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Welded steel tubes for pressure purposes — Technical delivery conditions —

Part 1:
Unalloyed steel tubes with specified room temperature properties

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

Partie 1: Tubes soudés en aciers non alliés avec caractéristiques spécifiées à température ambiante

Reference number
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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 approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 9330-1 was prepared by Technical Committee ISO/TC 17, *Steel.*

It constitutes a partial revision of ISO 2604-3 : 1975 and ISO 2604-6 : 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*

Annex A of this part of ISO 9330 is for information only.

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Welded steel tubes for pressure purposes — Technical delivery conditions —

Part 1:
Unalloyed steel tubes with specified room temperature properties

1 Scope

1.1 This part of ISO 9330 specifies the technical delivery conditions for welded tubes of circular cross-section, made of unalloyed quality steel with specified room temperature properties. These tubes are intended for pressure purposes including the transport of fluids under pressure.

Certain application standards and regulations permit the use of these tubes up to 350 °C (see annex A).

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

1.2 See ISO 404 for general technical delivery requirements.

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 curently valid International Standards.

ISO 377 : 1985, *Wrought steel — Selection and preparation of samples and test pieces.*

ISO 404 : 1981, *Steel and steel products — General technical delivery requirements.*

ISO 1106-3 : 1984, *Recommended practice for radiographic examination of fusion welded joints — Part 3: Fusion welded circumferential joints in steel pipes of up to* 50 mm *wall thickness.*

ISO 3205 : 1976, *Preferred test temperatures.*

ISO 2566-1 : 1984, *Steel — Conversion of elongation values — Part 1: Carbon and low alloy steels.*

ISO 4200 : 1985, *Plain end steel tubes, welded and seamless — General tables of dimensions and masses per unit length.*

ISO 4948-1 : 1982, *Steels — Classification — Part 1: Classification of steels into unalloyed and alloy steels based on chemical composition.*

ISO 5252 : 1977, *Steel tubes — Tolerance systems.*

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

ISO 6892 : 1981, *Metallic materials — Tensile testing.*

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

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

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

ISO 9302 : 1989, *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 9402 : 1989, *Seamless and welded (except submerged arc-welded) steel tubes for pressure purposes — Full peripheral magnetic transducer/flux leakage testing of ferromagnetic steel tubes for the detection of longitudinal imperfections.*

ISO 9764 : 1989, *Electric resistance and induction welded steel tubes for pressure purposes — Ultrasonic testing of the weld seam for the detection of longitudinal imperfections.*

ISO 9765 : – [1], *Submerged arc-welded steel tubes for pressure purposes — Ultrasonic testing of the seam for the detection of longitudinal and/or transverse imperfections.*

3 Symbols and denominations

3.1 Fundamental symbols

D = specified external diameter

δ = 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

PE = test pressure

σ = 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";

— the manufacturing process;

— reference to the relevant dimensional standard;

— dimensions (outside diameter × wall thickness), in millimetres (see 7.1);

— length (see 7.2);

— tolerance for exact lengths greater than 12 mm and for submerged arc-welded tubes (see 7.3.3);

— reference to this part of ISO 9330;

— steel grade (see table 4);

— 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 are the subject of special agreements:

— steel-making process (see 5.1);

— special tolerances on outside diameter and wall thickness (see tables 7 and 8);

— requirements concerning possible repair by welding (see 8.1.4);

— special straightness requirements (see 8.1.5);

— requirements for trimming the internal weld seam of electric resistance or induction welded tubes (ERW) (see 7.3.2);

— product chemical analysis (see 9.2);

— leak tightness test (see 9.4.2);

— specific marking (see 10.2);

— protective coating (see clause 11).

4.3 Example of an order

Example of an order for an electric-resistance welded tube conforming to the dimensional standard ISO 4200, with an external diameter of 168,3 mm, a wall thickness of 4 mm and a standard length (random length) of 4 m to 8 m, made of steel grade TW 360 with specified room-temperature properties, to be submitted to specific inspection and testing involving the issuing of an inspection certificate:

Tube ERW ISO 4200 — 168,3 × 4 — 4 to 8 — ISO 9330 — 1 TW 360 — inspection certificate

5 Manufacturing process

5.1 Steel-making process

Unless otherwise agreed at the time of ordering, the steel-making process is at the option of the manufacturer.

