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September 1980

Ball and Roller Bearing Steels

Technical Conditions of Delivery

DIN 17 230

Wälzlagerstähle; Technische Lieferbedingungen

For connection with the International Standard ISO 683/XVII – 1976 issued by the International Organization for Standardization (ISO) and with the EURONORM 94 – 73 issued by the European Coal and Steel Community, see Explanations.

The sections marked with a dot (•) contain details of arrangements which either must be made or can be made at the time of placing the purchase order.

1 Scope

This Standard encompasses the steels generally used for ball and roller bearing components (balls, rollers, needles, races and discs). It applies to the steel grades listed in Table 1 and to the product shapes and heat treatment conditions and surface conditions featured in Table 2.

2 Other relevant Standards and documents

DIN 1605 Part 1	Testing of materials; mechanical testing of metals; general and acceptance
DIN 5401	Rolling bearing components, balls
DIN 50 049	Certificates on material testings
DIN 50 115	Testing of metallic materials, notched bar impact bending test
DIN 50 133 Part 1	Testing of metallic materials; Vickers hardness testing; test load range: 49 to 980 N (5 to 100 kp)
DIN 50 145	Testing of metallic materials; tensile test
DIN 50 191	Testing of ferrous materials; end quench test, sample length 100 mm, sample diameter 25 mm
DIN 50 192	Determination of decarburizing depth
DIN 50 351	Testing of metallic materials; Brinell hardness testing
EURONORM 79	Nomenclature and classification of steel products in accordance with shapes and dimensions
EURONORM 103-71	Microscopic determination of the ferrite or austenite grain size of steels
Stahl-Eisen-Prüfblatt 1520 (Steel-Iron Test Sheet 1520) [1]	Microscopic examination of the carbide configuration in steels with sequences of illustrations
Stahl-Eisen-Prüfblatt 1570 (Steel-Iron Test Sheet 1570) [1]	Microscopic examination of high grade steels in respect of non-metallic inclusions, with sequences of illustrations
Stahl-Eisen-Prüfblatt 1570 Beiblatt 1 (Steel-Iron Test Sheet 1570 Suppl. 1) [1]	Microscopic examination of high grade steels in respect of narrow elongated non-metallic inclusions
Handbuch für das Eisenhüttenlaboratorium (Handbook for the Ferrous Metallurgy Laboratory) [1]:	Vol. 2: Die Untersuchung der metallischen Stoffe (The examination of metals); Düsseldorf, 1966; Vol. 5 (Ergänzungsband) (Suppl. Vol.): A4.1 – Aufstellung empfohlener Schiedsverfahren (List of recommended arbitration methods), B – Probenahmeverfahren (Sampling procedures), C – Analysenverfahren (Analyses procedures); refer to the most recent edition in each case

In addition, see the dimensional Standards in Appendix A.

3 Terms

3.1 Ball and roller bearing steels

Ball and roller bearing steels are steels for components of ball and roller bearings which are subjected during operation first and foremost to high local alternating stresses and are exposed to abrasive wear. In the worn condition they exhibit hard spots, at least in the surface zone.

3.2 Product shape

The definitions of EURONORM 79 apply to the product shapes.

3.3 Heat treatment

The definitions and technical terms of DIN 17 014 Part 1 apply to the types of heat treatment mentioned in this Standard.

4 Dimensions and permissible dimensional deviations

4.1 The Standards listed in Appendix A apply to the nominal dimensions and to the permissible dimensional deviations.

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[1] Verlag Stahleisen mbH, Postfach 8229, 4000 Düsseldorf 1

Continued on pages 2 to 16
Explanations on pages 17 and 18

Explanatory notes

1. This standard contains the following substantial amendments in comparison with the July 1968 edition of Preliminary Standard DIN 17 224:

a) The lower limit for the nickel content of steel X 12 CrNi 17 7 (material number 1.4310) has been reduced from 7,0 to 6,0 %. It is intended, that when *Stahl-Eisen Werkstoffblatt* 400 – Stainless rolled and forged steels – is revised, a nickel content of 6,0 to 9,0 % will also be specified for this steel.

In connection with the reduction of the lower limit for nickel when this steel is used as a spring material, the steel manufacturers have pointed out that, as a consequence of the content of chromium present and the intentional addition of molybdenum, there is no danger of a degradation of the corrosion properties.

b) A table has been included giving the deviations from the limiting values in the cast analysis permitted in the product analysis.

c) The strength levels K 115, K 130 and K 145 previously additionally included for strip have been deleted as, in the view of the spring manufacturers, they are not necessary and a footnote permits the agreement on lower tensile strength values where there are high requirements on deformability (this footnote has now also been extended to cover wire).

d) Where, in the previous edition of this standard, a tensile strength range of 25 kg/mm² (corresponding to 2501N/mm²) was specified, the range has been narrowed to 200 N/mm² by raising the lower limit, in order to accommodate the more stringent requirements on the tolerances for the finished product. The range for wire was not narrowed correspondingly, however, a tighter tolerance can be specified for this at the time or ordering.

e) The specifications for the 90° bending ability of strip have been extended to cover thicknesses greater than 0,75 to 0,90 mm. It has been possible for the first time to include data for steel X 5 CrNiMo 18 10 (material number 1.4401).

f) The specifications relating to the modulus of elasticity and shear modulus of wire and strip have been revised. It should be noted that lower values can be recorded when testing finished springs; the values given in table A.1 are not those to be used for the calculation of springs, those in DIN 2088, (Preliminary Standard) DIN 2089 Part 1 and Part 2 are to be used instead.

g) In order to make these more readily comprehensible, the specifications relating to the scope of testing have been given in a table, which also specifies the acceptance unit.

h) The torsion test (carried out as a reverse torsion test) has been adopted for the assessment of the surface quality of wire with diameter greater than 1,5 mm.

i) Flat wire (flats rolled from wire), which is not held as stock and for which there is not a great demand, has been dropped from the field of application, since it does not comply with the specifications of this standard with regard to, for example, the achievable values for the tensile strength and the spring bending limit.

j) DIN 59 381, and not DIN 1544, is now quoted as the dimensional standard for strip.

k) Specifications regarding the average peak-to-valley height of strip have been adopted.

l) The reference values for the increase in tensile strength of work-hardened products as a consequence of tempering or single artificial ageing, and of solution annealed products made from steel X 7 CrNiAl 17 7 as a consequence of two stage artificial ageing have been represented in graph form.

m) The requirement on "freedom from corkscrew cast" for wire with a diameter less than 5 mm has been specified precisely by means of a formula giving a maximum permissible axial displacement.

n) The standard has been editorially revised throughout.

2. The Explanatory notes to the Preliminary Standard DIN 17 224 (July 1968 edition) listed a number of items which it was wished to add to a revised version of the standard. Of these, it has still not yet been possible to include specifications on particle size and degree of purity. The inclusion of fatigue strength graphs was not favoured; it was proposed that graphs of this nature be included in the standards on the calculation of springs.

3. It was agreed that although tensile strength values can not be considered the property characterizing spring behaviour, knowledge of them was generally sufficient as a characteristic value and that agreement on further characteristic values is only necessary in special cases. Since, however, there is still uncertainty over appropriate criteria for the behaviour in use of springs, and proof of this, users and manufacturers of springs have decided to instigate a study of this question.

4. It is not possible, because of the varying contents of transformation martensite, which for their part are in turn influenced by the chemical composition, the degree of transformation and the heat treatment, and their differing effects on the corrosion resistance of a single steel grade, to give generally valid information on the behaviour of the steels against various corrosive media and types of corrosion. These relationships are further complicated by the influence of the surface condition (e.g. annealing colours) and the corrosive stress.

