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Steels with low temperature toughness
Technical delivery conditions for plate, sheet, strip, wide flats, sections, bars and forgings

DIN 17 280

Kaltzähe Stähle; technische Lieferbedingungen für Blech, Band, Breitflachstahl, Formstahl, Stabstahl und Schmiedestücke

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.

See Explanatory notes for connection with international standards and with *Stahl-Eisen-Werkstoffblatt* (Iron and steel material sheet) 680–70.

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.

1 Field of application

1.1 This standard applies to plate, sheet, strip, wide flats, sections, bars, hand forgings and drop forgings made from alloy steels with low temperature toughness, as listed in table 1, for low temperature applications. These products are predominantly used in the construction of chemical plant, vessels, pipework and for general mechanical engineering purposes.

Note. Other steels, such as fine grain structural steels as specified in DIN 17 102 and stainless austenitic steels as specified in DIN 17 440 and DIN 17 441, are also used for low temperature applications.

1.2 If products made from the steels complying with the requirements of this standard are intended for use in installations subject to regular inspection, the specifications in the relevant codes of practice shall be taken into consideration, e.g. the *Technische Regeln Druckbehälter* (Technical rules for pressure vessels), *Merkblätter der Arbeitsgemeinschaft Druckbehälter (AD-Merkblätter)* (Instruction sheets of the pressure vessels Study Group) (AD Instruction sheets), *Technische Regeln für brennbare Flüssigkeiten* (Technical rules on combustible liquids), *Technische Regeln Druckgase* (Technical rules on pressure gases). The same applies for other fields of application for which additional specifications exist.

1.3 In addition to the specifications of this standard, the general technical delivery conditions for steel specified in DIN 17 010 shall apply except where otherwise stated below.

2 Concept

2.1 For the purposes of this standard, steels with low temperature toughness are steels for which a minimum value of impact energy of 27 J at −60 °C or lower has been specified for ISO V-notch test pieces taken from the steel as supplied, in the transverse or tangential direction.

2.2 The definitions specified in EURONORM 79 shall apply for the product forms.

[1]) *DIN-Normenheft* (DIN Standardization Booklet) 3 includes notes explaining how to use symbols and material numbers for steels.

3 • Dimensions, permissible dimensional deviations, deviations of form and in mass

The nominal dimensions and the permissible dimensional deviations or, if required, the permissible deviations of form and in mass of the products shall be agreed at the time of ordering, preferably by reference to the dimensional standards applicable for this purpose (see Appendix B).

4 Masses

For mass calculation purposes, a density of 7,85 kg/dm^3 shall be taken as the basis for all steels covered by this standard.

5 Classification into grades

5.1 This standard covers the steel grades listed in table 1.

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

5.2.1 The factors taken into consideration when selecting the steel grade shall include not only the operating temperature, but also the overall stressing (including that resulting from the design or manufacturing process).

6 Designation and ordering

6.1 The standard designation for a steel complying with this standard is to be made up in accordance with the following example from

- the term "steel";
- the number of this standard;
- the symbol or material number identifying the steel grade (see table 1) [1]);
- the designation of the temper condition (see subclause 7.2.1 and tables 3 to 5 and 7).

Example:

Steel DIN 17 280 – 11 MnNi 5 3 N

or

Steel DIN 17 280 – 1.6212 N

6.2 The specifications of the appropriate dimensional standard shall apply for the standard designation of the products.

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Table 1. Chemical composition (as determined by the cast analysis)

Steel grade		% by mass										
Symbol	Material number	C	Si max.	Mn	P max.	S max.	$Al_{ges.}$ min.	Cr	Mo	Nb max.	Ni	V max.
26 CrMo 4	**1.7219**	0,22 to 0,29	0,35	0,50 to 0,80	0,030	0,025	–	0,90 to 1,20	0,15 to 0,30	–	–	–
11 MnNi 5 3	**1.6212**	max. 0,14	0,50	0,70 to 1,50	0,030	0,025	0,020	–	–	0,05	0,30[1] to 0,80	0,05
13 MnNi 6 3	**1.6217**	max. 0,16	0,50	0,85 to 1,65	0,030	0,025	0,020	–	–	0,05	0,30[1] to 0,85	0,05
14 NiMn 6	**1.6228**	max. 0,18	0,35	0,80 to 1,50	0,025	0,020	–	–	–	–	1,30 to 1,70	0,05
10 Ni 14	**1.5637**	max. 0,15	0,35	0,30 to 0,80	0,025	0,020	–	–	–	–	3,25 to 3,75	0,05
12 Ni 19	**1.5680**	max. 0,15	0,35	0,30 to 0,80	0,025	0,020	–	–	–	–	4,50 to 5,30	0,05
X 7 NiMo 6	**1.6349**	max. 0,10	0,35	0,60 to 1,40	0,025	0,020	–	–	0,20 to 0,35	–	5,00 to 6,00	0,05
X 8 Ni 9	**1.5662**	max. 0,10	0,35	0,30 to 0,80	0,025	0,020	–	–	max. 0,10	–	8,00 to 10,00	0,05

[1] The lower limit value for the nickel content may be reduced to 0,15 % for products with wall thicknesses not exceeding 30 mm.

6.3 The order shall include all information necessary for an unambiguous description of the products required and their finish and testing. If, for example, the designations as specified in subclauses 6.1 and 6.2 are not adequate for this where there are agreements relating to the subclauses marked with • and ••, the information additionally required shall be appended.

7 Requirements

7.1 Manufacturing process

7.1.1 The steels shall be produced by the basic oxygen process, by the open-hearth process, or in an electrical furnace.

A different, equivalent, process may also be employed, subject to agreement with the purchaser.

7.1.2 11 MnNi 5 3 and 13 MnNi 6 3 steels shall be specially killed (see table 1). Other steels complying with the requirements of this standard shall be fully killed.

7.2 Condition on supply

7.2.1 Heat treatment condition

7.2.1.1 The heat treatment conditions in which coils of 11 MnNi 5 3 and 13 MnNi 6 3 steels and all other products conforming to this standard are normally supplied are listed in tables 3 and 4 (see note to subclause 7.2.1.2).

The choice of the heat treatment condition from amongst those listed in tables 3 and 4 is left to the manufacturer's discretion.

An equivalent temperature control during and after hot forming may be substituted for normalizing in the case of 11 MnNi 5 3 and 13 MnNi 6 3 steels. This means that the requirements shall also be fulfilled even after a corresponding subsequent heat treatment (N or N + A).[2)]

7.2.1.2 •• It may be agreed at the time of ordering that the products be supplied in an untreated condition, in one of the heat treatment conditions specified in tables 3 and 4, or in a different condition.

Note. Coils of 26 CrMo 4, 14 NiMn 6, 10 Ni 14, 12 Ni 19, X 7 NiMo 6 and X 8 Ni 9 steels are usually supplied in the untreated condition.

7.2.2 •• Surface condition

Any surface condition differing from the as-rolled or as-forged conditions shall be particularly agreed at the time of ordering (e.g. for non-destructive testing).

2) If normalizing is replaced by an equivalent temperature control during and after hot forming, and if the products are intended for use in installations subject to regular inspection, the manufacturer shall, on first supply, provide certification that a condition equivalent to the normalized condition has been achieved. The purchaser may request such a certification only once.

