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High performance welded circular unalloyed steel tubes

Technical delivery conditions

DIN 1628

Geschweisste kreisförmige Rohre aus unlegierten Stählen für besonders hohe Anforderungen; technische Lieferbedingungen

Supersedes DIN 1626 Part 4, January 1965 edition, and parts of DIN 1626 Part 1, January 1965 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 welded circular tubes and pipes (hereinafter briefly referred to as "tubes") with a longitudinal or spiral weld, made of unalloyed steels as listed in table 1. These tubes are predominantly used in the construction of chemical plant, vessels, pipework and for general mechanical engineering purposes. They are designed to meet high performance requirements. Normally, there are no limiting values for the maximum permissible working pressure of these tubes. The permissible working temperature shall not exceed 300 °C. (The upper yield stress values for tubes at temperatures up to 300 °C are specified in Appendix A.)

The limits of application and other specifications given in this standard shall apply except in cases where other specifications are contained in codes of practice for specific fields of application, e.g. the *Technische Regeln für Dampfkessel (TRD)* (Technical rules on steam boilers) or the *Technische Regeln für Druckbehälter (TRB)* (Technical rules on pressure vessels), *AD-Merkblätter* (AD Instruction sheets).

1.2 This standard does not apply to

- welded circular unalloyed steel tubes not subject to special requirements (see DIN 1615);
- welded circular unalloyed steel tubes subject to special requirements (DIN 1626);
- welded circular steel tubes for structural steelwork (see DIN 17 120);
- steel tubes for pipelines conveying combustible liquids and gases (see DIN 17 172);
- electrically pressure welded creep-resisting steel tubes (see DIN 17 177);
- welded precision steel tubes (see DIN 2393 Part 2);
- welded and sized precision steel tubes (see DIN 2394 Part 2);
- medium-weight threaded steel tubes (see DIN 2440);
- heavyweight threaded steel tubes (see DIN 2441).

2 Classification into grades

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

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

3 Designation and ordering

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

- the term "tube";
- DIN number of dimensional standard (DIN 2458);
- characteristic dimensions of tube (outside diameter X wall thickness);
- number of DIN Standard giving the technical delivery conditions (DIN 1628);
- symbol or material number for the steel grade (see tables 1 and 3);
- in addition, for pressure welded tubes, where applicable, the code letters N or G where the tubes are to be supplied in the normalized condition or where there are special requirements with regard to cold workability (see subclauses 4.2.2 and 4.2.3).

Examples:

a) A welded tube conforming to this standard, with an outside diameter of 168,3 mm and a wall thickness of 4 mm as specified in DIN 2458, made from St 52.4 steel (material number 1.0581) shall be designated as follows:

Tube DIN 2458 – 168,3 X 4
DIN 1628 – St 52.4

or Tube DIN 2458 – 168,3 X 4
DIN 1628 – 1.0581

b) A welded tube conforming to this standard, with an outside diameter of 114,3 mm and a wall thickness of 3,2 mm as specified in DIN 2458, made from St 37.4 steel (material number 1.0255) in the normalized condition (N) shall be designated as follows:

Tube DIN 2458 – 114,3 X 3,2
DIN 1628 – St 37.4 N

or Tube DIN 2458 – 114,3 X 3,2
DIN 1628 – 1.0255 N

3.2 • In addition to the standard designation as given in subclause 3.1, the purchaser shall always state in his order the required quantity (e.g. total length to be supplied), the type of length (see table 4), the length of the individual tube in the case of specified lengths and exact lengths, the type of document on materials testing as specified in DIN 50 049 and, where applicable, any additional code of practice that may apply.

Example of an order:

1000 m tube DIN 2458 – 168,3 X 4
DIN 1628 – St 52.4

in specified lengths of 8 m, accompanied by document DIN 50 049 – 3.1 B.

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

4 Requirements

4.1 Manufacturing process

4.1.1 The process employed for making the steels used to manufacture the tubes conforming to this standard is at the manufacturer's discretion. The type of deoxidation of the steels shall be as specified in table 1.

•• If so agreed, the purchaser shall be informed of the steelmaking process used.

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

The tubes shall be fabricated in a fully mechanized process by double-sided submerged-arc fusion welding carried out in such a way that a longitudinal weld or a spiral weld is produced, or by electric pressure welding in such a way that a longitudinal weld is produced joining appropriately bent sheet or strip. If necessary, the tubes shall be finished to the final dimensions by additional hot reducing or cold drawing or by drifting or rolling to size.

Pressure welded tubes shall be supplied without welds used for joining lengths of strip.

4.1.3 The tubes shall be welded so as to ensure complete root penetration and so that the tubes conform to the requirements of this standard. The welding process shall be inspected to ensure that welds are properly carried out.

Tubes subject to internal pressure stresses can be used on the basis of a 100 % utilization of the permissible design stress in the weld.

4.1.4 In the case of fusion welded tubes, the welds shall be made from both sides.

Electrically pressure welded tubes shall be supplied without external upset. The internal upset of tubes having inside diameters not smaller than 20 mm shall not exceed the values specified in subclause 4.10.4 b.

• In the case of electrically pressure welded tubes having inside diameters smaller than 20 mm, an agreement shall be reached with regard to the internal upset.

Local repair of welds is permitted. The method of repair shall be agreed by the manufacturer and a recognized test house. Areas that are repaired shall then be subjected to non-destructive testing; in addition, the tube shall be tested for leak tightness.

