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Translation

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Technical specification for the supply of rough rolled non-alloy steel tyres for tractive and trailing stock

Spécification technique pour la fourniture de bandages bruts en acier non allié, laminés pour matériel roulant, moteur et remorqué

Technische Lieferbedingungen für Rohradreifen aus gewalztem, unlegiertem Stahl für Triebfahrzeuge und Wagen



UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
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The person responsible for this leaflet is named in the UIC Code

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Summary

The present technical specification applies to the supply of rough rolled non-alloy steel tyres for rolling stock, both tractive and trailing.

1 - Purpose and scope

The present technical specification applies to the supply of rough rolled non-alloy steel tyres for rolling stock, both tractive and trailing, in accordance with the particulars given in table 1 - page 23 and in point 3 - page 4.

2 - Information to be supplied by the purchaser

The purchasing railway must provide the following information in the call for tenders and in the order:

1. the class of steel (see point 3.1 - page 4 and table 1 - page 23),
2. the nature of the heat treatment (see points 3.2 - page 4 and 5.5 - page 9),
3. the dimensions of the tyre (see point 4.4 - page 6),
4. the instruction to undertake an examination of the micrographic structure (see point 4.2.2.1 - page 5 and table 2 - page 24), if required,
5. the instruction to check the chemical composition on ladle analysis (see point 4.1 - page 5), if required,
6. the instruction to carry out macroscopic and macrographic tests (see points 4.2.2.2 and 4.2.2.3 - page 5 and table 2), if required,
7. the instruction to perform a special ultrasonic and/or magnetic particle test (see point 4.2.2.4 - page 5 and table 2), if required,
8. the instruction to have a limited range of Brinell hardness (see point 4.2.3 - page 6 and table 2), if required,
9. the instruction to affix special markings and use special marking procedures (see point 4.5 - page 6), if required,
10. the instruction to use a special manufacturing process and/or obtain a specific finish (see point 5 - page 8), if required,
11. the instruction to perform a special inspection (see point 6 - page 10), if required,
12. the instruction to use special preparation and sampling methods for test pieces (see points 6.7.2 - page 12 and 6.7.3.1 - page 12), if required,
13. the instruction to lay a protection coating against corrosion (see point 7 - page 21), if required.

3 - Classification

It is necessary to state the classes of steel used and the heat treatment condition of the tyres in the order or its appended documents.

3.1 - Classes of steel

The present technical specification prescribes the following classes of steel: B1, B2, B3, B4, B5, B6, according to the characteristics specified in table 1 - page 23.

Unless otherwise stipulated in the order, it is necessary to use exclusively vacuum-processed steels.

3.2 - Metallurgical condition on delivery

The tyres shall be supplied in the:

1. non-treated condition (without symbol) for classes B1 and B2: in this case, no impact resilience characteristics are specified,
2. normalised condition (symbol N) for classes B1, B2, B3 and B4 or,
3. hardened and tempered condition (Symbol T) for classes B5 and B6.

"Normalising treatment" embraces the following operations:

- either leaving the part to cool sufficiently slowly after rolling until it has reached ambient temperature, sheltered from draughts, preferably in a covered cooling pit or beneath a cover, then raising it uniformly to a temperature above that of the transformation threshold, maintaining it at that temperature for a sufficiently long period; and then leaving it to cool in still air;
- or leaving the part to cool after rolling until it has reached a temperature between 540°C and 250°C, then raising it uniformly to a temperature above that of the transformation threshold and maintaining it at that temperature for a sufficiently long period; and then leaving it to cool slowly, sheltered from draughts, preferably in a covered cooling pit or beneath a cover.

Subject to the agreement of the purchasing railway, the slow cooling need not be effected when the steel has been degassed by effective means intended to avoid the formation of flakes.

3.3 - Degree of finish

According to the purchaser's indications, tyres shall be delivered:

1. in rough rolled condition,
2. rough-machined on one or more sides. Forging and rolling scale must be removed from the entire rough-machined surface.

4 - Characteristics

4.1 - Chemical composition

The maximum contents of the various constituents are shown in table 1 - page 23. These values refer to the analysis on product. With the agreement of the purchasing railway, the manufacturer may check the composition by carrying out a ladle analysis or an analysis on product.

The ladle analysis must be carried out on the basis of the values given in table 1, reduced by the permissible deviations corresponding to table 3 - page 25.

4.2 - Physical characteristics

4.2.1 - Appearance

The tyres must be free from seams and burrs. Their surface must bear no mark other than those stipulated in the positions stated in the order or its appended documents. Nevertheless the technical marks resulting from the Brinell hardness tests, provided for in this specification, may be allowed to remain on the outside surface of the rim.

4.2.2 - Flawlessness

The tyres must have no internal or external flaws (e.g. seams, inclusions, cracks, etc.). The traceability of the test results for each tyre must be ensured for a period of at least 5 years.

4.2.2.1 - Micrographic structure

If it is agreed, when the order is placed, to undertake an examination of the micrographic structure for the hardened and tempered tyres, it is also necessary to come to an agreement on the structural characteristics to be complied with (see point 6.7.3.5 - page 14).

4.2.2.2 - Macroscopic appearance

The examination of the surface after grinding must reveal no break of continuity.

4.2.2.3 - Macrographic appearance

The Baumann impression must not reveal any worse defects than those shown on the sulphur prints contained in the Appendix D - page 26.

4.2.2.4 - Ultrasonic test

Unless otherwise stipulated in the order, the ultrasonic test shall be conducted in accordance with the procedure described in point 6.8.9 - page 17:

- there must be no echo pulses attributable to internal flaws that are equal to or greater than the values obtained using:
 - the comparative reflector at the same distance, if the procedure used is that involving comparative tyres,

- the reference reflector, if the DGS (AVG) procedure is used, with the following diameter irrespective of the procedure applied:
 - 2 mm in diameter for class A defects,
 - 3 mm in diameter for class B defects,
- during cross-connection there must be no attenuation of the back echo greater than or equal to 15 dB/m.

4.2.2.5 - Magnetic particle test

When stipulated in the order, a magnetic particle test shall be carried out in accordance with point **6.8.10 - page 20** to demonstrate that the outside of the tyre is free from defects.

Linear pulses that are longer than:

- 2 mm in the case of machined surfaces,
- 6 mm in the case of unmachined surfaces

shall be considered as external defects.

4.2.3 - Homogeneity of the batches as regards hardness

The difference between the extreme hardness values obtained on tyres made of the same class of steel, having the same dimensions and produced from the same batch, must not exceed 30 HB.

4.3 - Mechanical characteristics

The mechanical characteristics of the tyres must correspond to those given in table **1 - page 23**.

4.4 - Dimensional characteristics

4.4.1 - The dimensions of the tyres must be stated in the order or its appended documents.

4.4.2 - The shape and dimensional tolerances, together with the permissible extra-thickness tolerances for machining must comply with the instructions given in *UIC Leaflet 810-2*.

4.5 - Manufacturer's marks

The marks applied to tyres (incl. their position and size) shall be as indicated in the technical specification and/or order and associated documents.

Failing any corresponding specifications, each tyre must be stamped with the following marks:

1. the supplier's mark,
2. the number of the cast,
3. the class of steel and the metallurgical condition (**see point 3.2 - page 4**),
4. the date of manufacture (month and last two figures of the year of manufacture),

5. the inspector's mark.

The marks applied must guarantee the traceability of each tyre and must not lead to cracks in service.

The use of stamps with sharp edges is not permitted.

5 - Manufacture

The manufacture of the tyres may only be entrusted to suppliers approved by the purchasing railway for this purpose.

5.1 - Steel manufacturing processes

The tyres must be made from steel produced by the open-hearth, the electric furnace or by a top-blown pure oxygen process. Other processes may also be used after agreement between the purchasing railway and the manufacturer.