Table 2. **Permissible deviations between the chemical composition determined in the product analysis and the limit values specified for the cast analysis** (In the case of forgings, this applies only for the dimensions listed in tables 3 and 4.)

Element	Limit values for the cast analysis as specified in table 1 % by mass	Permissible deviations between the results of the product analysis and the limit values for the cast analysis [1)] % by mass
C	≤ 0,29	0,02
Si	≤ 0,35 > 0,35 ≤ 0,50	0,03 0,05
Mn	≤ 0,80 > 0,80 ≤ 1,65	0,06 0,10
P	≤ 0,030	0,005
S	≤ 0,025	0,005
Al	≥ 0,020	0,005
Ni	≤ 0,85 > 0,85 ≤ 3,75 > 3,75 ≤ 5,30 > 5,30 ≤ 6,00 > 6,00 ≤ 10,00	0,05 0,07 0,10 0,12 0,15
Cr	≤ 1,20	0,10
Mo	≤ 0,10 > 0,10 ≤ 0,35	0,01 0,04
Nb	≤ 0,05	0,01
V	≤ 0,05	0,01

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

7.3 Chemical composition

7.3.1 The values specified in table 1 shall apply for the chemical composition in the cast analysis. Slight deviations from these values are permitted by agreement with the purchaser if the mechanical properties fulfil the requirements of this standard and weldability is not impaired.

7.3.2 The deviations specified in table 2 from the limit values listed in table 1 shall apply where the chemical composition is determined in the product analysis.

7.3.3 • The permissible deviations between the chemical composition of the product and the limit values specified in table 1 in the case of forgings, the dimensions of which exceed the thicknesses or diameters specified in tables 3 and 4, shall be agreed at the time of ordering.

7.4 Mechanical properties

7.4.1 For test pieces taken and prepared as specified in subclauses 8.2.3 to 8.2.5 and as shown in figures 1 to 9, the values listed in tables 3 and 4 shall apply (see also footnote 1 to table 4). The values are valid for the as delivered condition specified in subclause 7.2.1 and for the condition following normal stress relieving (see subclause 10.2).

• In the case of departures from the aforementioned conditions, the values of mechanical properties shall be agreed at the time of ordering.

7.4.2 If, following agreement at the time of ordering, the products are to be supplied in the non-heat treated condition the values of tables 3 and 4 shall apply to separately heat treated samples.

7.4.3 The equivalent diameter shall apply in the case of forgings (see DIN 17014 Part 1). The cross-sectional shapes and dimensions as shown in figures A.1 and A.2a to A.2d in Appendix A shall be assumed to correspond to the equivalent diameter.

7.5 Weldability

7.5.1 Products made from the steel grades complying with this standard are weldable, if the generally recognized rules of the art are observed, 26 CrMo 4 steel being weldable only to a limited extent.

7.5.2 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 (see DIN 8528 Part 1).

•• It may be agreed at the time of ordering to restrict the residual magnetism of 12 Ni 19, X 7 NiMo 6 and X 8 Ni 9 steels when supplied (see *DVS-Merkblatt* 1501).

7.6 Appearance of surface

7.6.1 The products shall have a smooth outside and inside surface consistent with the shaping process used.

7.6.2 Surface defects exceeding the extent permitted for imperfections shall be removed by suitable means. The resulting depressions are to be smoothed off.

•• Unless otherwise agreed at the time of ordering, this has to be done taking account of the thickness deviations laid down in the dimensional standards and of any machining allowances provided.

Note. See also EURONORM 163.

Surface defects may be repaired by welding only with the approval of the purchaser and of the inspector responsible for the acceptance test.

7.6.3 •• In the case of hot rolled round steel bars, at the time of ordering compliance with the requirements of one of the surface quality classes specified in the *Stahl-Eisen-Lieferbedingungen* (Iron and steel delivery conditions) 055 may be agreed for the permissible crack depth.

7.6.4 Within the given machining allowances, bars or forgings may exhibit surface defects.

7.7 Internal condition

7.7.1 The products shall be free from internal defects impairing their usability to a more than negligible extent.

7.7.2 •• At the time of ordering, ultrasonic testing may be agreed (see subclause 8.3.5).

8 Testing

8.1 Acceptance inspection

Supplies made on the basis of this standard shall be subjected to acceptance inspection (see subclause 8.5).

The specifications given in subclauses 8.2 to 8.5 shall apply in this respect.

8.2 Scope of test programme and sampling

8.2.1 The products shall be tested separately according to casts.

8.2.2 For verifying the mechanical properties of plate, sheet, strip, wide flats, sections and bars the following shall count as test units (see subclause 8.2.4 for forgings):

- for plate: the as rolled plate;
- for sheet cut from strip (the individual sheet being subjected to a heat treatment): the individual sheet;
- for sheet cut from strip (the individual sheet not being subjected to an additional heat treatment): the coil;
- for coiled strip: the coil;
- for wide flats [3]: 15 t, or a smaller quantity submitted for testing;
- for sections and bars [3]: 15 t, or a smaller quantity submitted for testing.

8.2.3 For the number of samples per test unit to be taken as specified in subclause 8.2.2 for carrying out the tensile test and the impact test, the specifications of subclauses 8.2.3.1 to 8.2.3.4 shall apply.

8.2.3.1 In the case of plate in supplied product lengths not exceeding 7 m per as rolled plate, one sample shall be taken from one end of each as rolled plate, whilst in the case of wide flats, sections and bars one sample per test unit shall be taken from one end of a product.

8.2.3.2 In the case of plate in supplied product lengths exceeding 7 m per as rolled plate, one sample shall be taken from both ends of each as rolled plate.

8.2.3.3 In the case of sheet cut from strip and subjected to a heat treatment, one sample shall be taken from one end of the product if the lengths supplied do not exceed 7 m and one sample each from both ends of the product if the lengths supplied exceed 7 m.

[3] The test unit is to be formed cast-wise from the products whose nominal thickness lies within the same thickness range for the yield stress specified in table 3.

Table 3. **Mechanical properties determined in the tensile test at ambient temperature** [1]

Steel grade		Heat treatment condition [2]	Upper yield stress R_{eH} [3] for product thicknesses s, in mm			Tensile strength R_m	Elongation after fracture ($L_0 = 5\,d_0$) ($L_0 = 5{,}65\sqrt{S_0}$)
			$s \leq 30$	$30 < s \leq 50$	$50 < s \leq 70$		
			for diameters d [4], in mm				
			$d \leq 45$	$45 < d \leq 75$	$75 < d \leq 105$		
Symbol	Material number		N/mm² min.			N/mm²	% min.
26 CrMo 4	1.7219	H + A	450	440	430	590 to 740	18
11 MnNi 5 3	1.6212	N or N + A	285	275	265	410 to 530	24
13 MnNi 6 3	1.6217	N or N + A	355	345	335	490 to 610	22
14 NiMn 6	1.6228	N or N + A or H + A	355	345	–	470 to 640 [5]	20 [5]
10 Ni 14	1.5637	N or N + A or H + A	355	345	335	470 to 640	20
12 Ni 19	1.5680	N or N + A or H + A	390	380	–	510 to 710 [5]	19 [5]
X 7 NiMo 6	1.6349	H + H + A	490	480	–	640 to 840 [5]	18 [5]
X 8 Ni 9	1.5662	N + N + A or H + A	490	480	470	640 to 840	18

1) • The values of thickness or diameter exceeding the values for the relevant steel grade specified in the table shall be agreed at the time of ordering.
2) N = normalized, H = hardened, A = tempered.
3) If the yield stress is not marked, the values of 0,2 % proof stress shall apply.
4) The equivalent diameter shall apply for forgings (see subclause 7.4.3).
5) For product thicknesses not exceeding 50 mm or for diameters not exceeding 75 mm.