4.1.5 The manufacturer's works shall have at its disposal the specialists and suitable equipment to enable welding work to be properly carried out and inspected. A certificate on the basis of a qualification test to be carried out by a recognized test house shall be provided. This certificate is valid only for those steel grades, dimensional ranges and welding processes specified in the certificate. If the above conditions change, a new qualification test shall be passed and the certificate amended accordingly.

4.2 As delivered condition

4.2.1 Tubes shall be supplied in the condition resulting from the manufacturing process. In order to comply with the requirements regarding mechanical and technological properties as listed in table 3 and subclause 4.5, in the case of electrically pressure welded tubes, the tubes or the weld shall, if necessary, be normalized.

Table 1. **Chemical composition (cast analysis) of steels for high-performance welded circular tubes**

Steel grade		Type of deoxidation (RR, fully killed)	Chemical composition, % by mass					
			C	Si	Mn	P	S	Addition of nitrogen fixing elements (e.g. not less than 0,020 % Al_{total})
			max.			max.		
Symbol	Material number							
St 37.4	**1.0255**	RR	0,17	0,35	≧ 0,35	0,040	0,040	Yes
St 44.4	**1.0257**	RR	0,20	0,35	≧ 0,40	0,040	0,040	Yes
St 52.4	**1.0581**	RR	0,22	0,55	≦ 1,60	0,040	0,035	Yes

Table 2. **Amounts by which the chemical composition in the product analysis may deviate from the limiting values applicable to the cast analysis** (see table 1)

Element	Amount by which the product analysis may deviate from the limiting values applicable to the cast analysis % by mass
C	+ 0,02
Si	+ 0,03
Mn	+ 0,06 or - 0,06
P	+ 0,010
S	+ 0,010

Table 3. **Mechanical properties of tubes in the as delivered condition at room temperature**

- For wall thicknesses exceeding 40 mm, the values shall be agreed at the time of ordering.

Steel grade		Upper yield stress R_{eH} for wall thicknesses, in mm,		Tensile strength R_m	Elongation after fracture A_5		Diameter of bending mandrel for the bend test on fusion welded tubes [1]	Impact energy [2] of the parent metal (ISO V-notch test pieces at + 20 °C)	
		up to 16	over 16 up to 40		longi-tudinal	trans-verse		longi-tudinal	trans-verse [3]
		N/mm²		N/mm²	%			J	
		min.			min.			min.	
Symbol	Material number								
St 37.4	**1.0255**	235	225	350[5] to 480	25	23	2 s	43	27
St 44.4	**1.0257**	275[4]	265[4]	420[5] to 550	21	19	3 s	43	27
St 52.4	**1.0581**	355	345	500[5] to 650	21	19	4 s	43	27

1) s is the wall thickness of tube (see subclause 5.5.5).

2) Average value from three tests; only one individual value may fall short of the specified minimum value by not more than 30 %.

3) These values apply also if the impact energy is tested in the centre of the weld for tubes having outside diameters exceeding 500 mm and wall thicknesses not smaller than 10 mm.

4) For cold finished tubes in the NBK condition (annealed above the upper transformation point under shielding gas or in a vacuum), minimum values of yield stress lower than these values by 20 N/mm² are permitted.

5) For cold finished tubes in the NBK condition, minimum values of tensile strength lower than these values by 10 N/mm² are permitted.

4.2.2 •• In the case of electrically pressure welded tubes, if normalizing of the tubes or the weld is desired, this shall be agreed at the time of ordering. In this case, code letter N (normalizing of complete tube) or G (normalizing of weld) is to be used in the designation (see subclause 3.1).

If the final forming stage in the production of the tube is a temperature-controlled hot forming operation, the requirement for normalizing shall be deemed to have been met if the forming process produces a condition equivalent to that produced by normalizing.

4.2.3 •• In cases where there are special requirements regarding cold workability, electrically pressure welded tubes are to be ordered in conditions N or G as described in subclause 4.2.2.

4.2.4 •• If the surfaces of the tubes are to be provided with an anti-corrosive agent with a limited life, this shall be agreed at the time of ordering.

4.2.5 •• If special requirements are made on the tubes (e.g. with regard to galvanizing, chromium plating or enamelling), this shall be agreed at the time of ordering.

4.3 Chemical composition

4.3.1 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 if the mechanical and technological properties of the tubes conform to this standard and weldability is not impaired.

4.3.2 Product analysis

In the test on the finished tube, the deviations shown in table 2 are permitted in comparison with the values specified in table 1.

4.4 Mechanical properties

4.4.1 The yield stress, tensile strength and elongation after fracture determined for the parent metal of the tubes shall conform to the values specified in table 3. These shall apply for tubes in the as delivered condition and for the test conditions described in clause 5 of this standard.

The minimum values for the tensile strength and the yield stress given in table 3 shall also apply for the weld.

4.4.2 The values specified in table 3 shall apply for the impact energy of the parent metals of the tubes and for tubes having outside diameters exceeding 500 mm in the centre of the weld.

4.5 Technological properties

The tubes shall meet the requirements specified in subclauses 5.5.3 to 5.5.5. In the tests described in the same subclauses, no unacceptable defects (e.g. cracks, scabs, laps or laminations) shall occur.

4.6 Weldability

Tubes made from the steel grades specified in this standard are suitable for gas fusion welding, arc welding, flash butt welding, electric pressure welding, and gas pressure welding.

