

Case hardening steels

Technical delivery conditions

DIN
17 210

Einsatzstähle; technische Lieferbedingungen

Supersedes December 1969 edition.

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

See Explanatory notes for connection with ISO/DIS 683/11 - 1985 published by the International Organization for Standardization (ISO) and Euronorm 84 - 70 published by the European Coal and Steel Community (ECSC).

The clauses and 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

- semi-finished products, e.g. blooms, slabs, billets,
- hot rolled wire,
- hot rolled or forged steel bars (round, square, hexagonal, octagonal and flat steel bars),
- hot rolled wide flats,
- hot or cold rolled plate, sheet and strip, and
- hammer forgings and drop forgings

made from the case hardening steels listed in table 2.

The heat treatment conditions in which the various product forms concerned can be supplied are shown in table 1, and the possible particular surface finishes are given in sub-clause 7.2.2.

Note 1. DIN Standards covering steels which are to meet the same requirements regarding chemical composition as given in table 2, but are supplied in other product forms or other treatment conditions, or intended for particular applications, and also DIN Standards covering similar steel grades are listed in the "Other relevant standards" clause.

Note 2. Hammer forged semi-finished products, for example blooms, slabs, billets and hammer forged steel bars are referred to in this standard as "semi-finished products" and "steel bars" and not as "hammer forgings and drop forgings".

1.2 In addition to the requirements specified in this standard, the general technical delivery conditions for steel and steel products given in DIN 17 010 shall apply unless otherwise specified in this standard.

2 Concepts

2.1 Case hardening steels

Case hardening steels as defined in this standard are structural steels with a comparatively low carbon content which are used for components whose surface zone is usually carburized or carbonitrided prior to hardening. Case hardened components normally have a much higher degree of hardness in the surface zone than in the core material.

Note. Other methods of heat treating components made from case hardening steels include hardening (without carburization), tempering, nitriding, nitro-carburizing and boriding.

2.2 Product forms

The definitions given in Euronorm 79 shall apply for the product forms.

2.3 Types of heat treatment

The terminology used in DIN 17 014 Part 1 shall apply for the types of heat treatment referred to in this standard.

3 ● Dimensions, permissible dimensional deviations and deviations of form

The nominal sizes, the permissible dimensional deviations and deviations of form for the products shall be agreed at the time of ordering, reference being made, if possible, to the appropriate dimensional standards (see Appendix B).

4 Masses

The masses of the steels covered by this standard have been calculated taking the density as 7,85 kg/dm³.

5 Designation and ordering

5.1 The standard designation for steel complying with this standard, shall give in the following order:

- the name of product (steel);
- the number of this standard;
- the symbol or material number identifying the steel grade (see table 2)*);
- where applicable, the symbol indicating compliance with the more stringent hardenability requirements (see sub-clause 7.3.3);
- where applicable, the code letter identifying the heat treatment condition (see table 1).

Example 1: Steel DIN 17 210 - Ck 15

or

Steel DIN 17 210 - 1.1141

Example 2: Steel DIN 17 210 - 16 MnCr 5 HH G

or

Steel DIN 17 210 - 1.7131 HH G

*) DIN-Normenheft (DIN Standardization booklet) No. 3 provides information on how the symbolic designations and material numbers of steels are formed.

Continued on pages 2 to 20

5.2 The specifications given in the relevant dimensional standard shall apply for the standard designation of the products.

5.3 The order shall provide any information necessary for a clear description of the required products including their condition and the test methods to be applied.

6 Classification into grades

6.1 Steel grades

6.1.1 This standard distinguishes between unalloyed quality steels and unalloyed and alloy high-grade steels (see EURONORM 20).

High-grade steels are distinguished from quality steels by the following:

- limiting values of hardenability in the end quench test (they are stated only for the alloy steels);
- a more uniform response to heat treatment;
- a limited content of oxidic inclusions;
- lower permitted contents of phosphorus and sulfur.

6.1.2 The group of high-grade steels includes two series of steel grades, one for which a maximum sulfur content of 0,035% by mass is specified, and the other specifying a sulfur content of 0,020 to 0,035% by mass (see table 2).

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

7 Requirements

7.1 Manufacturing process

The steelmaking process, the casting process and the process of shaping the product shall be at the manufacturer's discretion.

●● In special cases, however, an agreement on this may be made at the time of ordering.

7.2 Heat treatment condition and surface finish of material on delivery

7.2.1 ●● Heat treatment condition

The permitted heat treatment conditions are as listed in table 1. Unless otherwise agreed at the time of ordering, the products shall be supplied in the untreated condition.

7.2.2 ●● Special surface finish

If agreed at the time of ordering, the products shall be provided with one of the following special surface finishes:

- hot formed and pickled;
- hot formed and abrasive blasted;
- other surface finishes (in this case, the details shall also be agreed).

7.3 Chemical composition, hardness and hardenability

Table 1 summarizes the usual combination of heat treatment conditions of the material on delivery, product forms and requirements regarding chemical composition, maximum hardness or hardness range and hardenability.

●● Unless otherwise agreed, the requirements given in column 7 of table 1 shall apply for the relevant heat treatment condition of the material on delivery and for the particular product form.

7.3.1 Table 2 shall apply for the chemical composition determined in the cast analysis.

7.3.2 The specifications given in table 3 (see also footnote 3 to table 7) shall apply for the permissible deviations of the limiting values applicable to the cast analysis (see table 2) from the results of the product analysis.

7.3.3 ●● Narrower hardenability bands corresponding to figures 1 a, 1 c to 1 i, and footnote 1 to table 4 may be agreed at the time of ordering for steels complying with this standard, except for grades 20 Cr 4 and 20 CrS 4. Where a narrower hardenability band with respect to the upper or lower limiting curve is required, the letter symbol HH or HL shall be appended to the symbol or material number for the steel when ordering.

7.4 Technological properties

7.4.1 Weldability

Subject to proven welding processes being applied, the steels in this standard are suitable, for example, for flash butt welding and fusion welding. In the case of fusion welding, however, special measures, such as preheating shall be taken in the case of alloy steels (see also DIN 8528 Part 1).

7.4.2 Machinability

Where improved machinability is required, consideration should be given to those steels for which a minimum sulfur content by mass is specified.

The treatment conditions suitable for this purpose are G, BF and BG (see table 5).

In treatment condition BG, a well-developed ferrite-pearlite structure shall be present. Agreement may be reached whether small amounts of bainite are permitted.

●● In cases where the conditions characterized by the hardness values given in table 5 are not adequate for providing satisfactory machinability under the proposed machining conditions, a special heat treatment shall be agreed.

7.4.3 Shearability

7.4.3.1 Under suitable conditions, all steel grades specified in this standard are shearable in treatment conditions G, BF and BG.

7.4.3.2 In the untreated state (U), and assuming suitable conditions, the unalloyed steels and 17 Cr 3, 20 Cr 4, 20 CrS 4, 16 MnCr 5, 16 MnCrS 5, 20 MoCr 4, 20 MoCrS 4, 21 NiCrMo 2 and 21 NiCrMoS 2 steels are shearable.

7.4.3.3 ●● In the case of 20 MnCr 5, 20 MnCrS 5, 22 CrMoS 3 5, 15 CrNi 6 and 17 CrNiMo 6 steels, the condition "treated for shearability" (C) with the hardness (used as an assessment criterion) not exceeding 225 HB, may be agreed at the time of ordering (see table 5).

7.5 ●● Grain size

If "fine grain steel" has been ordered, the steel shall have a grain size of 5 or finer for the austenite when tested as described in DIN 50 601.

Note. It should be taken into account that unalloyed fine grain case hardening steels tend to form soft spots.

7.6 ●● Non-metallic inclusions

If requirements regarding the degree of cleanliness (applicable for oxidic non-metallic inclusions) determined microscopically as specified in DIN 50 602 have been agreed when ordering high-grade steels, the data given in table 6 shall apply for the characteristic K of the particular cast.

