UDC 669.14.018.8-462.211 : 621.643.2-034.14
: 621.774.21 : 620.1

July 1985

General purpose welded circular stainless steel tubes

Technical delivey conditions

DIN 17 455

Geschweißte kreisförmige Rohre aus nichtrostenden Stählen für allgemeine Anforderungen; technische Lieferbedingungen

This standard, together with DIN 17 440, DIN 17 441, DIN 17 456, DIN 17 457 and DIN 17 458 (July 1985 editions) supersedes DIN 17 440, December 1972 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

The subclauses marked with a single dot ● give specifications which are to be agreed upon at the time of ordering.

The subclauses marked with two dots ●● give specifications which are optional and may be agreed upon at the time of ordering.

Contents

1 Field of application

1.1 This standard applies to general purpose welded circular tubes and pipes (hereinafter briefly referred to as tubes) made from the stainless steels listed in table 1. They are used, for example, as construction tubing, as pipes for the food, pharmaceutical and automobile industries, and as pipes for domestic installations and for decorative purposes.

Tubes conforming to the requirements of this standard are intended to be used on the basis of an 80 % utilization of the permissible design stress in the weld.

1.2 This standard does not apply to welded circular austenitic stainless steel tubes subject to special requirements (see DIN 17 457).

2 Concept

Steels which are particularly resistant to chemically agressive agents are considered to be stainless steels; they generally have a chromium content of not less than 12 % by mass and a carbon content not exceeding 1,2 % by mass.

3 Classification into grades

This standard covers tubes made from the steel grades listed in table 1.

● The selection of the steel grade is at the purchaser's discretion.

4 Designation and ordering

4.1 The standard designation for tubes complying with this standard shall give in the following order:

- the term "tube";
- DIN number of the dimensional standard (e.g. DIN 2463 Part 1);
- characteristic dimensions of tube (outside diameter × wall thickness);
- number of the present standard (DIN 17 455);
- symbol or material number for the steel grade (see table 1);
- symbol for the type of condition of the tube (see table 6).

Example:

A welded tube conforming to this standard, with an outside diameter of 60,3 mm and a wall thickness of 2 mm as specified in DIN 2463 Part 1, made from X 5 CrNi 18 10 steel (material number 1.4301), in the pickled condition (d1), shall be designated as follows:

Tube DIN 2463 – 60,3 × 2
DIN 17 455 – X 5 CrNi 18 10 – d1

or Tube DIN 2463 – 60,3 × 2
DIN 17 455 – 1.4301 – d1

Continued on pages 2 to 14

4.2 ● In addition to the standard designation as given in subclause 4.1, the purchaser shall always state in his order the required quantitiy (e.g. the total length to be supplied), the type of length (see DIN 2463 Part 1), the length of the individual tube in the case of specified lengths and exact lengths, the tolerance class for diameter and wall thickness as specified in DIN 2463 Part 1, and the type of document on materials testing as specified in DIN 50049.

Example of an order:

1000 m tube DIN 2463 – 60,3 × 2
DIN 17455 – 1.4301 – d1
in specified lengths of 6 m, tolerance class D2, T3, accompanied by document DIN 50049 – 3.1B

4.3 ●● In addition to this, further details may be agreed at the time of ordering, as described in the subclauses marked with two dots.

5 Requirements

5.1 Manufacturing process

5.1.1 The process employed for making the steels used to manufacture the tubes conforming to this standard is at the manufacturer's discretion, unless a special steelmaking process has been specified at the time of ordering.

5.1.1.1 ●● If so agreed, the purchaser shall be informed on the steelmaking process used.

5.1.2 Tubes conforming to the requirements of this standard shall be manufactured from appropriately bent plate, sheet or strip by fusion welding or pressure welding, with or without filler metal, at the manufacturer's discretion, in automated fabrication or in single-piece fabrication. The welds of automatically welded tubes may be smoothed by appropriate methods, e.g. by hammering or rolling as part of the manufacturing process. Tubes with outside diameters not exceeding 168,3 mm may additionally be brought to the required tube dimensions by cold working (see types of condition I1 and I2 given in table 6).

Unless otherwise agreed at the time of ordering, the process used to manufacture the tubes is at the manufacturer's discretion. The manufacturer shall have at his disposal suitable equipment to enable welding work to be properly carried out, inspected and tested.

Local repair of the welds is permitted. Areas that are repaired shall then be subjected to non-destructive testing.

5.2 As delivered condition

The tubes may be supplied in one of the conditions specified in table 6 (see subclause 5.8). The guideline data given in table 5 shall be taken into consideration where the conditions specified in table 6 provide for heat treatment.

5.3 Chemical composition

5.3.1 Cast analysis

The chemical composition of the steels determined in the cast analysis [1]) shall be as specified in table 1. Slight deviations from these values are permitted subject to agreement with the purchaser or his representative if the mechanical properties, weldability and corrosion resistance of the steel conform to the requirements specified in this standard.

5.3.2 Product analysis

When testing the chemical composition of the finished product, the deviations shown in table 2 from the values specified in table 1 are permitted.

5.4 Mechanical and technological properties

5.4.1 The upper yield stress or, if this phenomenon is not pronounced, the 0,2 % proof stress, the tensile strength and the elongation after fracture of ferritic steel tubes shall conform to the values specified in table 3, which apply for tubes in the as delivered condition specified in subclause 5.2 and for the test conditions specified in subclause 6.4 and 6.5 of this standard.

5.4.2 The 0,2 % and 1 % proof stresses, the tensile strength and the elongation after fracture of austenitic steel tubes shall conform to the values specified in table 3, which apply for tubes in the as delivered condition specified in subclause 5.2 and for the test conditions specified in subclauses 6.4 and 6.5 of this standard.

The upper limit value of tensile strength may be exceeded if a tensile test transverse to the weld (see subclause 6.3.2.3) is carried out.