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

4.7 Appearance of surface and weld

4.7.1 The tubes shall have a smooth outside and inside surface consistent with the manufacturing process used.

4.7.2 Slight irregularities in the surface resulting from the manufacturing process, such as raised or depressed areas or shallow grooves are permitted as long as the remaining wall thickness fulfils the requirements specified in subclause 4.10.2.2 and the function of the tubes is not impaired (see also subclause 7.1).

4.7.3 Proper removal of shallow surface defects using appropriate means is permitted as long as the remaining wall thickness fulfils the requirements of subclause 4.10.2.2. Stopping of surface defects is not permitted.

4.8 Leak tightness

The tubes shall remain leaktight when tested as specified in subclause 5.5.7.

4.9 Non-destructive testing

The requirements given in *Stahl-Eisen-Prüfblatt* (Iron and steel test sheet) 1916 or 1917 are to be met in the non-destructive tests specified in subclause 5.5.9.

4.10 Dimensions, masses per unit length and permissible deviations

4.10.1 Dimensions

DIN 2458 shall apply for the outside diameter and wall thickness of tubes.

Table 4 shall apply for the types of tube length.

Table 4. **Types of length and permissible deviations in length**

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

[1] The products are supplied in the manufacturing lengths occurring in production. • The lengths differ according to the diameter, wall thickness and manufacturer's works and shall be agreed at the time of ordering.

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

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4.10.2 Permissible dimensional deviations

4.10.2.1 The information given in table 5 (see subclause 5.5.11) shall apply for the permissible deviations in outside diameter d_a.

●● For the tube ends, the lower permissible deviations in diameter given in table 5 may also be agreed.

4.10.2.2 The permissible deviations in wall thickness s are:

for $s \leq 3$ mm: $^{+0,30}_{-0,25}$ mm;

for s over 3 mm up to and including 10 mm: $^{+0,45}_{-0,35}$ mm[2]);

for $s > 10$ mm: $-0,50$ mm,

the upper limit being given by the permissible deviation in mass.

At isolated points, the minimum wall thickness resulting from the permissible undersize for the wall thickness may additionally fall short by 5% of the wall thickness, but only for lengths not greater than twice the outside diameter of the tube, or 300 mm whichever is the lower. This means locally limited areas which, for example, can occur as a result of removal of defects by grinding (see subclause 4.10.4 for the permitted weld reinforcement).

Misaligned edges in pressure welded tubes, where the reduction in cross section exceeds the permissible undersize of wall thickness, are not permitted.

4.10.2.3 ●● 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 2393 Part 1 or DIN 2394 Part 1.

4.10.2.4 The permissible deviations in length are given in table 4.

4.10.3 Permissible deviations of form

4.10.3.1 Circularity

The tubes shall be as circular as possible. The permissible deviations from circularity are specified in table 5. The out-of-roundness R (see subclause 5.5.12) shall be determined using the following formula:

$$R = 200 \cdot \frac{d_{a\,max} - d_{a\,min}}{d_{a\,max} + d_{a\,min}}, \text{ in \%},$$

where $d_{a\,max}$ is the greatest outside diameter measured and $d_{a\,min}$ is the smallest outside diameter measured.

4.10.3.2 Straightness

The tubes shall be straight to the eye.

●● Particular requirements regarding straightness may be agreed.

4.10.4 Permissible weld reinforcement

a) For fusion welded tubes, the weld reinforcement Δ_a shall not exceed the following values, as a function of the wall thickness s:

for $s \leq 8$ mm, $\Delta_a \leq 2,5$ mm;

for s over 8 mm up to and including 14 mm, $\Delta_a \leq 3,0$ mm;

for s over 14 mm up to and including 40 mm, $\Delta_a \leq 4,0$ mm.

b) For pressure welded tubes, in the case of inside diameters not smaller than 20 mm, after the upset has been removed, the weld reinforcement Δ_a on the inside shall not exceed 0,3 mm.

4.10.5 Finish of tube ends

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

●● 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.

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[2]) The upper limit for tubes made from heavy plate is given by the permissible deviation in mass.

Table 5. **Permissible deviations in outside diameter and from circularity**

Outside diameter d_a mm	Permissible deviation in diameter: Tube barrel and tube ends	Permissible deviation in diameter: ●● At tube ends, subject to particular agreement[1])	Permissible deviations of tube barrel from circularity[2])
< 200	± 1% d_a; (values up to ± 0,5 mm are permitted in all cases)	± 0,5% d_a; (values up to ± 0,3 mm are permitted in all cases)	Within the permissible deviation in diameter
$200 \leq d_a < 1000$	± (0,5% d_a + 1) mm[3])	$200 \leq d_a < 325$: ± 1,0 mm; $325 \leq d_a < 1000$: ± 1,6 mm[4])	2%; (this value is not guaranteed for $\frac{d_a}{s}$ exceeding 100)
≥ 1000	± 6 mm[3])	By agreement[4])	

[1]) Over a length of about 100 mm from the tube ends.

[2]) See subclause 4.10.3.1.

[3]) ●● Subject to agreement at the time of ordering, in the case of tubes with outside diameters exceeding 500 mm, the permissible deviation may also be referred to the inside diameter, in which case the permissible deviation in wall thickness is to be taken into account.

[4]) ●● Subject to agreement at the time of ordering, the permissible deviation may also be referred to the inside diameter, in which case the permissible deviation in wall thickness is to be taken into account.

4.10.6 Masses per unit length and permissible deviations

The values of masses per unit length of tubes are specified in DIN 2458. The following deviations from these values are permitted:

$^{+12}_{-8}$ % for a single tube,

$^{+10}_{-5}$ % for a batch of tubes not less than 10 t by mass.

