
INTERNATIONAL STANDARD



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Steel products for pressure purposes — Quality requirements — Part III : Electric resistance and induction-welded tubes

*Produits en acier pour appareils à pression — Spécifications de qualité —
Partie III : Tubes soudés électriquement par résistance et par induction*

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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 2604/III (originally ISO/DIS 2606) was drawn up by Technical Committee ISO/TC 17, *Steel*, and circulated to the Member Bodies in October 1971.

It has been approved by the Member Bodies of the following countries :

Australia	India	Romania
Austria	Ireland	South Africa, Rep. of
Belgium	Italy	Spain
Czechoslovakia	Japan	Switzerland
Denmark	Korea, Rep. of	Thailand
Egypt, Arab Rep. of	Netherlands	Turkey
Finland	New Zealand	United Kingdom
Germany	Norway	U.S.S.R.
Hungary	Portugal	

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

France
Sweden
U.S.A.

Steel products for pressure purposes — Quality requirements — Part III : Electric resistance and induction-welded tubes

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the quality requirements for plain end electric resistance and induction-welded tubes for pressure purposes manufactured from the steel types listed in table 3.

NOTE — The word "tube" is synonymous with "pipe".

This International Standard does not cover :

- a) casing, tubing, drill pipe and linepipe for use by the oil and natural gas industries;
- b) tubes for the transport of gas, water and sewage.

2 REFERENCES

ISO 148, *Steel — Charpy impact test (V-notch)*.¹⁾

ISO/R 165, *Flanging test on steel tubes*.

ISO/R 166, *Drift expanding test on steel tubes*.

ISO/R 202, *Flattening test on steel tubes*.

ISO/R 205, *Determination of proof stress and proving test for steel at elevated temperatures*.

ISO 375, *Steel — Tensile testing of tubes*.

ISO/R 377, *Selection and preparation of samples and test pieces for wrought steel*.

ISO/R 404, *General technical delivery requirements for steel*.

ISO/R 643, *Micrographic determination of the austenitic grain size of steels*.

ISO/R 783, *Mechanical testing of steel at elevated temperatures — Determination of lower yield stress and proof stress and proving test*.

ISO 2566/1, *Steel — Conversion of elongation values — Part I : Carbon and low alloy steels*.

ISO 2605/1, *Steel products for pressure purposes — Derivation and verification of elevated temperature properties — Part I : Yield or proof stress of carbon and low alloy steel products*.²⁾

ISO 2605/II, *Steel products for pressure purposes — Derivation and verification of elevated temperature properties — Part II : Proof stress of austenitic steel products*.²⁾

ISO 2694, *Pressure vessels*.²⁾

ISO/DATA No. 1, *Summary of average stress rupture properties for wrought boiler and pressure vessel steels for times of 10 000 hours to 250 000 hours and master curves*.

3 GENERAL REQUIREMENTS

3.1 Information to be supplied by the purchaser

3.1.1 The purchaser shall state on his enquiry and order the requirements given below :

- a) the tube dimensions and tolerances (see 3.8);
- b) the steel type (see table 3);
- c) the test category (see 3.11);
- d) the inspection procedures and type of documents (see 3.9, 3.15, 4.2 and 5.2).

3.1.2 Certain alternatives are permitted by this International Standard and the purchaser may also state on his enquiry and order his requirements as follows, but if no such statement is made, supply will be at the option of the manufacturer :

- e) the deoxidation practice (see 3.2.3);
- f) heat-treatment condition of supply (see 3.4);
- g) if a product (check) analysis is required (see 3.5.2 and 3.5.2.2);
- h) if additional mechanical tests are required (see 3.6.1.2);
- i) any special requirements for freedom from defects (see 3.7.2);
- j) any special straightness requirements (see 3.7.4);
- k) if special protection is required (see 3.7.6);
- l) if cast separation is required (see 3.12.1.3);

1) At present at the stage of draft (revision of ISO/R 148).

2) At present at the stage of draft.

- m) if room temperature impact tests are required and if so, the number of test pieces (see 3.12.1.6);
- n) if the hydraulic test is to be omitted (see 3.12.3);
- o) if a drift expanding or flanging test, when appropriate is required (see 3.13.3);
- p) the details of non-destructive tests, if required (see 3.13.6);
- q) if elevated temperature proof stress tests are required and if so, the testing temperature selected from table 5 (see 4.2.2.2);
- r) if low temperature V-notch impact tests are required and if so, the testing temperature selected from table 7 (see 5.2.2);
- s) if a maximum copper content is required (see table 3, note 1).

3.2 Manufacture of the steel

3.2.1 Unless otherwise stated on the enquiry and order, the steelmaking process and the deoxidation practice within the provisions of 3.2.2, 3.2.3 and table 3 will be at the option of the steel manufacturer.

3.2.2 The steel shall be produced by the open hearth, electric or one of the basic oxygen processes. Other processes may be used by agreement between the interested parties¹⁾. If he so requests, the purchaser shall be informed of the steelmaking process used.