5.4.3 The values listed in table 4 shall apply for the elevated temperature 0,2 % and 1 % proof stresses.

5.4.4 Tubes made from the steel grades specified in this standard are suitable for hot working.

5.4.5 Austenitic steel tubes in the heat treated condition are particularly suited for cold working (e.g. bending). This applies to a limited extent to ferritic steel tubes. It should be noted that the corrosion resistance and the mechanical and physical properties are changed by cold working.

5.5 Weldability

5.5.1 Tubes made from the steel grades specified in this standard are suitable for arc welding and pressure welding.

5.5.2 According to DIN 8528 Part 1 however, weldability is dependent not only on the grade of steel but also on the conditions during welding, on the design and the operating conditions of the structural component.

5.5.3 Any filler metal required shall be selected on the basis of DIN 8556 Part 1 taking the intended application, the stress, the welding process and other recommendations into consideration.

5.6 Further processing and heat treatment

See table 5 for guideline data on heat treatment in the fabrication of the tubes and on further processing, and also for guideline data on hot working as part of further processing.

5.7 Corrosion resistance

5.7.1 The corrosion resistance of tubes complying with this standard under the effect of the various corrosive stresses found in use is not the subject of this standard as it cannot be covered by a requirement of general validity.

5.7.1.1 ●● If necessary, specific corrosion tests may be agreed at the time of ordering. The conditions and the evaluation of the results of testing shall also be specified on this occasion.

5.7.2 The data given in table 3 shall apply for the resistance of the steels to intercrystalline corrosion when tested as specified in subclause 6.5.4.

[1]) When sequential castings are supplied, as is possible in the case of continuously cast tubes, the term "cast" should be read as "casting unit".

Table 1. **Steel grades and chemical composition determined in the cast analysis [1]**

Steel grade		% by mass				
Symbol [2]	Material number	C max.	Cr	Mo	Ni	Others [3]
Ferritic steels						
X6 CrTi 12	**1.4512**	0,08	10,5 to 12,5	–	–	Ti: 6 × % C, up to 1,00
X6 Cr 17	**1.4016**	0,08	15,5 to 17,5	–	–	–
X6 CrTi 17	**1.4510**	0,08	16,0 to 18,0	–	–	Ti: 7 × % C, up to 1,20
Austenitic steels						
X5 CrNi 18 10	**1.4301**	0,07	17,0 to 19,0	–	8,5 to 10,5	–
X2 CrNi 19 11	**1.4306**	0,030	18,0 to 20,0	–	10,0 to 12,5	–
X2 CrNiN 18 10	**1.4311**	0,030	17,0 to 19,0	–	8,5 to 11,5	N: 0,12 to 0,22
X6 CrNiTi 18 10	**1.4541**	0,08	17,0 to 19,0	–	9,0 to 12,0	Ti: 5 × % C, up to 0,80
X6 CrNiNb 18 10	**1.4550**	0,08	17,0 to 19,0	–	9,0 to 12,0	Nb: 10 × % C, up to 1,00 [4]
X5 CrNiMo 17 12 2	**1.4401**	0,07	16,5 to 18,5	2,0 to 2,5	10,5 to 13,5	–
X2 CrNiMo 17 13 2	**1.4404**	0,030	16,5 to 18,5	2,0 to 2,5	11,0 to 14,0	–
X6 CrNiMoTi 17 12 2	**1.4571**	0,08	16,5 to 18,5	2,0 to 2,5	10,5 to 13,5	Ti: 5 × % C, up to 0,80
X2 CrNiMoN 17 13 3	**1.4429**	0,030	16,5 to 18,5	2,5 to 3,0	11,5 to 14,5	N: 0,14 to 0,22; S ≤ 0,025
X2 CrNiMo 18 14 3	**1.4435**	0,030	17,0 to 18,5	2,5 to 3,0	12,5 to 15,0	S ≤ 0,025
X5 CrNiMo 17 13 3	**1.4436**	0,07	16,5 to 18,5	2,5 to 3,0	11,0 to 14,0	S ≤ 0,025
X2 CrNiMoN 17 13 5	**1.4439**	0,030	16,5 to 18,5	4,0 to 5,0	12,5 to 14,5	N: 0,12 to 0,22; S ≤ 0,025

[1] Elements not quoted in this table in respect of the individual steel grades shall not be added deliberately to the steel without the purchaser's consent, except for the purpose of finishing the melt. Such elements shall in no way impair the usability or processability of the steel, e.g. its weldability, nor shall they affect the properties specified in this standard.

[2] The symbols given in the December 1972 edition of DIN 17 440 may continue to be used during the period of validity of this standard (see table in the Explanatory notes).

[3] Unless otherwise specified, P ≤ 0,045 %, S ≤ 0,030 %, Si ≤ 1,0 %, for austenitic steels, Mn ≤ 2,0 %, and for ferritic steels, Mn ≤ 1,0 %.

[4] Tantalum determined together with niobium and expressed in the form of niobium content.

Table 2. **Amounts by which the chemical composition in the product analysis may deviate from the limit values specified for the cast analysis**

Element	Limit values specified for the cast analysis as in table 1 % by mass	Permissible deviations [1] % by mass
Carbon (C)	≤ 0,030 > 0,030 ≤ 0,08	+ 0,005 + 0,01
Silicon (Si)	≤ 1,0	+ 0,05
Manganese (Mn)	≤ 1,0 > 1,0 ≤ 2,0	+ 0,03 + 0,04
Phosphorus (P)	≤ 0,045	+ 0,005
Sulfur (S)	≤ 0,030	+ 0,005
Nitrogen (N)	≤ 0,22	± 0,01
Chromium (Cr)	≥ 10,5 < 15,0 ≥ 15,0 ≤ 20,0	± 0,15 ± 0,20
Molybdenum (Mo)	≥ 2,0 ≤ 5,0	± 0,10
Nickel (Ni)	≥ 8,5 < 10,0 ≥ 10,0 ≤ 15,0	± 0,10 ± 0,15
Niobium (Nb)	≤ 1,00	± 0,05
Titanium (Ti)	≤ 1,20	± 0,05

[1] If several product analyses are carried out for a single cast and if these elements show contents for a single element outside the range specified for the cast analysis, this content shall either exceed the permissible maximum content or be below the permissible minimum content, but not both at the same time for one cast.

