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					
17 MnCr 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				
44 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	X	30	●
X 82 WMoCrV 6 5 4	1.3553	X 80 WMoCrV 6 5 4	●	31	X
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: X = complete conformity; ● = minor deviation; ○ = appreciable deviation

UDC 669.14.018.44 : 621.882.2/.3

July 1976

Heat Resisting and Highly Heat Resisting Materials for Bolts and Nuts

Quality Specifications

DIN 17 240

Warmfeste und hochwarmfeste Werkstoffe für Schrauben und Muttern; Gütevorschriften

Sections marked with a dot (●) show when agreements should be made or can be made at the time of ordering.

1 Scope

1.1 This Standard applies to bars and wire of the materials according to Table 1 of dimensions up to those given in Table 4. These materials are normally used for bolts and nuts according to DIN 267 Part 13 – Bolts, screws, nuts and similar threaded and formed parts; technical conditions of delivery; bolts and nuts primarily of steels exhibiting toughness at subzero temperatures and hightemperature steels — at temperatures above about 300 °C up to the maximum service temperatures quoted in Table 4 as a guide for long-term operation. These temperatures may be exceeded where the properties of the material are adequate for the service stresses. The criterion is the total loading on the material resulting from temperature, mechanical loading and the ambient media during the proposed time of operation.

1.2 For bolts and nuts used at temperatures below 300 °C, steels according to

- DIN 1651 Free cutting steels; technical conditions of delivery
- DIN 1654 Drawn steel for cold pressed screws (bolts); quality specifications (new edition in course of preparation)
- DIN 17 100 Steels for general structural purposes; quality specifications
- DIN 17 111 Low-carbon unalloyed steels for bolts, nuts and rivets; quality specifications
- DIN 17 200 Quenched and tempered steels; quality specifications
- DIN 17 210 Case hardening steels; quality specifications
- DIN 17 440 Stainless steels; quality specifications
- Stahl-Eisen-Werkstoffblatt (Steel-Iron Data Sheet) 550 Steels for large forgings

should be used.

2 Definitions

2.1 Within the meaning of this Standard, materials are considered to be heat resisting if they have good mechanical properties under longtime loading, including high creep limits and high creep rupture strengths and a satisfactory relaxation resistance (see Section 2.2) at temperatures of up to ≈ 540 °C, and, as highly heat resisting, steels and alloys having the same characteristics to ≈ 800 °C.

2.2 Relaxation means the reduction in the pre-stress in bolts as a result of creep of the material. In this Standard, the residual stress to which the initial stress δ_A corresponding to an initial strain $\varepsilon_{A\ total}$ falls after a defined period of loading, e.g. 1000, 10 000 or 30 000 hours, is quoted to characterize the relaxation resistance of materials (see Table 10).

2.3 For technical definitions and expressions relating to heat-treatment of ferrous metals, see DIN 17 014 Part 1.

3 Dimensions and permissible dimensional deviations

3.1 The dimension standards listed at the end of this Standard apply to products made from materials according to this Standard, however in the case of materials X 22 CrMoV 12 1 to NiCr20TiAl (see Table 1) not all the dimensions listed in the dimension standards quoted can be supplied and not all the permitted deviations can be maintained. Where applicable, the manufacturer should draw attention to this fact when accepting an order.

3.2 ● If no dimensional standards exist for products, the permissible dimensional deviations should, if necessary, be agreed at the time of ordering.

Continued on pages 2 to 22
Explanations on page 23

4 Calculation of weight and permissible weight deviations

4.1 Calculation of the nominal weight of products should be based on the densities quoted in Table 7.

4.2 ● If the permissible weight deviations have not been standardized, they should if necessary be agreed at the time of ordering.

5 Classification by grades

5.1 Materials

This Standard covers the steels and alloys quoted in Table 1.

5.1.1 The choice of grade of material is left to the customer. It is recommended that the manufacturer be brought in for consultation.

5.2 As-delivered condition

5.2.1 ● The treatment condition in which the material is to be supplied shall in all cases be specified by the customer. Table 3 lists the treatment conditions in which materials can normally be supplied. These are not in all cases identical with the normal heat-treatment conditions for the finished bolts and nuts (see Table 4).

5.2.2 The materials from different melts shall be delivered separately and similarly, where applicable, batches of material having received different heat treatment and material of different dimension ranges.

6 Designation

6.1 The code numbers for the steels are formed in accordance with Section 2.1.2.2 of the explanations in Normenheft 3 (1970 issue), the material numbers for the steels according to DIN 17 007 Part 2 and the material number for the alloy NiCr20TiAl according to DIN 17 007 Part 4. The code letter or suffix number for the treatment condition according to Table 3 should be appended as appropriate to the code number or material number respectively.

Example for steel 24 CrMo 5, material number 1.7258, in quenched and tempered condition (V or .05): 24 CrMo 5 V or 1.7258.05.

Treatment conditions for which no code letters or suffix numbers have not yet been stipulated at the present time, should be quoted in the order by writing out in full [1].

6.2 The code number or material number for the grade of material and the code letter or suffix number for the treatment condition shall be appended to the symbol for the product as given in the examples of designation in the dimension standards.

Example:

Designation of a hot-rolled round steel of 65 mm diameter of steel grade 24 CrMo 5 in the quenched and tempered condition (see example in Section 6.1):

Round 65 DIN 1013 — 24 CrMo 5 V

or Round 65 DIN 1013 — 1.7258.05

7 Requirements

7.1 ● Melting process

It is left to the manufacturer to decide on the melting process, unless this has been agreed at the time of ordering. It must however be notified to the customer if required.

7.2 Chemical composition

7.2.1 The chemical composition determined in the ladle analysis shall conform to Table 1.

7.2.2 The customer can accept slight deviations from the composition limits provided these have no more than an insignificant effect on the properties of the material in use.

7.2.3 ● The chemical composition of the melt shall be notified to the customer on request.

7.2.4 ● Proof that the product analysis meets the limiting values for the ladle analysis given in Table 1, within the permissible deviations quoted in Table 2, can be agreed at the time of ordering.

7.3 Mechanical properties

7.3.1 The values for mechanical properties at room temperature or at elevated temperature, listed in Tables 4 and 5, are guaranteed for longitudinal specimens (see Fig. 1) of bars and wires supplied in the heat-treatment condition listed in Tables 4 and 5 (see also Fig. 2). In cases where the as-delivered condition (see Table 3) does not correspond to the heat-treatment condition given in Table 4 or 5, the values in these Tables apply to longitudinal specimens taken from the specimen sections after heat-treatment of the latter in accordance with the data in Table 4 or 5 and Table 8.

● *Note: If for example, in order to save material, transverse specimens are used for testing, in general the values given in Table 4 or 5 for the yield point and tensile strength can be used as a basis for acceptance. In this case, the values to be maintained for elongation, reduction in area and absorbed energy should be specially agreed (note also Section 8.3.2). In cases of doubt however, for the yield point and tensile strength also, acceptance should be based on the values determined on longitudinal specimens.*

7.3.2 Guide information for the long-time strength properties at elevated temperatures and the stress relaxation properties of the materials are given in Table 9 and 10 or in Figs 4 to 7. The values stated are mean values of the scatter bands so far observed and, in the case of the long-time strength properties at elevated temperature, mean values for smooth and notched specimens. It can be assumed that the lower limit of the scatter band for the creep strength of smooth and notched specimens is about 20 % lower than the values stated. The values will be checked again from time to time as further test results become available and, where necessary, corrected.

7.3.3 Guide values for the static modulus of elasticity of the materials as a function of temperature are given in Table 6 and Fig. 3.

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1) See also DIN 17 007 Part 4 (July 1963 issue) — Material numbers, principal groups 2 and 3, non-ferrous metals —. See especially Section 4 — Appended numbers — and Table 3.

7.4 Physical properties

7.4.1 Guide information for density, thermal expansion, thermal conductivity and specific heat of materials are given in Table 7.

7.5 ● Chemical properties

As regards the effect of chemically active substances (corrosion) on the steels referred to in this Standard and in particular the influence of temperature on the chemical behaviour, it is only possible to give useful information for each case separately. It is therefore advisable where necessary to discuss this with the manufacturer describing the particular operating conditions as precisely as possible.

7.6 Surface condition

7.6.1 The products shall have a smooth surface as far as consistent with the shaping process used.

7.6.1.1 In the case of products intended for machining, surface defects, e.g. scabs, grooves, laps, cracks and surface decarburization [2]) must be contained within the machining allowance; they may be removed by suitable methods provided this does not prejudice the intended application.

7.6.1.2 ● In the case of products intended for shaping without cutting (e.g. drop forging or rod drawing), where special requirements exist as to surface condition, this should be expressly stated in the order. In this case, surface defects that would split open during forming must be smoothed out by suitable means. The minimum permissible thickness according to the dimensional standards must however be maintained; it is only permissible to go slightly below this with the agreement of the customer.

7.6.2 Correcting of surface defects by welding is not permitted.

8 Testing

8.1 ● Delivery testings

For all materials in this Standard, the customer can agree delivery testings, which in general will be carried out by experts from the manufacturing works or, by special agreement at the time of ordering, also by other inspectors appointed by the customer. When wire is supplied in coils however, no delivery testings are normally carried out.

8.2 Extent of testing

8.2.1 ● Materials are classified for testing by melt, with heat treated material separate and by dimension ranges (see Section 8.2.1.1) so as to obtain one or more test units as required. Where no details are stated in Sections 8.2.2 to 8.2.6, the extent of testing (i.e. the number of specimens to be taken per test unit) shall be agreed at the time of ordering.

8.2.1.1 The diameter or distance across flats of the thickest product in a test unit may be a maximum of 1.5 times the corresponding dimension of the thinnest product.

8.2.2 ● If the rechecking of the chemical composition of the product has been agreed at the time of ordering, the extent of testing should be stipulated at the same time.

8.2.3 For a delivery testing, uniform strength of a test unit must be proved by hardness testing or (after agreement with the customer or his agent) by some other equivalent process.

8.2.3.1 The hardness testing shall be carried out

a) in the case of bars with a diameter of more than 120 mm, on one bar per test unit.
b) in the case of bars with a diameter of 120 mm or less, on 10 % of the bars in a test unit, subject to a minimum of 10 bars or, in the case of test units containing less than 10 bars, on each bar.

If the hardness values thus obtained correspond to the upper or lower limit of the prescribed range for tensile strength, the extent of testing shall be increased to 20 %. If hardness values are obtained with the 10 % or 20 % sample corresponding to the limits of the range for tensile strength, 100 % of the bars should be tested. In assessing the measured hardness values, account should be taken of the mean uncertainty of measurement as defined in DIN 50 150.

In the case of non-continuous heat-treatment, the bars intended for hardness measurement shall be distributed uniformly over the test unit. In the case of continuous heat-treatment, a larger number of specimens shall be taken from the first layer of bars in proportion to the rest of the test unit.

8.2.3.2 On the bars being tested, hardness shall be measured at one end of each bar, i.e. on half of them at one end and on the other half at the other end.

8.2.3.3 For the tensile test, one specimen each shall be taken from the hardest and softest bar in each test unit determined as in Section 8.2.3.1.

8.2.4 ● If the 0.2 limit has to be rechecked at elevated temperatures, the extent of testing shall be agreed at the time of ordering. In general, the 0.2 limit will be rechecked only on one specimen per melt and only at one temperature above room temperature.

8.2.5 The notch bar impact bending test shall be carried out on the same specimens (and specimen sections) as the tensile specimens have been taken from (see Section 8.2.3).

8.2.6 Alloy materials shall be subjected to a suitable testing to detect any incorrect identification of the material.

8.3 Sampling

8.3.1 For the analysis of the product, chips shall be cut uniformly over the complete cross-section of the product being tested.

8.3.2 ● For the tensile test, longitudinal specimens shall be taken from the bars selected as in Section 8.2.3.3, in such a manner that the axis of the specimen in the case of bars with dimensions up to 40 mm shall be coincident with the longitudinal axis of the bar and, with bars of over 40 mm, shall lie one sixth of the bar thickness below the surface or as near as possible to this position (see Fig. 1). If the testing of transverse specimens is agreed (see note to Section 7.3.1) the position of the specimens shall be agreed at the time of ordering.

8.3.3 For determination of the 0.2 limit at elevated temperature, specimens shall be taken as for the tensile test according to Section 8.3.2.

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2) In this context, surface decarburization shall be understood as the sum of the width of the decarburized zone and 2/3 the width of the carbide-reduced zone.

