INTERNATIONAL STANDARD

ISO 9330-6

First edition
1997-03-01

Welded steel tubes for pressure purposes — Technical delivery conditions —

Part 6:
Longitudinally welded austenitic stainless steel tubes

Tubes soudés en acier pour service sous pression — Conditions techniques de livraison —

Partie 6: Tubes soudés longitudinalement en aciers inoxydables austénitiques

Reference number
ISO 9330-6:1997(E)

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International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

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 9330-6 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 19, *Technical delivery conditions for steel tubes for pressure purposes*.

It constitutes a partial revision of ISO 2604-5:1978.

ISO 9330 consists of the following parts, under the general title *Welded steel tubes for pressure purposes — Technical delivery conditions*:

— *Part 1: Unalloyed steel tubes with specified room temperature properties*

— *Part 2: Electric resistance and induction welded unalloyed and alloyed steel tubes with specified elevated temperature properties*

— *Part 3: Electric resistance and induction welded unalloyed and alloyed steel tubes with specified low temperature properties*

— *Part 4: Submerged arc-welded unalloyed and alloyed steel tubes with specified elevated temperature properties*

— *Part 5: Submerged arc-welded unalloyed and alloyed steel tubes with specified low temperature properties*

— *Part 6: Longitudinally welded austenitic stainless steel tubes*

Annexes A and B of this part of ISO 9330 are for information only.

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Welded steel tubes for pressure purposes — Technical delivery conditions —

Part 6:
Longitudinally welded austenitic stainless steel tubes

1 Scope

1.1 This part of ISO 9330 specifies the technical delivery conditions for longitudinally welded tubes of circular cross-section, made of austenitic stainless steel, which are applied for pressure and corrosion resisting purposes at room temperature, at low temperatures or at elevated temperatures. These tubes are intended for pressure purposes, for example, for the construction of pressure vessels, chemical plants and steam-generating equipment and for interconnecting pipe work.

Tubes manufactured in accordance with this part of ISO 9330 may have specified room temperature properties, specified low temperature toughness properties and specified proof-stress values at elevated temperatures, as appropriate to the service for which they are intended.

The requirements of appropriate International Standards covering applications (e.g. ISO 1129, ISO 2037, ISO 6759, ISO 7598) and relevant national legal regulations shall be taken into account by the user. For boilers and pressure vessels, ISO/R 831 and ISO 5730 are available.

NOTES

1 The word "tube" is synonymous with "pipe".

2 This part of ISO 9330 can also be used as a basis for the manufacture of tubes of non-circular section. In this case, the values quoted in this part of ISO 9330 for chemical analysis and mechanical properties are applicable. All other requirements are by agreement between the purchaser and manufacturer.

This part of ISO 9330 does not cover

a) casing, tubing, drill pipe and linepipe for use by the oil and natural gas industries; and

b) tubes for the transport of gas, water and sewage.

1.2 For the general technical delivery requirements, see ISO 404.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9330. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9330 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 148:1983, *Steel — Charpy impact test (V-notch).*

ISO 377-1:1989, *Selection and preparation of samples and test pieces of wrought steels — Part 1: Samples and test pieces for mechanical test.*

ISO 404: 1992, *Steel and steel products — General technical delivery requirements.*

ISO 683-13:1986, *Heat treatable steels, alloy steels and free cutting steels — Part 13: Wrought stainless steels.*

ISO 783:1989, *Metallic materials — Tensile testing at elevated temperature.*

ISO/R 831:1968, *Rules for construction of stationary boilers.*

ISO 1127:1992, *Stainless steel tubes — Dimensions, tolerances and conventional masses per unit length.*

ISO 1129:1980, *Steel tubes for boilers, superheaters and heat exchangers — Dimensions, tolerances and conventional masses per unit length.*

ISO 2037:1992, *Stainless steel tubes for the food industry.*

ISO 2566-2:1984, *Steel — Conversion of elongation values — Part 2: Austenitic steels.*

ISO 3205:1976, *Preferred test temperatures.*

ISO 3651-1:1976, *Austenitic stainless steels — Determination of resistance to intergranular corrosion — Part 1: Corrosion test in nitric acid medium by measurement of loss in mass (Huey test).*

ISO 3651-2:1976, *Austenitic stainless steels — Determination of resistance to intergranular corrosion — Part 2: Corrosion test in a sulphuric acid/copper sulphate medium in the presence of copper turnings (Monypenny Strauss test).*

ISO 4200:1991, *Plain end steel tubes, welded and seamless — General tables of dimensions and masses per unit length.*