Table 4. Requirements relating to the impact energy in the impact test on ISO V-notch test pieces [1]

Steel grade		Heat treatment condition [2]	Product thickness s or diameter d [3], in mm	Location of test pieces	Minimum values of impact energy, in J [5] [6], at test temperature, in °C													
Symbol	Material number				− 196	− 160	− 140	− 120	− 110	− 100	− 90	− 80	− 70	− 60	− 50	− 40	− 20	+ 20
26 CrMo 4	1.7219	H + A	$s \leq 50$	Longitudinal										40	40	45	50	60
			$d \leq 75$	Transverse / tangential										27	27	30	35	40
			$50 < s \leq 70$ [4]	Longitudinal											40	40	50	60
			$75 < d \leq 105$ [4]	Transverse / tangential											27	27	35	40
11 MnNi 5 3	1.6212	N or N + A	$s \leq 70$ [4]	Longitudinal										40	45	50	55	70
13 MnNi 6 3	1.6217		$d \leq 105$ [4]	Transverse / tangential										27	30	35	40	45
14 NiMn 6	1.6228	N or N + A or H + A	$s \leq 30$	Longitudinal								40	45	50	50	60	65	65
			$d \leq 45$	Transverse / tangential								27	30	35	35	40	45	45
			$30 < s \leq 50$ [4]	Longitudinal									40	45	50	50	60	65
			$45 < d \leq 75$ [4]	Transverse / tangential									27	30	35	35	40	45
10 Ni 14	1.5637	N or N + A or H + A	$s \leq 30$	Longitudinal						40	45	50	50	50	55	55	60	65
			$d \leq 45$	Transverse / tangential						27	30	35	35	35	35	40	45	45
			$30 < s \leq 50$	Longitudinal							40	45	50	50	50	55	55	65
			$45 < d \leq 75$	Transverse / tangential							27	30	35	35	35	35	40	45
			$50 < s \leq 70$ [4]	Longitudinal								40 [7]	45	50	50	50	55	65
			$75 < d \leq 105$ [4]	Transverse / tangential								27 [7]	30	35	35	35	40	45

For [1] to [7], see page 7.

Table 4. (continued)

Steel grade		Heat treatment conditions [2]	Product thickness s or diameter d [3], in mm	Location of test pieces	Minimum values of impact energy, in J [5] [6], at test temperature, in °C													
Symbol	Material number				− 196	− 160	− 140	− 120	− 110	− 100	− 90	− 80	− 70	− 60	− 50	− 40	− 20	+ 20
12 Ni 19	1.5680	N or N + A or H + A	$s \leq 30$ $d \leq 45$	Longitudinal				40	45	50	55	60	60	65	65	65	70	70
				Transverse/ tangential				27	30	30	35	40	40	45	45	45	50	50
			$30 < s \leq 50$ [4] $45 < d \leq 75$ [4]	Longitudinal					40	45	50	55	60	60	65	65	65	70
				Transverse/ tangential					27	30	30	35	40	40	45	45	45	50
X 7 NiMo 6	1.6349	H + H + A	$s \leq 30$ $d \leq 45$	Longitudinal		40	45	45	45	50	55	60	65	70	70	70	70	70
				Transverse/ tangential		27	30	30	35	35	40	45	45	50	50	50	50	50
			$30 < s \leq 50$ [4] $45 < d \leq 75$ [4]	Longitudinal			40	45	45	45	50	55	60	65	70	70	70	70
				Transverse/ tangential			27	30	30	35	35	40	45	45	50	50	50	50
X 8 Ni 9	1.5662	N + N + A or H + A	$s \leq 70$ [4] $d \leq 105$ [4]	Longitudinal	40	50	50	50	50	60	60	70	70	70	70	70	70	70
				Transverse/ tangential	27	35	35	35	35	40	40	50	50	50	50	50	50	50

1) The impact energy values shall each be determined for the lowest test temperature stated for the steel grade and product thickness concerned; the values of impact energy at elevated test temperatures shall be considered to have been demonstrated in the same determination.

2) N = normalized, H = hardened, A = tempered.

3) The equivalent diameter shall apply for forgings (see subclause 7.4.3).

4) • For larger thicknesses or diameters, the values shall be agreed.

5) Average value from three test pieces, only one individual value may be less than the specified minimum value by a maximum of 30 %.

6) The values given in subclause 8.3.3 shall apply for product thicknesses less than 10 mm.

7) This value shall apply for a test temperature of − 85 °C.

8.2.3.4 In the case of sheet cut from strip, in which the sheet is not subjected to further heat treatment, the samples shall be taken as follows: one sample each from the sheet at either end of the coil, and additionally a further sample from the sheet halfway through the coil.

8.2.3.5 If strip is supplied as a coil, it is only necessary to take one sample from the outer end of the coil.

Note. Where coils of 11 MnNi 5 3 and 13 MnNi 6 3 steels are supplied in the condition described in subclause 7.2.1.1, paragraph 3, the test required as specified in footnote 2 shall also demonstrate the uniformity of the mechanical properties over the length of the coil. (See also the note to subclause 7.2.1.2 and subclause 7.4.2).

8.2.3.6 In the case of plate, sheet, strip and wide flats, the samples for the mechanical tests shall be taken from a position at 1/4 of the product width (see figure 1). In the case of strip, the samples shall be taken at an adequate length from the end of the strip.

8.2.3.7 In the case of bars having a solid cross section exceeding 40 mm thickness or diameter, and in the case of sections, sampling for the mechanical tests shall be carried out in accordance with figures 2 to 9.

In the case of bars having a solid cross section up to 25 mm in thickness or diameter, the sample shall be taken in such a way that it may be used as a test piece with as little further working as possible. The test pieces from bars with thicknesses greater than 25 mm but not exceeding 40 mm may be taken at any point on the cross section.

8.2.3.8 For the tensile test at room temperature a test piece shall be prepared from each sample. This test piece shall be taken parallel to the main rolling direction except in the case of plate, sheet or strip equal to or exceeding 600 mm in width when they shall be taken in the transverse direction.

In the case of plate, sheet, strip and wide flats it is usual to take flat test pieces from the sample. For thicknesses up to 40 mm, the two rolled surfaces shall be generally left on the test piece. At least one rolled surface is to remain intact on rectangular test pieces of products more than 40 mm thick. Round test pieces are permitted, but should only be provided when the thickness exceeds 40 mm. These test pieces shall be taken in such a manner that their axis is situated at a distance of one quarter of the product thickness from the surface or as close to this position as possible.

