INTERNATIONAL STANDARD ISO 3305

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Plain end welded precision steel tubes — Technical conditions for delivery

Tubes de précision en acier, soudés, à extrémités lisses — Conditions techniques de livraison

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FOREWORD

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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 3305 was drawn up by Technical Committee ISO/TC 5, *Metal pipes and fittings,* and circulated to the Member Bodies in March 1974.

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

Australia	Hungary	Sweden
Belgium	India	Switzerland
Bulgary	Israel	Thailand
Canada	Italy	Turkey
Denmark	Norway	United Kingdom
Egypt, Arab rep. of	Romania	U.S.S.R.
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The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Austria
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1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the technical conditions for delivery of welded tubes with plain ends, manufactured from the grades of steel shown in table 2, with precision dimensional tolerances and in those dimensions from ISO 560 shown in table 9.

Tubes in accordance with this International Standard are employed mainly for purposes where importance attaches to dimensional accuracy and, if required, small thicknesses and surface finish.

If such tubes are intended for use in hydraulic piping equipment, they must be used only in the annealed or normalized delivery condition.

2 REFERENCES

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

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

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

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

ISO 560, *Plain end precision steel tubes, seamless and welded — Dimensions and masses per unit length.*

ISO 2604/III, *Steel products for pressure purposes — Quality requirements — Part III : Welded tubes.*

3 DESIGNATION FOR THE ORDER

3.1 The tubes shall be designated by the following details :

a) quantity;

b) grade of steel;

c) reference to this International Standard;

d) condition of tubes at delivery;

e) outside diameter and thickness;

f) length.

Example : 2 000 m welded precision steel tubes in steel R 37, as per ISO 3305, annealed in controlled atmosphere (GBK), outside diameter 25 mm, thickness 2 mm, in random lengths.

3.2 Certain alternatives are permitted; other supplementary requirements may be specified and the purchaser should state his requirements in his enquiry and order; if he does not do so, supply will be made at the option of the manufacturer.

4 MATERIAL

The tubes shall be manufactured from a steel produced by an open hearth, electric or one of the basic oxygen processes.

The method of manufacture and deoxidation process is left to the option of the manufacturer.

On the purchaser's request, the supplier shall indicate the method of manufacture and the deoxidation practice used.

Rimmed steel is permitted for steel grades R 28, R 33, R 37 and R 42.

5 MANUFACTURE OF THE PRODUCT

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. They are normally cold-finished on both the inside and the outside surfaces. For certain applications, the tubes may be heat-treated. The conditions of the tubes at delivery shall be chosen from table 1.

6 CONDITION OF TUBES AT DELIVERY

The tubes are normally delivered in one of the conditions shown in table 1.

TABLE 1 – **Delivery conditions**

Denomination	Explanation	Symbol	Mechanical properties
Cold-finished/hard (cold-finished as-drawn)	No heat treatment after the last cold-finishing process. For this reason the tubes have only slight workability, concerning the extent of which no guarantee can be given.	BK	See table 3
Cold-finished/soft (lightly cold-worked)	After the last heat treatment, there is a light finishing pass (cold pass); with proper subsequent processing the tube can be cold-deformed within certain limits (bending, expanding, etc.)	BKW	See table 4
Annealed	After the final cold-finishing process, the tubes are annealed in a controlled atmosphere.	GBK	See table 5
	After the annealing treatment, the tubes are de-scaled mechanically or chemically (pickled).	GZF	
Normalized	The tubes are annealed above the upper transformation point in a controlled atmosphere.	NBK	See table 6
	After the annealing treatment, the tubes are de-scaled mechanically or chemically (pickled).	NZF	

7 CHEMICAL COMPOSITION

7.1 On ladle analysis, the steel shall show the composition given in table 2, appropriate to the steel type specified.

TABLE 2 – **Chemical composition on ladle analysis**

Grade[1]	C % max.	Si % max.	Mn % max.	S % max.	P % max.
R 28	0,13[2]	–	0,60	0,050	0,050
R 33	0,16[2]	–	0,70	0,050	0,050
R 37	0,17[2]	0,35	0,8	0,050	0,050
R 42	0,21	0,35	1,2	0,050	0,050
R 50	0,23	0,35	1,5	0,050	0,050

1) The symbols used are provisional.

