UDC 621.643.2-034.14 : 621.644.2
: 662.75/.76 : 620.1

May 1978

# Steel Pipes for Long-distance Pipelines for Combustible Liquids and Gases

Technical Conditions of Delivery

DIN 17 172

Stahlrohre für Fernleitungen für brennbare Flüssigkeiten und Gase; Technische Lieferbedingungen.

For connection with the International Draft Standards 3183 and 3845 published by the International Organization for Standardization (ISO) as well as with the Draft for spiral-welded pipes at present in preparation, see Explanations.

## 1 Scope

These conditions of delivery apply to seamless and to welded pipes made from the unalloyed and low alloy steels specified in Table 1 for the construction of long-distance pipelines (see Section 3) [1], [2].

## 2 Other relevant standards and data

| | |
|---|---|
| DIN 2413 | Steel pipes; calculation of wall thickness subjected to internal pressure |
| DIN 2448 | Seamless steel tubes; dimensions and weights |
| DIN 2458 | Welded steel tubes; dimensions and weights |
| DIN 2470 Part 1 | Gas pipelines of steel pipes for operating overpressures up to 16 bar; requirements in respect of pipeline components |
| DIN 2470 Part 2 | Gas pipelines of steel pipes for operating overpressures above 16 bar; requirements in respect of pipeline components |
| DIN 17 007 Part 2 | Material numbers; system of the principal group 1: steel |
| DIN 50 049 | Certificates on material testings |
| DIN 50 104 | Internal pressure test of hollow bodies of various shapes up to a specified internal pressure (water pressure test) |
| DIN 50 115 | Testing of metallic materials; notch bar impact bending test |
| DIN 50 120 Part 1 | Testing of steel; tensile test on welded joints; fusion welded butt joints |
| DIN 50 120 Part 2 | (at present circulating as draft) Testing of steel; tensile test on welded joints; pressure welded butt joints |
| DIN 50 121 Part 1 | Testing of metallic materials; technological bending test on welded joints and weld platings; fusion welded joints |
| DIN 50 125 | Testing of metallic materials; tensile test specimens; directions for their preparation |
| DIN 50 136 | Testing of metallic materials; flattening test on tubes |
| DIN 50 140 | Testing of metals; tensile test for tubes and strips from tubes without extensometer |
| DIN 50 145 | Testing of metallic materials; tensile test |
| DIN Normenheft 3 [3] | Kurznamen und Werkstoffnummern der Eisenwerkstoffe in DIN-Normen und Stahl-Eisen-Werkstoffblättern (DIN Standard Book 3 Code numbers and material numbers of ferrous materials featuring in DIN Standards and in Steel-Iron Data Sheets) |
| Stahl-Eisen-Prüfblatt 1916 [3] | Zerstörungsfreie Prüfung schmelzgeschweisster Fernleitungsrohre für brennbare Flüssigkeiten und Gase (Steel-Iron Test Leaflet 1916 Non-destructive testing of fusion welded long-distance pipelines for combustible liquids and gases) |
| Stahl-Eisen-Prüfblatt 1917 [3] | Zerstörungsfreie Prüfung pressgeschweisster Fernleitungsrohre für brennbare Flüssigkeiten und Gase (Steel-Iron Test Leaflet 1917 Non-destructive testing of pressure welded long-distance pipelines for combustible liquids and gases) |

[1] In addition, the TRbF 301 Technische Regeln für brennbare Flüssigkeiten (Technical regulations for combustible liquids), DIN 2470 Part 1 and DIN 2470 Part 2 should be taken into account.

[2] The pipes according to this Standard also meet the essential conditions for service according to the Standards 5 L, 5 LX and 5 LS of the American Petroleum Institute (API). (See comparison of grades in Table 3).

[3] Verlag Stahleisen mbH., Düsseldorf

Continued on pages 2 to 12
Explanations on pages 13 and 14

Handbuch für das Eisenhüttenlaboratorium, Band 2 [3]: Die Untersuchung der metallischen Stoffe, Düsseldorf 1966 (Handbook for ferrous metallurgy engineering laboratories, Volume 2: Investigation of metallic materials)

Handbuch für das Eisenhüttenlaboratorium, Band 5 (Ergänzungsband) [3]: A 4.1 – Aufstellung empfohlener Schiedsverfahren, B-Probenahmeverfahren, C-Analysenverfahren (Handbook for ferrous metallurgy engineering laboratories, Volume 5 (Complementary volume): A 4.1 – Setting up of recommended arbitration procedures, B-Sampling procedures, C-Analysis procedures), most recent edition in each case

TRbF 301 [4] Richtlinie für Fernleitungen zum Befördern gefährdender Flüssigkeiten – RFF – (Direction for long-distance pipelines for the transport of hazardous liquids – RFF –)

ASTM A 370 [5] Standard Methods and Definitions for Mechanical Testing of Steel Products

## 3 Definitions

Pipes for long-distance pipelines within the meaning of this Standard are pipes used for the construction of pipelines for combustible liquids (e.g. for crude oil and petroleum products) as well as for compressed and liquified combustible gases.

## 4 Material

The choice of steel grade and of type of pipe (e.g. seamless or welded) is left to the purchaser. This Standard is concerned with the steel grades specified in Tables 1 and 3, which are characterized in the main by their yield point and tensile strength at room temperature as well as by their absorbed energy at 0 °C.

Table 3 lists the steel grades in the relevant specifications of the American Petroleum Institute (API) which are approximately comparable to the steel grades according to this Standard.

## 5 Designation

**5.1** The code numbers of the steel grades have been compounded in accordance with Section 2.1.1.4 of the Explanations in the Normenheft 3, and the material numbers according to DIN 17 007 Part 2.

**5.2** The code number or the material number of the steel grade shall be entered in the standard designation of the product according to the following examples:

Designation of a seamless steel pipe of 273 mm outside diameter and 6.3 mm wall thickness according to DIN 2448, of StE 240.7 steel, material number 1.0457:

Pipe DIN 2448 – StE 240.7 – 273 x 6.3
or Pipe DIN 2448 – 1.0457 – 273 x 6.3

Designation of a welded steel pipe of 508 mm outside diameter and 8 mm wall thickness according to DIN 2458 of StE 320.7 TM steel, material number 1.0430:

Pipe DIN 2458 – StE 320.7 TM – 508 x 8
or Pipe DIN 2458 – 1.0430 – 508 x 8

The letters TM in the code number signify that the steel in question has been thermo-mechanically treated.

## 6 Requirements

### 6.1 Manufacturing process

#### 6.1.1 Smelting process

**6.1.1.1** The steels according to this Standard shall be smelted according to the oxygen blowing process, in an open hearth furnace or in an electric furnace.

**6.1.1.2** Unless otherwise agreed when ordering, the smelting process shall remain at supplier's discretion, within the limitations of these provisions, but it shall be revealed to the purchaser at the latter's request.

#### 6.1.2 Type of deoxidation

The steels StE 210.7 and StE 240.7 may be ordered and supplied as killed steels (R) or as specially killed steels (RR) (see Footnote 5 in Table 1).

All other steels are always supplied specially killed (see Footnote 7 in Table 1).

#### 6.1.3 Shaping and welding process

**6.1.3.1** Seamless pipes are manufactured from untreated or normalized steels according to Table 1 of this Standard, generally by hot rolling, hot pressing or hot drawing. The manufacture can however also be carried out by cold rolling or cold drawing.

**6.1.3.2** The welded pipes according to this Standard are generally manufactured by double-sided submerged arc fusion welding, or by electric pressure welding in the form of longitudinal welds or spiral welds, from suitably curved strip or plate.