The steel must be killed in the furnace or in the casting ladle, subjected to vacuum-processing and, in the absence of any agreement to the contrary between the parties, it must be bottom cast.

5.2 - Manufacture of the tyres

Depending upon the supplier's choice, the tyres shall be manufactured:

- either from cropped ingots, each cut providing two or more tyres,
- or from cropped blooms.

Individual ingots of special shape may only be used with the prior agreement of the purchasing railway.

The croppings must be sufficient to completely eliminate the defective parts at both ends of the ingot.

Any surface flaw must be fully removed before or during manufacture; where this is impossible, the defective sections must be discarded from the manufacture.

The ingot or bloom sections must be forged and punched by means of a power hammer or a press. They must be roughed by means of a power hammer, a press or a roughing rolling mill and, finally, shaped by rolling.

The punching must be such that:

- the diameter is not less than 150 mm,
- the weight is at least equal to 5% of the weight of the rough tyre.

If these operations leave a burr, it must be removed before rolling.

During the re-heating operation(s) before hot working and, where applicable, during hot working itself, the temperature of the ingot or bloom sections or of rough tyres must never exceed 1 260°C; rolling must be terminated at a temperature equal to or higher than 850°C.

After rolling and, where applicable, gauging and stamping of the marks, the tyres shall be left to cool sheltered from draughts, preferably in a covered cooling pit or under a cover.

5.3 - Removal of defective parts

Defective parts which do not comply with the required flawlessness prescribed in points 4.2.1 and 4.2.2 - page 5 must be removed before or during manufacture.

5.4 - Identification of the tyres during manufacture

All ingots, blooms, sections and tyres must be suitably marked, at each phase of their manufacture, so that each tyre can be identified before delivery, according to the provisions stipulated in point 4.5 - page 6. If these marks differ from the final identification marks defined in point 4.5, they must be sufficiently shallow to become invisible on the finished tyre.

5.5 - Heat treatment

If necessary, after shaping and marking, the tyres must undergo the heat treatment specified in the order or its appended documents. The various heat treatment operations must be carried out in a manner to ensure structural homogeneity at each spot of the same tyre and homogeneity of the tyres of the same batch (see point 3.2 - page 4).

The control of the temperature of the furnace is ensured by means of calibrated pyrometers; their recordings are held at the disposal of the representative of the purchasing railway.

5.6 - Minor alterations

5.6.1 - Authorised alterations

With the agreement of the purchasing railway, surface defects may be eliminated by removing metal, by machining or by careful grinding, provided that these processes do not give rise to cracks under the effect of heat and that, furthermore, they do not impede the observance of dimensional tolerances.

5.6.2 - Prohibited alterations

Any alteration which is carried out with the object of concealing a defect by welding, by the use of a blow torch, by heating, by an electric process for the removal of flaws, resurfacing by metal spraying, electrolytic or chemical deposits, etc. shall be prohibited and shall lead to rejection of the entire batch.

6 - Inspection

6.1 - Responsibility and type of inspection

In its order, the purchasing railway must specify whether the inspections intended to check the application of the manufacturing methods (see point 5 - page 8) and the observance of the quality standards (see point 4 - page 5) must be carried out:

1. either by the competent department of the manufacturer,
2. or in the presence of the purchasing railway, its representative or any person delegated by it.

Failing any other requirement being specified in the order, the provisions applicable shall be those stipulated in table 2 - page 24, column 5.

The delegation of authority given by the purchasing railway to the competent department of the manufacturer for performing the inspection does not deprive the purchasing railway of the right of supervising the efficiency of the manufacturing controls and the efficiency of the control and test methods in its own testing installations.

In this respect, he must be authorised to attend all tests carried out under the manufacturer's responsibility or to control the results recorded.

6.2 - Inspection of the manufacture

Whether the responsibility of the manufacturing control devolves upon the purchasing railway or upon the competent department of the manufacturer, the following rules shall apply:

The manufacturer must inform the purchasing railway and request its agreement as regards the main manufacturing process used for the execution of the order and all fundamental subsequent alterations he will propose to make, which may affect the quality of the tyres.

The representative of the purchasing railway must be authorised to control the manufacturing processes used by the supplier in order to check that they actually comply with the requirements of the present technical specification and with the agreements concluded previously.

For this purpose, he must have correctly-calibrated recording pyrometers at his disposal.

6.3 - Inspection of the characteristics of the tyres

6.3.1 - Test methods

Table 2 gives the test methods to be used and specifies whether these tests are compulsory or optional.

6.3.2 - Test units and sub-division into batches

The test unit corresponding to each type of test is shown in column 7 of table 2.

For the acceptance control, the tyres must be grouped into batches. Each batch must consist of tyres from the same cast and from the same heat treatment batch. It may include tyres of different dimensions.

6.3.3 - Condition of the tyres subjected to inspection

At the time of submission for inspection, the tyres must be in the condition corresponding to the regulations in table 2 - page 24, column 6.

6.4 - Submission to the purchasing railway for inspection

The purchasing railway (see point 6.1 - page 10, paragraph 2) must be advised, in writing (see point 6.5.2), of the date of submission for inspection and, in particular, of the number of tyres per type in each batch and of the reference number of the order.

6.5 - Certification

6.5.1 - Whether the quality control is the responsibility of the purchasing railway or of the competent department of the manufacturer, the manufacturer must certify that the regulations of the present technical specification regarding manufacture have actually been complied with. The final test certificate must also include the results from the following tests:

- chemical analysis,
- tensile test,
- impact resilience test,
- falling weight test,
- hardness test,
- Baumann impressions.

6.5.2 - The manufacturer must supply the certificates for the tests and controls for which he is responsible:

1. at the time of delivery if responsibility for all tests has been delegated to him,
2. at the time of the first submission for inspection (see point 6.4) if a part of the tests has been delegated to him.

6.6 - Number of checks and tests

The number of tyres to be subjected to the checks, per test unit, and the number of tests per tyre are shown in table 2, columns 8 to 10.

6.7 - Sampling and preparation of samples and test pieces

6.7.1 - Sampling

After identification of the batch, the inspector must select, at random, the tyre(s) intended for tests and must stamp it (them) indelibly.

On each of these tyres, he must mark the sample section (see Fig. 1 - page 13) from which the test pieces shall be taken.

In the event of a falling weight test, the marking of the sections of the tyre(s) must only be made after this test, and the section must be selected in one of the least deformed parts of the tyre.

6.7.2 - Preparation of the samples and test pieces

Unless otherwise specified, the conditions for the preparation of the samples and test pieces must comply with the instructions of *ISO Standard 377* (see Bibliography - page 32).

In addition, the samples and test pieces must bear the identification marks and the inspector's stamps and no alteration can be made, except in his presence.

6.7.3 - Number and position of the test pieces

The test pieces must be taken from the samples which were previously marked and must be stamped by the inspector.

6.7.3.1 - Chemical analysis

Unless stated to the contrary in the order or its appended documents, one of the following samples must be taken from one of the tyres under examination:

- at least 50 g of milling chippings, representing the average of a radial section of the tyre,
- or
- for the spectrographic analysis, a sample taken from the tensile test piece.

6.7.3.2 - Falling weight test

The test piece must be the sample tyre in delivery condition.

6.7.3.3 - Tensile test

A test piece must be taken from the sample at the position specified in figure 1.