2) Rimmed steel may be used for steel grades R 28, R 33, R 37 and R 42. If used for R 33 and R 37, the carbon content may be increased to 0,19 % max.

7.2 If a check analysis is required on tubes made from killed steel, the permissible deviations given in ISO 2604/III apply.

8 MECHANICAL AND TECHNOLOGICAL PROPERTIES

8.1 The mechanical properties depend on the delivery state. They are specified in tables 3, 4, 5 and 6.

TABLE 3 – **Mechanical properties in a cold-finished, as-drawn state**

Grade	R_m min.	A min. on $5{,}65\sqrt{S_o}$
	N/mm²	%
R 28	400	6
R 33	420	6
R 37	450	6
R 42	520	5
R 50	600	4

TABLE 4 – **Mechanical properties in a lightly cold-worked state**

Grade	R_m min.	A min. on $5{,}65\sqrt{S_o}$
	N/mm²	%
R 28	350	10
R 33	370	10
R 37	400	9
R 42	450	8
R 50	550	7

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TABLE 5 – **Mechanical properties in an annealed state**

Grade	R_m min.	A min. on $5{,}65\sqrt{S_o}$
	N/mm²	%
R 28	270	27
R 33	320	27
R 37	340	26
R 42	400	24
R 50	480	23

TABLE 6 – **Mechanical properties in a normalized state**

Grade	R_{eH} min.	R_m min.	A min, on $5{,}65\sqrt{S_o}$
	N/mm²	N/mm²	%
R 28	155	280	25
R 33	195	320	25
R 37	215	360	24
R 42	235	410	22
R 50	285	490	21

8.2 The tubes must meet the appropriate requirements of the technological tests given in clause 11 (tables 7 and 8). Tubes in the annealed or normalized condition are suitable for welding without special precautions. For cold-finished tubes which are welded or brazed, the mechanical properties in the heat-affected zone may be affected by the welding temperature.

9 APPEARANCE AND SOUNDNESS

9.1 The tubes shall have smooth external and internal surfaces, the degree of smoothness depending on the method of manufacture. The tubes shall have a workmanlike finish but small imperfections are permissible provided that the thickness remains within the lower tolerance limit.

Surface imperfections may be dressed provided that the thickness after dressing remains within the lower tolerance limit. Peening of surface defects is not permitted.

The internal fin on these tubes resulting from welding may still be visible, but the thickness at the weld shall be within the stipulated tolerances.

In the case of tubes with an inside diameter less than 15 mm, for manufacturing reasons the condition regarding a smooth internal surface is not observable in full.

Cold-finished tubes are permitted to have an adherent layer of phosphate and lubricant originating from the drawing process on the internal and external surface.

Tubes annealed or normalized in a controlled atmosphere may have a discoloration, but shall be free from loose scale.

9.2 The tubes ends shall be cut nominally square with the axis of the tube. By agreement between the interested parties, special end-finishing may be applied.

10 DIMENSIONS, MASSES AND TOLERANCES

10.1 Diameters and thicknesses

The dimensions and tolerances for outside and inside diameter and thickness are given in table 9.

The permissible variations in diameter in the case of the outside diameter and the inside diameter apply to cold-finished/hard and cold-finished/soft tubes. As a result of distortion during annealing, with annealed and normalized tubes the variations in diameter are greater, the permissible values being as follows :

Thickness/Outside diameter	Tolerance
$\frac{a}{D} \geqslant 1/20$	the values given in table 9
$\frac{1}{40} \leqslant \frac{a}{D} < \frac{1}{20}$	1,5 times the values given in table 9
$\frac{1}{60} \leqslant \frac{a}{D} < \frac{1}{40}$	twice the values given in table 9
$\frac{a}{D} < 1/60$	2,5 times the values given in table 9

The permissible dimensional variations in the tube outside diameter include ovality.

It is not possible in all cases to apply simultaneously all three permissible variations for outside diameter, inside diameter and thickness. Tubes are generally ordered to outside diameter and thickness.