Table 3. **Mechanical properties of the steels at ambient temperature in the as delivered condition specified in table 6** (with the exception of condition l0) **and their resistance to intercrystalline corrosion** (applicable to wall thicknesses up to 50 mm in the case of austenitic steel tubes and up to 5 mm in the case of ferritic steel tubes) [1]

Steel grade		Heat treatment condition [2]	Maximum HB or HV hardness [3]	Minimum yield stress or 0,2 % proof stress	Minimum 1 % proof stress	Tensile strength [2]	Minimum elongation after fracture [2] ($L_0 = 5\ d_0$) %		Resistance to intercrystalline corrosion [4]	
Symbol	Material number			N/mm²	N/mm²	N/mm²	Longi-tudinal	Trans-verse	in the as delivered condition	after further processing by welding without heat treatment
Ferritic steels										
X 6 CrTi 12	1.4512	Annealed	175	190	–	390 to 560	20	18	n. g.	n. g.
X 6 Cr 17	1.4016		185	270	–	450 to 600	20	18	g. [5]	n. g.
X 6 CrTi 17	1.4510		185	270	–	430 to 600	20	18	g.	g.
Austenitic steels										
X 5 CrNi 18 10	1.4301	Solution annealed and quenched		195	230	500 to 720	40	35	g. [6]	g. [6]
X 2 CrNi 19 11	1.4306			180	215	460 to 680	40	35	g.	g.
X 2 CrNiN 18 10	1.4311			270	305	550 to 760	35	30	g.	g.
X 6 CrNiTi 18 10	1.4541			200	235	500 to 730	35	30	g.	g.
X 6 CrNiNb 18 10	1.4550			205	240	510 to 740	35	30	g.	g.
X 5 CrNiMo 17 12 2	1.4401	Solution annealed and quenched		205	240	510 to 710	40	35	g. [6]	g. [6]
X 2 CrNiMo 17 13 2	1.4404			190	225	490 to 690	40	35	g.	g.
X 6 CrNiMoTi 17 12 2	1.4571			210	245	500 to 730	35	30	g.	g.
X 2 CrNiMoN 17 13 3	1.4429	Solution annealed and quenched		295	330	580 to 800	35	30	g.	g.
X 2 CrNiMo 18 14 3	1.4435			190	225	490 to 690	40	35	g.	g.
X 5 CrNiMo 17 13 3	1.4436			205	240	510 to 710	40	35	g. [6]	g. [6]
X 2 CrNiMoN 17 13 5	1.4439	Solution annealed and quenched		285	315	580 to 800	35	30	g.	g.

[1] ● For greater wall thicknesses, the values shall be specified by agreement.

[2] The upper value of tensile strength may be exceeded by 70 N/mm² and the minimum values of elongation after fracture may be 5 units less in the case of products which are supplied in conditions d0, k0, d1 and k1 described in table 6 and which are not in the solution annealed and quenched or annealed condition.

[3] Guideline values; a recomputation of the tensile strength from the hardness gives inaccurate values.

[4] When tested in accordance with DIN 50 914, g. means existing, n.g. means non-existent up to the limit temperatures listed in the last column of table 4 in the case of austenitic steels.

[5] Applies only for the "annealed" heat treatment condition.

[6] Only for wall thicknesses not exceeding 6 mm.

Table 4. **Minimum values of elevated temperature 0,2 % and 1 % proof stresses and guideline values for the limit temperature in the case of intercrystalline corrosive stress**

Steel grade		Heat treatment condition	0,2 % proof stress at a temperature, in °C, of											1 % proof stress at a temperature, in °C, of											Limit temperature [1]
Symbol	Material number		50	100	150	200	250	300	350	400	450	500	550	50	100	150	200	250	300	350	400	450	500	550	
			N/mm²											N/mm²											°C
X 5 CrNi 18 10	1.4301	Solution annealed and quenched	177	157	142	127	118	110	104	98	95	92	90	211	191	172	157	145	135	129	125	122	120	120	300 [2]
X 2 CrNi 19 11	1.4306		162	147	132	118	108	100	94	89	85	81	80	201	181	162	147	137	127	121	116	112	109	108	350
X 2 CrNiN 18 10	1.4311		245	205	175	157	145	136	130	125	121	119	118	280	240	210	187	175	167	161	156	152	149	147	400
X 6 CrNiTi 18 10	1.4541		190	176	167	157	147	136	130	125	121	119	118	222	208	195	185	175	167	161	156	152	149	147	400
X 6 CrNiNb 18 10	1.4550		191	177	167	157	147	136	130	125	121	119	118	226	211	196	186	177	167	161	156	152	149	147	400
X 5 CrNiMo 17 12 2	1.4401	Solution annealed and quenched	196	177	162	147	137	127	120	115	112	110	108	230	211	191	177	167	156	150	144	141	139	137	300 [2]
X 2 CrNiMo 17 13 2	1.4404		182	166	152	137	127	118	113	108	103	100	98	217	199	181	167	157	145	139	135	130	128	127	400
X 6 CrNiMoTi 17 12 2	1.4571		202	185	177	167	157	145	140	135	131	129	127	234	218	206	196	186	175	169	164	160	158	157	400
X 2 CrNiMoN 17 13 3	1.4429	Solution annealed and quenched	265	225	197	178	165	155	150	145	140	138	136	300	260	227	208	195	185	180	175	170	168	166	400
X 2 CrNiMo 18 14 3	1.4435		182	166	152	137	127	118	113	108	103	100	98	217	199	181	167	157	145	139	135	130	128	127	400
X 5 CrNiMo 17 13 3	1.4436		196	177	162	147	137	127	120	115	112	110	108	230	211	191	177	167	156	150	144	141	139	137	300 [2]
X 2 CrNiMoN 17 13 5	1.4439	Solution annealed and quenched	260	225	200	185	175	165	155	150	–	–	–	290	255	230	210	200	190	180	175	–	–	–	400

[1] Up to these temperatures, the material will, within 100 000 hours, not have changed so as to show susceptibility to intercrystalline corrosion.

