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Seamless circular fine grain steel tubes subject to special requirements

Technical delivery conditions

DIN 17179

Nahtlose kreisförmige Rohre aus Feinkornbaustählen für besondere Anforderungen; technische Lieferbedingungen

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 seamless circular tubes subject to special requirements and made from the fine grain structural steels listed in table 1. These tubes are predominantly used in the construction of pressure vessels, chemical plant, pipework and for general mechanical engineering purposes. They are designed for operating temperatures not exceeding 400 °C and, in the as delivered condition (see subclause 5.2), normally exhibit a minimum yield strength of between 255 and 460 N/mm², as given for the lowest wall thickness range in table 3.

If tubes made from the steel grades complying with this standard are intended for use in plant subject to regular inspection, the specifications in the relevant codes of practice shall be taken into consideration, e.g. the *Technische Regeln Druckbehälter* (Technical rules on pressure vessels), *Technische Regeln für Dampfkessel* (Technical rules on steam boilers), *Merkblätter der Arbeitsgemeinschaft Druckbehälter (AD-Merkblätter)* (Instruction sheets of the Pressure Vessels Study Group), *Technische Regeln für brennbare Flüssigkeiten* (Technical rules on combustible liquids), *Technische Regeln Druckgase* (Technical rules on compressed gases), *Technische Regeln für Gashochdruckleitungen* (Technical rules on high pressure gas pipelines). The same applies for tubes used in other fields of application for which additional specifications exist.

1.2 This standard does not apply to

- seamless circular fine grain structural steel tubes for structural steelwork as specified in DIN 17124;
- steel tubes for pipelines conveying combustible liquids and gases as specified in DIN 17172;
- seamless heat resistant steel tubes as specified in DIN 17175;
- seamless precision steel tubes as specified in DIN 2391 Part 2.

2 Concept

For the purposes of this standard, fine grain structural steels are steels with a minimum yield strength between 255 and 460 N/mm², whose chemical composition is selected so as to ensure weldability, this being a function of the minimum yield strength. The steels are fully killed and contain elements forming precipitations, e.g. nitrides and/or carbonitrides. These prevent the growth of crystal grains in the austenite region and lead to a fine grain in the as delivered condition (ferrite grain size 6 and finer when tested as described in DIN 50601). Thus, the steels of this type are highly resistant to brittle fracture.

3 Classification into grades

3.1 This standard comprises four series of steel grades as listed in table 1:

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a) the basic (StE . . .) series;

b) the high temperature (WStE . . .) series including grades which are to have a 0,2 % proof stress at elevated temperatures (see table 4);

c) the low temperature (TStE . . .) series including grades which are to have a minimum impact energy down to temperatures of −50 °C (see table 5);

d) the special low temperature (EStE . . .) series including grades which are to have a minimum impact energy down to temperatures of −60 °C (see table 5).

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

3.2 ●● It may be agreed at the time of ordering that the minimum elevated temperature 0,2 % proof stress values given in table 4 for the steels of the high temperature series shall also apply for the steels of the low temperature and special low temperature series.

4 Designation and ordering

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

- the name of product (tube);
- the DIN number of the dimensional standard (e.g. DIN 2448);
- characteristic dimensions of the tube (outside diameter × wall thickness);
- the DIN number of the present standard (DIN 17179);
- the symbol or material number identifying the steel grade (see table 1).

Example: A seamless tube conforming to this standard, with an outside diameter of 114,3 mm and a wall thickness of 3,6 mm as specified in DIN 2448, made from steel WStE 460 (material number 1.8935) shall be designated

Tube DIN 2448 − 114,3 × 3,6 − DIN 17179 − WStE 460

or

Tube DIN 2448 − 114,3 × 3,6 − DIN 17179 − 1.8935

4.2 ● In addition to the standard designation as specified in subclause 4.1, the order shall always give the quantity required (e.g. total length to be supplied), the type of length (see table 6), the length of the individual tube in the case of specified lengths and exact lengths, the type of materials testing certificate as specified in DIN 50049 or any additional technical rule or code of practice.

Example of an order:

1000 m tube DIN 2448 − 114,3 × 3,6 − DIN 17179 − WStE 460,

in specified lengths of 8 m, certificate DIN 50049 − 3.1 B

4.3 ●● In addition, further details such as are specified in the subclauses marked with two dots may be agreed at the time of ordering.

5 Requirements

5.1 Manufacturing process

5.1.1 The steels shall be produced either by the basic oxygen process, the open hearth process or in the electric furnace.

5.1.1.1 ●● Subject to agreement with the purchaser, an alternative equivalent process may also be used.

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

5.1.2 The steels shall be fully killed, shall have sufficient elements for nitrogen control and shall be fine grained (see clause 2).

5.1.3 ●● Unless otherwise agreed at the time of ordering, the process used to manufacture the tubes is left to the manufacturer's discretion.

The tubes shall be manufactured by hot or cold rolling, hot pressing, hot or cold drawing.

5.1.4 The manufacturer shall, once only, provide proof of compliance with the requirements specified in this standard.

5.2 As delivered condition

5.2.1 The tubes shall be supplied in the normalized condition.

Normalizing of the tubes may be dispensed with if in the case of steel grades having a minimum yield strength not exceeding 355 N/mm^2, the final forming operation in tube production is normalizing forming, ensuring a condition equivalent to normalizing (see *Stahl-Eisen-Werkstoffblatt* (Iron and steel materials sheet) 082).

