BSI

PD 6525 : Part 1 : 1990

Elevated temperature properties for steels for pressure purposes

Part 1. Stress rupture properties

Propriétés à températures élevées des aciers pour appareils à pression
Partie 1. Propriétés de rupture sous contrainte

Eigenschaften von Stählen für den Einsatz unter Druck bei hohen Temperaturen
Teil 1. Zeitstandverhalten

British Standards Institution

Foreword

This Part of this Published Document has been prepared under the direction of the Iron and Steel Standards Policy Committee. It is the result of work carried out by the Elevated and Low Temperature Properties of Steel Panel ISM/73/-/1, with support from the Department of Trade and Industry. It is considered of advantage to bring together into one document the elevated temperature stress rupture values found in several separate British Standards dealing with steels for pressure purposes.

It is intended that a second Part of this Published Document be produced covering elevated temperature proof stress values for steels.

Attention is drawn to clause **3** which both states the need for the supply of latest data (**3.1**) and establishes the authority of the values given (**3.2**).

This Part of this Published Document, is related to the International Standard Technical Report ISO/TR 7468 (1978) 'Summary of average stress rupture properties of wrought steels for boilers and pressure vessels'.

Contents

1 Scope

This Part of PD 6525 collates average stress rupture values for wrought carbon, ferritic alloy and austenitic steels contained in several British Standard specifications and other data assessments where elevated temperature properties are required. The steels are arranged in increasing alloy content. Indexes list the steels as given in the specifications for plates, sections and bars, forgings, bars for bolting and tubes/pipes respectively.

NOTE. The titles of publications referred to in this Published Document are listed on the inside back cover.

2 Data assessment

The stress rupture values given in this Part of PD 6525 have been obtained from a series of data assessments carried out by ISM/73/-/1 (see note 4 of clause 4).

Also contained in this Part of PD 6525 are indexes which relate British Standard specifications to the steels for which stress rupture values are given in this Published Document. The indexes are as follows:

BS 1501 : Part 1 :	see index 1;
: Part 2 :	see index 1;
: Part 3 :	see index 1;
BS 1502 :	see index 2;
BS 1503 :	see index 3;
BS 1506 :	see index 4 and index 7;
BS 3059 : Part 2 :	see index 5;
BS 3602 : Part 1 :	see index 5;
BS 3602 : Part 2 :	see index 5;
BS 3604 : Part 1 :	see index 5;
BS 3605 :	see index 5;

Stress rupture values are also given for other steels; from data assessments carried out, namely:

(a) those which are being introduced in revisions of the above British Standards (see **3.2**);

(b) for steels currently not in British Standards (see index 6);

(c) for bolting steels, properties from notched test specimens (see index 7).

However, for some steels included in British Standards, stress rupture data assessments have not been carried out, principally due to lack of data. Hence such steels, e.g. type 309S16 in BS 1501 : Part 3, are not listed in this Published Document.

The stress rupture values given for each steel are considered to be applicable to all wrought product forms, since the data assessments were based usually on information from a variety of wrought product forms.

3 Stress rupture values

3.1 Relation to data assessments

The stress rupture values given in this Part of PD 6525 are based on the assessment of test results provided by various laboratories in the UK and abroad. The validity of the values given depends on the range and amounts of data available. Therefore, in order that further assessments may be carried out to verify or modify these values so that they are relevant to the long service durations, it is important that data continue to be made available. The test results should be supported by information relating to steelmaking, product form, composition and heat treatment details. Appendix A gives a complete list of the information which should be provided when submitting data. The absence of full background details should not deter submission of test data.

The data should be submitted to:

British Standards Institution
ISM/73/-/1 Secretariat
3 York Street
Manchester
M2 2AT.

3.2 Relation to values in product standards

The collation of stress rupture values for wrought steels in this Part of PD 6525 represents the most recent assessment carried out for each steel and, as a result of the policy of keeping British Standards up to date, revisions will be introduced into this document as further assessments are carried out and validated by the appropriate BSI committee. In view of the fact that the product standards requiring the inclusion of stress rupture values will also be revised, there will be occasions when the stress rupture values in this document differ from those in the product standards for any given steel. Furthermore, steel designations may be changed and new steels may be introduced following revision, which could outdate some of the information given in this document.

In all cases therefore, it is essential that the stress rupture values given in the relevant product standard (as opposed to those given in this Part of PD 6525) be applied.

4 Notes to the stress rupture values

4.1 General

The notes given in 4.2 to 4.5 apply to the stress rupture values for all steels detailed in tables 1 to 40 inclusive.

4.2 Note 1. Year of approval of properties

The date that is shown in parentheses alongside the title/grade of the steel indicates the year of approval of its properties.

4.3 Note 2. Chemical composition/heat treatment

The limits of chemical composition and heat treatment for which the properties apply are the specified ranges covered by the various standards which contain that particular grade of steel. In the case of steels not included in British Standards (see index 6), the chemical composition/heat treatment for which the stress rupture values are considered to apply are given as those for an alternative grade of the same steel type, where this exists, or, in such cases as 0.5 % Mo (see table 5) and 30 % Ni 20 % CrTiAl (see table 35), they are as those given in previous editions of the relevant standard(s). No account has been taken of the cast to product variations allowed by the standards.

4.4 Note 3. Quantity and duration of data

The quantity and duration of data in these tables are the data used in the assessments, from which the average stress rupture values were derived.

The stress rupture values for steel MnCrMoV (see indexes 1, 2 and 3 and table 7) and steel NiCrMoV (see index 1 and table 6) were not obtained by the standard procedure and therefore the standard form of master curve and equations are not available. The information shown for these steels is the quantity and duration of the data known to be available at the time of the most recent data collection for these steels.

The asterisks (see note 4(a)) in the average stress rupture tables are based on the total data available which always exceeds that shown in these tables. Further information may be available by reference to BSI Panel ISM/73/-/1.

4.5 Note 4. Average stress rupture values

The values given in these tables are the average stress rupture values derived in accordance with the method given in the annex to ISO 6303 : 1981. The exceptions to this rule are for steels MnCrMoV (see table 7), NiCrMoV (see table 6), 1¼ % CrMo (see table 11), 2¼ % CrMo (Annealed) (see table 15), 0.4 % C 1¼ % CrMoV (Notched properties) (see table 38) and 1 % CrMoVTiB (Notched properties) (see table 39). The values shown for these steels have been determined either by non-standard methods or, in the case of 1¼ % CrMo, by reference to a similar steel grade. Test data normally show a ± 20 % scatter about the average values.

The extent to which test data can be extrapolated reliably depends on the number and duration of the tests. Three basic factors are involved: temperature, time and stress. Experience suggests that reliable extrapolations may be made, covering a range of ± 25 °C about each test temperature, provided that there are test data on at least five casts of steel and that the longest test of each series exceeds a certain minimum duration (see ISO 6303 : 1981). The confidence which can be placed upon such properties will be related to the extent of extrapolation. Two forms of extrapolation are recognized:

(a) *Extended time extrapolation*

Extrapolations exceeding approximately three times certain maximum test durations are described as extended time extrapolations. Stress rupture properties are normally listed at the time intervals shown in table 0, which defines the durations beyond which 'extended time extrapolation' is applied.

Values which have involved extended time extrapolation are marked with an asterisk in the tables of estimated average rupture stresses contained in this Part of PD 6525. When such values are used, account should be taken of the quantity and duration of the test data on which they are based.

(b) Extended stress extrapolation

This applies when values have been obtained by extending the parametric master curves to stresses beyond the range for which tests were carried out. Experience suggests that reliable extrapolation may be made up to 10 % beyond the range of stress values used to derive the master curve. Stress values greater than 10 % different from the range of the test data used in the assessment are not given. Extended stress extrapolation is indicated by the broken line extensions of the master curves.

Values which have involved extended stress extrapolation are marked with parentheses in the tables of estimated average rupture stresses contained in this Part of PD 6525. When such values are used, account should be taken of the quantity and duration of the test data on which they are based.

Table 0. Durations beyond which extended time extrapolation is applied

Test duration (in h) exceeded by data points from 5* casts at temperatures within 25 °C of that specified	10 000	20 000	30 000	50 000	70 000	80 000
Durations (in h) beyond which 'extended time extrapolation' is applied	30 000	50 000	100 000	150 000	200 000	250 000

*Results from tests in progress may be included when above the lower 20 % scatter band limit at the appropriate duration.

5 Master curves

The master curve for each steel represents the average rupture stress values over the range of time, temperature and stress values used in the assessment (see figures 1 to 39) as a function of stress and in the form of a time and temperature parameter, as follows:

$$P_{(\sigma)} = a + b(\log \sigma) + c(\log \sigma)^2 + d(\log \sigma)^3 + e(\log \sigma)^4$$

$$= \frac{\log t - \log ta}{(T - Ta)^r}$$

where

$P_{(\sigma)}$ is the creep rupture parameter;
T is the temperature (in K);
t is the time to rupture (in h);
σ is the stress (in N/mm^2);
r is a temperature exponent (see appendix B);
a to e are constants (see note 2).

NOTE 1. Values read off the graphs presented in this Part of PD 6525 may be subject to discrepancies introduced by the method of reproduction. In all cases the values presented in tabular form should be taken as being correct.

NOTE 2. The constants for the equation of the master curve (see appendix B) have been derived from a given set of data for each steel, using the VAX 8200 computer at British Steel plc, Swinden Laboratories. It is known that the use of a different type of computer may give slight differences in the numerical values of these constants. However, the resultant effect on the derived average rupture stress values based on the use of 11 signifcant figures in the calculations is insignificant.

6 Abbreviations used in the indexes and tables

The following abbreviations are used in the indexes and in tables 1 to 39.

AC : air cooled;
FC : furnace cooled;
Q : quenched;
OQ : oil quenched;
WQ : water quenched;
T : tempered;
ST : solution treated;
Rm : tensile strength;
AR : as rolled;
Norm. : normalized.

Index 1. Plates

Index 2. Sections and bars

Index 3. Forgings

Index 4. Bars for bolting

*Stress rupture values for notched bars are given in index 7.

Index 5. Tubes/pipes

Index 6. Steels not currently in British Standards

Index 7. Stress rupture values for notched bars to BS 3500 : Part 1

Table 1. C Steel Semi and Si killed (1974) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.07 to 0.24	–	0.25
	Si	0.005 to 0.330	–	0.35
	Mn	0.32 to 0.80	0.40	1.40
	P	0.003 to 0.048	–	0.045
	S	0.003 to 0.05	–	0.045
Heat treatment	°C 1. 899 to 950 AC 2. 850 to 920 AC + T 500 to 690		AR or Norm.	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h <10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h >100 000
	Number of test points available						
°C							
400	281(11)	34(7)	10(8)	11(8)	2(4)	1(1)	–
450	445(16)	45(10)	6(10)	5(2)	(3)	(1)	–
500	455(8)	27(6)	11(5)	3(6)	(4)	(3)	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
380	277	251	238	219	207	199*	192*
390	255	228	215	196	184	175*	167*
400	233	206	193	173	160	151*	143*
410	213	185	171	151	137	128*	121*
420	193	164	150	129	116	107*	101*
430	173	144	129	109	98*	90*	84*
440	154	124	110	92	82*	76*	71*
450	136	107	94	78	70*	64*	60*
460	118	91	80	67	60*	55*	50*
470	102	79	69	57	50*	44*	–
480	89	68	60	48	(39)	–	–
490	77	59	51	–	–	–	–
500	68	51	41	–	–	–	–
510	60	41	–	–	–	–	–
520	52	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

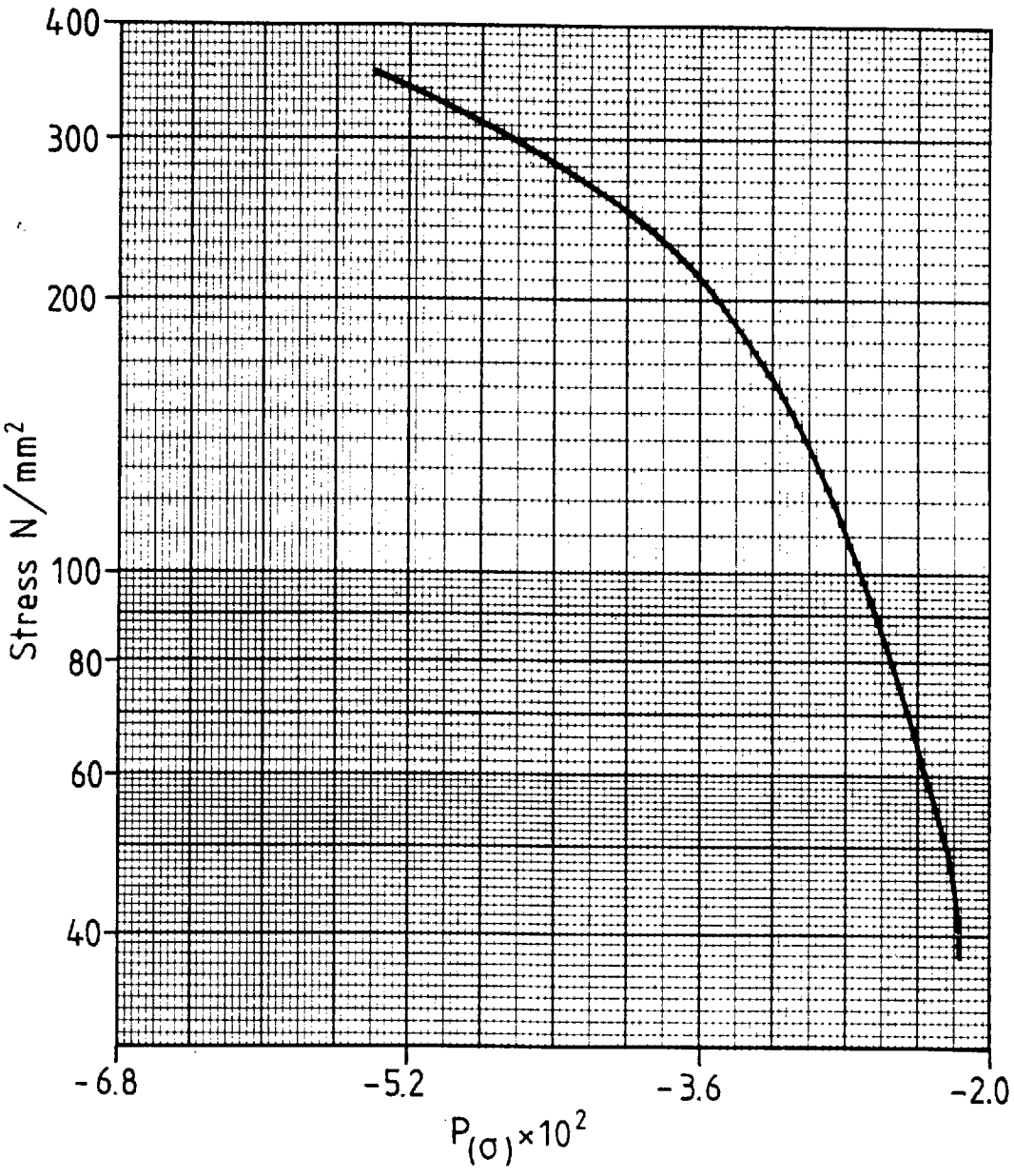

Figure 1. C Steel Semi and Si killed (1974)

Table 2. C Steel Si and Al killed (1974) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.10 to 0.185	–	0.25
	Si	0.01 to 0.32	–	0.35
	Mn	0.36 to 0.79	0.40	1.40
	P	0.007 to 0.029	–	0.045
	S	0.011 to 0.028	–	0.045
	Al (sol.)	0.016 to 0.102	0.015	–
Heat treatment	°C 1. 880 to 950 AC 2. 899 to 925 AC + T 600		AR or Norm.	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h <10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h >100 000
	Number of test points available						
°C							
400	29(1)	7	2(4)	(2)	–	–	–
450	59(2)	6	1(1)	1(2)	–	–	–
500	24	2(1)	1(1)	2	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
380	213	192	183	171*	164*	159*	155*
390	197	176	167	155*	149*	144*	140*
400	181	161	152	141*	134*	130*	126*
410	166	147	138	127*	121*	116*	113*
420	151	133	125	114*	108*	104*	101*
430	138	120	112	102*	96*	92*	89*
440	125	107	100	90*	84*	80*	77*
450	112	95	88	78*	73*	69*	66*
460	100	84	77	67*	62*	58*	55*
470	89	73	66	57*	52*	48*	45*
480	78	63	56*	47*	41*	(37)*	(34)*
490	67	52	46*	(36)*	–	–	–
500	57	42	(35)*	–	–	–	–
510	47	–	–	–	–	–	–
520	(37)	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

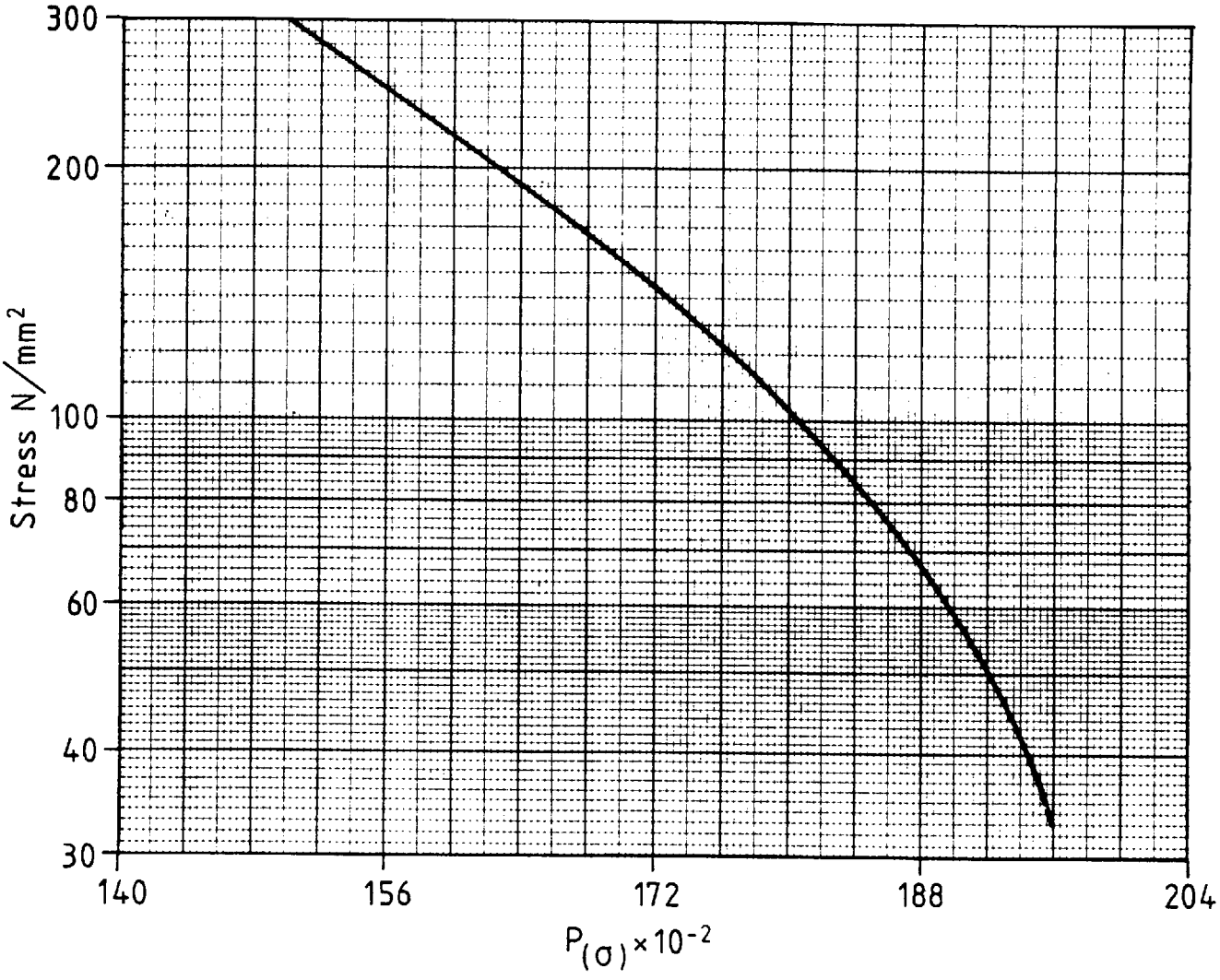

Figure 2. C Steel Si and Al killed (1974)

Table 3. C-Mn Steel (1974) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.09 to 0.29	–	0.30
	Si	0.006 to 0.49	–	0.50
	Mn	0.80 to 1.64	0.80	1.70
	P	0.008 to 0.048	–	0.045
	S	0.001 to 0.103	–	0.045
	Nb	0.001 to 0.077	0.01	0.10
Heat treatment	°C 1. 860 to 960 AC 2. 840 to 960 AC + T 550 to 720		AR or Norm.	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h <10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h >100 000
	Number of test points available						
°C							
400	448(6)	93(14)	42(9)	22(53)	4(1)	(4)	–
450	629(10)	75(9)	27(9)	19(30)	(16)	(3)	–
500	586(10)	80(8)	19(5)	15(23)	1(20)	(3)	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
380	291	262	248	227	215	206*	199*
390	266	237	223	203	190	181*	174*
400	243	214	200	179	167	157*	150*
410	221	192	177	157	144	135*	128*
420	200	171	156	136	124	115*	108*
430	180	151	136	117	105	97*	91*
440	161	132	118	100	89	82*	77*
450	143	115	102	85	76	70*	66*
460	126	99	87	73	65	60*	56*
470	110	86	75	63	56	52*	(48)*
480	96	74	65	55	(49)	–	–
490	84	65	57	(47)	–	–	–
500	74	57	50	–	–	–	–
510	65	50	–	–	–	–	–
520	58	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

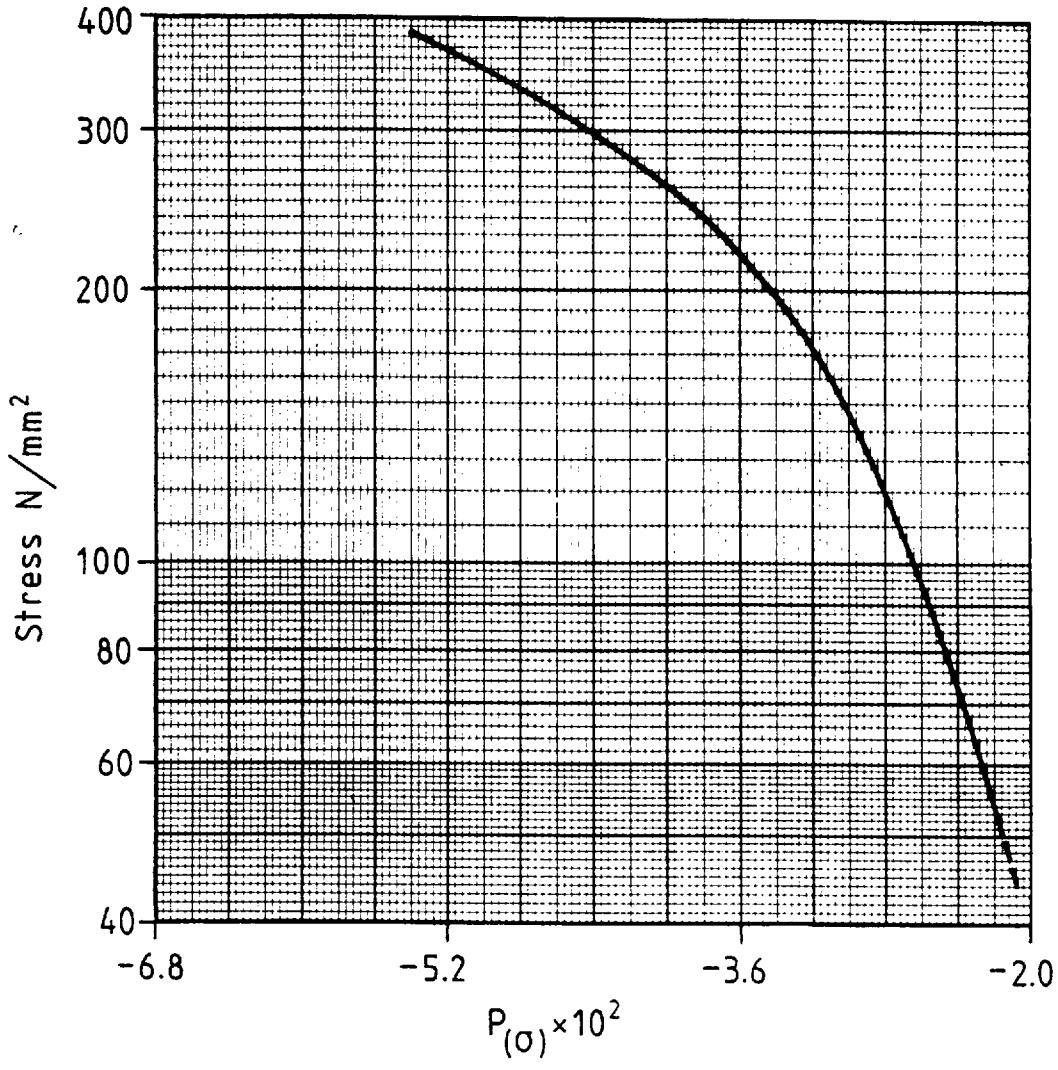

Figure 3. C-Mn Steel (1974)