[2] Only for wall thicknesses not exceeding 6 mm.

Table 5. **Guideline data for the heat treatment during fabrication and further processing of tubes and guideline data for hot working as part of further processing**

Steel grade		Heat treatment during fabrication and further processing of tubes		Hot working during further processing	
Symbol	Material number	Recrystallization or solution annealing temperature °C	Type of cooling	Temperature °C	Type of cooling
Ferritic steels					
X 6 CrTi 12 X 6 Cr 17 X 6 CrTi 17	1.4512 1.4016 1.4510	750 to 850	Air, water	1100 to 800	Air
Austenitic steels					
X 5 CrNi 18 10 X 2 CrNi 19 11 X 2 CrNiN 18 10	1.4301 1.4306 1.4311	1000 to 1080 [1]	Quenching in water, air [2]	1150 to 750	Air
X 6 CrNiTi 18 10 X 6 CrNiNb 18 10 X 5 CrNiMo 17 12 2 X 2 CrNiMo 17 13 2 X 6 CrNiMoTi 17 12 2	1.4541 1.4550 1.4401 1.4404 1.4571	1020 to 1100 [1]			
X 2 CrNiMoN 17 13 3	1.4429	1040 to 1120 [1]			
X 2 CrNiMo 18 14 3 X 5 CrNiMo 17 13 3	1.4435 1.4436	1020 to 1100 [1]			
X 2 CrNiMoN 17 13 5	1.4439	1040 to 1120 [1]			

[1] When heat treatment forms part of further processing of the product, an attempt shall be made to achieve the lower values of the range specified for solution annealing. If hot working has been carried out at a temperature of at least 850 °C or if the product has been cold worked, the temperature of renewed solution annealing may be 20 K less than the lower limit for solution annealing.

[2] If the cooling is sufficiently rapid.

5.8 Type of condition, appearance of surface and weld

5.8.1 The tubes shall be supplied in one of the conditions listed in table 6.

● The selection of the type of condition is left to the manufacturer's discretion.

Table 6. **Types of condition of tubes**

Symbol	Type of condition	Surface finish [1]
d0 [2]	Tubes welded from surface finish c1*) or c2*) plate, sheet or strip, not pickled	Metallically clean.
d1 [2]	Tubes welded from surface finish c1*) or c2*) plate, sheet or strip, pickled	Metallically bright.
d2 [2]	Tubes welded from surface finish c1*) or c2*) plate, sheet or strip, heat treated, pickled	
d3 [2]	Tubes welded from surface finish c1*) or c2*) plate, sheet or strip, bright heat treated	
k0 [2]	Tubes welded from surface finish h*), m*) or n*) plate, sheet or strip, not pickled	Metallically clean, except that the weld is substantially smoother than for type d0.
k1 [2]	Tubes welded from surface finish h*), m*) or n*) plate, sheet or strip, pickled	Metallically bright, except that the weld is substantially smoother than for types d1 to d3.
k2 [2]	Tubes welded from surface finish h*), m*) or n*) plate, sheet or strip, heat treated, pickled	
k3 [2]	Tubes welded from surface finish h*), m*) or n*) plate, sheet or strip, bright heat treated	
l0 [3]	Tubes welded from surface finish h*), m*) or n*) plate, sheet or strip, heat treated, pickled or bright heat treated, if appropriate, cold worked	
l1	Tubes welded from surface finish c1*), c2*), h*), m*) or n*) plate, sheet or strip, heat treated if appropriate, at least 20 % cold worked, heat treated, with re-crystallized weld metal, pickled	Metallically bright, weld almost indistinguishable.
l2	Tubes welded from surface finish c1*), c2*), h*), m*) or n*) plate, sheet or strip, heat treated if appropriate, at least 20 % cold worked, bright heat treated, with re-crystallized weld metal	
o	Ground [4]	Ground metallically bright, type and degree of grinding shall be agreed at the time of ordering [5].
p	Polished [4]	Polished metallically bright, type and quality of polishing shall be agreed at the time of ordering [5].

*) See DIN 17 440 or DIN 17 441.

[1] See also subclauses 5.8.2 and 5.8.3.

[2] A "g" is to be appended to the symbol for the type of condition of tubes having smoothed welds (see subclause 5.1.2).

[3] ●● The mechanical properties specified in table 3 do not apply for this type of condition. If required, they shall be agreed at the time of ordering.

[4] Conditions k1, k2, k3, l1 or l2 are usually used as the starting condition.

[5] ● The order shall specify whether grinding or polishing is to be internal or external, or internal and external.

5.8.2 The tubes shall have an inside and outside surface consistent with the manufacturing process used.

5.8.3 Slight irregularities in the surface resulting from the manufacturing process, such as raised or depressed areas or shallow grooves are permitted, except for condition p (polished), as long as the remaining wall thickness fulfils the requirements specified in subclause 5.10 and the function of the tubes is not impaired.

5.8.4 Proper removal of surface defects using appropriate means (e.g. grinding) is permitted as long as the remaining wall thickness fulfils the requirements specified in subclause 5.10.