8.2.3.9 In the case of plate, sheet and strip in product widths equal to or exceeding 600 mm, the impact test shall be carried out on transverse test pieces (with the longitudinal axis of the test pieces perpendicular to the main rolling direction).

In the case of strip in product widths less than 600 mm and in the case of wide flats, sections and bars, the impact test shall be carried out on longitudinal test pieces (with the longitudinal axis of the test pieces parallel to the main rolling direction).

•• In the case of strip in product widths less than 600 mm and in the case of wide flats it may be agreed that the impact test shall be carried out on transverse test pieces.

In the case of plate, sheet, strip and wide flats in product thicknesses up to 40 mm, the impact test pieces shall be taken from the region close to the product surface. In the case of product thicknesses exceeding 40 mm, the test pieces shall be taken in such a manner that their longitudinal axis is situated at a distance of one quarter of the product thickness from the surface, or as close to this position as possible.

The impact test shall not be carried out on products with a thickness less than 5 mm.

8.2.4 The following specifications shall apply with regard to the test units and to the test pieces to be taken for testing the mechanical properties of forgings.

8.2.4.1 Forgings of similar dimensions and common heat treatment from the same cast shall be collected to a single batch for testing.

8.2.4.2 Normalized or quenched and tempered forgings with individual masses not exceeding 5000 kg shall be tested by batches as shown in table 5.

Table 5. **Heat treatment mass of the individual forging and number of forgings per test batch**

Heat treatment mass of the individual forging kg	Number of forgings per test batch
Up to 15	≤150
above 15 up to 150	≤100
above 150 up to 300	≤ 50
above 300 up to 1000	≤ 25
above 1000 up to 5000	≤ 10 [1]

[1] • The number of test pieces shall be determined according to the relevant code of practice.

Forgings greater than 5000 kg in mass shall be tested individually.

8.2.4.3 The following shall apply for the number of samples to be taken for the tensile test and impact test:

- one sample from one forging per test batch of normalized forgings;
- one sample from each of two forgings per test batch of quenched and tempered forgings. One sample shall be taken from just one forging in the case of batches of ten forgings or less.

Where testing is carried out in batches, all quenched and tempered forgings shall be subjected to a hardness test.

One sample shall be taken from each end of the forging to be tested in the case of hammer forged bars or similar products 5 m or greater in length which have not been heat treated in a continuous furnace.

8.2.4.4 • The samples shall be taken as follows, depending on the agreements made at the time of ordering:

- from a single forging (which is then completely destroyed);

- from additional material provided on the forging for this purpose;
- from a test piece of similar dimensions forged in the same way and heat treated together with the actual forgings taken from the same cast.

8.2.4.5 The samples shall be taken from the cross section on the basis of the following criteria.

The test pieces shall be taken at a distance of one quarter of the diameter or (wall) thickness, but not more than 80 mm, from the surface, and at a corresponding distance from a further adjacent surface.

8.2.4.6 If appropriate, a distinction shall be made between the geometrical location of the test pieces in the forging and their position in relation to the direction of the grain flow.

The terms "longitudinal", "tangential" and "transverse" used in table 4 characterize the location of the test pieces in forgings in relation to the direction of the grain flow and, for the purposes of this standard shall be taken to mean:

longitudinal:	the longitudinal axis of the test piece lies parallel to the principal direction of the non-curved flow of the grain;
tangential:	the longitudinal axis of the test piece intersects the curved flow of the grain as a chord (and thus to some extent adopts an oblique position to it);
transverse: (see also sub-clause 8.2.4.7)	the longitudinal axis of the test piece intersects the flow of the grain at right angles. Test pieces, the longitudinal axis of which lies in the direction of an additional upset deformation (perpendicular to a broadside) of the flow of the grain (referred to as being "in the direction of thickness"), shall not be regarded as transverse test pieces.

●● In cases of doubt, sampling and the location of samples in relation to the flow of the grain shall be agreed at the time of ordering taking these requirements into consideration.

8.2.4.7 The specimens for the tensile test and the impact test shall be taken from the test piece or sample in the transverse or tangential directions as specified in subclause 8.2.4.6. Longitudinal test pieces may also be taken where diameters or edge lengths are less than 160 mm. One specimen shall be taken from each sample or test piece for the tensile test, and three separate specimens shall be prepared for the impact bending test.

8.2.5 The notch on the impact specimens shall be made perpendicular to the surface of the product in the case of all products.

8.2.6 If it has been agreed at the time of ordering that the chemical composition is to be determined by the product analysis, this analysis shall be carried out on one product per cast and delivery.

8.2.6.1 The specifications of *Stahl-Eisen-Prüfblatt* (Iron and steel test sheet) 1805 shall apply for sampling and the preparation of test pieces for the determination of the chemical composition in the product analysis. In cases of dispute, chips shall be taken at points evenly distributed over the entire cross section of the product.

8.2.7 The producer shall subject all products to a materials identity test.

8.3 Test methods to be applied

8.3.1 The chemical composition shall be tested by using the methods developed by the Chemists' Committee of the *Verein Deutscher Eisenhüttenleute* (Society of German Ferrous Metallurgy Engineers) and specified in the *Handbuch für das Eisenhüttenlaboratorium* (Handbook for the ferrous metallurgy laboratory), volumes 2 and 5; see also "Standards and other documents referred to" clause).

8.3.2 The tensile test shall be carried out at an ambient temperature of 15 to 35 °C as specified in DIN 50 145, normally using a short proportional bar having the initial gauge length $L_0 = 5{,}65\sqrt{S_0}$ (S_0 = test piece cross section) (in the case of bars and sections, round test pieces with an original gauge length of $L_0 = 5\,d_0$) as specified in DIN 50 125.

The upper yield stress shall be determined and taken as the yield stress. If a yield phenomenon is not pronounced, the 0,2 % proof stress shall be determined.

8.3.3 The impact bending test shall be carried out in accordance with DIN 50 115 on each of three ISO V-notch test pieces.

The impact energy shall always be determined at the lowest test temperature specified in table 4 for the steel grade and product thickness concerned.

The minimum values specified in table 4 shall apply for the average of 3 test pieces, but only one individual value may be less than the specified minimum value by not more than 30 %.

If the product thickness is not adequate for the production of ISO V-notch test pieces 10 mm in width, the values for products between 5 and 10 mm in thickness shall be determined on test pieces which are similar to ISO V-notch test pieces, but are between 5 and 10 mm in width. In this case, the values required are to be reduced in proportion to the cross section of the test piece.

8.3.4 ●● Unless otherwise agreed at the time of ordering, the surface finish of the products shall be assessed by visual examination, i.e. without the use of optical aids.

8.3.5 If it is agreed at the time of ordering that ultrasonic testing is to be carried out, the requirements of *Stahl-Eisen-Lieferbedingungen* 072 shall apply for universal plate, and those of *Stahl-Eisen-Prüfblatt* 1921 shall apply for forgings. Where these lack specifications, and in the case of other product forms, the conditions of testing and the requirements shall be agreed at the time of ordering.

8.4 Retests

DIN 17 010 shall apply for all products including forgings. In the case of forgings, retests may be carried out on other products from the same test unit.

8.5 Documents on materials testing

For products as specified in this standard one of the documents covered by DIN 50049, July 1982 edition, clause 3, shall be issued.