If he so requests, the purchaser shall be informed of the steel-making process used.

1) To be published.

5.2 Deoxidation process

Steels intended for the production of tubes covered by this part of ISO 9330 shall be killed, except for steel TW 320 which may be semikilled.

5.3 Product-making process for tubes

Tubes covered by this part of ISO 9330 may be hot-finished or cold-finished. The terms "hot-finished" and "cold-finished" apply to the condition of the tube before it is heat-treated in accordance with 5.4. Unless otherwise agreed, the process of manufacture is left to the discretion of the manufacturer.

Before commencing production, the manufacturer shall take appropriate measures to ensure that the tubes are manufactured to a consistent quality.

Welding may be either longitudinal or spiral (see table 1). The welding process shall be butt welding (grades TW 320 and TW 360 only), electric resistance welding or submerged arc-welding.

NOTES

1 A welded tube is a tubular product obtained by shaping a flat-rolled product and then welding the edges. The weld may be longitudinal or spiral.

2 Tubes manufactured by the butt welding process have a longitudinal weld which is formed by means of pressure applied by mechanically operated rolls on the edges of the strip. These edges were heated to welding temperature in a furnace.

No filler metal is used during the welding process.

3 Tubes manufactured by the electric resistance welding process have a longitudinal or spiral weld formed by means of pressure applied to the edges of the strip. These edges were heated to welding temperature by the resistance to the passage of an electric current at, and adjacent to, these surfaces. The electric current may be passed either by direct contact or induction methods.

No filler metal is used during the welding process.

4 Tubes manufactured by the submerged arc-welding process have a longitudinal or spiral weld deposited automatically without the application of pressure to the plate or strip edges.

Welding is carried out by means of a bare wire electrode, the arcs being enveloped in a granular flux, some of which fuses to form a removable slag covering. At least one pass is made on the inside and one pass on the outside of the tube.

5 The finished tubes shall not include welds used for joining lengths of the hot or cold, flat-rolled strip prior to tube forming.

Table 1 — Manufacturing processes for tubes

Nomenclature	Description	Weld position	Symbol
Pressure welding	Electric resistance and induction welded	Longitudinal or spiral	ERW
	Butt welded	Longitudinal	BW
Fusion welding	Submerged arc-welded	Longitudinal or spiral	SAW

5.4 Heat treatment and delivery condition

The tubes covered by this part of ISO 9330 shall be supplied in one of the delivery conditions indicated in tables 2 and 3.

Table 2 — Delivery conditions

Welding process	Method of forming and finishing			
	Hot formed, welded and hot finished	Cold formed, welded and hot finished	Cold formed and welded	Cold formed, welded and cold drawn
Butt welding (see 5.3, note 2)	No heat treatment			Normalizing[2]
Electric resistance welding (see 5.3, note 3)		No heat treatment Subcritical annealing[2] Normalizing[2]	Subcritical annealing[1] [3] Normalizing[1] [3]	Normalizing[2]
Submerged arc-welding (see 5.3, note 4)	Normalizing		No heat treatment Subcritical annealing[2] Normalizing[2]	

1) At the option of the manufacturer, the heat treatment may be carried out on the whole tube or only on the weld zone.

2) The heat treatment is carried out on the whole tube.

3) Unless otherwise agreed at the time of ordering, grades TW 320, TW 360, TW 410 and TW 430 may be supplied without heat treatment.

The choice between these delivery conditions is generally left to the discretion of the manufacturer. However, delivery of the tubes in the normalized condition may be agreed upon at the time of enquiry and order.

Table 3 — Heat-treatment conditions

Steel grade[1]	Temperature[2], °C	
	Subcritical annealing	Normalizing
TW 320 TW 360 TW 410 TW 430 TW 500	640 to 700	870 to 949

1) See table 4.

2) The temperatures are given as a guide.

6 Metallurgical properties

6.1 Chemical composition

6.1.1 Ladle analysis

On ladle analysis, the steel shall show the composition given in table 4 for the specified steel grade.

6.1.2 Product analysis

If a check analysis on the product is required (see 9.2), the permissible deviations given in table 5 shall apply to the ladle analysis specified in table 4.