5.8.5 At no point shall the thickness of the welded joint be below the wall thickness of the tube, taking the permissible dimensional deviations into account.

5.9 Leak tightness

The tubes shall remain leaktight when tested as specified in subclause 6.5.5.

5.10 Dimensions, masses per unit length and permissible deviations

DIN 2463 Part 1 shall apply for the dimensions and masses per unit length of tubes and for permissible deviations.

● DIN 11 850 shall apply for tubes intended for use in the food industry. The order shall follow the pattern of the sample order given in that standard.

5.11 Physical properties

Reference is made to volume 10 of the *Stahleisen-Sonderberichte* (iron and steel special reports) (see the "Standards and other documents referred to" clause) for guideline data on the physical properties of the steels conforming to the requirements of this standard.

6 Tests to be carried out and documents on materials testing

6.1 General

The tubes supplied may be accompanied by a test report or, subject to agreement at the time of ordering, by an inspection certificate or an inspection report as specified in DIN 50 049.

● The type of document required and the test house where acceptance inspection is to be carried out by a third party shall be specified in the order.

6.2 Test site

The tubes shall be tested at the manufacturer's works. Production shall not be unduly disturbed when acceptance inspection is carried out by experts who are not employees of the manufacturer.

6.3 Scope of test programme

6.3.1 The results of the cast analysis of the steel concerned shall be stated for the elements listed in table 1 where the tubes supplied are accompanied by a test report. Confirmation of the completion of the following tests as part of the continuous internal control carried out in the manufacturer's works shall additionally be given:

- testing of all tubes for leak tightness (see subclause 6.5.5);
- materials identity testing of all tubes;
- visual examination of the type of condition and surface finish of the tubes;
- check on dimensions of the tubes.

6.3.2 Where the tubes supplied are accompanied by an inspection certificate or inspection report, they shall be inspected by batches. Table 7 gives a synopsis of the scope of test programme in each case.

6.3.2.1 The tubes shall be divided up by steel grade and by dimensions into batches comprising 100 tubes. This division may be done in factory lengths.

Remainders of up to 50 tubes may be distributed uniformly across the batches. Numbers of tubes and remainders of more than 50 tubes or consignments of less than 50 tubes count as one complete batch.

6.3.2.2 The following tests shall be carried out on all tubes in the batch:

- testing for leak tightness;
- materials identity testing;
- visual examination of the type of condition and surface finish;
- check on dimensions.

6.3.2.2.1 ●● It may also be agreed to carry out the visual examination and check on dimensions of the tubes in accordance with a statistical random sampling scheme, e.g., as described in DIN 40 080.

6.3.2.3 One tube (sample tube) shall be taken for testing from each batch as defined in subclause 6.3.2.1. The following tests shall be carried out on this sample tube:

- 1 tensile test at ambient temperature on the parent metal;
- an additional test at ambient temperature transverse to the weld on tubes with an outside diameter not less than 200 mm (see also subclause 5.4.2).

6.3.2.4 ●● If a check of the elevated temperature 0,2 % and 1 % proof stresses has been agreed at the time of ordering, the test temperature and scope of test programme shall also be agreed.

6.3.2.5 ●● If a check of the chemical composition (product analysis) has been agreed, this check shall be carried out on one tube per cast.

6.3.2.6 ●● A test for resistance to intercrystalline corrosion may be carried out by agreement. The scope of test programme shall be agreed.

6.4 Sampling and sample preparation

The information given in figure 1 shall apply for the sampling points and the test piece location.

6.4.1 Tensile test

6.4.1.1 In the case of tubes with outside diameter less than 200 mm, one strip test piece (see DIN 50 140) shall be taken from the parent metal, longitudinal to the tube axis and offset from the weld by about 180°. It is permitted to remove local irregularities. The test piece shall not be heat treated and not straightened within the gauge length. At the manufacturer's discretion, tubes may also be subjected to a tensile test in full (see DIN 50 140).

In the case of tubes with outside diameter equal to or greater than 200 mm, a flat test piece as illustrated in figure 1 of DIN 50 120 Part 1 (September 1975 edition) for fusion welded tubes or in figure 2 of DIN 50 120 Part 2 (August 1978 edition) for pressure welded tubes shall be taken transverse to the weld, with the weld in the middle and cold straightened. A strip test piece shall be taken in addition from the parent metal, longitudinal to the tube axis and offset from the weld by about 180°.

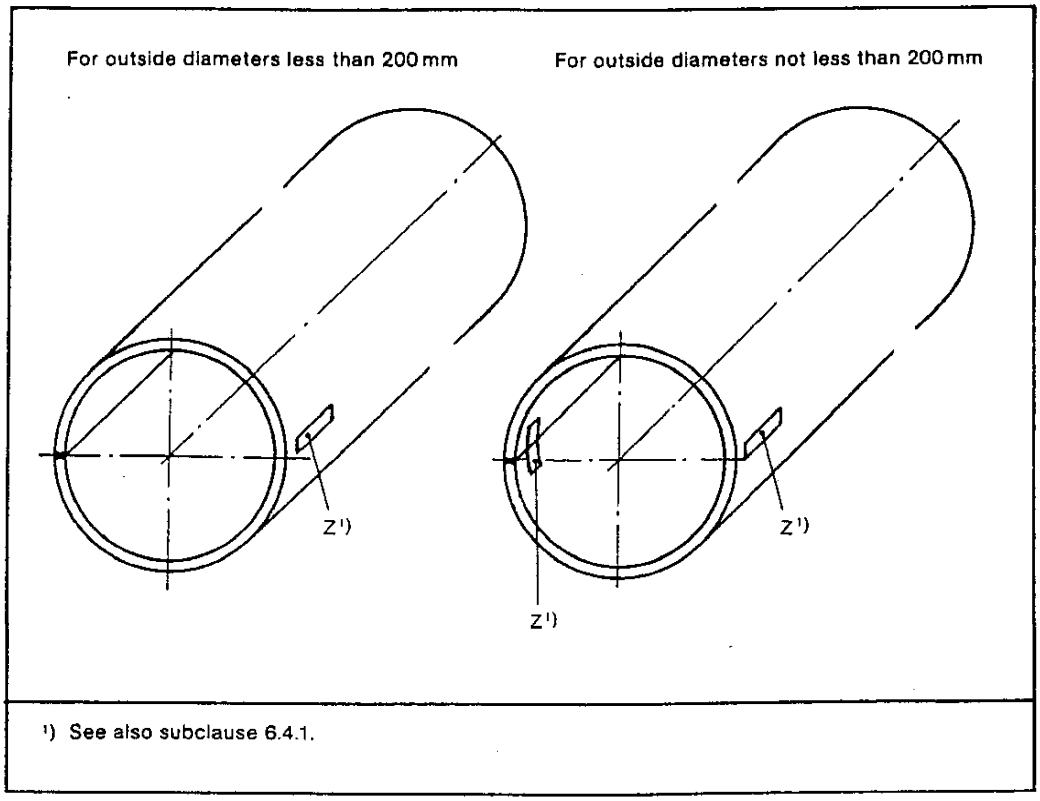
For testing the parent metal, round or flat test pieces worked on all sides may be taken transverse to the tube axis for the tensile test, if the tube dimensions permit this without straightening of the test piece (see DIN 50 125).