Table 4. 0.3 % Mo (1975) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.13 to 0.20	–	0.20
	Si	0.17 to 0.40	0.10	0.40
	Mn	0.48 to 0.81	0.40	0.80
	P	0.005 to 0.027	–	0.040
	S	0.005 to 0.030	–	0.040
	Mo	0.25 to 0.35	0.25	0.35
	Al (met.)	0.006 to 0.008	–	0.012
Heat treatment	°C 1. 890 to 925 AC 2. 900 to 950 AC + T 650		°C 880 to 960 AC + T 600 to 650	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h <10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h >100 000
	Number of test points available						
°C							
450	26(4)	3(4)	(4)	1(1)	1	–	–
500	109(1)	20(3)	11(3)	1(5)	2(1)	–	–
550	79(2)	10(1)	2(1)	2	1	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
450	298	273	260	239*	226*	217*	210*
460	273	244	229	208*	197*	188*	180*
470	247	216	200	178*	168*	159*	151*
480	222	187	172	148	139*	130*	124*
490	196	159	144	123	114*	105*	100*
500	171	134	119	101	91*	84*	80*
510	147	113	99	81	74*	69*	65*
520	125	93	80	66	60*	55*	52*
530	102	76	66	53*	48*	45*	(42)*
540	82	61	53	(42)*	–	–	–
550	64	49	(42)	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

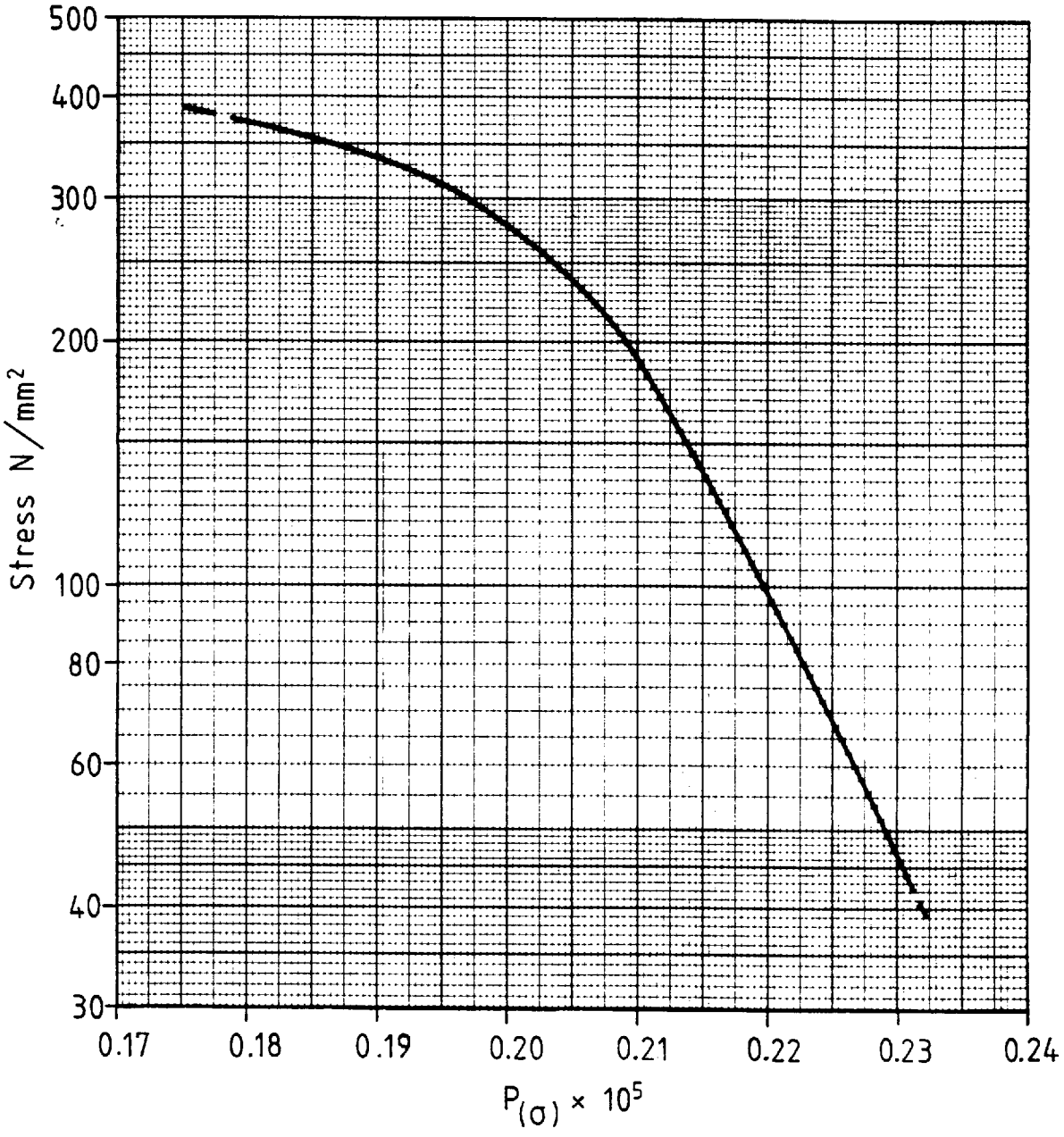

Figure 4. 0.3 % Mo (1975)

Table 5. 0.5 % Mo (1975) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.07 to 0.26	–	0.25
	Si	0.01 to 0.34	0.15	0.40
	Mn	0.42 to 0.78	–	0.90
	P	0.008 to 0.036	–	0.040
	S	0.007 to 0.048	–	0.040
	Mo	0.40 to 0.61	0.45	0.65
	Al (tot.)	0.002 to 0.018	–	0.012
Heat treatment	°C 1. Cold drawn + T 720 2. 720 to 871 FC 3. 900 to 1100 AC 4. 880 to 1093 AC + T 600 to 710		°C 900 to 940 AC + T 600 to 650	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h <10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h >100 000
	Number of test points available						
°C							
450/454	38(9)	16(4)	7(1)	6(5)	(12)	–	–
500	95(2)	15(7)	12(6)	3(4)	1(2)	–	–
550	82(1)	12(5)	5(2)	3(1)	1(2)	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
450	327	307	298	286	280	275*	271*
460	297	276	267	254	247	242*	238*
470	269	247	237	224	217	222*	208*
480	243	220	210	196	189*	183*	179*
490	218	195	184	170	162*	157*	153*
500	195	171	160	146	138*	132*	128*
510	173	148	137	123	115*	110*	105*
520	152	127	116	102	94*	88*	84*
530	133	108	97	82	74*	68*	64*
540	114	89	78	63	(54)*	–	–
550	97	71	60	–	–	–	–
560	80	(53)	–	–	–	–	–
570	64	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

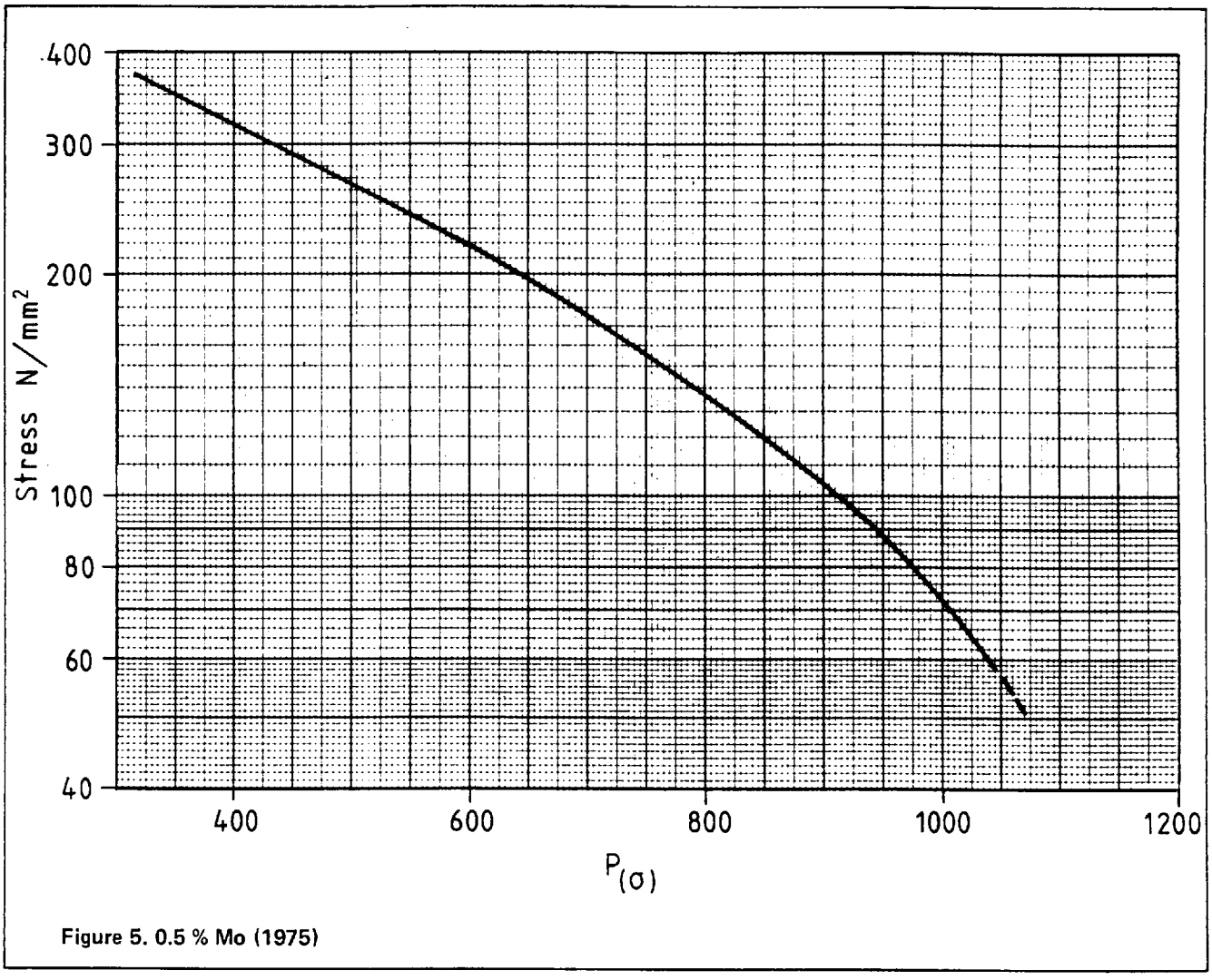

Figure 5. 0.5 % Mo (1975)

Table 6. NiCrMoV

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.115 to 0.145	–	0.14
	Si	0.15 to 0.40	–	0.40
	Mn	1.03 to 1.26	1.00	1.40
	P	0.010 to 0.022	–	0.025
	S	0.012 to 0.028	–	0.015
	Cr	0.37 to 0.695	0.40	0.70
	Mo	0.255 to 0.32	0.24	0.30
	Ni	0.79 to 1.58	0.60	1.00
	V	0.07 to 0.103	0.04	0.12
Heat treatment	°C 880 to 950 + T 600 to 650		°C 900 to 940 AC + T 640 minimum	

(b) Quantity and duration of data used in assessment† (see note 3)

Temperature	Test duration						
	h <10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h >100 000
	Number of test points available						
°C							
450	17	2	–	3	1	1(1)	–
500	27	5	2	1	(1)	–	–
550	27	3	2	–	3	1(4)	–
575	11	1	2	1	–	(1)	–

( ) Figures in parentheses denote unbroken tests.
†Data as available at last update.

(c) Average rupture stresses‡

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
400	363*	351*	344*	334*	325*	318*	311*
410	356*	340*	333*	324*	314*	308*	302*
420	345*	329*	320*	310*	301*	294*	288*
430	332	314	306	294	284*	276*	269*
440	315	299	288	272	263*	255*	248*
450	296	276	265	247	237*	230*	224*
460	277	254	238	218	206*	198*	191*
470	256	227	211	188	176*	167*	160*
480	235	201	184*	161*	146*	136*	128*
490	212	177	158*	134*	121*	113*	106*
500	188	152	134*	111*	100*	90*	84*
510	164	127	112*	90*	80*	71*	65*
520	141	103	89*	72*	61*	52*	45*
530	120	85	73	57	46	40	35*
540	100	68	58	43	34	28	24*
550	81	54	44	31	23	19	14*
560	66	42	–	–	–	–	–
570	55	34	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
‡Values obtained using non-standard extrapolation method. Values at 30 000 h, 50 000 h, 150 000 h and 250 000 h obtained by interpolation from values given in BS 1501 : Part 2.

NOTE. Figure not available (see 4.4).

Figure 6. NiCrMoV

Table 7. MnCrMoV

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m*/*m*)	% (*m*/*m*)	% (*m*/*m*)
	C	0.135 to 0.170	–	0.17
	Si	0.19 to 0.30	–	0.40
	Mn	1.18 to 1.44	1.00	1.50
	P	0.017 to 0.033	–	0.040
	S	0.013 to 0.038	–	0.040
	Cr	0.57 to 0.84	0.40	1.00
	Mo	0.20 to 0.32	0.20	0.35
	Ni	0.13 to 0.39	–	0.80
	Al	–	–	0.020
	Cu	0.06 to 0.16	–	0.30
	V	0.075 to 0.12	0.04	0.12
Heat treatment	°C 900 to 950 + T 650 to 675		°C 900 to 940 AC + T 640 minimum	

(b) Quantity and duration of data used in assessment† (see note 3)

Temperature	Test duration						
	h <10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h >100 000
	Number of test points available						
°C							
450	44(2)	5	5	6	1	–	–
500	59(2)	14(1)	3	3(3)	1	–	–
550	58(3)	4(2)	5	1	1	1(2)	–
575	28	5	3	2	2	(1)	–

( ) Figures in parentheses denote unbroken tests.
†Data as available at last update.

(c) Average rupture stresses‡

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
400	454*	435*	425*	417*	407*	399*	391*
410	445*	425*	416*	405*	394*	385*	377*
420	432*	411*	401*	388*	377*	368*	360*
430	415	392	381	367	355*	346*	337*
440	394	371	358	341	328*	318*	303*
450	371	346	330	309	296*	287*	273*
460	346	316	296	272	258*	249*	240*
470	321	284	263	235	219*	208*	199*
480	294	252	230	201	183*	171*	161*
490	265	219	198	168	152*	141*	132*
500	234	189	168	139	124*	113*	105*
510	205	157	136	113	99*	88*	80*
520	177	137	116	90	75*	66*	58*
530	150	106	89	70	58*	50*	42*
540	125	85	70	53	42*	34*	27*
550	102	68	55	39	30*	23*	16*
560	83	52	–	–	–	–	–
570	69	42	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
‡Values obtained using non-standard extrapolation method. Values at 30 000 h, 50 000 h, 150 000 h and 250 000 h obtained by interpolation from values given in BS 1501 : Part 2.

NOTE. Figure not available (see 4.4).

Figure 7. MnCrMoV

Table 8. ½ % Cr ½ % Mo ¼ % V (1987) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m*/*m*)	% (*m*/*m*)	% (*m*/*m*)
	C	0.07 to 0.16	0.10	0.18
	Si	0.12 to 0.36	0.15	0.40
	Mn	0.36 to 0.73	0.40	0.70
	P	0.007 to 0.037	–	0.040
	S	0.004 to 0.043	–	0.040
	Cr	0.26 to 0.68	0.30	0.60
	Mo	0.45 to 0.70	0.50	0.70
	V	0.19 to 0.31	0.22	0.28
	Al	0.001 to 0.009	–	0.020
Heat treatment	°C 930 to 990 AC + T 660 to 720		°C 930 to 990 AC + T 640 to 720	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h <10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h >100 000
	Number of test points available						
°C							
450	44(7)	11(2)	7(1)	5(1)	(3)	–	–
475	45	5	1	1(1)	1(1)	1(2)	–
500	176(12)	28(10)	11	6(2)	2(1)	2(2)	–
525	60(4)	7(1)	5(4)	9(1)	3(1)	(1)	1
550	371(21)	83(14)	22(16)	28(7)	2	5(4)	–
575	257(10)	41(10)	8(2)	14(4)	5(3)	1(3)	–
600	355(18)	58(5)	14	6	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
450	380	352	339	321	309	301*	295*
460	353	326	313	294	282	274*	267*
470	328	300	287	268	256	247	240*
480	304	276	262	242	230	221	214*
490	280	251	237	217	205	196	189*
500	257	227	213	193	181	172	166*
510	234	204	190	170	158	150	144*
520	212	182	168	149	138	130	125*
530	190	161	147	130	120	113	108*
540	170	142	129	113	104	98	93*
550	151	125	113	99	90	85	80*
560	133	109	99	86	77	71	65*
570	118	96	87	73	61	–	–
580	104	84	74	–	–	–	–
590	92	71	–	–	–	–	–
600	81	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).

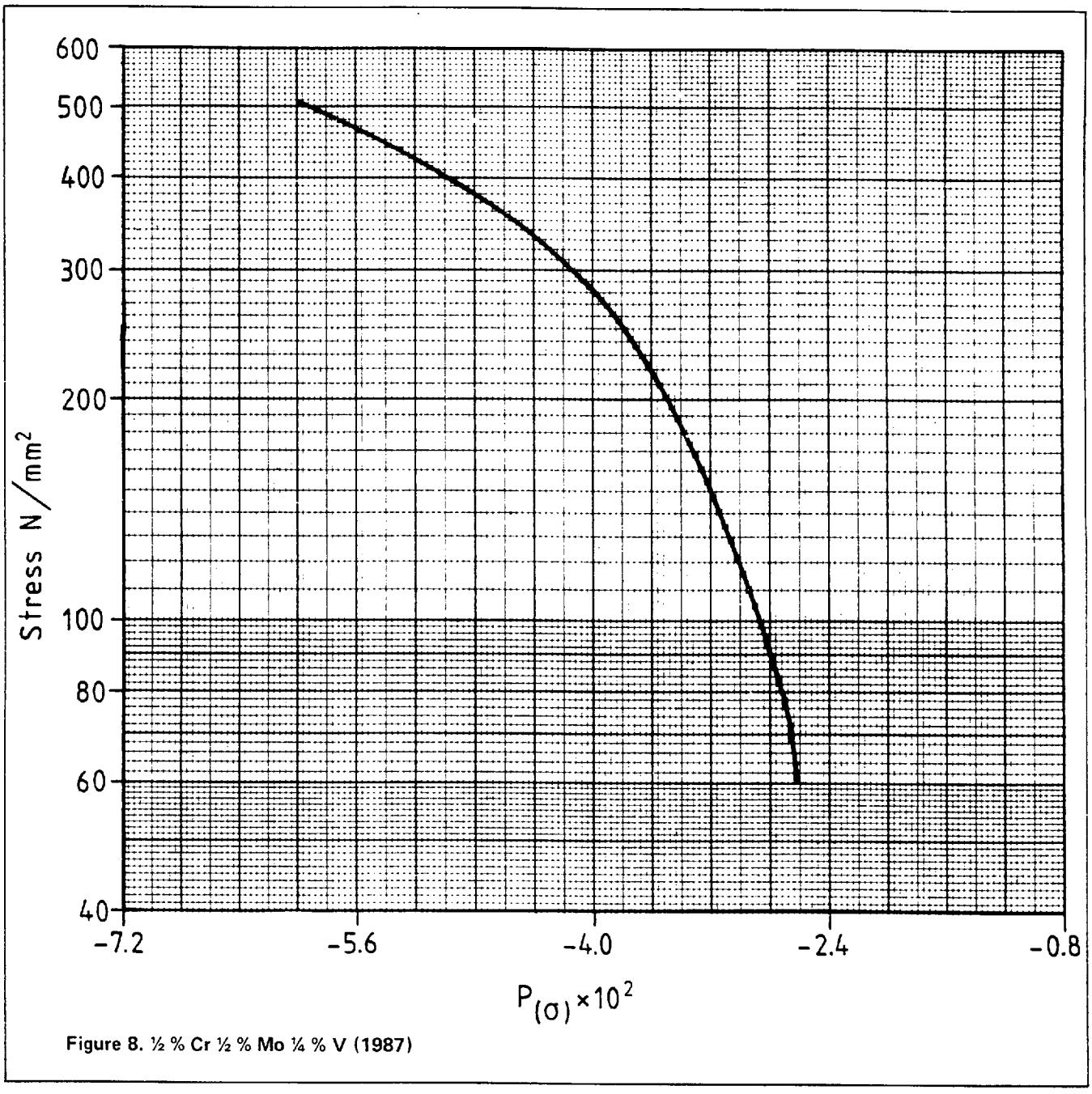

Figure 8. ½ % Cr ½ % Mo ¼ % V (1987)

Table 9. 1 % CrMo (Normalized) (1988) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m*/*m*)	% (*m*/*m*)	% (*m*/*m*)
	C	0.07 to 0.21	–	0.18
	Si	0.12 to 0.34	0.10	0.40
	Mn	0.41 to 0.75	0.40	0.70
	P	0.008 to 0.038	–	0.040
	S	0.003 to 0.038	–	0.040
	Cr	0.72 to 1.11	0.70	1.20
	Mo	0.40 to 0.58	0.45	0.65
	Ni	0.05 to 0.35	–	0.30
	Al	0.009 to 0.018	–	0.020
	Cu	0.03 to 0.20	–	0.30
	Sn	0.003 to 0.028	–	0.03
Heat treatment	°C 900 to 960 AC		°C 900 to 960 AC	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	**Test duration**						
	h <10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h >100 000
	Number of test points available						
°C							
450	9	7	3(1)	11(1)	2(1)	–	–
475	1(9)	3	2	1	4	2	–
500	35	15	2	2	–	–	–
525	18(6)	4	2	3	–	1(3)	–
550	82	12	–	3	–	1	–
575	23(1)	3	4	1	(4)	–	–
600	20	4	1	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	**10 000 h**	**30 000 h**	**50 000 h**	**100 000 h**	**150 000 h**	**200 000 h**	**250 000 h**
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
450	406	372	357	337	325	317*	311*
460	368	333	318	297	285	276*	270*
470	332	296	280	259	246	238*	231*
480	297	260	244	223	210	202*	196*
490	264	227	210	189	177	169*	163*
500	232	195	179	158	147	139*	133*
510	202	166	150	131	120*	113*	108*
520	174	139	125	107	97*	91*	87*
530	149	116	103	87	79*	73*	69*
540	126	96	84	70	64*	59*	56*
550	105	79	69	57*	52*	48*	46*
560	88	65	57	47*	43*	40*	38*
570	73	54	47	40*	36*	34*	32*
580	61	45	40	34*	31*	–	–
590	52	38	34	–	–	–	–
600	44	33	–	–	–	–	–
610	38	–	–	–	–	–	–
620	33	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).