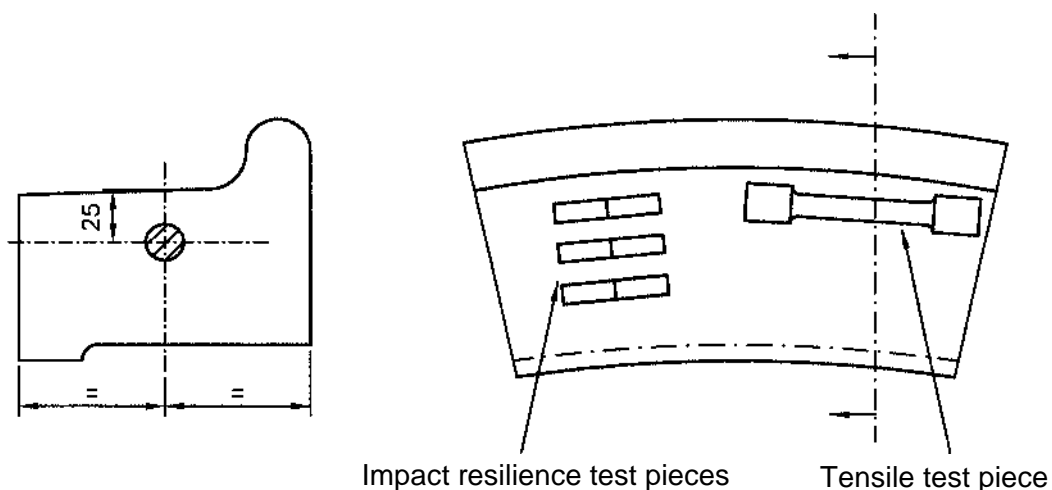
The test piece must be prepared in accordance with the instructions of *EN Standard 10002-1* (see Bibliography - page 32), the diameter of the test piece measuring, preferably, at least 10 mm and the length between the datum points measuring 5 times the diameter.

6.7.3.4 - Impact resilience test (U-notch)

Three test pieces must be taken from the sample at the positions specified in figures 1 and 2 - page 14.

The marking of the impact resilience test pieces must ensure the identification of their longitudinal faces parallel to the AA axis (see figure 2).

The test pieces must be prepared in accordance with the instructions of *EN Standard 10045-1* (see [Bibliography - page 32](#)). The axis of the cylinder forming the bottom of the notch must be parallel to the AA axis (see figure 2).



(Dimensions in mm)

Fig. 1 - Position of the tensile and impact resilience test pieces

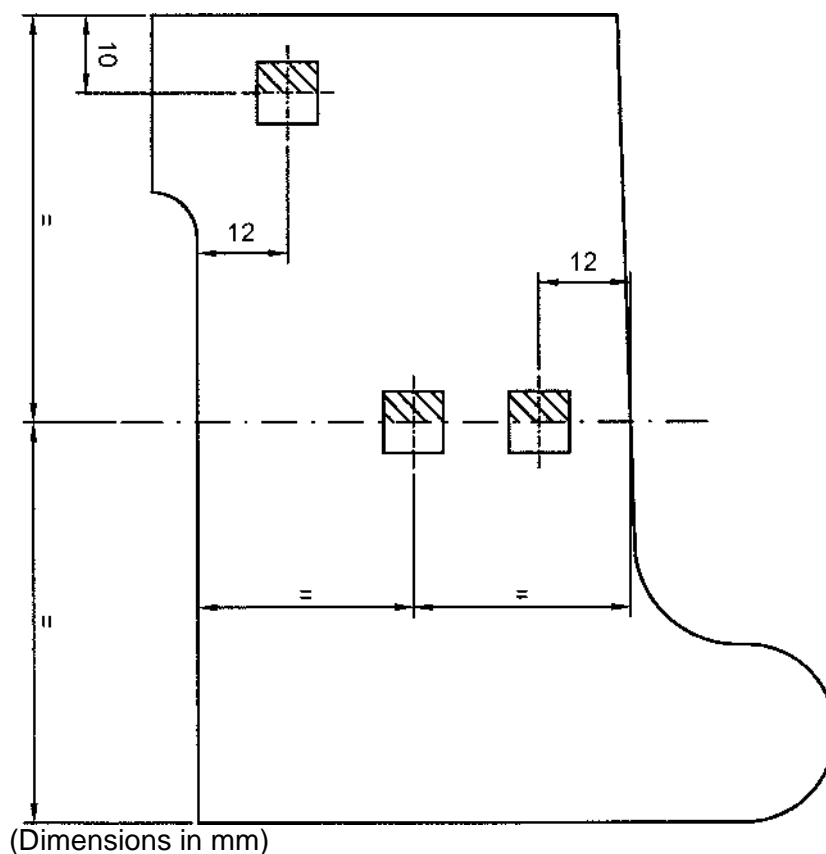


Fig. 2 - Position of the impact resilience test pieces

6.7.3.5 - Micrographic structure

If it is agreed, at the time of the call for tenders and of the order, to undertake an examination of the micrographic structure of the hardened and tempered tyres, the position of the test piece must also form the subject of an agreement.

6.7.3.6 - Macroscopy and macrography

The test piece shall consist of an entirely straight section; one of its faces shall be trued-up or polished sufficiently to eliminate machining marks and to obtain a clear macrographic image.

6.7.3.7 - Hardness

Each tyre to be inspected (see table 2 - page 24) must be subjected to a Brinell hardness test on the flat surface opposite the flange. The position chosen for the impression must be situated on a circle the radius of which is 35 mm more than that of the biggest bore of the tyre (see Fig. 3 - page 15). If required, this location must be prepared by grinding or milling in order to remove any decarburisation zones.

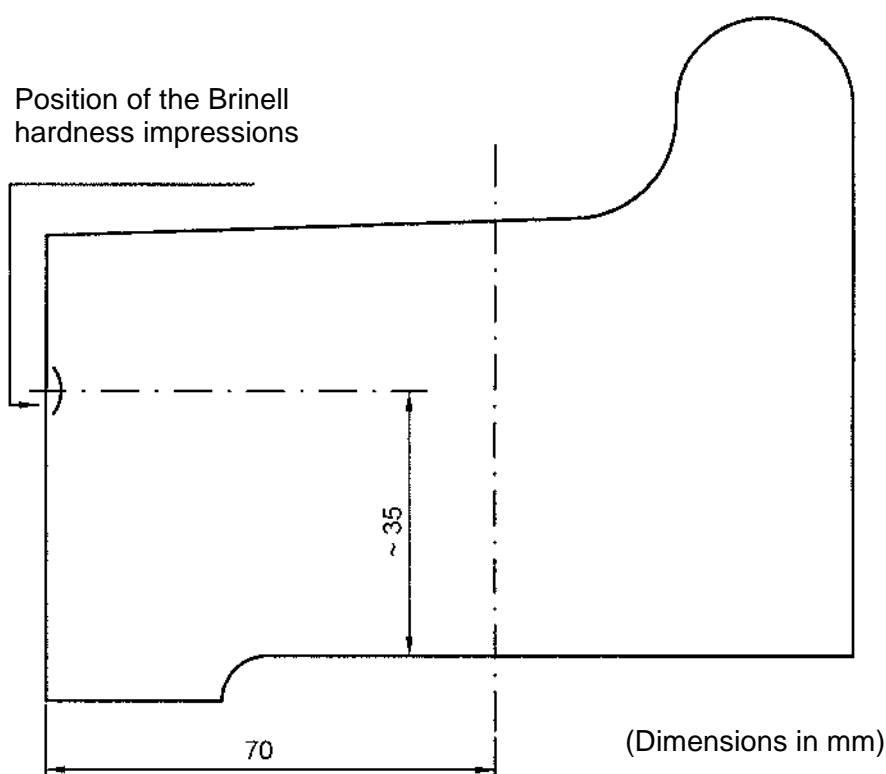


Fig. 3 - Position of the Brinell hardness impressions

6.7.3.8 - Ultrasonic test

The test piece shall consist of a tyre that has undergone the full heat treatment. The surface finish must enable the stipulated test sensitivity to be achieved and must not affect the acoustic contact between probe and test piece.

6.7.3.9 - Magnetic particle test

The test piece shall consist of a tyre that has undergone the full heat treatment. The surface finish must enable the stipulated test sensitivity to be achieved.

6.8 - Test methods

6.8.1 - Chemical analysis

The chemical analysis must be conducted in accordance with the methods defined in the corresponding ISO recommendations or with any other method approved by the purchasing railway.