6.4.1.2 As a rule, short proportional test pieces shall be taken for the tensile test on the parent metal.

Table 7. **Summary of scope of test programme and documents on materials testing required for tube consignments accompanied by an inspection certificate or inspection report** (see figure 1 for sampling points and location of test pieces; see subclause 6.3.2 for batch size)

Testing			Scope of test programme	Responsibility for carrying out the tests	Type of document on materials testing
No.	Type of test	As in subclause			
1	Cast analysis	5.3.1	Per cast or casting unit	Manufacturer	DIN 50 049 – 2.2 [1]
2	Tensile test at ambient temperature	6.3.2.3 6.4.1 6.5.1	One sample tube per batch. One test piece from the parent metal, plus one test piece transverse to the weld for tubes with outside diameters d_a not less than 200 mm.	By agreement.	DIN 50 049 – 3.1 B or DIN 50 049 – 3.1 C or DIN 50 049 – 3.2 C
3	Leak tightness test	6.3.2.2 6.5.5	All tubes	Manufacturer	DIN 50 049 – 2.1 [1]
4	Visual examination	6.3.2.2 6.5.6	All tubes	By agreement.	DIN 50 049 – 3.1 B or DIN 50 049 – 3.1 C or DIN 50 049 – 3.2 C
5	Materials identity test	6.3.2.2	All tubes	Manufacturer	DIN 50 049 – 2.1 [1]
6	Check on dimensions	6.3.2.2 6.5.7 6.5.8	All tubes	By agreement.	DIN 50 049 – 3.1 B or DIN 50 049 – 3.1 C or DIN 50 049 – 3.2 C
7	Hot tensile test [2]	6.3.2.4 6.5.2	By agreement.	By agreement.	DIN 50 049 – 3.1 B or DIN 50 049 – 3.1 C or DIN 50 049 – 3.2 C
8	Product analysis [2]	5.3.2 6.3.2.5 6.4.2 6.5.3	1 product analysis per cast	Manufacturer	DIN 50 049 – 3.1 B
9	Testing for intercrystalline corrosion [2]	5.7.2 6.3.2.6 6.5.4	By agreement.	Manufacturer	DIN 50 049 – 3.1 B

[1] This certificate can also be included in the next higher stage of document.
[2] Only by agreement between manufacturer and purchaser.



¹) See also subclause 6.4.1.

Figure 1. Sampling points and test piece locations (Z = tensile test piece)

6.4.2 Chemical composition

For checking the chemical composition by means of a product analysis on the finished tube, the sample chips shall be taken at points uniformly distributed over the entire wall thickness of the tube. In the case of tubes welded with filler metals, the chips shall be taken outside the weld. A similar sampling method shall be used for spectral analyses. In general, *Stahl-Eisen-Prüfblatt* (Iron and steel test sheet) 1805 shall apply for sampling.

6.5 Procedure

6.5.1 The tensile test shall be carried out as described in DIN 50140 or DIN 50145.

The tensile test transverse to the weld shall be carried out on test pieces as shown in figure 1 of DIN 50120 Part 1 (September 1975 edition) or figure 2 of DIN 50120 Part 2 (August 1978 edition).

6.5.2 If verification of the elevated temperature 0,2 % and 1 % proof stresses has been agreed, this shall be done as specified in DIN 50145.

6.5.3 The chemical composition shall be determined in accordance with the methods specified by the Chemists' Committee of the *Verein Deutscher Eisenhüttenleute* (Society of German Ferrous Metallurgy Engineers) (see the "Standards and other documents referred to" clause).

6.5.4 The resistance to intercrystalline corrosion shall be tested as specified in DIN 50914.

6.5.5 For the leak tightness test

- using water as described in DIN 50104, the test pressure shall be 50 bar. The test pressure shall be maintained for at least 5 seconds. In no case however shall the safety margin with respect to the yield stress or 0,2 % proof stress drop below 1,1 (see DIN 2413, June 1972 edition, subclause 4.6; $Y' = 0{,}9$). Where appropriate, this shall also apply in the case of thin-walled tubes with large outside diameters, even at 50 bar.
- using air under water, the test pressure shall be 6 bar. The test pressure shall be maintained for at least 5 seconds.
- using air and a foaming agent, the test pressure shall be 0,3 bar.

6.5.5.1 ●● Unless special agreements have been made at the time of ordering, the choice of the above test methods shall be at the manufacturer's discretion.