7.7 ●● Internal condition

Requirements regarding the internal condition of steel products, basing, for example, on non-destructive testing, may be agreed at the time of ordering.

7.8 Surface quality

7.8.1 General

7.8.1.1 The products shall have a smooth surface appropriate to the forming process used.

7.8.1.2 For the requirements regarding the surface quality of sheet and wide flats, the specifications given in EURO-NORM 163 shall apply.

7.8.1.3 When removing surface defects, the permissible deviations specified in the relevant dimensional standards may be exceeded only on approval of the purchaser or his representative.

7.8.1.4 Removal of surface defects by welding is permitted only on approval of the purchaser or his representative.

7.8.2 ●● Permissible depth of cracks

It may be agreed at the time of ordering that a specified depth of crack shall not be exceeded.

Specification of the permissible crack depth, in the case of steel bars and wire rods of circular cross section, shall be in accordance with *Stahl-Eisen-Lieferbedingungen* (Iron and steel delivery conditions) 055 (at present at the stage of draft).

7.8.3 ●● Suitability for bright drawing

Suitability for bright drawing may be agreed at the time of ordering in the case of steel bars and wire rods.

7.9 Separation of products by casts

Within one consignment, the products shall be separated by casts.

8 Testing

8.1 General

The manufacturer shall inspect the quality of his production in such a manner as he considers appropriate and on his own responsibility, with such measures as he considers suitable, in the light of the requirements specified in clause 7.

●● The issue of a document as specified in DIN 50 049 covering tests of materials carried out by the manufacturer's works or by independent inspectors, may be agreed at the time of ordering.

8.2 ●● Materials testing certificates issued by the manufacturer's works

8.2.1 If a test report (DIN 50 049 – 2.2) is to be issued in accordance with agreements made at the time of ordering, this report shall specify the results of the cast analysis for all the elements listed in table 2 for the relevant steel grade.

8.2.2 ● If a manufacturer's test certificate (DIN 50 049 – 2.3) is to be issued, the required tests shall be agreed.

The document shall give the following details:

- the results of the cast analysis for all the elements listed in table 2 for the relevant steel grade;
- the results of the agreed tests.

8.3 ●● Materials testing certificates issued by independent inspectors

Such documents, inspection certificate (DIN 50 049 – 3.1 A, DIN 50 049 – 3.1 B, DIN 50 049 – 3.1 C) or inspections report (DIN 50 049 – 3.2 A, DIN 50 049 – 3.2 C), shall be issued on the basis of acceptance inspection.

● The required tests or the tests required to comply with official regulations and the appropriate codes of practice shall be agreed.

●● If the acceptance inspection is not to be carried out by the works expert, the body carrying out the acceptance inspection or the expert concerned shall be nominated.

The document shall give the following details:

- the information referred to in subclause 8.2.2, items a and b;
- the mark identifying the inspector.

8.4 Scope of test programme, sampling, preparation of samples and test procedure

8.4.1 **Chemical composition, hardness and hardenability**
Where the chemical composition, hardness and hardenability are to be tested, the test conditions specified in table 7 shall apply.

8.4.2 ●● Grain size

If the "fine grain" requirement has been agreed at the time of ordering, one test piece per cast shall be tested.

Unless otherwise agreed at the time of ordering, sampling and preparation of the test pieces and determination of the quench grain size shall be carried out as described in DIN 50 601.

For this purpose, test pieces of not more than 20 mm diameter shall be heated in a furnace which is at the treatment temperature (not in a salt bath). Unless otherwise agreed at the time of ordering, the heat treatment for determining the quench grain size shall be carried out at $(930 \pm 10)^\circ\text{C}$ for 4 hours with subsequent quenching in water.

In cases of dispute, pretreatment shall be carried out at 1150°C (30 min, cooling with air) to produce a standard initial condition.

8.4.3 Non-metallic inclusions

DIN 50 602 shall apply for testing for non-metallic inclusions.

8.4.4 ●● Internal condition

In cases where testing of the products for their internal condition (e.g. by ultrasonics) has been agreed, but the testing procedure has not been specified, the scope of the test programme, test conditions and test criteria shall be left to the manufacturer's discretion.

8.4.5 ●● Surface defects

Unless otherwise agreed at the time of ordering, the method of testing products for surface defects, the scope of the test programme and the test criteria shall be left to the manufacturer's discretion.

8.4.6 ●● Visual examination and dimensional inspection

Unless otherwise agreed at the time of ordering, the procedure for visual examination and dimensional inspection shall be left to the manufacturer's discretion.

8.4.7 Retests

The specifications given in DIN 17 010 shall apply for retests.

9 Marking

9.1 The manufacturer shall mark the products or the bundles or packets, as far as possible in compliance with DIN 1599, in a suitable manner so that it is possible to identify the cast, the grade of steel and the source of the consignment.

9.2 If the consignments are to be accompanied by documents covering acceptance inspection, the marking shall additionally include the test piece number and the inspector's mark.

9.3 ●● Any further requirements with regard to marking of the products may be agreed at the time of ordering.

10 Heat treatment

Temperatures for quenching in the end quench test are given in table 4.

Guideline values for temperatures and examples of usual heat treatment stages in case hardening are given in table A.1 and figure A.1.

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 product supplied.

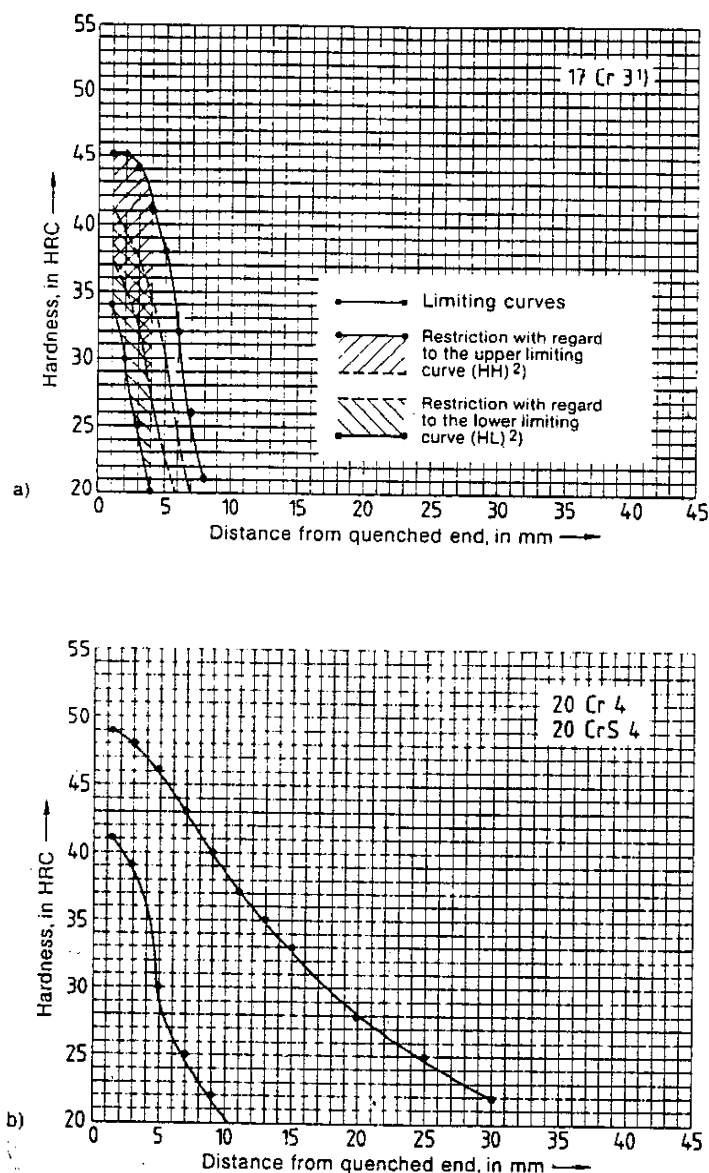


Figure 1. Hardenability bands for the Rockwell C hardness determined by the end quench test. (The curves shown in figure 1b are provisional.)