6.8.2 - Falling weight test

The falling weight test shall be carried out by means of a guided falling weight.

The falling weight must be symmetrical in mass and shape in relation to the guide plane. Its mass must be 1 000 kg.

The striking face of the falling weight must terminate in a cylindrical section with a radius not exceeding 100 mm, the axis of which is horizontal and in the guide plane.

The centre of gravity of the falling weight must be placed as low as possible in the guide plane and on the vertical line equidistant from the two guides.

The height of the guided section of the falling weight must be appreciably greater than the distance between the two guides.

The guides must be absolutely rigid, even and vertical; they must be so arranged that friction caused by the falling weight is reduced to a minimum.

The trip gear must not produce any side movement of the falling weight during its release.

The anvil block and its foundation must constitute a mass of at least 25 times that of the falling weight; the mass of the metal anvil block must not be less than 10 000 kg.

Before each test, the tyre for testing must be positioned vertically beneath the trip. The stress developed by each blow of the falling weight, expressed in Joules must be at least 150 times the mass of the tyre, expressed in kilograms.

After each blow, the decrease in internal vertical diameter must be measured by means of an adjustable gauge graduated in millimetres.

The final blow may be adjusted in relation to the decrease in the internal diameter to be obtained.

The temperature of the tyre for testing must be between 10°C and 30°C.

After the final blow, the tyre is notched and broken.

6.8.3 - Tensile test

The tensile test must be carried out according to the instructions of *EN Standard 10002-1* (see [Bibliography - page 32](#)).

6.8.4 - Impact resilience test (U-notch)

The impact resilience test must be conducted in compliance with the instructions of *EN Standard 10045-1* (see [Bibliography - page 32](#)).

6.8.5 - Examination of the micrographic structure

The particulars of the examination shall be agreed upon at the time of the call for tenders and of the order.

6.8.6 - Macroscopic examination

The polished surface of the test piece must be examined with a maximum magnification of 5.

6.8.7 - Macrographic examination

If the examination defined in point 6.8.6 is satisfactory, a macrographic image of the test piece is obtained by applying to its polished and degreased surface, for a period of at least 3 minutes, a sheet of gelatine-silver bromide paper, previously saturated with water containing 2% by volume of pure sulphuric acid.

6.8.8 - Brinell hardness

The Brinell hardness test must be carried out according to the instructions of *ISO Standard 6506* (see [Bibliography - page 32](#)).

6.8.9 - Ultrasonic test

6.8.9.1 - General

The tyres shall be tested for defects ultrasonically, in two acoustic irradiation directions:

- one perpendicular to the inside face (axial irradiation),
- one perpendicular to the wheel tread (radial irradiation).

The probe heads must be designed so that as large a test volume as possible is covered and the dead zone beneath the test surface is no more than 30 mm for axial irradiation and 10 mm for radial irradiation (see figure 4); the nominal frequency shall be between 2 and 4 MHz (inclusive) and shall be stipulated by the purchasing railway.

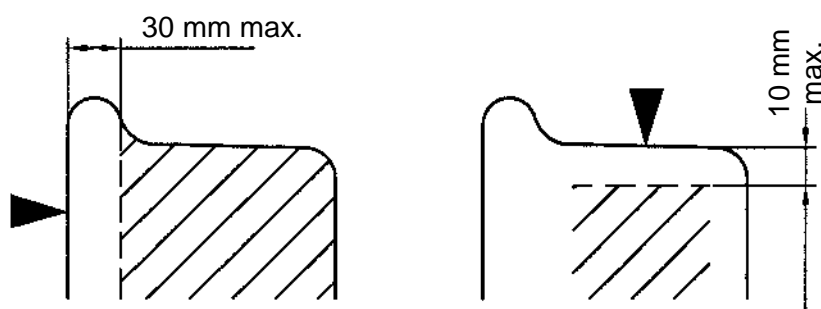


Fig. 4 - The dead zone for the probe head

The acoustic attenuation shall be measured using axial irradiation at a nominal frequency of between 2 and 4 MHz (inclusive); the purchasing railway shall determine the exact frequency.

For setting the test apparatus and evaluating the echo pulses, comparative tyres or the DGS (AVG) method can be used.

6.8.9.2 - Test with comparative tyres

To detect defects, an automatic test is performed in immersion.

The test sensitivity is adjusted using comparative reflectors on a comparative tyre as shown in figure 5 for radial irradiation and figure 6 - page 19 for axial irradiation. Comparative reflectors are flat-bottomed drill holes with a diameter of 2 mm (for class A defects) or 3 mm (for class B defects).

NB : the comparative tyre can be used to test one or more wheel designs from the point of view of steel grade, heat treatment condition, tread diameter, rim width, shape of the tread profile and surface finish. In the order documents the purchasing railway may reserve the right to conduct approval tests using comparative tyres.

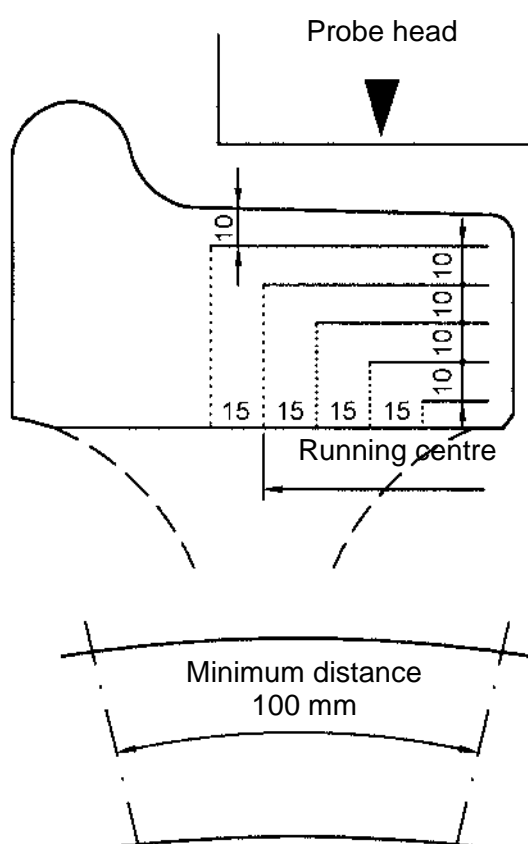


Fig. 5 - Sensitivity setting for radial irradiation

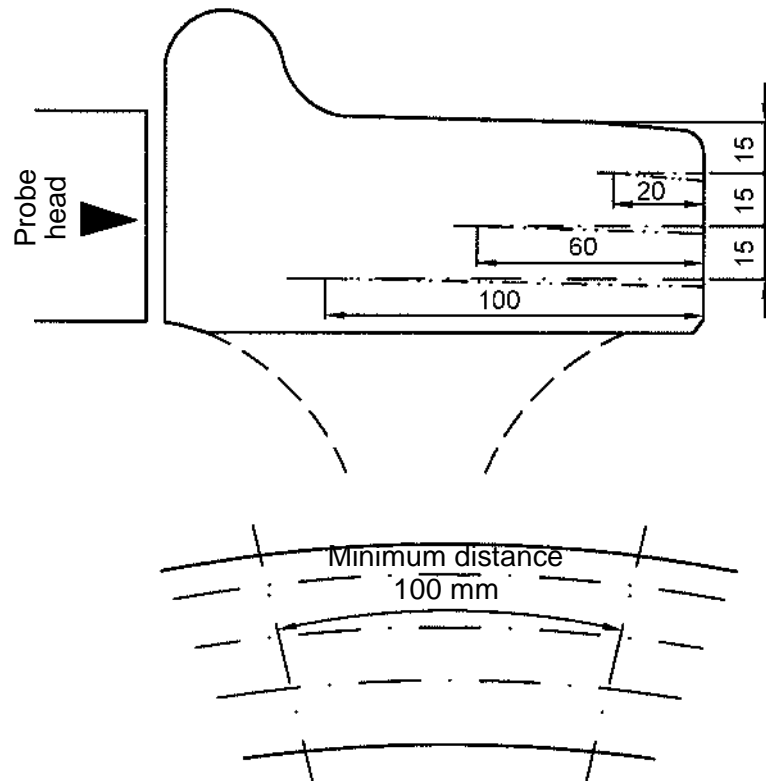


Fig. 6 - Sensitivity setting for axial irradiation

To regulate the permissible attenuation of the back echo height, a hole is drilled in the area of the sound field, as shown in figure 7. The drill hole must not provoke an echo pulse and as such must not be a flat-bottomed hole.