6.5.5.2 In place of the hydrostatic pressure test, a non-destructive test (e.g., as specified in *Stahl-Eisen-Prüfblatt* 1925, or a leak detection using helium) may be carried out.

6.5.5.3 ● For tubes with outside diameters less than 6 mm, the type of leak tightness test shall be agreed.

6.5.6 The type of condition and surface finish (surface appearance of the tubes) shall be examined visually on the outside of the tubes and, if possible, on the inside, under appropriate lighting conditions by an inspector having normal vision.

Note. Instead of the visual examination, a different test method may also be used, subject to agreement between manufacturer and purchaser.

6.5.7 The wall thicknesses shall be measured at the ends of the tubes using suitable measuring instruments.

6.5.8 The diameter shall be measured using suitable measuring instruments as a two-point measurement in the case of tubes not exceeding 168,3 mm in outside diameter or as a measurement of circumference in the case of tubes exceeding 168,3 mm in outside diameter.

6.5.9 The materials identity test shall be carried out in a suitable manner.

6.6 Retests

6.6.1 Tubes not satisfying the requirements when tested as specified in subclauses 6.5.5 to 6.5.8 (leak tightness test, visual examination, check on dimensions) shall be rejected. The manufacturer shall have the right to take suitable measures to correct defects or deviations found in these tests and to present these tubes for renewed acceptance inspection. Renewed presentation may be dispensed with, if the defects or deviations found in the tests specified in subclauses 6.5.5 to 6.5.8 are detected automatically and the defective parts are separated by cutting them off.

6.6.2 If one of the sample tubes fails the acceptance inspection specified in subclause 6.5.1, the manufacturer is justified in repeating the test giving unsatisfactory results on two test pieces of the same tube. Both test pieces shall satisfy the requirements. If the requirements are still not satisfied in the new tests, the tube shall be rejected.

Two further tubes shall be taken from the batch concerned in place of the rejected sample tube and shall be submitted to the test specified in subclause 6.5.1. If the requirement is still not fulfilled, the entire batch shall be considered not to comply with the standard. However, individual testing may be agreed between the parties concerned.

6.6.3 If the unsatisfactory result of testing can be improved by means of heat treatment or other suitable measures, the supplier shall be given the opportunity to present a batch which was rejected, for renewed acceptance inspection. If the test pieces continue to fail to satisfy the requirements, the entire batch shall be considered not to comply with the standard.

6.6.4 Test results attributable to improperly carried out sampling, sample preparation or test procedure or to an accidental and local defect in a test piece shall be deemed invalid.

6.7 Documents on materials testing

6.7.1 A test report (document 2.2) as specified in DIN 50 049 shall be issued for tubes not subject to acceptance inspection. This document shall certify that the following tests have been carried out:

- cast analysis or analysis of the casting unit;
- leak tightness test (by specifying the type of test method);
- materials identity test;
- check on dimensions and visual examination.

6.7.2 Depending on the agreement made at the time of ordering, either an inspection certificate or an inspection report specified in DIN 50 049 shall be issued for tubes subject to acceptance inspection. The type and scope of the tests, the responsibility for carrying out the tests and the type of documentation covering the tests are shown in table 7.

6.7.3 The documents shall state the marking of the tubes as specified in clause 7.

7 Marking

7.1 Every tube supplied in accordance with this standard shall be clearly and durably marked at one end, as follows:

- manufacturer's mark;
- steel grade (material number);
- symbol specified in table 6 identifying the type of condition of the tubes;
- an appended symbol W indicating that the tube is welded;
- inspector's mark where an inspection certificate or inspection report has been issued.

7.2 Marking as specified in subclause 7.1 shall be made by stamping, embossing or printing.

A different type of marking (e.g. labelling of the bundle of tubes) is permitted for tubes with small outside diameters and/or small wall thicknesses.

7.3 ●● Marking over the entire length of tube may be agreed at the time of ordering.

8 Complaints

8.1 Under current law, a complaint may only be raised against defective tubes if the defects impair their processing and use to a more than negligible extent. This shall apply unless otherwise agreed at the time of ordering.

8.2 It is normal and practical for the purchaser to give the supplier the opportunity to judge whether the complaints are justified, if possible by submitting the tube objected to or samples of the tubes supplied.

Standards and other documents referred to

DIN 2413	Steel pipes; calculation of wall thickness with regard to internal pressure
DIN 2463 Part 1	Welded austenitic stainless steel tubes; dimensions, masses per unit length
DIN 8528 Part 1	Weldability; metallic materials; concepts
DIN 8556 Part 1	Filler metals for welding stainless and heat resisting steels; designation, technical delivery conditions
DIN 11 850	Stainless steel tubes for food processing; dimensions, materials
DIN 17 440	Stainless steels; technical delivery conditions for plate and sheet, hot rolled strip, wire rod, drawn wire, steel bars, forgings and semi-finished products
DIN 17 441	Stainless steels; technical delivery conditions for cold rolled strip and slit strip and for plate and sheet cut therefrom
DIN 17 457	Welded circular austenitic stainless steel tubes subject to special requirements; technical delivery conditions
DIN 40 080	Sampling procedures and tables for inspection by attributes
DIN 50 049	Documents on materials testing
DIN 50 104	Internal pressure test on hollow products; leak tightness test up to a defined internal pressure; general specifications
DIN 50 120 Part 1	Testing of steel; tensile test on welded joints; fusion welded butt joints
DIN 50 120 Part 2	Testing of steel; tensile test on welded joints; pressure welded butt joints
DIN 50 125	Testing of metallic materials; tensile test pieces; guidelines for their preparation
DIN 50 140	Testing of metallic materials; tensile test on tubes and strips from tubes
DIN 50 145	Testing of metallic materials; tensile test
DIN 50 914	Testing of stainless steels for resistance to intercrystalline corrosion; copper sulfate-sulfuric acid method; Strauss test