5.2.2 In the case of tubes with a small wall thickness and made from steel grades having a minimum yield strength not less than 420 N/mm^2, a delayed cooling or additional tempering may be needed.

5.2.2.1 ●● In the case of tubes with a wall thickness exceeding 50 mm or if the wall thickness/diameter ratio of the tubes exceeds 0,15, an accelerated cooling after normalizing of liquid quenching and tempering may be the subject of a particular agreement between manufacturer and purchaser.

5.2.3 ●● If the surface of the tubes is to be provided with an anti-corrosive agent with a limited life, this shall be agreed at the time of ordering.

5.2.4 ●● If special requirements are made on the tubes with regard to further processing (e.g. galvanizing), this shall be agreed at the time of ordering.

5.3 Chemical composition

5.3.1 Chemical composition as determined by the cast analysis

The chemical composition of the steels as determined by the cast analysis [1]) is given in table 1.

The table specifies the permissible contents of the individual alloying elements. The manufacturer shall inform the purchaser on the types of alloying element used and on the associated percentages, for the steel grade supplied.

5.3.2 ●● Chemical composition as determined by the product analysis

If checking of the chemical composition on the product has been agreed at the time of ordering, the results of the product analysis shall be allowed to deviate, by the amounts stated in table 2, from the limit values for the cast analysis to be notified by the manufacturer.

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

Table 1. **Chemical composition as determined by the cast analysis**

Steel grade		% by mass														
Symbol	Material number	C ≤	Si	Mn	P ≤	S ≤	N ≤	Al_{tot} [1] ≥	Cr ≤	Cu ≤	Mo ≤	Ni ≤	Nb ≤	Ti ≤	V ≤	Nb + Ti + V ≤
StE 255	1.0461	0,18	≤ 0,40	0,50 to 1,30	0,035	0,030	0,020	0,020	0,30 [2]	0,20 [2]	0,08 [2]	0,30	0,03	–	–	0,05
WStE 255	1.0462	0,18			0,035	0,030										
TStE 255	1.0463	0,16			0,030	0,025										
EStE 255	1.1103	0,16			0,025	0,015										
StE 285	1.0486	0,18		0,60 to 1,40	0,035	0,030										
WStE 285	1.0487	0,18			0,035	0,030										
TStE 285	1.0488	0,16			0,030	0,025										
EStE 285	1.1104	0,16			0,025	0,015										
StE 355	1.0562	0,20	0,10 to 0,50	0,90 to 1,65	0,035	0,030						0,30 [4]			0,10	0,12
WStE 355	1.0565	0,20			0,035	0,030										
TStE 355	1.0566	0,18			0,030	0,025										
EStE 355	1.1106	0,18			0,025	0,015										
StE 420	1.8902	0,20	0,10 to 0,60	1,00 to 1,70	0,035	0,030			0,30	0,20 [3]	0,10	1,00	0,05	– [5]	0,20	0,22
WStE 420	1.8932				0,035	0,030										
TStE 420	1.8912				0,030	0,025										
EStE 420	1.8913				0,025	0,015										
StE 460	1.8905				0,035	0,030										
WStE 460	1.8935				0,035	0,030										
TStE 460	1.8915				0,030	0,025										
EStE 460	1.8918				0,025	0,015										

[1] If nitrogen is additionally controlled by niobium, titanium or vanadium, the requirement for a minimum aluminium content need not be complied with.

[2] The sum of the contents by mass of chromium, copper and molybdenum shall not exceed 0,45 %.

[3] If copper is added as an alloying element, the maximum content by mass may be 0,70 %.

[4] If nickel is added as an alloying element, the maximum content by mass may be 0,85 %.

[5] If titanium is added as an alloying element, the maximum content by mass may be 0,20 %.

5.4 Mechanical properties

5.4.1 The values of yield stress, tensile strength, elongation after fracture and impact energy given in tables 3,4 and 5 for tubes with a wall thickness not exceeding 40 mm are based on the test conditions given in clause 6 and shall apply for the as delivered condition as specified in subclauses 5.2.1 and 5.2.2.

5.4.2 ●● If tubes are subjected to stresses vertical to their axis, which will normally occur in the case of wall thicknesses equal to or exceeding 20 mm, minimum values of reduction in area after fracture as laid down in *Stahl-Eisen-Lieferbedingungen* (Iron and steel delivery conditions) 096 may be agreed at the time of ordering.

5.4.3 The minimum values of elevated temperature 0,2 % proof stress as given in table 4 shall apply for tubes made from the steel grades of the high temperature series and also for those of the low temperature series if this has been agreed at the time of ordering.

5.4.4 For characterizing the susceptibility to brittle fracture, table 5 gives minimum values of impact energy determined on ISO (V-notch)standard test pieces taken at different test temperatures and in different directions.

In the case of tubes with outside diameters not exceeding 500 mm, the values specified in table 5 shall apply for test pieces taken in the longitudinal direction. In the case of tubes with outside diameters exceeding 500 mm, the values specified shall apply for test pieces taken transverse to the tube axis.

5.4.4.1 ●● Subject to agreement at the time of ordering, for tubes with outside diameters not exceeding 500 mm, the values specified in table 5 shall also apply for test pieces taken transverse to the tube axis provided that the tube dimensions permit ISO standard test pieces to be taken as described in DIN 50115 without straightening of the tube.

