0,062 %,
- P % < 0,062 %.

4 - Characteristics of parts

4.1 - Geometrical characteristics

The shape, dimensions and tolerances for brake-shoes and supports shall be as laid down in *UIC Leaflet 542* (brake-shoes 250 mm and 320 mm in length).

4.2 - Mechanical characteristics

4.2.1 - Brinell hardness - Brake-shoes

Both the surface and core of the iron must have the following Brinell hardness: $197 < HB < 255$.

4.2.2 - Brake-shoe impact strength and support resistance

The brake-shoes must be able to withstand the initial impact of the test laid down in point [8.5.4 - page 15](#).

Following a subsequent impact or impacts designed to break the shoes, their steel supports must remain intact and attached to the iron pieces. The bridges may possibly become detached but should not show any soundness defects.

4.2.3 - Bend test for brake-shoe supports

The supports, separate from the shoes, must be able to withstand the bend test laid down in point [8.5.5 - page 16](#) without cracking or breaking.

This test is only prescribed in the following four cases: approval of a new supplier; certification of brake-shoes; lapse in quality discovered during manufacture or while in service; a change in manufacturing processes or in the product for the protection of supports.

4.3 - Physical characteristics

4.3.1 - Appearance, soundness and texture of brake-shoes

The brake-shoes must be suitably scraped and cleaned, freed from all gate, riser and dead-head, and possess no defect, whether visible or not, which is likely to be prejudicial to assembly or use.

All flashes must be under 2 mm in height and must not present any risks for handling.

The brake-shoe bridge, which comprises the recess for the cotter to connect with the brake-shoe holder, must not have any blowholes, underfilling, finning or cracks.

Casting defects (contraction cavities, blowholes, etc.), whether or not metallic inclusion is excluded, shall be allowed on the friction surface of the brake-shoe (apart from its middle third) and in the break after the impact test, within the following limits:

- one single defect with maximum dimension of 10 mm at most,

- several defects with dimensions of less than 10 mm and whose total area amounts to less than 5% of the surface.

After yielding under impact, the break in the iron must have a grey tinge and must be homogeneous.

4.3.2 - Appearance and soundness of brake-shoe supports

The brake-shoe supports must not have either split ends or surface flaws such as scale, shut, or the inclusion of oxide which might detract from good operating performance. The supports must be visible on at least 15 mm of each side of the bridge or at the ends of the brake-shoe in order **to ensure that they are positioned correctly**.

4.3.3 - Micrographic core and surface structure of the iron

A **metallographic** examination of the iron must show the following:

- untreated, magnification = $G \times 100$:
 - a type 1 **flake** graphite with A distribution and size 3 to 5 according to *ISO Standard 945*; B-distribution graphite possibly present in a maximum proportion in accordance with model image **3 - page 19** shown in Appendix **A**;
- after nital treatment, magnification of $G \geq 200$:
 - a perlitic matrix in which 50% maximum of the perlite is dissolved,
 - over the sample as a whole, a ferrite ratio, in isolated pockets, of less than **5%** (see model images in Appendix **B - page 20**),
 - total absence of free cementite or other types of carbides in the form of rods;
- after nital treatment, with magnification G :
 - **x 50 or 100** on the effective surface of the brake-shoe, a ferrite border with a maximum thickness of 0,3 mm on average and 0,5 mm at intermittent points (see model images in Appendix **B**),
 - between 25 and 50, a phosphoric eutectic system with even distribution (see model images in Appendix **B**).

5 - Brake-shoe marks

Each brake-shoe must be inscribed as a minimum with the following marks:

- supplier's name, initials, or mark,
- batch mark (number or date of the cast),
- year of manufacture,
- if possible, type, reference, or symbol of the brake-shoe.

These marks must be in the form of hollow casting or an embossed recess in the positions shown in *UIC Leaflet 542* or in the purchasing order. **They shall not touch the brake-shoe holder, in order to remain legible even after prolonged use of the brake-shoe.**

6 - Manufacture

6.1 - Manufacturing processes

The brake-shoes shall be cast from iron which has been smelted twice. The manufacturing processes shall be left to the choice of the supplier.

The supplier must take all necessary steps to avoid carburisation or the coarsening of the grain in the constituent steel of the brake-shoe supports.