If the inside diameter is more important, tubes may be ordered to inside diameter and thickness or outside diameter and inside diameter.

Special tolerances may be agreed upon between the interested parties.

10.2 Straightness

The tubes must be reasonably straight. For tubes having outside diameters exceeding 15 mm, the maximum deviation from straightness shall be 3 mm per metre. This deviation shall be measured between the tube and the straight line joining any two points 1 m away on the same generating line.

Special requirements regarding straightness shall be the subject of a special agreement between the interested parties.

10.3 Lengths

Concerning lengths, a distinction is drawn between :

a) random lengths between 2 and 7 m : these are supplied if, when ordering, no special agreement is reached concerning tube length;

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b) exact lengths : the following variations are permissible :

Length	Tolerance
$L \leqslant 500$ mm	$^{+2}_{0}$ mm
500 mm $< L \leqslant$ 2 000 mm	$^{+3}_{0}$ mm
2 000 mm $< L \leqslant$ 5 000 mm	$^{+5}_{0}$ mm
5 000 mm $< L \leqslant$ 7 000 mm	$^{+10}_{0}$ mm
$L >$ 7 000 mm	by agreement

If, in individual cases, lengths are required with a greater degree of accuracy, the permissible variations shall be agreed upon when ordering.

10.4 Masses

The mass per unit length of the tubes is given in ISO 560.

11 TESTING

Tests are normally applied only as a control of quality by the supplier. If required for tubes supplied against a particular order, this must be specifically stated in the order.

11.1 The tubes shall be subjected to the following tests :

a) visual inspection;

b) tensile test (as in ISO 375);

c) expanding test (as in ISO/R 166), or

d) flattening test (as in ISO/R 202).

Expanding tests are made only in the case of tubes made from R 28, R 33, R 37 and R 42 in an annealed or normalized condition where thicknesses are between 1 and 7 mm; in the case of all other dimensions and grades of steel, the flattening test is made where annealed or normalized tubes are concerned.

For tubes delivered in the annealed condition, the yield stress may be taken as 50 % of the minimum tensile strength given in table 5 for the purpose of calculating the test pressure.

A leaktightness test is not normally provided for these tubes. If these tubes are to be used for carrying fluids and are in the normalized or annealed condition, they shall be tested. The leaktightness test must be specified on the order.

11.2 Acceptance tests

According to the provisions of the order the tubes may be subjected to a final inspection prior to delivery, following the indications given in 11.1 to 11.5.

Acceptance testing may be carried out by an agent appointed by the purchaser. This agent may be an outside inspector or may be selected from the personnel of the manufacturer. The details of the acceptance testing shall be agreed upon at the time of ordering.

11.3 Category of tests

The tubes subjected to acceptance tests shall be tested in lots. A lot comprises 200 tubes of the same steel grade, condition of delivery and, if possible, of the same dimension.

All fractions of a lot comprising less than 200 as made tubes shall be considered as a complete lot. All fractions of a lot comprising less than 20 tubes shall be distributed among the other lots.

With all tubes a visual inspection shall be made, as far as possible, of the external and internal surfaces.

The tubes are to be checked for compliance with diameter and thickness.

11.4 Sampling

The tensile test and the expansion or flattening tests shall be carried out on one tube selected at random from each lot.

11.5 Test methods and results

All tests are to be carried out at ambient temperature.

11.5.1 *Tensile test*

In this test, carried out according to ISO 375, the tensile strength and percentage elongation are to be measured and the values obtained shall correspond to those in tables 3, 4 and 5. In the normalized condition, the yield stress shall also be measured and the values obtained shall correspond to those given in table 6.

11.5.2 *Flattening test*

The flattening test shall be carried out according to ISO/R 202. The test piece shall not show either crack or fissure when the distance between the platens is not greater than the values shown in table 7.

11.5.3 *Expansion test*

The expansion test shall be carried out according to ISO/R 166. The test piece shall not show either crack or fissure before expansion reaches the values given in table 8.

11.5.4 *Leaktightness test*

The leaktightness test may be a hydraulic test at a pressure specified in the order. The manufacturer may substitute an alternative test giving a guarantee of equivalent quality.

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