• At the time of ordering, the type of document and, if the tests are not to be carried out by the works inspector, the inspector appointed for acceptance inspection shall be named.

8.5.1 Details to be included in the document

The document shall include the following details:

a) the technical delivery conditions and technical rules with which the products supplied comply, all characteristic data, code numbers and letter symbols necessary for enabling the assignment of the test results to the various test units and supplies and possibly also to the different sampling and test conditions to be recognized;
b) the type of steelmaking process;
c) for the elements specified in table 1, the results of the cast analysis;
d) as delivered condition as specified in subclause 7.2 (stating the heat treatment temperatures for quenched and tempered or for tempered products);
e) the results of the tests to be carried out as specified in subclause 8.2.

9 Marking

9.1 The products shall be marked with

- the mark of the manufacturing works;
- the symbol for the steel grade;
- the cast number;
- the test piece number, and
- the inspector's mark.

9.2 Plate and sheet up to 5 mm thick shall be marked by stamping or by applying a paint insoluble in water, and plates over 5 mm thick by stamping. Bundled plates and strip shall be marked by means of a securely attached tag.

9.3 Plates which are not supplied bundled shall be marked on one end in such a manner that the marking is upright and therefore allows the main rolling direction to be identified. Markings applied by stamping shall be outlined with white paint.

9.4 In the case of sections and bars having metre weights not exceeding 15 kg, the marking shall be made exclusively by means of tags.

9.5 •• Any further marking to be applied shall be the subject of agreement at the time of ordering.

10 Heat treatment

10.1 Table 6 gives guideline data on temperatures for heat treatment.

10.2 Stress relieving shall be performed in the temperature range specified in table 6 with cooling in still air. The total holding period (as specified in DIN 17014 Part 1) shall not exceed (even with multiple treatments) a maximum of 150 min. With a holding period exceeding 90 min the lower limit of the temperature range should be aimed at.

11 Complaints

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

11.2 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 product objected to or samples of the products supplied.

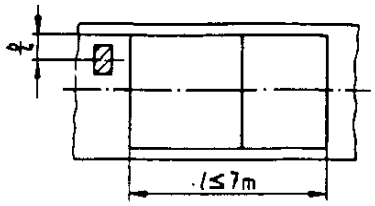
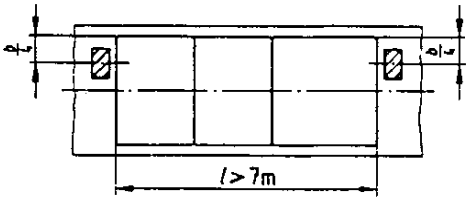
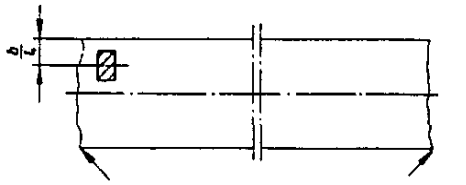
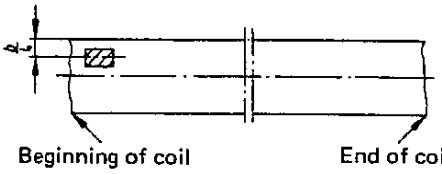
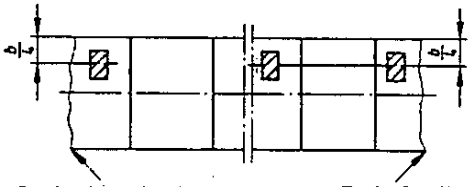
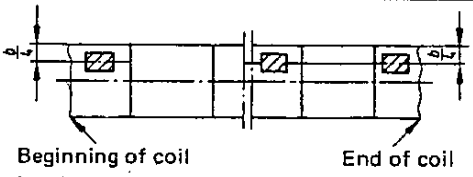
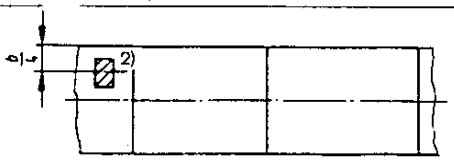
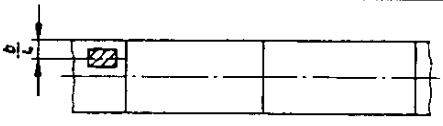
Table 6. **Guideline data for heat treatment**

Steel grade	Heat treatment	Normalizing (N) °C	Hardening (H) °C	Tempering (A) [1] °C	Stress relieving °C
26 CrMo 4	H + A	–	830 to 860	600 to 670	520 to 570
11 MnNi 5 3	N or N + A	890 to 940 890 to 940	– –	– 580 to 640	520 to 560
13 MnNi 6 3	N or N + A	890 to 940 890 to 940	– –	– 580 to 640	520 to 560
14 NiMn 6	N or N + A or H + A	850 to 900 850 to 900 –	– – 850 to 900	– 600 to 650 600 to 650	520 to 570
10 Ni 14	N or N + A or H + A	830 to 880 830 to 880 –	– – 820 to 880	– 580 to 660 580 to 660	520 to 560
12 Ni 19	N or N + A or H + A	800 to 850 800 to 850 –	– – 800 to 850	– 580 to 660 580 to 660	520 to 560
X 7 NiMo 6	H + H + A	–	850 to 920 + 690 to 740	590 to 630	520 to 570
X 8 Ni 9	N + N + A or H + A	880 to 930 + 680 to 800[2] –	– 770 to 820	540 to 600 540 to 600	[3]

1) In the case of tempering, cooling is usually in air.

2) The manufacturer shall select a tighter range within this spread, depending on the conditions present (e.g. product thickness).

3) Stress relieving after welding shall be avoided.

Product	Taking of samples For the preparation of the test pieces described in subclause 8.2, one sample shall be taken from each test unit from the positions marked by ▨	
	for	
Plate/sheet	a) supply in product lengths l not exceeding 7 m per as rolled plate	
	b) supply in product lengths l exceeding 7 m per as rolled plate	
Strip — supplied as coil	c) product widths b not less than 600 mm	
	d) product widths b smaller than 600 mm	
Strip — supplied as plate not subjected to further heat treatment [1]	e) product widths b not less than 600 mm	
	f) product widths b smaller than 600 mm	
Wide flats	g) product widths b not less than 600 mm	
	h) product widths b smaller than 600 mm	

1) For heat treated plate cut from strip and supplied in lengths not exceeding 7 m, item a) refers; for heat treated plate supplied in lengths exceeding 7 m, item b) refers.

2) Longitudinal test pieces shall be taken for the impact test (see also subclause 8.2.3.9).

Figure 1. Location of test pieces to be taken from plate, sheet, strip and wide flats for tensile testing and impact testing

Location of test pieces to be taken

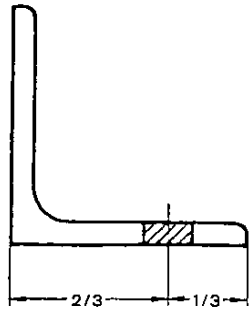


Figure 2.

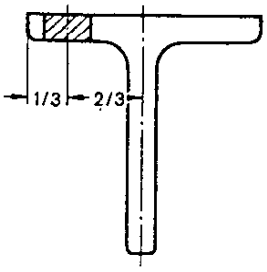


Figure 3.