The factory which manufactures welded pipes must dispose of suitable facilities in order to be able to execute, test and supervise the welding work flawlessly and irreproachably. The proof of this must be adduced in the form of a process testing. This proof shall only be valid in respect of those materials, analysis and dimension ranges as well as welding processes which are specifically named in the competence certificate issued on the strength of the successful process testing. If the above-mentioned pre-conditions change, it will be neccessary to apply for the relevant addenda to the certificate.

---

[3] See page 1

[4] Carl Heymanns-Verlag, Köln

[5] American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19 103

[6] The requirement for normalizing shall be deemed satisfied if a condition equal to the normalized condition has been achieved by a controlled temperature command during and after the rolling process.

Table 1. **Chemical composition of steels (ladle analysis)** [1]

| Steel grade | | Kind of deoxidation [2] | Chemical composition in % by wt. | | | | | Others |
|---|---|---|---|---|---|---|---|---|
| Code number | Material number | | C [3] | Si | Mn [3], [4] | P | S | |
| | | | maximum | | | maximum | | |
| **Untreated (see Section 6.2.1.1 a) or normalized steels** | | | | | | | | |
| StE 210.7 | 1.0307 | R [5] | 0.17 | 0.45 | ≧ 0.35 | 0.040 | 0.035 | – |
| StE 240.7 | 1.0457 | R [5] | 0.17 | 0.45 | ≧ 0.40 | 0.040 | 0.035 | |
| StE 290.7 | 1.0484 | RR [6] | 0.22 | 0.45 | 0.50 to 1.10 | 0.040 | 0.035 | |
| StE 320.7 | 1.0409 | RR [6] | 0.22 | 0.45 | 0.70 to 1.30 | 0.040 | 0.035 | |
| StE 360.7 | 1.0582 | RR [6] | 0.22 | 0.55 | 0.90 to 1.50 | 0.040 | 0.035 | 7) |
| StE 385.7 | 1.8970 | RR [6] | 0.23 | 0.55 | 1.00 to 1.50 | 0.040 | 0.035 | |
| StE 415.7 | 1.8972 | RR [6] | 0.23 | 0.55 | 1.00 to 1.50 | 0.040 | 0.035 | |
| **Thermo-mechanically treated steels** | | | | | | | | |
| StE 290.7 TM | 1.0429 | RR [7] | 0.12 [8] | 0.40 | 0.50 to 1.50 | 0.035 | 0.025 | 7) |
| StE 320.7 TM | 1.0430 | | 0.12 [8] | 0.40 | 0.70 to 1.50 | 0.035 | 0.025 | |
| StE 360.7 TM | 1.0578 | | 0.12 [8] | 0.45 | 0.90 to 1.50 | 0.035 | 0.025 | |
| StE 385.7 TM | 1.8971 | | 0.14 [8] | 0.45 | 1.00 to 1.60 | 0.035 | 0.025 | |
| StE 415.7 TM | 1.8973 | | 0.14 [8] | 0.45 | 1.00 to 1.60 | 0.035 | 0.025 | |
| StE 445.7 TM | 1.8975 | | 0.16 [8] | 0.55 | 1.00 to 1.60 | 0.035 | 0.025 | |
| StE 480.7 TM | 1.8977 | | 0.16 [8] | 0.55 | 1.10 to 1.70 | 0.035 | 0.025 | |

1) Elements not featured in this Table may not be intentionally added to the steel without purchaser's consent, other than for the purpose of finish-treatment of the melt. All suitable precautions shall be taken to avoid the introduction of any such elements from the scrap or from any other substances used during manufacture, because such elements may adversely affect the mechanical properties and the usability.

2) R = killed (semi-killed steel is not included herein),
RR = specially killed.

3) For every reduction of the maximum C content by 0.01 %, a corresponding increase of the maximum manganese content by 0.05 % is permissible, but only up to 1.9 % Mn maximum.

4) In the case of wall thicknesses > 15 mm, the specified manganese content may be exceeded by 0.10 % in the case of thermo-mechanically treated steels.

5) These steels can also be supplied specially killed by agreement; in this event the steel grades shall be designated RRStE 210.7 (material number 1.0319) resp. RRStE 240.7 (material number 1.0459).

6) The steels contain an adequate aluminium content to achieve the necessary fineness of grain, i.e. as a general rule ≧ 0.020 % $Al_{met}$.

7) In order to attain the mechanical properties and a fine-grained structure, steels StE 360.7, StE 385.7 as well as StE 415.7 may, and all thermo-mechanically treated steels must contain adequate of e.g. vanadium and niobium, in addition to aluminium. These materials may in part only be present in trace form. The sum total of these additives, in the case of wall thicknesses ≦ 15 mm, shall not exceed 0.15 % in the case of steels StE 360.7, StE 385.7 as well as StE 415.7, 0.16 % in the case of steels StE 290.7 TM, StE 320.7 TM as well as StE 360.7 TM, and 0.18 % in the case of the remaining thermo-mechanically treated steels; in the case of wall thicknesses > 15 mm, the sum total of these additives shall not exceed 0.17 % in the case of steel StE 360.7, 0.18 % in the case of steels StE 385.7 and StE 415.7, 0.17 % in the case of steels StE 290.7 TM, StE 320.7 TM as well as StE 360.7 TM, and 0.20 % in the case of the remaining thermo-mechanically treated steels. The vanadium content shall be ≦ 0.12 % in every case.

8) The C content shall not be less than 0.04 %.

Table 2. **Permissible variations of product analysis from the limiting values applicable to the ladle analysis**

| Element | Permissible variation of product analysis from the limiting values of the ladle analysis 1) |
|---|---|
| C | $^{+0,02}_{-0,01}$ |
| Si | $^{+0,03}_{0}$ |
| Mn | ± 0,06 |
| P | $^{+0,005}_{0}$ |
| S | $^{+0,005}_{0}$ |

1) For a melt, the variation of an element, in the event of several product analyses, may only be situated either below the minimum value or only above the maximum value of the range specified for the ladle analysis, but not both simultaneously.

As regards the starting material (plate or strip), the manufacturer shall furnish first-hand proof that the requirements specified in this Standard will be met with certainty.

The manufacture of the strip and plate shall be adequately supervised by the manufacturer.

The plate or strip from steels which have not been treated thermo-mechanically must be normalized 6), in so far as the complete pipe is not normalized according to Section 6.2.1.2b) 6) or c).

The plate or strip from thermo-mechanically treated steels shall be used in this condition. Any heat-treatment of finished pipes made from these steels may only be carried out after consultation with the manufacturer.

The welding shall be carried out in such a way that the weld is completely welded through in all cases, and that a weld quality rating of $v = 1.0$ is achieved.

In the case of fusion welded pipes, the welds must be welded from both sides.

In the case of pressure welded pipes, the upsetting burr must be machined off, both outside and inside (see Section 6.7.1.2.2).

If necessary, the welded pipes shall be processed to their final dimensions by expanding or sizing rolling. The cold working involved shall not however exceed an amount equal to 1.7 %.

**6.1.3.2.1** Local repairs are permissible on all welds of welded pipes. However, a non-destructive testing must be carried out after any repair work.

**6.1.3.2.2** The procedure to be adopted for the repair of welds and the type of the non-destructive testing of the repairs to be adopted shall be mutually agreed with the expert inspector before the start of pipe manufacture, taking the data of Section 7.5.8 into account.

The internal hydraulic test (see Section 7.3.6) shall be repeated.

6) See page 2.

7) These testings are intended to assess the behaviour of the pipes under stress conditions resembling as closely as possible the actual service conditions, but as a general rule their results cannot be expressed numerically.