- 1) It should be noted, that when the hardness test indentations are at 1 mm intervals and with hardness values of less than 30 HRC, there is an interaction between the indentations.
- 2) The restricted hardenability bands shall apply only up to the distance from the quenched end for which a hardness value is specified for the lower limiting curve; for greater distances, the restricted bands should be taken for guidance.

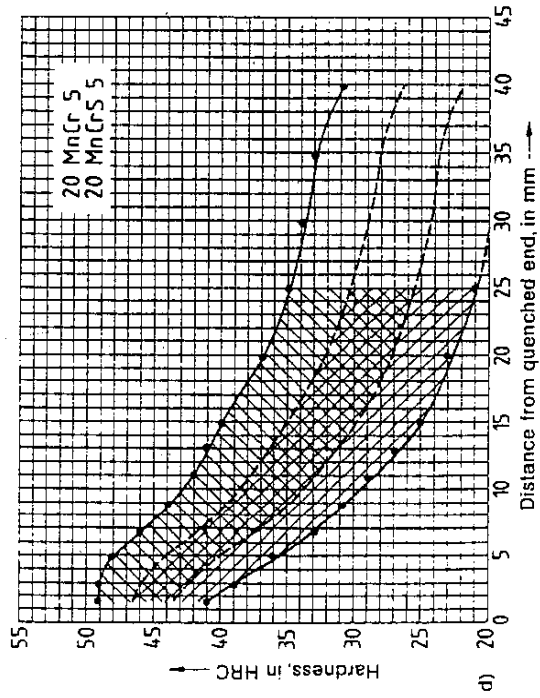
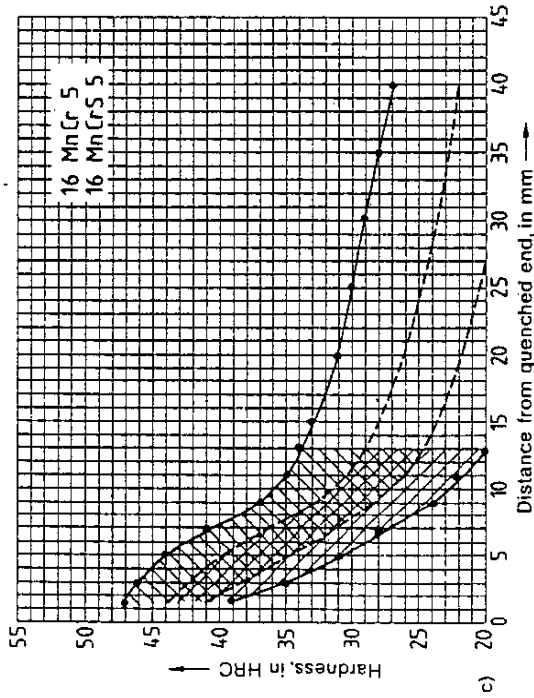
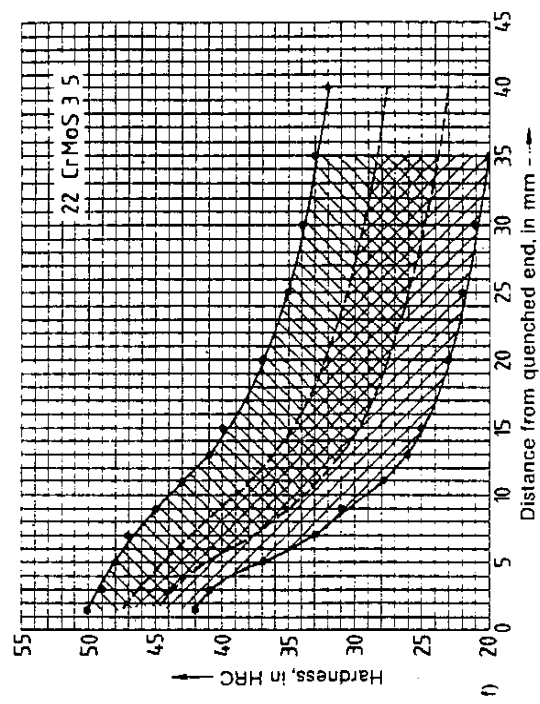
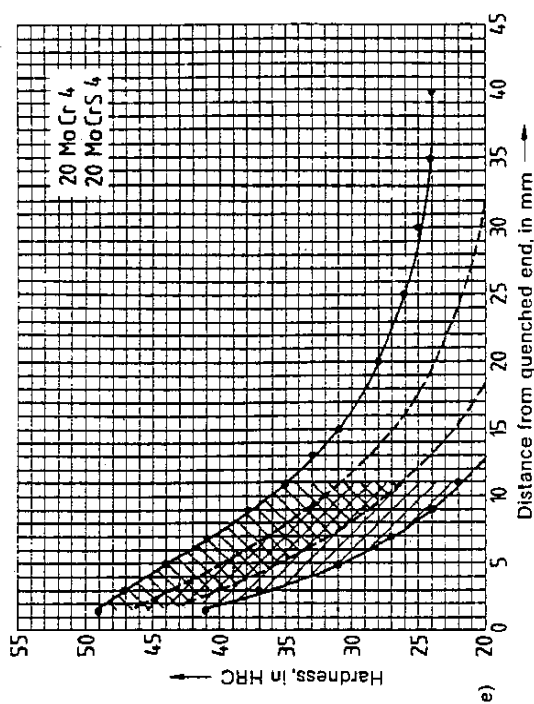


Figure 1. (continued)

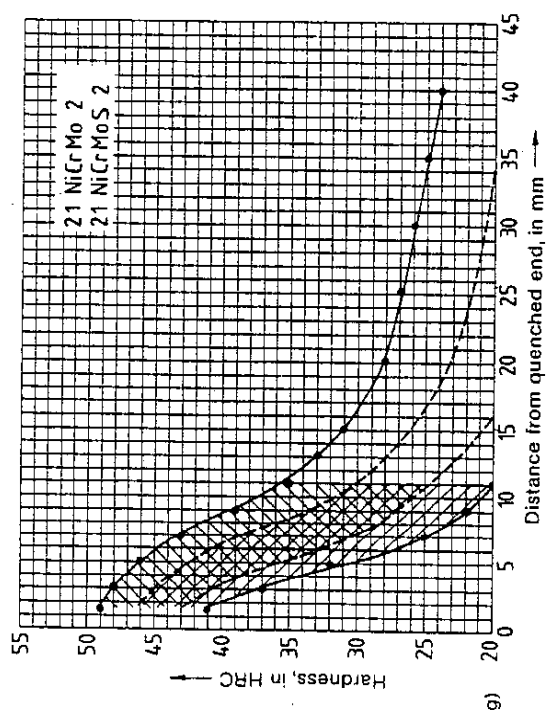
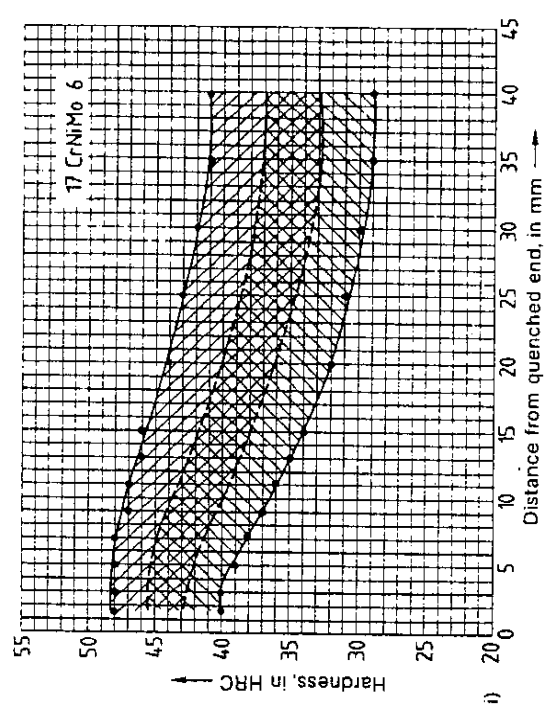
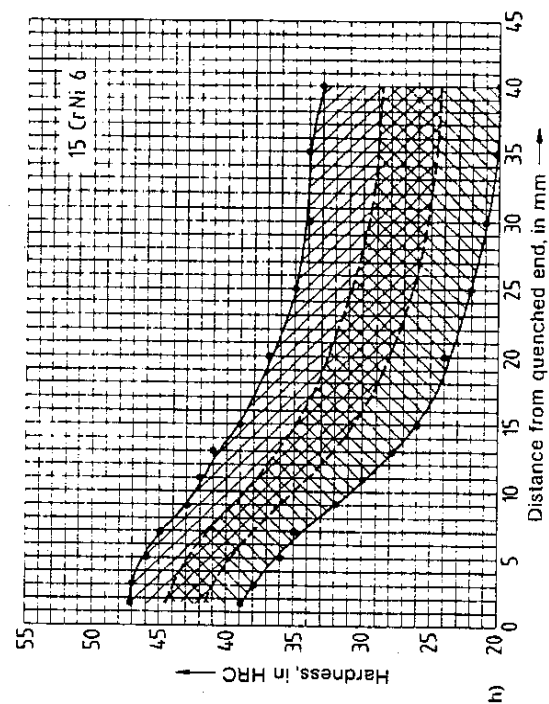