5.4.5 Tubes made from the steel grades specified in this standard are cold and hot workable (see *Stahl-Eisen-Werkstoffblatt* 088). They shall fulfil the requirements to be tested as described in subclause 6.5.3.

5.5 Weldability

Tubes made from the steel grades complying with this standard are weldable, if the generally recognized rules of the art (see *Stahl-Eisen-Werkstoffblatt* 088) are observed.

5.6 Heat treatment and further processing

5.6.1 The temperatures for normalizing the steel grades are a function of their chemical composition.

Although the normalizing temperature may not differ from one works to the next for one and the same steel grade (see subclause 5.3.1), it shall generally be between 880 and 960 °C.

Table 2. **Amounts by which the chemical composition as determined by the product analysis may deviate from the limit values to be stated by the manufacturer for the cast analysis (see subclause 5.3.2)**

Element	Limit values specified for the cast analysis as in table 1 % by mass	Permissible deviations of results of product analysis from the limit values as determined by the cast analysis [1] % by mass
C	≤ 0,20	0,02
Si	≤ 0,60	0,05
Mn	≤ 1,00 > 1,00 ≤ 1,70	0,06 0,10
P	≤ 0,035	0,005
S	≤ 0,030	0,005
Cr	≤ 0,30	0,04
Cu	≤ 0,70	0,07
Mo	≤ 0,10	0,03
Ni	≤ 1,00	0,05
Nb	≤ 0,05	0,01
Ti	≤ 0,20	0,02
V	≤ 0,20	0,02
N	≤ 0,020	0,002

[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.

5.6.2 Stress relieving shall be performed at temperatures between 530 and 580 °C, with cooling in still air. The holding period (as specified in DIN 17014 Part 1) shall not exceed 150 minutes. Where the holding period exceeds 90 minutes, the lower limit of the temperature range shall be aimed at.

5.6.3 In the event of further processing of the steels complying with this standard, the data specified in *Stahl-Eisen-Werkstoffblatt* 088 and in the certificate (see subclause 5.1.4) shall be observed.

5.7 Appearance of surface

5.7.1 Tubes shall have a smooth internal and external surface consistent with the manufacturing process.

5.7.2 Slight irregularities in the surface such as raised or depressed areas or shallow grooves resulting from the manufacturing process are permitted provided that the remaining wall thickness continues to meet the requirements specified in subclause 5.10.2.2, and the function of the tube is not impaired (see subclause 8.1).

Table 3. **Mechanical properties of tubes with a wall thickness not exceeding 65 mm [1]**

Steel grade								Mechanical properties									
Basic series		High temperature series		Low temperature series		Special low temperature series		Minimum upper yield stress, R_{eH} [2] for wall thicknesses, in mm, of						Tensile strength, R_m	Minimum elongation after fracture, A_5, when testing test pieces taken	
Symbol	Material number	Symbol	Material number	Symbol	Material number	Symbol	Material number	up to 12	over 12 up to 20	over 20 up to 40	over 40 up to 50	over 50 up to 65		N/mm²	parallel	transverse
								N/mm²							%	
StE 255	1.0461	WStE 255	1.0462	TStE 255	1.0463	EStE 255	1.1103	255		245	235	225		360 to 480 [3]	25	23
StE 285	1.0486	WStE 285	1.0487	TStE 285	1.0488	EStE 285	1.1104	285		275	265	255		390 to 510 [3]	24	22
StE 355	1.0562	WStE 355	1.0565	TStE 355	1.0566	EStE 355	1.1106	355		345	335	325		490 to 630 [3]	22	20
StE 420	1.8902	WStE 420	1.8932	TStE 420	1.8912	EStE 420	1.8913	420	410	400	385	375		530 to 680	21	19
StE 460	1.8905	WStE 460	1.8935	TStE 460	1.8915	EStE 460	1.8918	460	450	440	425	410		560 to 730	19	17

[1] ● For wall thicknesses exceeding 65 mm, the values shall be agreed at the time of ordering.
[2] If the yield stress cannot be easily recognized, the values shall apply for the 0,2 % proof stress.
[3] No objections shall be made if the upper limit is exceeded by up to 20 N/mm².

Table 4. **Values of elevated temperature 0,2 % proof stress** [1]

Steel grade		Wall thickness, in mm	Minimum values of 0,2 % proof stress at a test temperature of						
Symbol	Material number		100 °C	150 °C	200 °C	250 °C	300 °C	350 °C	400 °C
			N/mm²						
WStE 255	**1.0462**	Up to 20	226	206	186	167	137	118	108
		Over 20 up to 50	216	196					
		Over 50 up to 65	206	186	177	157	127	108	98
WStE 285	**1.0487**	Up to 20	255	235	206	186	157	137	118
		Over 20 up to 50	245	226					
		Over 50 up to 65	235	216	196	177	147	127	108
WStE 355	**1.0565**	Up to 20	304	284	255	235	216	196	167
		Over 20 up to 50	294	275					
		Over 50 up to 65	284	265	245	226	206	186	157
WStE 420	**1.8932**	Up to 12	363	343	314	284	265	235	206
		Over 12 up to 20	353	333					
		Over 20 up to 50	343	324	304	275	255	226	196
		Over 50 up to 65	333	314	294	265	245	216	186
WStE 460	**1.8935**	Up to 12	402	373	343	314	294	265	235
		Over 12 up to 20	392	363					
		Over 20 up to 50	382	353	333	304	284	255	226
		Over 50 up to 65	373	343	324	294	275	245	216

[1] ● In the case of wall thicknesses exceeding 65 mm, the values shall be agreed at the time of ordering.