### 6.2 "As-delivered" condition of the pipes

**6.2.1** The pipes manufactured from untreated or normalized steels shall as a general rule be supplied in the condition resulting from the shaping process according to Section 6.1.3, according to the details below.

**6.2.1.1** Seamless pipes:

a) Untreated, after a hot forming operation by rolling, pressing or drawing, on condition that said hot forming operation achieves an irreproachable structure condition with adequate uniformity without any further treatment;

b) Normalized. Cold rolled or cold drawn pipes must be normalized in every case.

**6.2.1.2** Welded pipes:

a) Pipes welded from normalized 6) and subsequently cold curved plate or strip, no further heat-treatment;

b) Pipes welded from normalized 6) and subsequently hot curved plate or strip under controlled temperature command, no further heat-treatment;

c) Pipes welded from hot or cold curved plate or strip and normalized;

d) In the case of electrically pressure welded pipes which are not normalized around the entire periphery, an annealing of the weld must be carried out in order to achieve as uniform as possible a distribution of the strength properties.

**6.2.1.3** If a heat-treatment differing from the date in Section 6.2.1 is demanded, this must be agreed when ordering.

**6.2.2** Pipes welded from cold curved thermo-mechanically treated plate or strip are supplied without any subsequent heat-treatment.

In the case of electrically pressure welded pipes, however, an annealing of the weld is carried out as a general rule, in order to achieve as uniform as possible a distribution of the strength properties.

### 6.3 Chemical composition

**6.3.1** Table 1 gives a synopsis of the chemical composition of the steel grades. Minor variations from the values specified for the ladle analysis are permissible, on condition that the service properties are not impaired thereby.

Table 3. Mechanical properties in the "as-delivered" condition [1]

| Steel grade: Untreated (see Section 6.2.1.1 a) or normalized steels | | Steel grade: Thermo-mechanically treated steels | | Yield point [2], [3], [4] N/mm² min. | Tensile strength [3], [5] N/mm² | Permissible yield point ratio | Elongation [6] ($l_0 = 5\,d_0$) % min. | Absorbed energy | Diameter of bending mandrel for the folding test on fusion welded pipes [7] | Flattening test on pressure welded and seamless pipes | Comparable steel according to API Standard | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Code number | Material number | Code number | Material number | | | | | | | | 5 L | 5 LX | 5 LS |
| StE 210.7 | 1.0307 | – | – | 210 | 320 to 440 | ≦ 0.85 | 26 | see Table 4 | 2 $s$ | see Section 7.5.4 | A | – | A |
| StE 240.7 | 1.0457 | – | – | 240 | 370 to 490 | | 24 | | 2 $s$ | | B | – | B |
| StE 290.7 | 1.0484 | StE 290.7 TM | 1.0429 | 290 | 420 to 540 | | 23 | | 3 $s$ | | – | X 42 | X 42 |
| StE 320.7 | 1.0409 | StE 320.7 TM | 1.0430 | 320 | 460 to 580 | | 21 | | 4 $s$ | | – | X 46 | X 46 |
| StE 360.7 | 1.0582 | StE 360.7 TM | 1.0578 | 360 | 510 to 630 | | 20 | | 4 $s$ | | – | X 52 | X 52 |
| StE 385.7 | 1.8970 | StE 385.7 TM | 1.8971 | 385 | 530 to 680 | | 19 | | 5 $s$ | | – | X 56 | X 56 |
| StE 415.7 | 1.8972 | StE 415.7 TM | 1.8973 | 415 | 550 to 700 | ≦ 0.85 [8] ≦ 0.90 [3] | 18 | | 5 $s$ | | – | X 60 | X 60 |
| – | – | StE 445.7 TM | 1.8975 | 445 | 560 to 710 | ≦ 0.90 [3] | 18 | | 6 $s$ | | – | X 65 | X 65 |
| – | – | StE 480.7 TM | 1.8977 | 480 | 600 to 750 | ≦ 0.90 [3] | 18 | | 6 $s$ | | – | X 70 | X 70 |

1) Make sure by competent further processing of the pipes that the specified limiting values are neither exceeded nor fallen short of.

2) In the case of a clearly defined yield point, the upper yield point shall apply, in the other case the yield limit for 0.5 % total elongation ($R_{t\,0.5}$).

3) If the value determined for the yield point for steel StE 415.7 TM is higher than 520 N/mm², or higher than 555 N/mm² for steel StE 445.7 TM, or higher than 600 N/mm² for steel StE 480.7 TM, then the yield point ratio must be ≦ 0.85 (see also Footnote 5) (see also Explanations).

4) The values can be considered valid for calculation for temperatures up to 50 °C.

5) Exceeding the upper limiting value by 30 N/mm² may not be objected. This applies to untreated or normalized steels StE 210.7 to StE 320.7 inclusive, but only on condition that the ratio of yield point to tensile strength does not exceed the value of 0.80.

6) These values apply to transverse specimens taken from the parent metal. Where longitudinal specimens are tested (see Fig. 1), the values of elongation to be achieved must be 2 units higher.

7) $s$ = wall thickness of pipe, bending angle = 180° (see Section 7.4.2.3).

8) This value applies to steel grade StE 415.7 (see also Footnote 5).

Table 4. **Minimum values of absorbed energy (ISO-V specimens) at 0 °C**

| Nominal outside diameter $d_a$ mm | Type of pipe | Location from which specimen is cut | Position of specimen | Absorbed energy at 0 °C | |
|---|---|---|---|---|---|
| | | | | Mean value J 1), 2) min. | Individual value J 2) min. |
| Up to 500 3) | Seamless<br>Pressure welded<br>Fusion welded | Parent metal | Longitudinal to pipe axis (see Fig. 1) | 47 | 38 |
| over 500 | Seamless<br>Pressure welded<br>Fusion welded | Parent metal | Transverse to pipe axis (see Fig. 1) | 27 4) | 22 4) |
| over 500 | Welded | Weld | Transverse to weld axis (see Fig. 1) | 27 | 22 |

1) Mean value from 3 tests

2) See Section 7.5.3.

3) In special cases where pipes with outside diameters of 300 to 500 mm and wall thicknesses of 6.3 mm and over are concerned, the verification of the absorbed energy may be agreed in the circumferential direction when ordering. In this event, the values of absorbed energy must also be agreed.

4) In the case of steel grades StE 385.7 (1.8970), StE 385.7 TM (1.8971), StE 415.7 (1.8972), StE 415.7 TM (1.8973), StE 445.7 TM (1.8975) and StE 480.7 TM (1.8977), the minimum values shall be 31 J for the mean value and 24 J for the individual value.

**6.3.2** In the event of a verification on the pipe according to Section 7.4.1, the variations according to Table 2 are permissible in respect of the data specified in Table 1, unless otherwise agreed when ordering.

### 6.4 Mechanical properties

**6.4.1** The data in Table 3 and Table 4 as well as of Section 6.4.2 apply to the testing of the mechanical properties according to Sections 7.4.2, 7.5.2 and 7.5.3. The minimum values of yield point and tensile strength specified for the longitudinal direction also apply to the circumferential direction.

**6.4.2** In the case of the absorbed energy the testing at 0 °C on ISO-V specimens according to the data given in Sections 7.3.4 and 7.5.3, the minimum values specified in Table 4 must be attained.

In addition, the absorbed energy on DVM specimens taken from plate or strip at right angles to the main direction of rolling shall amount at least to 27 J at 0 °C, without any necessity to adduce proof of this value on the occasion of the acceptance testing.

In the case of gas pipelines with larger diameter and higher pressure, it may be found necessary to agree higher values than those specified in Table 4 (see Section 5. of the Explanations).