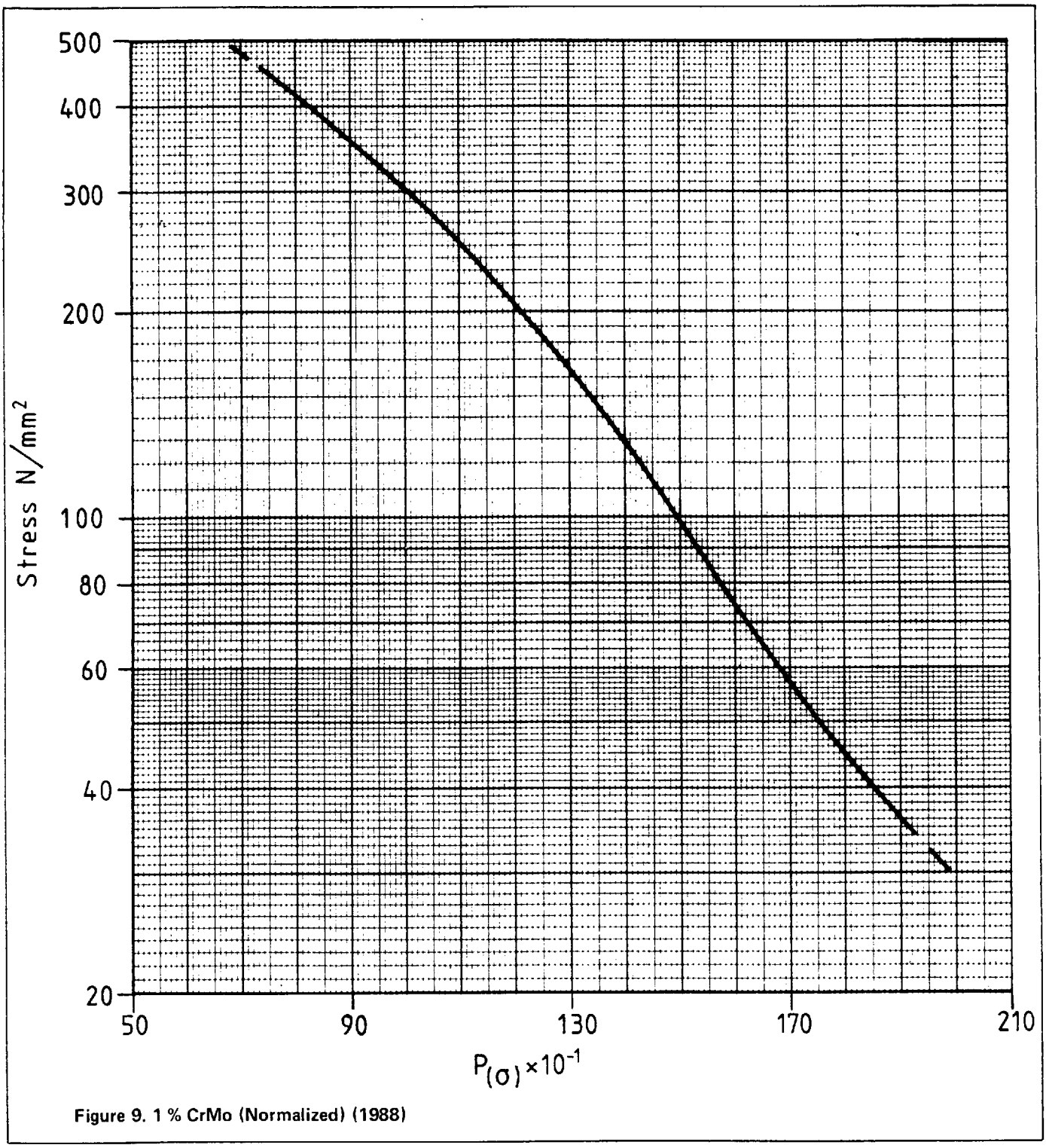

Figure 9. 1 % CrMo (Normalized) (1988)

Table 10. 1 % CrMo (Normalized and Tempered) (1988) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.07 to 0.18	–	0.18
	Si	0.13 to 0.40	0.10	0.40
	Mn	0.30 to 0.80	0.40	0.70
	P	0.004 to 0.044	–	0.040
	S	0.005 to 0.042	–	0.040
	Cr	0.65 to 1.11	0.70	1.20
	Mo	0.40 to 0.66	0.45	0.65
	Ni	0.016 to 0.35	–	0.30
	Al	0.001 to 0.018	–	0.020
	Cu	0.004 to 0.27	–	0.30
	Sn	0.003 to 0.028	–	0.030
Heat treatment	°C 900 to 960 AC + T 600 to 750		°C 900 to 960 AC + T 600 to 750	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h <10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h >100 000
	Number of test points available						
°C							
450	26(1)	22(13)	8(10)	10(13)	1(1)	–	–
475	(5)	2(3)	3	2	3	3	–
500	213(16)	71(8)	21(3)	7(5)	1(1)	–	–
525	50(5)	10(1)	3(1)	4	–	2(2)	–
550	307(11)	52(8)	17(6)	5(7)	–	–	–
575	51	7	6	1(6)	1(3)	(1)	–
600	82(1)	6	2	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
450	373	333	315	290	276	265*	257*
460	343	305	287	262	247	237*	229*
470	315	277	259	235	220	210*	202*
480	287	250	232	208	193	183*	175*
490	261	224	206	181	167	156*	148*
500	235	198	180	155	140	129*	121*
510	210	172	154	129	114	103*	95*
520	185	147	129	103	89	79*	72*
530	160	122	104	80	68*	61*	56*
540	136	97	80	62	53*	49*	46*
550	112	76	62	49	44	41	39
560	88	59	50	42	38	36*	34*
570	69	48	42	36	33	32*	31*
580	55	41	37	32	30	29*	28*
590	46	36	33	29	27	–	–
600	39	32	30	–	–	–	–
610	35	29	27*	–	–	–	–
620	31	–	–	–	–	–	–
630	29	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).

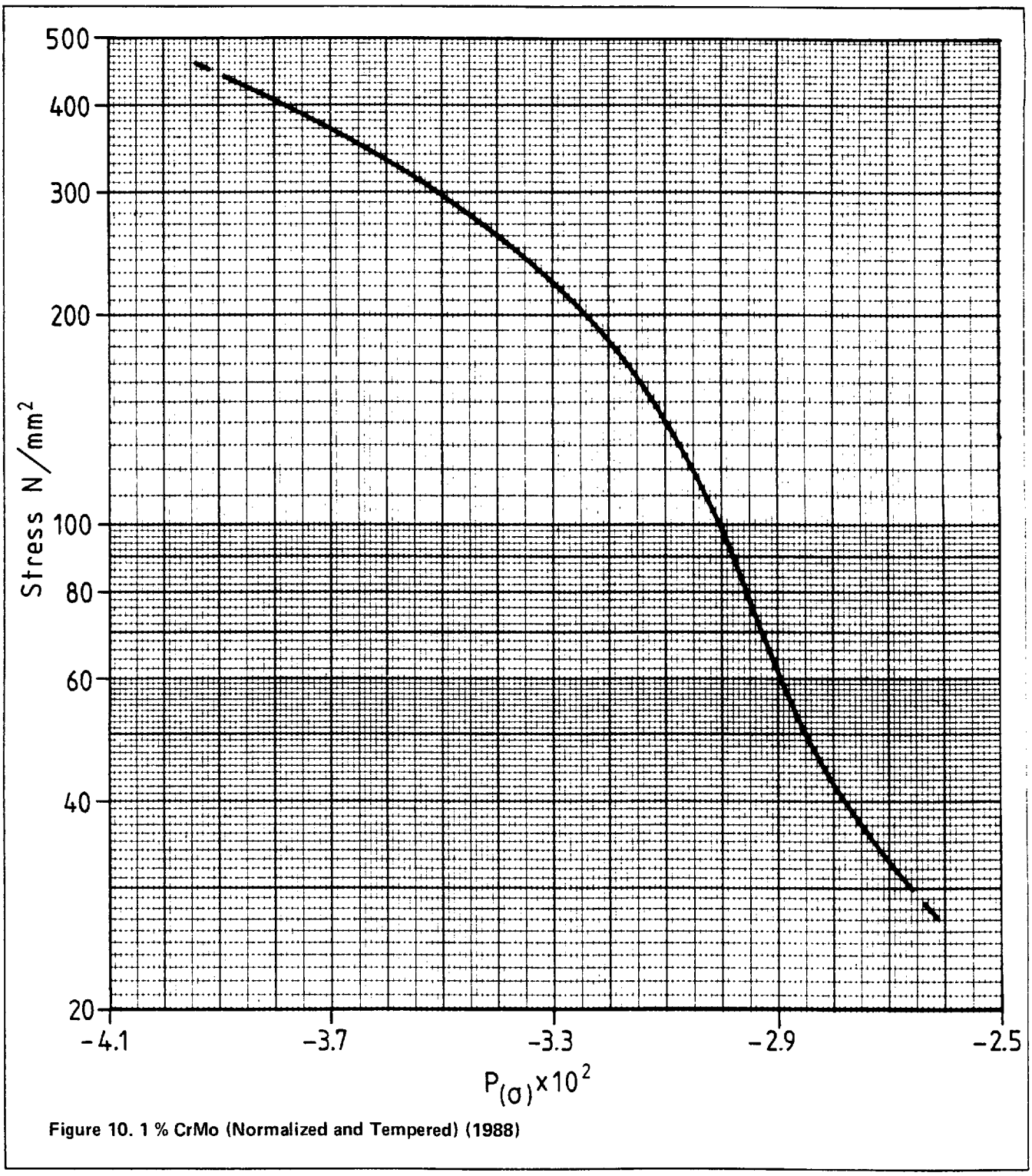

Figure 10. 1 % CrMo (Normalized and Tempered) (1988)

Table 11. 1¼ % CrMo (Normalized and Tempered) (1988) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m*/*m*)	% (*m*/*m*)	% (*m*/*m*)
	C	–	–	0.18
	Si	–	0.15	1.00
	Mn	–	0.30	0.70
	P	–	–	0.040
	S	–	–	0.040
	Cr	–	1.00	1.50
	Mo	–	0.45	0.65
	Ni	–	–	0.30
	Al	–	–	0.020
	Cu	–	–	0.30
	Sn	–	–	0.030
Heat treatment			°C 900 to 960 AC + T 640 minimum	

(b) Quantity and duration of data used in assessment† (see note 3)

Temperature	Test duration						
	h <10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h >100 000
	Number of test points available						
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–

†No assessment was carried out.

(c) Average rupture stresses‡

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
450	373	333	315	290	276	265*	257*
460	343	305	287	262	247	237*	229*
470	315	277	259	235	220	210*	202*
480	287	250	232	208	193	183*	175*
490	261	224	206	181	167	156*	148*
500	238	198	180	155	140	129*	121*
510	210	172	154	129	114	103*	95*
520	185	147	129	103	89	79*	72*
530	160	122	104	80	68*	61*	56*
540	136	97	80	62	53*	49*	46*
550	112	76	62	49	44	41	39
560	88	59	50	42	38	36*	34*
570	69	48	42	36	33	32*	31*
580	55	41	37	32	30	29*	28*
590	46	36	33	29	27	–	–
600	39	32	30	–	–	–	–
610	35	29	27*	–	–	–	–
620	31	–	–	–	–	–	–
630	29	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
‡The rupture stress values are the same as for 1 % CrMo (Norm. + T) (see table 10).

Master curve as for 1 % CrMo (Normalized and Tempered) (1988) (see figure 10).

Figure 11. 1¼ % CrMo (Normalized and Tempered) (1988)

Table 12. 0.4 % C 1¼ % CrMo (1975) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m*/*m*)	% (*m*/*m*)	% (*m*/*m*)
	C	0.36 to 0.44	0.35	0.45
	Si	0.24 to 0.35	0.10	0.35
	Mn	0.51 to 0.64	0.40	0.70
	P	0.013 to 0.036	–	0.035
	S	0.007 to 0.038	–	0.040
	Cr	1.11 to 1.44	1.00	1.50
	Mo	0.51 to 0.70	0.50	0.70
	Ni	0.09 to 0.29	–	0.40
Heat treatment	°C 850 to 880 OQ + T 625 to 680		°C 850 to 900 OQ or WQ + T 600 minimum	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h <10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h >100 000
	Number of test points available						
°C							
450	16(4)	2(2)	1	–	–	–	–
500	91(8)	7(3)	1	–	–	–	–
550	56(6)	3	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses†

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
450	498	464	447*	424*	–	–	–
460	447	406	386*	358*	–	–	–
470	393	344	322*	292*	–	–	–
480	337	284	262*	233*	–	–	–
490	282	231	211*	187*	–	–	–
500	234	189	173*	152*	–	–	–
510	195	157	142*	125*	–	–	–
520	163	130	117*	101*	–	–	–
530	138	108*	95*	–	–	–	–
540	116	(86)*	–	–	–	–	–
550	97	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).
†Values for times exceeding 100 000 h are not available.

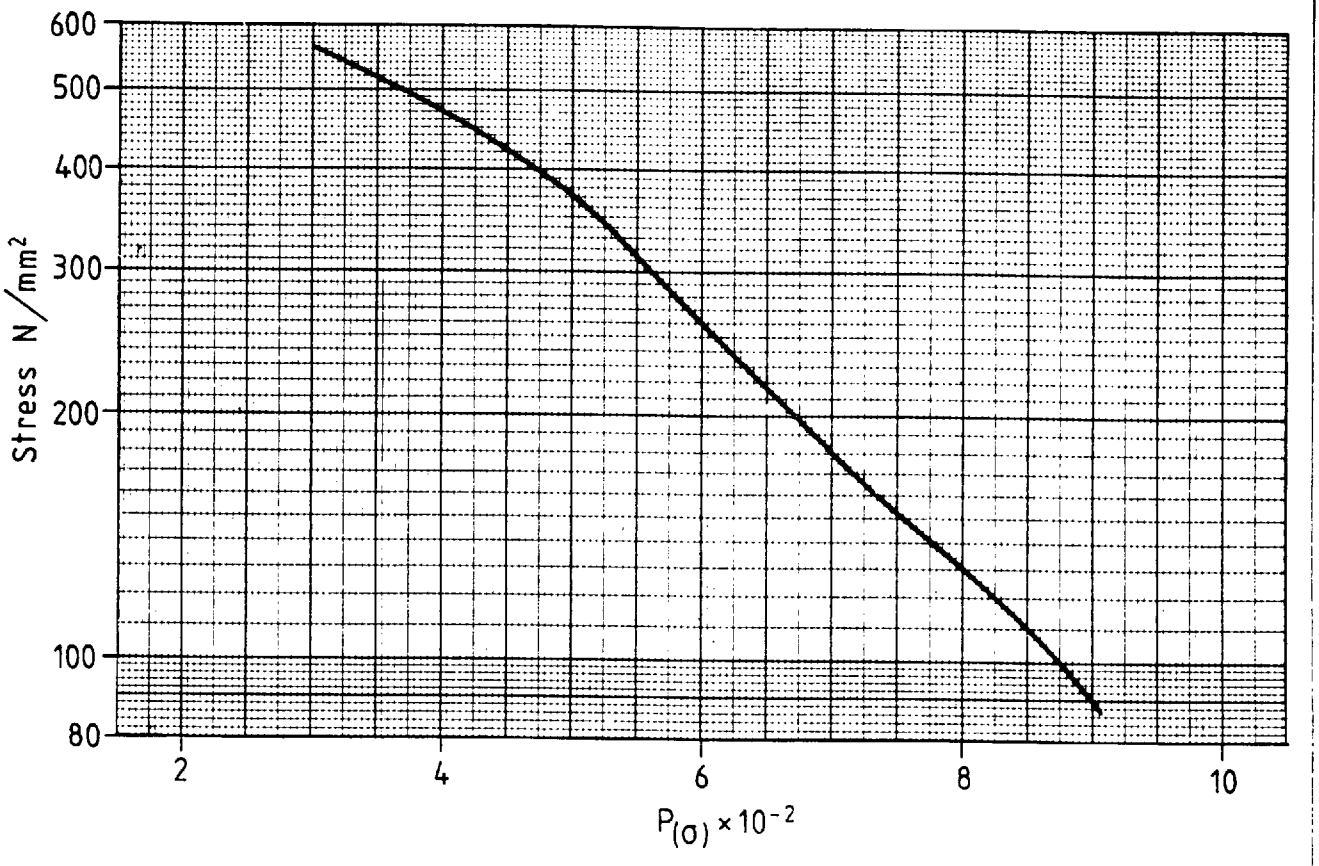

Figure 12. 0.4 % C 1¼ % CrMo (1975)

Table 13. 0.4 % C 1¼ % CrMoV (1979) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.34 to 0.42	0.30	0.45
	Si	0.20 to 0.32	0.10	0.35
	Mn	0.43 to 0.64	0.40	0.70
	P	0.010 to 0.038	–	0.040
	S	0.008 to 0.041	–	0.040
	Cr	1.03 to 1.30	1.00	1.50
	Mo	0.51 to 0.59	0.50	0.70
	V	0.22 to 0.30	0.20	0.30
Heat treatment	°C 940 to 960 OQ + T 680 to 710		°C 930 to 970 OQ + T 650 minimum	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
450	8	–	–	(1)	–	–	–
500	48(4)	7(3)	3(2)	–	–	–	–
550	53(4)	–	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses†

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
450	534	499*	481*	454*	–	–	–
460	489	452*	433*	403*	–	–	–
470	447	407*	385*	352*	–	–	–
480	406	362	337	299*	–	–	–
490	366	316	289	250*	–	–	–
500	324	270	244	210*	–	–	–
510	283	231	208	176*	–	–	–
520	245	199	177	–	–	–	–
530	213	168	–	–	–	–	–
540	186	–	–	–	–	–	–
550	151	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
†Values for times exceeding 100 000 h are not available.

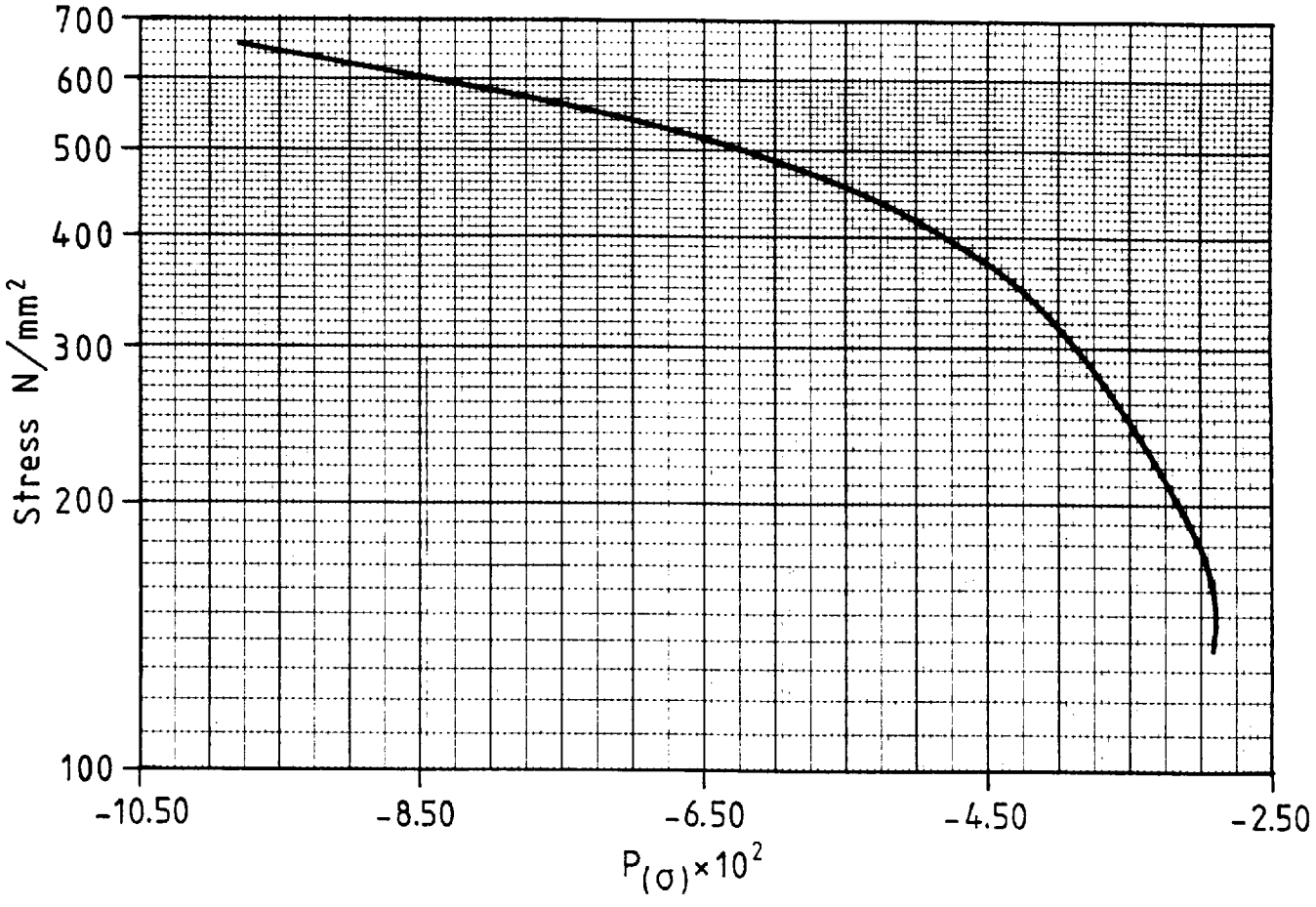

Figure 13. 0.4 % C 1¼ % CrMoV (1979)

Table 14. 1 % CrMoVTiB (1979) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m*/*m*)	% (*m*/*m*)	% (*m*/*m*)
	C	0.18 to 0.24	0.17	0.23
	Si	0.16 to 0.37	0.10	0.35
	Mn	0.35 to 0.60	0.35	0.75
	P	0.009 to 0.030	–	0.020
	S	0.004 to 0.032	–	0.020
	Cr	0.90 to 1.10	0.90	1.20
	Mo	0.88 to 1.05	0.90	1.10
	Ni	0.10 to 0.26	–	0.20
	Al (tot.)	0.024 to 0.076	–	0.08
	As	–	–	0.020
	B	0.0022 to 0.0057	0.001	0.010
	Cu	–	–	0.20
	Sn	–	–	0.020
	Ti	0.044 to 0.13	0.07	0.15
	V	0.58 to 0.77	0.60	0.80
Heat treatment	°C 970 to 1010 OQ or WQ + T 680 to 740		°C 660 to 700 + 970 to 990 OQ or WQ + T 680 to 720	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
500	36(6)	6(4)	1	1	–	–	–
550	176(15)	27(9)	8(4)	5(3)	–	–	–
575	12(9)	2	–	–	–	–	–
600	87(6)	2	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses†

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
490	483	457	443*	423*	–	–	–
500	418	395	383*	364*	–	–	–
510	380	358	345*	323*	–	–	–
520	353	329	313*	282*	–	–	–
530	329	300	277	214	–	–	–
540	306	262	219	178	–	–	–
550	280	210	185	158	–	–	–
560	241	183	166	–	–	–	–
570	203	167	–	–	–	–	–
580	183	150	–	–	–	–	–
590	170	–	–	–	–	–	–
600	157	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
†Values for times exceeding 100 000 h are not available.

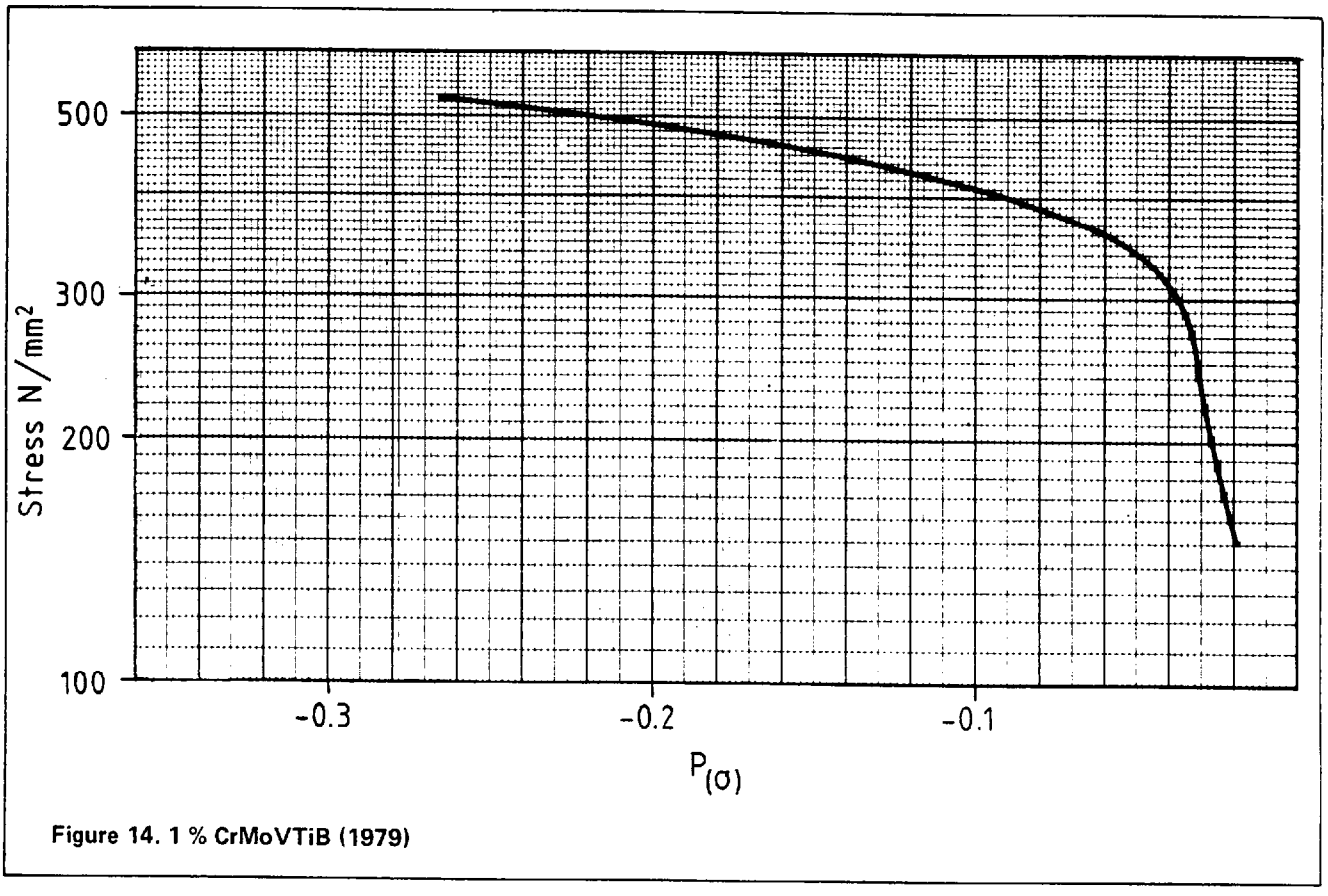

Figure 14. 1 % CrMoVTiB (1979)

Table 15. 2¼ % CrMo (Annealed) (1969) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges† (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.03 to 0.15	–	0.18
	Si	0.07 to 0.50	–	0.50
	Mn	0.29 to 0.63	0.30	0.80
	P	0.005 to 0.026	–	0.040
	S	0.004 to 0.034	–	0.040
	Cr	2.00 to 2.52	2.00	2.50
	Mo	0.84 to 1.13	0.90	1.20
	Al	–	–	0.020
Heat treatment	°C 1. 900 to 1030 AC + T 750 to 775 2. 890 to 980 FC to 500 to 720			

†Not in British Standards. Ranges quoted are for 2¼ % CrMo (Norm. + T ⩽ 750 ° C) (see table 17).

