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**Welded steel tubes for pressure  
purposes — Technical delivery  
conditions —**

Part 5:

**Submerged arc-welded unalloyed  
and alloyed steel tubes with specified  
low temperature properties**

*ISO 9330-5:2000*  
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*Partie 5: Tubes soudés à l'arc immergé en aciers non alliés et alliés  
avec caractéristiques spécifiées à basse température*



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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this part of ISO 9330 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 9330-5 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 19, *Technical delivery conditions for steel tubes for pressure purposes*.

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*

# Welded steel tubes for pressure purposes — Technical delivery conditions —

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

### 1 Scope

This part of ISO 9330 specifies the technical delivery conditions for submerged arc-welded tubes of circular cross-section, made of unalloyed or alloyed steel with specified low temperature properties. These tubes are intended for pressure purposes in cases when the material is also used as part of a low temperature piping system.

The requirements of appropriate international application standards and relevant national legal regulations shall be taken into account by the user. For pressure-containing equipment International Standard ISO 5730 is available.

For the general technical delivery requirements, see ISO 404.

NOTE The English words “tube” and “pipe” are synonymous.

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### 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 9330. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 9330 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 148:1983<sup>1)</sup>, *Steel — Charpy impact test (V-notch)*.

ISO 377:1997, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing*.

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

ISO 643:1983, *Steels — Micrographic determination of the ferritic or austenitic grain size*.

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

ISO 3205:1976, *Preferred test temperatures*.

ISO 3545-1:1989, *Steel tubes and fittings — Symbols for use in specifications — Part 1: Tubes and tubular accessories with circular cross-section*.

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1) This International Standard has been withdrawn and replaced by ISO 148-1:—, ISO 148-2:1998 and ISO 148-3:1998.

## ISO 9330-5:2000(E)

ISO 4200:1991, *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/TR 4949:1989, *Steel names based on letter symbols.*

ISO 5173:1981, *Fusion welded butt joints in steel — Transverse root and face bend test.*

ISO 5177:1981, *Fusion welded butt joints in steel — Transverse side bend test.*

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

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

ISO 6892:1998, *Metallic materials — Tensile testing at ambient temperature.*

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

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 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 12094:1994, *Welded steel tubes for pressure purposes — Ultrasonic testing for the detection of laminar imperfections in strip/plates used in the manufacture of welded tubes.*

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

#### 3.1 Fundamental symbols

$D$  is the specified outside diameter.

$T$  is the 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 Hydraulic test

$p_E$  is the test pressure.

$\sigma$  is the 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 on his enquiry and order the following information:

- a) the denomination "tube";
- b) reference to the relevant dimensional standard;
- c) dimensions (outside diameter  $\times$  wall thickness), see 7.1;
- d) length, see 7.2;
- e) tolerances if exact lengths greater than 12 m are ordered, see 7.3.4;
- f) reference to this part of ISO 9330, i.e. ISO 9330-5;
- g) steel grade, see Table 1;
- h) test category for unalloyed steels, see 9.3.1.

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### 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:

- a) dimensions (inside diameter  $\times$  wall thickness) see 7.1;
- b) steelmaking process, see 5.1;
- c) delivery condition, see 5.4;
- d) special straightness requirements, see 7.3.6;
- e) tolerances on the height of the weld seam, see 7.3.2;
- f) bevelled ends, see 8.2;
- g) product analysis, see 10.1.3;
- h) tensile testing of weld for tubes over 219 mm but less than 508 mm outside diameter, see 10.1.3;
- i) impact test on the weld and/or heat affected zone, see 10.1.3;
- j) specific marking, see 12.3;
- k) protective coating, see 13;
- l) type of inspection and testing and corresponding document, see 9.2 and 14.

### 4.3 Example of an order

Example of an order conforming to the dimensional standard ISO 4200, with an outside diameter of 457 mm, a wall thickness of 10 mm and a standard length (random length) of 4 m to 8 m, made of steel grade PL 21 with specified elevated temperature properties to be submitted to specific inspection and testing to test category I involving the issuing of an inspection document 3.1.B in accordance with ISO 10474:1991.

**Tube ISO 4200 - 457 × 10 - 4 to 8 - ISO 9330-4 - PL 21 - I - 3.1.B**

## 5 Manufacturing process

### 5.1 Steelmaking process

If requested, the purchaser shall be informed of the steelmaking process used.

Steels may be cast in ingots or may be strand cast. When steels of different grades are sequentially strand cast identification of the resultant transition material is required. The producer shall remove the transition material by an established procedure that positively separates the grades.

### 5.2 Deoxidation process

Steels intended for the production of tubes covered by this part of ISO 9330 shall be fully-killed.

### 5.3 Product-making process for tubes

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

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Tubes shall be submerged arc-welded (SAW) using at least one run on the inside and one run on the outside of the tube. Unless otherwise agreed, the process of manufacture is left to the discretion of the manufacturer, provided that the welding method and welder/welding operator have been approved in accordance with a qualified procedure.

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, if applicable.



## 5.4 Delivery condition

Tubes covered by this part of ISO 9330 shall be supplied heat-treated over their full length. The following heat treatments shall be used depending on the type of steel, see Table 1.

- normalizing;
- normalizing and tempering;
- quenching and tempering.