5. The European Coal and Steel Community (ECSC) is at present preparing a corresponding EURONORM (number 151). Judging by the progress of the discussions at the time of the publication of this standard there will be as great a technical correspondence as possible.

International Patent Classification

G 01 N 3/00
F 16 F 1/00
C 22 C 38/00
B 21 F 35/00
B 21 D 11/10

4.2 • In cases where no Standard is listed in Appendix A or the product concerned, the permissible dimensional leviations shall be mutually agreed at the time of placing he purchase order.

4.3 In cases of doubt, the three-point measurement nethod described in DIN 5401 should be used on peeled ınd ground round material for the detection of odd-ıumbered polygonal cross-sections which deviate from :rue circularity ("constant diameter").

5 Calculation of weight and permissible weight deviations

5.1 For the calculation of the nominal weight of products, the following density values shall be adopted:

– Through hardening steels	7.85 kg/dm³
– Case hardening steels	7.85 kg/dm³
– Heat-treatable steels	7.85 kg/dm³
– Stainless steels	7.7 kg/dm³
– High temperature hardness steels	
80 MoCrV 42 16,	
) . WMo-CrV 6 5 4	8.1 kg/dm³
X 75 WCrV 18 4 1	8.7 kg/dm³

5.2 • The permissible deviations in weight of the quantity ordered can be mutually agreed at the time of placing the purchase order.

6 Classification by grades

6.1 Steel grades

6.1.1 The steel grades featured in this Standard are **high-grade steels.**

The steels are subdivided into the following groups (see Table 1):

a) Steels with ≈ 1 % C and approx. 0.5 to 2 % Cr – these steels will subsequently be referred to as through hardening steels,

b) Case hardening steels,

c) Heat-treatable steels (which are mainly used for surlayer hardening),

d) Stainless steels,

e) High temperature hardness steels.

6.1.2 The selection of the steel grade is purchaser's concern.

6.2 Product shapes and treatment conditions

The product shapes and treatment conditions at delivery which generally apply to the steels in accordance with this Standard are specified in Table 2.

7 Designations

7.1 Designation of the steel grades and of treatment conditions

The code numbers have been formed in accordance with the Explanations to the DIN-Normenheft (Standards Book) 3, 1976 edition, Sections 2.1.2.1 and 2.1.2.2, and the material numbers have been formed in accordance with DIN 17 007 Part 2. The code letter applying to the treatment condition in accordance with Table 2 should, if applicable, be appended to the code number or to the material number.

Example 1:

Steel 100 Cr 6, material number 1.3505, condition „annealed for spheroidization of carbides" (GKZ):

100 Cr 6 GKZ

or

1.3505 GKZ

7.2 Designation in order

The following details shall be specified in the purchase order in the sequence below:

Quantity, shape of product, dimensional Standard, code number or material number of the desired steel grade, treatment condition at delivery and dimensions.

Example 2:

20 t round wire rod in accordance with DIN 59 115, made from a steel with the code number 100 Cr 6 or the material number 1.3505, in the condition "annealed for spheroidization of carbides" (GKZ), of diameter d = 10 mm and measuring accuracy B:

20 t wire DIN 59 115 – 100 Cr 6 GKZ – 10 B

or

20 t wire DIN 59 115 – 1.3505 GKZ – 10 B

If a different surface execution to "hot formed" is desired, this must also be stated in the purchase order.

8 Requirements

8.1 • Melting process and shaping process

Unless anything to the contrary has been mutually agreed at the time of placing the purchase order, the type of melting process of the steel and the shaping process of the product are left to the manufacturer's discretion. The type of melting process of the steel shall however be notified to the purchaser on request. Steel grade 80 MoCrV 42 16 shall be melted according to the vacuum remelting process or the electro slag remelting process or an equivalent process.

8.2 Product shape, treatment condition, surface execution and segregation of melts

8.2.1 The products shall comply with the purchase order specifications in respect of product shape, treatment condition at delivery and surface execution.

8.2.2 • The steels shall be supplied segregated according to melts, unless anything to the contrary has been agreed.

8.3 Chemical composition, hardenability and mechanical properties

8.3.1 The chemical composition according to the ladle analysis must conform to Table 1. However if the adduction of evidence of certain hardenability characteristic values has been agreed to at the time of placing the purchase order, then these values shall be determining for the acceptance. In such cases the ladle analysis may deviate slightly from the limiting values specified in Table 1.

The purchaser shall be notified of any deviations of the chemical composition of the melt in relation to the limiting values of Table 1.

8.3.2 • In the purchase order, the adduction of proof that the sample analysis has complied with the limiting values for the ladle analysis (see Table 1) within the permissible deviations specified in Table 3 may be mutually agreed.

8.3.3 The hardness values in accordance with Table 5 apply to the various treatment conditions at delivery.

8.3.4 The specifications of Table 4 apply to the limiting values of hardness in the end quench test. The data in column 2 of Table 11 apply to the hardening temperatures in the end quench test.

8.3.5 The mechanical property values on hardened and tempered cross-sections listed in Table 6 apply to samples which have been taken from round bars in the direction of rolling.

• In the case of other shapes of cross-section, the comparable diameter, the location for the removal of the sample, the direction of the sample and the values which must be complied with shall, if necessary, be mutually agreed at the time of placing the purchase order.

8.4 Technological properties

8.4.1 Shearability

Under appropriate conditions (avoidance of local stress peaks, preheating, cutter with suitably adapted profile, accurate guidance of the workpiece and adaptation of the shearing gap) the steel grades in accordance with this Standard are shearable in the treatment conditions specified as suitable for this purpose in each case.

• In the case of the case hardening steels and of the heat treatable steels, the condition "treated for shearability" (C) can be mutually agreed separately at the time of placing the purchase order (see also Footnote 2 of Table 2).

• In the case of the through hardening steels, the hardness values which have to be complied with and the requirements in respect of the structure shall be mutually agreed if necessary.

In the case of the stainless steels and of the high temperature hardness steels, shearability will in general only apply in the condition "annealed for spheroidization of carbides (GKZ)". See Table 5 for the hardness values prescribed for this condition.

8.4.2 Machinability (as applicable to shaping by cutting)

The initial condition for shaping by cutting is the condition "annealed for spheroidization of carbides" (GKZ), and, in the case of case hardening steels, the conditions "heat treated to a given tensile strength" (BF) and „heat treated to a ferritic-pearlitic structure" also come into consideration.

8.4.3 Cold workability

For the cold working (mainly the cold pressing) of the case hardening steels and of the through hardening steels, the treatment condition "annealed for spheroidization of carbides" (GKZ) (see Table 5) is the one coming mainly into consideration.

8.5 Structure

8.5.1 Austenitic grain size of the case hardening steels and of the heat-treatable steels

The steels must be fine-grained, i. e. their structure must consist basically of grains in accordance with the characteristic size numbers ≥ 5. However, when carrying out a re-check in accordance with EURONORM 103-71, Sections 3.5.1 and 3.5.3, isolated grains of sizes 4 and 3 will still be permitted.

Note: A DIN Standard containing the corresponding data is in course of preparation.

8.5.2 Carbide configuration

In the case of deliveries in the treatment conditions "annealed for spheroidization of carbides" (GKZ) and "annealed for the spheroidization of carbides + cold worked" (GKZ + K), the carbides must be fully spheroidized in the case of the through hardening ball and roller bearing steels, and predominantly spheroidized in the case of the stainless steel and of the high temperature hardness ball and roller bearing steels. The case hardening steels may exhibit incompletely spheroidized carbides (pearlite) in these conditions.

• Requirements relating to carbide size, pearlite percentage, carbide lattice, carbide forming-in and carbide banding shall if necessary be mutually agreed in advance at the time of placing the purchase order, on the basis of the Stahl-Eisen-Prüfblatt 1520[1]).