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
500	44	4	–	2(1)	–	–	–
530	22	–	–	–	–	–	–
538	36	1	1	–	–	–	–
550	102	7	5	3(1)	1	–	–
560	27	1	–	–	–	–	–
570	47	9	1	2	–	–	–
575	75	7	4	2(1)	–	–	–
590	22	3	–	–	–	–	–
593	31	3	1	–	–	–	–
600	90	10	7	4	–	–	–
649/650	27	–	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses‡

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
450	(251)	(226)*	211*	196*	193*	186*	181*
460	(236)	211*	197*	182*	177*	170*	165*
470	221	196*	183*	168*	161*	154*	149*
480	206	181	170*	154*	145*	138*	132*
490	191	168	156*	141*	129*	123*	118*
500	177	153	142*	127*	116*	110*	105*
510	162	139	128*	115*	103*	97*	93*
520	147	126	116*	102*	91*	85*	81*
530	133	113	104	90	79*	75*	72*
540	121	101	92	78	71*	66*	63*
550	108	89	81	69	62*	58*	54*
560	96	78	71	59	54*	50*	47*
570	85	70	62	51	46*	43*	40*
580	76	61	54	44*	40*	(37)*	(35)*
590	68	54	47	(38)*	(35)*	–	–
600	61	48	42	–	–	–	–

*Values which have involved extended time extrapolation (see table 4(a)).
( ) Values which have involved extended stress extrapolation (see table 4(b)).
‡Values obtained using non-standard extrapolation method.

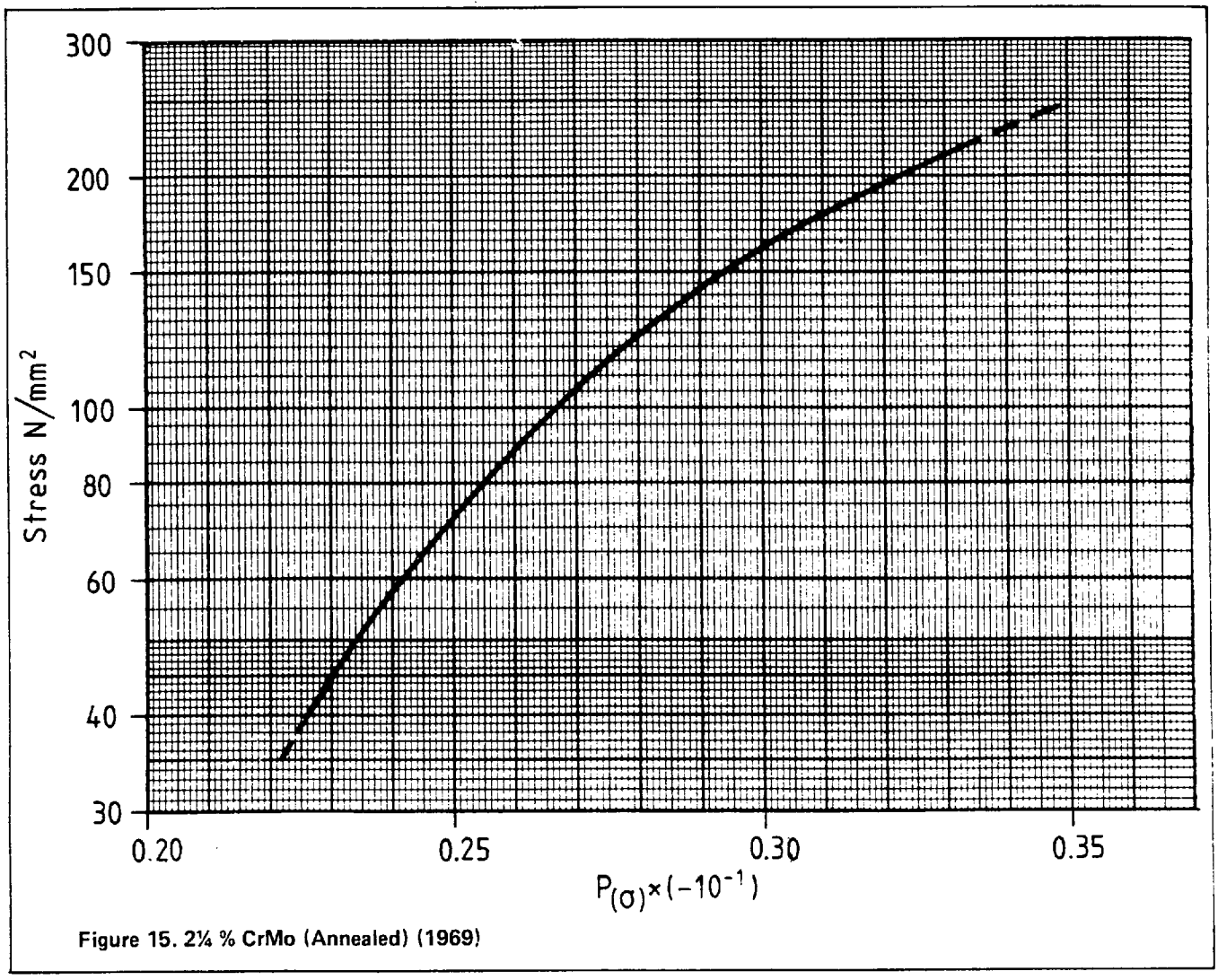

Figure 15. 2¼ % CrMo (Annealed) (1969)

Table 16. 2¼ % CrMo (Normalized and Tempered ≤ 720 °C) (1988) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges† (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.06 to 0.18	–	0.18
	Si	0.11 to 0.49	–	0.50
	Mn	0.33 to 0.80	0.30	0.80
	P	0.006 to 0.030	–	0.040
	S	0.005 to 0.037	–	0.040
	Cr	1.96 to 2.50	2.00	2.50
	Mo	0.87 to 1.12	0.90	1.20
	Ni	0.03 to 0.34	–	0.30
	Al	0.001 to 0.015	–	0.020
	Cu	0.02 to 0.25	–	0.30
	Sn	0.001 to 0.030	–	0.030
Heat treatment	°C 900 to 980 T 650 to 720		°C 900 to 980 + T 630 to 720	

†Not in British Standards. Ranges quoted are for 2¼ % CrMo (Norm. + T ≤ 750 °C) (see table 17).

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
475	15	6	–	4	1	2(3)	1
500	95(8)	18(11)	7(1)	5(2)	2(2)	1	–
525	20(2)	4	5(1)	6	–	2	–
538/540	38	3	1	(1)	–	(1)	–
550	227(20)	45(17)	9(8)	4(4)	–	–	–
565/566	66	4	–	4(3)	2(1)	1	–
575	38(4)	9(1)	3(4)	2(1)	2	2	–
593	20	1	4	1(1)	4	–	–
600	178(14)	22(8)	6(1)	–	–	–	–
625	30(1)	–	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
470	275	249	236	218	207	199	193*
480	251	225	212	194	183	175	169*
490	228	202	190	172	161	152	146*
500	207	181	168	151	140	132	125*
510	188	162	149	131	120	113	107*
520	169	143	130	113	103	97	91*
530	151	126	113	98	89*	82*	78*
540	134	110	99	84	76*	70*	65*
550	119	96	86	72	64	59*	54*
560	105	84	74	61	54	47*	–
570	92	73	64	51	–	–	–
580	82	63	54	–	–	–	–
590	72	54	–	–	–	–	–
600	63	–	–	–	–	–	–
610	54	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).

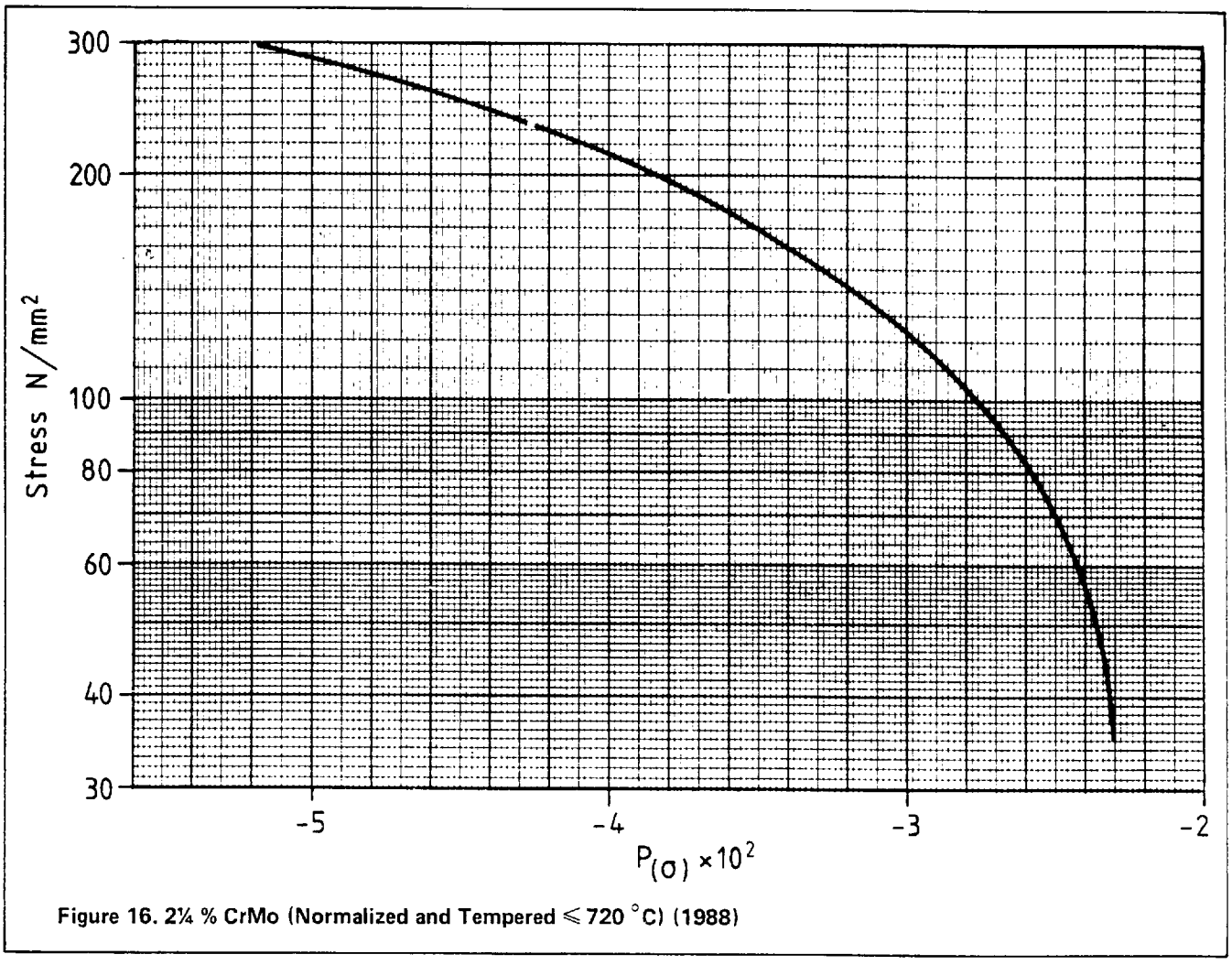

Figure 16. 2¼ % CrMo (Normalized and Tempered ⩽ 720 °C) (1988)

Table 17. 2¼ % CrMo (Normalized and Tempered ⩽ 750 °C) (1988) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m*/*m*)	% (*m*/*m*)	% (*m*/*m*)
	C	0.06 to 0.18	–	0.18
	Si	0.08 to 0.50	–	0.50
	Mn	0.33 to 0.80	0.30	0.80
	P	0.004 to 0.032	–	0.040
	S	0.004 to 0.037	–	0.040
	Cr	1.96 to 2.52	2.00	2.50
	Mo	0.87 to 1.20	0.90	1.20
	Ni	0.007 to 0.34	–	0.30
	Al	0.001 to 0.015	–	0.020
	Cu	0.02 to 0.25	–	0.30
	Sn	0.001 to 0.030	–	0.030
Heat treatment	°C 900 to 980 + T 650 to 750		°C 900 to 980 + T 630 to 750	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
475	20	7(4)	(1)	4	1	2(3)	1
500	223(11)	23(11)	7(1)	6(3)	2(2)	1	–
525	41(3)	6	7(1)	6	1	2	–
538/540	71	3	1	(1)	–	(1)	–
550	477(23)	69(17)	15(8)	6(4)	–	–	–
565/566	66	4	–	4(3)	2(1)	1	–
575	90(10)	15(4)	6(8)	3(1)	2	2	–
593	20	1	4	1(1)	2	–	–
600	316(14)	28(9)	10(2)	(1)	–	–	–
625	41(1)	2	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
470	271	242	229	210	199	191	184*
480	244	217	204	186	175	168	162*
490	220	194	182	165	155	147	141*
500	199	174	162	145	136	129	123*
510	180	156	144	128	119	112	107*
520	162	139	128	112	103	97	91*
530	146	124	113	98	89*	82*	78*
540	131	110	99	84	76*	70*	65*
550	118	96	86	72	64	58*	53*
560	105	84	74	61	52	44*	–
570	92	73	64	49	–	–	–
580	82	63	53	–	–	–	–
590	72	52	–	–	–	–	–
600	63	–	–	–	–	–	–
610	53	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).

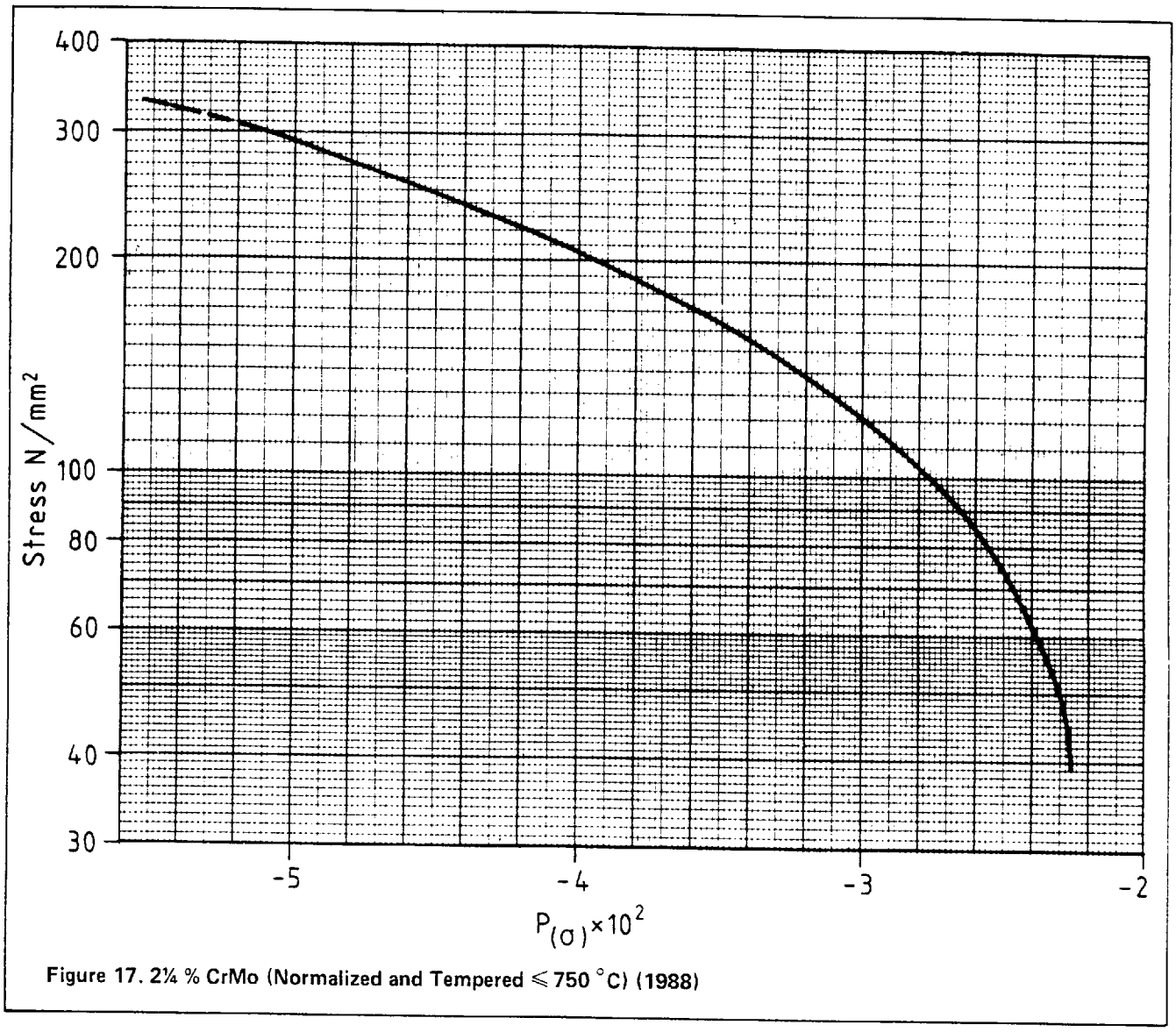

Figure 17. 2¼ % CrMo (Normalized and Tempered ⩽ 750 °C) (1988)

Table 18. 5 % CrMo (Annealed) (1974) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m*/*m*)	% (*m*/*m*)	% (*m*/*m*)
	C	0.06 to 0.14	–	0.15
	Si	0.27 to 1.53	–	0.50
	Mn	0.32 to 0.56	0.30	0.60
	P	0.008 to 0.030	–	0.030
	S	0.005 to 0.021	–	0.030
	Cr	4.31 to 5.44	4.00	6.50
	Mo	0.44 to 0.92	0.45	0.65
Heat treatment	°C 1. 880 to 920 + T 550 to 700 2. 920 3. 920 to 930 isothermal heat treatment 720 4. 900 to 910 FC		°C Annealed 850 to 950	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
500	51(4)	5(7)	2(2)	3(9)	–	–	–
550	57(5)	8(4)	2(7)	(2)	1	–	–
600	85(7)	9(3)	4(3)	–	1	–	–
650	21(1)	–	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
450	196*	172*	162*	146*	136*	130*	126*
460	179*	158*	146*	131*	123*	118*	114*
470	166*	142*	131*	119*	112*	107*	103*
480	151	129	120	109	101*	95*	91*
490	137	117	110	97	89*	84*	81*
500	125	108	99	86	79*	75*	72*
510	115	97	88	77	71*	67*	63*
520	105	86	79	68	63*	59*	56*
530	95	78	70	61*	56*	52*	49*
540	85	70	63	54*	49*	46*	43*
550	77	62	56	48*	43*	40*	38*
560	69	56	50	42*	38*	35*	33*
570	62	50	44	37*	34*	31*	30*
580	56	44	39	33	30*	28*	27*
590	50	39	35	29	27*	(25)*	–
600	45	35	31	(26)	–	–	–
610	40	31	28	–	–	–	–
620	36	28	(25)	–	–	–	–
630	32	(25)*	–	–	–	–	–
640	29	–	–	–	–	–	–
650	(26)	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

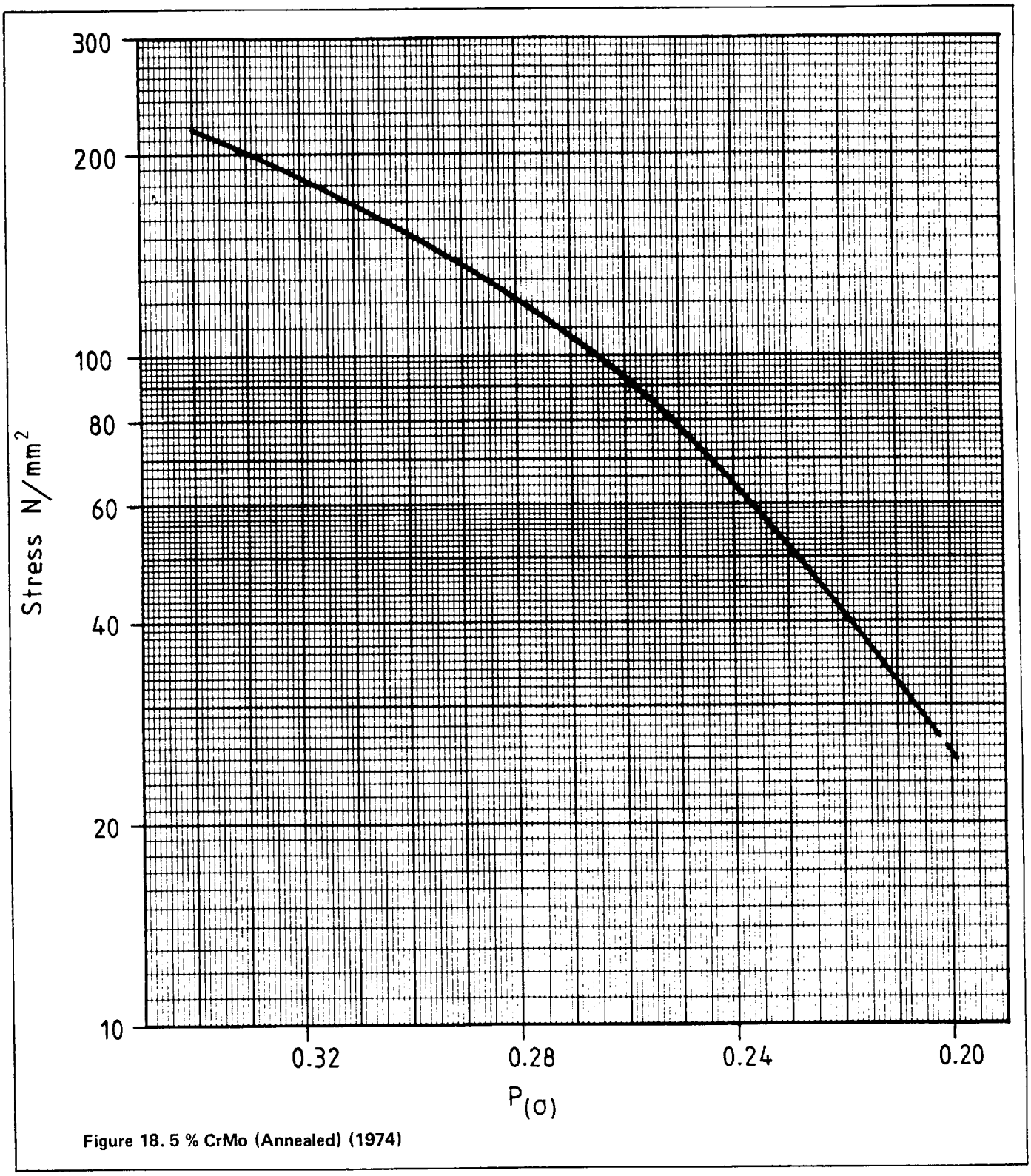

Figure 18. 5 % CrMo (Annealed) (1974)

Table 19. 5 % CrMo (Normalized and Tempered) (1974) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.08 to 0.13	–	0.18
	Si	0.24 to 1.43	0.15	0.50
	Mn	0.26 to 0.49	0.30	0.80
	P	0.011 to 0.025	–	0.040
	S	0.003 to 0.023	–	0.040
	Cr	4.61 to 5.44	4.00	6.00
	Mo	0.44 to 0.58	0.45	0.65
Heat treatment	°C 1. 950 WQ + T 680 2. 900 to 960 AC + T 650 to 760 3. 900 AC 4. 980 OQ + T 730		°C 925 to 975 + T 650 to 775	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
500	34(2)	7(1)	1(1)	(1)	–	–	–
550	84(6)	4(2)	1	–	–	–	–
575	36(1)	2(4)	(2)	–	–	–	–
600	80	9(4)	1(1)	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
450	–	–	–	276*	252*	237*	226*
460	–	273*	247*	218*	202*	192*	183*
470	226	221*	204*	181*	167*	158*	152*
480	220	187	172*	153*	142*	135*	129*
490	190	160	148*	132*	122*	114*	108*
500	164	140	129*	113*	103*	96*	90*
510	145	123	112*	96*	86*	80*	75*
520	129	107	96*	81*	73*	68*	64*
530	114	92	82*	70*	62*	57*	53*
540	100	80	71*	59*	52*	47*	44*
550	88	70	62*	50*	44*	40*	(37)*
560	77	61	53*	43*	(38)*	(36)*	–
570	68	52	45*	(37)*	–	–	–
580	60	45	39*	–	–	–	–
590	53	39	–	–	–	–	–
600	46	(35)	–	–	–	–	–
610	40	–	–	–	–	–	–
620	(36)	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