The cutting of the supports shall be carried out in such a way that their longest dimension is parallel to the grain of the sheet metal from which they are made. Any catching for the curvature of supports must not cause damage to the steel.

6.2 - Retouching

No retouching may be carried out without prior agreement from the purchasing Railway.

Any retouching and any hot or cold-rolling process with the intention of concealing a defect is prohibited and will result in rejection of the batch.

7 - Approval and certification procedures

7.1 - Approval of suppliers

Manufacture of brake-shoes can only be entrusted to suppliers approved by the purchasing Railway in accordance with the procedure laid down by the latter.

7.2 - Certification of brake-shoes

Brake-shoes shall be subject to the certification procedure laid down by the purchasing Railway. Brake-shoes for certification must have been manufactured under conditions of series production.

Any modification to the manufacturing process may involve reassessment of certification. This also applies to any lapse in quality discovered during manufacture or while in service.

7.3 - Supervision and monitoring of production quality

The supplier must set up structures and use methods which enable him to guarantee quality of manufacture and control of supplies for the purchasing Railway.

Subject to agreement between purchasing Railway and supplier, the latter may propose application of *ISO Standard 9002*.

The purchasing Railway is then able to ascertain, through auditing, monitoring and control carried out on the supplier's premises, the effectiveness of the measures in force.

The monitoring method chosen by the purchasing Railway is specified in the purchasing order.

8 - Tests and checks

8.1 - Submission

8.1.1 - State of brake-shoes as ready for submission

The brake-shoes shall be submitted for acceptance in delivery condition and as ready for use.

8.1.2 - Batching

The brake-shoes shall be submitted grouped in batches, each of which shall be restricted to shoes of the same type and bearing the same batch mark (cast number or date), i.e. shoes produced during the same day by smelting which has not been interrupted by loads intended for the casting of parts in iron of different composition.

8.1.3 - Formal submission procedure

Written notice of the submission date, **signed by a manager of the producing factory**, shall be given to the purchasing Railway.

This notice must specify the number of parts per type submitted in each batch as well as the corresponding purchasing-order references.

At the time of submission, the Railway representative shall receive a certificate attesting that the conditions of manufacture have been adhered to and that the stipulated tests, the results of which shall be appended to the certificate, were satisfactory.

8.2 - Type and extent of the tests and checks

Appendix **D - page 22** details and defines the extent of the tests and checks to be carried out on each batch by the supplier.

In the case of suppliers whose quality systems comply with *ISO Standard 9002* and have been approved by the purchasing Railway, the type and extent of the tests to be carried out may be altered. These alterations are then to form the subject of a written agreement between the purchasing Railway and the supplier and will appear in the corresponding quality or control and testing programmes.

Unless otherwise stipulated in the purchasing order, tests may be carried out in the absence of the purchasing Railway. In either case, test results shall be sent or made available to the latter.

For sampling purposes, the tests may be repeated in whole or in part at the request of the purchasing Railway's representative and in his presence for sampling purposes, in order to check product quality.

With regard to the manufacture of model or series parts, the customer Railway's representative must be able, should he deem it necessary:

- to check any stage in the manufacture,

- to request additional examinations or tests in order, for example, to guarantee the soundness of the brake-shoes or the position of the brake-shoe support (impact tests, longitudinal sections, etc.),
- to select samples and arrange for tests to be carried out by his own laboratory.

8.2.1 - Application of Appendix D for approval procedure

"Tightened inspection" is to be applied following approval of a new supplier or a new manufacturing process, certification of a brake-shoe model, or a production stop lasting longer than the period authorised by the purchasing Railway.

8.2.2 - Application of Appendix D for series inspection

The procedure for migrating from "tightened inspection" to "normal inspection" and then to "reduced inspection" and vice versa is laid down by the purchasing Railway on the basis of previous production.

As a rule, such migrations may be performed in the following manner:

- from tightened to normal or normal to reduced: if ten consecutive batches are satisfactory,
- from reduced to normal or normal to tightened: if one batch is unsatisfactory or if quality standards are not met when in service.

Application of these migrations may be implemented as follows:

- either for each characteristic independent of the others,
- or for sets of characteristics:
 - 1st set: chemical composition, impact test, texture, HB hardness, and micrographic structure,
 - 2nd set: appearance, soundness, and dimensions,
- or for all the characteristics in Appendix D - page 22.

