
International Standard



5948

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Railway rolling stock material — Ultrasonic acceptance testing

Matériel roulant de chemin de fer — Essai de réception aux ultra-sons

First edition — 1981-03-01

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UDC 629.4.02 : 620.179.16

Ref. No. ISO 5948-1981 (E)

Descriptors : steel products, rolled products, axles, wheels, tests, ultrasonic tests, specifications.

Price based on 3 pages

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 5948 was developed by Technical Committee ISO/TC 17, *Steel*, and was circulated to the member bodies in October 1979.

It has been approved by the member bodies of the following countries :

Australia	France	Norway
Austria	Germany, F.R.	Romania
Belgium	Hungary	South Africa, Rep. of
Brazil	India	Spain
Bulgaria	Ireland	Sweden
Canada	Italy	Switzerland
Chile	Japan	Turkey
China	Korea, Dem. P. Rep. of	United Kingdom
Czechoslovakia	Korea, Rep. of	USA
Egypt, Arab Rep. of	Netherlands	USSR
Finland	New Zealand	

No member body expressed disapproval of the document.

Railway rolling stock material — Ultrasonic acceptance testing

1 Scope and field of application

This International Standard specifies requirements for the ultrasonic testing of axles, wheels and tyres for railway rolling stock material in the heat-treated condition in which it is to be delivered for the purpose of

- a) the measurement of the ultrasonic testability which is mainly applied to axles to ensure that after certain periods of service they can be readily ultrasonically tested for fatigue cracks;
- b) the detection of internal discontinuities;
- c) the measurement of the ultrasonic testability and the detection of internal discontinuities.

Unless otherwise agreed, this International Standard shall be applied when ultrasonic acceptance tests are ordered for products to be delivered in accordance with ISO 1005, Parts 1, 3 and 6¹⁾.

2 References

ISO 1005/1, *Railway rolling stock material — Part 1: Rough rolled tyres for tractive and trailing stock — Quality requirements.*²⁾

ISO 1005/3, *Railway rolling stock material — Part 3: Axles for tractive and trailing stock — Quality requirements.*²⁾

ISO 1005/6, *Railway rolling stock material — Part 6: Solid wheels for tractive and trailing stock — Quality requirements.*²⁾

ISO 2400, *Welds in steel — Reference block for the calibration of equipment for ultrasonic examination.*

ISO 5180, *Calibration of equipment for ultrasonic examination using a reference block.*²⁾

NOTE — Pending publication of these International Standards, it will be necessary for the relevant requirements to be agreed by the interested parties.

3 General requirements

When ultrasonic tests are specified for the acceptance of the products, these shall be carried out at the manufacturer's works by competent staff and, if so requested, in the presence of the representative of the railway.³⁾

4 Ordering

The following requirements may be specified in the order :

- a) the type of test or tests to be carried out :
 - 1) ultrasonic testability by attenuation tests (see 10.1.1) or
 - 2) ultrasonic testability by transparency tests (see 10.1.2);
 - 3) discontinuity detection tests;
 - 4) attenuation and discontinuity detection tests;
 - 5) transparency and discontinuity detection tests;
- b) if transverse waves are to be used (see 6.2.2);
- c) which parts of the components are to be scanned.

If the order does not specify these details, the manufacturer may assume that the type of tests given in the table, column 2, shall be carried out with longitudinal waves and in accordance with the requirements for scanning given in the table, column 3.

5 Surface condition of the products

5.1 The surface condition of both the testing and reflecting surfaces of the products shall be such that there is no interference with the test.

1) See note in clause 2. An International Standard dealing with the definitions of terms used in ultrasonic testing is in preparation.

2) At present at the stage of draft.

3) Here and throughout the text, "the representative of the railway" is always understood to be the representative of the railway administration.

5.2 When ultrasonic acceptance tests are specified on products delivered in the unmachined condition, any scale shall tightly adhere to the metallic surface and shall be sufficiently smooth to meet the conditions of 5.1.

5.3 When products to be ultrasonically tested are machined before testing, the operation shall ensure that a surface finish suitable for ultrasonic testing is achieved.

6 Equipment characteristics

6.1 Type of equipment

A suitable ultrasonic pulse echo instrument with a gain control calibrated in decibels (dB) shall be used.

6.2 Probes

6.2.1 Unless otherwise specified in the order, longitudinal wave probes with a frequency of 2 to 3 MHz and a transducer with a diameter of about 25 mm or rectangular transducers with equivalent characteristics shall be used.

6.2.2 For special cases, when the use of transverse wave probes is agreed for the detection of discontinuities (see clause 4), unless otherwise specified, probes with a frequency of 2 to 3 MHz and an angle of refraction between 35° and 70° shall be used.

6.2.3 In cases where the tests are not carried out by immersion of the probe and the component in the couplant (see 7.1), probes with a plastic pad may be used in order to eliminate the dead zone.

6.2.4 When testing bearing, wheel and gear seats of axles in the radial direction for discontinuities, the use of shaped probes to suit the axle diameter may be necessary to ensure adequate contact area.

7 Couplants

7.1 In order to ensure that adequate transmission of ultrasonic energy is obtained between the probe and the material, a suitable couplant shall be applied between the probe and the product. This can also be achieved by the immersion of the component and the probe in the couplant.

7.2 The same couplant shall be used for the calibration of the ultrasonic pulse echo instrument and for carrying out the tests.