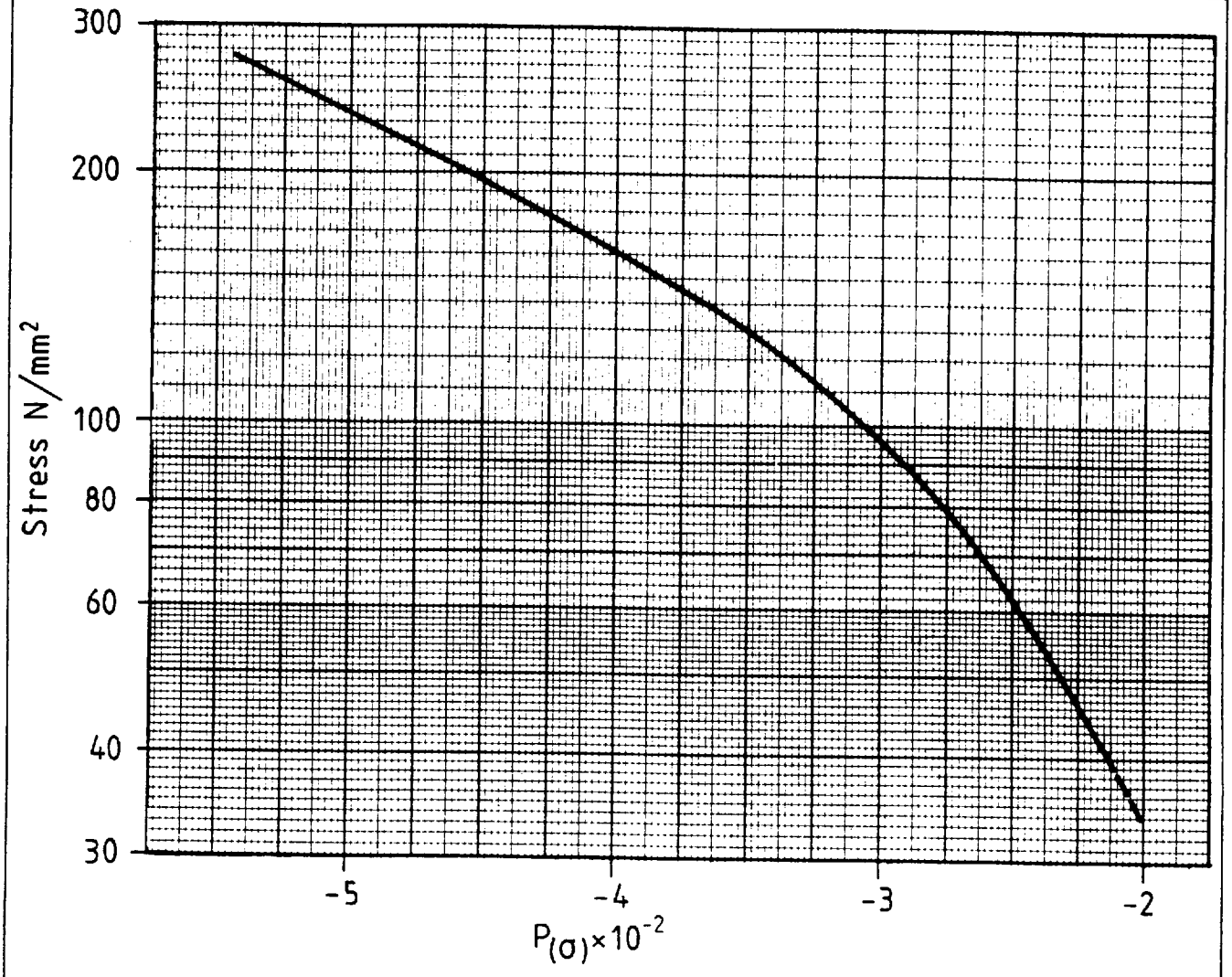

Figure 19. 5 % CrMo (Normalized and Tempered) (1974)

Table 20. 9 % CrMo (annealed) (1974) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.075 to 0.16	–	0.15
	Si	0.22 to 0.61	0.25	1.00
	Mn	0.34 to 0.54	0.30	0.60
	P	0.008 to 0.026	–	0.030
	S	0.006 to 0.034	–	0.030
	Cr	7.60 to 9.85	8.00	10.00
	Mo	0.87 to 1.07	0.90	1.10
	Al	–	–	0.020
Heat treatment	°C 843 to 950 FC		°C 850 to 950 FC	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
500	29(2)	4(2)	–	–	–	–	–
550	34(6)	8(2)	(5)	1(1)	–	–	–
600	77(3)	5(4)	(1)	(1)	–	–	–
650	29	–	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
450	278	255	245*	229*	220*	214*	209*
460	250	228	218*	203*	194*	188*	183*
470	226	204	194*	179*	171*	164*	160*
480	203	182	172*	157*	149*	143*	138*
490	182	161	151*	138*	130*	124*	119*
500	163	143	133*	120*	112*	107*	103*
510	145	126	116*	104*	97*	92*	88*
520	129	110	102*	90*	84*	80*	77*
530	114	97	89	79*	73*	70*	67*
540	101	85	78	69*	64*	61*	59*
550	89	75	69	61*	57*	54*	52*
560	79	67	61	55*	51*	48*	46*
570	71	60	55	49*	45*	43*	41*
580	63	54	49*	44*	40*	38*	36*
590	57	48	44*	39*	36*	–	–
600	52	43	40*	(34)*	(31)*	–	–
610	47	39	35*	–	–	–	–
620	43	35	(31)*	–	–	–	–
630	39	–	–	–	–	–	–
640	35	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

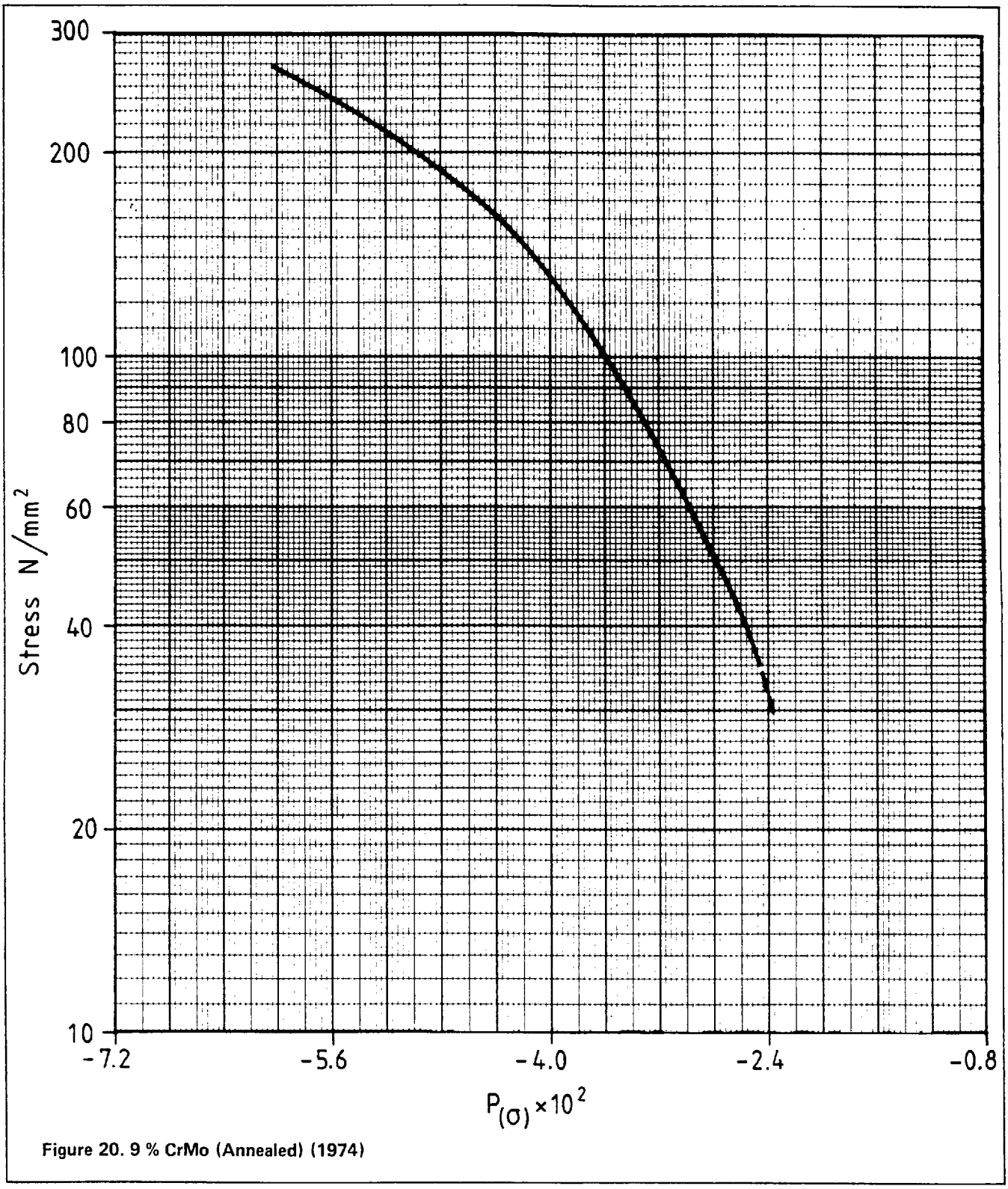

Figure 20. 9 % CrMo (Annealed) (1974)

Table 21. 9 % CrMo (Normalized and Tempered) (1987) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m*/*m*)	% (*m*/*m*)	% (*m*/*m*)
	C	0.06 to 0.14	–	0.15
	Si	0.22 to 0.85	0.25	1.00
	Mn	0.32 to 0.59	0.30	0.60
	P	0.012 to 0.029	–	0.030
	S	0.004 to 0.034	–	0.030
	Cr	8.24 to 9.81	8.0	10.0
	Mo	0.88 to 1.07	0.90	1.10
	Al	–	–	0.020
Heat treatment	°C 900 to 1000 + T 700 to 800		°C 850 to 1000 AC + T 700 to 800	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
475	64	10(11)	5(3)	3(3)	1	1	2(3)
500	147(3)	20(11)	3(5)	(5)	(1)	–	–
525	75(1)	18(3)	7(7)	2(4)	5(1)	3	1(2)
550	156(5)	16(9)	3(11)	3(9)	(1)	–	–
575	49(1)	15(4)	6	5(3)	3	1	1(1)
600	185(2)	21(1)	2(2)	–	–	–	–
625	45(2)	8	1	–	1	–	–
650	67(1)	7	5	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
430	–	(418)	(402)	(381)	369*	360*	354*
440	(404)	373	359	340	329*	321*	315*
450	364	335	322	304	294	286	281*
460	329	302	290	273	263	256	251*
470	298	273	261	245	236	229	224*
480	270	246	235	220	211	205	200*
490	245	222	212	198	189	183	179*
500	222	201	191	177	169	163	159*
510	202	181	171	158	150	144	140*
520	183	163	153	140	133	127	123*
530	165	146	136	124	116	111	106*
540	149	130	120	108	100	95	91*
550	133	114	103	93	85	80	76*
560	119	100	91	78	71	66*	62*
570	104	86	77	65	58	53*	50*
580	91	73	64	53	47	43*	41*
590	78	60	53	43	39	36*	34*
600	66	50	43	36	33	31*	29*
610	55	41	36	31*	28*	27*	26*
620	46	35	31	27*	25*	(24)*	(23)*
630	38	30	27	(24)*	(23)*	–	–
640	33	27	25	(22)*	–	–	–
650	29	(24)	(23)	–	–	–	–
660	26	(22)	–	–	–	–	–
670	(24)	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

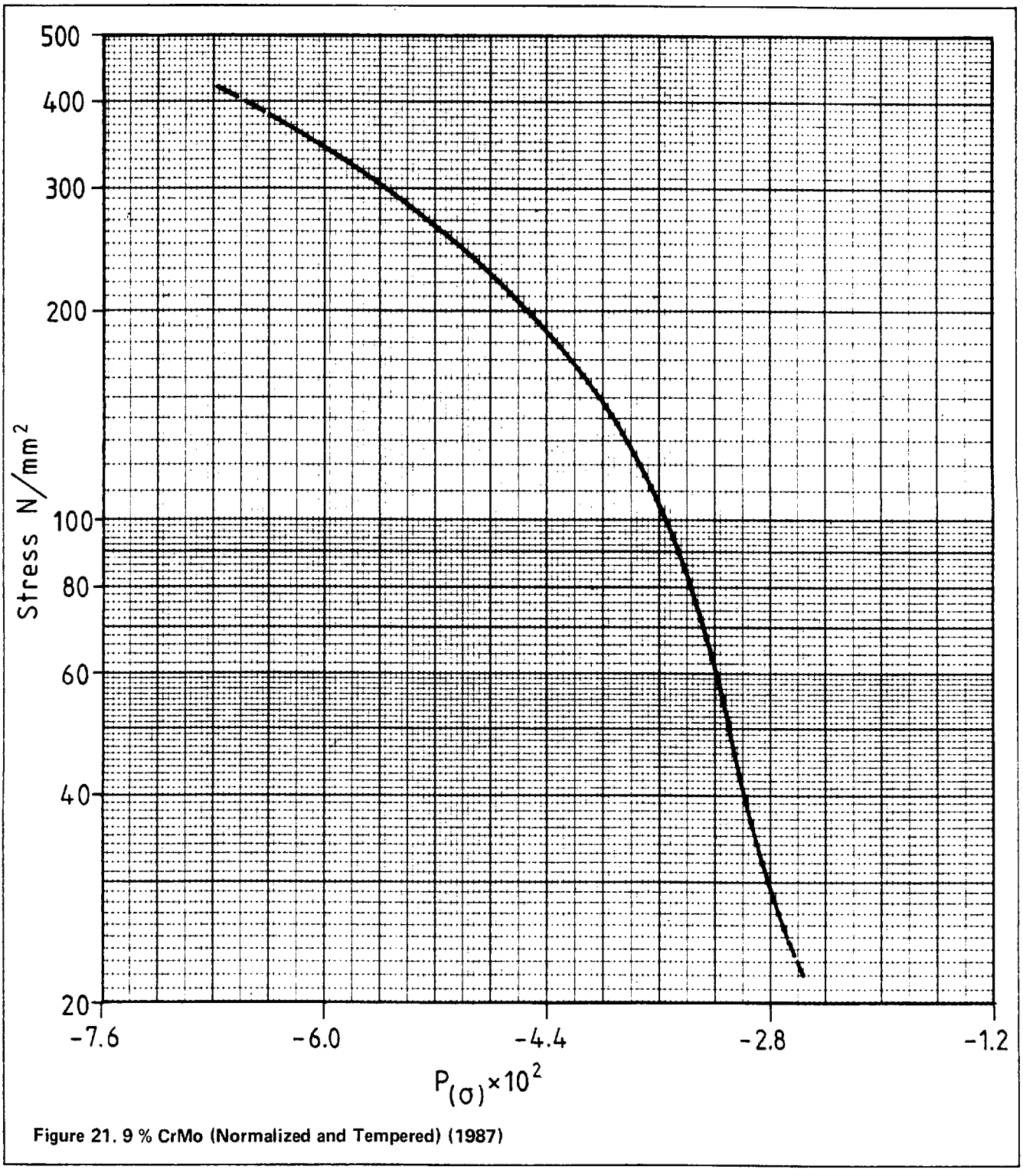

Figure 21. 9 % CrMo (Normalized and Tempered) (1987)

Table 22. 12 % CrMoV (R_m 690 N/mm² to 840 N/mm²) (1988) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.15 to 0.24	0.17	0.23
	Si	0.08 to 0.54	0.15	0.40
	Mn	0.41 to 0.92	0.30	1.00
	P	0.005 to 0.047	–	0.040
	S	0.002 to 0.024	–	0.040
	Cr	10.40 to 12.60	11.00	12.50
	Mo	0.89 to 1.24	0.70	1.20
	Ni	0.31 to 0.74	0.30	0.80
	V	0.21 to 0.38	0.20	0.35
Heat treatment	°C 1020 to 1070 + T 680 to 780		°C 1020 to 1070 + T 680 to 780	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
500	51(1)	10(1)	3	2(5)	–	(1)	–
525	17	–	2	3	1	1	1
550	213(4)	45(7)	25(3)	5(3)	1(1)	1(3)	–
575	93	11(1)	1	7(2)	2	1(1)	–
600	280(3)	60(2)	14(4)	4(4)	3(3)	–	–
625	86	12(1)	3	(3)	–	(2)	–
650	112(2)	5(1)	3	1	–	1	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
480	350	324	311	294	284*	277*	271*
490	319	293	281	265	255*	247*	242*
500	290	265	254	237	228*	221*	215*
510	264	240	228	212	203*	196*	190*
520	240	216	205	189	179*	172*	167*
530	217	194	183	167	157	151*	145*
540	196	173	162	146	137	130*	125*
550	176	153	142	127	118	112*	107*
560	157	135	124	109	101	95*	90*
570	139	117	107	93	86	80*	76*
580	123	102	92	80	73	68*	65*
590	107	88	79	68	62	58*	56*
600	93	75	68	59	54	50*	48*
610	81	65	59	51	46	44*	41*
620	71	57	51	44	40	38*	36*
630	62	50	45	38	35*	32*	30*
640	54	44	39	33	30*	–	–
650	48	38	34	28	–	–	–
660	42	33	29	–	–	–	–
670	37	29	–	–	–	–	–
680	33	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).

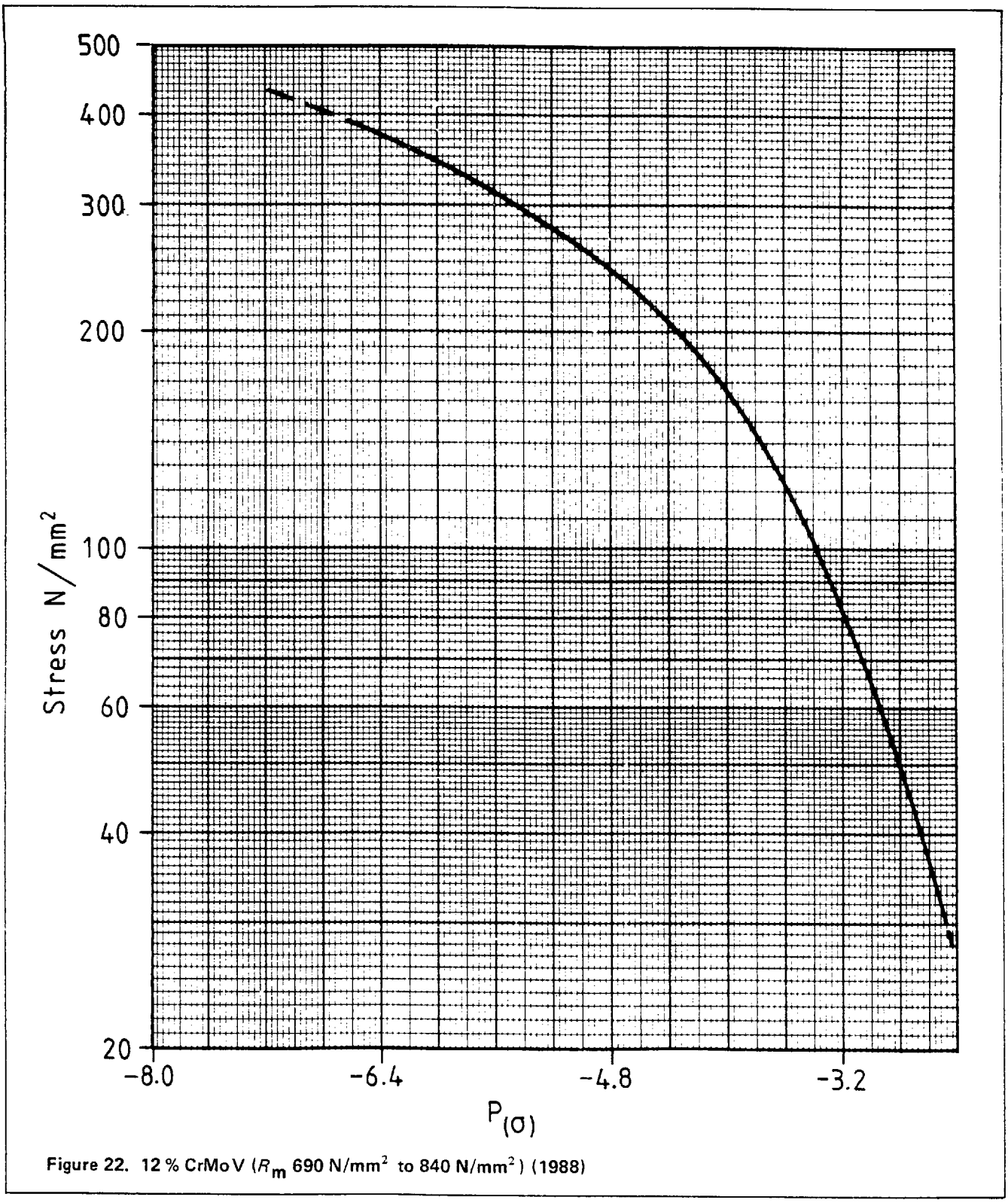

Figure 22. 12 % CrMoV (R_m 690 N/mm² to 840 N/mm²) (1988)

Table 23. 18 % Cr 8 % Ni (1987) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.03 to 0.10	0.04	0.10
	Si	0.18 to 0.84	–	1.00
	Mn	0.28 to 1.86	–	2.00
	P	0.008 to 0.048	–	0.045
	S	0.004 to 0.031	–	0.030
	Cr	17.42 to 19.20	17.0	19.0
	Ni	8.04 to 11.98	8.0	12.0
	Nb	0.001 to 0.085	–	0.05
Heat treatment	°C 1000 to 1121		°C 950 to 1125	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
550	38(2)	3(1)	1(1)	1(1)	2	1	–
600	164(2)	10(3)	2	5(1)	5	1(1)	–
649/650	273(3)	26	8(3)	6(2)	3	–	–
700/704	132	12(2)	6	2	–	–	–
732	18	1	1	1	–	–	–
750	19	4	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
550	186	165	155	143	136*	131*	127*
560	174	154	145	133	127*	122*	118*
570	163	144	136	124	118*	113*	110*
580	153	135	126	116	109	105*	102*
590	144	126	118	107	101	97*	94*
600	134	117	110	99	94	90*	86*
610	126	109	102	92	86	82*	79*
620	117	101	94	85	79	75*	72*
630	109	94	87	78	72*	69*	66*
640	102	87	80	71	66*	63*	60*
650	94	80	73	65	60*	57*	55*
660	87	73	67	59	55*	52*	50*
670	81	67	62	54	51*	48*	46*
680	74	62	56	50*	47*	44*	43*
690	68	56	52	46*	43*	41*	40*
700	63	52	48	43*	40*	39*	38*
710	56	48	44	40*	38*	36*	–
720	53	44	41	37*	–	–	–
730	49	41	39	–	–	–	–
740	45	39	36	–	–	–	–
750	42	37	–	–	–	–	–
760	39	–	–	–	–	–	–
770	37	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).