Figure 1. (concluded)

Table 1. Heat treatment conditions and product forms in which steels are usually supplied and associated requirement classes as specified in tables 2 to 5

No.	1	2	3	4	5	6	7			
	Heat treatment condition of material on delivery	Code letter	Form of product					The following requirements given in tables 2 to 5 shall apply:		
			Semi-finished product	Steel bars	Wire rods	Flat products	Hammer forgings and drop forgings			
1	Untreated	No code letter or U	X	X	X	X	Chemical composition as in tables 2 and 3.	7.1	7.2	7.3
2	Treated for shearability	C	X	—	—	—	Maximum hardness or hardness range as in		—	Hardenability as in table 4 ¹⁾ .
3	Softened	G	X	X	X	X			table 5, column 2.	
4	Treated for strength	BF	X	X	X	X			table 5, column 3.	
5	Treated for ferrite/pearlite structure	BG	X	—	X	X			table 5, column 4.	
6	●● If a heat treatment condition other than those given in lines 1 to 5 is required, this shall be specified in uncoded form in the order; in such cases, the product form and the requirements shall be agreed at the time of ordering.									
1) Except for the values characterized as provisional.										

Table 2. Chemical composition of case hardening steels (cast analysis)

Steel grade		Chemical composition, in % by mass ^{1), 2)}							
Symbol	Material number	C	Si max.	Mn	P max.	S ³⁾	Cr	Mo	Ni
C 10 ⁴⁾	1.0301 ⁴⁾	0,07 to 0,13	0,40	0,30 to 0,60	0,045	0,045	—	—	—
Ck 10	1.1121	0,07 to 0,13	0,40	0,30 to 0,60	0,035	0,035	—	—	—
C 15 ⁴⁾	1.0401 ⁴⁾	0,12 to 0,18	0,40	0,30 to 0,60	0,045	0,045	—	—	—
Ck 15	1.1141	0,12 to 0,18	0,40	0,30 to 0,60	0,035	0,035	—	—	—
Cm 15	1.1140	0,12 to 0,18	0,40	0,30 to 0,60	0,035	0,020 to 0,035	—	—	—
17 Cr 3	1.7016	0,14 to 0,20	0,40	0,40 to 0,70	0,035	0,035	0,60 to 0,90	—	—
20 Cr 4	1.7027	0,17 to 0,23	0,40	0,60 to 0,90	0,035	0,035	0,90 to 1,20	—	—
20 CrS 4	1.7028	0,17 to 0,23	0,40	0,60 to 0,90	0,035	0,020 to 0,035	0,90 to 1,20	—	—
16 MnCr 5	1.7131	0,14 to 0,19	0,40	1,00 to 1,30	0,035	0,035	0,80 to 1,10	—	—
16 MnCrS 5	1.7139	0,14 to 0,19	0,40	1,00 to 1,30	0,035	0,020 to 0,035	0,80 to 1,10	—	—
20 MnCr 5	1.7147	0,17 to 0,22	0,40	1,10 to 1,40	0,035	0,035	1,00 to 1,30	—	—
20 MnCrS 5	1.7149	0,17 to 0,22	0,40	1,10 to 1,40	0,035	0,020 to 0,035	1,00 to 1,30	—	—
20 MoCr 4	1.7321	0,17 to 0,22	0,40	0,70 to 1,00	0,035	0,035	0,30 to 0,60	0,40 to 0,50	—
20 MoCrS 4	1.7323	0,17 to 0,22	0,40	0,70 to 1,00	0,035	0,020 to 0,035	0,30 to 0,60	0,40 to 0,50	—
22 CrMoS 3 5	1.7333	0,19 to 0,24	0,40	0,70 to 1,00	0,035	0,020 to 0,035	0,70 to 1,00	0,40 to 0,50	—
21 NiCrMo 2	1.6523	0,17 to 0,23	0,40	0,65 to 0,95	0,035	0,035	0,40 to 0,70	0,15 to 0,25	0,40 to 0,70
21 NiCrMoS 2	1.6526	0,17 to 0,23	0,40	0,65 to 0,95	0,035	0,020 to 0,035	0,40 to 0,70	0,15 to 0,25	0,40 to 0,70
15 CrNi 6	1.5919	0,14 to 0,19	0,40	0,40 to 0,60	0,035	0,035	1,40 to 1,70	—	1,40 to 1,70
17 CrNiMo 6	1.6587	0,15 to 0,20	0,40	0,40 to 0,60	0,035	0,035	1,50 to 1,80	0,25 to 0,35	1,40 to 1,70

¹⁾ Elements not listed in this table shall not be deliberately added to the steel except for finishing the cast, without the purchaser's approval. In cases of doubt, the limits given in EURONORM 20 shall apply.

²⁾ Except for phosphorus and sulfur, only minor deviations from the limits specified for the cast analysis are permitted, if restricted hardenability bands in the end quench test (see footnote 1 to table 4) have been ordered; the deviations shall not exceed the values specified in table 3.

³⁾ In each case the maximum content is given, except where ranges are specified.

⁴⁾ ●● This steel may also be ordered with a lead content of 0,15 to 0,30% by mass (applies for the product analysis). In this case, the symbol C 10 Pb (material number 1.0302) or C 15 Pb (material number 1.0403) shall be used.

Table 3. Amounts by which the chemical composition in the product analysis may deviate from the limiting values specified for the cast analysis in table 2 (applies to products which, when supplied, have a cross section of not more than 62 500 mm²)

Element	Maximum permissible content in the cast analysis % by mass	Permissible deviations in the product analysis from the limiting values specified for the cast analysis ¹⁾ % by mass
C	≤ 0,24	0,02
Si	≤ 0,40	0,03
Mn	≤ 1,00 > 1,00 ≤ 1,40	0,04 0,05
P	≤ 0,045	0,005
S	≤ 0,045	0,005
Cr	≤ 1,80	0,05
Mo	≤ 0,30 > 0,30 ≤ 0,50	0,03 0,04
Ni	≤ 1,00 > 1,00 ≤ 1,70	0,03 0,05
¹⁾ If several product analyses are to be carried out, the deviations shown by an element within one cast shall lie either only above the upper limit or below the lower limit of the range specified for the cast analysis.		