Table 5. **Impact energy requirements to be met by impact tests on ISO standard test pieces**

Steel grades as in tables 1 and 3	Direction of sampling [1]	Minimum values of impact energy, A_V, for wall thicknesses, s, from 10 to 65 mm [1] [2] at a test temperature, in °C, of								
		−60	−50	−40	−30	−20	−10	0	+10	+20
		J								
Basic series and high temperature series	Longitudinal	–	–	–	–	39	43	47	51	55
	Transverse	–	–	–	–	21	24	31	31	31
Low temperature series	Longitudinal	–	27	31	39	47	51	55	59	63
	Transverse	–	16	20	24	27	31	31	35	39
Special low temperature series	Longitudinal	25	30	40	50	65	80	90	95	100
	Transverse	20 [3]	27 [3]	30 [3]	35 [3]	45 [3]	60 [3]	70 [3]	75 [3]	80 [3]

[1] See also subclauses 5.4.4 and 6.5.2.

[2] ● In the case of wall thicknesses exceeding 65 mm, the values shall be agreed at the time of ordering.

[3] This value shall apply for wall thicknesses not exceeding 40 mm. In the case of larger wall thicknesses, the values shall be agreed at the time of ordering.

5.7.3 Proper removal of shallow surface defects using appropriate means is permitted provided that the remaining wall thickness continues to meet the requirements specified in subclause 5.10.2.2. Stopping of surface defects is not permitted.

5.8 Soundness

The tubes shall be sound when tested as specified in subclause 6.3.7.1.

5.9 ●● Non-destructive testing

Subject to agreement at the time of ordering, the tubes may be subjected to non-destructive testing as specified in subclause 6.5.7.2. The requirements given in *Stahl-Eisen-Prüfblatt* 1915 are to be met in this test.

5.10 Dimensions, masses per unit length and permissible deviations

5.10.1 Dimensions

5.10.1.1 DIN 2448 shall apply for the outside diameter and wall thickness of tubes.

5.10.1.2 Table 6 shall apply for the types of tube length.

Table 6. **Types of tube length and permissible deviations in length**

Type of length		Permissible deviations in length, in mm, for outside diameters	
		up to 500	over 500
Manufacturing length [1]		[1]	[1]
Specified length		± 500	± 500
Exact length up to 6 m		+10 0	+25 0
	over 6 up to 12 m	+15 0	+50 0
	over 12 m	By agreement.	

[1] The tubes are supplied in the manufacturing lengths occurring in production.
● These lengths are a function of the tube outside diameter, wall thickness and manufacturer's works and shall be agreed at the time of ordering.

5.10.2 Permissible dimensional deviations

5.10.2.1 The information given in table 7 (see subclause 6.5.9) shall apply for the permissible deviations in outside diameter, d_a.

Table 7. **Permissible deviations in outside diameter**

Outside diameter, d_a, in mm	Permissible deviation in diameter of tube barrel and at tube ends	●● At tube ends, subject to particular agreement [1]
$d_a \leq 100$	$\pm 1\% \cdot d_a$ (values up to ± 5 mm are permitted in all cases)	± 0,4 mm
$100 < d_a \leq 200$	$\pm 1\% \cdot d_a$	$\pm 0{,}5\% \cdot d_a$
$200 < d_a$	$\pm 1\% \cdot d_a$ [2]	$\pm 0{,}6\% \cdot d_a$

[1] This covers a zone of about 100 mm from the tube ends.
[2] ●● Subject to agreement at the time of ordering, the permissible deviation may also be specified as a function of the inside diameter, in which case the permissible deviation in wall thickness is to be taken into account.

5.10.2.1.1 ●● For the tube ends, the lower permissible deviations in diameter given in table 7 may also be agreed.

5.10.2.2 The permissible deviations in wall thickness are given in table 8.

5.10.2.3 ●● In special cases, by agreement at the time of ordering, tubes may be supplied in accordance with these technical delivery conditions with the permissible deviations in outside diameter and wall thickness as specified in DIN 2391 Part 1.

5.10.2.4 ●● By agreement, the order may also specify the inside diameter (see table 7).

5.10.2.5 The permissible deviations in length are given in table 6.

5.10.3 Permissible deviations of form

5.10.3.1 Circularity

Tubes shall be as circular as possible. The out-of-roundness shall be within the permissible deviations specified for the outside diameter.

Table 8. **Permissible deviations in wall thickness**

Permissible deviations in wall thickness for an outside diameter, d_a, and wall thickness, s								
not exceeding 130 mm *)			above 130 up to and including 320 mm			above 320 up to and including 660 mm		
$\leq 2 \cdot s_n$	$2 \cdot s_n < s \leq 4 \cdot s_n$	$> 4 \cdot s_n$	$\leq 0{,}05\, d_a$	$0{,}05\, d_a < s \leq 0{,}11\, d_a$	$> 0{,}11\, d_a$	$\leq 0{,}05\, d_a$	$0{,}05\, d_a < s \leq 0{,}09\, d_a$	$> 0{,}09\, d_a$
+15% −10%	+12,5% −10,0%	± 9%	+17,5% −12,5%	± 12,5%	± 10%	+22,5% −12,5%	+15 % −12,5%	+12,5% −10,0%

*) s_n is the wall thickness as specified in DIN 2448.