8.3.4 The specimens for the notch bar impact bending test shall be taken in such a manner that their longitudinal axis lies in the product approximately in the same way as that of the tensile specimens according to Section 8.3.2 (Note Section 8.5.4.1).

8.3.5 The specimens to be taken for the tests and the bars from which the specimens are taken shall be adequately marked so that specimen and bar are clearly identified as belonging together.

8.4 Marking

Each bar exceeding 25 mm in diameter or across flats shall be marked at one end with the melt number, the manufacturer's symbol and the code number or material number of the material. In the case of bars of up to 25 mm diameter or across flats, it is sufficient to identify each bundle with a tie-on tag bearing the same information. The same applies to coils of wire of any dimensions.

8.5 Test methods to be used

8.5.1 ● The chemical composition shall be tested by the methods [3] specified by the Chemists' Committee of the Verein Deutscher Eisenhüttenleute (Association of German Ferrous Metallurgists). Methods not specified by the Chemists' Committee shall be specially agreed.

8.5.2 The tensile test shall be carried out according to DIN 50 145, using the short proportional bar with gauge length $L_0 = 5\,d_0$ according to DIN 50 125.

The 0.2 limit shall be determined at room temperature according to DIN 50 145.

8.5.3 The 0.2 limit at elevated temperature shall be determined, where required, according to DIN 50 145.

8.5.4 The notch bar impact bending test shall be carried out on the basis of the information in Table 4 on ISO V-notch specimens or on DVM specimens according to DIN 50 115.

8.5.4.1 ● In general, the absorbed energy shall be determined as the mean of three tests on specimens lying side by side at the same distance from the surface or, if this is impossible, immediately behind each other in the same specimen bar; proof of the absorbed energy on only one or two specimens may however be agreed at the time of ordering. In arbitration cases, the mean of three specimens shall be taken.

8.5.4.2 ● For products of dimensions such that it is not possible to take a notch impact specimen of standardized dimensions, special agreements shall be made at the time of ordering for carrying out the notch bar impact bending test.

8.5.5 The Brinell hardness shall be determined according to DIN 50 351.

8.5.6 ● As regards the method for rechecking the surface decarburization, where required, agreement should be made at the time of ordering.

8.5.7 A test standard for determining the relaxation properties is being prepared.

8.6 Repeat testings

8.6.1 Where an unsatisfactory result in a testing is clearly due to inadequacies in the testing technique or an insignificant local defect in a specimen, the unsatisfactory result should be ignored when deciding whether the requirements have been met and the test concerned repeated.

8.6.2 If the unsatisfactory result of a testing can be traced to unsatisfactory heat-treatment, the bars of the corresponding test unit may be heat-treated again and the whole testing should then be repeated.

8.6.3 If the result of a tensile test on properly heat-treated material does not meet the prescribed requirements, proceed as follows.

If there are other bars of the same hardness among those tested in the same test unit, further specimens for the tensile test and the notch bar impact bending test shall be taken from two of these bars. If there are no further bars of the same hardness among those tested in the same test unit, the extent of hardness testing should be doubled. According to the result of the first (unsatisfactory) tensile test, the repeat testings shall be carried out on specimens from the two softest or two hardest bars of all those checked.

If the result of the notch bar impact bending test on properly heat-treated material does not meet the prescribed requirements, further specimens shall be taken from any two other bars of the test unit without increasing the extent of hardness testing.

8.6.3.1 Properly heat-treated bars having unsatisfactory test results shall in all cases be rejected. Both repeat testings must meet the prescribed requirements, otherwise the complete test unit may be rejected. If necessary, the bars can then be tested separately and certified as meeting the conditions if the results are satisfactory.

8.7 Test certificates

The delivery testing is certified by one of the certificates according to DIN 50 049. The type of certificate must be agreed at the time of ordering.

9 Hot forming and heat-treatment

Table 8 gives information on the temperatures (and hold times) to be used for hot forming and heat-treatment.

10 Complaints [4]

10.1 Objections may only be raised to external or internal defects if they impair to an appreciable extent appropriate working and utilization of the grade of steel and shape of product.

10.2 The customer must give the supplier the opportunity to check for himself the validity of the objection, where possible by submitting the material complained of together with samples of the material supplied.

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[3] Handbuch für das Eisenhüttenlaboratorium (Handbook for the Ferrous Metallurgical Laboratory), Vol. 2: Investigation of Metallic Materials; Vol. 4: Arbitration Analyses, Düsseldorf, Verlag Stahleisen mbH, using the latest edition.

[4] For explanations on this objections clause in quality standards for iron and steel, see DIN-Mitt. (DIN News) Vol. 40 (1961) No. 2, pp. 111/12.

The following dimension standards apply for the materials in 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 and hot forged rods

DIN 1013 Steel bars, hot rolled round steel; dimensions, weights, permissible variations
DIN 59 130 Hot rolled round steel bars for bolts and rivets; dimensions, weights, permissible deviations
DIN 1015 Steel bars, hot rolled hexagon steel; dimensions, weights, permissible variations
DIN 7527 Part 6 Steel forgings; machining allowances and permissible variations for open-die forged bars

For bright rods and wires

DIN 668 Bright round steel; dimensions, permissible variations according to ISA tolerance zone h11, weights
DIN 670 Bright round steel; dimensions, permissible variations according to ISA tolerance zone h8, weights
DIN 671 Bright round steel; dimensions, permissible variations according to ISA tolerance zone h9, weights
DIN 176 Bright drawn hexagon steel; dimensions, permissible variations, weights

Table 1. Chemical composition of heat resisting and highly heat resisting materials for bolts and nuts (ladle analysis)

Material		Chemical composition in % by wt.												
Code number	Material number	C	Si	Mn	P (maximum)	S (maximum)	Al	B	Cr	Mo	Ni	Ti	V	Others
C 35 1)	1.0501	0,32 to 0,39	0,15 to 0,35	0,50 to 0,80	0,045	0,045								
Ck 35	1.1181	0,32 to 0,39	0,15 to 0,35	0,50 to 0,80	0,035	0,035								
Cq 35	1.1172	0,32 to 0,39	0,15 to 0,40 4)	0,50 to 0,80	0,035	0,035								
24 CrMo 5	1.7258	0,20 to 0,28	0,15 to 0,35	0,50 to 0,80	0,030	0,035			0,90 to 1,20	0,20 to 0,35				
21 CrMoV 5 7 2)	1.7709	0,17 to 0,25	0,15 to 0,35	0,35 to 0,85	0,030	0,035			1,20 to 1,50	0,65 to 0,80			0,25 to 0,35	
40 CrMoV 4 7	1.7711	0,36 to 0,44	0,15 to 0,35	0,35 to 0,85	0,030	0,035			0,90 to 1,20	0,60 to 0,75			0,25 to 0,35	
X 22 CrMoV 12 1	1.4923	0,18 to 0,24	0,10 to 0,50	0,30 to 0,80	0,035	0,035			11,0 to 12,5	0,80 to 1,20	0,30 to 0,80		0,25 to 0,35	
X 19 CrMoVNbN 11 1	1.4913	0,16 to 0,22	0,10 to 0,50	0,30 to 0,80	0,035	0,035		≦0,010	10,0 to 11,5	0,50 to 1,00	0,30 to 0,80		0,10 to 0,30	Nb 0,15 to 0,50, N 0,05 to 0,10
X 8 CrNiMoBNb 16 16	1.4986	0,04 to 0,10	0,30 to 0,60	≦1,5	0,045	0,030		0,05 to 0,10	15,5 to 17,5	1,60 to 2,00	15,5 to 17,5			Nb + Ta: 10 x % C to 1,20
NiCr20TiAl 3)	2.4952	≦0,10	≦1,00	≦1,0	0,030	0,015	1,00 to 1,80	≦0,008	18,0 to 21,0		≧65	1,8 to 2,7		Co ≦2,00 Fe ≦3,00

1) Only usable for nuts.
2) Instead of bolts and nuts of this steel, it is possible for a transitional period to use also bolts and nuts of steels 24 CrMoV 5 5 (material number 1.7733) and 21 CrMoV 5 11 (material number 1.8070) (see Explanations). In special cases, it is possible also to use steel 21 CrMoNiV 4 7 (material number 1.6981) instead of this material.
3) For this alloy, in all cases the values given in the latest issue of DIN 17 742 apply.
4) ● Lower silicon contents may be agreed at the time of ordering, in which case any resulting changes in the guaranteed properties must be taken into account.

Table 2. Permissible deviation of the bar analysis from the limiting values for the ladle analysis for the steels in Table 1 1)

Element	Permissible maximum contents in the ladle analysis % by wt.	Permissible deviations of bar analysis from the limiting values of the ladle analysis 2), 3) % by wt.
C	< 0,20 ≧0,20 ≦ 0,44	± 0,01 ± 0,02
Si	≦ 1,0	± 0,05
Mn	≦ 1,5	± 0,04
P	≦ 0,045	± 0,005
S	≦ 0,045	± 0,005
N	≦ 0,10	± 0,01
Cr	≦ 2,00 >10 ≦15,0 >15 ≦20,0	± 0,05 ± 0,15 ± 0,20
Mo	≦ 0,35 > 0,35 ≦ 2,00	± 0,04 ± 0,05
Ni	≦ 1,00 ≧ 15,5 ≦17,5	± 0,03 ± 0,15
Nb (+ Ta)	≦ 1,20	± 0,05
V	≦ 0,35	± 0,03

1) ● For the alloy NiCr20TiAl, and for the boron contents of steels, where necessary the permissible deviations should be agreed at the time of ordering.
2) ● Applies to diameters ≦160 mm or cross-sections of equivalent area. For forgings, the permissible deviations should be agreed at the time of ordering.
3) It is permissible for the deviation for an element in the bar analysis for a melt to be entirely below the minimum value or entirely above the maximum value of the range given for the ladle analysis but not both at the same time.

Table 3. Normal as-delivered conditions and associated code letters and suffix numbers in the material numbers

Material: Code number	Material number	Normal as-delivered conditions (X): untreated (= hot formed)	normalized	soft annealed	spheroidized	quenched and tempered	solution annealed	precipitation hardened	hot strain hardened + age hardened
C 35	1.0501	X	X			X			
Ck 35	1.1181	X	X			X			
Cq 35	1.1172	X 1)			X				
24 CrMo 5	1.7258	X		X		X			
21 CrMoV 5 7	1.7709	X		X		X			
40 CrMoV 4 7	1.7711			X		X			
X 22 CrMoV 12 1	1.4923			X		X			
X 19 CrMoVNbN 11 1	1.4913			X		X			
X 8 CrNiMoBNb 16 16	1.4986								X
NiCr20TiAl	2.4952	X					X	X	
Code letter 2), 3)		U	N	G	(GKZ)	V	(L)	(AH)	(WK + AL)
Suffix numbers in the material number 2)		00	01	02	4)	05	4)	4)	4)

1) This as-delivered condition is normal only for deliveries to works having their own annealing facilities.
2) For the as-delivered condition quoted above.
3) The code letters in brackets have not so far been standardized. They are used here merely as an aid for abbreviated designation of the as-delivered conditions in the Tables.
4) Not yet stipulated in DIN 17 007 Part 2.

Table 4. Guaranteed values for mechanical properties at room temperature of heat resisting and highly heat resisting materials for bolts and nuts (applies to longitudinal specimens)

Material: Code number	Material number	Condition 2)	Applicable for diameters mm	Yield point or 0.2 % proof stress N/mm² min.	Tensile strength N/mm²	Elongation ($L_0 = 5\ d_0$) % min.	Reduction in area % min.	Absorbed energy 3): DVM specimens J min.	Absorbed energy 3): ISO V-notch specimens J min.	Guidance value for normal upper limit of temperature of use in continuous operation
C 35 1)	1.0501	N V	≦100 ≦160	280 280	500 to 650 500 to 650	21 22	— 40	— —	— —	350 400
Ck 35	1.1181	V	≦ 60 > 60 ≦160	280 280	500 to 650 500 to 650	22 22	45 45	55 41	55 39	350 4) 350 4)
Cq 35	1.1172	V 5)	≦ 40	280	500 to 650	22	45	55	55	350 4)
24 CrMo 5	1.7258	V	≦100 >100 ≦160	440 420	600 to 750 600 to 750	18 18	60 60	103 89	118 102	400 400
21 CrMoV 5 7	1.7709	V	≦250	550	700 to 850 6)	16	60	69	63	540
40 CrMoV 4 7	1.7711	V	≦100	700	850 to 1000 6)	14	45	41 7)	47 7)	540
X 22 CrMoV 12 1	1.4923	V	≦250	600 700	800 to 950 900 to 1050	14 11	40 35	34 27	27 20	580 580
X 19 CrMoVNbN 11 1	1.4913	V	≦250	780	900 to 1050	10	40	24	20	580
X 8 CrNiMoBNb 16 16	1.4986	(WK + AL)	≦100	500	650 to 850	16	40	48	47	650
NiCr20TiAl	2.4952	(AH)	≦160	600	≧1000	12	12	17	20	700

1) Only usable for nuts.
2) See also Tables 3 and 8.
3) For acceptance testings, agreement can be made as to which of the two shapes of specimen quoted is to be used. If the values obtained for absorbed energy are below the minimum required values for ISO V-notch specimens, proceed as if the proof of absorbed energy were required on DVM specimens.
4) In the case of nuts, the normal upper limit of temperature of use in continuous operation can be 50 °C higher.
5) Because of its subsequent working by cold-forming, steel Cq 35 is normally supplied in the "spheroidized" (GKZ) condition.
6) The upper limit of the tensile strength range must not be exceeded; values slightly below the lower limit of the tensile strength range are permissible provided the minimum value for the yield point is reached.
7) The values given are provisional values that will have to be checked.