Table 4. Limits for Rockwell C hardness determined in the end quench test ¹⁾

(Hardness values not given in this table can be calculated from figures 1 a to 1 i by interpolation.)

Steel grade Symbol	Material number	Hardening tem- perature for end quench test °C	Limits of hardenability band	Hardness, in HRC, at a distance from the quenched end, in mm, of														
				1	2	3	4	5	6	7	8	9	10	11	13	15		
17 Cr 3	1.7016	880	Maximum Minimum	45 34	45 30	44 25	41 20	38 -	32 -	26 -	21 -	-	-	-	-	-	-	-
				Hardness, in HRC, at a distance from the quenched end, in mm, of														
				1,5	3	5	7	9	11	13	15	20	25	30	35	40		
20 Cr 4 ²⁾ 20 CrS 4 ²⁾	1.7027 ²⁾ 1.7028 ²⁾	870	Maximum Minimum	49 41	48 39	46 30	43 25	40 22	37 -	35 -	33 -	28 -	25 -	22 -	-	-	-	-
16 MnCr 5 16 MnCrS 5	1.7131 1.7139	870	Maximum Minimum	47 39	46 35	44 31	41 28	37 24	35 22	34 20	33 -	31 -	30 -	29 -	28 -	27 -		
20 MnCr 5 20 MnCrS 5	1.7147 1.7149	870	Maximum Minimum	49 41	49 39	48 36	46 33	44 31	42 29	41 27	40 25	37 23	35 21	34 -	33 -	31 -		
20 MoCr 4 20 MoCrS 4	1.7321 1.7323	910	Maximum Minimum	49 41	47 37	44 31	41 27	38 24	35 22	33 -	31 -	28 -	26 -	25 -	24 -	24 -		
22 CrMoS 3 5	1.7333	910	Maximum Minimum	50 42	49 41	48 37	47 33	45 31	43 28	41 26	40 25	37 23	35 22	34 21	33 20	32 -		
21 NiCrMo 2 21 NiCrMoS 2	1.6523 1.6526	925	Maximum Minimum	49 41	48 37	46 32	43 25	39 22	35 20	33 -	31 -	28 -	27 -	26 -	25 -	24 -		
15 CrNi 6	1.5919	860	Maximum Minimum	47 39	47 38	46 36	45 35	43 32	42 30	41 28	39 26	37 24	35 22	34 21	34 20	33 20		
17 CrNiMo 6	1.6587	860	Maximum Minimum	48 40	48 40	48 39	48 38	47 37	47 36	46 35	46 34	44 32	43 31	42 30	41 29	41 29		

¹⁾ ●● For the steels specified (except for grades 20 Cr 4 and 20 CrS 4), a hardenability band as determined in the end quench test, restricted to two-thirds of the original band width with respect to either the upper or the lower limiting curve (see figures 1 a and 1 c to 1 i) may be agreed at the time of ordering. If a restriction in the hardenability band with respect to the upper limiting curve is required, the letter symbol HH shall be specified in the order; and if a restriction in the hardenability band with respect to the lower limiting curve is required, the letter symbol HL shall be specified in the order.

²⁾ The limiting values of Rockwell C hardness are to be regarded as provisional for this steel.

Table 5. Hardness for different treatment conditions

1		2	3	4	5
Steel grade		Hardness for treatment condition ¹⁾			
Symbol	Material number	C (treated for shearability) HB max.	G ¹⁾ (softened) HB max.	BF ²⁾ (treated for strength) HB	BG ³⁾ (treated for ferrite/pearlite structure) HB
C 10	1.0301	—	131	—	—
Ck 10	1.1121	—	131	—	—
C 15	1.0401	—	143	—	—
Ck 15	1.1141	—	143	—	—
Cn 15	1.1140	—	143	—	—
17 Cr 3	1.7016	—	174	—	—
20 Cr 4	1.7027	—	197	149 to 197	145 to 192
20 CrS 4	1.7028	—	197	149 to 197	145 to 192
16 MnCr 5	1.7131	—	207	156 to 207	140 to 187
16 MnCrS 5	1.7139	—	207	156 to 207	140 to 187
20 MnCr 5	1.7147	255	217	170 to 217	152 to 201
20 MnCrS 5	1.7149	255	217	170 to 217	152 to 201
20 MoCr 4	1.7321	—	207	156 to 207	140 to 187
20 MoCrS 4	1.7323	—	207	156 to 207	140 to 187
22 CrMoS 3 5	1.7333	255	217	170 to 217	152 to 201
21 NiCrMo 2	1.6523	—	197	152 to 201	145 to 192
21 NiCrMoS 2	1.6526	—	197	152 to 201	145 to 192
15 CrNi 6	1.5919	255	217	170 to 217	152 to 201
17 CrNiMo 6	1.6587	255	229	179 to 229	159 to 207

1) The treatment condition "annealed for spheroidal carbides" (GKZ) is dealt with in DIN 1654 Part 3.
 2) For diameters up to about 150 mm.
 3) For diameters up to about 60 mm.

Table 6. ●● Microscopic degree of cleanness of high-grade steels ¹⁾
(applies to oxidic non-metallic inclusions)

Diameter d or cross section equal in area, of steel bars, in mm	Integrated characteristic K (oxides) for the various casts
$140 < d \leq 200$	$K 4 \leq 55$
$100 < d \leq 140$	$K 4 \leq 50$
$70 < d \leq 100$	$K 4 \leq 50$
$35 < d \leq 70$	$K 4 \leq 45$
$17 < d \leq 35$	$K 3 \leq 45$
$8 < d \leq 17$	$K 3 \leq 35$
$d \leq 8$	$K 2 \leq 40$

¹⁾ See subclause 7.6.

Table 7. Test conditions for verifying compliance with the requirements¹⁾

No.	Property	2	3		4	5	6
			Test unit ²⁾	Number of test pieces per test unit			
1	Chemical composition	S	2 and 3	The manufacturer shall inform the purchaser of the results of the cast analysis. See footnote 3 as to whether a product analysis is to be carried out ³⁾ .			
2	Hardenability	S	4	1	1	As described in DIN 50 191.	The test shall be carried out as described in DIN 50 191. The hardening temperature shall conform to the specifications given in table 4. The hardness values shall be determined as specified in DIN 50 103 Part 1, method C.
3	Hardness of products in the C, G, BF or BG conditions	S + W	5	1	1	<p>In cases of dispute, the hardness shall be determined as close as possible to the product surface at a distance of one diameter or length of (smaller) side from one end, and in the case of squares and flats, at a distance of 0,25 times the product thickness or width from a longitudinal edge.</p> <p>●● If the above specifications cannot be complied with, appropriate agreements shall be made at the time of ordering (for example in the case of hammer forgings or drop forgings). Preparation of samples as described in DIN 50 351.</p>	<p>As described in DIN 50 351.</p> <p>In the case of small cross sections (for example wire), the hardness can be converted from the tensile strength as found from DIN 50 150. The tensile strength shall be determined as specified in DIN 50 145, or if necessary, in DIN 51 210 Part 1.</p>

1) Verification is only necessary if the requirement as specified in table 1, column 7 and the relevant test have been agreed.

2) S = cast, W = heat treatment batch.

3) ●● If subsequent checking of the chemical composition on the product has been agreed at the time of ordering, one product analysis shall be carried out per cast. The specifications given in *Stahl-Eisen-Prüfblatt* (Iron and steel test sheet) 1805 shall apply for sampling and preparation of samples. The composition may be determined by chemical or spectrochemical methods of analysis. For the analytical procedure, the specifications given in *Handbuch für das Eisenhüttenlaboratorium* (Handbook for the ferrous metallurgy laboratory) shall apply. In cases of dispute, the method to be applied shall be agreed.