5.10.3.2 Straightness

5.10.3.2.1 Tubes shall be straight to the eye.

5.10.3.2.2 ●● Particular requirements regarding straightness may be agreed.

5.10.4 Finish of tube ends

5.10.4.1 Tube ends shall be cut perpendicular to the tube axis and shall be free from burr.

5.10.4.2 ●● Subject to agreement, tubes with s not smaller than 3,2 mm may be supplied with end faces prepared for butt welding and exhibiting the following finish:

- the bevel of groove flank shall be $30°^{+5°}_{0}$,
- the thickness of the root face shall be $(1,6 \pm 0,8)$ mm.

Other types of edge preparation are subject to particular agreement.

5.10.5 Masses per unit length

The masses per unit length shall comply with the values specified in DIN 2448. For tubes in non-standard sizes, the mass per unit length shall be calculated taking the density as 7,85 kg/dm^3 for all steel grades.

6 Testing and materials testing certificates

6.1 General

Tubes complying with this standard may be supplied with one of the following materials testing certificates as specified in DIN 50049:

- certificate DIN 50049 – 3.1A (inspection certificate A);
- certificate DIN 50049 – 3.1B (inspection certificate B);
- certificate DIN 50049 – 3.1C (inspection certificate C).

● The type of certificate required and the test house where acceptance inspection is to be carried out by a third party shall be stated at the time of ordering.

6.2 Test site

The tubes shall be tested at the manufacturer's works. Production at the manufacturer's works 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

Table 9 shows a summary of the scope of test programme in each case.

6.3.1 The tubes shall be inspected by batches.

For the purposes of testing, the tubes shall be divided by steel grade and, if possible, also by casts, dimensions and heat treatment units as a function of the outside diameter, d_a, into batches each comprising the following numbers of tubes:

for $d_a \leq 500$ mm, 100 tubes;
for $d_a > 500$ mm, 50 tubes.

Remainders of up to 50 % of a batch may be distributed uniformly across the other batches. Numbers of tubes and remainders amounting to more than 50 % and consignments of more than 10, but not more than 50 tubes count as one complete batch.

6.3.2 Two sample tubes shall be taken at the inspector's discretion from each of the two first batches (see subclause 6.3.1) and one sample tube from each further batch for the purposes of testing as specified in subclauses 6.4.1 and 6.4.2 (tensile test and impact test); sampling shall ensure that every cast is represented.

6.3.3 One sample tube shall be taken where consignments are 10 tubes or less.

6.3.4 The following tests shall be carried out on the sample tubes as specified in subclauses 6.3.2 and 6.3.3:

- tensile test;
- impact test (3 test pieces) in the case of wall thicknesses not smaller than 5 mm;
- flattening test for tubes with a wall thickness not exceeding 40 mm;
- non-destructive testing of the tube ends over a length of 25 mm as described in *Stahl-Eisen-Prüfblatt* 1916, on tubes with a wall thickness exceeding 40 mm.

6.3.5 ●● If it has been agreed at the time of ordering to check the chemical composition (product analysis), this analysis shall be carried out on one tube per cast.

6.3.6 ●● If it has been agreed at the time of ordering to verify the elevated temperature 0,2 % proof stress, this analysis shall be carried out on one tube per cast.

6.3.7 Furthermore,

6.3.7.1 all tubes shall be tested at the manufacturer's works for soundness, normally by means of a hydraulic test (see subclause 6.5.5). If, under the test conditions specified in subclause 6.5.5 (test pressure: 80 bar), a load limit of $0,7 \times R_{eH}$ (equivalent to a safety factor of about 1,5 against the yield stress) is not exceeded, then, at the manufacturer's discretion, instead of the hydraulic test a suitable non-destructive test method (an eddy current test as specified in *Stahl-Eisen-Prüfblatt* 1925, for example) may be used for testing the soundness.

6.3.7.2 all tubes shall be inspected inside and outside for their surface appearance;

6.3.7.3 all tubes shall be inspected for their accuracy to size and permissible deviations as specified in subclause 5.10.

6.4 Sampling and sample preparation

See figure 1 for the sampling points and the location of test pieces.

6.4.1 Tensile test

6.4.1.1 For the tensile test, one strip test piece (see DIN 50140) shall be taken from the sample tube, longitudinal to the tube axis. The test piece shall not be heat treated and not straightened within the gauge length.

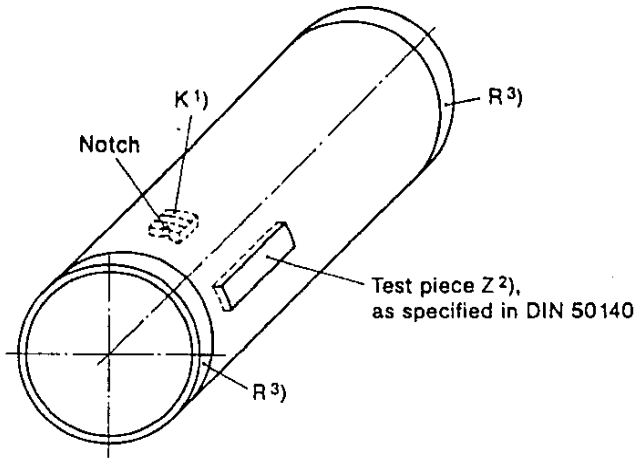
At the manufacturer's discretion, tubes may also be subjected to the tensile test in full (see DIN 50140).