3.2.3 Deoxidation practice shall be as defined in table 3 for the steel type specified.

NOTE — ISO documents covering the use of tubes for pressure purposes place additional limitations on deoxidation practice for certain applications. For such applications the purchaser shall ensure that these limitations are stated on the enquiry and order.

3.3 Manufacture of the product

3.3.1 The tubes shall be manufactured from either hot- or cold-rolled steel strip longitudinally welded continuously by the passage of an electric current across the abutting edges without the addition of filler metal.

3.3.2 If rimmed steel strip is used, the strip shall be rolled in single widths and not slit longitudinally except to trim the edges.

3.3.3 The tubes may be as-welded, hot-reduced or cold-finished. The terms "as-welded", "hot-reduced" and "cold-finished" apply to the condition of the tube before it is heat-treated in accordance with 3.4.

3.4 Heat treatment

3.4.1 The tubes shall be supplied in the as-welded or hot-reduced condition or the heat-treated condition given in table 3 for the particular steel type ordered. Where more than one level of properties is specified in table 3 for a given steel type, the level required shall be stated on the enquiry and order.

3.4.2 By agreement between the interested parties, the tubes may be delivered in a condition other than the final heat-treated condition according to table 3, in which case they shall be suitable for subsequent manipulation and the purchaser shall be informed of the heat treatment necessary to give the required properties (see also 3.6.1 and 3.12.1.4).

3.5 Chemical composition

3.5.1 Ladle analysis

The steel shall show on ladle analysis the composition given in table 3 appropriate to the steel type specified.

3.5.2 Product analysis

3.5.2.1 If a check analysis on the product is required, the permissible deviations given in table 4 shall apply to the ladle analysis specified in table 3 for samples taken from the standard position (see 3.5.2.2).

If a check analysis for acceptance purposes is required, this shall be stated on the enquiry and order.

3.5.2.2 If a check analysis on the product is required, the number of samples to be taken shall be agreed between the interested parties.

The samples shall be taken either from the test pieces used for the verification of the mechanical properties, or from drillings through the whole thickness of the tube at the same location as for the mechanical test samples.

The requirements of 3.2 and 3.3 of ISO/R 377, covering the method of selection and preparation of samples for chemical analysis, shall apply.

3.5.3 Cases of dispute

In cases of dispute, the methods for chemical analysis shall be in accordance with the relevant ISO documents. If no ISO document is available, the method to be used shall be agreed between the interested parties.

1) Such as the user, purchaser and manufacturer of the equipment, the producer of the supplied construction material and the inspection and/or certifying authority.

3.6 Mechanical and technological properties

3.6.1 Mechanical properties

3.6.1.1 The mechanical properties at room temperature to be obtained on test pieces selected, prepared and tested in accordance with 3.12.1 and 3.13 are given in table 3.

3.6.1.2 If heat treatments different from, or additional to, the normal reference heat treatment are to be carried out after the delivery of the tubes (which may have an adverse effect on the mechanical properties), the purchaser may require, at the time of enquiry and order, additional mechanical tests on additional samples which have been given heat treatments different from, or additional to, those in table 3. In this case the heat treatment of the samples and the mechanical properties to be obtained on them shall be agreed between the interested parties the time of enquiry and order.

NOTE — The mechanical properties can be affected by heating or reheating during fabrication. Purchasers who intend to heat or reheat any of the steel are advised to discuss the application and proposed heating or reheating treatment with the supplier.

3.6.2 Weldability

The steels covered by this International Standard are generally regarded as being weldable. However, the general weldability of any of the steels, but especially of the steels with relatively high carbon content or relatively high alloy content, cannot be guaranteed as the behaviour of the steel during and after welding is dependent not only on the steel, but also on the welding conditions and the final use for which the steel is employed. Therefore, where appropriate, the welding procedure shall be agreed between the interested parties at the time of enquiry and order.

3.7 Appearance and soundness

3.7.1 The tubes shall have a workmanlike finish and shall be clean and free from such surface and internal defects as can be established by the test category (see 3.11).

3.7.2 Any special requirements for freedom from defects shall be agreed between the interested parties at the time of enquiry and order.

3.7.3 The requirements for surface defects, rectification and internal defects given in 8.1, 8.2 and 8.3 of ISO/R 404 shall apply.

3.7.4 The tubes shall be reasonably straight. Complete straightness cannot be guaranteed. Special requirements regarding straightness shall be the subject of agreement.

3.7.5 The ends shall be cut square with the axis of the tube.

3.7.6 The tubes may be supplied uncoated or with the manufacturer's standard mill protective coating, unless otherwise specified.

3.8 Dimensions and tolerances

3.8.1 The dimensions shall be in accordance with the appropriate ISO document.

3.8.2 The tolerances on the outside diameter and thickness of the tubes depend upon the method of manufacture, the steel type and the heat treatment, and shall be selected from the appropriate ISO document.

3.8.3 The requirements of 8.4 of ISO/R 404 shall apply.

3.9 Inspection procedures

The purchaser shall indicate on his enquiry and order which of the five inspection procedures listed in clause 4 of ISO/R 404 is to be followed.