ISO/TR 4949:1989, *Steel names based on letter symbols.*

ISO 5252:1991, *Steel tubes — Tolerance systems.*

ISO 5730:1992, *Stationary shell boilers of welded construction (other than water-tube boilers).*

ISO 6759:1980, *Seamless steel tubes for heat exchangers.*

ISO 6761:1981, *Steel tubes — Preparation of ends of tubes and fitting for welding.*

ISO 6892:1984, *Metallic materials — Tensile testing.*

ISO 7438:1985, *Metallic materials — Bend test.*

ISO 7598:1988, *Stainless steel tubes suitable for screwing in accordance with ISO 7-1.*

ISO 8492:1986, *Metallic materials — Tube — Flattening test.*

ISO 8493:1986, *Metallic materials — Tube — Drift expanding test.*

ISO 8495:1986, *Metallic materials — Tube — Ring expanding test.*

ISO 8496:1986, *Metallic materials — Tube — Ring tensile test.*

ISO 9302:1994, *Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes — Electromagnetic testing for verification of hydraulic leak-tightness.*

ISO 9303:1989, *Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes — Full peripheral ultrasonic testing for the detection of longitudinal imperfections.*

ISO 9304:1989, *Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes — Eddy current testing for the detection of imperfections.*

ISO 9305:1989, *Seamless steel tubes for pressure purposes — Full peripheral ultrasonic testing for the detection of transverse imperfections.*

ISO 9765:1990, *Submerged arc-welded steel tubes for pressure purposes — Ultrasonic testing of the weld seam for the detection of longitudinal and/or transverse imperfections.*

ISO/TR 9769:1991, *Steel and iron — Review of available methods of analysis.*

ISO 10332:1994, *Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes — Ultrasonic testing for the verification of hydraulic leak-tightness.*

ISO 10474:1991, *Steel and steel products — Inspection documents.*

ISO 11496:1993, *Seamless and welded steel tubes for pressure purposes — Ultrasonic testing of tube ends for the detection of laminar imperfections.*

ISO 12096:1996, *Submerged arc-welded steel tubes for pressure purposes — Radiographic testing of the weld seam for the detection of imperfections.*

ISO 14284:1996, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition.*

3 Symbols and denominations

3.1 Fundamental symbols

D = specified outside diameter

D_1 = specified inside diameter

T = specified wall thickness

3.2 Symbols for tolerances

See ISO 5252.

3.3 Symbols for tests

3.3.1 Tensile test

See ISO 6892.

3.3.2 Flattening test

H = distance between platens

K = constant factor of deformation

3.3.3 Hydraulic test

p_t = test pressure

S = stress which occurs in the metal during the test

4 Information to be supplied by the purchaser

4.1 Mandatory information

The purchaser shall state in his enquiry and order the following information:

- the denomination "tube";
- reference to the relevant dimensional standard;
- dimensions (outside diameter × wall thickness or, by agreement, inside diameter × wall thickness) in millimetres (see 7.1);
- length (see 7.2);
- tolerance, if exact lengths greater than 12 m are ordered (see 7.3.2);
- reference to this part of ISO 9330;
- steel grade (see table 1);
- test category (see 9.2);
- type of inspection and testing and corresponding document (see 9.1 and clause 12).

4.2 Optional information

Enquiries and orders for tubes in accordance with this part of ISO 9330 shall be supplemented, if it is deemed necessary by the purchaser, with the indication of one or more of the following optional requirements, which shall be the subject of special agreements:

- steelmaking process (see 5.1);
- heat treatment of hot-finished tubes [see 5.3.1 b)];
- special tolerances on outside diameter and on wall thickness (see table 5);
- heat treatment requested (see 6.2.1);
- bevelled tube ends (see 8.2);
- special straightness requirements (see 8.1.10);
- symbol for the type of condition (see 8.1.1 and table 6);
- product chemical analysis (see 9.3);

— determination of proof stress at elevated temperatures (see 9.4.2);
— leak tightness test (see 9.5);
— impact test at room temperature (see 9.9.5.1);
— impact test at low temperature (see 9.4.3 and 9.9.5.2);
— specific marking (see 10.3);
— non-destructive testing for transverse defects (see 9.9.8.3, tubes of test category II);
— non-destructive testing of tube ends for laminar imperfections (see 9.9.8.4);
— corrosion test (see 6.4);
— bar coding (see 10.1);
— protective coating (see clause 11).

4.3 Example of an order

Example of an order for a welded tube conforming to the dimensional standard ISO 1127, with an outside diameter of 168,3 mm, a wall thickness of 4 mm and a standard length (exact length) of 6 m, made of steel grade X 6 CrNiNb 18 11, in type of condition HFS2, to be submitted to specific inspection and testing to test category I involving the issuing of an inspection certificate according to ISO 10474, 3.1.B.