Appendix A

Supplementary specifications

Table A.1. Usual temperatures for case hardening ¹⁾

Steel grade		a	b			c
Symbol	Material number	Carburizing temperature ²⁾ °C	core-hardening temperature ³⁾ °C	case-hardening temperature ³⁾ °C	Quenching agent	Tempering °C
C 10	1.0301	880 to 980	880 to 920	780 to 820	Taking the required properties of the component into account, the choice of the quenching agent depends on the hardenability or case hardenability of the steel used, on the geometry and cross section of the work-piece to be hardened and on the effect of the quenching agent.	150 to 200
Ck 10	1.1121					
C 15	1.0401					
Ck 15	1.1141					
Cm 15	1.1140					
17 Cr 3	1.7016					
20 Cr 4	1.7027					
20 CrS 4	1.7028					
16 MnCr 5	1.7131					
16 MnCrS 5	1.7139					
20 MnCr 5	1.7147					
20 MnCrS 5	1.7149					
20 MoCr 4	1.7321					
20 MoCrS 4	1.7323					
22 CrMoS 3 5	1.7333					
21 NiCrMo 2	1.6523					
21 NiCrMoS 2	1.6526					
15 CrNi 6	1.5919					
17 CrNiMo 6	1.6587					

1) For usual heat treatment sequences, see figure A.1.

2) The main criteria to be considered for the choice of carburizing temperature are the time desired for carburization, the carburizing medium chosen, the plant available for carburization, the sequence of process planned and the type of structure required.

3) When applying the direct method, the steel is to be quenched when its temperature has sunk to the carburizing temperature or a lower temperature. The lower hardening temperatures are in each case to be preferred, in particular when there is risk of distortion.

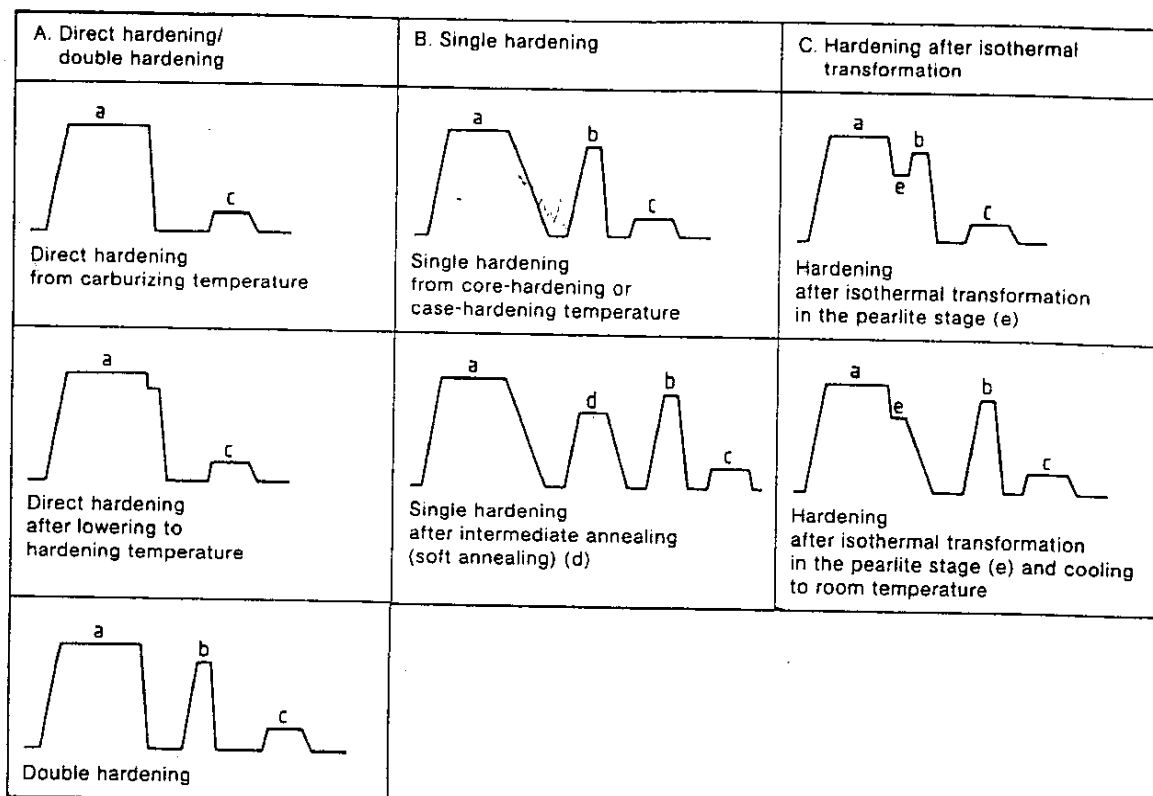


Figure A.1. Heat treatment sequences for case hardening (cf. table A.1)

Appendix B

Dimensional standards relating to products complying with this standard

Hot rolled wire

- DIN 59 110 Steel wire rod; dimensions, permissible deviations, masses
DIN 59 115 Steel wire rod for bolts, nuts and rivets; dimensions, permissible deviations, masses

Hot rolled and 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 hammer forged bars
DIN 59 130 Steel bars; hot rolled round steel for bolts and rivets; dimensions, permissible dimensional deviations and deviations of form

Cold rolled flat products

- DIN 1541 Steel flat products; cold rolled unalloyed steel wide strip and sheet; dimensions, permissible dimensional deviations and deviations of form
- DIN 1544 Steel flat products; cold rolled steel strip; dimensions, permissible dimensional deviations and deviations of form

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 7526 Steel forgings; tolerances and permissible deviations for drop forgings
- Supplement 1 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 hammer forged discs
- DIN 7527 Part 2 Steel forgings; machining allowances and permissible deviations for hammer forged pierced discs
- DIN 7527 Part 3 Steel forgings; machining allowances and permissible deviations for seamless hammer forged rings
- DIN 7527 Part 4 Steel forgings; machining allowances and permissible deviations for seamless hammer forged bushes
- DIN 7527 Part 5 Steel forgings; machining allowances and permissible deviations for hammer forged, rolled and welded rings
- DIN 7527 Part 6 Steel forgings; machining allowances and permissible deviations for hammer forged bars

Standards and other documents referred to

- DIN 1599 Identification markings for steel
- DIN 1654 Part 3 Steels for cold heading and cold extruding; technical delivery conditions for case hardening steels
- DIN 8528 Part 1 Weldability; metallic materials; concepts
- DIN 17 010 General technical delivery conditions for steel and steel products
- DIN 17 014 Part 1 Heat treatment of ferrous materials; terminology
- DIN 50 049 Materials testing certificates
- DIN 50 103 Part 1 Testing of metallic materials; Rockwell hardness test; C, A, B, F scales
- DIN 50 145 Testing of metallic materials; tensile test
- DIN 50 150 Testing of steel and cast steel; conversion table for Vickers hardness, Brinell hardness, Rockwell hardness and tensile strength
- DIN 50 191 Testing of ferrous materials; end quench test; test piece length: 100 mm, test piece diameter: 25 mm
- DIN 50 351 Testing of metallic materials; Brinell hardness test
- DIN 50 601 Metallographic examination; determination of the ferritic or austenitic grain size of steel and ferrous materials
- DIN 50 602 Metallographic examination; microscopic examination of special steels standard diagrams to assess the content of non-metallic inclusions
- DIN 51 210 Part 1 Testing of metallic materials; tensile test on wires, without extensometer measurement
- EURONORM 20 Definitions and classification of steel grades
- EURONORM 79 Terminology and classification of steel products by shapes and sizes
- EURONORM 163 Delivery conditions for surface quality of hot rolled sheet, plate and wide flats

Stahl-Eisen-Lieferbedingungen 055³⁾

(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-Prüfblatt 1805³⁾

Probenahme und Probenvorbereitung für die Stückanalyse bei Stählen (Sampling and preparation of samples for product analysis of steels)

³⁾ Verlag Stahleisen mbH, Postfach 82 29, D-4000 Düsseldorf 1.