In the case of wall thicknesses greater than 30 mm, at the manufacturer's discretion, circular test pieces as described in DIN 50125 may be taken longitudinal to the tube axis, at a distance of one quarter of the wall thickness from the outside surface or as close as possible to this point.

6.4.1.2 In the case of tubes with outside diameters not smaller than 200 mm, round or flat test pieces may be taken transverse to the tube axis (see DIN 50125), provided that the tube dimensions permit this procedure for an unstraightened tube. These test pieces shall be worked on all sides.

6.4.1.3 Normally, short proportional test pieces shall be taken for the tensile test. If the test pieces are not worked on all sides it is permitted to remove local irregularities, the rolling skin shall however be retained at the thinnest spots.

6.4.1.4 ●● If minimum values of reduction in area after fracture have been agreed at the time of ordering, testing shall be carried out on the basis of *Stahl-Eisen-Lieferbedingungen* 096, the scope of test programme being the subject of a particular agreement.



1) To be taken transverse to the tube axis in the case of wall thicknesses not less than 5 mm if the tube dimensions permit sampling without straightening of the tube. Otherwise, they shall be taken longitudinal to the tube axis (see also subclause 6.4.2).

2) See also subclauses 6.4.1.1 and 6.4.1.2.

3) For wall thicknesses not exceeding 40 mm.

Figure 1. Sampling points and test piece location in the illustration,
K = set of 3 standard test pieces each, as specified in DIN 50115;
R = flattening test piece as specified in DIN 50136;
Z = tensile test piece (see subclause 6.4.1).

6.4.2 Impact test

For the purposes of the impact test, a set of three ISO standard test pieces shall be taken from the sample tube as follows:

- in the case of tubes with outside diameter not exceeding 500 mm, longitudinal to the tube axis;
- in the case of tubes with outside diameter exceeding 500 mm, transverse to the tube axis, if the tube dimensions permit this without straightening of the tube;
- ●● in the case of tubes with outside diameter not exceeding 500 mm, transverse to the tube axis, if this has been agreed at the time of ordering (see subclause 5.4.4.1) and the tube dimensions permit standard test pieces to be taken.

In the case of tubes the wall thickness of which exceeds 30 mm, the centre line of the test pieces shall have a distance from the external surface equal to one quarter of the wall thickness or shall be positioned as close as possible to this location.

The test pieces shall be taken and prepared in such a way that the axis of the notch is perpendicular to the tube surface.

If the wall thickness is inadequate for the manufacture of ISO standard test pieces, test pieces shall be taken whose width measured in the direction of the notch axis is equal to the wall thickness, but whose other dimensions correspond to those of ISO standard test pieces, in the case of wall thicknesses from 5 mm to 10 mm (see subclause 6.5.2). In this case, the values otherwise required decrease in direct proportion to the test piece cross section.

6.4.3 Flattening test

For the flattening test, one test piece shall be taken from each end of the sample tube. The relevant specifications given in DIN 50136 shall be observed for sampling.

6.4.4 Chemical composition

For checking the chemical composition by a product analysis on the finished tube, sample chips shall be taken at points uniformly distributed over the entire wall thickness of the product; a similar procedure shall be used for spectral analyses. As a general rule, *Stahl-Eisen-Prüfblatt* 1805 shall apply for sampling.

6.5 Test procedure

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

If verification of the elevated temperature 0,2 % proof stress has been agreed, this shall be determined as specified in DIN 50145 at one of the test temperatures given in table 4.

6.5.1.1 ●● The test temperature may be specified at the time of ordering; if no test temperature has been specified, the test shall be carried out at 300 °C.

6.5.2 The impact test shall be carried out as specified in DIN 50115 on three test pieces each. The specified minimum values shall apply for the mean obtained from three test pieces; only one individual value may be lower than this specified minimum value, yet by not more than 30 %.

Where the width of test pieces is not equal to 10 mm (see subclause 6.4.2), the impact energy measured, $A_{v,p}$, shall be stated along with the test piece cross-sectional area. It can

be converted to the impact energy, A_v, in J, using the following formula:

$$A_v = \frac{8 \times 10 \times A_{v,p}}{S_p} \quad (1)$$

where

S_p is the cross-sectional area of the test piece under the notch.

6.5.2.1 Testing shall be carried out at −20 °C for the basic series, at −50 °C for the high temperature series and at −60 °C for the special low temperature series, on test pieces taken as specified in subclause 6.4.2.

6.5.2.2 ●● Any other test temperature shall be agreed at the time of ordering.

6.5.3 The flattening test shall be carried out as specified in DIN 50136, even in cases where the outside diameter exceeds 400 mm. The test pieces or tube ends shall be flattened until a specified distance between platens, H, is reached.

The following formula shall be used for calculating H, in mm:

$$H = \frac{(1 + c) \cdot s}{c + s/d_a} \quad (2)$$

where

s is the wall thickness, in mm;

d_a is the outside diameter, in mm;

c is a constant having the following value:
0,07 for all steel grades with a minimum yield strength up to and including 355 N/mm²;
0,05 for steel grades with a minimum yield strength exceeding 355 N/mm².

If the ratio s/d_a exceeds a value of 0,15, c shall be reduced by 0,01 for the steel grades concerned.