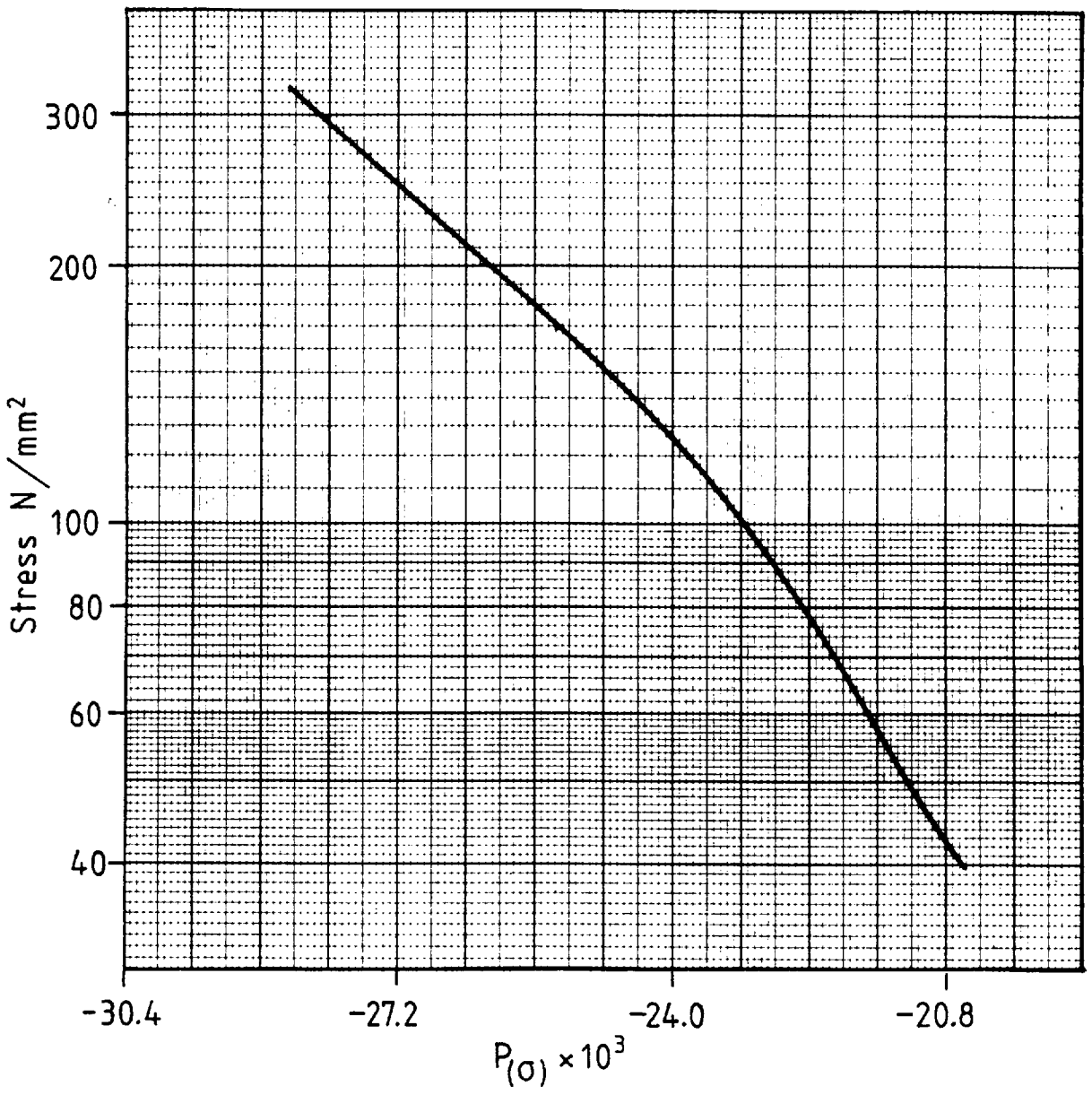

Figure 23. 18 % Cr 8 % Ni (1987)

Table 24. 18 % Cr 8 % NiN (1974) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.02 to 0.062	–	0.07
	Si	0.36 to 0.53	–	1.0
	Mn	1.06 to 1.62	–	2.0
	P	0.008 to 0.026	–	0.045
	S	0.008 to 0.020	–	0.030
	Cr	18.34 to 18.92	17.0	19.0
	Ni	9.92 to 10.61	8.0	12.0
	N	0.17 to 0.25	0.12	0.25
Heat treatment	°C 1050 to 1120		°C 1000 to 1100	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
550	22(1)	2	1(1)	1(3)	(2)	–	–
600	27(2)	4	2(2)	1(4)	–	–	–
650	25	5(1)	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
500	308	270*	252*	230*	216*	207*	200*
510	288	252*	236*	214*	201*	192*	185*
520	270	236*	220*	199*	187*	179*	172*
530	254	221	206	186	174*	166*	159*
540	239	207	193	173	162*	154*	147*
550	225	195	180	161	150*	142*	136*
560	212	182	169	150	139*	131*	124*
570	199	171	158	139	128*	120*	113*
580	188	160	147	129	117*	108*	(101)*
590	177	150	137	118	106*	–	–
600	167	140	127	107	(94)*	–	–
610	157	130	117	(96)	–	–	–
620	147	120	106	–	–	–	–
630	138	110	(96)	–	–	–	–
640	129	(100)	–	–	–	–	–
650	120	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

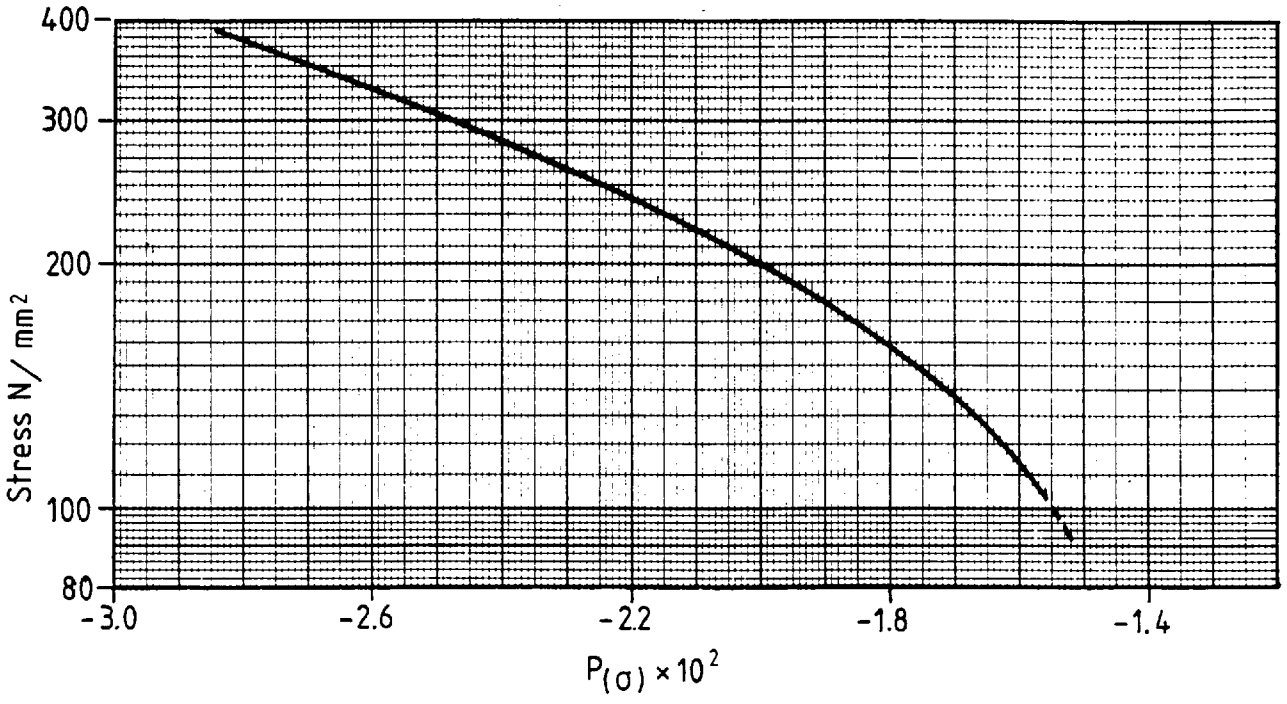

Figure 24. 18 % Cr 8 % NiN (1974)

Table 25. 18 % Cr 12 % NiMo (1982) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.020 to 0.070	–	0.10
	Si	0.25 to 0.70	–	1.0
	Mn	0.30 to 2.08	–	2.0
	P	0.016 to 0.035	–	0.045
	S	0.006 to 0.035	–	0.030
	Cr	16.42 to 17.90	16.0	18.5
	Mo	2.05 to 2.94	2.0	3.0
	Ni	10.35 to 14.52	10.0	15.0
	B	0.0001 to 0.001	–	0.001
Heat treatment	°C 1. 1050 to 1150 AC 2. 1000 to 1100 Q 3. 1050 to 1150 4. 1050 AC + T 750 to 850		°C 1000 to 1120	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
550	31	4(1)	2(1)	1(1)	(1)	(1)	–
600	173(8)	28(2)	6(2)	10	4	7(2)	–
650	250(19)	36(3)	5(2)	8(2)	–	2(1)	–
700	144(6)	18(11)	4(2)	2	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
540	247	222	210	194*	185*	178*	173*
550	233	208	197	181*	172*	164*	159*
560	220	195	183	167*	158*	151*	146*
570	206	181	170	154*	145*	138*	133*
580	193	168	157	141	132	125	120*
590	180	155	144	128	120	113	108*
600	167	143	132	116	108	102	97*
610	155	131	120	105	97	91	87*
620	142	119	108	94	86	81	77*
630	130	107	97	84	77*	72*	69*
640	119	97	87	75	69*	65*	61*
650	108	87	78	67	61*	58*	55*
660	97	78	70	60	55*	52*	50*
670	87	69	62	54	50*	47*	(45)*
680	78	62	56	49*	(45)*	(43)*	–
690	70	56	51	(44)*	–	–	–
700	63	51	46	–	–	–	–
710	57	46	(42)	–	–	–	–
720	52	(42)	–	–	–	–	–
730	47	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

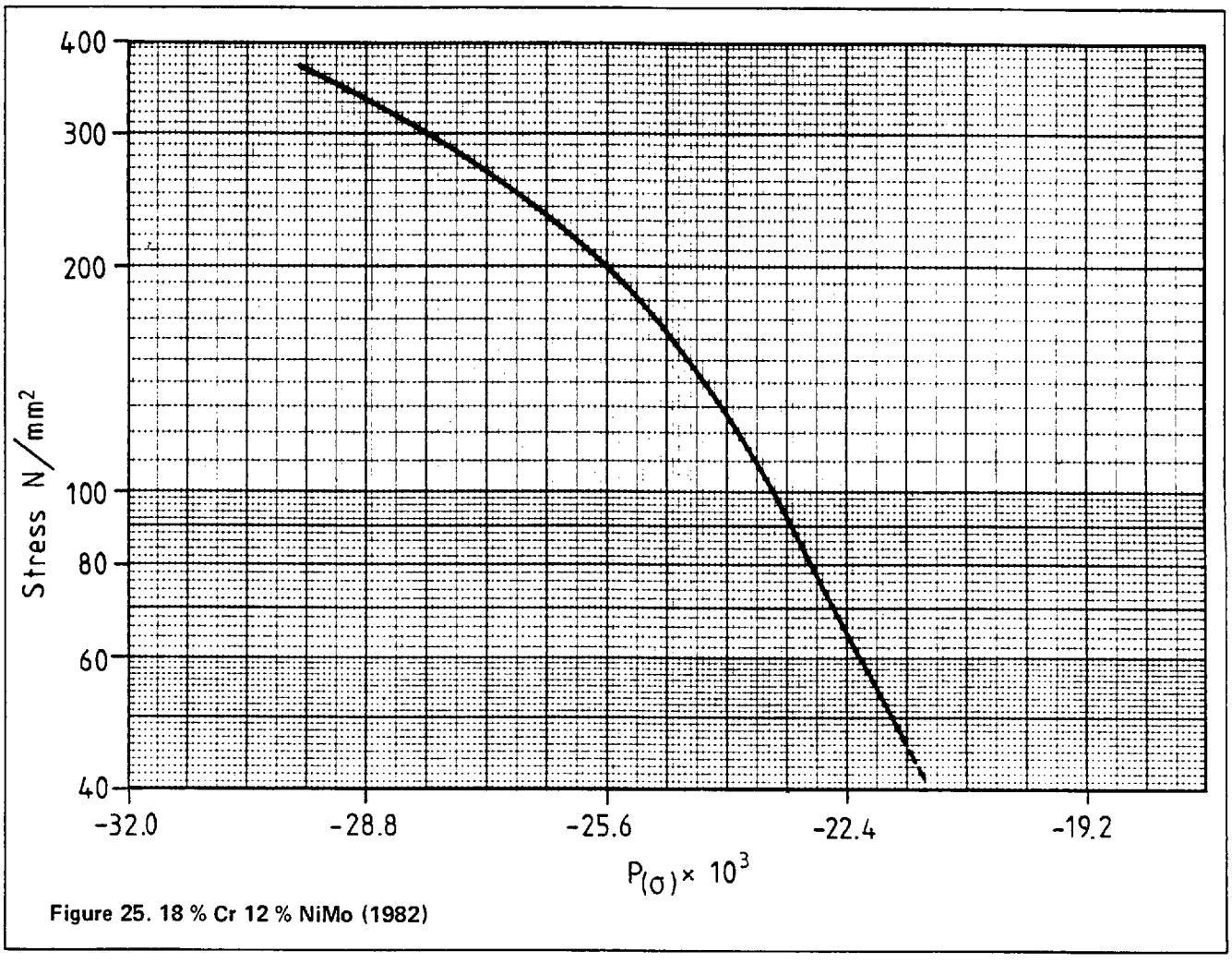

Figure 25. 18 % Cr 12 % NiMo (1982)

Table 26. 18 % Cr 12 % NiMoB (1982) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m*/*m*)	% (*m*/*m*)	% (*m*/*m*)
	C	0.030 to 0.10	–	0.10
	Si	0.06 to 0.71	–	1.0
	Mn	0.61 to 1.78	–	2.0
	P	0.012 to 0.031	–	0.045
	S	0.005 to 0.027	–	0.030
	Cr	15.80 to 18.00	16.0	18.5
	Mo	2.00 to 2.80	2.0	3.0
	Ni	10.13 to 13.70	10.0	15.0
	B	0.0011 to 0.006	0.002	0.006
Heat treatment	°C 1. ST 1060 to 1180 2. 1050 to 1100 AC 3. 1050 to 1130 Q		°C 1000 to 1100	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
550	47	6	3(1)	2	–	(1)	–
600	131	21(4)	23(2)	16(1)	6(4)	3(3)	1(1)
650	219(4)	45(1)	33	8(2)	7(5)	1(1)	(2)
700	127	17	4	2	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
540	268	239	227	211*	201*	195*	190*
550	251	225	213	197*	188*	181*	176*
560	236	211	199	184*	175*	169*	164*
570	222	197	186	171*	162*	156*	151*
580	208	184	173	159	150	144	139*
590	195	172	161	146	138	131	126*
600	183	160	149	134	125	119	114*
610	171	148	137	122	113	106	101*
620	159	136	125	110	101	94	90*
630	147	124	113	98	89	83	79*
640	135	112	101	86	79	74	71*
650	124	100	90	76	70	66	64*
660	112	89	79	69	64	61	59*
670	101	79	71	63	59	57	(55)*
680	90	71	64	57	(54)	(53)*	(51)*
690	80	64	59	(54)*	(51)*	–	–
700	71	59	(55)	(51)	–	–	–
710	65	(55)	(52)	–	–	–	–
720	60	(52)	–	–	–	–	–
730	56	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

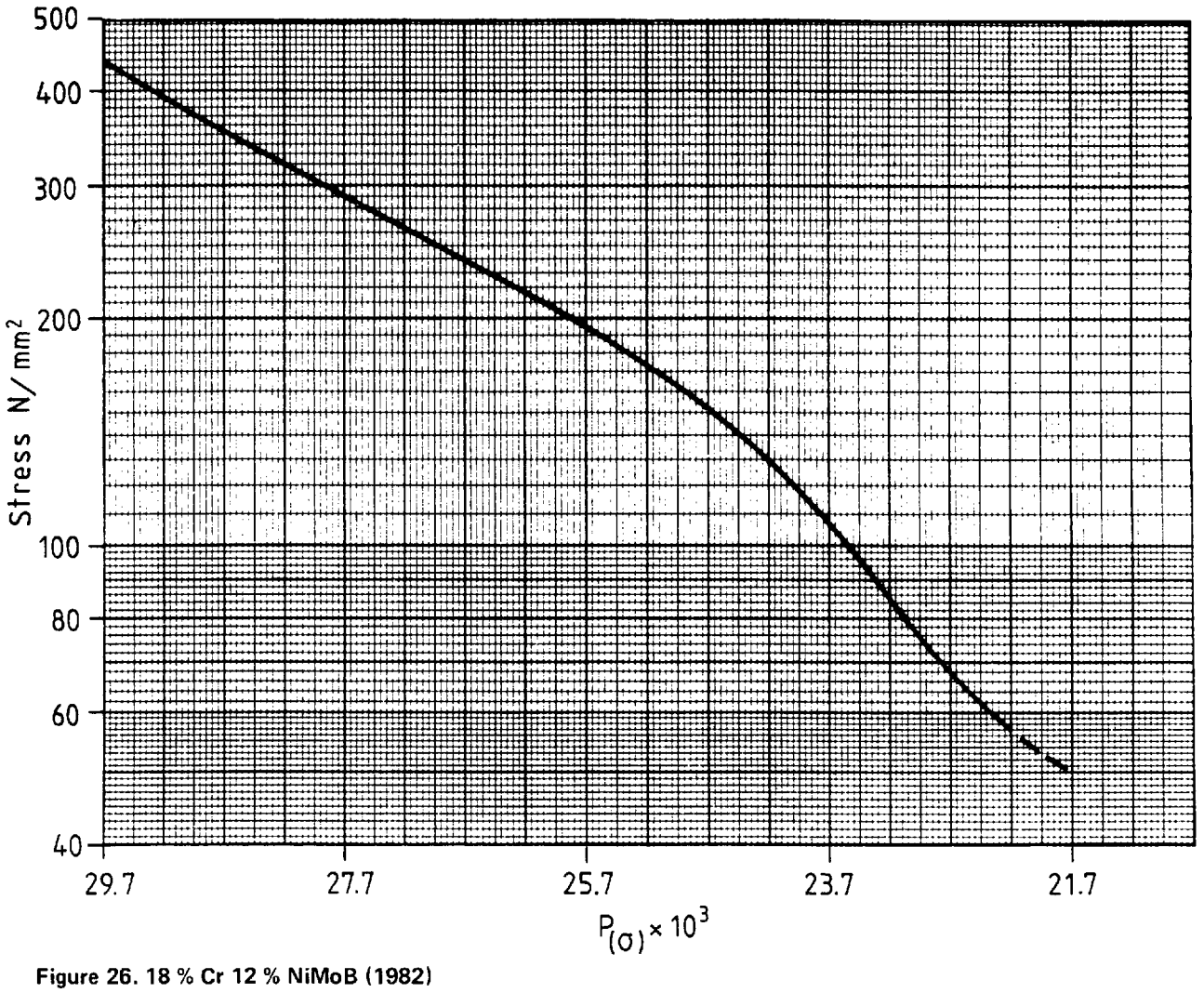

Figure 26. 18 % Cr 12 % NiMoB (1982)

Table 27. 18 % Cr 12 % NiMoN (1974) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.02 to 0.06	–	0.07
	Si	0.29 to 0.50	–	1.0
	Mn	1.34 to 2.86	–	2.0
	P	0.009 to 0.026	–	0.045
	S	0.007 to 0.021	–	0.030
	Cr	16.00 to 17.55	16.5	19.0
	Mo	2.25 to 2.87	2.0	3.0
	Ni	9.35 to 12.66	10.0	14.5
	N	0.107 to 0.290	0.12	0.22
Heat treatment	°C 1050 to 1120 AC		°C 1000 to 1120	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
550	20(1)	4	2(2)	–	(3)	–	–
600	25(2)	7(2)	4	(1)	(1)	–	–
650	43	8	5(2)	1(4)	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
530	349	325	315*	302*	295*	289*	285*
540	329	306	297*	284*	277*	271*	268*
550	311	289	279*	267*	259*	254*	250*
560	294	272	263*	250*	243*	238*	234*
570	278	256	247*	234*	227*	221*	217*
580	262	241	231	218*	211*	205*	201*
590	247	226	216	202*	194*	189*	184*
600	233	211	200	186*	178*	172*	167*
610	218	196	185	170*	160*	154*	148*
620	204	180	169	152*	141*	133*	127*
630	189	164	151	132	(120)*	–	–
640	175	146	132	–	–	–	–
650	159	127	–	–	–	–	–
660	142	–	–	–	–	–	–
670	122	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

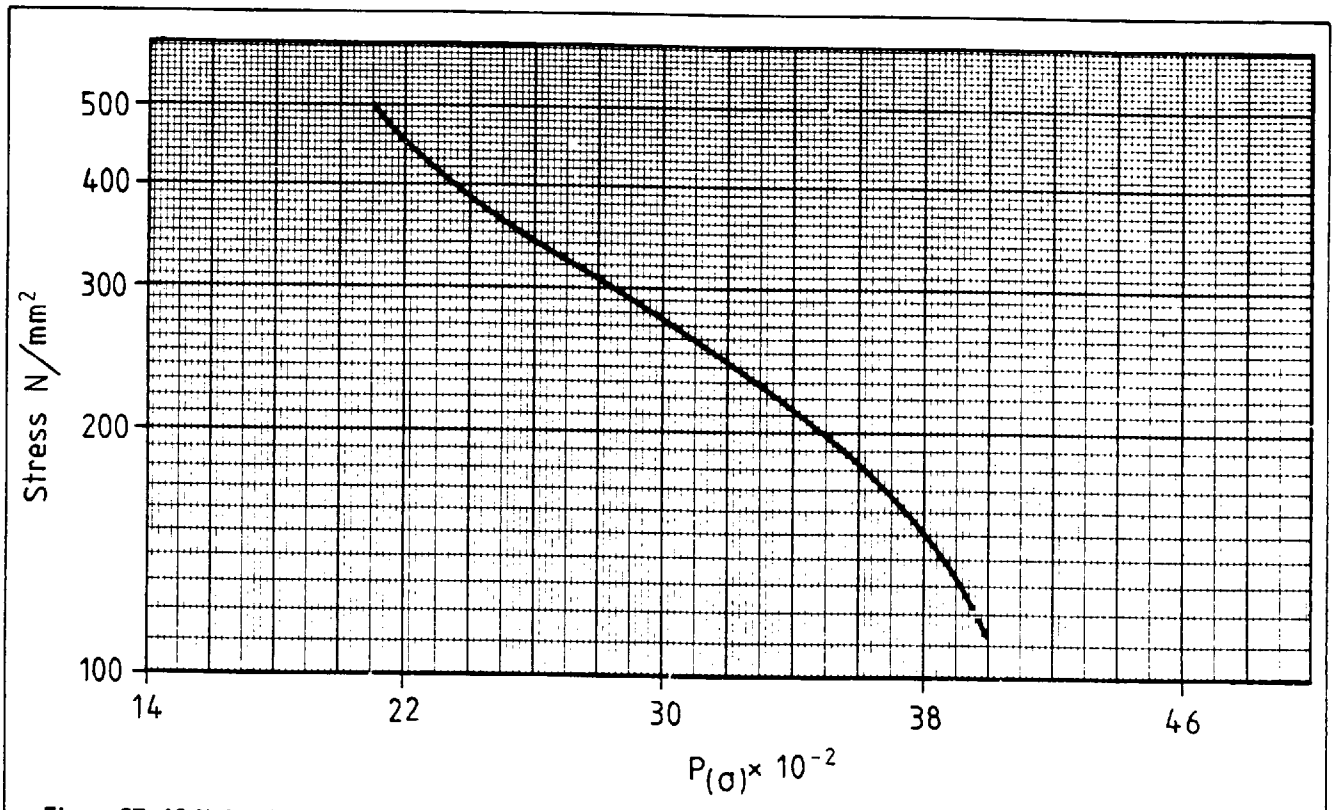

Figure 27. 18 % Cr 12 % NiMoN (1974)

Table 28. 18 % Cr 10 % NiTi (Heat treatment 950 °C to 1070 °C) (1987) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.033 to 0.10	0.04	0.10
	Si	0.076 to 1.15	–	1.00
	Mn	0.21 to 1.79	–	2.00
	P	0.009 to 0.041	–	0.045
	S	0.005 to 0.032	–	0.030
	Cr	17.06 to 18.60	17.0	19.0
	Ni	8.90 to 12.69	9.0	13.0
	Ti	0.21 to 0.62	4 X % C	0.80
Heat treatment	°C 950 to 1070		°C 950 to 1070	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
550	21(2)	–	1(1)	–	–	–	–
600	128	19	4	2	(1)	–	–
625	20	6	(2)	–	–	–	–
649/650	192(3)	10(4)	2	–	–	–	–
700/704	81	5	2	(3)	1	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
540	222	189	174*	154*	143*	136*	130*
550	206	174	160*	142*	131*	123*	118*
560	192	161	147*	129*	119*	112*	107*
570	178	148	135*	118*	108*	101*	96*
580	165	136	124	107*	97*	91*	86*
590	152	125	112	96*	87*	81*	76*
600	140	114	102	86*	78*	72*	67*
610	129	103	92	77*	69*	63*	59*
620	118	93	82	68*	61*	55*	51*
630	108	84	73	60*	53*	48*	45*
640	98	75	65	53*	46*	42*	39*
650	88	67	57	46*	40*	36*	34*
660	79	59	50	40*	35*	32*	30*
670	71	52	44	35*	31*	(28)*	(26)*
680	63	45	38*	31*	(27)*	–	–
690	56	39	34*	(27)*	–	–	–
700	49	35	29*	–	–	–	–
710	43	30	(26)*	–	–	–	–
720	38	(27)	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