*Handbuch für das Eisenhüttenlaboratorium*³⁾;

volume 2: *Die Untersuchung der metallischen Stoffe* (Investigation of metallic materials)

volume 5 (supplementary volume):

A 4.4 – *Aufstellung empfohlener Schiedsverfahren* (List of recommended arbitration procedures);

B – *Probenahmeverfahren* (Sampling procedure);

C – *Analysenverfahren* (Methods of analysis);

latest edition in each case

DIN-Normenhelf 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)

See Appendix B for other standards referred to.

Other relevant standards

DIN 1651	Free cutting steels; technical delivery conditions
DIN 1652	Bright unalloyed steels; technical delivery conditions
DIN 1654 Part 1	Steels for cold heading and cold extruding; technical delivery conditions; general
DIN 17 115	Steels for welded round link chains; quality specifications
DIN 17 230	Bail and roller bearing steels; technical delivery conditions

Previous editions

DIN 1661:	09.24, 06.29.
DIN 1662:	07.28, 06.30; Suppl. 3: 05.32.
DIN 1663:	05.36, 12.39x; Suppl. 3 and 4: 02.37, 08.40.
DIN 1664:	05.41.
DIN 1666:	11.43.
DIN 17 210:	12.51, 01.59, 12.69.

Amendments

The following amendments have been made in comparison with the December 1969 edition.

- a) Cold rolled sheet, plate and strip have been included. Seamless tubes are no longer covered (see Explanatory notes).
- b) The criteria for distinguishing between high-grade steels and quality steels have been altered on the basis of EURO-NORM 20-74.
- c) For the various treatment conditions, only code letters have been given, because the corresponding appended numbers are not generally used outside the civil aviation industry.
- d) The following steel grades have been deleted: 15 Cr 3 (1.7015), 25 MoCr 4 (1.7325), 25 MoCrS 4 (1.7326) and 18 CrNi 8 (1.5920) (see Explanatory notes).
- e) The following steel grades have been adopted for the first time: 17 Cr 3 (1.7016), 20 Cr 4 (1.7027), 20 CrS 4 (1.7028), 22 CrMoS 3 5 (1.7333), 21 NiCrMo 2 (1.6523), 21 NiCrMoS 2 (1.6526), C 10 Pb (1.0302), and C 15 Pb (1.0403).
- f) The percentage by mass of carbon in 15 CrNi 6 (1.5919) and 17 CrNiMo 6 (1.6587) steels has been raised to 0,14 to 0,19 % and 0,15 to 0,20 % respectively.
- g) In the case of 20 MoCr 4 (1.7321) and 20 MoCrS 4 (1.7323) steels, the percentages by mass of manganese and chromium have been altered to 0,70 to 1,00 % Mn and 0,30 to 0,60 % Cr.
- h) The proportion by mass of silicon has been specified uniformly at 0,40 % maximum.
- i) It is permitted to exceed slightly the limiting values specified for the cast analysis only in those cases where restricted hardenability bands are required. Subject to this condition, except in the case of phosphorus and sulfur, it is permitted to exceed the limiting values specified for the cast analysis by the amount of the permissible deviations specified for the product analysis.
- j) The previous system of requirement classes has been discarded (see Explanatory notes).
- k) Following the review of the previous specifications, compliance with the hardenability bands specified for the alloy steels dealt with in the December 1969 edition has now been made mandatory (see Explanatory notes).
- l) The restricted hardenability bands are now represented graphically (see Explanatory notes).
- m) For high-grade steels, the maximum permissible content of oxidic non-metallic inclusions has been specified (see Explanatory notes).
- n) The mechanical properties of blank hardened cross sections have been deleted (see Explanatory notes).
- o) The hardness data associated with the various treatment conditions have been revised.
- p) The guidance data for case hardening have been amended.

³⁾ Verlag Stahleisen mbH, Postfach 82 29, D-4000 Düsseldorf 1.

Explanatory notes

This standard has been adapted very closely to DIN 17 200, November 1984 edition.

Of the points arising in the discussions preceding the publication of this standard, particular mention should be made of the following.

- a) The tube manufacturers requested that seamless tubes made from case hardening steels should be covered in a separate standard. The reasons for this request were
 - that, for example, not all steels specified in this standard are to be used for tube making, whilst some case hardening steels used for tubes are not covered by this standard;
 - that there are a number of specifications specific to tubes (for example, test methods) and that in this way the number of footnotes could be reduced and hence the layout of the standard made more suitable for data processing purposes, and
 - that, finally, revision of the standard would be facilitated.
- b) Steel grades 25 MoCr4 (1.7325), 25 MoCrS 4 (1.7326) and 18 CrNi8 (1.5920) have been dropped because there is no demand for them which would justify standardization. Grade 15 Cr 3 (1.7015) has been superseded by the more usual grade 17 Cr 3 (1.7016).
- c) A request from Switzerland for inclusion of steel grades 14 NiCr 14 (1.5752) and 10 NiCrMo 7 was not adopted. The non-acceptance of this request was not due to doubts regarding the quality of these steels, but instead is attributable to the fact that, owing to their higher price resulting from the alloy content, these steels have not been able in the past to establish themselves on the German market.
- d) A request presented from several parties that the proportion by mass of sulfur should be limited to 0,025 % max. in the case of steel grades 16 MnCr 5 (1.7131), 15 CrNi 6 (1.5919) and 17 CrNiMo 6 (1.6587) was not agreed to by the steel manufacturers because different figures were quoted in the requests actually presented for lower maximum contents than 0,035 % and the quantities delivered are comparatively small.
- e) For the high-grade steels with controlled sulfur content, a range of between 0,020 and 0,040 % is being proposed for the revision of ISO 683/11-1970, whereas in this standard they amount to between 0,020 and 0,035 %. The upper limit of 0,035 % was regarded in the German discussions as a good compromise between the requirements for toughness and machinability; raising the upper limit to 0,040 % would hardly be likely to improve machinability. As regards the lower limit of 0,020 %, some representatives of the motorcar industry were afraid that with sulfur contents of 0,015 % in the product, as would be possible on the basis of the deviations permitted for the product analysis, machinability could be impaired. The steelmakers observed on this point that it would be necessary then to raise the value of the sulfur content to 0,025 up to 0,040 % for the cast analysis, but this would have an adverse effect on the toughness values.

The representatives of the motorcar industry were of the opinion that the steel grades with a maximum sulfur content no longer represent the state of the art, because case hardening steels are not machinable, at least not during automatic processing, if the full range of permissible sulfur content, e.g. from 0 to 0,040 % by mass (as determined in the product analysis of high-grade steels) is exploited. They therefore requested that maximum sulfur content grades should be cancelled and replaced by controlled sulfur content grades. This would reduce the number of grades specified in this

standard by 6 grades and the misleading code letter "m" or "S" in the symbols identifying the steel grades could be omitted. For special cases, a footnote should refer to agreements to be made on lower sulfur contents. This proposal did not find the support of the representatives of the other interest groups. They pointed out that such a procedure would not be acceptable, particularly with regard to flat products and heavy forgings; and that other user groups called for the specification of — differing — maximum values. This point is to be discussed again during the next revision of this standard.