8.3 - Test results

Any characteristic, which is found not to comply with the required conditions in the course of a series of tests and checks, shall result in the rejection of the batch concerned.

However in cases where the purchasing Railway is able to agree implementation of additional tests or checks, possible retouching and/or grading and the number of parts which the supplier must mandatorily submit to these tests or checks shall be decided by agreement between the purchasing Railway and the supplier.

8.4 - Selection of samples and test-pieces

Brake-shoes intended for tests and checks shall be selected at random from each batch submitted and shall be marked indelibly.

Brake-shoes intended for impact tests must invariably be selected from those found to have the greatest degree of hardness.

8.4.1 - Chemical analysis of the product

8.4.1.1 - Cast iron

The samples for chemical analysis of the cast iron shall consist:

- either of cast-iron medallions selected for spectral analysis during casting of brake-shoes,
- or of shavings obtained by planing or drilling portions of cast iron or small plates of full sections, approximately 10 mm thick, taken from the proximity of the fracture in brake-shoes which have yielded as a result of the impact test. The selection of the shavings shall be carried out in such a way that the sample represents the average composition of the iron as far as possible.

In case of dispute concerning the results from the analysis of the medallions, the analysis of the parts themselves shall be conclusive.

8.4.1.2 - Brake-shoe support

The chemical composition of the steel used in the brake-shoe supports shall be checked either in the casting or the half-finished product, or in the support itself before it is used in the manufacture of brake-shoes.

8.4.2 - Geometrical characteristics

The brake-shoes constitute the test-pieces for the geometrical inspection.

8.4.3 - Brinell hardness

The test-pieces for the hardness test shall consist of:

- complete brake-shoes,
- chips cut at right angles in the proximity of fractures in brake-shoes which have yielded as a result of the impact test, before the cutting of a sample intended for micrographic examination.

8.4.4 - Impact and texture tests, support resistance

The test-pieces for the impact tests shall consist of complete brake-shoes.

The test-pieces for inspection of the iron texture and for support resistance shall consist of brake-shoes which have yielded as a result of the impact test.

8.4.5 - Soundness of bridges and position of brake-shoe support

The test-pieces for inspection of the soundness of bridges and the position of brake-shoe supports shall consist of complete brake-shoes.

8.4.6 - Micrography

The test-pieces for micrographic inspection shall consist of small plates of full sections, approximately 10 mm thick, taken from the proximity of the break in brake-shoes which have yielded as a result of the impact test and of which a square area with sides 25 to 30 mm has been polished for the purposes of micrographic inspection (see Figure 1 below).

The method of selection must not alter the structure.

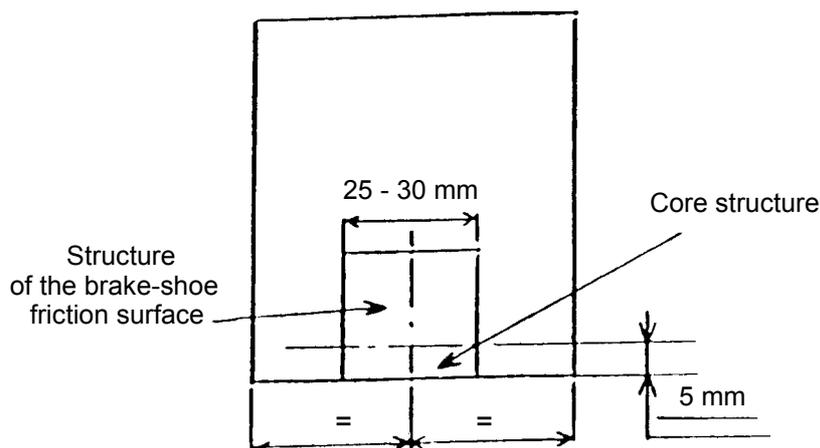


Fig. 1 - Test-piece

8.4.7 - Brake-shoe support bend test

The test-pieces for the bend tests shall consist of a portion of the support 100 to 150 mm long, taken from brake-shoes which have yielded as a result of the impact test.

8.5 - Testing and checking methods

8.5.1 - Chemical analysis

The chemical composition of the cast iron and steel used in the manufacture of the brake-shoes shall be confirmed by a test certificate to be provided by the supplier. The tests shall be carried out by a laboratory approved by the purchasing Railway.