### 6.5 Technological properties

The pipes must satisfy the requirements of the technological testings 7) prescribed according to Sections 7.3.5 and 7.3.6 (see Table 3). On the occasion of these testings, no inadmissible cracks, scabs, shuts, laminations and other flaws shall make their appearance.

### 6.6 Weldability

The pipes of all steel grades according to this Standard are by preference suitable for arc fusion welding and flash butt welding as well as for electric pressure welding. In the case of gas fusion welding, the peculiarities of a high heat adduction, particularly in the case of thermo-mechanically treated steels, must be taken into account. One should however bear in mind that the behaviour of a steel during and after welding does not depend solely on the material itself, but also on the conditions prevailing during the welding of the pipes, and that it can be adversely affected by these conditions.

### 6.7 Condition of the surfaces and of the weld

**6.7.1** The pipes shall exhibit a smooth external and internal surface, in keeping with the kind of manufacture.

**6.7.1.1** Minor surface irregularities caused by the manufacturing process, such as buckles or dimples or shallow grooves are permissible, on condition that the wall thickness remains within the permissible dimension variations according to Section 6.8.2.2, and that the usability of the pipes is not seriously impaired thereby.

In the case of pressure welded pipes, staggered bevel edges of welds, in respect of which the reduction in cross-sectional area exceeds the permissible limit by which the wall thickness may fall short of according to Section 6.8.2.2, are not permissible.

**6.7.1.2** The weld reinforcement shall not exceed the following values.

7) See page 4

6.7.1.2.1 In the case of fusion welded pipes:

up to 8 mm wall thickness . . . . . 2.5 mm,
over 8 up to 14 mm wall thickness . . . . . 3.0 mm,
over 14 mm wall thickness . . . . . 4.0 mm.

6.7.1.2.2 In the case of pressure welded pipes:

After working off the upsetting bulge, the weld reinforcement shall not exceed 0.3 mm + 0.05 · $s$ ($s$ = nominal wall thickness in mm) both internally and externally.

6.7.1.3 The weld surface of fusion welded pipes shall be uniformly fine to medium-scaly.

6.7.2 The condition of the welds of fusion welded pipes must meet the requirements according to the Stahl-Eisen-Prüfblatt (Steel-Iron Test Leaflet) 1916, whilst the condition of the welds of pressure welded pipes shall meet the requirements according to the Stahl-Eisen-Prüfblatt 1917.

The internal and external condition of the frontal edge areas of pipes destined for circumferential welds shall be free of any defects which might impair the pipe joint welds, on all the pipes. The testing and valuation according to the Stahl-Eisen-Prüfblätter 1916 and 1917 also apply to seamless pipes.

6.7.3 The suitably executed removal of surface flaws of minor depth is permissible on condition that suitable means are used for this purpose, and in so far as the wall thickness remains above the minimum permissible wall thickness according to Section 6.8.2.2 (see also Sections 6.1.3.2.1 and 6.1.3.2.2). The caulking of surface flaws is not permissible.

### 6.8 Dimensions, weights and permissible variations

#### 6.8.1 Dimensions

The following standards apply:

– in the case of seamless pipes, DIN 2448,
– in the case of welded pipes, DIN 2458.

#### 6.8.2 Permissible dimension variations

6.8.2.1 The data in Table 6 (see Section 7.5.9.1) apply to the permissible diameter variations on the body of the pipe resp. at the ends of the pipe:

6.8.2.2 The permissible wall thickness variations amount to:

– in the case of seamless pipes
with nominal outside diameters $d_a$
up to 130 mm ± 10 % of the wall thickness $s$
above 130 mm ± 12.5 % of the wall thickness $s$

– in the case of welded pipes
with nominal wall thicknesses $s$
up to 10 mm: $^{+0.45}_{-0.35}$ mm [8]
above 10 mm: – 0,50 mm

The upper limit is specified by the permissible weight variations.

The variations are permissible within one and the same cross-section.

The minimum wall thickness which results from the permissible shortfalls on wall thickness mentioned above may in addition be compounded by a further 5 % shortfall on the nominal wall thickness at a few individual locations, namely on lengths of piping not exceeding twice the pipe outside diameter, but limited to 300 mm length maximum. This concession is intended in the first place to apply to locally limited spots which may have arisen as a result of the manufacturing process or of the grinding down of flaws. (See Section 6.7.1.2 in respect of permissible weld reinforcements.)

#### 6.8.3 Lengths

A distinction is made between

a) Factory lengths:
The pipes are delivered according to the minimum average lengths specified in Table 5, depending on the purchase order, and the length of the individual pipes must be situated within the associated length group.

Table 5. **Minimum average lengths and length groups**

| Minimum average length m | Length group m |
|---|---|
| 6 | 3 to 8 |
| 8 | 4 to 11 |
| 11 | 5.5 to 14 |
| 13.5 | 6.5 to 16.5 |
| 14.5 | 7.5 to 18 |

Any shortfall on the minimum lenght and/or exceeding of the maximum length of a length group will only be tolerated on condition that this has been agreed when ordering.

b) Fixed lengths: The specified dimension is met within a variation of ± 500 mm.

c) Precision lengths with smaller permissible variations than those of the fixed lengths may be agreed when ordering.

#### 6.8.4 Out-of-roundness $U$

6.8.4.1 The pipes shall be circular as near as possible. The out-of-roundness shall not exceed the values of Table 6. The out-of-roundness shall be determined (see Section 7.5.9.2) according to the formula below (for explanation of the symbols, see DIN 2413, June 1972 issue, sections 2.2 and 4.7):

$$U = 200\frac{\hat{d}_a - \check{d}_a}{\hat{d}_a + \check{d}_a} \text{ in \%}$$

6.8.4.2 Flat spots or ridges resulting from the curving of plates or strips shall not exceed the values listed below, at a distance up to 50 mm from the weld – in the case of spiral welds, the distance shall be measured parallel to the pipe axis, in the case of longitudinal welds it shall be measured at right angles to the pipe axis:

below 7.5 mm wall thickness . . . 2.5 mm,
from 7.5 up to 18.0 mm wall thickness . . . 1/3 · wall thickness,
above 18.0 mm wall thickness . . . 6.0 mm.

8) In the case of pipes manufactured from heavy plate, the upper limit is given by the permissible weight variation.

### 6.8.5 Straightness and execution of ends

The pipes shall appear straight to the eye. Any special requirements in respect of straightness must be agreed. In cases of doubt, the variation in respect of straightness shall not exceed 2 mm per 1000 mm pipe length, measured over the entire length of the pipe.

Absolute straightness cannot be guaranteed.

The pipe ends shall be cut at right angles to the pipe axis, they shall be free of burrs.

In the case of butt weld joints, the welding bevel at the pipe ends shall be executed as follows:

- The chamfering angle of the weld bevel shall amount to $30° \; {}^{+5°}_{0}$
- The width of the remaining end face shall amount to 1.6 mm ± 0.8 mm.

### 6.8.6 Weights and permissible variations

The following standards apply to weights:

in the case of seamless pipes, DIN 2448

in the case of welded pipes, DIN 2458

The following variations in respect of these weights are permissible:

- for an individual pipe $\; {}^{+10}_{-8}$ %,
- for a waggon load of at least 10 t ± 7.5 %.

## 7 Testings and test certificates

### 7.1 General

Pipes according to this Standard are supplied together with an acceptance testing. The confirmation of these testings is certified by means of a test certificate A, B or C according to DIN 50049, depending on the agreement when ordering (see Section 7.7.1). The purchaser must if appropriate take into account the provisions relating to any certificates required by the Standards or other Codes of Practice relating to the laying of the pipes [1].