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 cast.

When maxima only are specified, the deviation are positive only.

Table 5 — Permissible deviations from the specified chemical composition limits given in table 4

Element	Permissible deviation % (m/m)
C	+ 0,03
Si	+ 0,05
Mn	± 0,10
P	+ 0,005
S	+ 0,005

6.2 Mechanical properties

The mechanical properties of the tubes covered by this part of ISO 9330, measured at room temperature (23 °C ± 5 °C, see ISO 3205), are given in table 6.

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 which the steel is employed.

Table 4 — Chemical composition (ladle analysis) [% m/m][1]

Steel grade[2]	C max.	Si max.	Mn	P max.	S max.
TW 320	0,16	—	0,30 to 0,70	0,040	0,040
TW 360	0,17	0,35	0,30 to 0,80	0,040	0,040
TW 410	0,21	0,35	0,40 to 1,20	0,040	0,040
TW 430	0,21	0,35	0,40 to 1,20	0,040	0,040
TW 500[3]	0,22	0,35	< 1,60	0,040	0,040

1) Elements not included in this table shall not be internationally added without the agreement of the purchaser, except for elements such as aluminium which may be added for finishing of the cast.

All reasonable precautions shall be taken to prevent the addition of elements from scrap or other materials used in the manufacture, but residual elements may be tolerated, provided that the mechanical properties and applicability are not adversely affected.

If the amount of residual elements is likely to affect the weldability of the steel, the content of such elements (ladle analysis) shall be stated in the documents mentioned in clause 12.

A maximum copper content of 0,25 % (m/m) may be requested by the purchaser in order to facilitate subsequent operations of forming.

2) Provisional designation awaiting an International Standard on this subject.

3) Additions of niobium, titanium and vanadium are permitted at the discretion of the manufacturer, unless otherwise agreed between the purchaser and the manufacturer, up to the levels permitted for unalloyed steels in ISO 4948-1. In this case, the test certificate should state the level of these elements.

Table 6 — Mechanical properties at room temperature

Steel grade	Tensile test[1]					Bend test[2]	Drift expanding test[3] Percentage increase of D	
	Tensile strength R_m	Upper yield stress or proof stress[4] R_{eH} or $R_{p0,2}$ min. for thicknesses (mm) N/mm²		Elongation[5] A min. %		Diameter of mandrel	For d/D ratio[6]	
	N/mm²	$\delta \leqslant 16$	$16 < \delta \leqslant 40$	l	t		$\leqslant 0,8$	$> 0,8$
TW 320	320 to 460	195	—	25	23	$3\,\delta$	10	12
TW 360	360 to 500	235	225	25	23	$3\,\delta$	10	12
TW 410	410 to 550	255	245	22	20	$4\,\delta$	8	10
TW 430	430 to 570	275	265	21	19	$4\,\delta$	8	10
TW 500	500 to 650	355	345	21 (1)	19 (1)	$4\,\delta$	6	8

1) See 9.3 and 9.8.2.

2) See 9.3 and 9.8.4.

3) See 9.3 and 9.8.3.2.

4) For wall thicknesses greater than 40 mm, the values to be obtained shall be the subject of agreement between the manufacturer and the purchaser at the time of ordering.

5) l = longitudinal; t = transverse.

6) d = internal diameter; D = external diameter.

7 Dimensions, masses and tolerances

7.1 Outside diameters, wall thicknesses and masses

The outside diameters, wall thicknesses and masses of the tubes covered by this part of ISO 9330 shall be selected from those given in ISO 4200.

7.2 Lengths

7.2.1 The enquiry and order shall state whether the tubes are to be delivered with random lengths (see 7.2.2) or with exact lengths (see 7.2.3).

7.2.2 If the tubes are to be delivered with random lengths, their lengths shall be within the usual length range of normal production. The relevant length ranges are dependent on the diameter and wall thickness of the tube, as well as on the production facilities of the manufacturer, and shall be agreed at the time of ordering.

7.2.3 If the tubes are to be delivered with exact lengths, the length tolerances given in 7.3.3 shall apply.

7.3 Tolerances

7.3.1 Tolerances on outside diameter and wall thickness, excluding the weld seam

The outside diameter and the wall thicknesses of the tubes covered by this part of ISO 9330 shall be within the tolerance limits given in table 7 (see 9.5).

