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Railway rolling stock material — Ultrasonic acceptance testing

Matériel roulant de chemin de fer — Essai de réception aux ultrasons



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 5948 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 13, *Railway rolling stock material*.

This second edition cancels and replaces the first edition (ISO 5948:1981), of which it constitutes a technical revision.

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Railway rolling stock material — Ultrasonic acceptance testing

1 Scope

This International Standard specifies the testing conditions and the acceptance standard for ultrasonic acceptance tests for the components and types of tests covered in table 1, columns 1 to 6.

Unless otherwise agreed, this International Standard shall be applied when the product standards require mandatory ultrasonic tests or when the ordered optional tests are made mandatory (see ISO 1005-1, ISO 1005-3 and ISO 1005-6).

NOTE 1 Following the revision of ISO 1005-6, ultrasonic acceptance tests are mandatory for all wheels of testing category B, but optional for all wheels of testing category A. According to ISO 1005-1 and ISO 1005-3, ultrasonic acceptance tests on tyres and axles are optional in every case.

2 Normative references

The following standards contain provisions which,

through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1005-1:1994, *Railway rolling stock material — Part 1: Rough-rolled tyres for tractive and trailing stock — Technical delivery conditions.*

ISO 1005-3:1982, *Railway rolling stock material — Part 3: Axles for tractive and trailing stock — Quality requirements.*

ISO 1005-6:1994, *Railway rolling stock material — Part 6: Solid wheels for tractive and trailing stock — Technical delivery conditions.*

Table 1 — Main characteristics and conditions of the different types of tests

1	2	3	4	5	6	7	8	9	10	11
Symbol	1)	Components	Purpose of the tests	Beam direction	Main characteristics of the ultrasonic tests		Probes ²⁾	Calibration	Area to be scanned ³⁾	Acceptance standard
					Evaluation method	Type	Frequency MHz	See 9.1 and 9.2.2 a)		See
D 1	m	Tyres and solid wheels	Discontinuity detection tests	Axial (see figures 1 and 2)	Distance-gain-size (DGS) method or Comparison method	Longitudinal wave	2 to 5	9.2.1	On the face of the rim situated on the inside of the flange ⁴⁾ (see figures 1 and 2)	12.1
D 2	o			Radial (see figure 3)	DGS method or Comparison method			9.2.1 9.2.2 b)		
Da	m	Axles	Discontinuity detection tests	Radial, unless otherwise agreed	DGS method (loss in backwall echo height) or Comparison method (loss in backwall echo height)	Longitudinal wave	2 to 5	9.3.1	On the whole length, unless otherwise agreed upon	12.1
T	o		Permeability (transparency) tests	To be agreed upon ⁵⁾	Comparison method (loss in backwall echo height)			9.3.2		
						Longitudinal wave	To be agreed upon	9.4	To be agreed upon	12.2

1) See 3.3.

2) The probes shall be of a design and dimensions appropriate for the tests. Probes and equipment shall be selected so that the "dead zone" (as defined below) is limited to 30 mm. However, if defects near the surface are to be detected (e.g. when testing wheel treads in a radial direction), probe design and equipment should be adequate to limit the "dead zone" to 10 mm.

In this International Standard, "dead zone" means the zone situated under the scanned surface in which the correlation between signal size and reflector size is affected. The depth of this zone is principally a function of transducer design and frequency.

When scanning curved areas, for example the tread of wheels or tyres or the bearing, wheel or gear seats of axles, the use of shaped probes to suit the diameter may be appropriate to ensure adequate contact area.

3) Where discontinuities are indicated or where abnormal losses in backwall echo height occur, scanning should also be carried out on other areas of the surface, if this seems appropriate for the estimation of size of discontinuities.

4) Unless otherwise specified, testing from the opposite side of the flange is also permitted for immersion testing.

5) The axial beam direction is normally preferred in cases where the shape of the axle is not too complicated.

3 Ordering

3.1 If, according to the indications in note 1 to clause 1, ultrasonic acceptance tests are optional, but the purchaser requests that such tests shall be carried out, this shall be specified in the order.

3.2 For all products covered by this International Standard (see clause 1), where appropriate, the following details may be agreed upon at the time of enquiry and order:

- a) the type(s) of ultrasonic acceptance test(s) to be carried out (see table 1, columns 1 to 6);

NOTE 2 If, for axles, the transparency test (symbol T) is ordered, certain details of the test should also be agreed upon (see table 1, last line).

- b) details of the surface condition (see 6.1);
- c) the requirements for the probe (see 7.2);
- d) the area to be scanned (see 10.1);
- e) the acceptance standard (see clause 12).

When these possibilities are used for agreements, care shall be taken that the testing conditions and the acceptance standard remain compatible.

3.3 If the order does not specify the details given in 3.2, the manufacturer may assume that the type of test indicated with an "m" in table 1, column 2, shall be carried out, and that the normal testing conditions and acceptance standards specified in this International Standard shall apply.

4 Location of testing and qualifications of the personnel

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 purchaser's representative.

5 Heat-treatment condition

The products shall be in the heat-treatment condition in which they are to be delivered (see also 10.2).

6 Surface condition of the products

6.1 Unless otherwise agreed, independent of the surface condition in which the product is to be delivered, ultrasonic testing may be carried out either in the unmachined or machined condition, provided that the requirements of 6.2 to 6.4 are observed.

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

6.3 When ultrasonic acceptance tests are carried out on products in the unmachined condition, any scale shall tightly adhere to the metallic surface and shall be sufficiently smooth to meet the conditions of 6.2.