### 7.2 Place of testing

The pipes shall be tested at manufacturer's works, preferably in such a way that the normal manufacturing sequence is not unduly disturbed.

### 7.3 Extent of testing

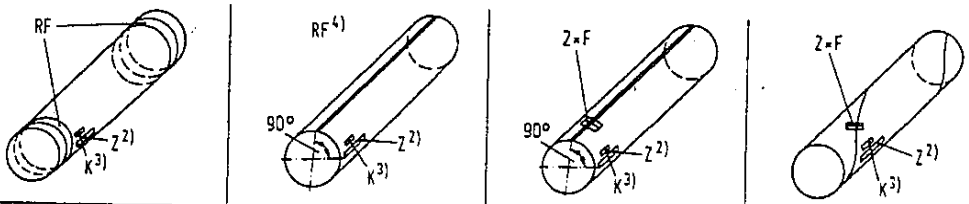
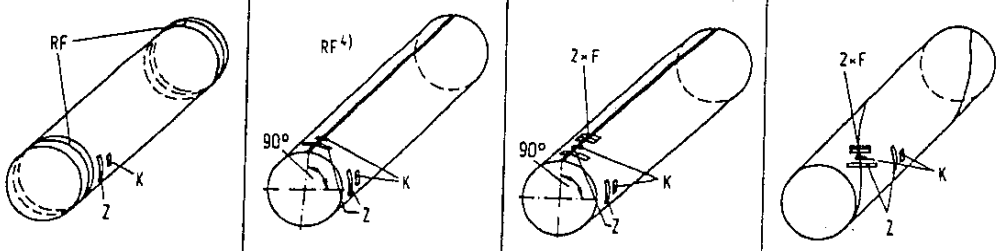
7.3.1 With the exception mentioned in Section 7.3.5.2, the pipes shall be tested in batches. For this purpose, the pipes shall be segregated according to steel grade and as far as possible also according to dimensions, and shall be sorted into batches of the following size:

up to 500 mm nominal outside diameter 100 pieces

over 500 mm nominal outside diameter 50 pieces

The batches shall be put together in such a way that the requirements according to Section 7.3.3.1 can be met.

1) See page 1

| Nominal outside diameter $d_a$ mm | Seamless pipes | Pressure welded pipes | Fusion welded pipes with | |
|---|---|---|---|---|
| | | | longitudinal weld | spiral weld |
| ≦ 500 | $N$ [1] = 1/100   | | | |
| > 500 | $N$ [1] = 1/50   | | | |

1) $N$ = Number of pipes per batch to be selected as a general rule (see Section 7.3.3.1 and Section 7.3.3.2).

2) At manufacturer's choice, transverse specimens may also be taken for the tensile test.

3) Pay attention to Footnote 3 in Table 4.

4) In addition, two flattening specimens each shall be taken from both ends of each coil length (see Section 7.3.5.2).

Figure 1. Locations at which specimens are taken, and position of specimens (F = folding specimen according to DIN 50121 Part 1, K = set of 3 each ISO V notch bar impact specimens according to DIN 50115 [see Section 7.4.2.2], Z = tensile specimen [see Section 7.4.2.1], RF = flattening specimens according to DIN 50136)

Remnants amounting up to 50 % of the batch sizes may be uniformly distributed over the individual batches. Piece numbers and remnants exceeding 50 % as well as quantities delivered which amount to less than 50 % of the batch sizes, shall be deemed to represent a self-contained batch.

**7.3.2** In cases where the subsequent testing of the chemical composition on the finished pipe has been agreed when ordering, the extent of testing must also be agreed on this occasion.

**7.3.3** The extent of testing for the tensile test must meet the following requirements.

**7.3.3.1** The pipes to be tested shall be selected by the tester from the batches in such a way that every melt forming part of the delivery is included. If this should result in batch sizes of less than 10 pipes each, then special arrangements in respect of the extent of testing may be made with the expert.

The testing of the strip joint welds of spiral welded pipes shall be carried out on batches of 50 pipes with strip joint weld.

Subject to agreement, testing may be waived if the pipes to be tested originate from a melt and manufacture in respect of which an adequate proof of quality has already been furnished by acceptance testings on other deliveries.

**7.3.3.2** One pipe from each test batch shall be tested. If necessary, a larger extent of testing can be agreed when ordering.

**7.3.3.3** In the case of welded pipes with a nominal outside diameter over 500 mm, two tensile specimens shall be taken according to the details given in Section 7.4.2, from the pipes selected for the tensile tests, otherwise one tensile specimen shall be taken (see Fig. 1).

**7.3.4** In the case of nominal wall thicknesses $\geqq 5$ mm, three ISO V notch bar specimens shall be taken from the parent metal according to the details given in Section 7.4.2, from the pipes selected for the tensile tests according to Section 7.3.3, for the purpose of carrying out the notch bar impact bending tests; in the case of welded pipes with a nominal outside diameter over 500 mm, an additional set of three ISO V notch bar specimens shall be taken from the weld (see Fig. 1 and Table 4).

**7.3.5** The extent of testing for the flattening test resp. the folding test is governed by the shaping process used for the pipes (see Fig. 1).

**7.3.5.1** In the case of seamless pipes, one specimen each shall be taken from both ends of the pipes selected for the tensile tests according to Section 7.3.3, for the purpose of carrying out the flattening test (see Fig. 1).

**7.3.5.2** In the case of pressure welded pipes, two specimens each shall be taken from both ends of each coil length, for the flattening test (see Fig. 1).

*Note: In order to avoid any possible confusion with the definition of "factory length" used in Section 6.8.3, we have used the definition "coil length" in this instance, instead of the definition "manufacturing length" used in DIN 50 136 – Flattening test on pipes – the definition "coil length" has also been similarly used in DIN 17 177 (at present circulating as draft).*

**7.3.5.3** In the case of fusion welded pipes, two folding specimens shall be taken from the pipes selected for the tensile tests according to Section 7.3.3 (see Fig. 1).

**7.3.6** All pipes shall be subjected to an internal hydraulic test at the supplier's works.

Subject to agreement between manufacturer and purchaser, another testing may be substituted instead of the internal hydraulic test, provided that its equivalence has been satisfactorily demonstrated.

**7.3.7** Every pipe shall be visually examined both inside and outside in respect of its surface condition.

**7.3.8** The following details apply to the scope of the non-destructive testings.

**7.3.8.1** The weld of all welded pipes shall be non-destructively tested according to the details in Section 7.5.8.

**7.3.8.2** In the case of all pipes provided with welding bevels for circumferential joint welds, the frontal edge areas shall be non-destructively tested according to Section 7.5.8.2.

**7.3.9** The outside or inside diameter and the wall thickness of all pipes shall be tested. In the case of welded pipes, the weld dimensions shall be checked.

### 7.4 Sampling and preparation of specimens

**7.4.1** In cases where the subsequent testing of the chemical composition on the finished pipe has been agreed when ordering, the necessary chips must be removed from across the entire wall thickness; in the case of spectral analysis, a corresponding procedure should be followed.

**7.4.2** The specimens for the tensile test, the notch bar impact bending tests as well as the flattening and folding tests shall be taken in accordance with the details given in Fig. 1. The following additional details must also be taken into consideration, and this also applies to the preparation of the specimens.