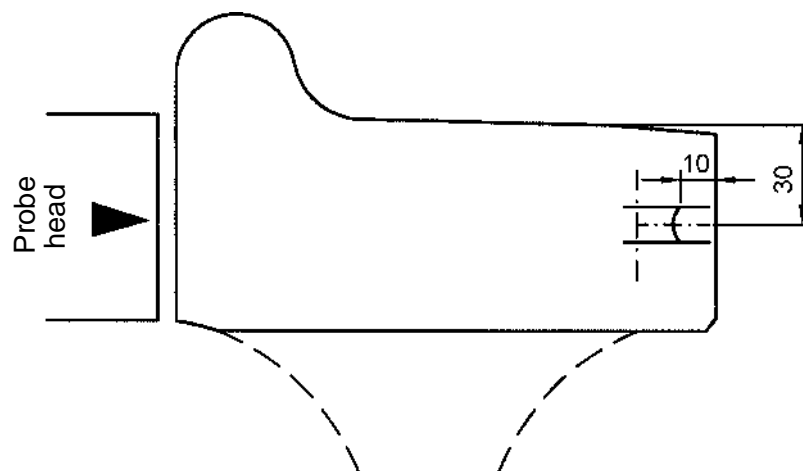


Fig. 7 - Sensitivity setting for monitoring of acoustic attenuation (axial irradiation)

Its shape and diameter should be selected so that the back echo is attenuated in keeping with the agreed maximum permissible acoustic attenuation.

The comparative tyre shall be used for setting the test apparatus, but also for permanently monitoring the settings of the equipment.

The installation must be equipped with an automatic system marking solid-cast wheels which do not comply to the specifications.

6.8.9.3 - Testing using the DGS (AVG) method

Testing for defects is conducted using handheld probes.

The test sensitivity is adjusted using the back echo from the tyre for axial irradiation so that echo pulses from defects with permissible reference reflector diameters of 2 mm (for class A defects) or 3 mm (for class B defects) can be evaluated using a DGS (AVG) diagram.

The DGS (AVG) diagram must be valid for the test apparatus and the material to be tested.

Acoustic attenuation is monitored by observation of the back echo during axial irradiation and if appropriate can be calculated from the heights of the back and repeat echos.

6.8.10 - Magnetic particle test

The pre-treated tyres shall be tested for surface defects (e.g. seams) using the magnetic particle method. The zone to be tested shall be the whole surface, including the wheel flange. The test method must be one recognised by the purchasing railway. The test shall be carried out in accordance with *ISO Standard 6939* and *EN Standard 473* (see [Bibliography - page 32](#)).

6.8.11 - Checking of the appearance

The checking of the appearance must be made by visual examination before delivery.

6.8.12 - Checking of dimensions

The checking of dimensions must be made in accordance with the regulations of *UIC Leaflet 810-2*.

6.9 - Conclusion of the inspection

Any defect in appearance or dimensions must result in the rejection of the tyre. The same shall apply in respect of any ultrasonic test revealing defects more serious than those tolerated by the order or its appended documents.

Any other result not conforming to the required standard must lead to the rejection of the corresponding batch.

If the purchasing railway agrees to the performance of check-tests, the procedures to be used must be specified by special agreement between the purchasing railway and the manufacturer.

7 - Delivery

The accepted tyres must only be given a protection coating against corrosion before storage or forwarding by the order or its appended documents.

In this case, the protection method against rust must be agreed with the consent of the purchasing railway.

8 - Guarantee

The tyres shall be guaranteed by the supplier for five years against any defect imputable to manufacture and not revealed during inspection at the factory.

This period shall be calculated from the end of the month stamped on the tyre.

In the case of tyres used on new stock, the delivery date of the vehicles on which they are fitted shall be regarded as the date beginning the guarantee period.

Tyres which, during the guarantee period, show defects making them either unfit for service or reducing their period of service shall be rejected.

Before being rejected definitively, defective tyres can, however, be subjected to an inspection carried out with the participation of the purchasing railway and the supplier, if the latter so requests.

If this inspection, carried out in the presence of the parties involved, confirms that the defects are imputable to manufacture, the defective tyres shall be rejected definitively.

If the results of the inspection carried out in the presence of the parties concerned do not enable an agreement to be reached between the purchasing railway and the supplier, experts approved by both parties shall be called in to settle the dispute. The costs shall be borne by the party found to be responsible.

When two tyres from the same cast have broken in service, or when more than 5% of the tyres from the same cast reveal defects giving rise to their rejection, whether it occurred during machining, before or after packing of the tyre or later in the course of its utilisation, the purchasing railway shall have the right to reject all the tyres from the cast in question.

The rejected tyres shall be made available to the supplier with a view to their replacement, or reimbursement at the price in force at the time of withdrawal.

Appendix A - Class of steel - chemical composition - heat treatment on delivery condition and mechanical characteristics

Table 1: Class of steel - chemical composition - heat treatment on delivery condition and mechanical characteristics

Class of steel	Chemical composition (maximum content in %) ^a											Mechanical characteristics ^b					
	C	Si	Mn	P ^c	S ^c	Cr	Cu	Mo	Ni	V	(Cr + Mo + Ni)	Heat treatment on delivery condition ^d	R _{eH} or R _{p0,2} ^e (N/mm ²)	R _m (N/mm ²)	A min. (%)	KU min. (J) ^f	Falling weight tests
B1	0,48	0,50	1,20	0,040	0,040	0,30	0,30	0,08	0,30	0,05	0,60	- N	for information purposes	600 to 720 600 to 720	12 18	- 15	The tyre must be capable of withstanding, without breaking or cracking under repeated impacts, a decrease in the inside diameter (in mm) of ^g : $f \geq 5,6 \frac{D_2}{R_m \times e}$
B2	0,58	0,50	0,90	0,040	0,040	0,30	0,30	0,08	0,30	0,05	0,60	- N		700 to 820 700 to 820	9 14	- 10	
B3	0,60	0,50	1,10	0,040	0,040	0,30	0,30	0,08	0,30	0,05	0,60	N		750 to 880	12	10	
B4	0,70	0,50	0,90	0,040	0,040	0,30	0,30	0,08	0,30	0,05	0,60	N		800 to 940	10	10	
B5	0,60	0,50	0,80	0,040	0,040	0,30	0,30	0,08	0,30	0,05	0,60	T		800 to 920	14	15	
B6	0,65	0,50	0,90	0,040	0,040	0,30	0,30	0,08	0,30	0,05	0,60	T		920 to 1 050	12	10	

a. Analysis on product (see point 4.1).

b. R_{eH} = ultimate limit of elasticity

R_{p0,2} = traditional limit of elasticity at 0,2% (unproportional elongation)

R_m = Tensile strength

A = Percentage of elongation at rupture ($L_0 = 5,65 \sqrt{S_0}$)

KU = Resilience on ISO U-notch test-piece at 20°C.

c. If specified on the order, the purchasing railway may limit this content to 0,035.

d. - = non-treated (as rolled)

N = normalised or normalised and tempered

T = hardened and tempered.

e. If the traditional limit of elasticity of steel for a total elongation of 0,5% (R_{t0,5}) does not exceed 600 N/mm², R_{t0,5} can be chosen instead of R_{eH} or R_{p0,2}.

f. Average of the three tests: one of the results may be lower than the minimum value specified in the present table, but must not be less than 70% of this value.

g. D is equal to half the sum of the inside and outside diameters (in mm)

R_m is the minimum specified tensile strength in N/mm²

e is the thickness of the tyre being tested (in mm).