**Table 1 — Heat treatment conditions**

Steel grade (see Table 2)		Reference heat treatment <sup>a</sup>	Normalizing temperature °C	Tempering temperature °C	Quenching and tempering temperature °C		
					Hardening temperature °C	Cooling medium <sup>b</sup>	Tempering temperature °C
Unalloyed steels	PL 21	N	900-940	—	—	—	—
	PL 23	N	890-930	—	—	—	—
	PL 25	Q+T	—	—	890-930	water or oil	600-680
	PL 26	N	890-930	—	—	—	—
Alloyed steels	11 MnNi 5-3	N <sup>c</sup>	890-940	580-640	—	—	—
	13 MnNi 6-3	N <sup>c</sup>	890-940	580-640	—	—	—
	12 Ni 14	Q+T <sup>d</sup>	830-880	580-640	820-880	water or oil	580-660
	X12Ni 5	Q+T <sup>d</sup>	800-850	580-640	800-850	water or oil	580-660
	X10 Ni 9	Q+T	880-930	—	770-820	water or oil	540-600

<sup>a</sup> N = normalizing; Q + T = quenching + tempering.

<sup>b</sup> When choosing the cooling medium the influence of other parameters, such as dimensions and quenching temperature, on properties and crack susceptibility shall be taken into account. Other cooling media such as synthetic quenchants may also be used.

<sup>c</sup> Tempering can occasionally be necessary after normalizing. In such a case the manufacturer shall inform the purchaser accordingly and shall state the tempering temperature as well.

<sup>d</sup> If the product's dimensions so permit, normalizing (with subsequent tempering if necessary) may be carried out at the manufacturer's discretion instead of quenching and tempering. In such a case the manufacturer shall inform the purchaser accordingly.

## 6 Metallurgical properties

### 6.1 Chemical composition

#### 6.1.1 Heat analysis

The heat analysis reported by the steel producer shall apply and comply with the requirements given in Table 2.

**Table 2 — Chemical composition (heat analysis), % (*m/m*)**

Steel grade <sup>a</sup>		C	Si	Mn	P	S	Al	Mo	Ni	V	Nb
		max.	max.		max.	max.	(total) min.	max.		max.	max.
Unalloyed steel	PL 21	0,17	0,35	0,40-1,00	0,030	0,025	0,015 <sup>b</sup>	—	—	—	—
	PL 23	0,19	0,35	0,60-1,20	0,030	0,025	0,015 <sup>b</sup>	—	—	—	—
	PL 25	0,17	0,35	0,40-1,00	0,030	0,025	0,015 <sup>b</sup>	—	—	—	—
	PL 26	0,20	0,35	0,80-1,40	0,030	0,025	0,015 <sup>b</sup>	—	—	—	—
Alloyed steel	11 MnNi5-3	0,14	0,50	0,70-1,50	0,030	0,025	0,020 <sup>c</sup>	—	0,3 <sup>d</sup> -0,8	0,05	0,05
	13 MnNi6-3	0,18	0,50	0,85-1,65	0,030	0,025	0,020 <sup>c</sup>	—	0,3 <sup>d</sup> -0,8	0,05	0,05
	12 Ni 14	0,15	0,35	0,3-0,8	0,025	0,020	0,020	—	3,25-3,75	0,05	—
	X 12 Ni 5	0,15	0,35	0,3-0,8	0,025	0,020	0,020	—	4,5-5,3	0,05	—
	X 10 Ni 9	0,13	0,35	0,3-0,8	0,025	0,020	0,020	0,010	8,5-9,5	0,05	—

NOTE Elements not included in this table should not be intentionally added without the agreement of the purchaser except for elements which may be added for deoxidation and finishing of the heat. All reasonable precautions should be taken to prevent the addition of elements from scrap or other materials used in the manufacture, but residual elements may be present 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 (heat analysis) should be stated in the documents mentioned in clause 14.

<sup>a</sup> Classification in accordance with ISO 4948-1, designation in accordance with ISO/TR 4949.

<sup>b</sup> Metallic aluminium content. Where the total aluminium content is determined, the results shall be deemed to meet the requirement provided the total aluminium content value obtained is not less than 0,018 % (*m/m*). In case of dispute, the metallic aluminium content shall be determined. Alternatively, an austenitic grain size of 6 or finer, determined in accordance with ISO 643, can be agreed upon. By agreement between the interested parties, aluminium may be replaced by other elements having a similar effect.

<sup>c</sup> Total aluminium content. By agreement between the interested parties, aluminium may be replaced by other elements having a similar effect.

<sup>d</sup> The lower limit value for the nickel content may be reduced to not less than 0,15 % (*m/m*) for tubes with wall thickness  $\leq 10$  mm.

### 6.1.2 Product analysis

If a product analysis is required (see 10.1.3), the permissible deviations given in Table 3 shall apply to the heat analysis specified in Table 2.

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 positive only.

**Table 3 — Permitted deviations from the specified chemical composition limits given in Table 2**

Element	Content specified for the heat analysis % (m/m)	Permissible deviation
C	$\leq 0,20$	+ 0,05
Si	$\leq 0,50$	+ 0,05
Mn	$\leq 1,65$	$\pm 0,10$
P	$\leq 0,030$	+ 0,005
S	$\leq 0,025$	+ 0,005
Al	$\geq 0,020$	- 0,005
Mo	$\leq 0,10$	+ 0,04
Ni	$\leq 0,85$	$\pm 0,05$
	$> 0,85 \leq 3,75$	$\pm 0,07$
	$> 3,75 \leq 5,30$	$\pm 0,10$
	$> 5,30 \leq 9,50$	$\pm 0,15$
V	$\leq 0,05$	+ 0,01
Nb	$\leq 0,05$	+ 0,01