8.5.2 - Geometrical characteristics

The checking of shapes and dimensions shall be carried out employing the appropriate methods, including the use of correctly-calibrated measuring instruments and gauges.

8.5.3 - Brinell hardness

The hardness test must be carried out with a 10 mm diameter ball and under a load of 29 400 N (3 000 kg) as specified in *ISO Standard 6506-1*.

A substitute test shall be carried out on the same brake-shoe or chip in the event of a value being obtained which is lower than the minimum laid down, and which appears to result from an unevenly-shaped punch mark or from porosity.

Two measurements shall be made at each end on a lateral surface of the brake-shoe after 2 mm of material has been removed by grinding or machining (see Figure 2 below).

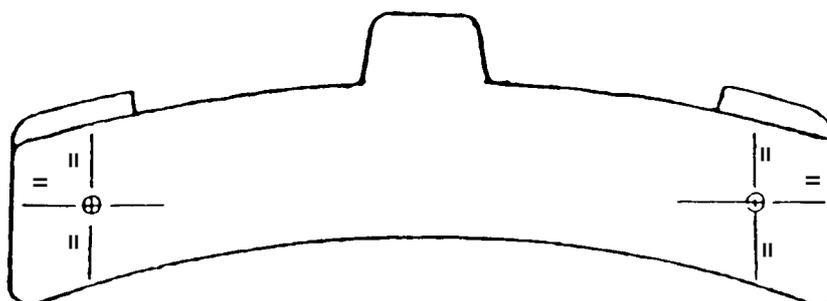


Fig. 2 - Brake-shoe - Hardness test with two measurements

Three measurements shall be carried out, across a diagonal, on chips cut from brake-shoes which have yielded as a result of the impact test (see Figure 3 below).

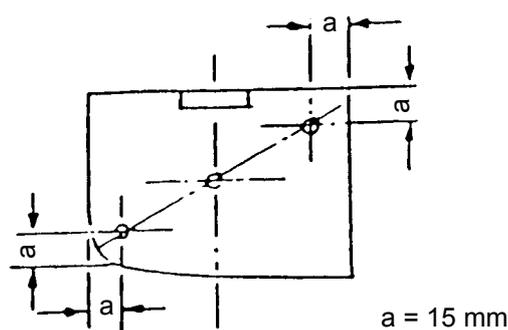


Fig. 3 - Brake-shoe - Hardness test with three measurements

8.5.4 - Impact test - Texture - Support resistance

The impact test shall include the following elements:

- falling weight M, between 50 and 150 kg,
- distance L between the two rests supporting the brake-shoe, between 160 mm and the length of the brake-shoe:
 - if the brake-shoe is supported by two rests 160 mm apart, rigidly fixed to the anvil-block, the ends of the brake-shoe must not touch the latter,
 - if the brake-shoe is resting on its ends, the latter shall be placed directly on the anvil-block;
- height of drop H, such that:
 - at the first impact designed to test the brake-shoe impact strength, the product "H x L x M" shall be equal to $4,8 \text{ kg/m}^2$,
 - for the following impact designed to break the brake-shoe, the product "H x L x M" shall be equal to 12 kg/m^2 .

The height of drop H shall be the vertical distance between the lower part of the base of the falling weight and the upper surface of the bridge of the brake-shoe.

The brake-shoe shall be placed horizontally, the rests being symmetrical in relation to its median transversal plane. The latter meets the vertical plane through which moves the centre of gravity of the falling weight.

The brake-shoe must be at ambient temperature. No test may be carried out if the temperature is 0°C or below.

Broken brake-shoes shall be retained until the batches have been finally accepted.

In view of the shape of the brake-shoes, the base of the falling weight must be in the form of a cylindrical sloping section as shown in Figure 4 below.