Appendix B - Type and number of tests on tyres

Table 2 : Type and number of tests on tyres

1	2	3	4	5	6	7	8	9	10	
	Heat treatment on delivery condition ^a	Type of checks and tests	Remarks			Test unit ^b	Number of tyres/batch to be subjected to checks and tests		Number of tests per tyre	
			c	d	e		Total number of tyres in the batch			
							≤ 100	> 100		
1	All	Chemical analysis ^f	m	a		c	1	1	1	
2	N, T	Falling weight test	o	b	h	c, h	1	2	1	
3	-	Falling weight test	m	b		c, h	1	2	1	
4	All	Tensile test on a sample on delivery condition	m	b	h	c, h	1	2	1	
5	N, T	KCU impact resilience test	m	b	h	c, h	1	2	3	
6	T	Micrographic structure	o	a	h	c, h	1	2	1	
7	All	Macroscopic and macrographic appearance	o	a		c	1	2	1	
8	N	Brinell hardness (uniformity)	o	a	h	c, h	100 %	100 %	1	
9	T	Brinell hardness (uniformity))	m	a	h	c, h	100 %	100 %	1	
10	All	Ultrasonic test	o	a	f	t	100 %	100 %	1	
11	All	Appearance and dimensions	m	a	f	t	100 %	100 %	1	
12	All	Examen magnétoscopique	o	a	f	t	100 %	100 %	1	

a. N = normalised and tempered
 T = hardened and tempered
 - = non-treated (see point 2.2).

b. c = Tyres of the same cast
 c, h = tyres of the same cast and of the same batch (see point 6.3.2)
 t = the test unit and the tyre itself.

c. m = obligatory
 o = this test shall only be carried out if stipulated on the order or its appended documents.

d. Except in the case of a different agreement (see point 5.1), checks or tests must be carried out:
 a) by the competent department of the manufacturer or
 b) in the presence of the purchasing railway or of its representative.

e. h = the tests must not be carried out before the prescribed heat treatment

f = acceptance tests must be carried out on final delivery condition.

f. See point 4.1.

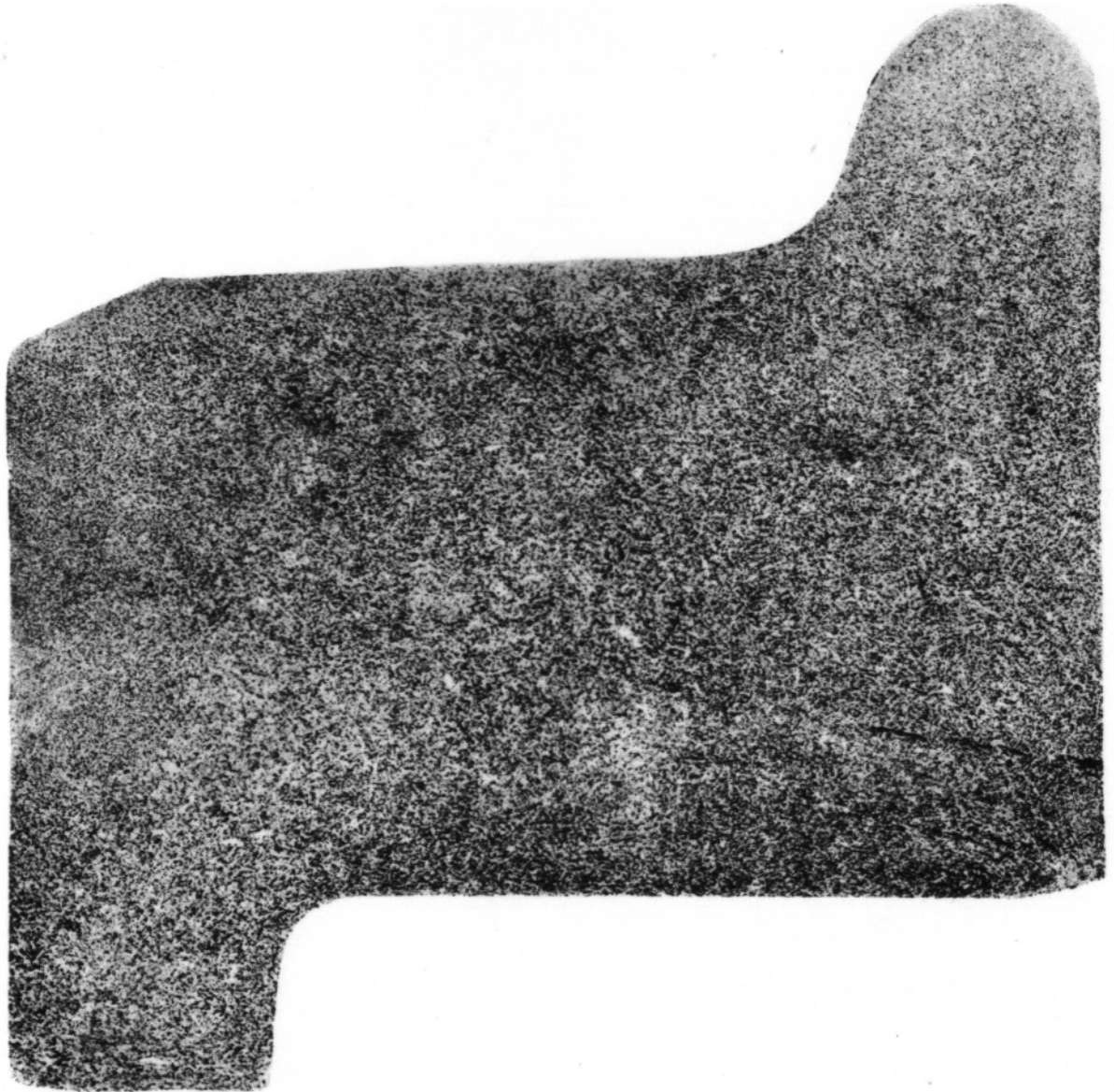
Appendix C - Deviations from the limiting values given in appendix A applicable to analyses on product, permissible for ladle analyses