8.6 Non-metallic inclusions

The steels shall exhibit a high degree of purity.

The determining characteristic cumulants K in this respect, in accordance with Stahl-Eisen-Prüfblatt 1570[1]) are specified in Table 7. In the case of the air-melted through hardening ball and roller bearing steels, the oxides and sulphides are rated, whilst in the case of the case hardening and heat-treatable steels, only the oxides are rated.

• As regards the stainless steels and high temperature hardness steels, and also all steels which are not air-melted, the requirements concerning them shall be mutually agreed at the time of placing the purchase order, if necessary.

8.7 Surface condition

8.7.1 All products shall exhibit a surface which complies with the standards of workmanlike manufacturing conditions.

8.7.2 Peeled, ground or otherwise machined bright steel products must be free from surface flaws and surface decarburization. The "roll-peeled" surface execution which is sometimes ordered does not count as bright steel.

• If the naturally occurring surface strain hardenings and the roughness are likely to affect the utilization adversely, then special arrangements concerning the as-delivered condition can be made at the time of placing the purchase order.

Any surface unevenness resulting from machining and due to the process (e. g. fluting in the transverse direction of the bars) shall not be assessed as a surface defect on con-

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[1]) See page 1

dition that any such unevenness is situated within the permissible dimensional deviations.

8.7.3 Wire rod, rolled steel bars and drawn bright steel

8.7.3.1 Through hardening, stainless and high temperature hardness steels

The specifications contained in Table 8 and Fig. 1 apply to the permissible depth of surface cracks and of surface decarburization.

8.7.3.2 Case hardening steels and heat-treatable steels

The specifications contained in Table 9 and Fig. 1 apply to the permissible depth of surface cracks and of surface decarburization.

8.7.4 • In the case of product shapes, surface executions and dimensions other than those featured in Tables 8 and 9, such as for example forged steel bars, the requirements relating to the depth of surface defects and/or of surface decarburization shall, if necessary, be mutually agreed at the time of placing the purchase order.

9 Heat-treatment

The specifications of Table 11 apply to the heat-treatment.

10 Testing

10.1 • Acceptance tests

The manufacturer shall on the basis of his own judgment and on his own responsibility take all the necessary steps in connection with his manufacturing process and testing procedures to ensure that the requirements in accordance with Section 8 are satisfied.

The purchaser may arrange for acceptance tests in connection with the requirements in accordance with Section 8 to be carried out, at the time of placing the purchase order. Such acceptance tests will as a general rule be carried out by experts of the supplier, but by special agreement at the time of placing the purchase order they may be carried out by outside personnel duly appointed by the purchaser. Unless anything to the contrary has been mutually agreed, the provisions contained in Sections 10.2 to 10.4 shall apply to the acceptance tests. Even if no acceptance tests have been agreed, the delivery must comply with the requirements in accordance with Section 8.

10.2 Test unit, extent of testing, sampling and test method

The details featured in Table 10 apply to the above items.

Footnotes to Table 1.

1) Elements which are not featured in this Table may not be deliberately added to the steel except for the purpose of finish-treating the melt. Every suitable precaution must be taken to ensure that no such elements are inadvertently added via the scrap or via other substances used for manufacture; percentages of companion elements are however permissible on condition that the specified values of mechanical properties and of hardenability are satisfied, and that the usability of the product is not impaired.

2) In the case of steel melted or remelted under vacuum, the manganese content may be allowed to drop slightly below the lower limit specified.

3) In the case of melting or remelting under vacuum, or of remelting according to the electroslag process, the phosphorus and sulphur contents shall each be ≤ 0.015 %.

4) • A lower carbon content may be mutually agreed at the time of placing the purchase order.

5) • A C content of 0.95 to 1.10 % may also be mutually agreed at the time of placing the purchase order.

6) • Unless anything to the contrary has been mutually agreed at the time of placing the purchase order, the silicon content may be lower than the lower limit specified.

7) • Subject to mutual agreement between purchaser and manufacturer, the steel may be ordered with a higher maximum sulphur content.

8) This grade is always melted according to a special process.

Table 1. **Chemical composition of the ball and roller bearing steels (according to the ladle analysis) [1]**

Steel grade		Chemical composition in % by weight										
Code number	Material number	C	Si	Mn [2]	P [3] max	S [3] max	Cr	Mo	Ni	V	W	Cu max
Through hardening steels												
100 Cr 2	**1.3501**	0,90 to 1,05[4]	0,15 to 0,35[6]	0,25 to 0,45	0,030	0,025	0,40 to 0,60	–	max. 0,30	–	–	0,30
100 Cr 6	**1.3505**	0,90 to 1,05[5]	0,15 to 0,35[6]	0,25 to 0,45	0,030	0,025[7]	1,35 to 1,65	–	max. 0,30	–	–	0,30
100 CrMn 6	**1.3520**	0,90 to 1,05	0,50 to 0,70	1,00 to 1,20	0,030	0,025	1,40 to 1,65	–	max. 0,30	–	–	0,30
100 CrMo 7	**1.3537**	0,90 to 1,05	0,20 to 0,40[6]	0,25 to 0,45	0,030	0,025	1,65 to 1,95	0,15 to 0,25	max. 0,30	–	–	0,30
100 CrMo 7 3	**1.3536**	0,90 to 1,05	0,20 to 0,40[6]	0,60 to 0,80	0,030	0,025	1,65 to 1,95	0,20 to 0,35	max. 0,30	–	–	0,30
100 CrMnMo 8	**1.3539**	0,90 to 1,05	0,40 to 0,60	0,80 to 1,10	0,030	0,025	1,80 to 2,05	0,50 to 0,60	max. 0,30	–	–	0,30
Case hardening steels												
17 MnCr 5	**1.3521**	0,14 to 0,19	max. 0,40	1,00 to 1,30	0,035	0,035	0,80 to 1,10	–	–	–	–	0,30
19 MnCr 5	**1.3523**	0,17 to 0,22	max. 0,40	1,10 to 1,40	0,035	0,035	1,00 to 1,30	–	–	–	–	0,30
16 CrNiMo 6	**1.3531**	0,15 to 0,20	max. 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	–	–	0,30
17 NiCrMo 14	**1.3533**	0,15 to 0,20	max. 0,40	0,40 to 0,70	0,035	0,035	1,30 to 1,60	0,15 to 0,25	3,25 to 3,75	–	–	0,30
Heat-treatable steels												
Cf 54	**1.1219**	0,50 to 0,57	max. 0,40	0,40 to 0,70	0,025	0,035	–	–	–	–	–	0,30
44 Cr 2	**1.3561**	0,42 to 0,48	max. 0,40	0,50 to 0,80	0,025	0,035	0,40 to 0,60	–	–	–	–	0,30
43 CrMo 4	**1.3563**	0,40 to 0,46	max. 0,40	0,60 to 0,90	0,025	0,035	0,90 to 1,20	0,15 to 0,30	–	–	–	0,30
48 CrMo 4	**1.3565**	0,46 to 0,52	max. 0,40	0,50 to 0,80	0,025	0,035	0,90 to 1,20	0,15 to 0,30	–	–	–	0,30
Stainless steels												
X 45 Cr 13	**1.3541**	0,42 to 0,50	max. 1,00	max. 1,00	0,040	0,030	12,5 to 14,5	–	max. 1,00	–	–	0,30
X 102 CrMo 17	**1.3543**	0,95 to 1,10	max. 1,00	max. 1,00	0,040	0,030	16,0 to 18,0	0,35 to 0,75	max. 0,50	–	–	0,30
X 89 CrMoV 18 1	**1.3549**	0,85 to 0,95	max. 1,00	max. 1,00	0,045	0,030	17,0 to 19,0	0,90 to 1,30	–	0,07 to 0,12	–	0,30
High temperature hardness steels												
80 MoCrV 42 16	**1.3551**	0,77 to 0,85	max. 0,25	max. 0,35	0,015[8]	0,015[8]	3,75 to 4,25	4,00 to 4,50	–	0,90 to 1,10	–	–
X 82 WMoCrV 6 5 4	**1.3553**	0,78 to 0,86	max. 0,40	max. 0,40	0,030	0,030	3,80 to 4,50	4,70 to 5,20	–	1,70 to 2,00	6,00 to 6,70	–
X 75 WCrV 18 4 1	**1.3558**	0,70 to 0,78	max. 0,45	max. 0,40	0,030	0,030	3,80 to 4,50	max. 0,60	–	1,00 to 1,20	17,5 to 18,5	–

[1] to [8] see page 4

10.3 Re-tests

The provisions of DIN 17 010 (at present still in draft form) apply to the above item.