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

7 Equipment characteristics

7.1 Type of equipment

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

7.2 Probes

Unless otherwise agreed, the requirements in table 1, columns 7 and 8, shall apply.

7.3 Other facilities

Adequate facilities shall be available, to ensure that products not complying with the requirements are identified accordingly.

8 Couplants

8.1 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.

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

9 Setting of the sensitivity of the instrument

9.1 General

The setting of the sensitivity of the instrument shall be carried out under the same conditions (see 7.2 and clause 8) as the tests themselves.

In the case of discontinuity-detection tests, in each case the sensitivity shall be set so that, within the area to be scanned outside the "dead zone" (see note 2 to table 1), a reference reflector with a diameter specified as acceptance standard in clause 12 can, irrespective of its distance from the surface to be scanned, be detected positively.

NOTE 3 Calibration blocks applied for establishing the DGS diagrams or for setting the sensitivity according to 9.2, 9.3 or 9.4 shall have an acoustic attenuation similar to that of the wheels or tyres to be tested.

9.2 Sensitivity setting for wheels or tyres

9.2.1 For wheels or tyres to be tested with the beam in an axial or radial direction and to be evaluated by the distance-gain-size (DGS) method, the sensitivity is set with the help of the DGS diagram and the backwall echo occurring when axially testing the tyre or the wheel rim.

9.2.2 For wheels and tyres to be evaluated by the comparison method, the sensitivity shall be set:

- a) when being tested with the beam in an axial direction, with the help of a calibration block of the type shown in figure 1 and an internal reference standard of the type shown in figure 2 (see note 4) (both may be combined in the same block); or
- b) when being tested with the beam in a radial direction, with the help of a calibration block of the type shown in figure 3.

NOTE 4 In this International Standard, "internal reference standard" means a calibration block with a bore on the backwall with the position, form, depth and diameter indicated in figure 2.

9.3 Sensitivity setting for axles

9.3.1 For axles to be tested with the beam in a radial direction and to be evaluated by the DGS method, the sensitivity is set with the help of the DGS diagram and the occurring backwall echo.

9.3.2 For axles to be evaluated by the comparison method, the sensitivity shall be set, when being tested with the beam in a radial direction, with the help of a calibration block of the type shown in figure 4.

9.4 Sensitivity setting for testing the permeability of axles

For testing the permeability (ultrasonic transparency) of axles, the amplification shall be adjusted such that the height of the first backwall echo obtained on a standard axle admitted by the purchaser is 90 % of the screen height.

10 Scanning

10.1 Each individual component shall be scanned. Unless otherwise agreed in the order or its appended documents, the scanning shall be carried out on the areas indicated in table 1, column 10.

10.2 When choosing the time of scanning, it shall be taken into consideration that, depending on the heat-treatment conditions, discontinuities may occur during a certain period after the steel has reached ambient temperature.

10.3 Adequate coupling between the probe and the product shall be maintained and the probe shall be moved over the surface to be tested (see 10.1) to ensure that the maximum possible volume 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 defects which are considered to be inadmissible.

11 Evaluation of indications

11.1 Estimation of the 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.

- b) Comparison method.

In this case, the height of the discontinuity echo is compared with the height of the echo of a flat-bottomed hole, with its bottom situated at the same distance from the probe as the discontinuity

and exhibiting the diameter specified as the acceptance standard. The height of this reference echo is determined from the curve which can be drawn through the peaks of the echos from the various holes in the calibration block.

Unless otherwise agreed and except in cases of dispute, the comparison method may be used in a version designated as the "one hole comparison method".

In this case, the sensitivity is set so that the echo of the flat bottom situated most distant from the probe is equal to 50 % of the screen height. Each signal greater than this 50 % limit is, independent of the distance of the relevant discontinuity from the probe, regarded as a reason for rejection.

When applying this one hole comparison method, discontinuities situated more distant from the probe than the flat bottom used for the sensitivity setting, and giving a signal height of 50 % of the screen height, correspond to a reference reflector somewhat greater than the flat bottom used for the sensitivity setting. Contrary to this, discontinuities situated less distant from the probe than the flat bottom used for the sensitivity setting, and giving a signal height of 50 % of the screen height, correspond to reflectors considerably smaller than the flat bottom used for the sensitivity setting.

Therefore, wheels rejected on the basis of the results of the one hole comparison method may, for a final decision on rejection or acceptance, be retested according to the DGS method or three hole comparison method.

11.2 Determination of the permeability of axles

The permeability is determined by the height of the first backwall echo obtained on the axles tested according to 9.4.

12 Acceptance standard

12.1 Discontinuity detection test according to the DGS or comparison method

In the case of discontinuity detection tests on wheels or tyres or axles, the height of the echo of the discontinuity shall not be greater than the height of the echo of a flat bottomed hole situated at the same distance from the probe as the discontinuity and with a diameter of 3 mm.

In special cases, for example for high speed wheels, a diameter of 2 mm instead of 3 mm may be agreed upon at the time of enquiry and order.

Unless otherwise agreed, if the loss in backwall echo height is greater than 4 dB, it has to be made sure by additional tests, for example in a radial beam direction, that the loss is not the result of defects.

NOTE 5 Centreline defects are permitted in axles, within a zone to be agreed upon at the time of enquiry and order, on condition that these defects will not prevent or interrupt subsequent testing to be carried out in service.

12.2 Permeability

The height of the first backwall echo obtained on the axles being tested shall be equal to or greater than 90 % of the screen height.

At the established test sensitivity, the grass level beyond the first 15 % of the time base shall not exceed 5 % of the full screen height.