5 Testing and documents on materials testing

5.1 General

Tubes complying with this standard shall be supplied with one of the following documents on materials testing as specified in DIN 50 049:

- document DIN 50 049 – 3.1 A (inspection certificate A);
- document DIN 50 049 – 3.1 B (inspection certificate B);
- document DIN 50 049 – 3.1 C (inspection certificate C).

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

5.2 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.

5.3 Scope of test programme

5.3.1 The tubes shall be inspected by batches

Table 6 gives a synopsis of the scope of the test programme in each case.

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

for $d_a \leqq 500$ mm, 100 tubes;

for $d_a > 500$ mm, 50 tubes.

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

The test of welds used for joining lengths of strip in the case of spirally welded tubes shall be carried out on batches comprising 50 tubes with strip joining welds.

One tube (sample tube) shall be taken at the inspector's discretion from each batch for the tests to be carried out. The following tests shall be carried out on this sample tube:

- tensile test on the parent metal;
- additional tensile test transverse to the weld in the case of tubes exceeding 500 mm outside diameter;
- impact test on the parent metal in the case of wall thicknesses not smaller than 10 mm;
- additional impact test at the centre of the weld of tubes with outside diameters exceeding 500 mm and wall thicknesses not smaller than 10 mm;
- •• product analysis, if this has been agreed at the time of ordering.

In addition, the following tests shall be carried out:

for pressure welded tubes;

- flattening test on one end of each rolled or cut length (the lengths shall not exceed 30 m, see subclause 5.4.3.3) or on one end of each partial length irrespective of the tube diameter (if the weld is not recognizable, the drift expanding test shall be carried out instead);

for fusion welded tubes,

- bend test on two sample tubes of each batch.

5.3.2 During manufacture, the welded joints of all tubes shall be subjected to non-destructive testing over their entire length.

•• Subject to agreement at the time of ordering, an additional non-destructive test of the outer surface of the tube for longitudinal defects shall be carried out.

5.3.3 Furthermore,

5.3.3.1 all tubes shall be tested by the manufacturer's works for leak tightness, normally by means of a hydraulic test (see subclause 5.5.7).

If, under the test conditions specified in subclause 5.5.7 (test pressure, 80 bar) a load limit of 0,7 × R_{eH} (equivalent to a safety factor of about 1,5 against the yield stress) is not exceeded, then, at manufacturer's discretion, instead of the hydraulic test a suitable non-destructive test method may be used for testing the leak tightness (for example an eddy current test as specified in *Stahl-Eisen-Prüfblatt* 1925).

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

5.3.3.3 the tubes shall be inspected for their accuracy to size and permissible deviations as specified in subclause 4.10.

5.4 Sampling and sample preparation

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

5.4.1 Tensile test

5.4.1.1 In the case of tubes with outside diameters not greater than 500 mm, one strip test piece (see DIN 50 140) shall be taken from the parent metal of the sample tube, longitudinal to the tube axis and offset from the weld by about 90°. 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 50 140).

5.4.1.2 In the case of tubes with outside diameters equal to or greater than 200 mm, at the manufacturer's discretion, a flat test piece (see DIN 50 125) may also be taken from the parent metal transverse to the tube axis. The test piece shall be cold straightened and may be annealed at a temperature below 500 °C.

5.4.1.3 In the case of tubes with outside diameters greater than 500 mm, a flat test piece as illustrated in figure 1 of DIN 50 120 Part 1 (September 1975 edition) or in figure 2 of DIN 50 120 Part 2 (August 1978 edition) shall be taken transverse to the weld, with the weld in the middle, and one flat test piece (see DIN 50 125)

Table 6. **Summary of the scope of test programme and documents on materials testing**
See figure 1 for sampling points and location of test pieces; see subclause 5.3.1 for batch size.

Testing			Scope of test programme		Responsibility for carrying out the tests	Type of document on materials testing
No.	Type of test	Sub-clause	Fusion welded tubes	Pressure welded tubes		
1	Tensile test	5.4.1 5.5.1	1 sample tube per batch. 1 test piece from the parent metal for outside diameters ≦ 500 mm, plus 1 test piece transverse to the weld for outside diameters > 500 mm.		By agreement	DIN 50049 – 3.1 A or DIN 50049 – 3.1 B or DIN 50049 – 3.1 C
		5.4.1.5	For strip joining welds of fusion welded tubes, 1 test piece from 1 sample tube per batch.			
2	Impact test	5.4.2 5.5.2	At one end of sample tube specified above (No. 1) (for wall thickness ≧ 10 mm): 1 set of 3 individual test pieces for outside diameters ≦ 500 mm, 1 additional set of 3 individual test pieces with weld for outside diameters ≧ 500 mm.		By agreement	DIN 50049 – 3.1 A or DIN 50049 – 3.1 B or DIN 50049 – 3.1 C
3	Flattening test or drift expanding test	5.4.3.1 5.4.3.2 5.5.3 5.5.4	–	At one end of each rolled or cut length (30 m max.) 1 test piece, irrespective of the tube outside diameter; see subclause 5.4.3.3 for subsections.	By agreement	DIN 50049 – 3.1 A or DIN 50049 – 3.1 B or DIN 50049 – 3.1 C
4	Bend test	5.4.4 5.5.5	On 2 test pieces each from 2 sample tubes per batch	–	By agreement	DIN 50049 – 3.1 A or DIN 50049 – 3.1 B or DIN 50049 – 3.1 C
5	Leak tightness test	5.3.3.1 5.5.7	All tubes		Manufacturer	DIN 50049 – 2.1 [1]
6	Inspection of surface	5.5.8	All tubes		By agreement	DIN 50049 – 3.1 A or DIN 50049 – 3.1 B or DIN 50049 – 3.1 C
7	Non-destructive testing of weld	5.5.9	All tubes		Manufacturer	DIN 50049 – 3.1 B
8	Check on dimensions	5.5.10 5.5.11 5.5.12	All tubes		By agreement	DIN 50049 – 3.1 A or DIN 50049 – 3.1 B or DIN 50049 – 3.1 C
9	Product analysis [2]	5.4.5 5.5.6	By agreement		Manufacturer	DIN 50049 – 3.1 B