Tube ISO 1127 - 168,3 × 4 - 6 - ISO 9330-6 - X 6 CrNiNb 18 11 - HFS2 - I - ISO 10474 3.1.B

5 Manufacturing process

5.1 Steelmaking process

If he so requests, the purchaser shall be informed of the steelmaking process used.

NOTE — Steels may be cast in ingots, strand cast or prepared by another process which gives equivalent results. When steels of different grades are sequentially strand cast, identification of the resultant transition material is required. The producer should remove the transition material by an established procedure that positively separates the grades.

5.2 Product-making process for tubes

Tubes covered by this part of ISO 9330 shall be manufactured from appropriately bent hot or cold flat-rolled skelp or plate, longitudinally welded by fusion across the abutting edges, with or without the addition of filler metal, in automated fabrication or for example, in single-piece fabrication. The filler metal used shall be compatible with the parent material. The welds of automatically welded tubes may be smoothed by appropriate methods, for example, by hammering or rolling as part of the manufacturing process (bead conditioned).

For welds with filler metal added there shall be a minimum of two passes deposited, one of which shall be on the inside. Tubes with more than one seam are permitted. All seams shall be tested in accordance with the requirements of this part of ISO 9330.

Tubes with outside diameters not exceeding 168,3 mm may additionally be brought to the required tube dimensions by cold working (see type of condition LWCF2 and LWCF3 in table 6). Fusion-welded austenitic stainless steel tubes shall be as welded, cold finished or bead conditioned.

The terms "as welded", "cold finished" and "bead conditioned" apply to the condition of the tube before heat treatment, if required in accordance with 5.3.

Longitudinally welded cold-finished austenitic stainless steel tubes (LWCF) shall be sufficiently cold worked prior to final heat treatment.

Unless otherwise agreed, the process of manufacture is left to the discretion of the manufacturer.

5.3 Heat treatment and delivery condition

5.3.1 The tubes shall be supplied suitably heat treated over their full length (see table 3) in either

a) the solution-treated condition; or

b) the hot-finished condition for tubes which have been pressed at a temperature within the solution-treatment temperature range in table 3 and cooled rapidly (see 4.2).

5.3.1.1 For type of condition and surface condition of the tubes, see table 6. The selection of the type of condition is left to the discretion of the purchaser (see 4.2 and table 6).

5.3.2 Solution treatment shall consist of heating the tubes uniformly to a temperature within the range given in table 3 and cooling rapidly.

6 Metallurgical properties

6.1 Chemical composition

6.1.1 Heat analysis

On heat analysis, the steel shall show the composition given in table 1 for the specified steel grade.

6.1.2 Product analysis

If a check analysis on the product is required (see 9.3), the permissible deviations given in table 2 shall apply to the heat analysis limits specified in table 1.

The deviations, other than when maxima only are specified, apply either above or below the specified limits of the range, but not both above and below, for the same element from different sample products from the same heat.

When maxima only are specified, the deviations are always positive.

6.2 Mechanical and technological properties

6.2.1 At room temperature

The mechanical and technological properties of the tubes covered by this part of ISO 9330, measured at room temperature (23 °C ± 5 °C, see ISO 3205), shall comply with the requirements of table 3.

NOTE — If heat treatments different from, or additional to, the normal reference heat treatment (which may have an adverse effect on the mechanical properties) are to be carried out after the delivery of the tubes, the purchaser may request, at the time of enquiry and order, additional mechanical tests on samples, that have been given heat treatments different from, or additional to, those given in table 3. The heat treatment of the samples and the mechanical properties to be obtained from tests on them should be agreed between the purchaser and manufacturer at the time of enquiry and order.

6.2.2 At elevated temperature

6.2.2.1 The minimum proof-stress values, $R_{p0,2}$ and $R_{p1,0}$, at elevated temperatures are indicated in table 4.

NOTE — The values are not normally subjected to verification but, if verification is required by the purchaser, 9.4.2 should be referred to.