**7.4.2.1** Unless something to the contrary has been agreed (see Section 7.4.2.1.2), short proportional bars of rectangular cross-section (flat specimens) shall be taken for the tensile test on the parent metal, according to DIN 50 125 and DIN 50 140, and tensile specimens

---

9) Handbuch für das Eisenhüttenlaboratorium (Handbook for ferrous metallurgy laboratories), Vol. 2: Die Untersuchung metallischer Stoffe (Investigation of metallic materials), Düsseldorf: Verlag Stahleisen mbH, 1966; Handbuch für das Eisenhüttenlaboratorium, Vol. 5 (Ergänzungsband) (Complementary volume): A 4.1 – Aufstellung empfohlener Schiedsverfahren, B-Probenahmeverfahren, C-Analysenverfahren (Setting up of recommended arbitration procedures, B – Sampling procedures, C-Analysis procedures), most recent edition in each case Düsseldorf: Verlag Stahleisen mbH.

according to Fig. 1 of DIN 50 120 Part 1 resp. Part 2 (at present circulating as draft) shall be taken for the tensile tests on the weld.

In the case of strip joint welds on spiral welded pipes, the same provisions apply as for the other welds.

The specimens taken at right angles to the pipe axis or to the weld shall be straightened flat.

The longitudinal specimens may not be straightened within the measuring length.

In the case of specimens taken from the parent metal, local irregularities may be removed, but the rolling skin should be left intact at the thinnest spots as far as possible.

7.4.2.1.1 Subject to agreement, specimens which are to be taken in the circumferential direction may be taken from the pipes and straightened before the latter are subjected to a subsequent heat-treatment, on condition that the specimens are subjected to the same heat-treatment conditions as the pipes themselves.

7.4.2.1.2 Subject to agreement, the yield point may also be determined on a round specimen according to DIN 50 125, or by means of the hydraulic ring expansion test on an annular specimen, according to ASTM A 370.

7.4.2.2 The ISO V notch bar impact bending specimens shall in every case be taken or prepared in such a way that the longitudinal axis of the notch lies at right angles to the surface, and in the case of specimens to be taken from the weld, that the longitudinal notch axis lies at the centre of the weld.

In cases where the wall thickness is insufficient for the manufacture of standard ISO V notch impact bending specimens, then 10 mm specimens shall be taken in the case of wall thicknesses of 5 mm or less; the width of such specimens, measured in the direction of the longitudinal axis of the notch, shall be equal to the wall thickness, and they shall comply in all other respects with the standard ISO V notch impact bending specimen (see also Section 7.5.3).

7.4.2.3 When taking and preparing the specimens for the flattening test resp. the folding test, the relevant details in DIN 50 136 resp. DIN 50 121 Part 1 must be observed in addition.

The specimens for the folding test may be aged for 6 hours at 250 °C before the testing, for the purpose of removing the hydrogen.

### 7.5 Execution of the testings

7.5.1 The chemical composition shall be tested according to the methods [9] specified by the Chemist's Committee of the Verein Deutscher Eisenhüttenleute (Association of the German Ferrous Metallurgists).

7.5.2 The tensile test on the parent metal shall be carried out according to DIN 50 145, the tensile test on the weld according to DIN 50 120 Part 1 resp. Part 2 (at present circulating as draft) (see Section 7.4.2.1.2).

7.5.3 The notch bar impact bending test shall be carried out at 0 °C on ISO V notch specimens according to DIN 50 115. In the case of specimens, the width of which does not correspond to the standard width of 10 mm (see Section 7.4.2.2, final paragraph), the determined absorbed energy $A_{v,p}$ shall be converted to the absorbed energy $A_v$ (see Section 6.4.2 and Table 4) by means of the formula $A_v = 8 \cdot 10 \cdot A_{v,p}/S_p$, where $S_p$ represents the cross-section of the specimen beneath the notch.

7.5.4 The flattening test shall be carried out according to DIN 50 136; in the case of pressure welded pipes, one of the two specimens taken from both ends of the coil length shall be tested at 12 o'clock position whilst the other specimen (also taken from both ends of the coil) shall be tested at 3 o'clock position.

The specimens or pipe ends shall be squeezed together to the point where a given amount of flattening $H$ (i.e. a given distance between the two pressure plates) has been attained.

This amount in mm is given by the formula:

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

Wherein:

$s$ Wall thickness in mm

$d_a$ Outside diameter in mm and

$c$ Constant for which the following values should be used:

- 0.09 in the case of steel grades StE 210.7 and StE 240.7
- 0.08 in the case of steel grades StE 290.7 and StE 290.7 TM
- 0.07 in the case of steel grades StE 320.7 and StE 360.7 resp. StE 320.7 TM and StE 360.7 TM
- 0.06 in the case of steel grades StE 385.7 and StE 415.7 resp. StE 385.7 TM and StE 415.7 TM
- 0.05 in the case of steel grades StE 445.7 TM and StE 480.7 TM

After the amount of flattening $H$ has been attained, the test is carried on in the case of electrically pressure welded pipes until the specimen is completely flattened (see DIN 50 136). Any fracture which occurs on this occasion can serve to assess the welding joint.

7.5.5 The folding test shall be carried out according to DIN 50 121 Part 1 (January 1978 issue), fig. 7 and fig. 9, with the bending mandrel diameters specified in Table 3, up to a bending angle of 180 degrees. One specimen shall be tested with the weld root in the tension zone, whilst the other specimen shall be tested with the root in the pressure zone. Small incipient cracks at the edges of the specimen or on localized welding flaws such as pores and small inclusions shall not be rejected, on condition that they have no adverse effect on the folding behaviour of the folding specimens.

7.5.6 The internal hydraulic test shall be carried out according to DIN 50 104. The magnitude of the test pressure shall be determined according to DIN 2413, June 1972 issue, section 4.6, with a degree of utilization of the yield point normally selected at $Y' = 0.95$; a higher test pressure with a degree of utilization of the yield point situated between 0.95 and 1.0 must be specially agreed. The test pressure need not be higher than twice the permissible operating overpressure. The test pressure shall be maintained for at least 10 seconds and shall be recorded in the case of pipes with a nominal size of 200 mm and over, and it shall also be notified to the purchaser if this has been agreed (see also Section 7.3.6).

9) See page 9

7.5.7 The visual inspection of the internal and external surface shall be carried out under suitable lighting conditions. More thoroughgoing testings may be agreed in special cases.

7.5.8 The non-destructive testings shall be carried out by the manufacturer. Subject to agreement beforehand, the purchaser or an expert duly appointed by him, is entitled to witness this testing.

7.5.8.1 The non-destructive testing of the welds prescribed according to Section 7.3.8.1 shall be carried out and valuated according to Stahl-Eisen-Prüfblatt 1917 in the case of pressure welded pipes, and according to Stahl-Eisen-Prüfblatt 1916 in the case of fusion welded pipes. If the pipes are tested by means of internal hydraulic tests (see Section 7.3.6), then the non-destructive testing of the welds shall be carried out after the internal hydraulic test.

7.5.8.2 The non-destructive testing of the frontal edge areas of the pipes provided for the manufacture of circumferential joint welds and welding bevels, which is prescribed according to Section 7.3.8.2, shall also be carried out and valuated on seamless pipes according to Stahl-Eisen Prüfblatt 1916 or 1917 (both of which are identically worded in this respect).

7.5.9 The wall thicknesses shall be rechecked at the ends of the pipes with the aid of suitable measuring instruments.

7.5.9.1 In the case of pipes having a nominal outside diameter over 500 mm, the diameter variation shall be determined by measuring the circumference. In the case of pipes having a nominal outside diameter up to 500 mm, the diameter variation may be determined either by measuring the circumference or with the aid of an inside caliper gauge.

7.5.9.2 The out-of-roundness shall be determined in one cross-sectional plane with the aid of an inside caliper gauge.

### 7.6 Repeat testings

7.6.1 Pipes which fail to meet the requirements according to Sections 7.5.6 to 7.5.9 during the testings shall be rejected.