10.4 • Test certificates

Tests in connection with deliveries of steels in accordance with this Standard shall be certified by means of certificates in accordance with DIN 50 049. The type of certificate shall be mutually agreed at the time of placing the purchase order.

11 • Marking

The products shall be suitably marked with the manufacturer's trade marke, the code number or the material number of the steel grade, the melt number and, if this last item has been mutually agreed at the time of placing the purchase order, the treatment condition.

12 Complaints [2])

12.1 Any objections relating to external and internal defects may only be raised in cases where such defects adversely affect the processing and utilization appropriate to a given steel grade and a given product shape more than just marginally.

12.2 The purchaser shall give the supplier the opportunity to convince himself that the complaint is justified, in so far as possible by the submission of samples of the rejected material and of samples of the delivered material.

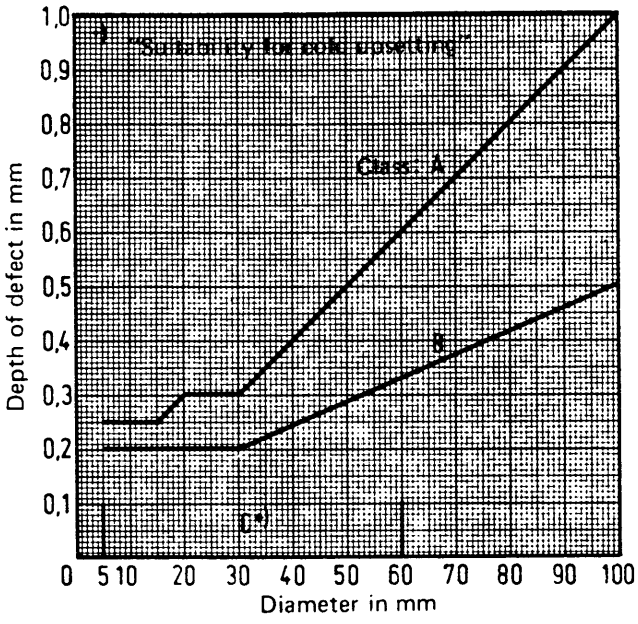

Figure 1. Marking of the surface crack depth classes A, B and C

2) See "Explanations" to DIN 17 010 for the explanations relating to this complaints clause in quality Standards for iron and steel.

Table 2. **Product shapes and treatment conditions [1] predominantly applying to the steels**

Product		Billets		Steel bars							Wire				Tubes						Rings and discs				
Treatment condition		Untreated (U)	Treated for shearability [2] (C)	Untreated (U)	Heat-treated to achieve a given tensile strength (BF)	Heat-treated for ferritic-pearlitic structure (BG)	Annealed for spheroidization of carbides (GKZ)	Annealed for spheroidization of carbides + cold drawn (GKZ + K)	Annealed for spheroidization of carbides + peeled (GKZ + SH)	Annealed for spheroidization of carbides + ground (GKZ + ground)	Untreated (U)	Annealed for spheroidization of carbides (GKZ)	Annealed for spheroidization of carbides + cold drawn (GKZ + K)	Annealed for spheroidization of carbides + cold drawn + soft annealed (GKZ + K + G)	Heat-treated for ferritic-pearlitic structure (BG)	Heat-treated for ferritic-pearlitic structure + cold finished (BG + K)	Annealed for spheroidization of carbides (GKZ)	Annealed for spheroidization of carbides + peeled (GKZ + SH)	Annealed for spheroidization of carbides + cold finished (GKZ + K)	Annealed for spheroidization of carbides + cold finished + soft annealed (GKZ + K + G)	Heat-treated to achieve a given tensile strength (BF)	Heat-treated for ferritic-pearlitic structure (BG)	Annealed for spheroidization of carbides (GKZ)	Annealed for spheroidization of carbides + machined (GKZ + machined)	Hardened and tempered (V)
Steel grade / Code number	Material number																								
Through hardening steels																									
100 Cr 2	1.3501			×			×	×	×	×	×	×	×	×			×	×	×	×					
100 Cr 6	1.3505	×	×	×			×	×	×	×	×	×	×	×			×	×	×	×			×	×	
100 CrMn 6	1.3520	×	×	×			×		×	×	×	×	×	×			×	×	×	×			×	×	
100 CrMo 7	1.3537	×	×	×			×		×	×							×	×	×	×			×	×	
100 CrMo 7 3	1.3536	×	×	×			×		×	×							×	×	×	×			×	×	
100 CrMnMo 8	1.3539	×	×	×			×		×	×													×	×	
Case hardening steels																									
17 MnCr 5	1.3521	×	×	×	×	×	×	×	×	×		×	×		×	×	×	×	×		×	×	×	×	
19 MnCr 5	1.3523	×	×	×	×	×	×	×	×	×		×	×		×	×	×	×	×		×	×	×	×	
16 CrNiMo 6	1.3531	×	×	×	×	×	×	×	×	×		×	×	×							×	×	×	×	
17 NiCrMo 14	1.3533	×	×	×			×		×	×													×	×	
Heat-treatable steels																									
Cf 54	1.1219	×	×				×	×	×												×				×
44 Cr 2	1.3561	×	×																						×
43 CrMo 4	1.3563	×	×																						×
48 CrMo 4	1.3565	×	×																						×
Stainless steels																									
X 45 Cr 13 X 102 CrMo 17 X 89 CrMoV 18 1	1.3541 1.3543 1.3549						×	×	×	×		×	×	×									×	×	
High temperature hardness steels																									
80 MoCrV 42 16 X 82 WMoCrV 6 5 4 X 75 WCrV 18 4 1	1.3551 1.3553 1.3558						×	×	×	×		×		×									×	×	

1) Marking of the relevant interrelation by means of a cross X.

2) These steels are not usually sheared in cases where their diameter exceeds 120 mm approx.; in the case of such dimensions, the steels must be capable of being sawed.