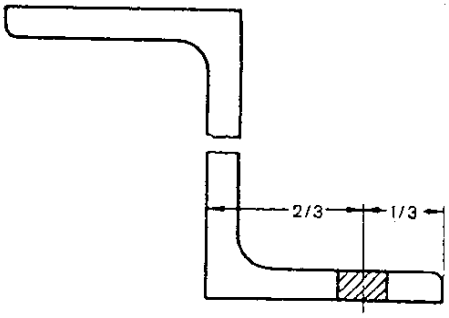


Figure 4.

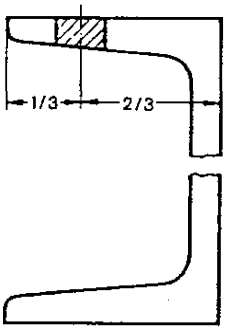


Figure 5.

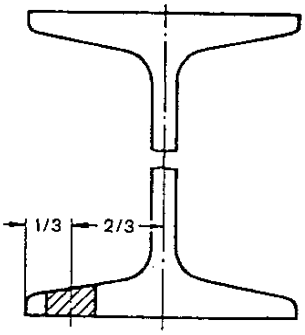


Figure 6.

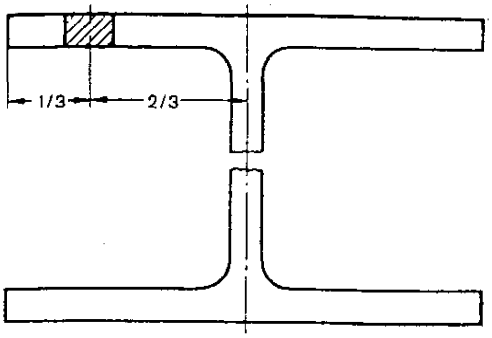


Figure 7.

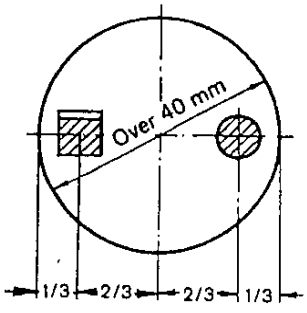


Figure 8.

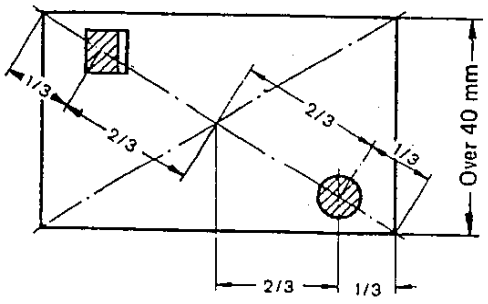


Figure 9.

Figures 2 to 9. Location of test pieces to be taken from sections and bars for tensile testing and impact testing (see subclause 8.2.4.5 for forged bars)

Appendix A

Equivalent diameter

A.1 In the case of square steel and flat steel, the equivalent diameter shall be determined as shown in figure A.1.

A.2 In the case of forgings, the equivalent diameter shall be determined as shown in figure A.2.

A.3 • For all other product forms, the equivalent diameter shall be agreed.

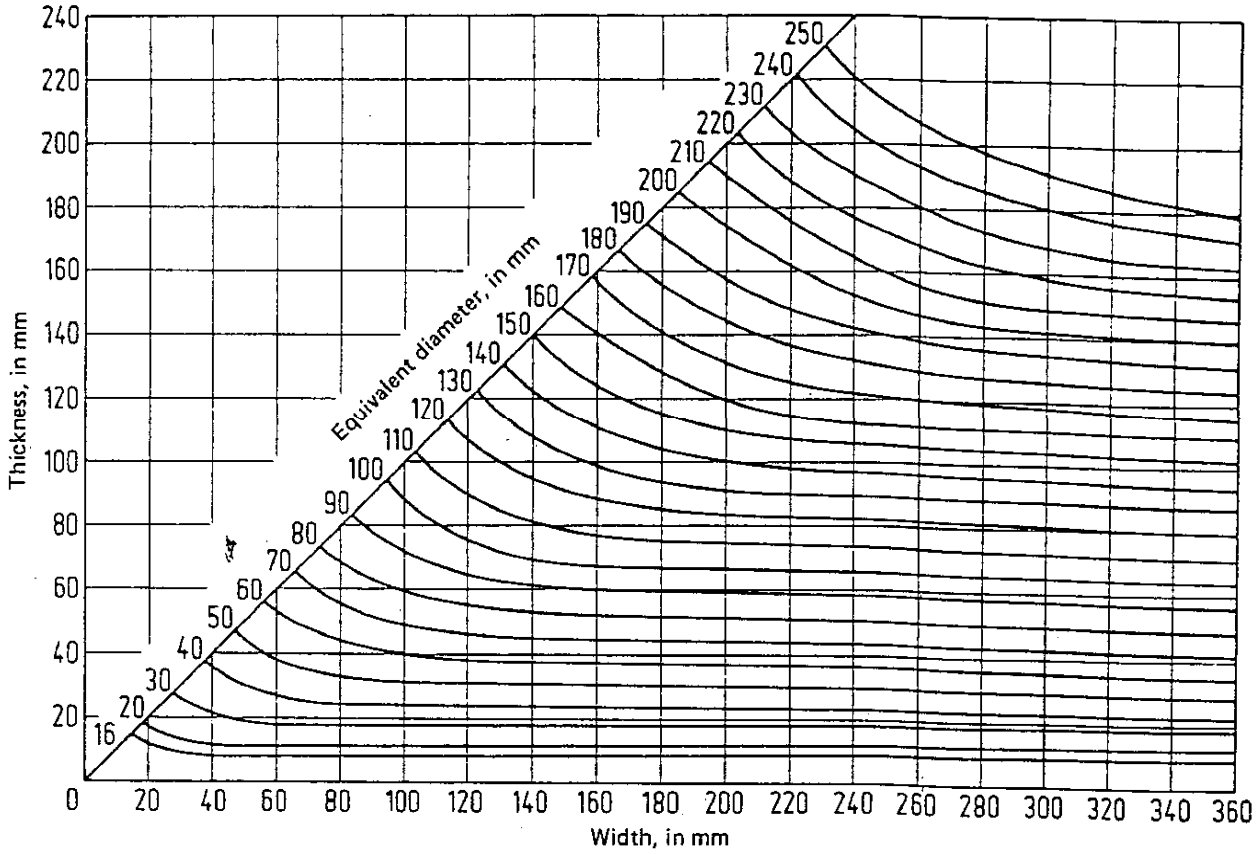
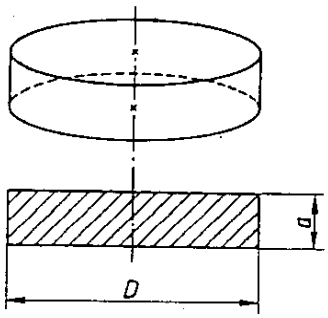


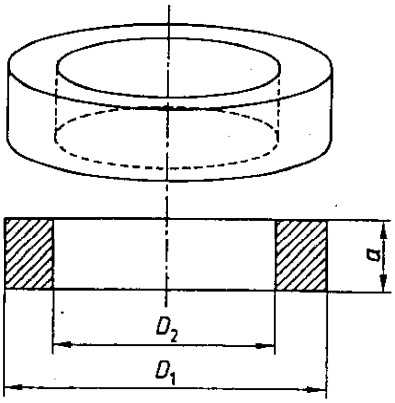
Figure A.1. Equivalent diameter for square and rectangular cross sections

Example: for a 40 mm X 60 mm flat steel, the equivalent diameter is 50 mm.