NOTE — The inspection procedure selected shall, if appropriate, be compatible with the requirements of the ISO document covering the use of the product.

3.10 General rules for carrying out acceptance tests

The requirements of clause 5 of ISO/R 404 covering the following shall apply :

- place of acceptance;
- submission for inspection;
- rights of the inspector;
- acceptance.

3.11 Test categories

The tubes shall be subjected to the tests given in table 1 for the appropriate test category.

TABLE 1 — Test categories

Tests ¹⁾	Test categories			
	II	III	IV	V
Visual inspection	X	X	X	X
Hydraulic	X	X	X ²⁾	X ²⁾
Tensile	X	X	X	X
Flattening	X	X	X	X
Drift expanding or flanging		X		X
Non-destructive testing			X ²⁾	X ²⁾

1) If required, an impact test at room temperature may be carried out for any of the test categories (see 3.12.1.6).

2) See 3.12.3.

3.12 Number, selection and preparation of samples and test pieces

3.12.1 Mechanical tests at room temperature

3.12.1.1 The requirements of 2.3 and 2.4 of ISO/R 377, covering the identification and preparation of samples and test pieces, shall apply.

3.12.1.2 For test categories II and III, the number of tubes on which mechanical tests at room temperature are to be performed shall be as follows :

- a) up to and including 323,9 mm outside diameter : one tube in each 200 tubes as made;
- b) over 323,9 mm outside diameter : one tube in each 100 tubes as made.

The samples shall be taken at random from batches containing not more than 200 tubes as presented for inspection. If the number of samples specified in this clause, when applied to a particular order, necessitates a number of tubes which includes a fraction, the fraction shall be treated as unity.

A batch is a convenient quantity of tubes of the same type of steel, diameter and thickness, such that a suitable number of sample tubes taken at random from a batch for purposes of test will adequately represent the whole batch.

3.12.1.3 For test categories IV and V, the number of tubes on which mechanical tests at room temperature are to be performed shall be as follows :

- a) not heat-treated : 2 % of the tubes from each batch;
- b) heat-treated : 2 % of the tubes from each heat-treatment batch.

For tubes not heat-treated, a batch shall consist only of tubes of the same diameter and thickness and of the same steel type. For tubes which are heat-treated, a batch shall consist only of tubes of the same diameter and thickness, and of the same steel type, subjected to the same finishing treatment in a continuous furnace, or heat-treated in the same furnace charge in a batch-type furnace.

Cast separation may be carried out when specified on the enquiry and order and agreed between the interested parties.

NOTE — Cast separation is required for all tubes having specified elevated temperature properties and which are subjected to acceptance tests for these properties.

3.12.1.4 The test sample shall be cut from the tube after final heat treatment. If the tubes are to be delivered in a condition different from the specified final heat-treatment condition, the test samples shall be in the reference heat-treatment condition required by table 3.

3.12.1.5 From each tube selected for testing, one test piece shall be prepared for each of the mechanical tests required by 3.11.

For the tensile test, the test piece may be taken longitudinally or transversely at the option of the manufacturer. The dimensions of the test piece shall comply with the appropriate ISO document.

3.12.1.6 Where the dimensions of the tube permit the taking of a full size (10 mm X 10 mm) test piece, and if agreed between the interested parties, or if required by the application code (see, for example, ISO 2694), one or, if agreed at the time of enquiry and order, three V-notch impact test pieces shall be taken from one of the tubes selected.

The form and dimensions of the test pieces shall be in accordance with ISO 148.

The test pieces shall be cut so that the longitudinal axes are transverse to the longitudinal axis of the tube. The notch shall be perpendicular to the original surface of the tube.

3.12.2 Visual inspection

Every tube shall be inspected.

3.12.3 Hydraulic test

A hydraulic test shall be carried out on each tube except that, by agreement between the interested parties, the hydraulic test may be omitted for tubes of test categories IV and V which have been ultrasonically tested for acceptance purposes in accordance with the annex.

3.12.4 Non-destructive testing

3.12.4.1 For welded tubes, ultrasonic or any equivalent testing method shall be used for the continuous examination of the weld area. This examination is made for the purpose of quality control during the process of manufacture by a method and at a place chosen by the manufacturer.

3.12.4.2 All tubes to test categories IV and V shall be non-destructively tested for acceptance purposes.

3.13 Test methods and test results

3.13.1 Tensile test at room temperature

3.13.1.1 The tensile test shall be carried out in accordance with ISO 375.

3.13.1.2 The tensile strength R_m , the lower yield stress R_{eL} or proof stress R_p , and elongation A shall be determined. The results obtained shall meet the requirements given in table 3.

For acceptance purposes, the proof stress (total elongation) R_t may be determined. The 0,5 % proof stress (total elongation) $R_{t0,5}$ shall be used for ferritic steels having a specified lower yield stress R_{eL} or 0,2 % proof stress (non-proportional elongation) $R_{p0,2}$. However, in cases of dispute the lower yield stress R_{eL} or proof stress (non-proportional elongation) $R_{p0,2}$ shall be determined.