Table 7 — Tolerances on outside diameter and wall thickness

Outside diameter mm	Tolerances[1] on D	Tolerances[1] on δ
$D \leqslant 219,1$	± 1,0 % with a minimum ± 0,5 mm	± 10 % with a minimum ± 0,2 mm
$D > 219,1$	± 0,75 % with a maximum ± 6 mm	

1) Different tolerances on D and δ may be specified by agreement between the purchaser and the manufacturer. See also ISO 5252.

7.3.2 Tolerance on the height of the weld seam

The heights of the external and internal weld seam shall be within the tolerance limits indicated in table 8 (see 9.5).

For the internal weld seam of pressure welded tubes, see 4.2.

7.3.3 Tolerances on exact lengths

For lengths up to and including 6 m: $^{+\,10}_{\ 0}$ mm

For lengths above 6 m up to and including 12 m: $^{+\,15}_{\ 0}$ mm

For lengths greater than 12 m and for submerged arc-welded tubes (SAW) of any length, the plus tolerances are to be agreed between the purchaser and the manufacturer.

7.3.4 Ovality

For tubes of $D < 457$ mm, ovality is included in the limits of the diameter tolerances.

For tubes of $D \geqslant 457$ mm and $D/\delta < 100$ the ovality shall not exceed 2 %.

For tubes with a D/δ ratio $\geqslant 100$, the values for ovality are to be agreed between the manufacturer and purchaser.

8 Appearance and soundness

8.1 Appearance

8.1.1 The tubes shall have smooth internal and external surfaces with the degree of smoothness depending on the method of manufacture.

8.1.2 The tubes shall have a workmanlike finish but small imperfections are permissible, provided that the thickness remains within the tolerance limits.

8.1.3 Larger surface imperfections may be dressed, provided that the thickness after dressing remains within the lower tolerance limits.

8.1.4 Surface defects shall not be repaired by hammering.

Repair by welding may be permitted by agreement and according to a process agreed between the parties concerned.

8.1.5 The tubes shall be reasonably straight. Special requirements regarding straightness shall be the subject of an agreement.

8.2 Ends

Tubes shall be delivered with nominally square-cut ends, free from excessive burrs, or with bevelled ends (see ISO 6761).

9 Inspection and testing

9.1 Documents on inspection and testing

9.1.1 Table 9 gives a survey of the inspection procedures and the type of documents considered in ISO 404 which may be agreed at the time of enquiry and order for deliveries according to this part of ISO 9330.

Table 8 — Tolerances on the height of the weld seam

Weld seam		Butt welded tubes	Electric resistance or induction welded tubes	Submerged arc-welded tubes[1]
External		—	Trimmed	For $\delta \leqslant 8$ mm: 3 mm For $8 < \delta \leqslant 14{,}2$ mm: 3,5 mm For $\delta > 14{,}2$ mm: 4,8 mm
Internal	Not trimmed	0,3 mm + 0,05 δ	+ 1,5 mm maximum[2]	
	Trimmed		0,3 mm maximum	

1) The values apply for both the external and the internal seam.

2) See 4.2.

Table 9 — Applicable inspection procedures and types of documents

Symbol	Inspection and testing procedure	Type of document designation
TR	Non-specific testing and inspection[1]	Test report
IC	Specific testing and inspection[2] by the qualified department of the manufacturer's works	Inspection certificate signed by the representative of the qualified department of the manufacturer's works
ICP	Specific inspection and testing[2] in the presence of the purchaser or an organization designated by the purchaser	Inspection certificate signed by the manufacturer and purchaser or an organization designated by the purchaser
IR		Inspection report signed by the manufacurer and purchaser or his representative

1) Non-specific inspection and testing means the inspection and testing carried out by the manufacturer in accordance with his own procedures, on products made by the same manufacturing process, but not necessarily on the product actually supplied.

2) Specific inspection and testing means the inspection and testing procedure carried out on the products to be supplied, in order to verify whether these products comply with the requirements of the order.

9.1.2 If, in accordance with the agreements at the time of enquiry and order, a test report (TR) is to be provided, this shall include:

a) a statement that the material complies with the requirements of the order;

b) the results of a tensile test.