The following shall apply for determining the equivalent diameter (d):



a) in the case of compact solid parts (for example, circular discs without holes) and in the case of similar pieces with holes (with an inside diameter of the hole of up to 200 mm),
1,5 times the smallest side length, i.e.
$d = a \times 1{,}5$;



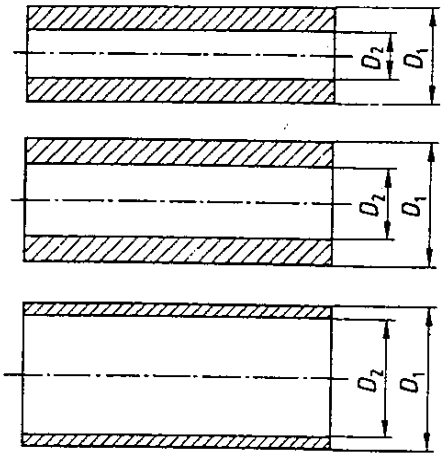
b) in the case of rings (with an inside diameter of more than 200 mm),
1,5 times the thickness,

if $\frac{D_1 - D_2}{2} < a$,

or $d = a \times 1{,}5$,

if $\frac{D_1 - D_2}{2} > a$;

c) in the case of open cylindrical hollow parts



twice the wall thickness, if the inside diameter is less than 80 mm:

$$d = \frac{D_1 - D_2}{2} \times 2;$$

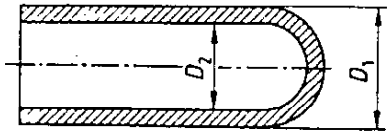
1,75 times the wall thickness if the inside diameter is between 80 and 200 mm:

$$d = \frac{D_1 - D_2}{2} \times 1{,}75;$$

1,5 times the wall thickness if the inside diameter is greater than 200 mm:

$$d = \frac{D_1 - D_2}{2} \times 1{,}5;$$

d) in the case of cylindrical hollow parts closed at one end *),



2,5 times the wall thickness:

$$d = \frac{D_1 - D_2}{2} \times 2{,}5;$$

*) Cylindrical hollow parts closed at both ends are treated as round bars (see figure A.1).

e) in the case of non-cylindrical symmetrical hollow parts, the equivalent diameter shall be determined as appropriate on the basis of item c or d above.

Figure A.2. Equivalent diameters in the case of forgings

Appendix B

Dimensional standards relating to products covered by this standard

Hot rolled and hot forged bars

DIN 1013 Part 1	Steel bars; hot rolled round steel for general purposes; dimensions, permissible dimensional deviations and deviations of form
DIN 1013 Part 2	Steel bars; hot rolled round steel for special purposes; dimensions, permissible dimensional deviations and deviations of form
DIN 1014 Part 1	Steel bars; hot rolled squares for general purposes; dimensions, permissible dimensional deviations and deviations of form
DIN 1014 Part 2	Steel bars; hot rolled squares for special purposes; dimensions, permissible dimensional deviations and deviations of form
DIN 1015	Steel bars; hot rolled hexagons; dimensions, masses, permissible deviations
DIN 1017 Part 1	Steel bars; hot rolled flats for general purposes; dimensions, masses, permissible deviations
DIN 1017 Part 2	Steel bars; hot rolled flats for special applications (bar drawing shops, screw works, etc.); dimensions, masses, permissible deviations
DIN 7527 Part 6	Steel forgings; machining allowances and permissible deviations for hand forged bars
DIN 59 130	Steel bars; hot rolled round steel for bolts and rivets; dimensions, permissible dimensional deviations and deviations of form

Bright bars

DIN 174	Bright flat steel; dimensions, permissible deviations, masses
DIN 176	Bright drawn hexagonal steel; dimensions, permissible deviations, masses
DIN 178	Bright square steel; dimensions, permissible deviations, masses
DIN 668	Bright round steel; dimensions, permissible deviations according to ISO tolerance zone h11
DIN 670	Bright round steel; dimensions, permissible deviations according to ISO tolerance zone h8
DIN 671	Bright round steel; dimensions, permissible deviations according to ISO tolerance zone h9
DIN 59 360	Ground and polished bright round steel; dimensions, permissible deviations according to ISO tolerance zone h7
DIN 59 361	Ground and polished bright round steel; dimensions, permissible deviations according to ISO tolerance zone h6

Hot rolled plate, sheet, strip and hot rolled wide flats

DIN 1016	Steel flat products; hot rolled strip, hot rolled sheet under 3 mm thickness; dimensions, permissible dimensional deviations, deviations of form and in mass
DIN 1543	Steel flat products; hot rolled plate 3 to 150 mm thick; permissible dimensional deviations, deviations of form and in mass
DIN 59 200	Steel flat products; hot rolled wide flats; dimensions, permissible dimensional deviations, deviations of form and in mass

Forgings

DIN 2519	Steel flanges; technical delivery conditions
DIN 7526	Steel forgings; tolerances and permissible deviations for drop forgings
Supplement to DIN 7526	Steel forgings; tolerances and permissible deviations for drop forgings; examples of application
DIN 7527 Part 1	Steel forgings; machining allowances and permissible deviations for hand forged discs
DIN 7527 Part 2	Steel forgings; machining allowances and permissible deviations for hand forged pierced discs
DIN 7527 Part 3	Steel forgings; machining allowances and permissible deviations for seamless hand forged rings
DIN 7527 Part 4	Steel forgings; machining allowances and permissible deviations for seamless hand forged bushes
DIN 7527 Part 5	Steel forgings; machining allowances and permissible deviations for hand forged, rolled and welded rings
DIN 7527 Part 6	Steel forgings; machining allowances and permissible deviations for hand forged bars

Sections

DIN 1019	Steel bars; hot rolled bulb flats; dimensions, masses, permissible deviations, static values
DIN 1024	Steel bars; hot rolled round edged T bars; dimensions, masses, permissible deviations, static values
DIN 1025 Part 1	Steel sections; hot rolled I beams; narrow flange I beams, I range; dimensions, masses, permissible deviations, static values
DIN 1025 Part 2	Steel sections; hot rolled I beams; wide flange I beams; IPB and IB range; dimensions, masses, permissible deviations, static values
DIN 1025 Part 3	Steel sections; hot rolled I beams; lightweight wide flange I beams, IPBl range; dimensions, masses, permissible deviations, static values