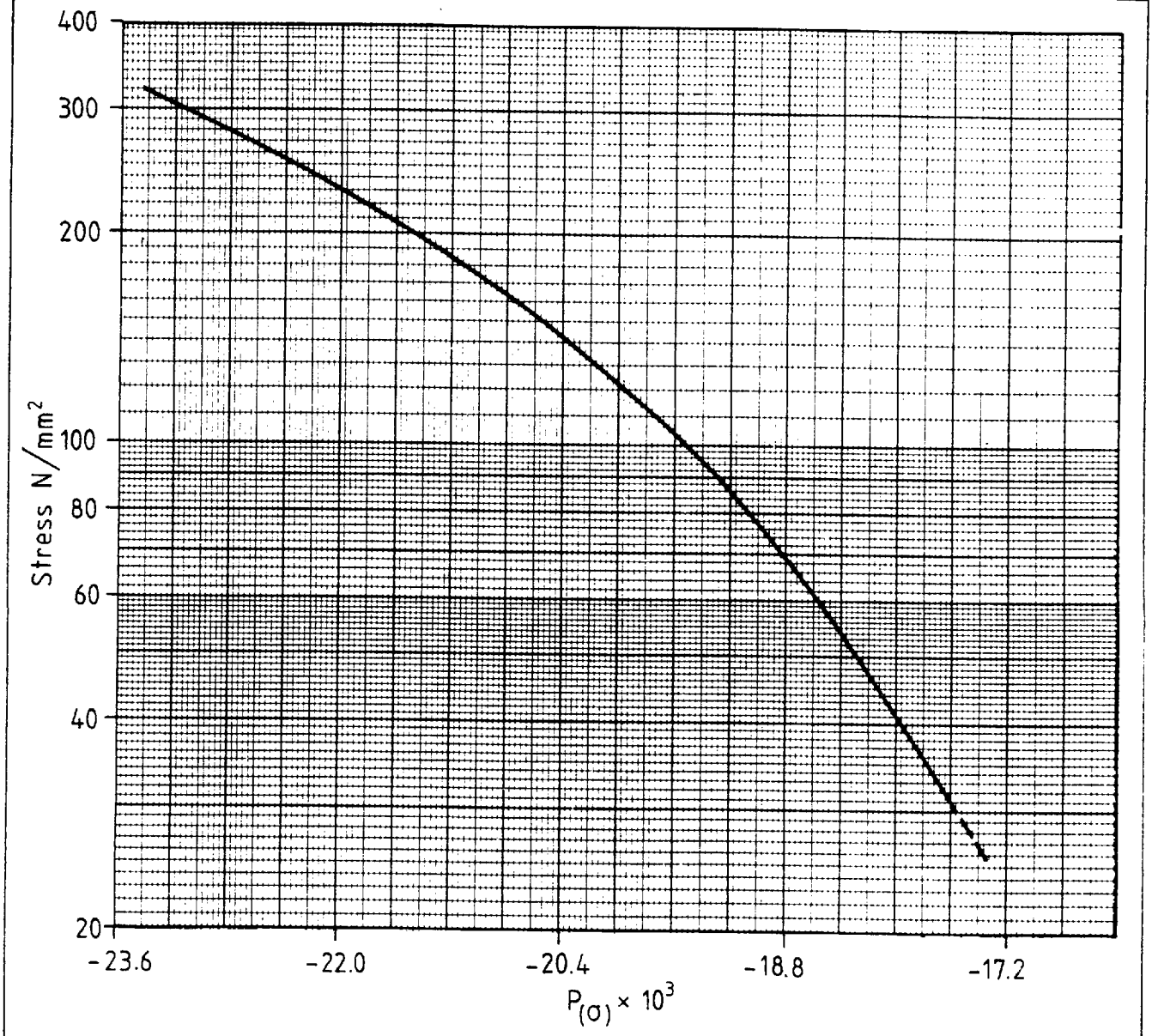

Figure 28. 18 % Cr 10 % NiTi (Heat treatment 950 °C to 1070 °C) (1987)

Table 29. 18 % Cr 10 % NiTi (Heat treatment 1070 °C to 1140 °C) (1987) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.03 to 0.106	0.04	0.10
	Si	0.30 to 1.02	–	1.00
	Mn	0.34 to 1.96	–	2.00
	P	0.007 to 0.033	–	0.045
	S	0.003 to 0.032	–	0.030
	Cr	16.99 to 19.00	17.0	19.0
	Ni	9.00 to 12.89	9.0	13.0
	Ti	0.25 to 0.64	4 × % C	0.80
Heat treatment	°C 1070 to 1140		°C 1070 to 1140	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
550	35(7)	9(1)	3	2	3	1	1
600	211(2)	37(1)	21	16	8	1(1)	1
625	25	1	1	1(1)	–	–	–
649/650	433(6)	32(2)	21	5	3	4(1)	–
700/704	129(1)	7(1)	7	3(6)	3(2)	1(2)	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
540	237	212	201	185	176	170*	165*
550	223	198	186	170	160	154*	149*
560	210	183	171	155	146	139*	134*
570	196	169	157	140	131	125*	120*
580	182	155	142	127	118	112*	108*
590	169	141	129	114	106	100*	97*
600	156	128	117	102	95	90*	87*
610	143	116	105	92	86	81*	78*
620	130	105	95	83	78	74*	71*
630	119	95	86	76	71	67	65*
640	108	86	78	69	65	62	60*
650	98	79	72	64	60	57	55*
660	90	72	66	59	55	53	51*
670	82	67	61	54	51	49	48*
680	75	61	56	51	48	(46)*	(45)*
690	70	57	53	48	(45)	(43)*	–
700	65	53	49	(45)	–	–	–
710	60	50	(46)	–	–	–	–
720	56	(47)	(44)	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

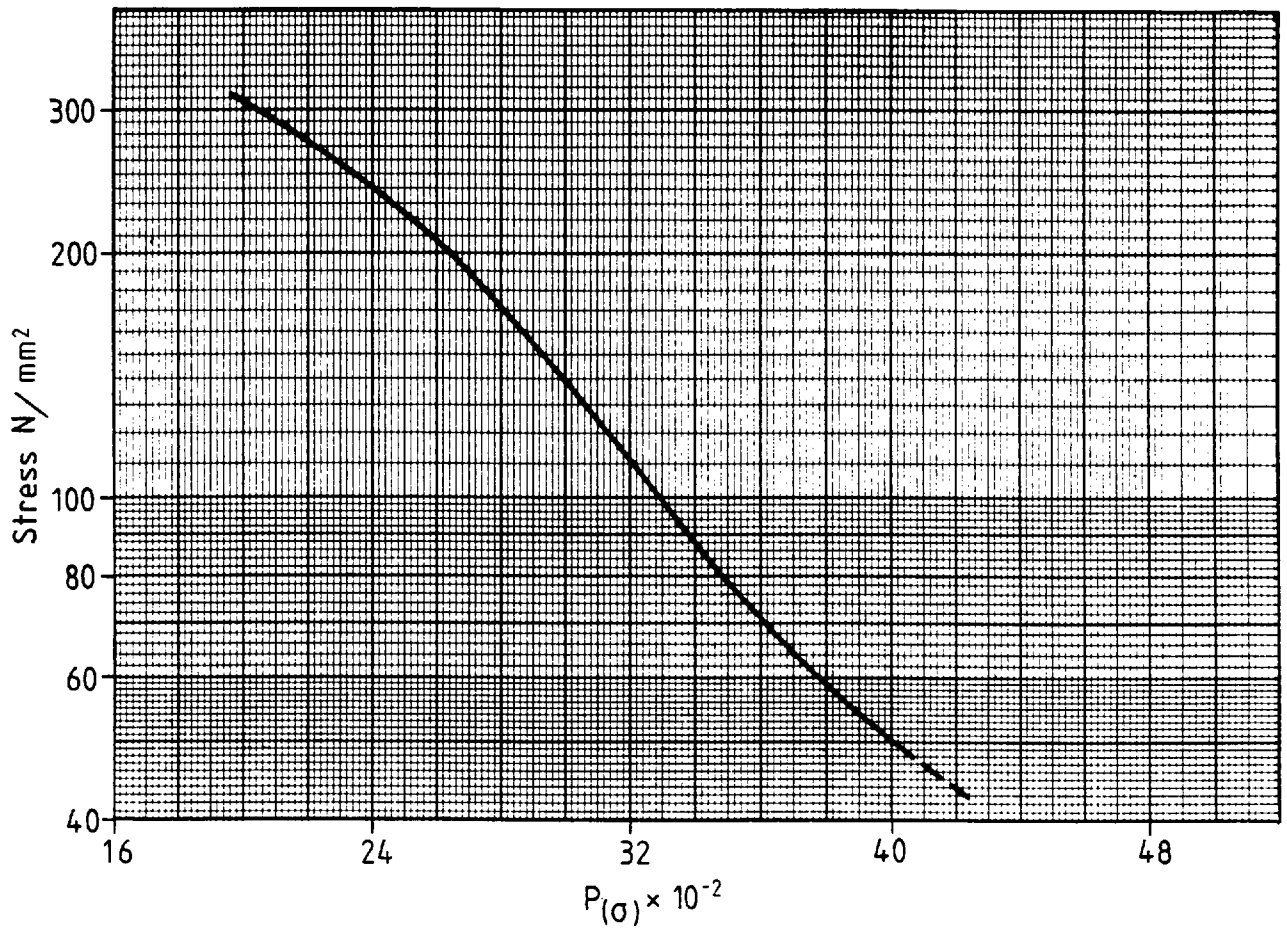

Figure 29. 18 % Cr 10 % NiTi (Heat treatment 1070 °C to 1140 °C) (1987)

Table 30. 18 % Cr 12 % NiNb (Heat treatment 950 °C to 1070 °C) (1988) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m*/*m*)	% (*m*/*m*)	% (*m*/*m*)
	C	0.034 to 0.11	0.04	0.10
	Si	0.12 to 0.94	–	1.00
	Mn	0.41 to 1.92	–	2.00
	P	0.008 to 0.025	–	0.045
	S	0.004 to 0.030	–	0.030
	Cr	16.85 to 19.00	17.0	19.0
	Ni	9.14 to 13.55	9.0	14.0
	Nb	0.47 to 1.22	10 × % C	1.20
Heat treatment	°C 950 to 1066		°C 950 to 1070	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
600	54	4	1(1)	1(1)	–	–	1
649/650	173(1)	10(1)	3	2	(1)	1	–
700/704	93	6	1	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
540	258	214*	196*	174*	162*	154*	147*
550	236	197*	181*	161*	149*	142*	136*
560	218	182*	167*	148*	138*	131*	125*
570	202	169*	155*	137*	127*	120*	115*
580	187	157	144	127*	117*	110*	105*
590	174	145	133	117*	108*	101*	96*
600	162	135	123	107*	98*	92*	86*
610	151	125	114	98*	89*	82*	77*
620	140	116	105	89*	80*	72*	66*
630	131	107	96	80*	70*	61*	–
640	121	98	87	71*	57*	–	–
650	113	90	78	58*	–	–	–
660	104	81	69	–	–	–	–
670	96	72	56	–	–	–	–
680	88	62	–	–	–	–	–
690	80	–	–	–	–	–	–
700	71	–	–	–	–	–	–
710	61	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).

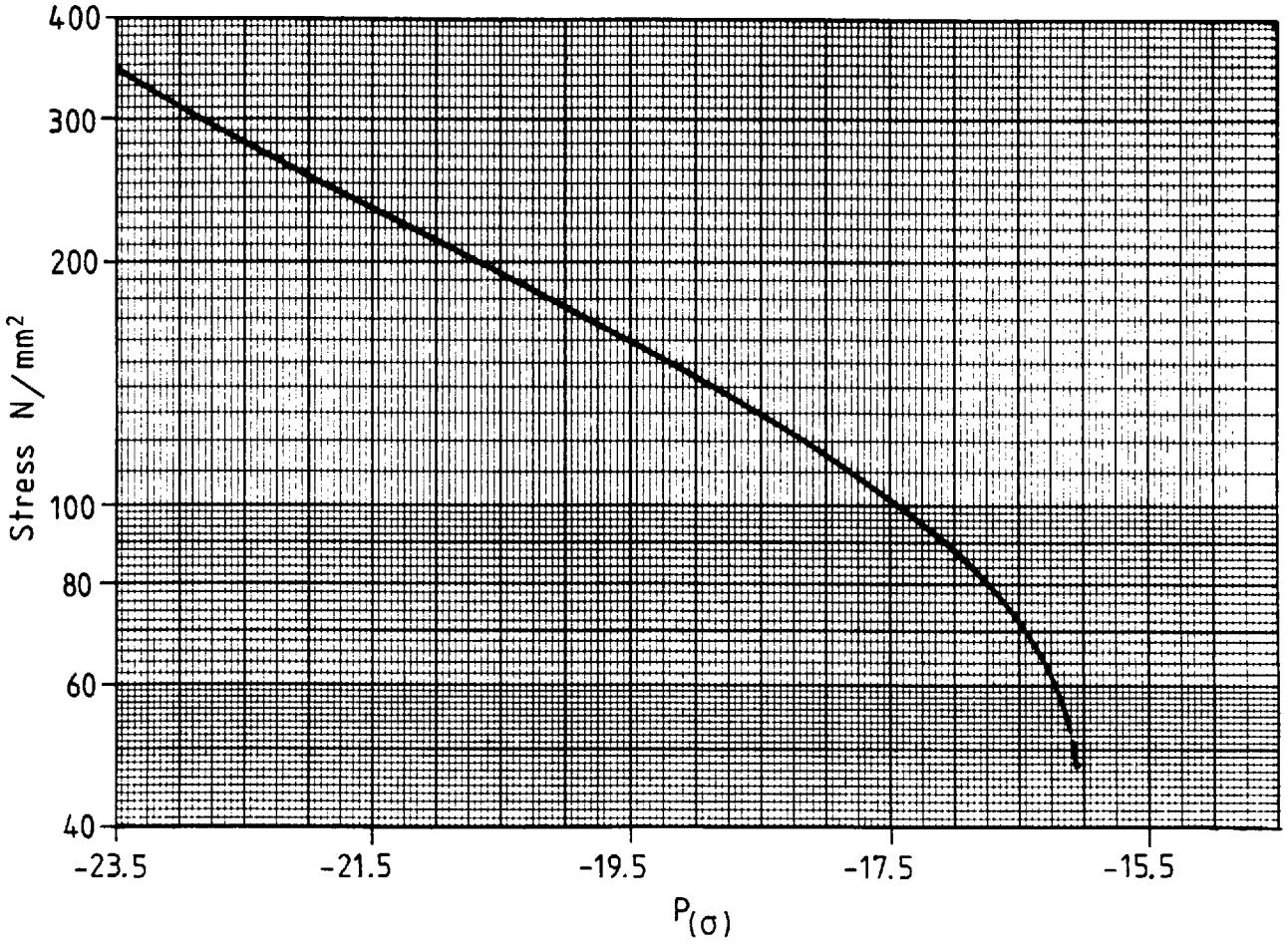

Figure 30. 18 % Cr 12 % NiNb (Heat treatment 950 °C to 1070 °C) (1988)

Table 31. 18 % Cr 12 % NiNb (Heat treatment 1070 °C to 1125 °C) (1988) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.04 to 0.082	0.04	0.10
	Si	0.20 to 0.78	–	1.00
	Mn	0.31 to 1.90	–	2.00
	P	0.006 to 0.029	–	0.045
	S	0.004 to 0.022	–	0.030
	Cr	16.90 to 18.80	17.0	19.0
	Ni	10.10 to 13.55	9.0	14.0
	Nb	0.39 to 1.14	10 X % C	1.20
Heat treatment	°C 1080 to 1121		°C 1070 to 1125	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	**Test duration**						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
600	65(3)	6(1)	1	–	2	(1)	–
625	19	1	–	(1)	–	–	–
649/650	220(3)	19(3)	4(1)	2	–	(1)	1
700	52(3)	6	1(1)	(1)	1	(2)	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	**10 000 h**	**30 000 h**	**50 000 h**	**100 000 h**	**150 000 h**	**200 000 h**	**250 000 h**
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
540	253	220*	205*	186*	176*	169*	164*
550	237	204*	190*	172*	163*	156*	151*
560	221	190*	176*	159*	150*	144*	139*
570	206	176*	163*	147*	138*	132*	128*
580	192	163	151*	135*	127*	122*	117*
590	178	151	139*	125*	117*	112*	108*
600	166	139	129*	115*	107*	102*	99*
610	154	129	118	106*	99*	94*	90*
620	142	119	109	97*	90*	86*	83*
630	132	109	100	89*	83*	78*	75*
640	122	101	92	81*	75*	71*	68*
650	112	93	84	74*	68*	64*	61*
660	104	85	77	67*	62*	59*	55*
670	96	78	70	61*	55*	(51)*	(47)*
680	88	71	64	54*	(48)*	–	–
690	81	64	57	–	–	–	–
700	74	58	(50)	–	–	–	–
710	68	(51)	–	–	–	–	–
720	61	–	–	–	–	–	–
730	55	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

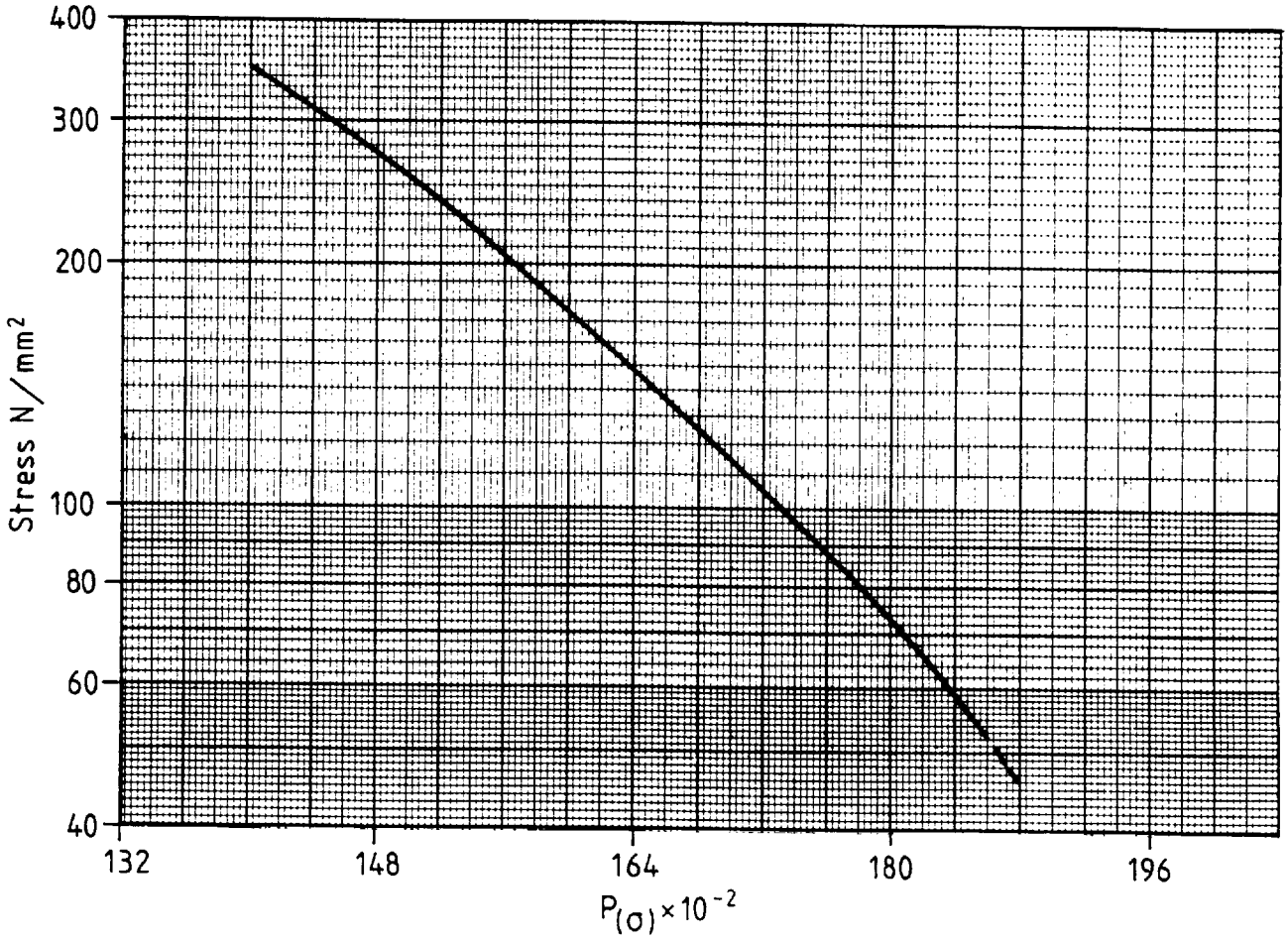

Figure 31. 18 % Cr 12 % NiNb (Heat treatment 1070 °C to 1125 °C) (1988)

Table 32. 18 % Cr 10 % NiNbN (1974) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.03 to 0.06	–	0.08
	Si	0.28 to 0.44	0.20	1.00
	Mn	1.47 to 1.59	0.50	2.00
	P	0.023 to 0.032	–	0.045
	S	0.009 to 0.021	–	0.030
	Cr	17.57 to 18.28	17.0	19.0
	Ni	9.66 to 12.60	9.0	12.0
	Nb	0.57 to 0.85	10 X % C	1.00
	N	0.17 to 0.21	0.15	0.25
Heat treatment	°C 1030 to 1050		°C 1000 to 1120	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
500	13(1)	2(2)	1	–	–	–	–
600	19(1)	3	1	2	–	–	–
650	14	3	1	1	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
530	324	288	271*	246*	231*	220*	212*
540	305	268	251*	226*	211*	201*	193*
550	285	249	231*	206*	192*	183*	175*
560	266	228	212*	188*	175*	166*	160*
570	247	210	194*	172*	160*	152*	146*
580	229	193	177*	157*	146*	139*	133*
590	211	177	162*	144*	134*	127*	122*
600	194	162	149*	132*	122*	116*	110*
610	179	149	137*	121*	112*	105*	99*
620	165	137	126*	110*	100*	(92)*	–
630	152	127	115*	99*	–	–	–
640	140	116	105*	–	–	–	–
650	130	106	(94)*	–	–	–	–
660	120	95	–	–	–	–	–
670	110	–	–	–	–	–	–
680	100	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

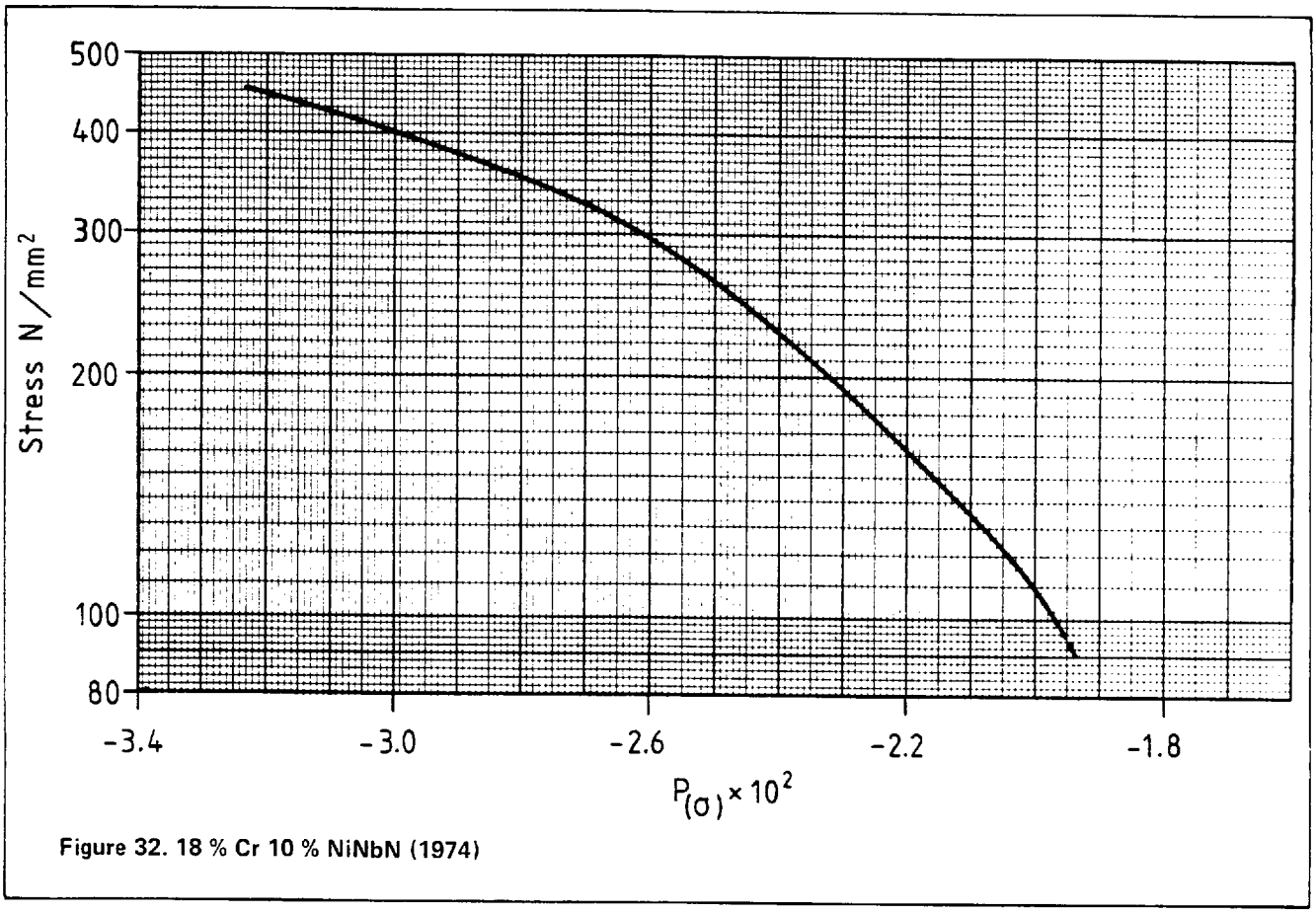

Figure 32. 18 % Cr 10 % NiNbN (1974)

Table 33. 15 % Cr 10 % Ni 6 % MnNbV (1988) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m*/*m*)	% (*m*/*m*)	% (*m*/*m*)
	C	0.074 to 0.14	0.06	0.15
	Si	0.25 to 0.73	0.20	1.00
	Mn	5.75 to 6.75	5.50	7.00
	P	0.015 to 0.037	–	0.040
	S	0.005 to 0.026	–	0.030
	Cr	14.40 to 16.00	14.0	16.0
	Mo	0.77 to 1.20	0.80	1.20
	Ni	8.94 to 11.00	9.0	11.0
	B	0.0025 to 0.009	0.003	0.009
	Nb	0.75 to 1.20	0.75	1.25
	V	0.20 to 0.57	0.15	0.40
Heat treatment	°C 1040 to 1200		°C 1050 to 1150	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
650	593(13)	62(2)	40	16(9)	6(1)	4(2)	1
700	199	10	7	15(1)	2(2)	2	1
750	44	1	3	–	–	–	–
800	78	1	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stressest

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
600	241	223	213	199	190	183	177
610	231	211	201	185	174	165	158
620	221	200	187	167	154	143	134
630	210	185	170	147	130	118	109*
640	198	168	151	122	106	97	90*
650	184	148	127	100	88	82	78*
660	167	124	104	84	76	72	69*
670	147	102	87	74	68	64	62*
680	124	86	76	66	61	58	56*
690	102	75	67	59	55	52	51*
700	86	67	61	54	50	48	46*
710	75	60	55	49	46	43	42*
720	67	55	50	45	41	39	37*
730	61	50	46*	40*	37*	35*	32*
740	55	46	41*	36*	32*	–	–
750	51	41	37*	30*	–	–	–
760	46	37	32*	–	–	–	–
770	42	32	–	–	–	–	–
780	38	–	–	–	–	–	–
790	34	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
†Values below 640 °C have not been obtained from the master curve.