9.1.3 If, in accordance with the agreements at the time of ordering, an inspection certificate (IC or ICP) or an inspection report (IR) (see table 9) is to be provided, the specific inspection and tests described in 9.2 to 9.7 shall be carried out and their results shall be stated in the document.

In addition, the document shall include:

a) the results of the ladle analysis;

b) the results of all inspections and tests pertaining to supplementary requirements (see 4.2);

c) the symbols, code letters or code numbers relating the order and the test pieces to the corresponding batches and tested tubes.

9.2 Testing of chemical composition

9.2.1 A test of the chemical composition of the tubes may be agreed upon at the time of ordering (see 9.8.1).

9.2.2 The number of samples to be taken shall be agreed upon by the parties involved at the time of ordering.

9.2.3 The samples may be taken either

a) from the test pieces used for the verification of the mechanical properties, or

b) from drillings taken through the whole thickness of the tube or from a solid section, at the same location as the mechanical test samples.

9.3 Testing of mechanical and technological characteristics

9.3.1 Batch

When specific inspection is required, the delivery shall be divided into batches. A batch is formed by tubes of the same or similar outside diameter, the same or similar wall thickness, the same steel grade, the same manufacturing process and the same heat-treatment conditions. The number of tubes per batch shall comply with the conditions given in table 10.

9.3.2 Acceptance unit

The acceptance unit consists of one tube for each batch.

Table 10 — Number of tubes per batch

Outside diameter range mm	Number of tubes per batch	
$D \leqslant 114{,}3$	400	with a maximum limit of 100 per batch
$114{,}3 < D \leqslant 323{,}9$	200	
$323{,}9 < D$	100	

NOTES

1 For submerged arc-welded tubes (SAW) the batches shall consist of tubes which have been welded using the same type of filler wires.

2 Any residual fraction of the batch is considered as a batch.

9.3.3 Number of tests

For each acceptance unit, the following tests shall be carried out:

— one tensile test on the base material (see 9.8.2);

— one tensile test on the weld (see 9.8.2) for tubes with $D \geqslant 508$ mm; for tubes with 219 mm $< D <$ 508 mm a tensile test on the weld is not carried out unless otherwise agreed at the time of ordering; for tubes with $D \leqslant 219$ mm a tensile test on the weld is not carried out;

— two flattening tests (see 9.8.3.1) for electric resistance or induction welded and butt welded tubes (ERW and BW), with the weld positioned at 0° and 90°; for ERW and BW tubes with $D < 168{,}3$ mm the flattening tests may be replaced by a drift expanding test (see 9.8.3.2) at the option of the manufacturer; for ERW and BW tubes with $D \geqslant 508$ mm the flattening tests may be replaced at the manufacturer's option by two bending tests, one test in the direction of original curvature and one test in the reverse direction, the weld line being positioned at the centre of the test piece and the weld bead removed;

— two bend tests (see 9.8.4) for submerged arc-welded tubes (SAW), one test in the direction of original curvature and one test in the reverse direction, the weld line being placed at the centre of the test piece and the weld bead removed.

9.3.4 Selection of samples and test pieces

Samples and test pieces shall be taken at the tube ends and in accordance with the requirements of ISO 377.

9.3.5 Location and orientation of the test pieces

9.3.5.1 Test piece for the tensile test of the base material

The test piece for the tensile test of the base material shall be taken in accordance with the requirements of ISO 6892.

At the manufacturer's option, for tubes with $D \leqslant 219$ mm the test piece is either a full tube section or is taken in a direction longitudinal to the axis of the tube. In the latter case, the

test piece shall be taken from the side opposite the weld. The test piece shall represent the full thickness of the tube and shall not be flattened before testing.

For tubes with 219 mm $< D <$ 508 mm the test piece shall be taken in a direction either longitudinal or transverse to the axis of the tube, at the manufacturer's option, unless otherwise agreed at the time of ordering. In both cases the test piece, at the manufacturer's option, is either a flattened strip or a machined round bar specimen. The test piece shall be taken from the side opposite the weld. For tubes with an external $D \geqslant 508$ mm the test piece shall be taken in a direction transverse to the axis of the tube. The test piece shall be taken from the side opposite the weld.