1) This certificate may also be included in the next higher stage of document.
2) The product analysis shall only be carried out if so agreed between the manufacturer and purchaser.

transverse to the tube axis and offset from the weld by about 90°. The test pieces shall be cold straightened and may be annealed at a temperature below 500 °C.

5.4.1.4 Instead of sampling as described in subclause 5.4.1.2, at the manufacturer's discretion, it is also permitted to take an unstraightened test piece worked on all sides (see DIN 50125) transverse to the tube axis for testing the parent metal.

5.4.1.5 Normally, short proportional test pieces shall be taken for the tensile test on the parent metal. If the test pieces are not worked on all sides it is permitted to

remove local irregularities but the rolling skin shall be retained at the thinnest area.

For the strip joining welds in the case of spirally welded tubes, the same specifications shall apply as for the other welds.

5.4.2 Impact test

For the purposes of the impact test carried out on the parent metal, a set of three ISO V-notch test pieces shall be taken from the tube transverse to the tube axis provided that the tube dimensions permit this without straightening of the test pieces. Otherwise, the test pieces shall be taken longitudinal to the tube axis. 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.

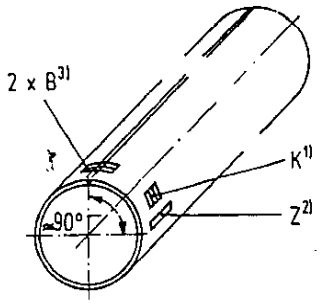
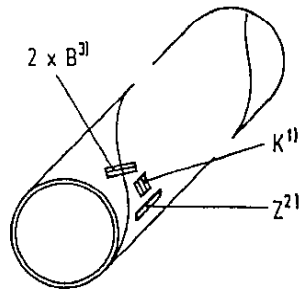
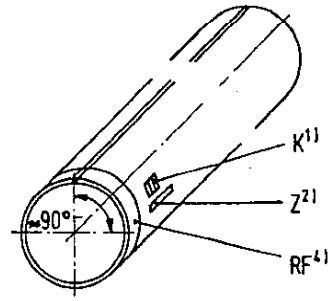
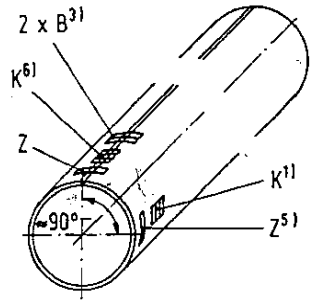
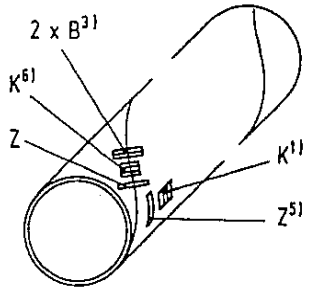
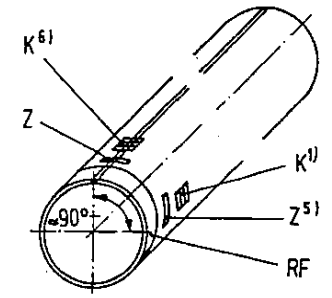
For the purposes of the impact test carried out in the centre of the weld, a set of three ISO V-notch test pieces shall be taken from the sample tube transverse to the weld.

The test pieces shall be taken and prepared in such a way that the axis of the notch is perpendicular to the tube surface. In the case of test pieces taken from the weld, the axis of the notch is to lie in the middle of the weld.

5.4.3 Flattening test and drift expanding test

5.4.3.1 For the flattening test in the case of pressure welded tubes, one test piece shall be taken from each rolled or cut length of tube or subsection. The relevant specifications in DIN 50 136 shall be observed for sampling.

5.4.3.2 For the drift expanding test in the case of pressure welded tubes, one test piece shall be taken from one end of each rolled or cut length of tube or sub-

Outside diameter mm	Fusion welded tubes		Pressure welded tubes
	Longitudinal weld	Spiral weld	
≤ 500			
> 500			

1) The test pieces shall be taken transverse to the weld in the case of wall thicknesses not smaller than 10 mm, if the dimensions permit this without straightening of the tube; otherwise, they shall be taken longitudinal to the weld (see also subclause 5.4.2).

2) See also subclauses 5.4.1.1, 5.4.1.2 and 5.4.1.5.

3) On two sample tubes per batch.

4) If the weld is not recognizable, one test piece for the drift expanding test shall be taken instead of the test piece used for the flattening test (see also subclause 5.4.3.2).

5) See also subclauses 5.4.1.3 to 5.4.1.5.

6) For wall thicknesses not smaller than 10 mm.

In the illustration above

B = bend test piece as specified in DIN 50 121 Part 1,

K = set of 3 ISO V-notch test pieces each, as specified in DIN 50 115,

RF = flattening test piece as specified in DIN 50 136,

Z = tensile test piece (see subclause 5.4.1).