Table 5. Guaranteed values for yield point at elevated temperatures of heat resisting and highly heat resisting materials for bolts and nuts (applicable to longitudinal specimens)

Material: Code number	Material number	Condition 1)	Applicable for diameters mm	Yield point or 0.2 % stress limit at a temperature of 2), 3) N/mm² min.: 20 °C	200 °C	250 °C	300 °C	350 °C	400 °C	450 °C	500 °C	550 °C	600 °C	650 °C
Ck 35	1.1181	V	≦160	280	220	203	186	167	147	–	–	–	–	–
Cq 35	1.1172	V	≦ 40	280	220	203	186	167	147	–	–	–	–	–
24 CrMo 5	1.7258	V	≦100 >100 ≦160	440 420	412 382	392 372	363 344	333 324	304 294	275 265	235 226	– –	– –	– –
21 CrMoV 5 7	1.7709	V	≦250	550	500	480	460	441	412	372	334	275	–	–
40 CrMoV 4 7	1.7711	V	≦100	700	635	617	598	578	540	500	460	403	–	–
X 22 CrMoV 12 1	1.4923	V	≦250	600 700	530 603	505 578	480 550	452 515	423 485	382 442	344 392	284 329	206 250	–
X 19 CrMoVNbN 11 1	1.4913	V	≦250	780	700	680	655	620	580	530	470	400	315	–
X 8 CrNiMoBNb 16 16	1.4986	(WK + AL)	≦100	500	432	412	393	372	353	334	314	284	255	206
NiCr20TiAl	2.4952	(AH)	≦160	600	568	564	560	550	540	530	520	510	500	480

1) See Tables 3 and 8.
2) For unalloyed and low alloy ferritic-pearlitic steels, the yield point, or when there is no clearly defined yield point, the 0.2 % limit is the criterion but for other materials only the 0.2 % limit.
3) The values for temperatures lying above the point of intersection with the corresponding creep limit curve, are guide values and are not subject to checking.

Table 6. Guidance values for the static modulus of elasticity of heat resisting and highly heat resisting materials for bolts and nuts

Material group 1)	Static modulus of elasticity at a temperature of (10³ N/mm²): 20 °C	100 °C	200 °C	300 °C	400 °C	450 °C	500 °C	550 °C	600 °C	700 °C	800 °C
Ferritic steels (1.0501, 1.1181, 1.1172, 1.7258, 1.7709, 1.7711)	211	204	196	186	177	172	164	152	127	–	–
Steels with about 12 % Cr (1.4923, 1.4913)	216	209	200	190	179	175	167	157	127	–	–
Austenitic steels (1.4986)	196	192	186	181	174	170	165	161	157	147	–
NiCr20TiAl	216	212	208	202	196	193	189	184	179	161	130

1) Steels belonging to the material groups listed are quoted by their material number.

Table 7. Guidance values for the physical properties of heat resisting and highly heat resisting materials for bolts and nuts

Material: Code number	Material number	Density at 20 °C kg/dm³	Coefficient of thermal expansion between 20 °C and (10^{-6} K⁻¹): 100 °C	200 °C	300 °C	400 °C	500 °C	600 °C	700 °C	800 °C	(Mean) thermal conductivity 1): at °C	W/(K · m)	(Mean) specific heat capacity 1): at °C	J/(kg · K)
C 35 Ck 35 Cq 35	1.0501 1.1181 1.1172	7,85	11,1	12,1	12,9	13,5	13,9	14,1			20	42	20	460
24 CrMo 5 21 CrMoV 5 7 40 CrMoV 4 7	1.7258 1.7709 1.7711										20	33	20	460
X 22 CrMoV 12 1 X 19 CrMoVNbN 11 1	1.4923 1.4913	7,7	10,5	11	11,5	12	12,3	12,5			20 20 to 650	24 29	20 0 to 800	460 540
X 8 CrNiMoBNb 16 16	1.4986	7,9	16,6	17,7	17,9	17,9	17,9	18,1	18,3	18,6	20 650	15 25	20 0 to 800	460 590
NiCr20TiAl	2.4952	8,2	11,9	12,6	13,1	13,5	13,7	14,0	14,5	15,1	20 100 900	13 12 28	20 0 to 800	460 590

1) In most cases these are the results of measurements on individual melts. When further test results become available, it is intended to standardize values and where necessary correct them.

Table 8. Information for hot forming and heat-treatment of heat resisting and highly heat resisting materials for bolts and nuts [1])

Material: Code number	Material: Material number	Hot forming °C	Hardening, quenching or solution annealing °C	Cooling in	Tempering or age hardening or precipitation hardening °C	Stress-relief annealing °C
C 35 Ck 35 Cq 35	1.0501 1.1181 1.1172	1100 to 850	870 to 900	Oil	650 to 710, min. 2 h	550 to 620
24 CrMo 5	1.7258	1100 to 850	900 to 950	Oil or air	650 to 710, min. 2 h	550 to 620
21 CrMoV 5 7 [2])	1.7709	1100 to 850	890 to 940	Oil or air	680 to 720, min. 2 h	580 to 650
40 CrMoV 4 7 [2])	1.7711	1100 to 850	880 to 930	Oil (or air)	670 to 730, min. 2 h	570 to 640
X 22 CrMoV 12 1	1.4923	1100 to 850	1020 to 1070	Air or oil	640 to 720, min. 2 h	600 to 680
X 19 CrMoVNbN 11 1	1.4913	1100 to 850	1100 to 1150	Air or oil	670 to 750, min. 2 h	630 to 710
X 8 CrNiMoBNb 16 16	1.4986	1150 to 850 [3])	—	—	750 to 800, 5 to 1 h/air	750 to 800
NiCr20TiAl [4])	2.4952	1150 to 1050	1050 to 1080, 8 h	Air	840 to 860, 24 h/air and 690 to 710, 16 h/air	—

1) The temperatures for hot forming are guide values, the other information should as far as possible be complied with.
2) Because of its importance with regard to embrittlement, it is not permissible to go above the quenching temperature or below the tempering temperature quoted.
3) Hot strain hardening at 750 to 850 °C.
4) The complete, three-stage heat-treatment should be carried out after the last plastic forming operation (e.g. after thread rolling).

Table 9. Guidance values for the long-time high temperature strength values

Material: Code number	Material number	Temperature °C	0.2 % creep limit for a time of 10000h (N/mm²)	30000h	100000h	1 % creep limit for a time of 10000h (N/mm²)	30000h	100000h	Creep rupture strength for 10000h (N/mm²)	30000h	100000h
Ck 35 and Cq 35	1.1181 1.1172	350	199	172	133	208	185	151	246	230	218
		360	182	157	122	197	177	139	236	215	202
		370	167	142	112	185	163	130	224	200	185
		380	149	128	100	174	154	120	212	188	169
		390	133	114	90	161	140	109	200	174	154
		400	118	101	79	147	127	98	187	159	138
		410	103	88	69	132	115	87	173	145	122
		420	90	77	60	116	100	77	156	130	106
		430	79	67	51	102	88	67	138	113	93
		440	68	57	43	89	76	58	118	98	80
		450	59	49	35	78	66	49	100	86	69
		460	50	40	29	68	56	40	87	75	61
		470	43	34	25	58	48	34	77	64	53
		480	35	29	21	49	41	29	69	55	45
		490	29	24	18	42	35	26	61	48	39
		500	25	21	16	35	30	22	53	43	34
24 CrMo 5	1.7258	420	204	180	165	274	248	221	387	344	308
		430	188	170	152	258	230	203	364	322	281
		440	174	155	138	242	212	186	338	292	253
		450	162	143	125	226	195	171	311	266	226
		460	149	130	113	210	180	155	283	240	200
		470	135	118	100	195	163	141	255	213	178
		480	124	105	87	180	148	127	226	188	157
		490	112	94	75	163	135	112	200	165	136
		500	100	82	64	147	120	98	176	145	118
		510	88	70	53	130	105	83	153	125	100
		520	77	58	42	115	90	69	133	106	82
		530	66	47	32	98	74	54	114	88	66
		540	55	37	24	81	58	39	95	71	51
		550	46	29	18	64	41	25	79	54	36
21 CrMoV 7 and 40 CrMoV 4 7	1.7709 1.7711	420	394	373	351	437	409	364	481	445	410
		430	369	349	323	412	382	338	455	419	385
		440	343	322	293	387	359	314	429	392	358
		450	317	294	262	361	334	288	405	364	328
		460	287	264	228	337	308	265	378	336	299
		470	267	235	197	313	284	242	351	308	268
		480	242	204	168	288	259	220	324	281	240
		490	216	178	142	266	239	197	298	256	207
		500	191	154	119	242	215	175	271	230	188
		510	166	131	99	221	193	154	248	208	167
		520	144	112	83	199	172	132	226	187	146
		530	123	94	67	177	150	112	207	168	128
		540	106	81	55	157	130	94	189	151	111
		550	89	67	44	138	108	74	170	135	95
X 22 CrMoV 12 1, quenched and tempered to 800 to 950 N/mm² tensile strength	1.4923	450	343	310	264	436	401	373	480	453	432
		460	314	283	240	405	372	341	451	422	397
		470	285	256	215	375	338	308	422	396	368
		480	258	230	193	344	306	278	394	360	336
		490	230	204	168	316	278	248	366	335	306
		500	204	179	147	289	254	221	338	304	275
		510	178	156	127	262	228	195	312	278	245
		520	155	133	108	235	200	170	286	250	216
		530	132	114	91	211	177	148	261	222	187
		540	114	96	77	187	156	127	235	196	161
		550	96	81	63	165	135	108	211	172	137
		560	80	67	51	144	117	91	187	150	118
		570	68	55	41	126	99	77	165	128	99
		580	58	46	33	108	84	64	143	111	83
		590	51	39	28	92	71	53	122	93	70
		600	46	36	27	79	60	44	103	79	59
		650	—	—	—	—	—	—	46	35	26
		700	—	—	—	—	—	—	25	20	14
		750	—	—	—	—	—	—	14	—	—
		800	—	—	—	—	—	—	9	—	—
X 22 CrMoV 12 1, quenched and tempered to 900 to 1050 N/mm² tensile strength	1.4923	450	359	322	273	475	450	403	516	489	445
		460	330	295	249	445	418	372	487	459	414
		470	300	268	226	415	386	340	458	428	382
		480	274	242	203	386	356	310	428	398	352
		490	246	216	180	356	325	280	398	366	319
		500	219	192	160	327	296	251	368	334	288
		510	194	168	139	298	266	221	337	303	256
		520	170	147	119	270	238	193	308	272	226
		530	148	127	101	242	210	167	278	242	196
		540	128	108	86	215	183	142	250	215	170
		550	109	91	70	189	158	120	222	185	144
		560	92	76	57	166	134	99	196	160	122
		570	78	62	45	142	114	81	171	136	101
		580	65	51	37	123	95	65	148	115	84
		590	55	43	31	104	80	53	126	97	70
		600	47	37	27	87	66	42	108	82	59

Table 9. (continued)