Stahl-Eisen-Prüfblatt 1805 [2]) *Probenahme und Probenvorbereitung für die Stückanalyse bei Stählen* (Sampling and sample preparation for the product analysis of steels)

Stahl-Eisen-Prüfblatt 1925 [2]) *Elektromagnetische Prüfung von Rohren zum Nachweis der Dichtheit* (Electromagnetic testing of tubes for leak tightness)

Handbuch für das Eisenhüttenlaboratorium [2]) (Handbook for the ferrous metallurgy laboratory);

volume 2: *Die Untersuchung der metallischen Werkstoffe* (Investigation of metallic materials); Düsseldorf 1966;

volume 5 (supplement):

A 4.1 – *Aufstellung empfohlener Schiedsverfahren* (List of recommended arbitration procedures);

B – *Probenahmeverfahren* (Sampling methods);

C – *Analysenverfahren* (Methods of analysis);

most recent edition in each case.

Stahleisen-Sonderberichte, volume 10 [2]): *Physikalische Eigenschaften von Stählen und ihre Temperaturabhängigkeit; Polynome und graphische Darstellungen* (Physical properties of steels and their dependence on temperature; polynomials and graphic representations)

Previous editions

DIN 17 440: 01.67, 12.72

Amendments

The following amendments have been made in comparison with the December 1972 edition of DIN 17 440.

a) The specifications for tubes have been excluded from the field of application of DIN 17 440. These specifications, according to manufacturing process and level of requirements, are now dealt with in Standards DIN 17 455 to DIN 17 458.

b) The layout of the present standard has been harmonized with that of recently published standards for tubes made from other steel groups.

c) Where applicable, the symbols (see table in the Explanatory notes) and specifications relating to chemical composition, mechanical properties and heat treatment have been adopted from DIN 17 440, July 1985 edition.

Explanatory notes

In response to a request from the tube manufacturers, following the procedure applied for other steel groups, stainless steel tubes are no longer specified in DIN 17 440, but are covered by a series of standards which deal separately with processes of tube manufacture (welded or seamless) and fields of application (general purpose tubes and tubes subject to special requirements). The reasons given when making the request were that

- not all the steels covered in DIN 17 440 are used for tubes;
- there are a number of specifications particular to tubes (e.g., relating to testing);
- the number of footnotes may be reduced thereby making the standard more suitable for data processing, and
- the revision of the standards, and consequently a more rapid updating to the latest state of the art, will also be simplified.

[2]) Obtainable from *Verlag Stahleisen mbH*, Postfach 82 29, D-4000 Düsseldorf 1.

In accordance with this concept, this standard deals only with general purpose welded circular stainless steel tubes (e.g. construction tubing, pipes for the food, pharmaceutical and automobile industries, and pipes for domestic installations and decorative purposes).

It was agreed that, where applicable, all specifications agreed for DIN 17 440, July 1985 edition, would also be adopted for DIN 17 455 to DIN 17 458.

Subclause 7.3 of this standard permits agreement on marking tubes over their entire length. Longitudinal marking of tubes with an outside diameter of 17,2 to 114,3 mm and a wall thickness of 1,6 to 3,2 mm is normal practice at the time of publication of this standard.

Of the tube steel grades listed in DIN 17 440, December 1972 edition, X 10 Cr 13 (1.4006), X 8 CrNb 17 (1.4511), X 5 CrNi 18 12*) (1.4303), X 2 CrMiMoN 17 12 2 *) (1.4406), X 2 CrNiMo 18 16 4 *) (1.4438) and X 6 CrNiMoNb 17 12 2 *) (1.4580) steels are not covered by this standard, whilst X 6 CrTi 12*) (1.4512) and X 2 CrNiMoN 17 13 5*) (1.4439) steels have been added.

As the symbols for the steel grades differ from those specified in DIN 17 440, December 1972 edition, following the specifications for the chemical composition, and in accordance with DIN 17 440, July 1985 edition, a compilation of the material numbers, which have not changed, and the previous and new symbols is given below in tabular form. It shall be noted that the symbols used in DIN 17 440, December 1972 edition, may still be used during the period of validity of this standard.

Material number	Previous symbol from DIN 17 440, December 1972 edition	New symbol
1.4016	X 8 Cr 17	X 6 Cr 17
1.4301	X 5 CrNi 18 9	X 5 CrNi 18 10
1.4306	X 2 CrNi 18 9	X 2 CrNi 19 11
1.4311	X 2 CrNiN 18 10	X 2 CrNiN 18 10
1.4401	X 5 CrNiMo 18 10	X 5 CrNiMo 17 12 2
1.4404	X 2 CrNiMo 18 10	X 2 CrNiMo 17 13 2
1.4429	X 2 CrNiMoN 18 13	X 2 CrNiMoN 17 13 3
1.4435	X 2 CrNiMo 18 12	X 2 CrNiMo 18 14 3
1.4436	X 5 CrNiMo 18 12	X 5 CrNiMo 17 13 3
1.4439 [1]	X 3 CrNiMoN 17 13 5 [1]	X 2 CrNiMoN 17 13 5
1.4510	X 8 CrTi 17	X 6 CrTi 17
1.4512 [1]	X 5 CrTi 12 [1]	X 6 CrTi 12
1.4541	X 10 CrNiTi 18 9	X 6 CrNiTi 18 10
1.4550	X 10 CrNiNb 18 9	X 6 CrNiNb 18 10
1.4571	X 10 CrNiMoTi 18 10	X 6 CrNiMoTi 17 12 2

[1] Not included in DIN 17 440, December 1972 edition.

International Patent Classification

F 16 L 9/16
B 21 C 37/08
E 03 F 3/04
C 22 C 38/40
G 01 M 3/00
G 01 M 19/00

*) Symbol as specified in DIN 17 440, July 1985 edition.