6.2.2.2 Estimates of the average stress rupture properties are given in annex A, for information.

Table 1 — Chemical composition (heat analysis), of austenitic steels for welded tubes

Steel grade 1)	Chemical composition, % (m/m) 2)								
	C	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	Others
X 2 CrNi 18 10	≤ 0,030	1,00	2,00	0,045	0,030	17,00 to 19,00	—	9,00 to 12,00	—
X 5 CrNi 18 9	≤ 0,07	1,00	2,00	0,045	0,030	17,00 to 19,00	—	8,00 to 11,00	—
X 6 CrNiNb 18 10	≤ 0,08	1,00	2,00	0,045	0,030	17,00 to 19,00	—	9,00 to 12,00	Nb ≥ 10 × % C ≤ 1,00 3)
X 6 CrNiTi 18 10	≤ 0,08	1,00	2,00	0,045	0,030	17,00 to 19,00	—	9,00 to 12,00	Ti ≥ 5 × % C ≤ 0,80
X 2 CrNiMo 17 12	≤ 0,030	1,00	2,00	0,045	0,030	16,50 to 18,50	2,00 to 2,50	11,00 to 14,00	—
X 2 CrNiMo 17 13	≤ 0,030	1,00	2,00	0,045	0,030	16,50 to 18,50	2,50 to 3,00	11,50 to 14,50	—
X 5 CrNiMo 17 12	≤ 0,07	1,00	2,00	0,045	0,030	16,50 to 18,50	2,00 to 2,50	10,50 to 13,50	—
X 6 CrNiMoTi 17 12	≤ 0,08	1,00	2,00	0,045	0,030	16,50 to 18,50	2,00 to 2,50	11,00 to 14,00	Ti ≥ 5 × % C ≤ 0,80
X 6 CrNiMoNb 17 12	≤ 0,08	1,00	2,00	0,045	0,030	16,50 to 18,50	2,00 to 2,50	11,00 to 14,00	Nb ≥ 10 × % C ≤ 1,00 3)
X 5 CrNiMo 17 13	≤ 0,07	1,00	2,00	0,045	0,030	16,50 to 18,50	2,50 to 3,00	11,00 to 14,00	—
X 2 CrNiN 18 10	≤ 0,030	1,00	2,00	0,045	0,030	17,00 to 19,00	—	8,50 to 11,50	N: 0,12 to 0,22
X 2 CrNiMoN 17 13	≤ 0,030	1,00	2,00	0,045	0,030	16,50 to 18,50	2,50 to 3,00	11,50 to 14,50	N: 0,12 to 0,22

1) The designations were made according to the rules stated in ISO/TR 4949.

2) Elements not included in this table shall not be intentionally added without the agreement of the purchaser, other than for the purpose of finishing the heat. If, in special cases, the purchaser considers that the level or residual elements is important in relation to the mechanical and technological properties of the steel in the intended application, the cast (ladle) analysis limits for such elements shall be agreed upon at the time of enquiry or order. The agreed elements shall then be analysed and the values reported.

3) Niobium content includes tantalum determined as niobium.

Table 2 — Permissible deviations from the specified chemical composition limits given in table 1

Element	Content specified for the heat analysis % (*m*/*m*)	Permissible deviation % (*m*/*m*)
C	≤ 0,030 > 0,030	+ 0,005 + 0,01
Si	≤ 1,00	+ 0,05
Mn	≤ 2,00	+ 0,05
P	≤ 0,045	+ 0,005
S	≤ 0,030	+ 0,003
Cr	≤ 19,0	± 0,20
Mo	≤ 3,00	± 0,08
N	≤ 0,22	± 0,02
Nb	≤ 1,00	± 0,05
Ni	≤ 14,50	± 0,15
Ti	≤ 0,80	± 0,15

6.2.3 At low temperature

The minimum longitudinal impact values and the test temperature shall be agreed upon at the time of enquiry and ordering. For information, absorbed energy values at various temperatures are described in annex B.

NOTE — The values are not normally subjected to verification but, if verification is required by the purchaser, 9.4.3 and the steel grade selection given in annex B should be referred to.

6.3 Weldability

Steels intended for the production of tubes covered by this part of ISO 9330 are generally regarded as being weldable. However, account should be taken of the fact that the behaviour of the steel during and after welding depends not only on the steel, but also very much on the conditions of preparing and carrying out the welding and the final use for the steel.

6.4 Corrosion resistance

6.4.1 The corrosion resistance considerations contained in this part of ISO 9330 relates to intergranular corrosion. Other types of corrosion or effects of the various corrosion media found in use is not the subject of this part of ISO 9330.

6.4.2 If specific corrosion tests are required, they shall be agreed upon at the time of enquiry and order. The conditions and the evaluation of the results of testing shall also be established at this time.

For resistance to intergranular corrosion, requirements shall be agreed upon, for example on the basis of the intergranular corrosion tests given in ISO 3651-1 or ISO 3651-2.

6.4.3 The data given in table 3 shall apply for the resistance of the steels to intergranular corrosion, when tested as specified in ISO 3651-2 (see 9.4.4 and 9.6.6).

Guideline values for the limit temperature in the case of intergranular corrosion stress are indicated in table 4.