7.6.2 If one of the pipes selected fails during the acceptance testing according to Sections 7.5.2, 7.5.3 and 7.5.5, then the test which did not furnish the stipulated results shall be repeated on the same pipe. If the specifications are again not met during this repeat test, then the pipe concerned shall be rejected. In its place, two further pipes shall be selected from the batch concerned,

Table 6. **Permissible diameter variations and out-of-roundness**

| Nominal outside diameter $d_a$ mm | Max. permissible diameter variation | | | | Max. permissible out-of-roundness | |
|---|---|---|---|---|---|---|
| | Pipe body | | Pipe end [1] | | Pipe body | Pipe end [1] |
| | Welded pipes | Seamless pipes | Welded pipes | Seamless pipes | Welded and seamless pipes | Welded and seamless pipes |
| < 200 | ± 1 % $d_a$ (Values up to ± 0.5 mm are permissible in all cases) | | ± 1 % $d_a$ (Values up to ± 0.5 mm are permissible in all cases) The following values may be agreed when ordering: ± 0.5 % $d_a$ (Values up to ± 0.4 mm are permissible in all cases) | | 2 % | 2 % |
| 200 ≦ $d_a$ < 500 | ± (0.4 % $d_a$ + 1.0 mm) | ± 1 % $d_a$ | ± 0.5 % $d_a$ [2] but at most ± 1.6 mm | ± 0.7 % $d_a$ [2] | In the case of $\frac{d_a}{s} > 100$, no guarantee can be given that an out-of-roundness of 2 % max. can be complied with. | Between the limit values $\frac{d_a}{s} = 100$ ($U$ = 2 %) and $\frac{d_a}{s} = 50$ ($U$ = 1.4 %) the out-of-roundness $U$ is a linear function of the ratio of the nominal outside diameter $d_a$ to the wall thickness $s$. For $20 \leqq \frac{d_a}{s} < 50$, special arrangements can be agreed when ordering. In the case of $\frac{d_a}{s} > 100$, no guarantee can be given that an out-of-roundness of 2 % max. can be complied with. |
| 500 ≦ $d_a$ < 1200 | ± 0.5 % $d_a$ [3], but at most ± 5 mm | ± 1 % $d_a$ [3] | ± 1.6 mm [3] | | | |
| ≧ 1200 | ± 5 mm [3] | | by agreement [3] | | | |

[1] The values specified for this apply along a length of approx. 100 mm from the pipe end.
[2] Subject to an appropriate agreement when ordering, the permissible variation may also be related to the inside diameter, in which case the tolerance on the wall thickness may if necessary have to be taken into account.
[3] If nothing to the contrary has been agreed when ordering, the permissible diameter variations relate to the inside diameter.

and all prescribed testings shall be repeated on these two pipes. If a further failure should arise on this occasion, then the entire batch shall be deemed non-accepted; however it may be agreed to retest the property which failed to meet the requirements on every single pipe of the batch concerned.

If the deficient result of the testing can be improved by a heat-treatment, it shall be left to the manufacturer's discretion to decide if he wants to heat-treat a non-accepted batch and once again submit it for acceptance. If on this occasion the specimens again fail to meet the requirements, then the entire batch shall be definitively rejected.

7.6.3 If one of the specimens from a pipe should fail during the flattening test according to Section 7.5.4, then the test shall be repeated on new specimens taken from both ends of the pipe concerned, according to Sections 7.3.5.1 resp. 7.3.5.2. If one of these replacement specimens should fail, then the pipe concerned shall be rejected, and two further pipes from the test unit concerned shall be tested. If one specimen from these pipes should again fail, then the entire test unit shall be rejected. In certain circumstances, an individual testing may be agreed. Purely local flaws may be ignored in this context; however if serious flaws of the same nature should be discovered to any great extent, the presence of which must also be reckoned with on pipes which have yielded a good test result, because of the nature of such flaws, then a special decision must be taken in respect of the usability of the pipes.

### 7.7 Test certificates

7.7.1 The results of the acceptance testing shall be certified by means of a test certificate A, B or C [1] according to DIN 50049, according to the agreement made when ordering, and the certificate shall feature the "as-delivered" condition specified by the manufacturer in each case.

The results of the ladle analysis, and in certain cases of the analysis on the individual piece (see Section 7.3.2), of the non-destructive testing as well as the confirmation that the internal hydraulic test (see Section 7.3.6) has been successfully withstood, shall in principle be certified by means of an acceptance test certificate B according to DIN 50049.

7.7.2 The correlation between pipe marking and acceptance values must be clearly ascertainable from the test certificates.

## 8 Marking of the pipes

The pipes shall be marked with the manufacturer's trade mark, the code number of the steel grade, a pipe number and the tester's stamp mark. The marking shall be affixed in such a way that it will still be readily recognizable after the pipes have been lagged.

## 9 Complaints

9.1 Objections may only be raised in respect of external and internal flaws if they do more than just trivially impair the processing and use which is appropriate to the steel grade and type of product.

9.2 The purchaser must give manufacturer the opportunity to convince himself that the complainst are justified, as far as possible *) by submission of samples of the material delivered and complained about.

**Other standards and publications akin to standards:**

API 5 L Specification relating to line pipes, published by American Petroleum Institute, 28th edition, with addendum 1, March 1975 [10],

API 5 LS Specification relating to spiral welded line pipes, published by American Petroleum Institute, 8th edition, March 1975 [10],

API 5 LX Specification relating to line pipes with enhanced test requirements, published by American Petroleum Institute, 20th edition, March 1975 [10].

---

1) See page 1

*) See in this connection:
Erläuterungen zu der Beanstandungsklausel in Gütenormen für Stahl und Eisen (Explanations relating to the complaints clause in quality standards for steel and iron). DIN-Mitt. 40 (1961) pages 111/112.

10) German translation available from:
Beuth Verlag GmbH, Burggrafenstrasse 4–10, 1000 Berlin 30.

## *Explanations*

The technical development, particularly in the field of steel grades and in the field of non-destructive testing as well as the efforts made towards the international standardization of the pipes concerned, made it appear desirable to adapt DIN 17 172 to the most recent state of the art.

The present Standard is related to the following International Draft Standards published by the International Organization for Standardization (ISO):

DIS 3183

Oil and natural gas industries; Steel line pipe and

DIS 3845

Oil and natural gas industries; High-test steel line pipe.

These International Draft Standards apply solely to seamless and longitudinal welded pipes; an International Draft Standard for spiral welded pipes is in course of preparation. In addition to the subject matter contained in DIN 17 172, DIS 3183 and DIS 3845 contain details relating to the pipe dimensions (corresponding to DIN 2448 and DIN 2458) as well as to the pressure to be applied for the internal hydraulic test. The pipes according to DIS 3183 and DIS 3845 are supplied in "as rolled" condition or after being subjected to a heat-treatment (e.g. normalizing or stress-free annealing); pipes made from thermo-mechanically treated steels are not explicitly mentioned, although the addition of niobium, titanium and vanadium is possible according to DIS 3845.

As regards the strength grades, it should be mentioned that the lowest grade according to DIS 3183, which has a minimum yield point of 172 N/mm² (grade E 17), is not listed in DIN 17 172, whilst the highest strength grade according to DIN 17 172, viz. StE 480.7 TM, does not appear in DIS 3845, although it will be included in the final edition of this International Standard.