DIN 1025 Part 4	Steel sections; hot rolled I beams; heavy wide flange I beams, IPBv range; dimensions, masses, permissible deviations, static values
DIN 1025 Part 5	Steel sections; hot rolled I beams; medium flange I beams; IPE range; dimensions, masses, permissible deviations, static values
DIN 1026	Steel bars; steel sections; hot rolled round edge channels; dimensions, masses, permissible deviations, static values
DIN 1027	Steel bars; hot rolled round edge Zeds; dimensions, masses, permissible deviations, static values
DIN 1028	Steel bars; hot rolled round edge equal angles; dimensions, masses, permissible deviations, static values
DIN 1029	Steel bars; hot rolled round edge unequal angles; dimensions, masses, permissible deviations, static values

Standards and other documents referred to

DIN 8528 Part 1	Weldability; metallic materials, concepts
DIN 17010	General technical delivery conditions for steel and steel products
DIN 17014 Part 1	Heat treatment of ferrous materials; technical terms and definitions
DIN 17102	Weldable normalized fine grain structural steels; technical delivery conditions for plate, strip, wide flats, sections and bars
DIN 17440	Stainless steels; technical delivery conditions for plate and sheet, hot rolled strip, wire rod, drawn wire, steel bars, forgings and wrought products
DIN 17441	Stainless steels; technical delivery conditions for cold rolled strip and slit strip and for plate and sheet cut therefrom
DIN 50049	Documents on materials testing
DIN 50115	Testing of metallic materials; impact test
DIN 50125	Testing of metallic materials; tensile test pieces; rules for their preparation
DIN 50145	Testing of metallic materials; tensile test
EURONORM 79	Terminology and classification of steel products by shape and size
EURONORM 163	Technical delivery conditions referring to the surface condition of hot rolled plate, sheet and wide flats

DIN-Normenheft 3 *Kurznamen und Werkstoffnummern der Eisenwerkstoffe in DIN-Normen und Stahl-Eisen-Werkstoffblättern* (Symbols and material numbers for ferrous materials used in DIN Standards and Iron and steel material sheets)

Stahl-Eisen-Lieferbedingungen 055 [4]
(at present at the stage of draft) *Warmgewalzter Stabstahl und Walzdraht mit rundem Querschnitt und nicht profilierter Oberfläche; Oberflächengüteklassen; technische Lieferbedingungen* (Hot rolled steel bars and wire rods of circular cross section and non-profiled surface; surface quality classes; technical delivery conditions)

Stahl-Eisen-Lieferbedingungen 072 [4]
Ultraschallgeprüftes Grobblech (Heavy plate tested by ultrasonic methods)

Stahl-Eisen-Lieferbedingungen 1805 [4]
Probenahme und Probenvorbereitung für die Stückanalyse bei Stählen (Sampling and preparation of samples for product analysis of steels)

Stahl-Eisen-Lieferbedingungen 1921 [4]
Ultraschallprüfung von Schmiedestücken und geschmiedetem Stabstahl ab rd. 100 mm Durchmesser oder Kantenlänge (Ultrasonic testing of forgings and forged steel bars not less than about 100 mm in diameter or edge length)

Handbuch für das Eisenhüttenlaboratorium [4];
volume 2: *Die Untersuchung der metallischen Stoffe* (Investigation of metallic materials);
volume 5 (supplementary volume):
A 4.1 – *Aufstellung empfohlener Schiedsverfahren* (List of recommended arbitration procedures);
B – *Probenahmeverfahren* (Sampling procedures);
C – *Analysenverfahren* (Methods of analysis); most recent edition in each case.

DVS-Merkblatt 1501
Empfehlungen für das Schweißen der kaltzähen Nickelstähle 10 Ni 14, 12 Ni 19 und X 8 Ni 9 [5]
(Recommendations referring to the welding of 10 Ni 14, 12 Ni 19 and X 8 Ni 9 nickel steels with low temperature toughness)

See also Appendix B for other standards referred to.

[4] Obtainable from *Verlag Stahleisen mbH*, Breite Straße 27, D-4000 Düsseldorf 1.

[5] Obtainable from *Deutscher Verlag für Schweißtechnik GmbH*, Krefeld.

Explanatory notes

This first edition of a DIN Standard for plate and sheet, strip, wide flats, sections, bars and forgings produced from steel with low temperature toughness is based on *Stahl-Eisen-Prüfblatt* 680-70 *Kaltzähe Stähle; Gütevorschriften* (Steels with low temperature toughness; quality requirements) published by the *Verein Deutscher Eisenhüttenleute*. Seamless and welded circular tubes made from steels with low temperature toughness have been standardized in DIN 17 173 and DIN 17 174 which were published jointly. DIN 17 280 covers only alloyed special steels, stainless austenitic steels with low temperature toughness (now covered in DIN 17 440 and DIN 17 441) and 14 Ni 6 and 16 Ni 14 steels having been dropped as compared with *Stahl-Eisen-Werkstoffblatt* 680.70. 11 MnNi5 3, 13 MnNi6 3, 14 NiMn 6 and X 7 NiMo 6 steels have been included for the first time.

It was agreed during discussions on this standard that the lowest test temperatures for the impact test specified in table 4 shall not, in any event, be equated with the lowest application temperatures. It was also agreed that the users should not experience any disadvantages in the application of the steels as a consequence of the transition from DVM test pieces to ISO V-notch test pieces; this is to be taken into consideration in the revision of *AD-Merkblatt* W 10 *Werkstoffe für tiefe Temperaturen; Eisenwerkstoffe* (Materials for low temperature applications; ferrous materials).

The impact energy values at the lowest temperature specified in each case have been verified by evaluation of existing results. Following the wishes of certain users, the values at higher temperatures have been established by consideration of typical curves.

This standard is related to International Standards ISO 2604/1 – 1975, Steel products for pressure purposes; quality requirements. Part 1: Forgings, and ISO 2604/4 – 1975, Steel products for pressure purposes; quality requirements. Part 4: Plate, published by the International Organization for Standardization and to EURONORM 129-76, Nickel alloyed steels for low temperature applications; quality requirements, published by the European Coal and Steel Community (ECSC). See the table below for a comparison of the steel grades with low temperature toughness (with the exception of unalloyed and stainless steels) complying with ISO 2604/4 – 1975 and with EURONORM 129-76 with the grades complying with this standard.

DIN 17 280		EURONORM 129-76		ISO 2604/4 - 1975	
Symbol	Material number	Symbol	[1]	Steel number	[1]
26 CrMo 4	**1.7219**	–		–	
–	–	FeE 245 Ni 2		–	
11 MnNi 5 3	**1.6212**	FeE 285 Ni 2	○	–	
13 MnNi 6 3	**1.6217**	FeE 355 Ni 2	○	–	
–	–	FeE 285 Ni 6		P 41	
14 NiMn 6	**1.6228**	FeE 355 Ni 6	●	P 42	○
–	–	FeE 285 Ni 14		P 43	
10 Ni 14	**1.5637**	FeE 355 Ni 14	●	P 44	○
12 Ni 19	**1.5680**	FeE 390 Ni 20	○	–	
X 7 NiMo 6	**1.6349**	–		–	
X 8 Ni 9	**1.5662**	FeE 490 Ni 36	●	P 45	○
–	–	FeE 585 Ni 36		–	

[1] This column indicates the degree of agreement with regard to the chemical composition of the steels as specified in this standard and those in EURONORM 129-76 and ISO 2604/4 – 1975.

The symbols have the following meanings: ● = slight differences, ○ = substantial differences.

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