8 Calibration of the instrument

8.1 The calibration of the instrument shall be carried out under the same conditions (see 6.2 and clause 7) as the tests themselves using suitable calibration blocks. These may for example consist of a wheel, tyre or axle or a part thereof, of blocks of the kind described in ISO 2400 or of other suitable blocks.

8.1.1 For the detection of internal discontinuities, the sensitivity shall be adjusted either

- a) by regulating the height of the back wall echo or
- b) by the regulation of the height of the echo of a flat-bottomed hole.

In both cases a) and b), the sensitivity shall be adjusted so that the maximum permissible discontinuity size can be positively detected, irrespective of the position and the distance of the discontinuity from the probe. Details of the adjustment, in the case of the application of the comparison method, are given for tyres and solid wheels in ISO 1005/1 and ISO 1005/6 respectively.

8.1.2 For examination of total ultrasonic transparency (see 10.1.2), the sensitivity shall be adjusted to a reproducible level using a suitable reference test piece. The details concerning the type of the reference test piece and the height of the first back wall echo or of a reference defect shall be agreed at the time of enquiry and order.

9 Scanning

9.1 When ultrasonic acceptance tests are ordered, each individual component shall be scanned according to the requirements of the table, column 3, unless otherwise agreed in the order or its appended documents.

Table — Type of tests to be carried out, and areas to be scanned, in cases where ultrasonic tests are ordered but no corresponding details are given

1	2		3
Components	Type of tests		Area to be scanned ¹⁾
	See clause 4 item		
Tyres and solid wheels	a 3)	Discontinuity detection test	On the face of the rim situated on the side of the flange
Axles	a 4) or a 5)	Either attenuation tests or transparency tests	On the end face of the axle in a longitudinal direction
		Discontinuity detection test	On seats in a radial direction

1) Where discontinuities are indicated, the scanning should also be carried out on other areas of the surface if this seems appropriate for the estimation of the size of the discontinuities.

9.2 When choosing the time of scanning, the following shall be taken into consideration :

- a) depending on the manufacturing conditions, discontinuities may occur during a certain period after the steel has reached ambient temperature;

b) the tests shall be carried out after the final heat treatment;

c) for practical reasons, the tests may be carried out before the components are machined.

9.3 Adequate coupling between the probe and the product shall be maintained and the probe shall be moved over the surface to be tested (see 9.1) to ensure that the maximum possible area of the component is scanned by the ultrasonic beam.

The rate of scanning shall be selected in order to ensure that it is possible to detect all those defects which are considered to be inadmissible.

10 Testing

10.1 Ultrasonic testability

The ultrasonic testability shall be determined by one of the methods given in 10.1.1 and 10.1.2 respectively, after taking into consideration the requirements given in 6.2.1.

10.1.1 Unless otherwise agreed, the inherent ultrasonic attenuation α for a given frequency shall be determined in accordance with the following formula :

$$\alpha = \frac{V_{1,2} - \Delta Vd - \Delta Vc}{2L}$$

where

α is the inherent attenuation of the material, which depends on the wave length in the material, the grain size, the dispersion of internal defects and residual stresses;

$V_{1,2}$ is the difference in amplitude between the first bottom echo and the second, expressed in decibels. This term contains the attenuation proper of the material and an additional attenuation composed of ΔVd and ΔVc ;

ΔVd is the attenuation due to divergencies of the beam which depends on the characteristics of the probe and the wave length within the material. It may be determined using the Distance-Gain-Size-Diagram (DGS);

ΔVc is the attenuation due to losses in coupling. It may be neglected in the case of attenuations of significant value. For special cases, ΔVc shall be taken into account and the method of its determination shall be agreed at the time of enquiry and order;

L is the dimension of the product in the direction of the beam.

10.1.2 The total ultrasonic transparency (n_T) for a given frequency [and a given adjustment to the sensitivity (see 8.1.2)] is determined by the number of bottom echoes visible on the screen.

The different conditions on which ultrasonic transparency depends shall be taken into account when the acceptance standard is specified. The conditions are influenced by probe characteristics, probe contact and geometry of the product and shall be agreed in accordance with the relevant requirements of this International Standard (see 6.2 and clause 7).

10.2 Estimation of size of discontinuities

When any significant discontinuity is indicated during scanning, the operator shall use one of the following two methods to estimate its size.

a) Distance-Gain-Size method (DGS)

In this method, use is made of the DGS diagram. Where this has been derived for other curvature of the surface and other testing conditions, as in the discontinuity detection tests, these differences shall be taken into account.

b) Comparison method

In this case the ratio of the height of the discontinuity echo to the height of the back wall echo of an adjacent sound zone is used as the criterion for comparison and acceptance.

Instead of the back wall echo, the echo of a flat-bottomed hole can also be taken as a reference echo [see 8.1.1 b)].

11 Acceptance standard

11.1 The acceptance standard for ultrasonic testability shall be agreed at the time of enquiry and order, taking into account the testing conditions (see 10.1.2).

11.2 The admissible equivalent discontinuity size [see 10.2 a)] or the admissible ratio of the height of the discontinuity echo to the height of the back wall echo of an adjacent sound zone [see 10.2 b)] and the document of certification shall be agreed at the time of enquiry and order, taking into account the test requirements [see 10.2 b)], the service conditions for which the products are provided and the position of any discontinuities.

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