Material: Code number	Material number	Temperature °C	0.2 % creep limit for a time of 10000h (N/mm²)	0.2 % creep limit 30000h	0.2 % creep limit 100000h	1 % creep limit for a time of 10000h (N/mm²)	1 % creep limit 30000h	1 % creep limit 100000h	Creep rupture strength for 10000h (N/mm²)	Creep rupture strength 30000h	Creep rupture strength 100000h
X 19 CrMoVNbN 11 1	1.4913	450	442	413	373	500	478	448	578	560	530
		460	408	380	338	475	450	416	545	522	488
		470	376	348	305	450	423	388	512	485	448
		480	344	316	274	424	392	358	480	452	410
		490	315	285	245	398	366	328	450	415	373
		500	286	257	216	374	339	298	420	382	334
		510	261	230	191	349	310	268	394	353	298
		520	238	205	168	323	281	238	368	323	265
		530	215	181	143	298	253	210	341	292	232
		540	191	159	120	274	224	181	315	262	201
		550	170	135	98	250	197	153	289	235	172
		560	147	113	—	225	167	—	263	207	144
		570	127	90	—	201	138	—	238	180	119
		580	105	68	—	177	110	—	213	155	96
		590	88	45	—	154	81	—	188	132	75
		600	69	23	—	133	49	—	164	111	59
X 8 CrNiMoBNb 16 16, hot strain hardened	1.4986	580	245	200	164	358	328	302	381	352	323
		590	240	193	158	336	303	278	364	330	298
		600	235	186	147	324	288	255	344	308	275
		610	230	180	137	306	264	230	325	288	251
		620	225	170	126	287	242	204	306	263	228
		630	210	156	112	268	220	179	287	242	204
		640	195	145	96	247	196	153	267	220	181
		650	176	127	79	226	171	128	245	196	157
		660	145	104	64	204	148	104	221	173	133
		670	120	85	51	182	125	85	198	151	113
NiCr20TiAl	2.4952	500	533	494	452	624	576	530	(745)	(666)	(578)
		510	516	475	426	608	557	504	(711)	(633)	(545)
		520	498	452	402	586	533	477	(680)	(601)	(510)
		530	480	430	377	567	512	450	646	570	480
		540	462	407	353	544	488	418	615	538	447
		550	445	386	330	523	465	390	582	510	416
		560	425	363	309	500	442	362	552	476	384
		570	410	344	284	474	412	334	520	445	354
		580	385	321	262	450	386	308	491	417	327
		590	364	299	243	425	361	282	462	382	298
		600	343	278	220	398	336	257	433	360	272
		610	322	259	201	370	311	230	403	333	247
		620	302	238	181	348	289	210	378	309	222
		630	283	220	162	326	265	187	351	282	198
		640	265	202	145	303	245	167	325	258	176
		650	245	184	128	275	224	149	300	235	157
		660	228	169	113	260	202	132	275	212	135
		670	211	152	98	240	185	115	251	190	118
		680	191	138	84	219	165	99	229	170	102
		690	174	123	72	201	149	85	208	152	88
		700	157	110	61	183	133	72	186	133	75
		710	140	96	52	167	118	64	170	118	65
		720	125	84	43	150	103	55	153	104	57
		730	108	71	35	135	90	47	137	93	49
		740	93	61	30	122	79	40	125	82	44
		750	83	50	24	106	69	33	114	75	37
		760	66	41	20	97	59	29	103	67	33
		770	54	33	16	85	53	24	94	59	29
		780	45	25	12	75	46	20	86	53	25
		790	33	20	9	68	40	17	78	47	23
		800	24	15	5	58	35	16	70	43	20

Table 10. **Provisional guidance values for the relaxation properties** [1])

Material: Code number	Material number	Temperature °C	for an initial strain $\varepsilon_{A\ total}$ %	Residual stress in N/mm² after stressing duration for 1000 h	10 000 h	30 000 h
21 CrMoV 5 7 and 40 CrMoV 4 7	1.7709 and 1.7711	300	0,2	328	325	317
		350		314	299	292
		400		288	262	250
		410		281	252	235
		420		273	242	222
		430		263	227	200
		440		253	211	180
		450		239	186	154
		460		224	163	130
		470		208	138	108
		480		191	117	90
		490		172	98	70
		500		150	81	56
		510		128	67	43
		520		109	53	33
		530		92	41	25
		540		75	33	18
X 22 CrMoV 12 1	1.4923	400	0,2	255	232	216
		410		250	223	206
		420		243	212	193
		430		234	200	180
		440		225	189	170
		450		216	173	155
		460		206	159	140
		470		195	143	125
		480		183	130	110
		490		170	115	98
		500		157	103	85
		510		142	91	75
		520		127	80	64
		530		114	69	54
		540		100	60	45
		550		87	51	38
		560		75	44	30
		570		65	37	25
		580		56	32	20
X 19 CrMoVNbN 11 1	1.4913	400	0,2	262	237	206
		410		257	231	202
		420		252	225	199
		430		246	218	195
		440		240	212	190
		450		234	206	185
		460		228	198	180
		470		221	191	173
		480		214	183	165
		490		207	175	157
		500		199	166	147
		510		190	155	136
		520		181	143	124
		530		171	130	108
		540		160	114	92
		550		149	98	79
		560		134	78	66
		570		118	63	53
		580		100	48	40
		590		80	39	30
		600		61	30	21

[1]) The values given in this Table are the mean values of the scatter band so far obtained, which will be checked from time to time as further test results become available and if necessary corrected. A test standard is in preparation.

Table 10. (continued)

Material: Code number	Material: Material number	Temperature °C	for an initial strain $\varepsilon_{A\ total}$ %	Residual stress in N/mm² after stressing duration for 1000 h	10 000 h	30 000 h	for an initial strain $\varepsilon_{A\ total}$ %	Residual stress in N/mm² after stressing duration for 1000 h	10 000 h	30 000 h
NiCr20TiAl	2.4952	450	0,15	280	266	256	0,20	381	363	342
		500		271	250	234		362	335	310
		510		269	245	228		356	327	300
		520		266	239	221		349	316	288
		530		263	232	213		341	305	274
		540		259	225	205		331	292	257
		550		255	218	196		321	277	237
		560		249	209	187		309	260	217
		570		244	201	176		296	240	199
		580		238	193	166		282	220	182
		590		231	183	155		268	200	165
		600		224	174	144		252	184	149
		610		216	163	133		235	169	135
		620		208	153	121		221	156	121
		630		200	141	108		207	141	108
		640		190	129	96		194	130	96
		650	0,15 and 0,20	181	119	85				
		660		170	107	75				
		670		160	97	65				
		680		149	88	56				
		690		138	79	48				
		700		127	70	40				
		710		117	61	33				
		720		107	53	27				
		730		97	45	22				
		740		88	38	17				
		750		79	31	13				

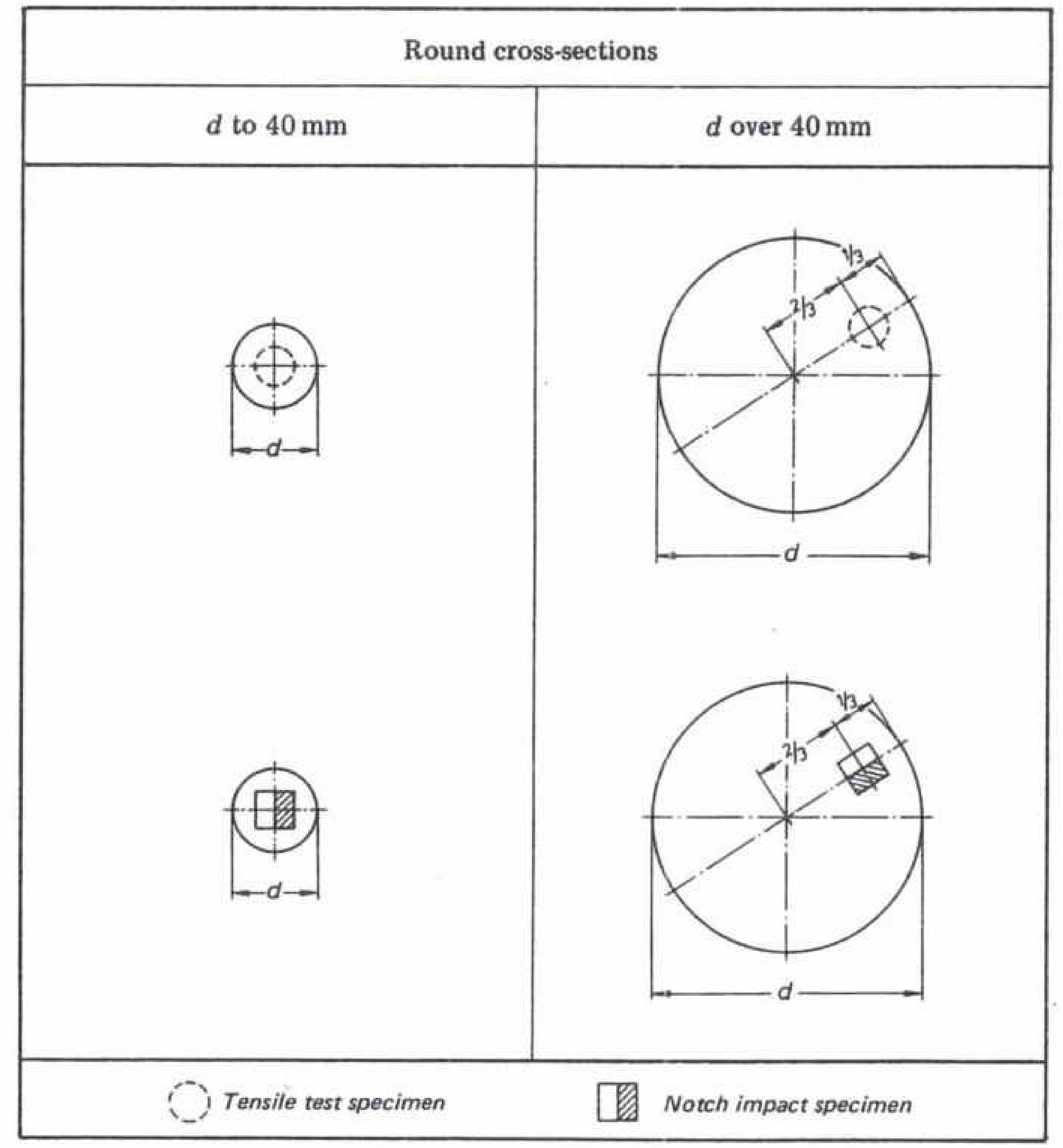


Figure 1. Position of tension and notch impact specimens

The condition "position of specimen axis at 1/6 along the diameter or diagonal of cross-section of the specimen section or specimen bar" can be complied with for

Tensile test specimens with gripped ends of diameter 10 mm:

— for round steel from about 33 mm diameter

— for square steel from about 39 mm side length.

For notch impact specimens of 10 mm x 10 mm cross-section, the corresponding dimensions shall in each case be about 3 mm larger.

The axis of the notch of the notch impact specimen shall be as far as possible perpendicular to the fibre direction in the material.

The prescribed position from which the specimen is to be taken shall be complied with as precisely as possible.