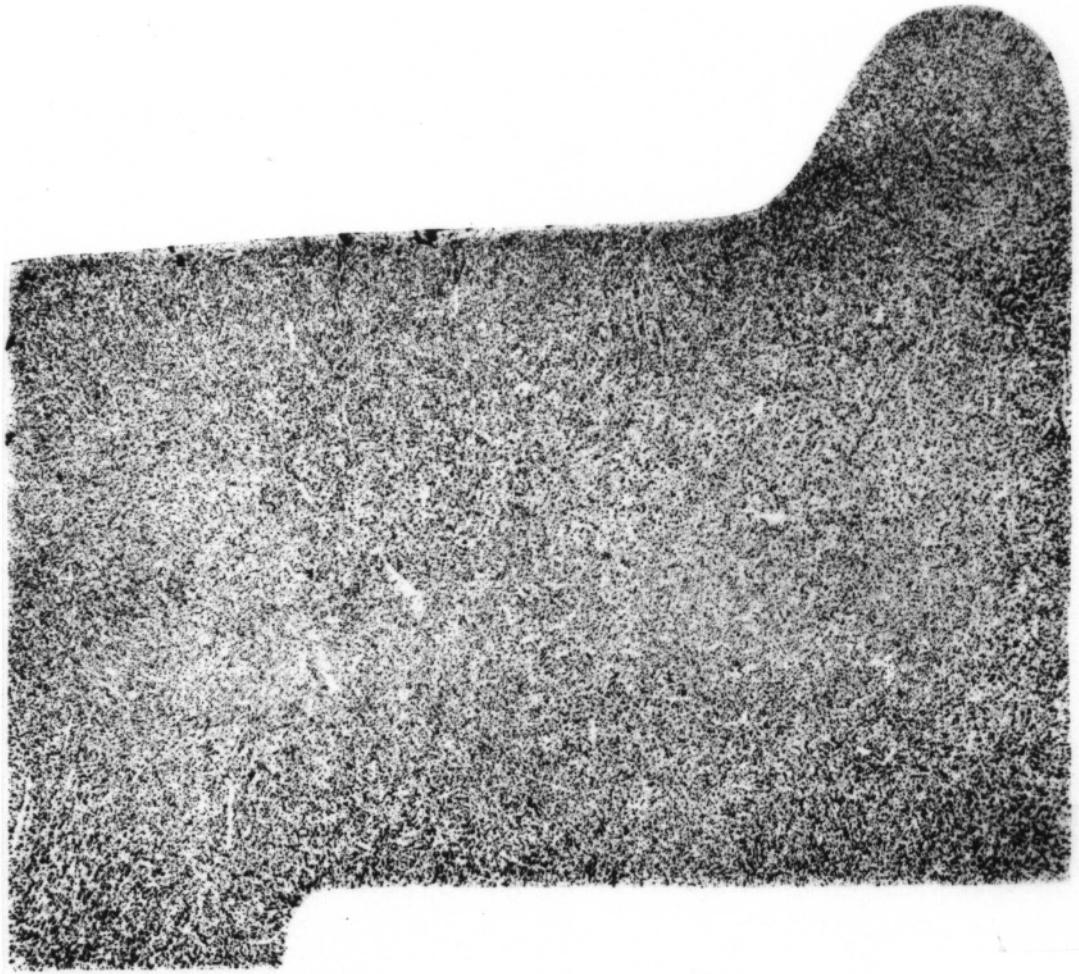
Table 3: Deviations from the limiting values given in appendix A applicable to analyses on product, permissible for ladle analyses

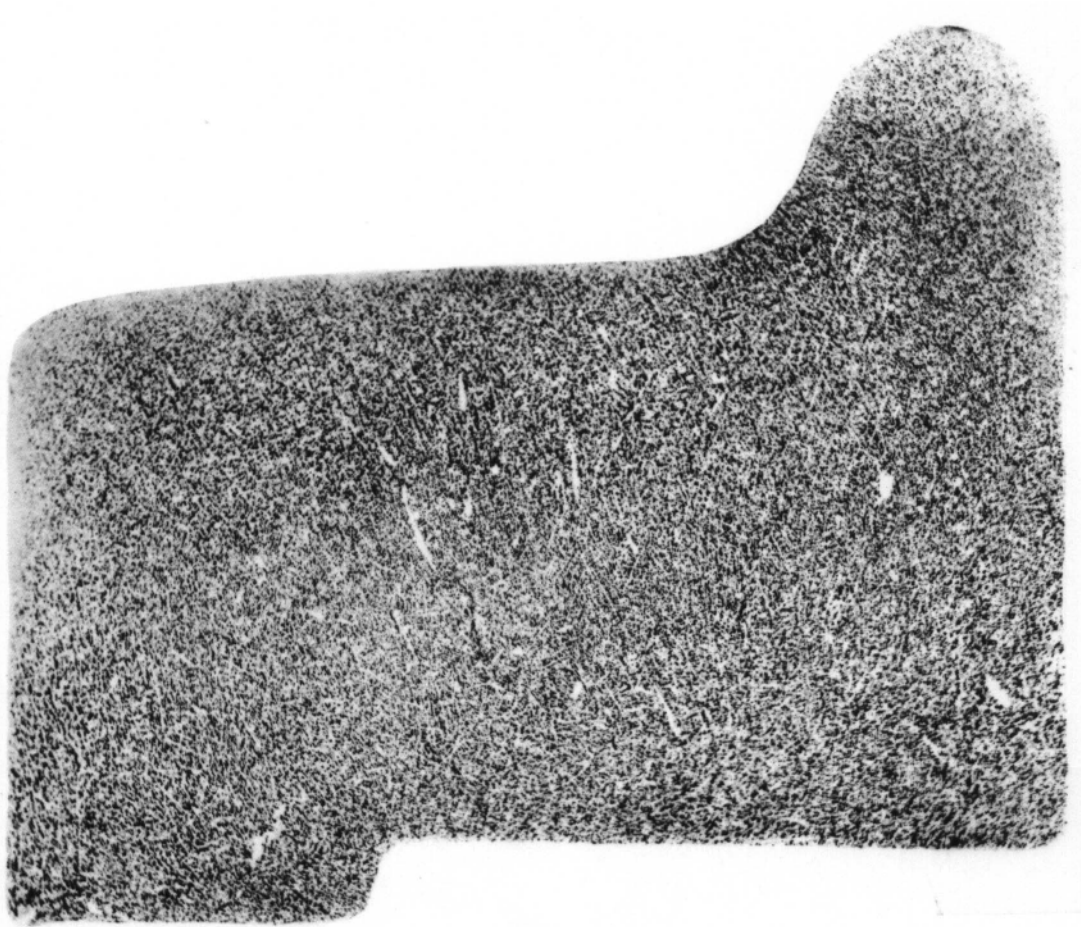
Constituent	Maximum content permissible in the analysis on product (%)	Deviation between the limiting values of the ladle analysis and the limiting values relative to the analysis on product (%)
C	$\leq 0,55$	-0,02
	$> 0,55 \leq 0,70$	-0,03
Si	$\leq 0,50$	-0,03
Mn	$\leq 1,00$	-0,04
	$> 1,00 \leq 1,20$	-0,05
P	$\leq 0,040$	-0,005
S	$\leq 0,040$	-0,005
Cr	$\leq 0,30$	-0,05
Mo	$\leq 0,08$	-0,03
Ni	$\leq 0,30$	-0,05
V	$\leq 0,05$	-0,02

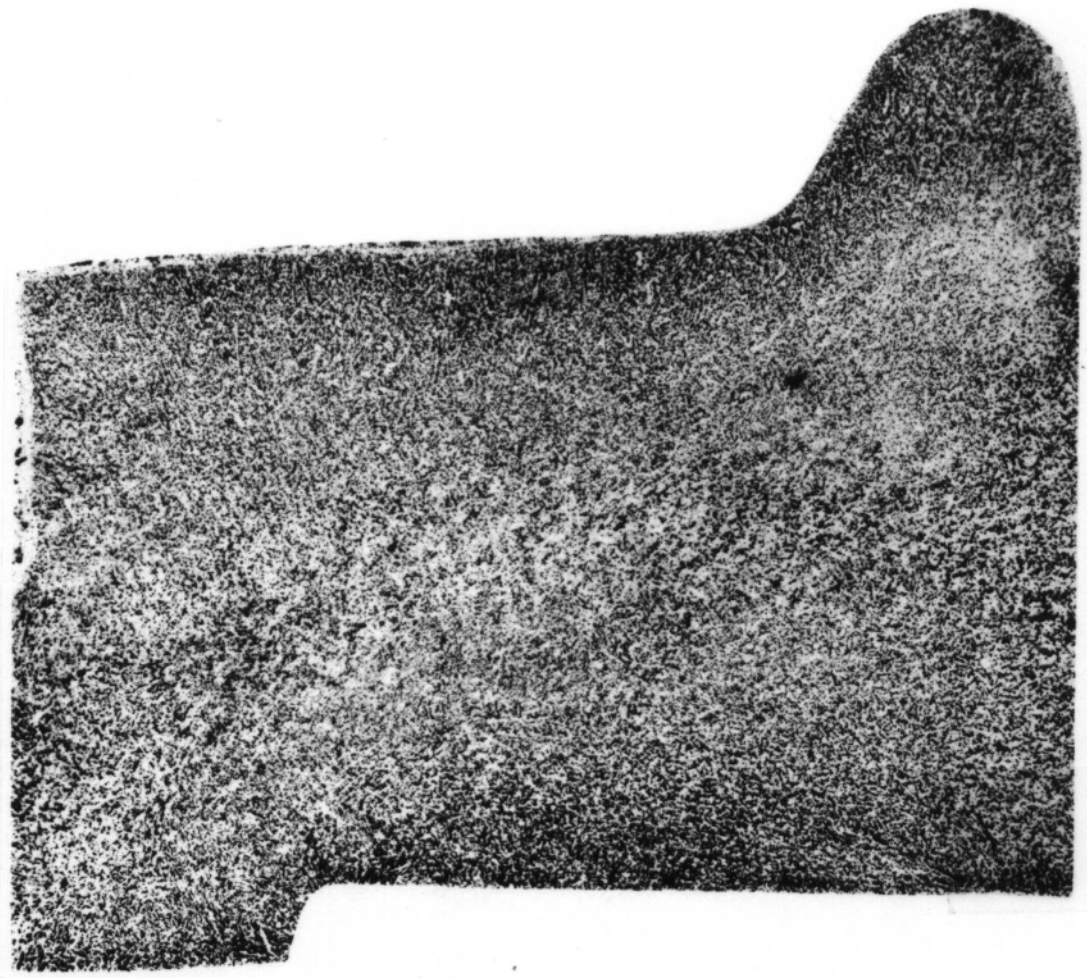
Appendix D - Macrographies - sulphur prints