Table 3. **Permissible deviations of sample analysis values from the limiting values valid for the ladle analysis in accordance with Table 1**

1	2	3	4	5	6	7
Element	Permissible percentage in the ladle analysis %	Permissible deviations [1] [2] for the group of through hardening steels	case hardening steels	heat-treatable steels	stainless steels	high temperature hardness steels
C	< 0,60	–	± 0,02	± 0,02	± 0,02	–
	≥ 0,60 ≤ 1,10	± 0,03	–	–	± 0,03	± 0,03
Si	≤ 0,40	± 0,03	± 0,03	± 0,03	–	+ 0,03 0
	> 0,40 ≤ 1,00	± 0,05	–	–	+ 0,05 0	+ 0,05 0
Mn	≤ 1,00	± 0,04	± 0,04	± 0,04	+ 0,03 0	+ 0,04 0
	> 1,00 ≤ 1,40	± 0,06	± 0,06	–	–	–
P and S	≤ 0,035	+ 0,005 0	+ 0,005 0	+ 0,005 0	+ 0,005 0	+ 0,003 0
	> 0,035 ≤ 0,045	–	–	–	+ 0,010 0	–
Cr	≤ 2,00	± 0,05	± 0,05	± 0,05	–	–
	> 2,00 < 10,0	± 0,10	–	–	–	± 0,10
	≥ 10,0 < 15,0	–	–	–	± 0,15	–
	≥ 15,0 ≤ 19,0	–	–	–	± 0,20	–
Mo	≤ 0,30	± 0,03	± 0,03	± 0,03	–	–
	> 0,30 < 0,60	± 0,05	± 0,05	–	–	+ 0,03 0
	≥ 0,60 < 1,75	–	–	–	± 0,05	–
	≥ 1,75 ≤ 5,20	–	–	–	–	± 0,10
Ni	≤ 1,00	+ 0,03 0	–	–	+ 0,03 0	–
	> 1,00 ≤ 2,00	–	± 0,05	–	–	–
	> 2,00 ≤ 3,75	–	± 0,07	–	–	–
V	≤ 1,50	–	–	–	± 0,03	± 0,05
	> 1,50 ≤ 2,00	–	–	–	–	± 0,10
W	≤ 7,00	–	–	–	–	± 0,10
	> 7,00 ≤ 18,5	–	–	–	–	± 0,20
Cu	≤ 0,30	+ 0,03 0	+ 0,03 0	+ 0,03 0	+ 0,03 0	–

1) For one melt, the deviation of an element in the sample analysis may be situated either only below the minimum value or only above the maximum value of the range specified for the ladle analysis, but not both simultaneously.

2) These values apply to diameters ≤ 160 mm or to cross-sections of equal area.

Table 4. **Limiting values of Rockwell C hardness for hardenability testing in the end quench test** [1]

Steel grade			Hardness HRC at a distance in mm from the quenched end face															
Code number	Material number		1	2	3	4	5	6	7	8	9	10	11	13	15	20	25	30
Cf 54 [2]	1.1219 [2]	max	64	63	62	59	54	38	37	36	36	35	34	33	32	30	28	27
		min	57	53	43	34	30	29	29	28	28	27	26	25	24	21	–	–
			Hardness HRC at a distance in mm from the quenched end face															
			1,5	3	5	7	9	11	13	15	20	25	30	35	40	45	50	–
17 MnCr 5	**1.3521**	max	47	46	44	41	37	35	34	33	31	30	29	28	27	–	–	–
		min	39	35	31	28	24	22	20	–	–	–	–	–	–	–	–	–
19 MnCr 5	**1.3523**	max	49	49	48	46	44	42	41	40	37	35	34	33	31	–	–	–
		min	41	39	36	33	31	29	27	25	23	21	–	–	–	–	–	–
16 CrNiMo 6	**1.3531**	max	48	48	48	48	47	47	46	46	44	43	42	41	41	–	–	–
		min	40	40	39	38	37	36	35	34	32	31	30	29	29	–	–	–
17 NiCrMo 14 [2]	**1.3533** [2]	max	48	47	47	46	46	46	46	46	46	46	45	45	44	44	43	–
		min	40	39	39	38	38	38	38	37	37	36	34	33	32	31	30	–
44 Cr 2 [2]	**1.3561** [2]	max	62	61	59	57	53	47	42	39	36	33	32	31	30	29	29	–
		min	54	49	40	32	28	25	23	22	20	–	–	–	–	–	–	–
43 CrMo 4 [2]	**1.3563** [2]	max	61	61	61	61	61	61	61	60	58	55	53	51	49	48	47	–
		min	54	54	53	52	51	49	47	45	40	37	35	33	32	32	31	–
48 CrMo 4	**1.3565**	max	65	65	64	64	63	63	63	62	61	60	58	57	55	54	54	–
		min	58	58	57	55	54	53	51	48	45	41	39	38	37	36	36	–

1) See Table 11 for the quenching temperatures.
2) The values specified for this steel are tentative values which may, if necessary, have to be amended at a later date on the basis of additional information.

Table 5. **Hardness in the usual as-delivered conditions**

Steel grade		Hardness in the condition						
		C	BF	BG	BG + K	GKZ; GKZ + SH; GKZ + ground	GKZ + K	GKZ + K + G
Code number	Material number	HB[1] max	HB[1]	HB[1]	HB[1] max	HB[1] max	HB[1] max	HB[1] [2] max
Through hardening steels								
100 Cr 2	**1.3501**	[3]	–	–	–	207	241[4][5]	207[6]
100 Cr 6	**1.3505**	[3]	–	–	–	207	241[4][5]	207[6]
100 CrMn 6	**1.3520**	[3]	–	–	–	217	251[5]	– [6]
100 CrMo 7	**1.3537**	[3]	–	–	–	217	251[5]	– [6]
100 CrMo 7 3	**1.3536**	[3]	–	–	–	217	251[5]	– [6]
100 CrMnMo 8	**1.3539**	[3]	–	–	–	217	–	–
Case hardening steels								
1. MnCr 5	**1.3521**	255	156 bis 207	140 bis 187	240[7]	170	207[8]	170[9]
19 MnCr 5	**1.3523**	255	170 bis 217	152 bis 201	250[7]	180	220[8]	–
16 CrNiMo 6	**1.3531**	255	179 bis 227	159 bis 207	–	180	229[8]	180
17 NiCrMo 14	**1.3533**	255	–	–	–	241	–	–
Heat-treatable steels [10]								
Cf 54	**1.1219**	255	–	–	–	–	–	–
44 Cr 2	**1.3561**	255	–	–	–	–	–	–
43 CrMo 4	**1.3563**	255	–	–	–	–	–	–
48 CrMo 4	**1.3565**	255	–	–	–	–	–	–
Stainless steels								
X 45 Cr 13	**1.3541**	[3]	–	–	–	248	269[8]	248
X 102 CrMo 17	**1.3543**	[3]	–	–	–	255	285[8]	255
X 89 CrMoV 18 1	**1.3549**	[3]	–	–	–	255	285[8]	255
High temperature hardness steels								
80 MoCrV 42 16	**1.3551**	[3]	–	–	–	248	285[8]	248
X 82 WMoCrV 6 5 4	**1.3553**	[3]	–	–	–	248	285[8]	248
X 75 WCrV 18 4 1	**1.3558**	[3]	–	–	–	255	293[8]	255

1) HV in the case of thin products.

2) Guide values.

3) See Section 8.4.1 re. shearability of this steel.

4) The hardness of steel wire for needle bearings annealed for spheroidization of carbides and cold drawn may amount up to 320 HB approx.

5) The hardness for cold finished tubes may amount up to 320 HB approx.

6) In the case of tubes, the hardness in this condition can amount up to 250 HB.

7) Guide value for tubes.

8) Guide values. Depending on the degree of cold working, the values may be situated up to 50 HB approx. above those for the condition "annealed for the spheroidization of carbides" (GKZ).

9) In the case of tubes, the hardness in this condition can amount up to 220 HB.

10) See also Table 6.