- f) Since the system of forms of supply for characterizing the desired requirements, as specified in the December 1969 edition of DIN 17 210, was hardly ever used in practice, it has been omitted from this standard, and after detailed discussions on the various details it has been replaced by the normal combinations of heat treatment conditions of the material on delivery, product forms and requirements given in table 1. This means that there is now also a clear statement as to which requirements have to be complied with for which heat treatment condition, if no relevant information is given in the order.
- g) The heat treatment dealt with in subclause 8.4.2 for the purpose of determining the austenite grain size concerns a reference heat treatment which depends on the temperature rise taking place sufficiently slowly to allow reproducible results to be obtained. For this reason, the use of salt baths has been excluded.
- h) The hardenability bands for alloy steels have been checked on the basis of large scale evaluations by the steel manufacturers; on this basis, it was possible to specify as binding values the hardenability bands, which had previously been provisional, for the alloy steels dealt with in the December 1969 edition, and for grades 17 Cr 3 (1.7016), 22 CrMoS 3 5 (1.7333), 21 NiCrMo 2 (1.6523) and 21 NiCrMoS 2 (1.6526) which have been included for the first time. The values for grades 20 Cr 4 (1.7027) and 20 CrS 4 (1.7028) are provisional.

It should be noted that the values specified in table 4 are based on an evaluation of cast analysis and that some variations may occur in comparison with the cast analysis when a subsequent test is made on the product. In order to be able, at a later date, to give some quantitative information on the extent of the deviations, manufacturers and users have been requested to collect data on this point. The users were of the opinion that the values given in table 4 should also apply to product analyses.

The steel manufacturers stated that their results regarding hardenability values were essentially based on tests on separately cast bars which could be regarded as representative of the relevant cast with regard to chemical composition, and hence also hardenability. The end quench test pieces were taken from these low-segregation test bars after forging down to about 30 mm diameter. If the values were to apply to product tests also, it would be necessary to take into account the accuracy of the tests and the inhomogeneity within the casts, which would mean widening the bands given in table 4; on the basis of a foreign test it was found that there is an instrument-dependent dispersion of ± 2 HRC even for a single bar in tests carried out by different test houses. The users pointed out that from their point of view (and for acceptance inspection), only a product test was possible. Since the cast analyses evaluated by the steel manufacturers covered numerous casts and the production of various manufacturers and hence included virtually all possible combinations of chemical composition, the possible inhomogeneities in the cast would

already have been taken into account, so that the values given in table 4 should remain valid for product tests also. Within a cast a certain dispersion of the hardenability values would be acceptable, but the values would in any case have to be within the limits specified in table 4.

- i) Except for grades 15CrNi6 (1.5919) and 17CrNiMo6 (1.6587) steels, the limiting curves of the restricted hardenability bands have been extended beyond the distance from the quenched end in which the lower limiting curve of the non-restricted band reaches the lowest hardness value (21 or 20 HRC). These extended limiting curves are not based on evaluations, but have been derived from the following schematic procedure. For restriction with respect to the upper limiting curve of the unrestricted hardenability band, the hardness range obtained at the intersection of the lower limiting curve of the restricted band with the curve indicating the distance from the quenched end of the lowest hardness value represented was adopted; the upper limiting curve in the case of restriction with respect to the lower limiting curve of the unrestricted bands was similarly continued parallel to the upper limiting curve of the complete range of hardenability in the ratio existing at that "intersection". These "constructed" limiting curves cannot therefore be binding and can only give an approximate guide and should be so regarded when material is ordered.
- j) The proposal that the Brinell hardness values listed in table 5 should be rounded to 0 or 5 was rejected, since two indentation diameters as specified in ISO 410, Metallic materials; hardness test; tables of Brinell hardness values for use in tests made on flat surfaces, might be assigned to some hardness values thus rounded and would hence leave them open to interpretation.
- k) The values adopted in this standard for the oxidic degree of cleanness of high-grade steels are based on large-scale evaluations. It should be noted that the specifications given in table 6 are limited in terms of dimensions and cannot be extrapolated to the complete field of application of this standard.
- l) There was, in principle, agreement that it would be reasonable to create surface quality classes for the requirements regarding surface quality (permissible

depth of cracks). However, since there was no clear idea as to the values to be specified and it was desired not to hold up the preparation of this standard, it was regarded as reasonable not to give any concrete values for this, but instead to prepare product-related *Stahl-Eisen-Lieferbedingungen* and to make a reference to these as already practised in this standard in the case of round steel bars, wire rods and flat products. The same procedure is to be adopted for the international standards.

- m) In the draft version of this standard only guideline values were given for the mechanical properties of blank hardened round steel bars. However, since hardenability is a characteristic of the steels covered in this standard and since the blank hardening test which the classification societies are apt to require is considered more a matter of quality assurance in further processing, the responsible working committee decided to omit these guideline values entirely and regarded this alteration as being too insignificant to justify the publication of a second draft standard.

The steel manufacturers had previously pointed out that the blank hardening test is hardly ever demanded and for this reason they did not possess any documentation for fixing proper limiting values for the mechanical properties in the blank hardened condition. Occasional checks had, however, revealed that the values specified hitherto were in some cases highly questionable.

Although the users also found the test results questionable (influence of grain size and of the quenchant not being taken into account), it was nevertheless regretted that the standard does not include any binding characteristic values for the elongation after fracture and reduction in area after fracture of the steels. It could become more difficult to acquire an approval for specific applications, in particular for the steels for which no hardenability values, or at least no binding values, are specified.

This standard bears a relationship to ISO/DIS 683/11, December 1985 edition, Heat-treatable steels, alloy steels and free-cutting steels. Part 11: Wrought case hardening steels, and to EURONORM 84 - 70, Case hardening steels; quality specifications. The table below gives a survey of the steel grades covered by this standard and the international documentation for case hardening steels.

Case hardening steels specified in					
DIN 17 210		EURONORM 84-70		ISO/DIS 683/11	
Symbol	Material number	Symbol	1)	Symbol	1)
C 10 C 10 Pb Ck 10 —	1.0301 1.0302 1.1121 —	— — 2 C 10 3 C 10	● ●	— — C 10 —	 ●
C 15 C 15 Pb Ck 15 Cm 15	1.0401 1.0403 1.1141 1.1140	— — 2 C 15 3 C 15	● ●	— — C 15 E4 C 15 M2	 ● ●
17 Cr 3	1.7016	—		—	
—	—	15 Cr 2		—	
20 Cr 4 20 CrS 4	1.7027 1.7028	— —		20 Cr 4 20 CrS 4	● ●
16 MnCr 5 16 MnCrS 5	1.7131 1.7139	16 MnCr 5 —	● 	16 MnCr 5 16 MnCrS 5	● ○
20 MnCr 5 20 MnCrS 5	1.7147 1.7149	— —		20 MnCr 5 20 MnCrS 5	● ○
— —	— —	18 CrMo 4 —		18 CrMo 4 18 CrMoS 4	
20 MoCr 4 20 MoCrS 4	1.7321 1.7323	20 MoCr 4 —	○ 	— —	
22 CrMoS 3 5	1.7333	—		—	
—	—	15 NiCr 6		—	
15 CrNi 6	1.5919	14 CrNi 6	○	—	
—	—	13 NiCr 12		15 NiCr 13	
21 NiCrMo 2 21 NiCrMoS 2	1.6523 1.6526	20 NiCrMo 2 —	○ 	20 NiCrMo 2 20 NiCrMoS 2	● ○
—	—	17 NiCrMo 5		17 NiCrMo 6	
17 CrNiMo 6	1.6587	17 CrNiMo 7	●	18 CrNiMo 7	●
—	—	14 NiCrMo 13		—	
<p>1) This column indicates the degree of agreement with regard to the chemical composition of the steels as specified in this standard and those specified in the international documentation.</p> <p>The symbols have the following meanings: ● = slight differences; ○ = significant differences.</p>					

International Patent Classification

C 22 C 38/04
C 21 D 9/00