Figure 1. Sampling points and location of test pieces

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section. The relevant specifications in DIN 50 135 shall be observed for sampling.

5.4.3.3 If, when testing in accordance with subclauses 5.4.3.1 and 5.4.3.2, rolled or cut lengths of tube which may not exceed 30 m in length are subsequently cut into subsections, no test pieces need be taken from these subsections provided that it is clearly indicated from which already tested rolled or cut lengths of tube the subsections have been taken. If such identification is not given, the rolled or cut lengths of tube shall not be tested; the subsections shall be tested instead.

5.4.4 Bend test

For the bend test in the case of fusion welded tubes, two test pieces shall be taken from the sample tube transverse to the weld and with the weld in the centre. The relevant specifications in DIN 50 121 Part 1 shall be observed for sampling. Before the test, the test pieces may be aged for six hours at 250 °C to remove the hydrogen.

5.4.5 Chemical composition

For checking the chemical composition by a product analysis on the finished tube, or, at the manufacturer's discretion, on the starting product (sheet or strip), the sample chips shall be taken at points uniformly distributed over the entire thickness of the product; a similar procedure shall be used for spectral analyses. In general, *Stahl-Eisen-Prüfblatt* 1805 shall apply for sampling.

5.5 Test procedure

5.5.1 The tensile test on the parent metal shall be carried out as specified in DIN 50 140 or DIN 50 145.

The tensile test transverse to the weld shall be carried out on test pieces as shown in figure 1 of DIN 50 120 Part 1 (September 1975 edition) or figure 2 of DIN 50 120 Part 2 (August 1978 edition).

5.5.2 The impact test shall be carried out as described in DIN 50 115.

5.5.3 The flattening test on pressure welded tubes shall be carried out as specified in DIN 50 136, even in cases where the outside diameter exceeds 400 mm. The test pieces shall be tested alternately with the weld in the 12 o'clock position or in the 3 o'clock position. The test pieces or tube ends shall be flattened until a specified distance between platens H is reached.

5.5.3.1 The weld shall not open before the distance between platens H reaches two-thirds of the original outside diameter of the tube.

5.5.3.2 Cracks or breaks in the material shall not occur outside the weld before the distance between platens H has gone below a value

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

but not below two-thirds of the original tube ouside diameter.

In the equation

s is the wall thickness, in mm;

d_a is the outside diameter, in mm, and

c is a constant having the following value:

0,09 for steel grade St 37.4;

0,07 for steel grades St 44.4 and St 52.4.

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

5.5.3.3 In the case of pressure welded tubes subject to special requirements with regard to cold formability in accordance with subclause 4.2.3 (as delivered condition N or G), the distance between platens H referred to in subclause 5.5.3.2 shall be reached without the weld opening and without cracks or breaks occurring in the material outside the weld.

5.5.4 The drift expanding test on pressure welded tubes shall be carried out as specified in DIN 50 135, with the expansion reaching the values specified in table 7.

Table 7. **Minimum expansion in the drift expanding test**

Steel grade	Expansion for a ratio of inside diameter (d_i) to outside diameter (d_a)	
	≤ 0,8	> 0,8
	%	
St 37.4	10	12
St 44.4	8	10
St 52.4	6	8

5.5.5 The bend test on fusion welded tubes shall be carried out as specified in DIN 50 121 Part 1, January 1978 edition, figures 7 and 9, using mandrels the diameters of which are specified in table 3. The bend angle shall not exceed 180°. One test piece shall be tested with the outside of the tube in the tension zone and the other with the inside of the tube in tension zone, the weld being at the centre of the test piece. No objection shall be raised to small cracks at the edge of the test piece or to local defects in the weld, e.g. pores or small inclusions, provided they do not affect the behaviour of the test pieces under bending.

5.5.6 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).

5.5.7 For the hydraulic leak tightness test (see also subclause 5.3.3.1) as specified in DIN 50 104, the test pressure shall be 80 bar.

5.5.7.1 •• A higher test pressure may be agreed.

5.5.7.2 In no case however shall the safety margin with respect to the yield stress go below 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.

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

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

Note. A demonstrably suitable non-destructive method of test may also be used instead of the visual examination.

5.5.9 Non-destructive testing of the welded joint in the case of electrically pressure welded tubes shall be carried out in accordance with test class B of *Stahl-Eisen-Prüfblatt* 1917.

In the case of fusion welded tubes, non-destructive testing shall be carried out as described in *Stahl-Eisen-Prüfblatt* 1916.

If non-destructive testing of the outer surface of the tube has been agreed (see subclause 5.3.2) a suitable method, e.g. as specified in *Stahl-Eisen-Prüfblatt* 1917, shall be used.

Non-destructive testing shall be carried out by the manufacturer.

•• Subject to prior agreement, the purchaser or a qualified inspector acting on his behalf may be present at the inspection.

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

5.5.11 The diameter shall be measured using suitable measuring instruments as a two-point measurement or measurement of circumference. In the case of tubes with outside diameters greater than 500 mm, only the measurement of circumference shall be used.

5.5.12 For determining the circularity, a two-point measurement in one cross-sectional plane shall be made.

5.6 Retests

5.6.1 Tubes not satisfying the requirements when tested as specified in subclauses 5.5.3 or 5.5.4 (flattening test or drift expanding test) or 5.5.7 to 5.5.12 (leak tightness 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 correct defects or deviations found in these tests and to present these tubes for renewed acceptance inspection.