Table 6. **Mechanical properties of the heat-treatable steels at room temperature (applicable to longitudinal samples)** [1]

Steel grade		Diameter [2]	Yield point (0.2 % proof stress)	Tensile strength	Elongation at fracture ($L_0 = 5\,d_0$)	Contraction in area after fracture	Absorbed energy [3]
Code number	Material number	mm	N/mm^2 min	N/mm^2	% min	% min	J min
Cf 54	**1.1219**	$\leq$ 16	520	750 to 900	12	30	–
		> 16 $\leq$ 40	450	700 to 850	14	35	–
		> 40 $\leq$ 100	400	650 to 800	15	40	–
44 Cr 2	**1.3561**	$\leq$ 16	650	900 to 1100	12	35	35
		> 16 $\leq$ 40	550	800 to 950	14	40	40
		> 40 $\leq$ 100	400	650 to 800	15	45	40
43 CrMo 4	**1.3563**	$\leq$ 16	900	1100 to 1300	10	40	35
		> 16 $\leq$ 40	750	1000 to 1200	11	45	40
		> 40 $\leq$ 100	650	900 to 1100	12	50	40
		> 100 $\leq$ 160	550	800 to 950	13	50	40
		> 160 $\leq$ 250	500	750 to 900	14	55	40
48 CrMo 4 [4]	**1.3565** [4]	$\leq$ 16	900	1100 to 1300	9	40	35
		> 16 $\leq$ 40	780	1000 to 1200	10	45	35
		> 40 $\leq$ 100	700	900 to 1100	12	50	35
		> 100 $\leq$ 160	650	850 to 1000	13	50	35
		> 160 $\leq$ 250	600	800 to 950	13	50	35

[1] For diameters up to 25 mm, the test specimens shall be taken from the centre of the sample section; for larger diameters, the sample axis must lie 12.5 mm beneath the surface.

[2] Please note Section 8.3.5.

[3] These values apply to the mean value from 3 DVM samples in accordance with DIN 50 115. (DVM = German Technical Materials Testing Association). One individual value may be allowed to lie up to 30 % below this mean value.

[4] This steel is mainly used for fairly large dimensions and simple components.

Table 7. **Degree of purity of air-melted through hardening ball and roller bearing steels and of case hardening and heat-treatable steels**

Steel bars Diameter d mm	**Forged rings or rolled tubes** Wall thickness s mm	**Characteristic cumulant K** (oxides + sulphides) **for through hardening ball and roller bearing steels** [1]	**Characteristic cumulant K** (oxides) **for case hardening and heat-treatable steels** [2] [3]
$d > 200$	$s > 100$	K4 $\leq$ 22	K 4 $\leq$ 45
140 < $d \leq$ 200	70 < $s \leq$ 100	K4 $\leq$ 20	K 4 $\leq$ 40
100 < $d \leq$ 140	50 < $s \leq$ 70	K4 $\leq$ 18	K 4 $\leq$ 35
70 < $d \leq$ 100	35 < $s \leq$ 50	K4 $\leq$ 15	K 4 $\leq$ 30
35 < $d \leq$ 70	17,5 < $s \leq$ 35	K4 $\leq$ 12	K 4 $\leq$ 25
17 < $d \leq$ 35	8,5 < $s \leq$ 17,5	K3 $\leq$ 15	K 3 $\leq$ 30
8 < $d \leq$ 17	$s \leq$ 8,5	K3 $\leq$ 10	K 3 $\leq$ 20
$d \leq$ 8		K2 $\leq$ 12	K 2 $\leq$ 25

[1] For the steel 100 Cr 6 (1.3505) these values only apply on condition that the maximum sulphur content specified and agreed at the time of placing the purchase order was not to exceed 0.025 %.

[2] These data are tentative.

[3] • The overall characteristic cumulants (oxides + sulphides) shall, if necessary, be mutually agreed, taking the max. permissible sulphur content into account.

Table 8. **Permissible depth of surface cracks and of decarburization for the through hardening, the stainless and the high temperature hardness steels**

Product shape and surface execution	Permissible crack depth [1] max: untreated	heat-treated	Permissible decarburization depth max, mm: untreated	heat-treated
Rolled steel bars $d > 20$ mm	crack depth class A [2]	crack depth class A	$0{,}008 \times d$	$0{,}01 \times d$
	crack depth class B [2]	-	$0{,}008 \times d$	-
Bright steel bars, drawn	-	crack depth class C	-	subject to mutual agreement
Bright steel bars, machined	-	no cracks (see Section 8.7.2)	-	no decarburization
Wire rod	crack depth class C	crack depth class C	subject to mutual agreement	subject to mutual agreement
Bright wire, drawn	-	crack depth class C	-	subject to mutual agreement

1) See Fig. 1 re. permissible crack depths for the various crack depth classes.

2) ● The desired crack depth class must be specified at the time of placing the purchase order.

Table 9. **Permissible depth of surface cracks and of decarburization for the case hardening and heat-treatable steels**

Product shape and surface execution	Permissible crack depth [1] max	Permissible decarburization depth [2] max, mm: untreated	heat-treated
Rolled steel bars and wire	Crack depth class A [3]	$0{,}015 \times d$	$0{,}02 \times d$
	Crack depth class B [3]	$0{,}015 \times d$	$0{,}02 \times d$
	Crack depth class C [3]	$0{,}015 \times d$	$0{,}02 \times d$

1) See Fig. 1 re. permissible crack depths for the various crack depth classes.

2) Not applicable to case hardening steels.

3) ● The desired crack depth class must be specified at the time of placing the purchase order.

Table 10. **Synopsis of test conditions to be selected for acceptance tests** [1]

1	2	3	4	5	6	7
Ser. No.	Nature of quality requirement	Test unit [2]	Number of test pieces	Number of samples per test piece	Sampling [3] according to	Test method according to
1	**Chemical composition**					
1a	in accordance with the ladle analysis	S	[4]	[4]	[4]	[7]
1b	in accordance with the sample analysis	S	≥ 1/melt [5]	≥ 1 [5]	[6]	[7]
2	**Hardenability in the end quench test**	S	1/melt	1	DIN 50 191	DIN 50 191
3	**Hardness in the condition**					
3a	Treated for shearability (C)	S + W + A [8]	1/50 t, but max. 3 [9]	1	[5]	DIN 50 351 or DIN 50 133 Part 1 in the case of thin products
3b	Heat-treated to achieve a given tensile strength (BF)	S + W + A [8]		1	[5]	
3c	Heat-treated for ferritic-pearlitic structure (BG)	S + W + A [8]		1	[5]	
3d	Annealed for spheroidization of carbides (GKZ)	S + W + A [8]		1	[5]	
3e	Annealed for spheroidiziation of carbides + cold worked (GKZ + K)	S + W + A [8]		1	[5]	
3f	Annealed for spheroidization of carbides + cold worked + soft annealed (GKZ + K + G)	S + W + A [8]		1	[5]	
4	**Mechanical properties** in the hardened and tempered condition (V)	S + W + A [8]	1/50 t, but max. 3 [9]	1	[5]	DIN 50 145 DIN 50 115
5	**Structure**					
5a	Austenitic grain size	S	1/melt	1	EU 103-71 Section 3.3	EU 103-71, Sections 3.4.1 [13] and 3.5.3
5b	Carbide configuration	S + W + A [8]	1 [12]	1 [12]	SEP 1520 [14]	SEP 1520 [14]
5c	Percentage of non-metallic inclusions	S	see SEP 1570 [10]	see SEP 1570 [10]	SEP 1570 [10]	SEP 1570 and SEP 1570 Bbl. 1 [10]
6	**Surface**					
6a	Surface decarburization (with the exception of case hardening steels)	S + O + W + A	1 [12]	1 [12]	DIN 50 192	[11]
6b	Other surface condition	S + O + A	[5]	[5]	[5]	[5]

1) The data relating to the test methods (column 7) are also valid in arbitration cases.

2) A, O, S or W = Separate tests according to dimensions, surface executions, melts or heat treatment lots. In the case of heat-treatment in continuous furnaces, each 15 t or commenced portion of 15 t shall count as one heat-treatment lot.