The successor issue of DIN 17 172 differs from the previously valid version of the Standard mainly in respect of the following points:

1. In the code number of the steel grades, reference is no longer made to the minimum tensile strength in kp/mm², but rather to the minimum yield point in N/mm², as in DIS 3183 and DIS 3845, which latter value is of greater significance for the calculation; thus for example St 34.7 now becomes StE 210.7. (In DIS 3183 and DIS 3845, the minimum yield points are rounded to the nearest "0" for the formation of the code number, and only the first 2 digits are featured, e.g. E 21 in the case of a minimum yield point of 207 N/mm².)
2. As regards the selection of grades, steels USt 34.7 and USt 38.7 have been deleted, whilst grades StE 385.7 and StE 415.7 have been newly adopted. In addition, the thermo-mechanically treated steels StE 290.7 TM to StE 480.7 TM have been taken additionally into consideration for welded pipes. These grades are mainly characterized by their lower carbon, phosphorus and sulphur contents, and by an exceptionally fine-grained structure, in comparison with the comparable grades of conventional steels.
3. The ratio of yield point to tensile strength was limited to $\leqq 0.85$ in the previously valid issue of DIN 17 172, dated October 1966. Such a yield point ratio cannot however always be met in the case of the very fine-grained steels StE 415.7 to StE 480.7 TM. The manufacturers have therefore requested that the permissible yield point ratio be raised to 0.9 for the above-mentioned grades. In this connection, they pointed out the exceptionally good operational behaviour of the pipes of these grades which have been laid to date in considerable quantities.

   Some users have proposed that the limitation of the yield point ratio should be deleted altogether; this was not agreed to however, in view of the American Petroleum Institute (API) specifications.

   Chiefly from the Technical Control it was considered desirable to incorporate additional conditions in the case of yield point ratios above 0.85 approximately, which would have the effect of ensuring an adequate ductility of the pipes in respect of stress relaxation, even under multi-axis stressing; the reasons for this request included the necessity for unrestricted use of the pipes even in difficult application situations such as laying of pipes in mining areas, and also the fact that an adequate amount of operational experience on steel grade StE 480.7 TM has only become available within the last few years. In the end it was decided to adopt the solution expressed in Footnote 3 of Table 3.

   On the occasion of the next revision of DIN 17 172, it will have to be examined afresh whether the data relating to the yield point ratio can be deleted altogether, or whether a uniform value of $\leqq 0.85$ can be specified for all steel grades. All interested parties are hereby requested to assemble the relevant documentation. (No limitation of the yield point ratio is specified in DIS 3183, whilst DIS 3845 prescribes a maximum value of 0.85 only in the case of cold expanded pipes of strength grades E 29 to E 45, with the additional provision that in the case of pipes of grade E 45 with a wall thickness of 9.5 mm or above, this value may be allowed to go up to 0.90.)
4. According to comparative tests carried out by the manufacturers, the minimum absorbed energy values for ISO V notch specimens reproduced in Table 4 are considered as a somewhat more stringent requirement than the previously standardized notch bar impact strength values relating to DVM specimens.

   Up to now, it was only necessary to verify the absorbed energy on welded pipes, and this involved tests on transverse specimens, taken both from the parent metal and the weld, irrespectively of the welding process or of the pipe diameter. Since then, considerations on the fracture mechanics relating to the generation of longitudinal cracks have led to the retention of the absorbed energy testing on transverse specimens taken from the parent metal only in the case of pipes with diameters over 500 mm.

   In the case of pipes with diameters up to 500 mm, the absorbed energy on the parent metal must

now be determined on longitudinal specimens.

Contrary to DIN 2470 Part 2, it may be agreed that the absorbed energy of the parent metal can also be determined on transverse specimens in the case of pipes with outside diameters from 300 to 500 mm and wall thicknesses of 6.3 mm or over.

In addition, the weld shall be tested in each case on transverse specimens, in the case of welded pipes with nominal outside diameters over 500 mm (see Table 4 and Fig. 1).

(DIS 3183 does not provide for the notch bar impact bending test at all, whilst DIN 3845 only provides for it subject to agreement.)

5. Since the end of the sixties, the phenomenon of longitudinal ductile cracks on gas pipelines has become a recognized feature. This phenomenon has been investigated and described in publications originating up to now mainly from the three Institutions named below. The appearance of such longitudinal cracks presupposes however that certain critical incipient crack lengths [11]) have been exceeded, or that some damage to the pipeline has led to a critical incipient crack. There is a consensus of opinion that after the appearance of the initial crack it requires a given notch bar impact strength to prevent the ductile propagation of the crack. It has also been shown that this required notch bar impact strength increases with increasing peripheral stress. The diameter and the wall thickness exercise on additional influence on the necessary notch bar impact strength. There are different opinions as to the magnitude of the required values.

   According to the interpretations of the Battelle Institute in USA, [11]) the ductile propagation of the crack is treated mathematically as a continuous crack initiation process. The resulting relationship for the required notch bar impact strength has however been determined empirically in its present form from numerous tests, and is not capable of extrapolation beyond the range investigated without reservations.

   The calculation assessments of the British Gas Corporation [12]) for the determination of the necessary notch bar impact strength start from the assumption of a predominantly dynamic phenomenon. In the case of the energetic consideration put forward by them, the main difficulty resides in the fact that the energy available for the propagation of the crack is very small in relation to the energy liberated on expansion of the gas. A few tests have been carried out in this case also.

   The results of the tests carried out by the American Iron and Steel Institute (AISI) [13]) confirm the dynamic aspect of the phenomenon. In addition, they make it clear that further tests will be required for the precise assessment of the individual parameters.

   The lack of uniformity in the theories and test results available to date have led amongst others to the carrying out of further investigations in Europe by a group of gas transport companies and pipe manufacturers (European Pipeline Research Group, EPRG); a report on these investigations will be published in due course.

6. In the case of electrically pressure welded pipes, it was decided to abandon the previous practice of taking two specimens from each pipe selected for the tensile test (i.e. as a general rule from 1 % of the pipes) for the purpose of carrying out the folding tests according to DIN 50121 Part 1, and of taking an additional specimen in the case of pipes up to 200 mm diameter for the ring tensile test (without determination of the tensile strength); specimens, thereof, are to be taken from the beginning and end of each coil for two annular flattening tests each, according to DIN 50136, in one case (each) with the weld at 12 o'clock position, and in the other case at 3 o'clock position. This transition to the annular flattening test was justified by the fact that the test results were less dependent on the preparation of the specimen than in the case of the folding test.

   Initial misgivings that welding defects would not be as easily revealed when using this method have been taken care of by the additional regulation that the ring must be completely pressed together above the initial amount $H$ (see Section 7.5.4), and that any fracture which might occur during this procedure can be taken into account for the assessment of the welded joint.

7. By reference to the Stahl-Eisen-Prüfblätter

   1916 Zerstörungsfreie Prüfung schmelzgeschweisster Fernleitungsrohre für brennbare Flüssigkeiten und Gase

   1917 Zerstörungsfreie Prüfung pressgeschweisster Fernleitungsrohre für brennbare Flüssigkeiten und Gase

   the most recent advances in the field of testing and valuation of pipes by non-destructive test methods have been taken into account.

---

11) Maxey, W. A., "Fracture Initiation, Propagation and Arrest", lectured on the conference of the American Gas Association, Houston, Texas, in November 1974

12) Poynton, W. A., Fearnehough, G. D., "An Analysis of Shear Fracture Propagation in Gas Pipelines", lectured on "Dynamic Crack Propagation", Bethlehem, Pennsylvania, in July 1972

13) Ives, K. D., Shoemaker, A. K., McCartney, R. F., "Pipe Deformation During a Running Shear Fracture in Line Pipe", lectured on "Pressure Vessels and Piping Conference", Miami Beach, Florida, in June 1974