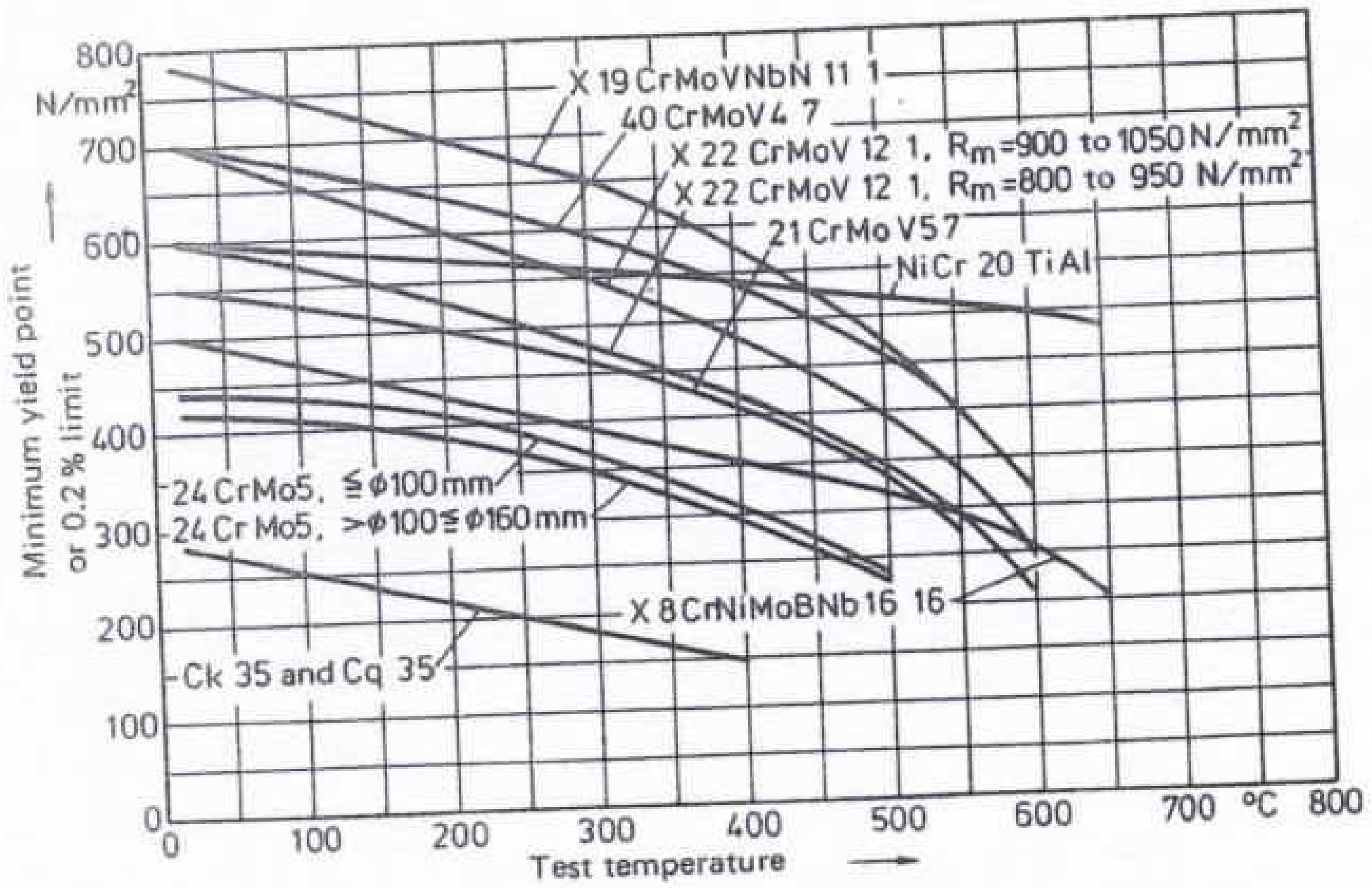


Figure 2. Minimum yield point or 0.2 % limit values as a function of the test temperature (the values in Table 5 apply) (R_m = Tensile strength)

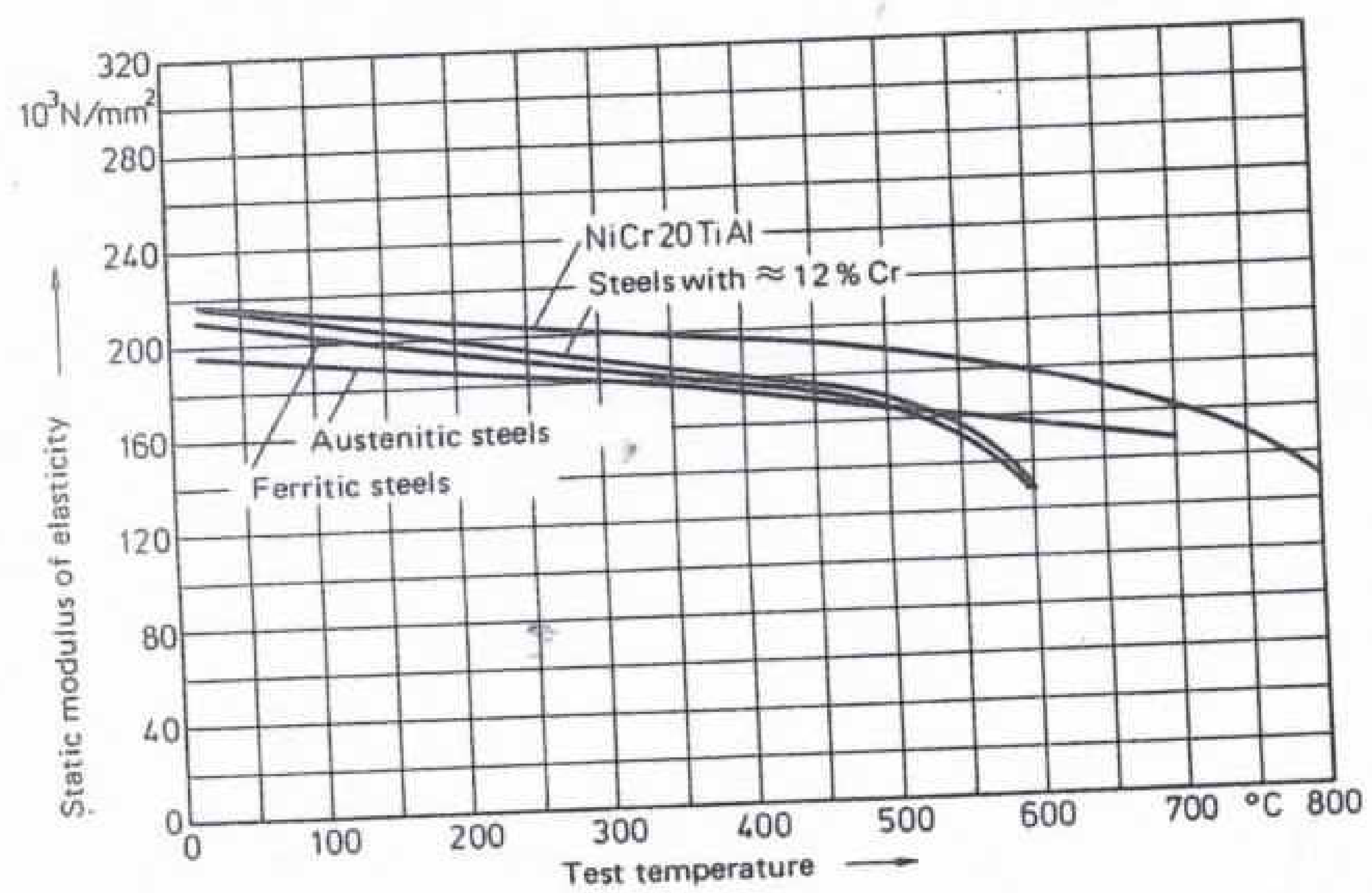
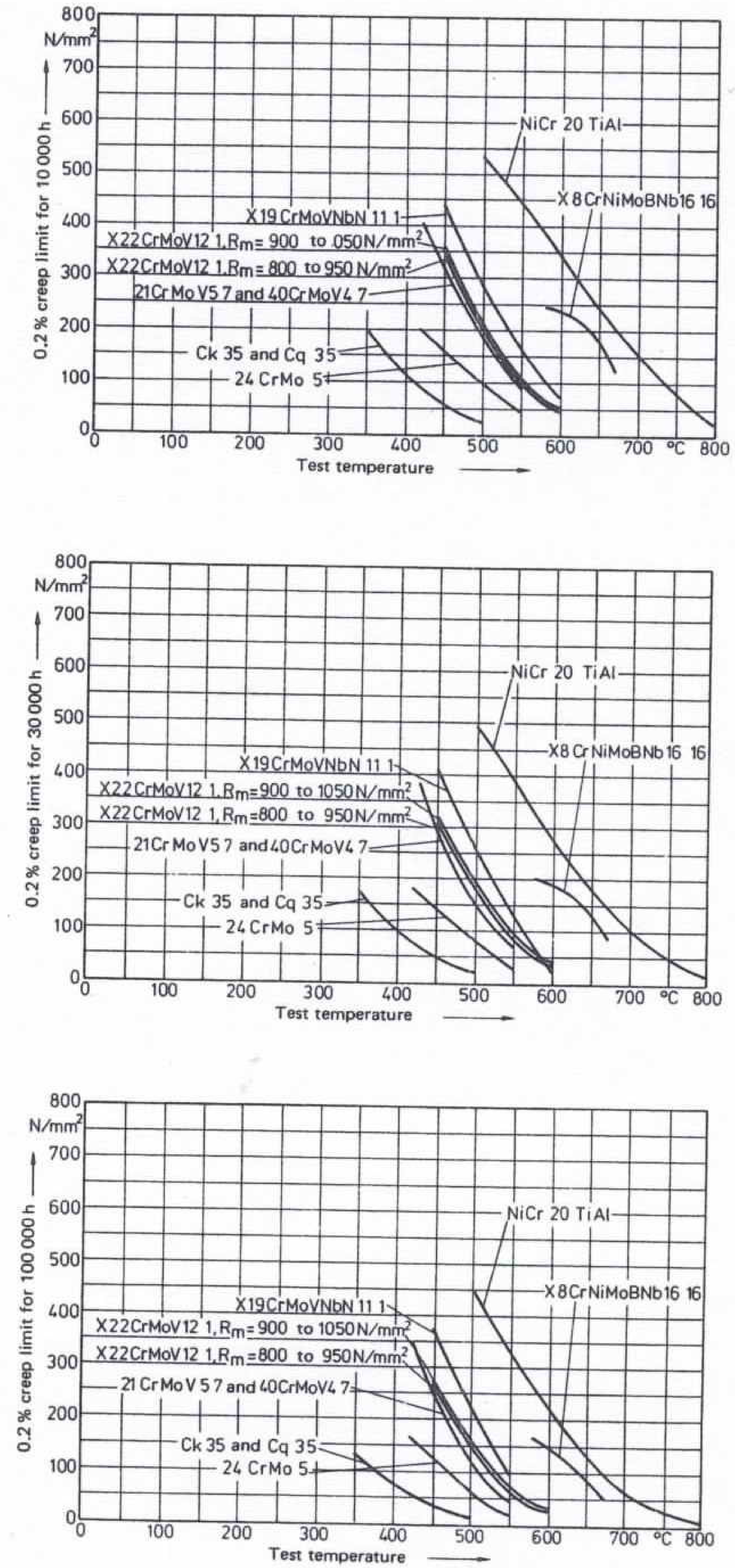


Figure 3. Guide values for the static modulus of elasticity (see also Table 6)