9.3.5.2 Test piece for the tensile test on the weld

The test piece for the tensile test on the weld shall be taken transverse to the weld, with the weld at the centre. The test piece shall be a strip section with the full thickness of the tube, and the weld bead may be removed.

9.3.5.3 Test piece for the flattening test

For ERW and BW tubes with $D \leqslant 406$ mm the test piece for the flattening test shall consist of a tube section, in conformity with ISO 8492.

For ERW tubes with $D > 406$ mm the flattening test may be carried out on a half-ring section of the tube.

9.3.5.4 Test piece for the drift expanding test

The test piece for the drift expanding test shall consist of a tube section, in conformity with ISO 8493.

9.3.5.5 Test piece for the bend test

The test piece for the bend test shall consist of a section cut in the tube in accordance with the requirements of ISO 7438. For tubes with a thickness greater than 20 mm the test piece may consist of a segment with rectangular section, 38 mm wide and 19 mm thick.

9.4 Leak tightness test

9.4.1 The tubes shall all be submitted to a leak tightness test.

9.4.2 Unless otherwise specified by the purchaser, the hydraulic leak-tightness test may be replaced, at the discretion of the manufacturer, by a non-destructive test (see 9.8.5.2), except for submerged arc-welded tubes (SAW).

9.5 Dimensional testing

The tubes shall be checked with respect to dimensions by suitable methods.

The tolerance on diameter is normally measured across the diameter; however, for tubes where $D > 457$ mm this tolerance may be measured by a circumference tape.

The ovality shall be measured across the diameter on the pipe ends for a distance of 100 mm.

9.6 Visual examination

The tubes shall be submitted to a visual examination to confirm, in particular, their conformity with the requirements of 8.1 and 8.2.

9.7 Non-destructive test of the weld

When requested in the order the tubes shall all be submitted to a non-destructive test of the weld.

9.8 Test methods and results

9.8.1 Chemical analysis

9.8.1.1 If agreed at the time of ordering, a check analysis shall be carried out (see 9.2.1 and 9.2.2).

9.8.1.2 The elements shall be determined in conformity with the methods considered in the corresponding International Standards.

Spectrographic analysis is permitted.

9.8.1.3 The results shall comply with the values in table 4, taking into account the permissible deviations given in table 5.

9.8.2 Tensile test

9.8.2.1 The tensile test shall be carried out at room temperature in conformity with ISO 6892 (see 9.3.3, 9.3.5.1 and 9.3.5.2).

9.8.2.2 The tensile strength, R_m, the proof stress, $R_{p0,2}$, or the upper yield stress, R_{eH}, and the percentage elongation after fracture, A, shall be determined during the tensile test of the base metal. The tensile strength, R_m, shall be determined during the tensile test on the weld.

The percentage elongation after fracture shall be reported with reference to a gauge length of $5{,}65\sqrt{S_o}$ where S_o is the original cross-sectional area. If other gauge lengths are used, the corresponding elongation referred to a gauge length of $5{,}65\sqrt{S_o}$ shall be obtained in accordance with ISO 2566-1.

9.8.2.3 The results of the tensile test shall comply with the values in table 6 for the steel grade concerned.

9.8.3 Flattening test or drift expanding test

9.8.3.1 Flattening test

The flattening tests (see 9.3.3) shall be carried out in conformity with ISO 8492.

For the two flattening tests the weld shall be at 0° and at 90° to the direction of approach of the platens.

The test shall be carried out in two stages:

a) firstly, no crack shall appear in the weld up to the moment when the distance between the platens reaches two thirds of the outside diameter of the tube (three quarters of the diameter for butt welded tubes);

b) then, the base material shall not crack up to the moment when the distance between the platens reaches one third of the outside diameter of the tube (60 % of the diameter for butt welded tubes).

A slight incipient crack at the edges shall not be regarded as a justification for rejection.

9.8.3.2 Drift expanding test

The drift expanding test shall be carried out in conformity with ISO 8493. The angle of the conical mandrel is 30°.

9.8.4 Bend test

The bend test (see 9.3.3) shall be carried out in conformity with ISO 7438. The two test pieces shall be doubled over, cold, around a mandrel with a diameter as indicated in table 6 for the steel grade concerned, respectively in the direction of initial curvature and in the opposite direction.