6.5.4 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).

6.5.5 In the hydraulic test (see also subclause 6.3.7.1) as specified in DIN 50104, the test pressure shall be 80 bar.

6.5.5.1 ●● A higher test pressure may be agreed.

6.5.5.2 In no case, however, shall the safety margin with respect to the yield stress be lower than 1,1 (DIN 2413, June 1972 edition, subclause 4.6, $Y' = 0{,}9$ shall be complied with). Where appropriate, this shall also apply in the case of thin-walled tubes with large outside diameters, even at 80 bar.

6.5.5.3 The test pressure shall be maintained for at least five seconds.

6.5.6 The appearance of the tubes shall be examined visually under appropriate lighting conditions by an inspector having normal vision.

Note. Subject to agreement between manufacturer and purchaser, any other suitable method of test may be used instead of the visual examination.

6.5.7 Non-destructive testing

6.5.7.1 The test conditions given in *Stahl-Eisen-Prüfblatt* 1916 shall apply for non-destructive testing as specified in subclause 6.3.4.

6.5.7.2 If non-destructive testing as specified in subclause 5.9 has been agreed, the test conditions given in *Stahl-Eisen-Prüfblatt* 1915 shall apply.

6.5.8 The wall thicknesses shall be measured at the ends of the tube using suitable measuring instruments.

6.5.9 The outside diameter shall be measured using suitable measuring instruments, as a two-point measurement.

6.6 Retests

6.6.1 Tubes not satisfying the requirements when tested as specified in subclauses 6.5.5 to 6.5.9 (soundness test, visual examination, non-destructive testing, check on dimensions) shall be rejected.

The manufacturer's works shall have the right to take suitable measures to remedy defects or to correct deviations found in these tests and to present these tubes for renewed acceptance inspection.

6.6.2 If one of the sample tubes fails the acceptance inspection including tensile test, impact test and flattening test specified in subclauses 6.5.1 to 6.5.3, the manufacturer is justified in repeating the test giving unsatisfactory results on the same tube with twice the number of test pieces. All 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 tests specified in subclauses 6.5.1 to 6.5.3. If one of the requirements is still not fulfilled, the entire batch shall be considered not to comply with the standard. However, testing of tubes individually may be agreed between the parties concerned.

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.

6.6.3 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 Materials testing certificates

6.7.1 Depending on the agreement made at the time of ordering (see subclause 6.1), either certificate

DIN 50049 – 3.1A (inspection certificate A),
DIN 50049 – 3.1B (inspection certificate B), or
DIN 50049 – 3.1C (inspection certificate C)

shall be issued for tubes complying with this standard. The type and scope of the tests, the responsibility for carrying out the tests and the type of certificate covering the tests are shown in table 9.

In each case, the technical rule agreed at the time of ordering shall be specified.

6.7.2 The certificates shall state the marking of the tubes as specified in clause 7, the as delivered condition as specified in subclause 5.2 and, subject to agreement, the steelmaking process.

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 symbol;
- symbol identifying the steel grade;
- an appended symbol S indicating that the tube is of the seamless type;
- inspector's mark;

Table 9. **Summary of the scope of test programme and materials testing certificates**
(see figure 1 for sampling points and location of test pieces; see subclause 6.3.1 for batch size)

Testing			Scope of test programme	Responsibility for carrying out the tests	Type of materials testing certificate as specified in DIN 50049
No.	Type of test	As in subclause			
1	Cast analysis	5.3.1	All characterizing elements per cast or casting unit.	Manufacturer	DIN 50049 – 2.2 [1]
2	Tensile test	6.4.1 6.5.1	On two sample tubes from the two first batches, from each further batch or from consignments of not more than 10 tubes, one test piece from each sample tube.	By agreement.	DIN 50049 – 3.1 A or DIN 50049 – 3.1 B or DIN 50049 – 3.1 C
3	Impact test	6.4.2 6.5.2	At one end of sample tube specified above (No. 2) for wall thicknesses not less than 5 mm, one set of 3 test pieces.	By agreement.	DIN 50049 – 3.1 A or DIN 50049 – 3.1 B or DIN 50049 – 3.1 C
4	Flattening test	6.4.3 6.5.3	At each end of sample tube specified above (No. 2) for wall thicknesses not exceeding 40 mm, 1 test piece.	By agreement.	DIN 50049 – 3.1 A or DIN 50049 – 3.1 B or DIN 50049 – 3.1 C
5	Non-destructive testing of tube ends	6.3.4 6.5.7.1	At tube ends over a length of 25 mm of sample tube specified above (No. 2) for wall thicknesses exceeding 40 mm.	Manufacturer	DIN 50049 – 2.1 [1]
6	Non-destructive testing of tubes [2]	5.9 6.5.7.2	All tubes.	By agreement.	DIN 50049 – 3.1 B
7	Soundness test	6.3.7.1 6.5.5	All tubes.	Manufacturer	DIN 50049 – 2.1 [1]
8	Surface inspection	6.5.6	All tubes.	By agreement.	DIN 50049 – 3.1 A or DIN 50049 – 3.1 B or DIN 50049 – 3.1 C
9	Check on dimensions	6.5.8 6.5.9	All tubes.	By agreement.	DIN 50049 – 3.1 A or DIN 50049 – 3.1 B or DIN 50049 – 3.1 C
10	Product analysis [3]	6.4.4 6.5.4	By agreement.	Manufacturer	DIN 50049 – 3.1 B
11	Reduction in area after fracture [4]	6.4.1.4	By agreement.	Manufacturer	DIN 50049 – 3.1 B

[1] This certificate may also be included in the next higher stage of document.