5.6.2 If one of the sample tubes fails the acceptance inspection including tensile test, impact test and bend test specified in subclauses 5.5.1, 5.5.2 and 5.5.5, 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 5.5.1, 5.5.2 and 5.5.5. If one of the requirements is still not be fulfilled, the entire batch shall be considered not to comply with the standard. However, individual testing 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.

5.6.3 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.

5.7 Documents on materials testing

5.7.1 Depending on the agreement made at the time of ordering (see subclause 5.1), either document DIN 50 049 – 3.1 A (inspection certificate A), DIN 50 049 – 3.1 B (inspection certificate B) or DIN 50 049 – 3.1 C (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 documentation covering the tests are shown in table 6. In each case, the technical rule agreed at the time of ordering shall be specified.

5.7.2 The documents shall state the marking of the tubes as specified in clause 6.

6 Marking

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

- manufacturer's mark;
- symbol identifying the steel grade (where applicable supplemented by code letters N or G where a particular as delivered condition as described in subclauses 4.2.2 or 4.2.3 has been agreed);
- an appended symbol *W* indicating that the tube is welded;
- inspector's mark.

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

7 Complaints

7.1 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.

7.2 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.

Appendix A

Elevated temperature upper yield stress values for tubes[1)]

Table A.1.

Steel grade		Upper yield stress values for a design temperature of and a wall thickness							
		50 °C[2)]		200 °C[2)]		250 °C		300 °C	
Symbol	Material number	≤16 mm	>16≤40 mm	≤16 mm	>16≤40 mm	≤16 mm	>16≤40 mm	≤16 mm	>16≤40 mm
		N/mm²							
St 37.4	**1.0255**	235	225	185	175	165	155	140	135
St 44.4	**1.0257**	275	265	215	205	195	185	165	160
St 52.4	**1.0581**	355	345	245	235	225	215	195	190

1) The values specified are approximate values for the 0,2 % proof stress and it is not required to verify them. This should be taken into account in design by using a higher safety coefficient (e.g. as in DIN 2413, June 1972 edition, subclause 4.1.2, the value shall be increased by 20 % for category II).

2) For the ranges between 20 °C and 50 °C and between 50 °C and 200 °C linear interpolation should be made. It is not permitted to round the values.

Other standards and documents referred to

DIN 1615	Welded circular unalloyed steel tubes not subject to special requirements; technical delivery conditions
DIN 1626	Welded circular unalloyed steel tubes subject to special requirements; technical delivery conditions
DIN 2393 Part 1	Welded precision steel tubes; dimensions
DIN 2393 Part 2	Welded precision steel tubes; technical delivery conditions
DIN 2394 Part 1	Welded and sized precision steel tubes; dimensions
DIN 2394 Part 2	Welded and sized precision steel tubes; technical delivery conditions
DIN 2413	Steel pipes; calculation of wall thickness with regard to internal pressure
DIN 2440	Medium-weight threaded steel tubes
DIN 2441	Heavyweight threaded steel tubes
DIN 2458	Welded steel tubes; dimensions, masses per unit length
DIN 8528 Part 1	Weldability; metallic materials, concepts
DIN 17 120	Welded circular steel tubes for structural steelwork; technical delivery conditions
DIN 17 172	Steel pipes for long-distance pipelines conveying combustible liquids and gases; technical delivery conditions
DIN 17 177	Electrically pressure welded creep-resisting steel tubes; technical delivery conditions
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 50 115	Testing of metallic materials; impact test
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 50 121 Part 1	Testing of metallic materials; bend test on welded joints and welded claddings; fusion welded joints
DIN 50 125	Testing of metallic materials; tensile test pieces, guidelines for their preparation
DIN 50 135	Testing of metallic materials; drift expanding test on tubes
DIN 50 136	Testing of metallic materials; flattening test on tubes
DIN 50 140	Testing of metallic materials; tensile test on tubes and strips from tubes
DIN 50 145	Testing of metallic materials; tensile test
Stahl-Eisen-Prüfblatt 1805[3)]	*Probenahme und Probenvorbereitung für die Stückanalyse bei Stählen* (Sampling and sample preparation for the product analysis of steels)

3) See page 12.

Stahl-Eisen-Prüfblatt 1916 [3]

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 1917 [3]

Zerstörungsfreie Prüfung elektrisch-pressgeschweisster Rohre aus ferritischen Stählen
(Non-destructive testing of electrically pressure welded ferritic steel tubes)

Stahl-Eisen-Prüfblatt 1925 [3]

Elektromagnetische Prüfung von Rohren zum Nachweis der Dichtheit
(Electromagnetic testing of tubes for leak tightness)

Handbuch für das Eisenhüttenlaboratorium [3] (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);

(latest edition in each case).

Previous editions

DIN 1626: 12.52x; DIN 1626 Part 1: 01.65; DIN 1626 Part 4: 01.65

Amendments

The following amendments have been made in comparison with DIN 1626 Part 1, January 1965 edition, and DIN 1626 Part 4, January 1965 edition (see also Explanatory notes):

a) The symbols for the steel grades have been changed (see table in the Explanatory notes).

b) The maximum values for carbon, phosphorus and sulfur contents have been reduced (see tables 1 and 2).

c) The values for the mechanical properties have been converted and in some cases changed (see table 3).

d) The whole text has been revised, taking into account the specifications of DIN 1626 Part 1, January 1965 edition.