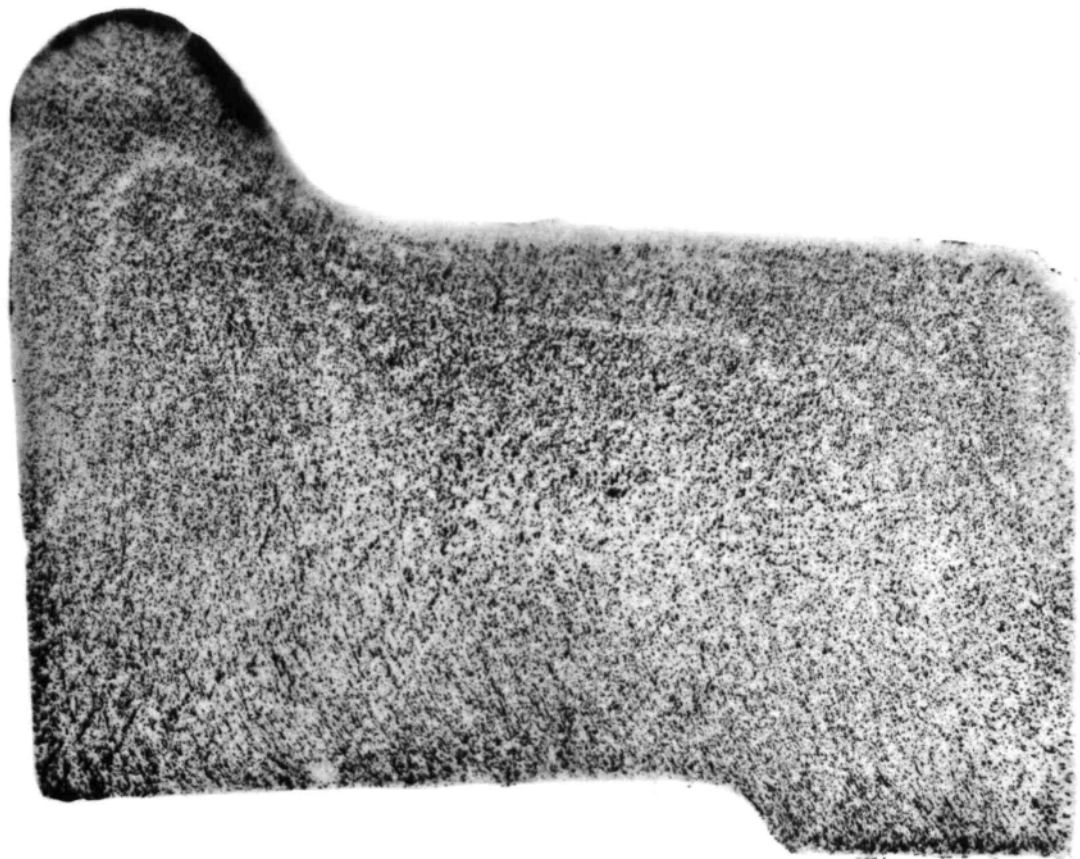
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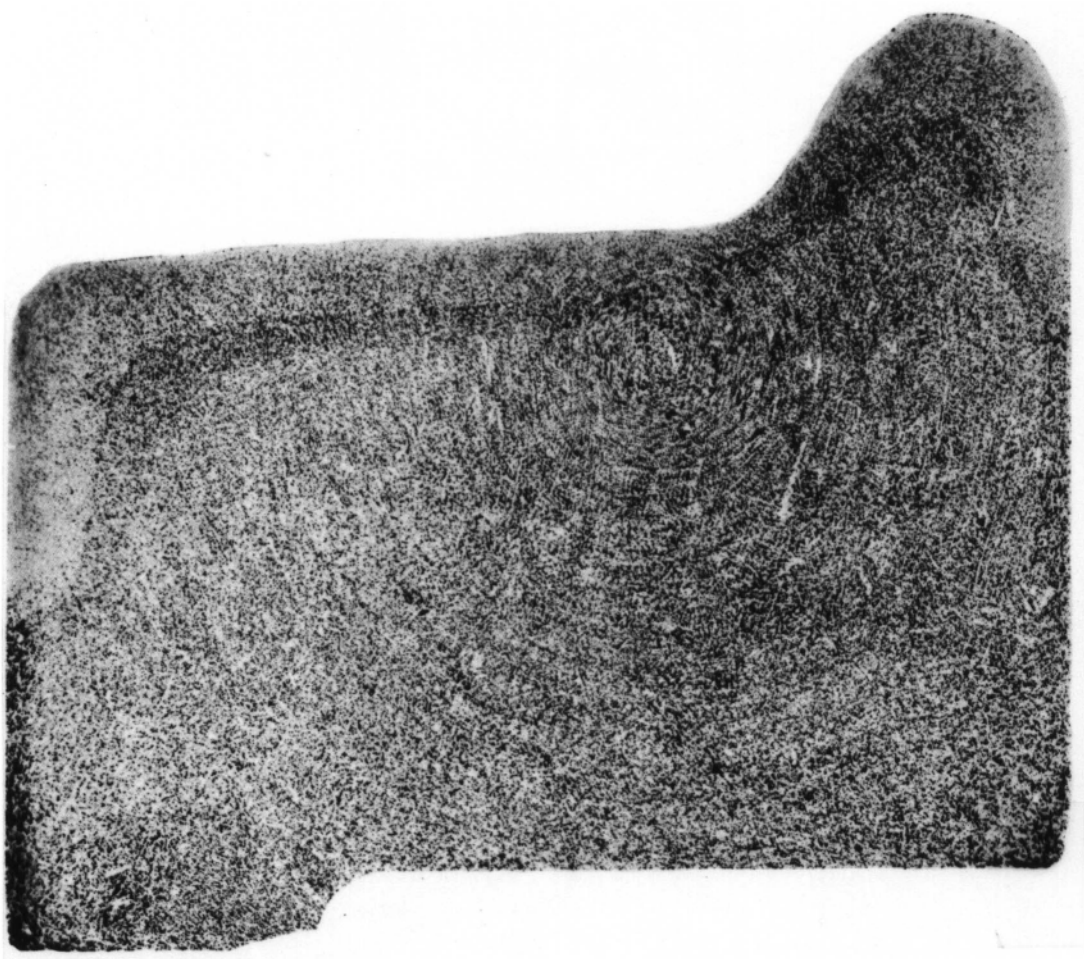












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