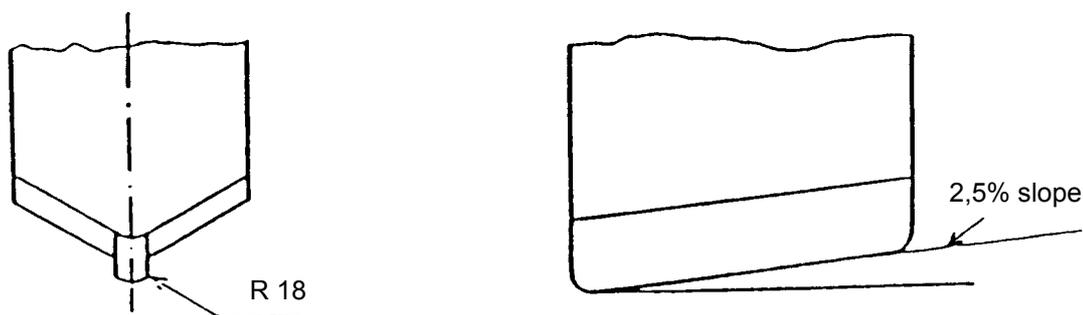


Fig. 4 - Falling weight - Cylindrical sloping section

Texture examination of the break in the iron shall be effected by the naked eye and corrected if necessary.

The resistance test for the brake-shoe support shall be carried out manually by pulling on portions of cast iron from brake-shoes which have yielded as a result of the impact test.

8.5.5 - Bend test for brake-shoe support

For brake-shoe supports 3 mm thick or less, the principle and performance conditions of the reverse bend test are laid down in *ISO Standard 7799*:

- the number of bends shall be 10,
- the radius of supports shall be 10 mm,
- the angle of bend shall be 90°.

For brake-shoe supports over 3 mm thick, the principle and performance conditions of the simple bend test with parallel side parts are laid down in *ISO Standard 7438*:

- the distance between the side parts shall be 25 mm.

8.5.6 - Appearance, soundness and marking

The appearance of the brake-shoes and their supports shall be inspected with the naked eye and corrected if necessary. The visible length of the brake-shoe support, its position at the end of the brake-shoe if this type of support is employed, marks and dimensions of casting defects shall be checked with the assistance of the customary measuring instruments, appropriate to the order of magnitude and level of precision required.

8.5.7 - Micrography

The micrographic examination shall be carried out using a microscope with:

- x 100 magnification on a suitably polished test-piece, not treated for the graphite analysis,
- x 200, 50 or 100 magnification, subsequently x 25 to x 50, depending on test being carried out, on the same test-piece treated with a 4% nitric acid alcohol solution (nital) for the structural analysis, with a normal treatment time for the matrix (perlite and ferrite) and with an extended treatment time for the phosphoric eutectic distribution.

9 - Delivery

Each delivery must be accompanied by a securely-fixed label bearing, as a minimum, the following information:

- order number,
- brake-shoe type,
- content (batch mark and number of brake-shoes by batch),
- consignee.

The quality certificate shall accompany each delivery if requested by the customer Railway.

The type of packing shall be as specified in the purchasing order.

10 - Warranty

Warranty conditions shall be laid down by the purchasing Railway in the purchasing order or its accompanying documents.

Appendix A - Structure: Appearance of graphite untreated - Magnification: X 100



Fig. 1 - Acceptable appearance - Image model 1



Fig. 2 - Acceptable appearance - Image model 2



Fig. 3 - Acceptable appearance - Image model 3



Fig. 4 - Unacceptable appearance - Image model 4

Appendix B - Structure: Appearance of graphite after treated



*Fig. 5 - Ferrite ratio after nital treatment.
Magnification: X 200 - 5% ferrite*



*Fig. 6 - Ferrite border average < 0,3 mm and maximum < 0,5 mm after nital treatment -
Magnification: X 50*

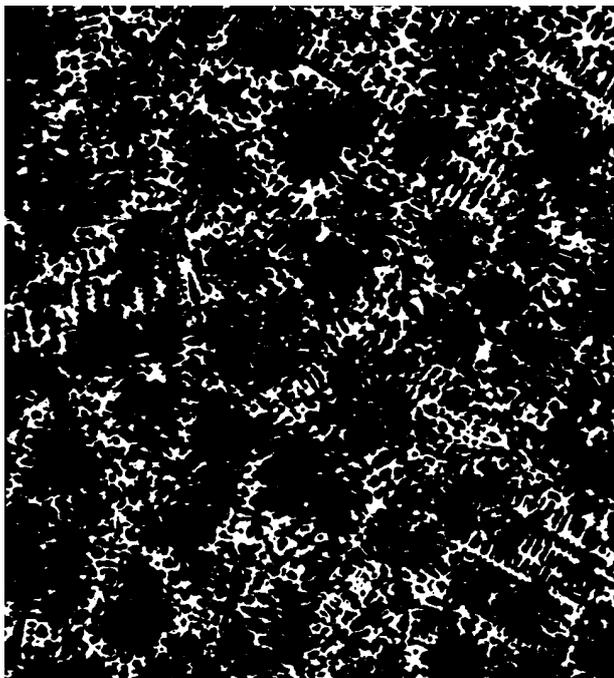


Fig. 7 - Phosphoric eutectic distribution after nital treatment. Magnification: X 25