[2] Non-destructive testing of the tubes is only to be carried out subject to agreement between the manufacturer and purchaser.

[3] The product analysis is only to be carried out subject to agreement between the manufacturer and purchaser.

[4] This property is to be tested only subject to agreement between the manufacturer and purchaser on test pieces taken transverse to the tube axis.

- cast number or identification of the cast;
- tube number for tubes with outside diameter not less than 159 mm;
- mark indicating that a non-destructive test has been carried out, if testing has been agreed in accordance with subclause 5.9.

7.2 Marking shall generally be applied by stamping. A different marking method (e.g. labelling the bundle of tubes) is also permitted for tubes with a small outside diameter and/or a small wall thickness.

8 Complaints

8.1 Under current law, a complaint may only be raised against defective tubes if the defects noticeably impair their processing and use. 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 2391 Part 1 Seamless precision steel tubes; dimensions

DIN 2391 Part 2 Seamless precision steel tubes; technical delivery conditions

DIN 2413 Steel pipes; calculation of wall thickness as a function of the internal pressure

DIN 2448 Seamless steel tubes; dimensions, masses per unit length

DIN 17014 Part 1 Heat treatment of ferrous materials; terminology

DIN 17124 Seamless circular fine grain steel tubes for structural steelwork; technical delivery conditions

DIN 17172 Steel pipes for long-distance pipelines for combustible liquids and gases; technical delivery conditions

DIN 17175 Seamless heat resistant steel tubes; technical delivery conditions

DIN 50049 Materials testing certificates

DIN 50104 Internal pressure test on hollow products; soundness test up to a defined internal pressure; general specifications

DIN 50115 Testing of metallic materials; impact test

DIN 50125 Testing of metallic materials; tensile test pieces; preparation

DIN 50136 Testing of metallic materials; flattening test on tubes

DIN 50140 Testing of metallic materials; tensile test on tubes and strips from tubes

DIN 50145 Testing of metallic materials; tensile test

DIN 50601 Metallographic examination; determination of the ferritic or austenitic grain size of steel and ferrous materials

Stahl-Eisen-Werkstoffblatt 082[2]) *Begriffsbestimmung zur thermo-mechanischen Behandlung von Stahl* (Terminology associated with the thermo-mechanical treatment of steel)

Stahl-Eisen-Werkstoffblatt 088[2]) *Schweißgeeignete Feinkornbaustähle, Richtlinien für die Verarbeitung, besonders für das Schweißen* (Weldable fine grain structural steels; rules for processing, with special reference to welding)

Stahl-Eisen-Lieferbedingungen 096[2]) *Blech, Band und Breitflachstahl mit verbesserten Eigenschaften für Beanspruchungen senkrecht zur Erzeugnisoberfläche* (Plate, strip and wide flats with improved properties for stressing at right angles to the surface of the product)

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 1915[2]) *Ultraschallprüfung auf Längsfehler von Rohren aus warmfesten Stählen* (Ultrasonic testing of creep-resisting steel tubes for longitudinal defects)

Stahl-Eisen-Prüfblatt 1916[2]) *Zerstörungsfreie Prüfung schmelzgeschweißter Fernleitungsrohre für brennbare Flüssigkeiten und Gase* (Non-destructive testing of fusion welded pipes for pipelines conveying combustible liquids and gases)

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

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 4.4 – *Aufstellung empfohlener Schiedsverfahren* (List of recommended arbitration procedures);
B – *Probenahmeverfahren* (Sampling methods);
C – *Analysenverfahren* (Methods of analysis);
most recent edition in each case.

Explanatory notes

When *Stahl-Eisen-Werkstoffblatt* 089-70 *Schweißbare Feinkornbaustähle, Gütevorschriften* (Weldable fine grain structural steels, quality specifications) published by the *Verein Deutscher Eisenhüttenleute* was adopted as Standard DIN 17102, it was decided that DIN Standards were also to be prepared for weldable fine grain structural steel tubes and forgings. For the succinct presentation in the relevant specification and to facilitate their application, a total of 5 standards on weldable fine grain steel tubes have been prepared, classified according to manufacturing process (welded or seamless), use (for structural steelwork or subject to special requirements) and cross-sectional shape (circular or square and rectangular). This standard deals with seamless circular tubes subject to special requirements, whereas DIN 17124 covers seamless circular and DIN 17125 seamless (and welded) square and rectangular tubes (hollow sections) not subject to special requirements for structural steelwork.

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[2]) Published by *Verein Deutscher Eisenhüttenleute*; obtainable from *Verlag Stahleisen mbH*, Postfach 82 29, D-4000 Düsseldorf 1.

The specifications for chemical composition, mechanical properties, etc. comply with those given in DIN 17102. In the present standard, however, reflecting market demand, the steel grades are limited to the grades with a minimum yield strength of 255, 285, 355, 420 and 460 N/mm^2.

International Patent Classification

F16L 9/02	E03C 1/00
F16L 9/16	E03C 1/12
F16L 9/22	E03F 3/04
F16J 12/00	G01N 3/00
C22C 38/00	G01M 19/00
E03B 7/02	