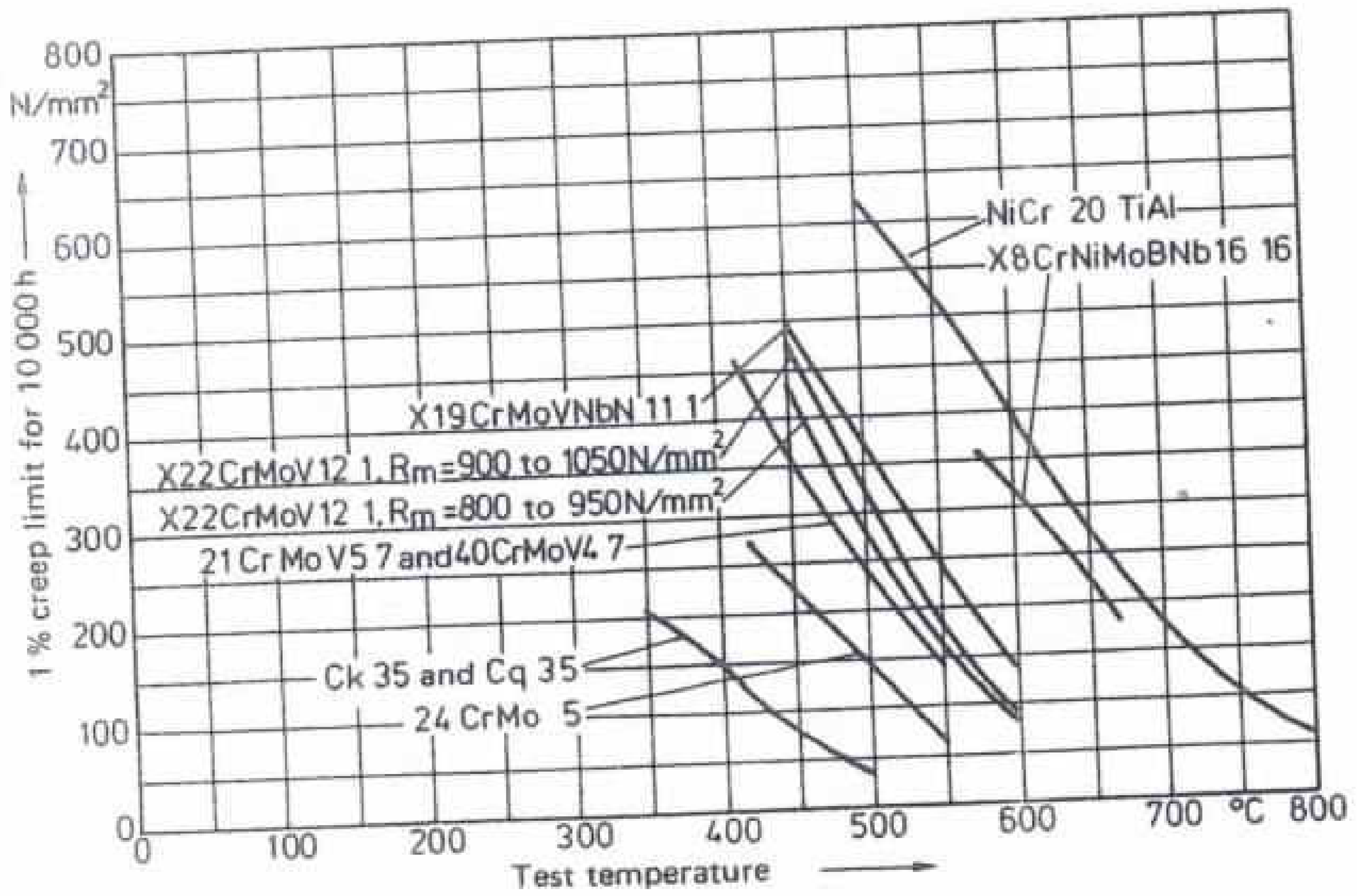


a)
0.2 % creep limit — 10 000 h

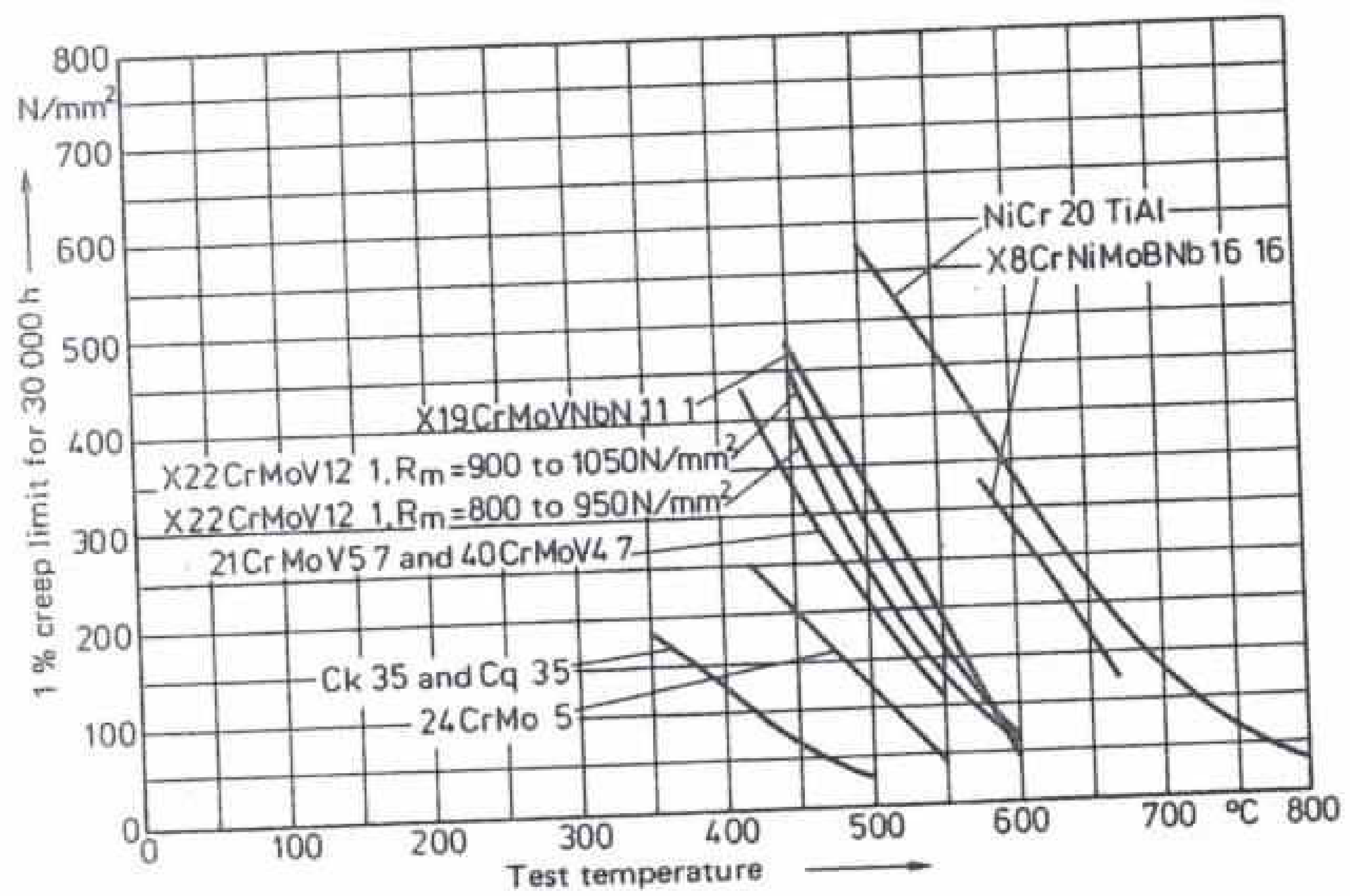
b)
0.2 % creep limit — 30 000 h

c)
0.2 % creep limit 100 000 h

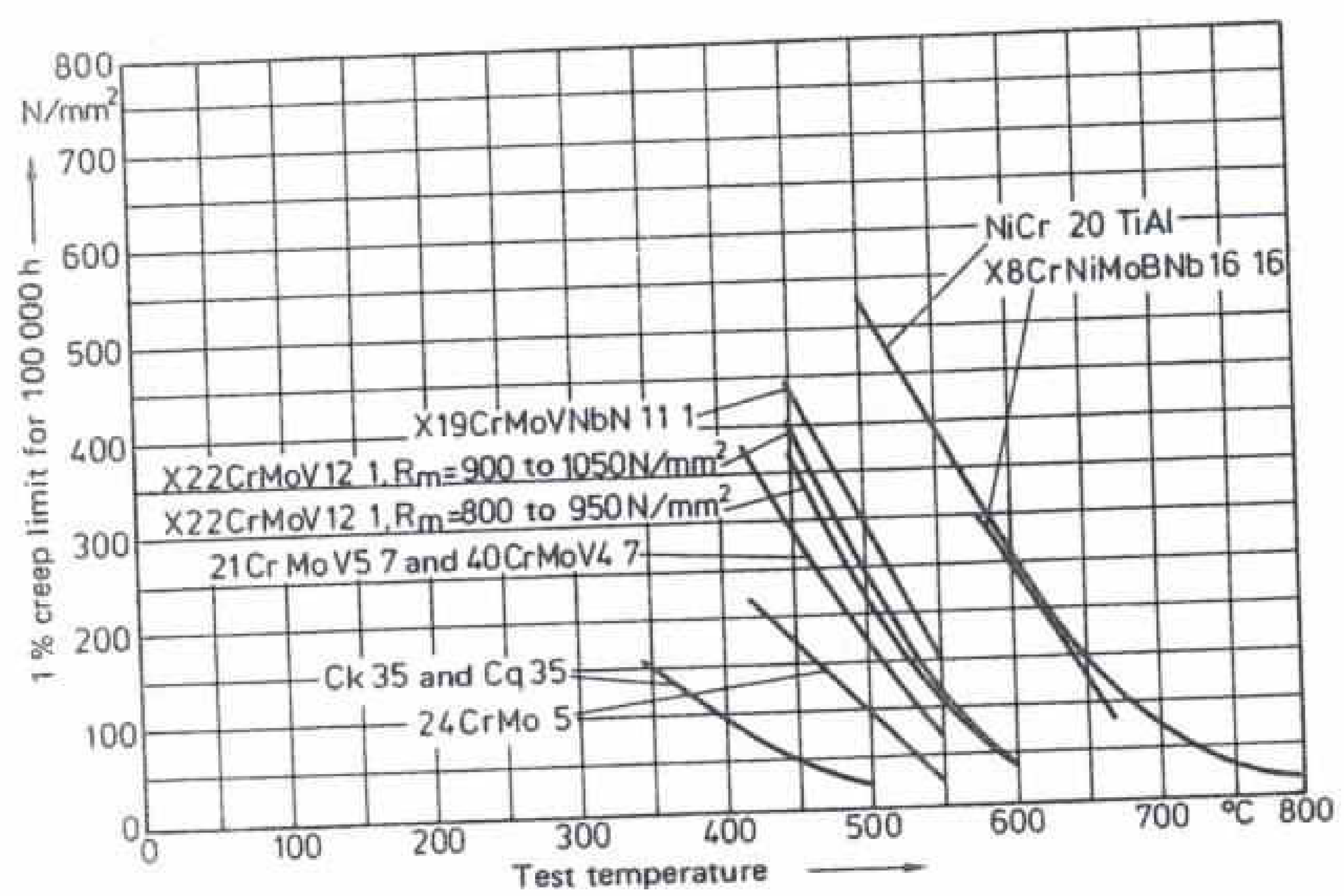
Figure 4. Guide values for the 0.2 % creep limit as a function of temperature (see also Table 9) (R_m = Tensile strength)