Fig. 8 - Magnification: X 100

Appendix C - Special properties of P14 - category brake-shoes

Purpose

The provisions of *UIC Leaflet 832* shall also apply to the supply of category P14 brake-shoes, with the exception of the paragraphs below:

3.1 - P 14 cast-iron grade

The phosphorous content of the iron shall be between 1,35 and 1,55%.

4.2.1 - Brinell hardness for brake-shoes

At both surface and core level, the iron shall have the following Brinell hardness:

$$200 < HB < 255.$$

5 - Brake-shoe marks

Each brake-shoe shall bear the P14 mark in addition to the marks specified in *UIC Leaflet 832*.

8.5.4 - Impact test - Texture - Support resistance

Impact-test conditions shall be those specified in *UIC Leaflet 832* with the exception of the height of drop H, such that:

- at the first impact designed to test the brake-shoe impact strength, the product of "H x L x M" shall be equal to 3,744 kg/m²;
- for the following impact designed to break the brake-shoe, the product of "H x L x M" shall be equal to 8 kg/m².

Appendix D - Type and extent of the tests and checks

Tests and checks	Number of tests or checks per batch (B) in terms of parts									
	B < 2 000									
	Reduced inspection		Normal inspection		Tightened inspection					
	2 000 < B < 4 000									
	Reduced inspection		Normal inspection		Tightened inspection					
	B > 4 000									
	Reduced inspection		Normal inspection		Tightened inspection					
	Sam ^a	NR ^b	Sam	NR	Sam	NR	Sam	NR	Sam	NR
P and Mn/S content	2	1	2	1	3	1	4	1	6	1
TC and Si content ^c	2		2		3		4		6	
Dimensions, Appearance, Marks	30	2	50	2	80	3	120	3	170	4
HB hardness ^d :										
- Shoe	2 x 12	3	2 x 20	4	2 x 30	6	2 x 40	6	2 x 50	8
- Chip	3 x 2	2	3 x 2	2	3 x 3	2	3 x 4	2	3 x 5	3
Impact and texture tests										
Support resistance	3	1	5	1	8	1	12	1	18	1
Soundness of bridge										
Position of support	30	1	50	1	80	1	120	1	170	1
Micrography	2	1	2	1	3	1	4	1	6	1
Brake-shoe support:										
- C, S and P content	- One analysis per casting of half-finished product									
- Bend test	- To be specified by the purchasing Railway									

a. Sam: sample size.

b. NR: number of defective parts resulting in rejection of batch.

c. In case of dispute concerning results of one of the mechanical or physical characteristics, the particular batch shall be rejected if values recorded for these elements are outside the tolerances.

d. 2 x 12 = 2 impressions x 12 brake-shoes; 3 x 2 = 3 impressions x 2 chips.

Bibliography

1. UIC leaflets

International Union of Railways (UIC)

UIC Leaflet 542: Brake parts - Interchangeability, 4th edition of 1.1.82 and 4 Amendments

UIC Leaflet 832: Technical specification for the supply of brake-shoes made from phosphoric iron for tractive and trailing stock, 2nd edition of 1.1.93

2. Minutes of meetings

International Union of Railways (UIC)

Traction and Rolling Stock Committee (Question 5/SA/FIC - Revision of leaflets. Point 8.1 - Leaflet 832: "Brake-shoes made from phosphoric iron"), June 1992

3. International standards

International Organization for Standardization (ISO)

ISO 945:1975 : Cast iron -- Designation of microstructure of graphite, 1975

ISO 6506-1:1999 : Metallic materials -- Brinell hardness test - Part 1: Test method, 1999

ISO 7438:1985 : Metallic materials -- Bend test, 1985

ISO 7799:1985 : Metallic materials -- Sheet and strip 3 mm thick or less -- Reverse bend test, 1985

ISO 9002:1994 : Quality systems -- Model for quality assurance in production, installation and servicing, 1994

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