Explanatory notes

Recent technical developments in the manufacture and use of welded and seamless unalloyed steel tubes and the desire to harmonize requirements, meant that a revision of the technical delivery conditions for such products as specified in DIN 1626 Part 1 to Part 4, January 1965 editions and in DIN 1629 Part 1 to Part 4, January 1961 editions, had become necessary. A revision of the standards was carried out in a joint committee of the *Normenausschuss Eisen und Stahl (FES)* (Iron and Steel Standards Committee) and the *Normenausschuss Rohre, Rohrverbindungen und Rohrleitungen (FR)* (Pipes, Pipe Joint Assemblies and Pipelines Standards Committee) with the participation of the *Normenausschuss Gastechnik (NAGas)* (Gas Technology Standards Committee) and the *Normenausschuss Erdöl- und Erdgasgewinnung (NÖG)* (Petroleum and Natural Gas Production Standards Committee).

The essential changes compared with DIN 1626 Part 1 to Part 4, January 1965 editions, made in these revised editions of the technical delivery conditions for welded tubes are as follows:

Restructuring standards

In order to improve clarity and to facilitate the application of the standards to the particular use of the products, it appeared expedient to change the existing numbering system and to revise the contents of the various standards. On this basis, for the field of welded tubes the following breakdown was introduced:

DIN 1615 (tubes not subject to special requirements), superseding DIN 1626 Part 2 (tubes for general applications),

DIN 1626 (tubes not subject to special requirements), superseding DIN 1626 Part 3 (tubes subject to quality specifications) and

DIN 1628 (high performance tubes), superseding DIN 1626 Part 4 (specially tested tubes subject to quality specifications).

The content of DIN 1626 Part 1 has been incorporated into DIN 1626 and DIN 1628, as appropriate.

Classification and designation of steel grades

The classification of the steels has been based on DIN 17 100 as before. The revised edition of the standard for general structural steels (January 1980 edition) however necessitated a corresponding change in the classification of steel grades in the tube standards. In addition to this, the symbols for the steels for welded tubes subject to special requirements and high performance welded

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

tubes have been changed to bring them into line with the designation of steels for seamless tubes in the same requirement class.

The following table compares the former steel grades for welded tubes with those specified in DIN 1615, DIN 1626 and DIN 1628. However, in some cases it is necessary to take account of differences, particularly in the type of deoxidation used for the steels.

Steel grade		Comparable steel grade	
Symbol	Specified in DIN 1626[1)]	Symbol	Specified in DIN
St 33	Part 2	St 33	1615
St 37	Part 2	–	–
St 42	Part 2	–	–
St 34-2	Part 3	–	–
St 37-2	Part 3	USt 37.0	1626
		St 37.0	1626
St 42-2	Part 3	–	–
–		St 44.0	1626
St 52-3	Part 3	St 52.0	1626
St 34-2	Part 4	–	–
St 37-2	Part 4	St 37.4	1628
St 42-2	Part 4	–	–
–		St 44.4	1628
St 52-3	Part 4	St 52-4	1628

1) January 1965 edition, in each case.

Properties of products

The specifications relating to the chemical composition and the yield stress, tensile strength and elongation after fracture values are the same as the values specified in DIN 1629 and DIN 1630 for seamless tubes.

The mechanical properties determined in the tensile test are largely the same as those specified in DIN 17 100. Compared with the technical delivery conditions for general structural steels however, the maximum values for the phosphorus and sulfur contents have been substantially reduced. As a result of this, especially in view of more detailed impact energy values given in DIN 1628, October 1984 edition (see table 3), the requirements for welded unalloyed steel tubes are now more stringent than those applying to the starting products (plate, sheet and strip) specified in DIN 17 100.

The values that have to be achieved in the bend test on fusion welded tubes remain virtually unchanged compared with the earlier requirements. This applies also to the flattening test in the case of pressure welded tubes, for which however more stringent conditions apply when ordering tubes subject to special requirements regarding cold workability. The ring expanding tests and ring tensile tests specified in DIN 1626 Part 3 and Part 4, January 1965 editions, according to the outside diameter, have been omitted.

By way of extension of previous specifications, welds on tubes complying with DIN 1626 shall, if these tubes are certified, also be subjected to non-destructive testing over their entire length. It remains to be clarified whether the test conditions for test class A at present given in *Stahl-Eisen-Prüfblatt* 1917, October 1970 edition, for pressure welded tubes for which a 90 % utilization of the design stress is intended provide sufficient sensitivity for detecting defects or whether they may need to be made more stringent. It is in any case intended to extend *Stahl-Eisen-Prüfblatt* 1916, which applies to fusion welded tubes, to include specifications for test class A.

Scope of test programme

The information on the scope of test programme provided in subclause 5.3 of DIN 1626, October 1984 edition, and of DIN 1628, October 1984 edition, has been largely brought into line with the specifications in DIN 17 172, May 1978 edition, and DIN 17 177, May 1979 edition. Compared with the earlier specifications, this meant that there were changes in the method of test (for example in the position of the test pieces for the tensile test as a function of the outside diameter of the tubes) and in the number of tests per batch. The new specifications did not meet with the unanimous approval of all the representatives of consumers and the technical inspection boards but were accepted as reasonable by a majority of the participants taking into account the current state of production technology and also in comparison with the specifications in other national and international technical delivery conditions.

Other contents

Some other amendments to the text of the standards resulted necessarily from the new specifications with regard to the factual content. For all these standards, the objective has been to ensure identical layout with identical wording (where this is appropriate to the particular case).

International Patent Classification

B 21 C 37-08