3) For the Brinell hardness test (DIN 50 351), the provisions of DIN 1605 Part 1 must also be taken into consideration.

4) ● The chemical composition of the melt shall be notified if this has been mutually agreed at the time of placing the purchase order.

5) ● To be mutually agreed at the time of placing the purchase order, if necessary.

6) For the sample analysis, chips shall be removed uniformly across the entire cross-section of the product to be tested.

7) Handbuch für das Eisenhüttenlaboratorium (Handbook for the Ferrous Metallurgy Laboratory), volume 2, volume 5 (supplementary volume), Düsseldorf, Verlag Stahleisen mbH, most recent edition in each case.

8) Products with thicknesses which do not differ greatly from one another (thickness ratio approx. ≤ 1.5) may be lumped together in a single test unit.

9) ● In the case of rolled and forged rings and discs of fairly large dimensions, the number of test pieces shall be mutually agreed.

10) Stahl-Eisen-Prüfblatt 1570 and Stahl-Eisen-Prüfblatt 1570 Beiblatt 1 (obtainable from Verlag Stahleisen mbH, Postfach 8229, 4000 Düsseldorf).

11) In arbitration cases, the decarburization depth shall be deemed to be the distance between the surface and the layer at which the carbon content attains a value of 90 % of the lower limiting value specified in Table 1. In order to determine this decarburization depth, the procedure described in DIN 50 192, May 1977 edition, Section 6.3 shall be followed. In the case of local decarburization, the decarburization depth shall be determined metallographically on samples in the as-delivered condition.

12) ● Provided nothing to the contrary has been mutually agreed at the time of placing the purchase order.

13) For the determination of the quenching grain size, the samples shall be austenized at 930 °C (4 hours holding time) in the case of case hardening steels, and at 850 °C (90 minutes holding time) in the case of heat-treatable steels. As soon as a corresponding DIN Standard has been published, the provisions it will contain shall be the ones applicable here.

14) Stahl-Eisen-Prüfblatt 1520. (Obtainable from Verlag Stahleisen mbH, Postfach 8229, 4000 Düsseldorf).

Table 11. **Heat treatment** [1]

1		2	3	4	5	6	7
Steel grade		Hardening temperature for end quench test °C ±5 °C	Normalizing °C	Preheating temperature °C	Hardening in oil [2] °C	Hardening in water [2] °C	Tempering °C
Code number	Material number						
Through hardening steels							
100 Cr 2	**1.3501**	–	–	–	820 to 850	–	150 to 180
100 Cr 6	**1.3505**	–	–	–	830 to 870	–	150 to 180
100 CrMn 6	**1.3520**	–	–	–	830 to 870	–	150 to 180
100 CrMo 7	**1.3537**	–	–	–	840 to 880	–	150 to 180
100 CrMo 7 3	**1.3536**	–	–	–	840 to 880	–	150 to 180
100 CrMnMo 8	**1.3539**	–	–	–	840 to 880	–	150 to 180
Case hardening steels							
17 MnCr 5	**1.3521**	870	–	–	810 to 840	–	150 to 180
19 MnCr 5	**1.3523**	870	–	–	810 to 840	–	150 to 180
16 CrNiMo 6	**1.3531**	860	–	–	800 to 830	–	150 to 180
17 NiCrMo 14	**1.3533**	830	–	–	780 to 820	–	150 to 180
Heat-treatable steels							
Cf 54	**1.1219**	840	830 to 860	–	815 to 845	805 to 835	550 to 660
44 Cr 2	**1.3561**	850	840 to 870	–	830 to 860	820 to 850	550 to 660
43 CrMo 4	**1.3563**	850	840 to 880	–	830 to 860	820 to 850	540 to 680
48 CrMo 4	**1.3565**	850	840 to 880	–	830 to 860	820 to 850	540 to 680
Stainless steels							
X 45 Cr 13	**1.3541**	–	–	–	1020 to 1070	–	100 to 200
X 102 CrMo 17	**1.3543**	–	–	–	1030 to 1080	–	100 to 200
X 89 CrMoV 18 1	**1.3549**	–	–	–	1030 to 1080	–	100 to 200
High temperature hardness steels							
80 MoCrV 42 16	**1.3551**	–	–	750 to 875	1070 to 1120 [3]	–	500 to 580 [4]
X 82 WMoCrV 6 5 4	**1.3553**	–	–	750 to 875	1180 to 1230 [3]	–	500 to 580 [4]
X 75 WCrV 18 4 1	**1.3558**	–	–	750 to 875	1220 to 1270 [3]	–	500 to 580 [4]

1) Guide values, except for the hardening temperatures for the end quench test; in actual practice, the temperatures and other conditions shall be selected in such a way that the desired properties are attained.

2) Selection of the appropriate quenching medium in the case of the heat-treatable steels according to the shape and dimensions of the work piece in each case.

3) This steel is usually quenched in a salt bath at a temperature of 500 to 560 °C

4) 2 hours tempering time.

Appendix A

Dimensional Standards mainly applicable to the steels of this Standard

For hot rolled wire:

DIN 59 110	Steel wire rod; dimensions, permissible variations, weights
DIN 59 115	Steel wire rod for bolts, nuts and rivets; dimensions, permissible variations, weights

For hot rolled steel bars, flat steel or wide flat steel and for hot forged bars:

DIN 1013 Part 1	Steel bars; hot rolled round steel for general purposes; dimensions, permissible variations for dimension and form
DIN 1013 Part 2	Steel bars; hot rolled round steel for special purposes; dimensions, permissible variations for dimension and form
DIN 1014 Part 1	Steel bars; hot rolled squares for general purpose; dimensions, permissible deviations on dimension and form
DIN 1014 Part 2	Steel bars; hot rolled squares for special purpose; dimensions, permissible deviations on dimension and form
DIN 2077	Spring steel, round, hot rolled; dimensions, permissible deviations on dimension and form
DIN 7527 Part 6	Steel forgings; machining allowances and permissible variations for open-die forged bars
DIN 59 130	Steel bars; hot rolled round steel for bolts and rivets; dimensions, permissible deviations on dimension and form

For bright, ground an polished bars:

DIN 175	Polished round steel; dimensions, permissible variations according to ISA tolerance zone h9, weights
DIN 668	Bright round steel; dimensions, permissible variations according to ISA tolerance zone h11, weights
DIN 671	Bright round steel; dimensions, permissible variations according to ISA tolerance zone h9, weights
DIN 59 360	Grinded and polished round steel bars; dimensions, permissible variations according to ISA tolerance zone h7, weights

For forgings:

DIN 7527 Part 3	Steel forgings; machining allowances and permissible variations for seamless open-die forged rings

Appendix B

Comparison between the code numbers and material numbers used in this Standard and the code numbers and material numbers previously used by the ball and roller bearing industry for the corresponding steel grades.

Table B1.