a)
1.0 % creep limit — 10 000 h

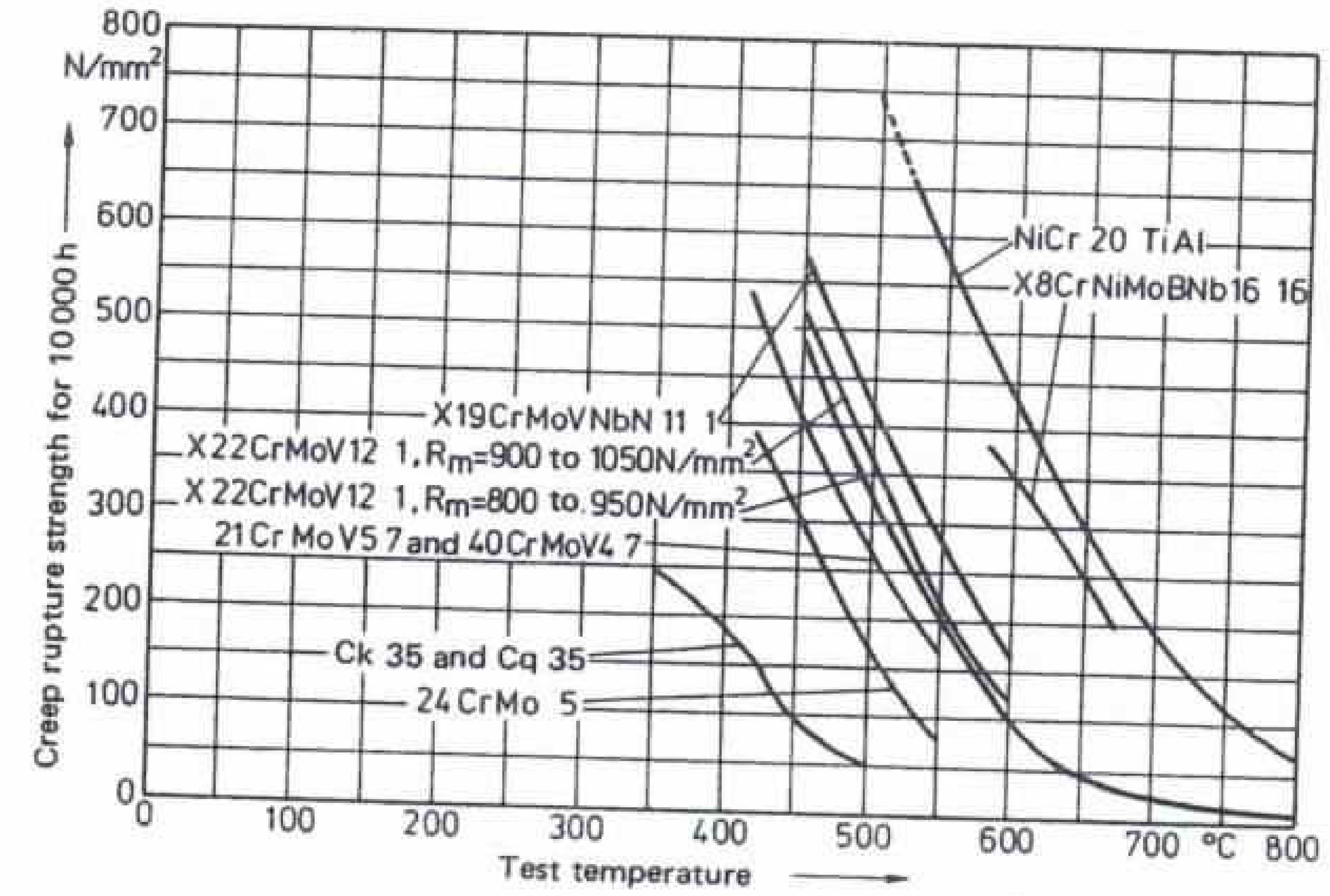


b)
1.0 % creep limit — 30 000 h

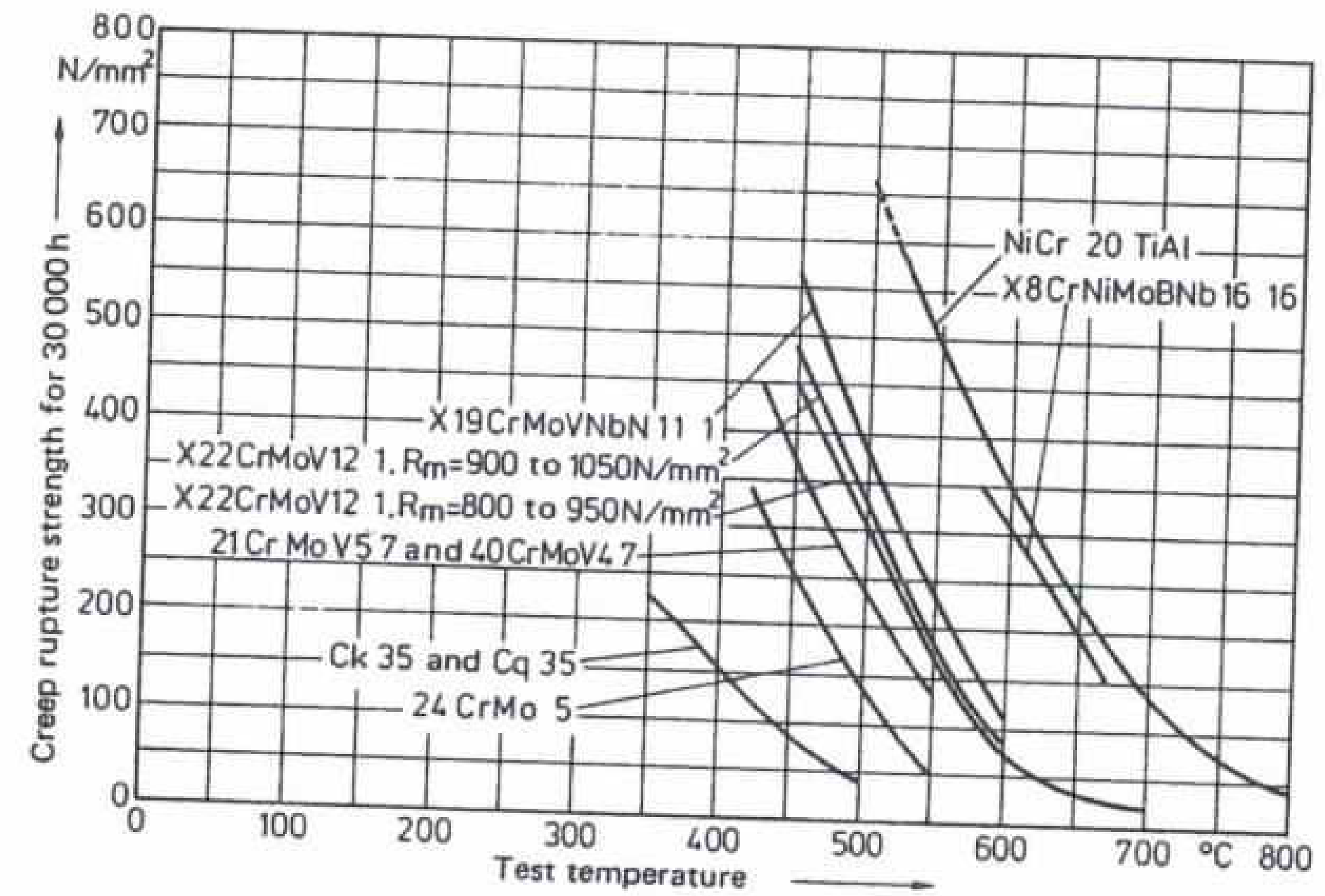


c)
1.0 % creep limit — 100 000 h

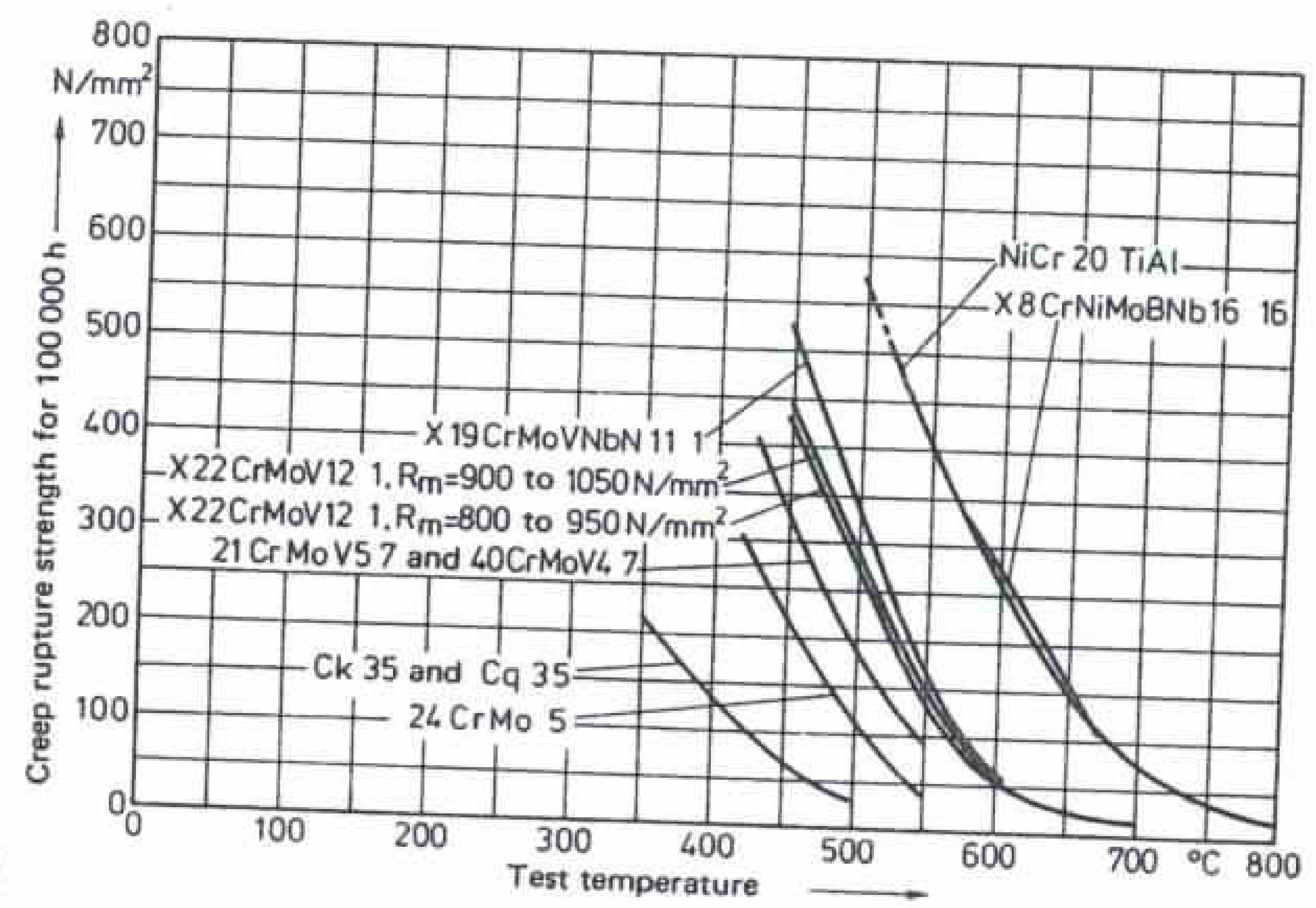
Figure 5. Guide values for the 1.0 % creep limit as a function of temperature (see also Table 9) (R_m = Tensile strength)