After testing, the test pieces shall show no crack or flaw, but slight premature failure at the edges shall not be considered a cause for rejection.

9.8.5 Leak tightness test

9.8.5.1 Hydraulic test

If the leak tightness test is carried out by a hydraulic test, the test pressure is defined, up to a maximum of 70 bar, by the following formula

$$PE = 20 \frac{\sigma \delta}{D}$$

where

PE is the test pressure, in bars;

D is the specified external diameter, in millimetres;

δ is the specified wall thickness, in millimetres;

σ is the stress, in newtons per square millimetre, corresponding to 80 % of the specified minimum value of R_{eH} or $R_{p0,2}$ (see table 6) for the steel grade concerned.

The test pressure shall be maintained for at least 5 s.

The tube shall withstand the test without showing leaks or visible deformation.

9.8.5.2 Non-destructive test

If the tube is not submitted to the hydraulic test defined in 9.8.5.1, it shall be submitted to a non-destructive test (see 9.4.2) according to the electromagnetic test method of ISO 9302 or an ultrasonic test.

9.8.6 Non-destructive test of the weld

Each tube shall be submitted by the manufacturer to a non-destructive test of the weld as indicated below.

9.8.6.1 Electric resistance or induction welded tubes and butt welded tubes (ERW and BW)

The non-destructive test shall be carried out according to one of the test methods of ISO 9303, ISO 9304, ISO 9402 and ISO 9764, as agreed between the manufacturer and the purchaser at the time of ordering, with an acceptance level L4.

9.8.6.2 Submerged arc-welded tubes

The non-destructive test shall be carried out, at the option of the manufacturer,

— either according to the ultrasonic test method of ISO 9765, with acceptance level L4, and an additional radiographic test method over a distance of 200 mm along the weld on both ends of the tube; in the absence of a specific International Standard, the radiographic test method and the corresponding acceptance level shall be fixed by agreement between the purchaser and the manufacturer;

— or according to a radiographic test method; in the absence of a specific International Standard, such a test method and the corresponding acceptance level shall be fixed by agreement between the purchaser and the manufacturer.

The radiographic examination shall in any case be carried out in compliance with the recommended practice described in ISO 1106-3.

9.8.6.3 Skelp end welds for spiral welded tubes shall be tested at the option of the manufacturer, by either a radiographic or ultrasonic test method as specified in 9.8.6.2.

9.9 Invalidation of the tests

See ISO 404, 6.4.

9.10 Re-tests

See ISO 404, 6.5.

9.11 Sorting or re-treatment

See ISO 404, 6.6.

Marking

10.1 Marking to be applied

The following marking shall, according to the size of the tubes, either be applied on a label attached to the bundle or the box of tubes, or be marked indelibly at one end of each tube.

The marking shall include the following information:

a) the mark of the manufacturer of the tubes;

b) the designation of the steel grade, with the addition of the letter N if the order specified a normalizing treatment;

c) the mark of the inspector, if an inspection certificate (IC or ICP) or an inspection report (IR) (see table 9) were requested;

d) reference to this part of ISO 9330.

10.2 Specific marking

Other marking may be applied if specifically requested in the order.

11 Protection

The tubes are normally delivered without protection or with the manufacturer's normal mill protection.

If special protection is to be applied, this shall be specified in the enquiry and order.

12 Documents

Documents issued shall conform with 9.1.

13 Claims after delivery

See ISO 404: 1981, clause 12.

Annex A
(informative)

Elevated temperature proof stress

The values given in table A.1 are not guaranteed and are given for information only. They are not subject to verification and may be amended at some time in the future.

Table A.1 — Values for $R^t_{p0,2}$ at elevated temperatures (N/mm²)

Grade	Temperature, t					
	100 °C	150 °C	200 °C	250 °C	300 °C	350 °C
TW 320	166	158	147	125	100	90
TW 360	185	175	165	145	120	110
TW 410	210	195	185	170	145	135
TW 430	215	200	190	175	155	140
TW 500	250	240	230	215	195	180

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Descriptors: steel products, steel tubes, welded tubes, unalloyed steels, pressure pipes, delivery condition, physical properties.

Price based on 11 pages