In this Standard [1]		Previously [1]	
Code number	Material number	Code number	Material number
100 Cr 2	1.3501	105 Cr 2 (W 1)	1.3501
100 Cr 6	1.3505	100 Cr 6 (W 3)	1.3505
100 CrMn 6	1.3520	100 CrMn 6 (W 4)	1.3520
100 CrMo 7	1.3537	100 CrMo 7 (W 24)	1.3537
100 CrMo 7 3	1.3536	100 CrMo 6 (W 5)	1.3536
100 CrMnMo 8	1.3539	100 CrMnMo 8 (W 7)	1.3539
17 MnCr 5	1.3521	16 MnCr 5	1.7131
19 MnCr 5	1.3523	20 MnCr 5	1.7147
16 CrNiMo 6	1.3531	17 CrNiMo 6	1.6587
17 NiCrMo 14	1.3533	18 NiCrMo 14	1.3533
Cr 54	1.1219	Cr 53	1.1213
44 Cr 2	1.3561	46 Cr 2 45 Cr 2	1.7006 1.7005
43 CrMo 4	1.3563	41 CrMo 4 42 CrMo 4	1.7223 1.7225
48 CrMo 4	1.3565	50 CrMo 4 49 CrMo 4	1.7228 1.7238
X 45 Cr 13	1.3541	X 40 Cr 13	1.4034
X 102 CrMo 17	1.3543	X 105 CrMo 17	1.4125
X 89 CrMoV 18 1	1.3549	X 90 CrMoV 18	1.4112
X 80 MoCrV 42 16	1.3551	81 MoCrV 42 16	1.2369
X 82 WMoCrV 6 5 4	1.3553	S 6-5-2	1.3343
X 75 WCrV 18 4 1	1.3558	S 18-0-1	1.3355

[1] The changeover in the code numbers and in the material numbers was dictated by the need to avoid any risk of confusion with similar grades as regards their chemical composition, but which are supplied in accordance with different conditions of delivery.

Further Standards and documents

DIN 17 007 Part 2 Material numbers; system of the principal group 1: steel

DIN 17 014 Part 1 Heat treatment of ferrous materials; technical terms and expressions

DIN-Normenheft (Standards Book) 3 Code numbers and material numbers of the ferrous materials in DIN Standards and in Stahl-Eisen Material Sheets

Explanations

1. This first edition of a DIN Standard on ball and roller bearing steels replaces the "Stahl-Eisen" conditions of delivery 350–53 – Ball and Roller Bearing Steels; Technical Conditions of Delivery – and also the "Stahl-Eisen" Material Sheet 350–53 – Ball and Roller Bearing Steels; its contents are modelled on the EURONORM 94 – 73 – Ball and Roller Bearing Steels; Quality Specifications – published by the European Coal and Steel Community (ECSC), and on the Standard ISO 683/XVII – 1976 published by the International Organization for Standardization (ISO):

   Heat-treated steels, alloy steels and free-cutting steels – Part 17: Ball and roller bearing steels

   However, this Standard has been modelled on existing DIN Standards in so far as its layout is concerned.

   This Standard also differs from the above-named international Standards in the following respects:

   a) As regards the **selection of grades**, more attention was paid to Germany's special needs, with the result that on the one hand some of the steel grades standardized in EURONORM 94 – 73 and in ISO 683/XVII have not been incorporated in this Standard, whilst on the other hand heat-treatable steels have been incorporated additionally (see also item 2 of the Explanations in this respect).

      At the end of these Explanations, you will find a comparison table of the steel grades in accordance with this Standard with those in accordance with EURONORM 94 – 73 and with ISO 683/XVII.

   b) EURONORM 94 – 73 and ISO 683/XVII feature minimum hardness values for a **hardenability test** applicable to the through hardening, the stainless and the high temperature hardness steels, on samples to be quenched on all sides, the hardness values having to be demonstrated in the tempered condition. No similar table of values has been incorporated in this Standard, as the consensus of opinion of the ball and roller bearing manufacturers was that there was no need for it.

   c) The **limiting values of hardness in the end quench test** differ slightly, in the case of steel 17 MnCr 5 (material number 1.3521) and of steel 17 NiCrMo 14 (material number 1.3533), from those for the comparable grades in EURONORM 94 – 73 and in ISO 683/XVII.

   d) The specifications relating to **hardness in the usual as-delivered conditions** (Table 5) deviate in part from those of EURONORM 94 – 73 and of ISO 683/XVII.

   e) The **specifications relating to heat-treatment** (Table 11) are partially not in agreement with those of EURONORM 94 – 73 and of ISO 683/XVII.

   f) According to EURONORM 94 – 73 and ISO 683/XVII the requirements relating to the **content of non-metallic inclusions** must, if necessary, be specially agreed mutually at the time of placing the purchase order, for all steel groups (see also item 3 of these Explanations in this connection).

   g) The specifications relating to the permissible depth of surface scracks and of decarburization deviate from those of the International Standards. In addition, no distinction is made in these requirements in connection with the subsequent processing of the products concerned. Nevertheless, different permissible decarburization depths are specified in this Standard for the untreated ("as-rolled") condition than those applying to the various heat treatment conditions. It should also be noted that the permissible decarburization depths stipulated in this Standard do not apply to the mean value (which is the usual practice) but to the maximum value which arises; this represents a more stringent requirement in comparison with the International Standards.

   h) This Standard does not feature any requirement classes.

2. Differences between the heat-treatable steels featured in this Standard and the comparable grades featured in the editions of DIN 17 200 and DIN 17 212 valid today reside mainly in the limitation of the content of non-metallic inclusions and in the stipulation of permissible depths of surface defects and of permissible decarburization depths.

3. The permissible **contents of non-metallic inclusions** stipulated in Table 7 apply to oxides + sulphides in the case of the through hardening steels, and to oxides only in the case of the case hardening steels and of the heat-treatable steels. The steel manufacturers drew our attention to the fact that in their opinion the values specified for the overall characteristic cumulant "oxides + sulphides" are no longer attainable in the case of case hardening and heat-treatable steels at sulphur contents of approx. 0.015 or 0.020 % and over.

   In the case of the stainless and of the high temperature hardness ball and roller bearing steels, there are as yet no adequate data available to enable any values to be stipulated; in order to enable such values to be incorporated in the subsequent edition of this Standard, suitable data will be collected in the meantime.

Table 12. **Comparison of ball and roller bearing steels in accordance with this Standard with those in accordance with EURONORM 94 – 73 and with ISO 683/XVII – 76**

Ball and roller bearing steels in accordance with					
DIN 17 230 Code number	Material number	EURONORM 94 – 73 Code number	[1]	ISO 683/XVII – 76 Number of the steel grade	[1]
Through hardening steels					
100 Cr 2	1.3501				
100 Cr 6	1.3505	100 Cr 6	●	1	●
				2	
100 CrMn 6	1.3520	100 CrMn 6	●	3	○
100 CrMo 7	1.3537	100 CrMo 7	○	4	○
100 CrMo 7 3	1.3536	100 CrMnMo 7	●	5	○
100 CrMnMo 8	1.3539				
Case hardening steels					
1 nCr 5	1.3521	16 MnCr 5 F	●	10	●
19 MnCr 5	1.3523				
16 CrNiMo 6	1.3531				
				11	
		20 NiCrMo 2 F		12	
		20 NiCrMo 4 F		13	
		20 NiCrMo 7 F		14	
		18 NiCrMo 6 F		15	
17 NiCrMo 14	1.3533	18 NiCrMo 14 F	●	16	●
Heat-treatable steels					
Cf 54	1.1219				
Cr 2	1.3561				
43 CrMo 4	1.3563				
48 CrMo 4	1.3565				
Stainless steels					
X 45 Cr 13	1.3541	X 45 Cr 13	●	20	●
X 102 CrMo 17	1.3543	X 100 CrMo 17	●	21	○
X 89 CrMoV 18 1	1.3549				
High temperature hardness steels					
80 MoCrV 42 16	1.3551	80 MoCrV 40 16	×	30	●
X 82 WMoCrV 6 5 4	1.3553	X 80 WMoCrV 6 5 4	●	31	×
X 75 WCrV 18 4 1	1.3558	X 75 WCrV 18 4 1	●	32	●

[1] In this column the degree of conformity of the chemical composition of the steels in accordance with this Standard on the one hand with the steels in accordance with EURONORM 94–73 or with ISO 683/XVII–76 on the other hand is indicated.
Significance of symbols: × = complete conformity; ● = minor deviation; ○ = appreciable deviation