a)
Creep rupture strength — 10 000 h

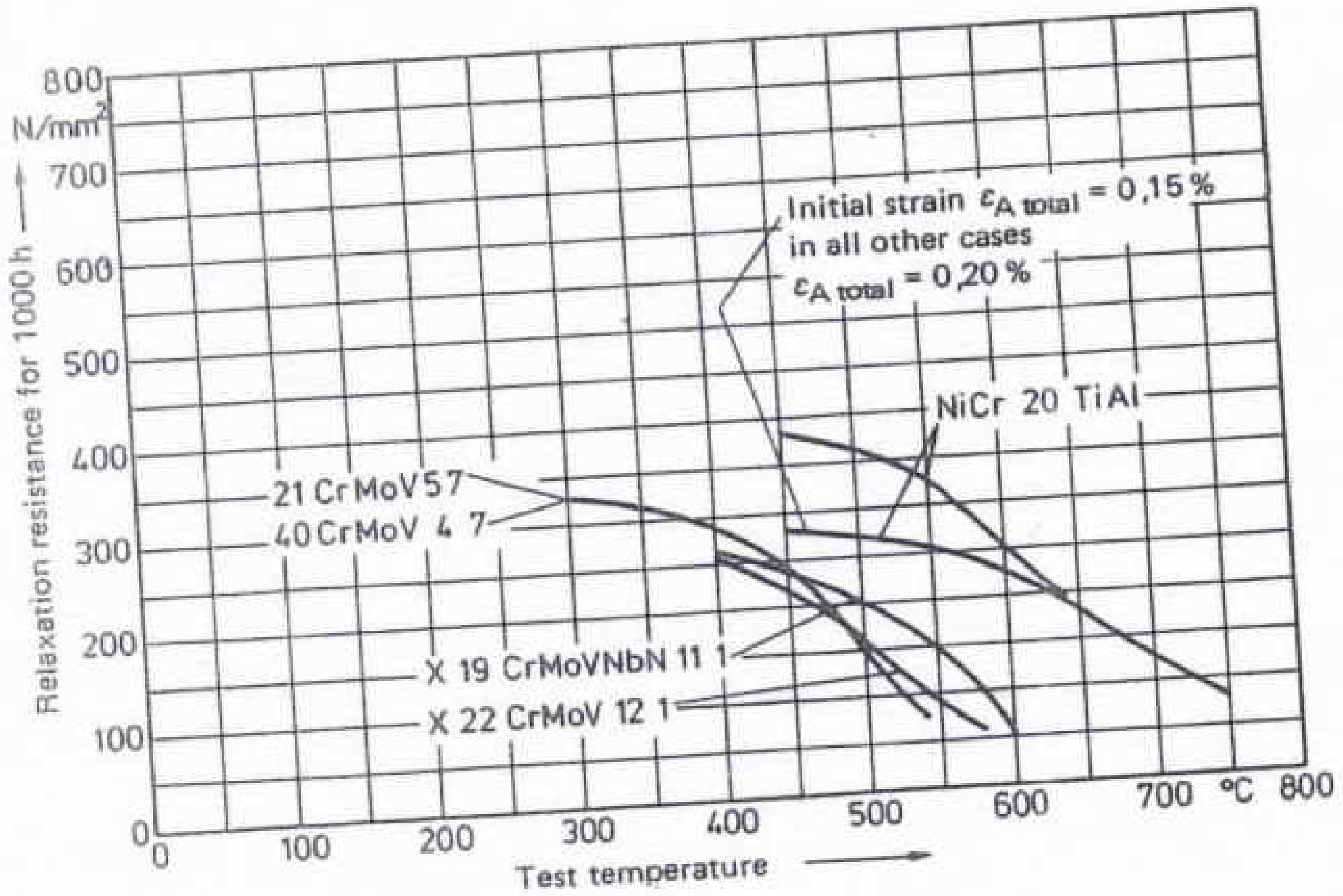


b)
Creep rupture strength — 30 000 h

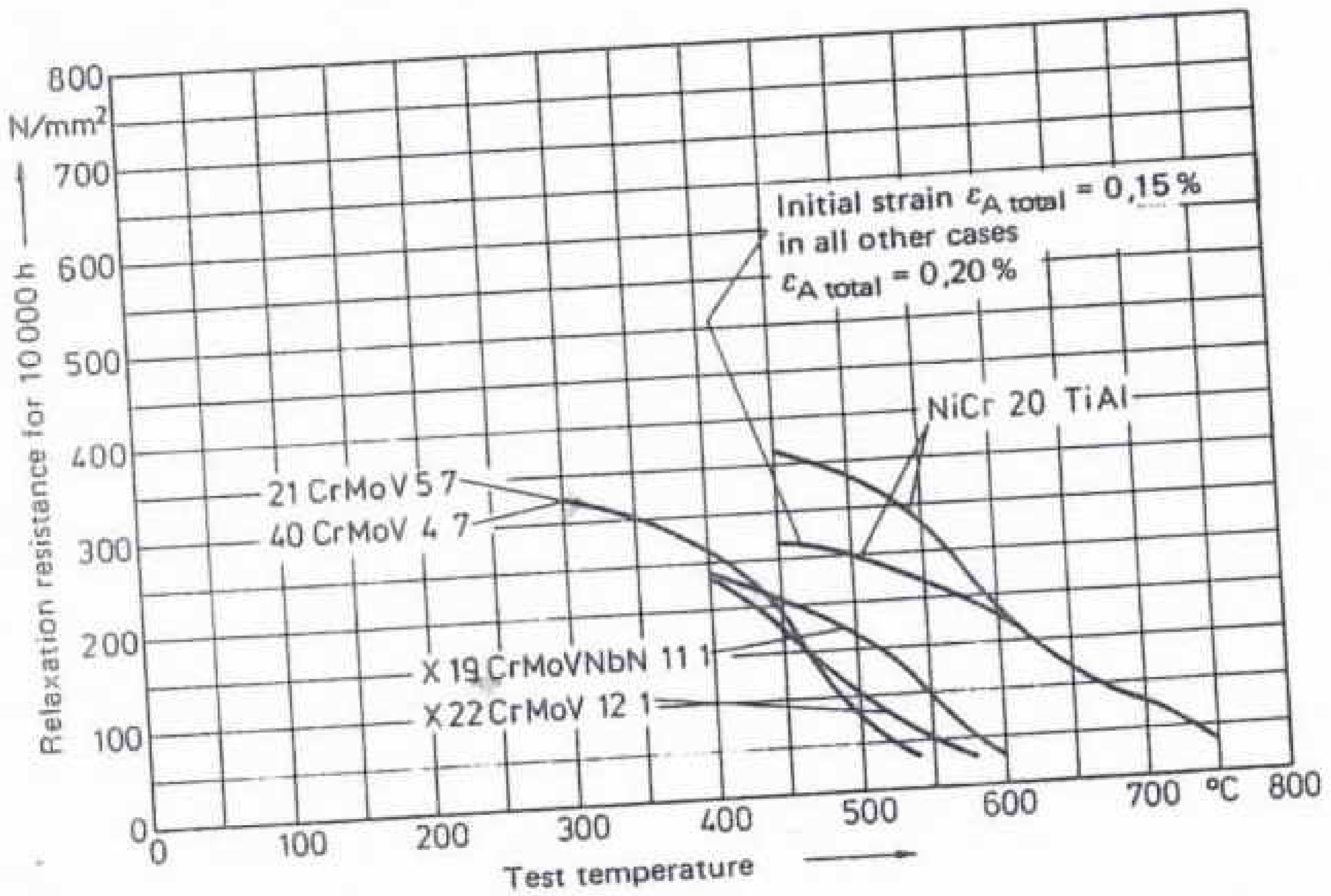


c)
Creep rupture strength — 100 000 h

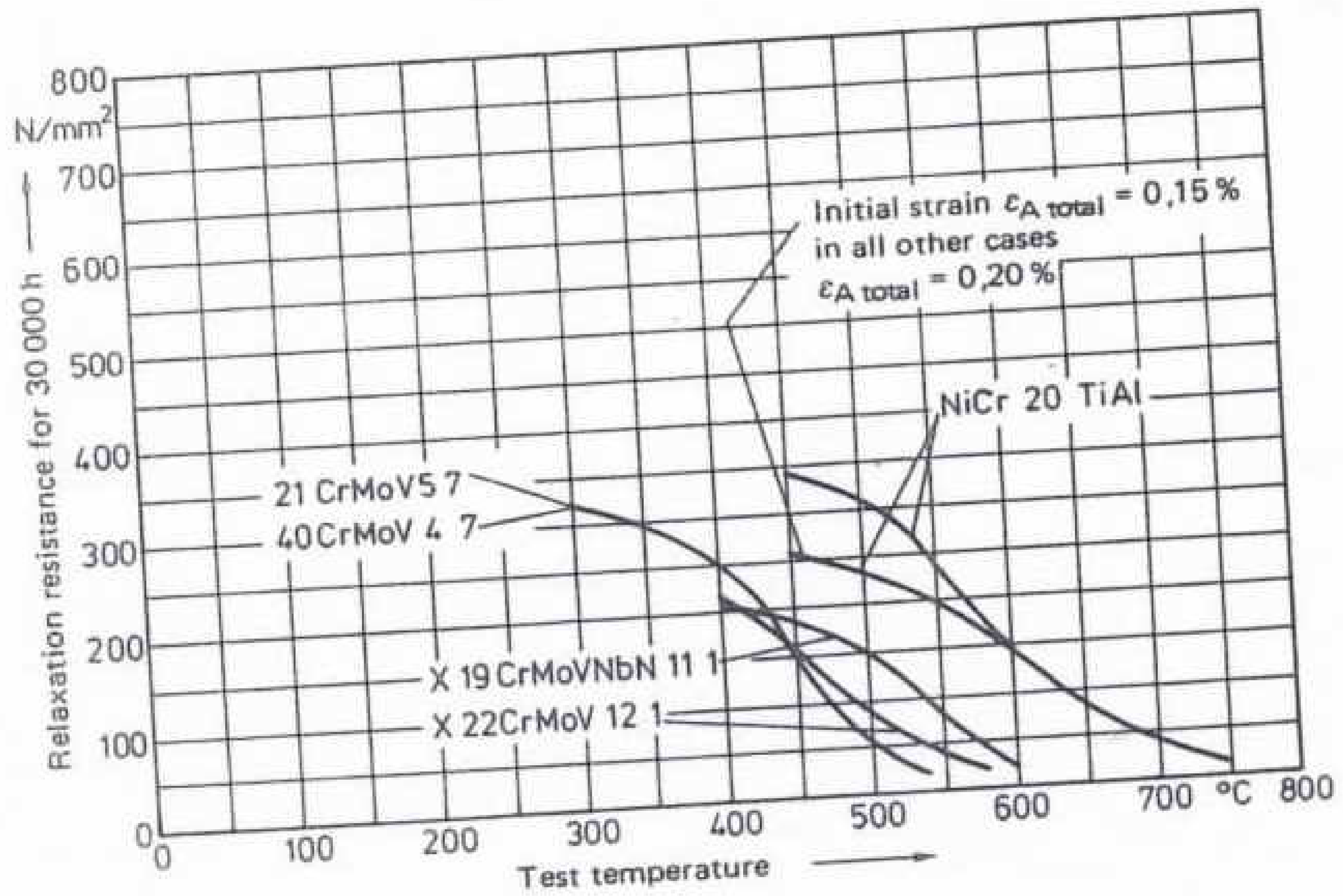
Figure 6. Guide values for the creep rupture strength as a function of temperature (see also Table 9) (R_m = Tensile strength)



a)
Relaxation resistance – 1000 h



b)
Relaxation resistance – 10 000 h



c)
Relaxation resistance – 30 000 h

Figure 7. Guide values for the relaxation resistance as a function of temperature (see also Table 10)

Explanations

This new issue of DIN 17 240 replaces the January 1959 version of Standards DIN 17 240 Part 1 "Heat resisting steels for bolts and nuts; technical conditions of delivery" and Part 2 "Heat resisting steels for bolts and nuts; quality specifications". Its contents differ from the stipulations in the 1959 issues essentially in the following aspects:

1 Selection of materials

The steels

C 45	(Material number 1.0503),
Ck 45	(Material number 1.1191),
24 CrMoV 5 5	(Material number 1.7733),
21 CrMoV 5 11	(Material number 1.8070) and
X 15 CrMo 12 1	(Material number 1.4920; still material number 1.4921, now obsolete, in the 1959 issue of DIN 17 240)

have been deleted and the steels or alloys

Cq 35	(Material number 1.1172),
21 CrMoV 5 7	(Material number 1.7709),
40 CrMoV 4 7	(Material number 1.7711),
X 19 CrMoVNbN 11 1	(Material number 1.4913) and
NiCr 20 TiAl	(Material number 2.4952)

have been newly adopted.

The cold upsetting steel Cq 35 is being increasingly used for nuts and smaller diameter screws (to about 20 mm).

The grade 21 CrMoV 5 7 replaces the grades 24 CrMoV 5 5 and 21 CrMoV 5 11. On the basis of studies carried out by the Research Association for Heat Resisting Materials, a co-operative body in which steel producers and users are represented, the latter two grades do not, as might be supposed from the guidance values given in DIN 17 240 Part 1 and Part 2, January 1959 issues, have better values than the new grade, particularly with regard to creep behaviour. Bolts and nuts of these two older steels that are still in stock may however be used without reservation in place of bolts or nuts of steel 21 CrMoV 5 7.

The grade 40 CrMoV 4 7 is equivalent to grade B 16 according to ASTM A 193. It is distinguished by the fact that even at 550 °C it still has a relatively high 0.2 % limit values and for this reason and because of the good results obtained with it abroad, has been adopted in DIN 17 240, although it does not fulfil the requirements of the AD Data Sheet (November 1970 issue) (steel bolts and nuts) in respect of DVM absorbed energy ($\geqq$ 8 kgm/cm² corresponding to $\geqq$ 55 J for alloy steels or $\geqq$ 6 kgm/cm² corresponding to $\geqq$ 41 J for unalloyed steels) (see Table 4).

The former nut steel X 15 CrMo 12 1 (material number 1.4920; see above) has been deleted because, on the basis of more recent knowledge on the possibilities of coupling nut and bolt materials, steel X 22 CrMoV 12 1 (material number 1.4923) can be used for both bolts and nuts.

The steel X 19 CrMoVNbN 11 1 (material number 1.4913) and the alloy NiCr20TiAl (material number 2.4952) have been adopted in this Standard because they are being increasingly used.

2 Relaxation resistance

In order to assess the quality of a bolted connection, in general it is important to know the extent to which the materials used tend to lose with time at their service temperature, the initial pre-stress they have been given, because an increasing proportion of the total strain consists of permanent deformation.

As a supplement to the information on long-time high temperature strength contained in Table 9, Table 10 therefore contains provisional guidance values on the relaxation resistance of the materials in this Standard, expressed in terms of the residual stress as a function of temperature and duration of stressing for a given initial strain on the bolt. These values provide no information on maximum permissible stressing. They do however give an indication as to the intervals at which it is advisable to re-tighten bolted connections in order to restore the required pre-stress. In general, it is advisable to replace bolts after a permanent strain of 1 % has been reached.

The values given in Table 10 are mean values of the scatter band so far recorded. They will be checked from time to time as further test results become available and if necessary corrected. On the basis of information so far available from tests of to ≈ 30 000 hours, it can be assumed that the lower limit of this scatter band is about 20 % lower than the quoted mean value at the temperatures given for the steel grades listed.

The values given have been determined in relaxation tests on smooth test bars under uniaxial tensile stress or using the models of bolted connections described in the literature.

3 Absorbed energy

The values of absorbed energy applicable to DVM specimens have in some cases been considerably increased (Table 4) compared with the values formerly stipulated, on the basis of recent statistical evaluations. In addition, minimum values of absorbed energy applicable to ISO V-notch specimens have been adopted in this Standard. In some cases, there was only relatively little test documentation available for these. All those involved are requested to collect and report any further test results on absorbed energy so that the present stipulations can be checked on this basis and if necessary subsequently modified. This applies particularly to the materials newly adopted in the Standard as mentioned above.

4 Transverse specimens

During the discussions, differences of opinion arose as to whether the values given in Tables 4 and 5 for the yield point (or 0.2 % limit) and tensile strength could also be standardized for transverse specimens taken from the core in the case of steel Ck 35 for example. For this reason, as in DIN 17 200 – quenched and tempered steels – sampling has not yet been definitely stipulated in this Standard in the case of transverse specimens, but left open for agreement to be made (see Section 8.3.2).

5 Extent of hardness testing

On the basis of the earlier stipulations (see DIN 17 240 Part 1, Section 3.23, of January 1959 issue) irrespective of the diameter, every bar had to be subjected to a hardness testing in order to check the uniformity of the delivery. On the basis of statistical evaluations on uniformity of deliveries and the use of special processes for monitoring uniformity of the products in a number of manufacturing works, it has been possible to eliminate this testing effort completely (see Section 8.2.3). According to the circumstances of individual manufacturers, agreements should be made for a further reduction in the extent of testing.