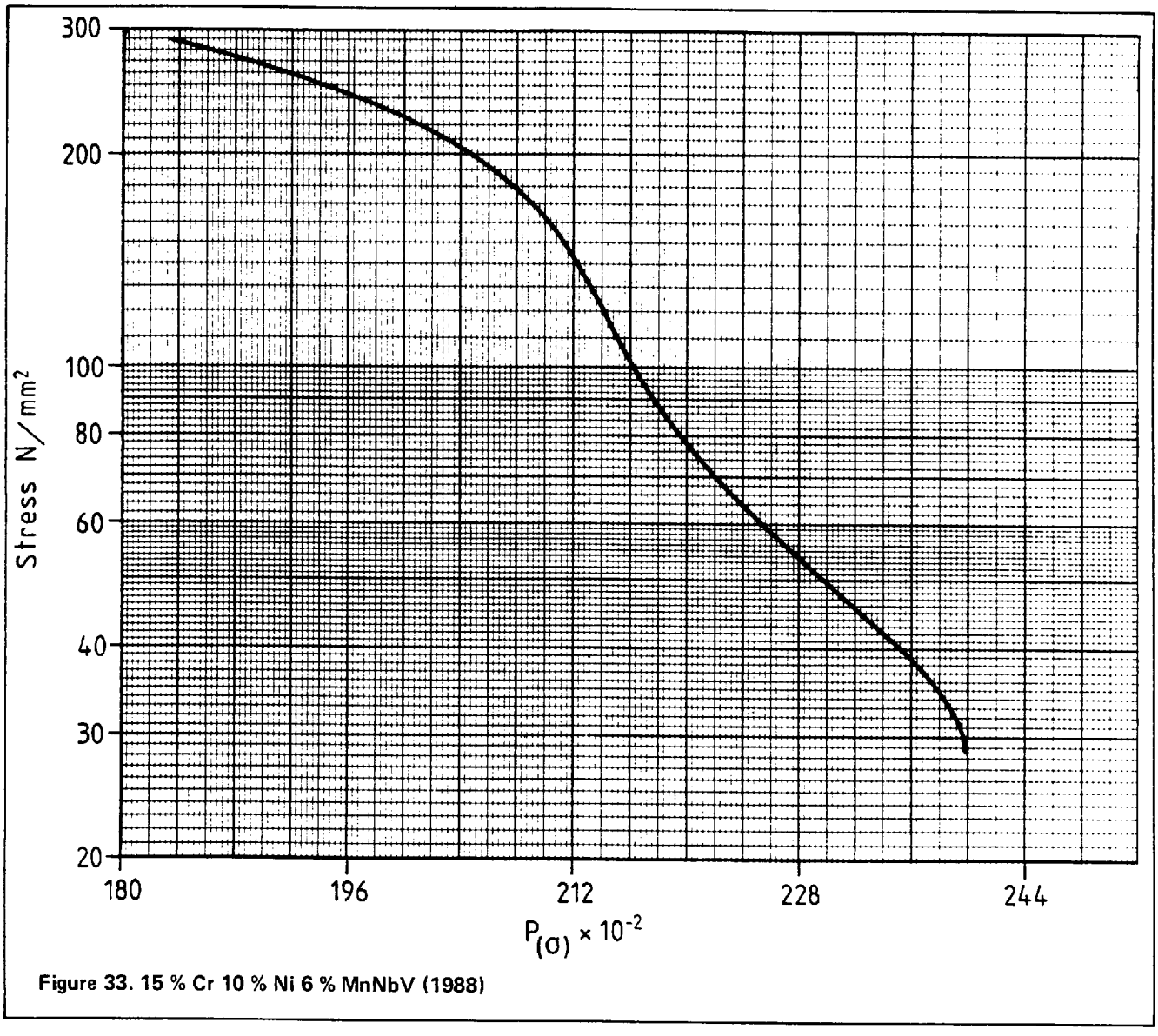

Figure 33. 15 % Cr 10 % Ni 6 % MnNbV (1988)

Table 34. 16 % Cr 16 % NiMoNb (1971) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges†
		% (*m*/*m*)	
Chemical composition	C	0.03 to 0.09	
	Si	0.12 to 0.80	
	Mn	0.11 to 1.46	
	P	0.012 to 0.023	
	S	0.007 to 0.023	
	Cr	15.90 to 17.27	
	Mo	1.60 to 2.43	
	Ni	15.37 to 17.90	
	Nb	0.52 to 1.29	
Heat treatment	°C 1000 to 1100 AC 1050 to 1150 WQ 1050 WQ + T 750		

†Not in British Standards.

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
600	13	4(1)	1(2)	1(3)	1(1)	(1)	–
650	101	19	15(2)	11(2)	1(2)	(2)	–
700	50	4	2	2(5)	(2)	(3)	–
750	5	3	–	1	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
600	220	187	173	150	134*	124*	116*
610	203	170	154	133	118*	108*	100*
620	186	154	138	119	103*	94*	86*
630	171	140	125	105	90*	81*	75*
640	157	127	112	93	78*	71*	65*
650	143	114	101	83	69*	61*	56*
660	131	103	90	74	60*	53*	48*
670	120	92	81	65	52*	46*	41*
680	109	83	73	58	45	40*	36*
690	99	75	65	50	39	34*	31*
700	90	67	57	44	34	30*	(26)*
710	82	59	50	38	30	–	–
720	75	53	44	33	(26)	–	–
730	68	47*	39*	(28)*	–	–	–
740	61	41*	33*	–	–	–	–
750	55	37*	29*	–	–	–	–
760	50	32*	(26)*	–	–	–	–
770	45	29*	–	–	–	–	–
780	40	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

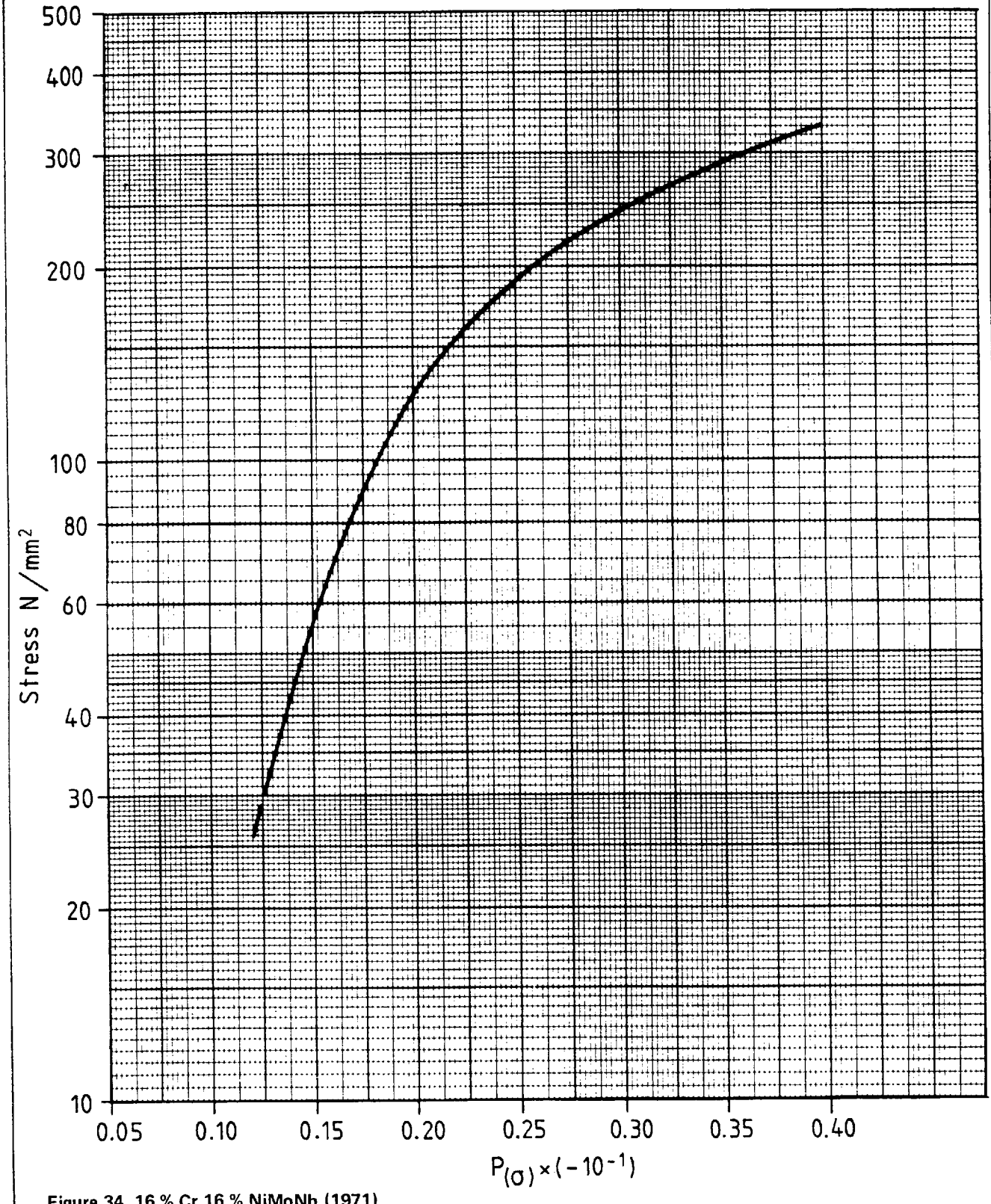

Figure 34. 16 % Cr 16 % NiMoNb (1971)

Table 35. 30 % Ni 20 % CrTiAl (1972) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.02 to 0.10	–	0.10
	Si	0.25 to 0.75	–	1.00
	Mn	0.40 to 1.31	–	1.5
	P	0.003 to 0.014	–	–
	S	0.007 to 0.025	–	0.015
	Cr	19.20 to 22.16	19.0	23.0
	Ni	30.10 to 35.20	30.0	35.0
	Al	0.085 to 0.58	0.15	0.60
	Ti	0.29 to 0.61	0.15	0.60
	Cu	–	–	0.75
Heat treatment	°C 980 to 1150 AC		°C Approximately 1000	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
600	72(22)	3	6	3	–	–	–
649/650	120(37)	1(2)	–	–	–	–	–
700/704	179(28)	16(2)	6	1(1)	–	–	–
750	54(5)	5	–	3(1)	–	–	–
800	116	8	1	1	–	–	–
900	146	9	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
550	223	197*	185*	171*	163*	158*	154*
560	207	182*	171*	157*	150*	145*	141*
570	192	168*	158*	145*	138*	134*	130*
580	177	155	146	134*	127*	123*	120*
590	164	143	135	123*	117*	113*	110*
600	152	132	124	114*	108*	104*	101*
610	141	122	114	104*	99*	95*	92*
620	130	113	105	96*	90*	87*	84*
630	121	104*	97*	88*	83*	79*	77*
640	112	95*	89*	80*	76*	72*	70*
650	103	88*	81*	73*	69*	66*	64*
660	95	80*	75*	67*	63*	60*	58*
670	87	74*	68*	61*	58*	55*	53*
680	80	68	63	56*	53*	50*	48*
690	74	62	57	51*	48*	46*	44*
700	68	57	52	47*	43*	41*	40*
710	62	52	48	42*	40*	38*	37*
720	57	48	43	39*	36*	35*	34*
730	53	43	40*	36*	34*	32*	31*
740	48	40	36*	33*	31*	30*	29*
750	44	36	34*	30*	28*	27*	26*
760	40	34	31*	28*	26*	25*	24*
770	37	31	29*	25*	24*	22*	21*
780	34	29	26*	23*	21*	20*	19*
790	32	26	24*	21*	19*	18*	17*
800	30	24	22*	19*	17*	16*	15*
810	27	22	20*	17*	15*	14*	–
820	25	20	18*	15*	14*	–	–
830	23	18*	16*	–	–	–	–
840	21	16*	14*	–	–	–	–
850	19	14*	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).

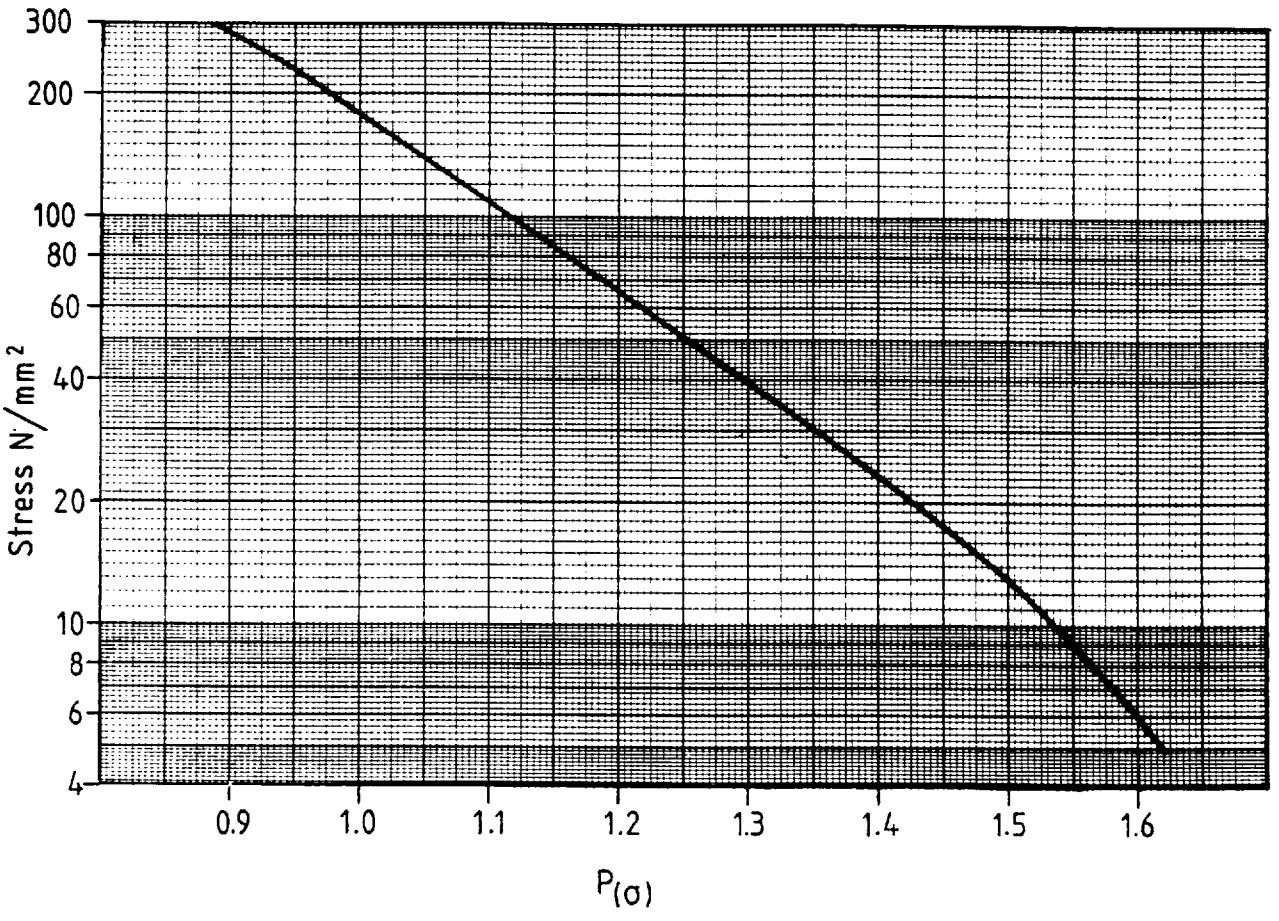

Figure 35. 30 % Ni 20 % CrTiAl (1972)

Table 36. 25 % Cr 20 % Ni (1988) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.018 to 0.20	–	0.15
	Si	0.26 to 1.78	–	1.50
	Mn	0.93 to 2.00	–	2.00
	P	0.009 to 0.035	–	0.045
	S	0.001 to 0.025	–	0.030
	Cr	22.30 to 25.93	23.00	26.00
	Ni	19.54 to 23.00	19.00	22.00
Heat treatment	°C 1050 to 1130 + hot finished		°C 1000 to 1120	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
600	10(3)	1	–	–	–	1	–
650	46(2)	3(1)	–	–	–	–	–
700	72(2)	1(2)	(1)	–	–	(1)	–
800	39	–	–	–	–	–	–
900	30(3)	2	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
600	137	113	104*	92*	86*	82*	79*
610	120	98	90*	79*	74*	71*	68*
620	105	85	78*	69*	64*	61*	59*
630	92	75	68*	60*	56*	54*	52*
640	81	66	60*	53*	50*	47*	46*
650	72	58	53*	47*	44*	42*	41*
660	64	52	47*	42*	39*	38*	36*
670	57	46	42*	38*	35*	34*	33*
680	51	42	38	34*	32*	31*	29*
690	47	38	35	31*	29*	28*	27*
700	42	34	32	28*	26*	25*	24*
710	39	31	29	26*	24*	23*	22*
720	35	29	26	23.5*	22*	21*	20*
730	32	27	24.5*	22*	20*	19.5*	18.5*
740	30	24.5	22.5*	20*	18.5*	18*	17*
750	28	22.5	21*	18.5*	17*	16.5*	16*
760	26	21	19*	17*	16*	15*	14.5*
770	24	19.5	18*	15.5*	14.5*	14*	13.5*
780	22	18	16.5*	14.5*	13.5*	13*	12.5*
790	21	17	15.5*	13.5*	12.5*	12*	11.5*
800	19.5	15.5	14*	12.5*	11.5*	11*	10.5*
810	18	14.5	13*	11.5*	10.5*	10*	9.5*
820	17	13.5	12*	10.5*	10*	9.5*	(9)*
830	16	12.5	11.5*	10*	(9)*	–	–
840	15	12	10.5*	(9)*	–	–	–
850	14	11	10*	–	–	–	–
860	13	10	(9)*	–	–	–	–
870	12	9.5	–	–	–	–	–
880	11.5	(9)	–	–	–	–	–
890	10.5	–	–	–	–	–	–
900	10	–	–	–	–	–	–
910	9.5	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
( ) Values which have involved extended stress extrapolation (see note 4(b)).

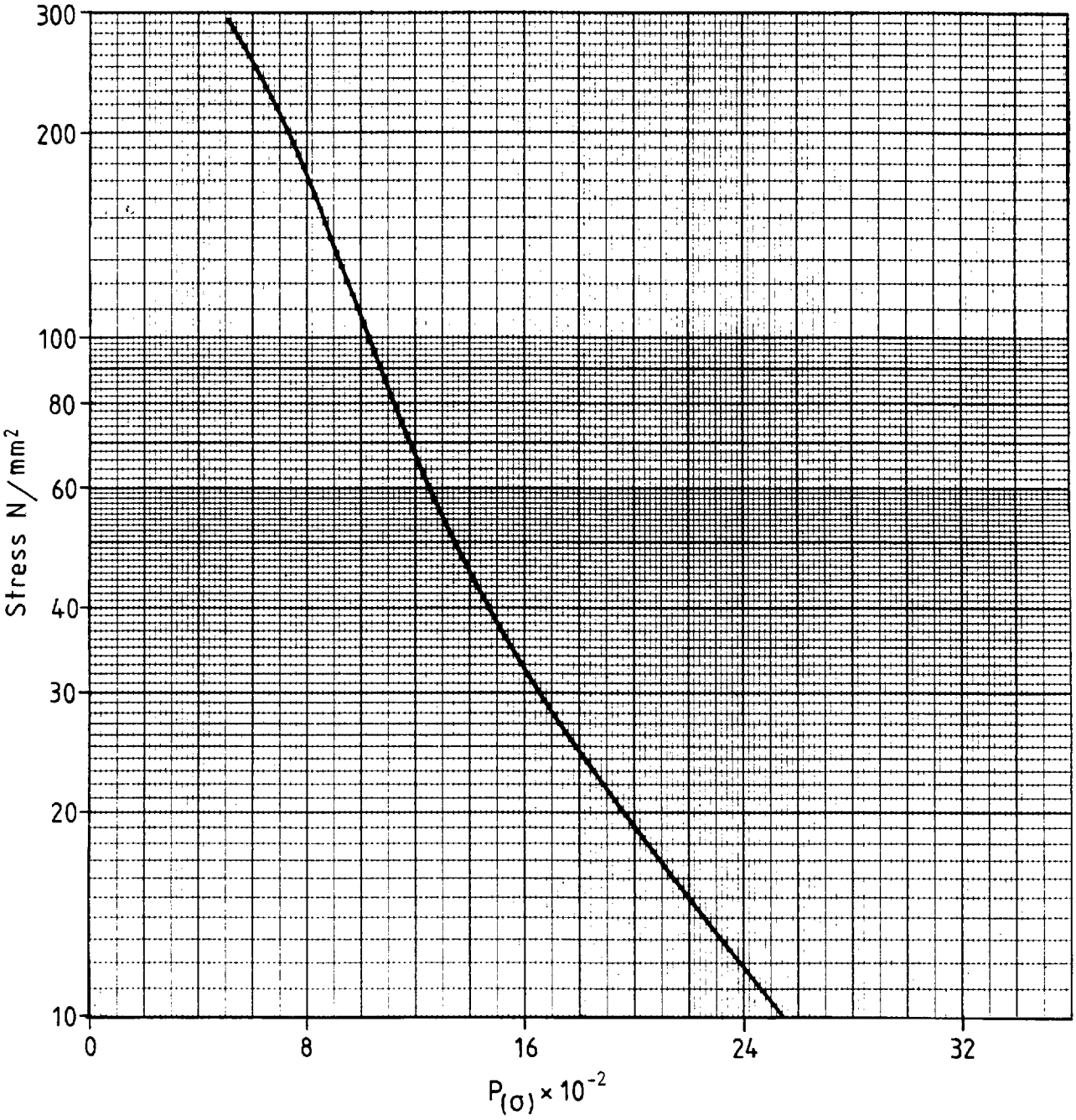

Figure 36. 25 % Cr 20 % Ni (1988)

Table 37. 0.4 % C 1¼ % CrMo (Notched properties) (1979) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.36 to 0.43	0.35	0.45
	Si	0.24 to 0.31	0.10	0.35
	Mn	0.51 to 0.64	0.40	0.70
	P	0.013 to 0.032	–	0.035
	S	0.026 to 0.035	–	0.040
	Cr	1.11 to 1.39	1.00	1.50
	Mo	0.51 to 0.61	0.50	0.70
	Ni	0.11 to 0.20	–	0.40
Heat treatment	°C 850 to 880 OQ + T 625 to 680		°C 850 to 900 OQ or WQ + T 600 minimum	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
450	3(2)	7(1)	4	1	–	–	–
500	26(6)	5(1)	–	–	–	–	–
550	26(5)	2	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses†

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
450	613	540	504	455*	–	–	–
460	552	471	432	379*	–	–	–
470	489	400	359	305*	–	–	–
480	423	330	289*	238*	–	–	–
490	357	264	227*	185*	–	–	–
500	293	209	178*	143*	–	–	–
510	236	164	139*	110*	–	–	–
520	189	129	108*	–	–	–	–
530	151	100*	–	–	–	–	–
540	120	–	–	–	–	–	–
550	94	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
† Values for times exceeding 100 000 h are not available.

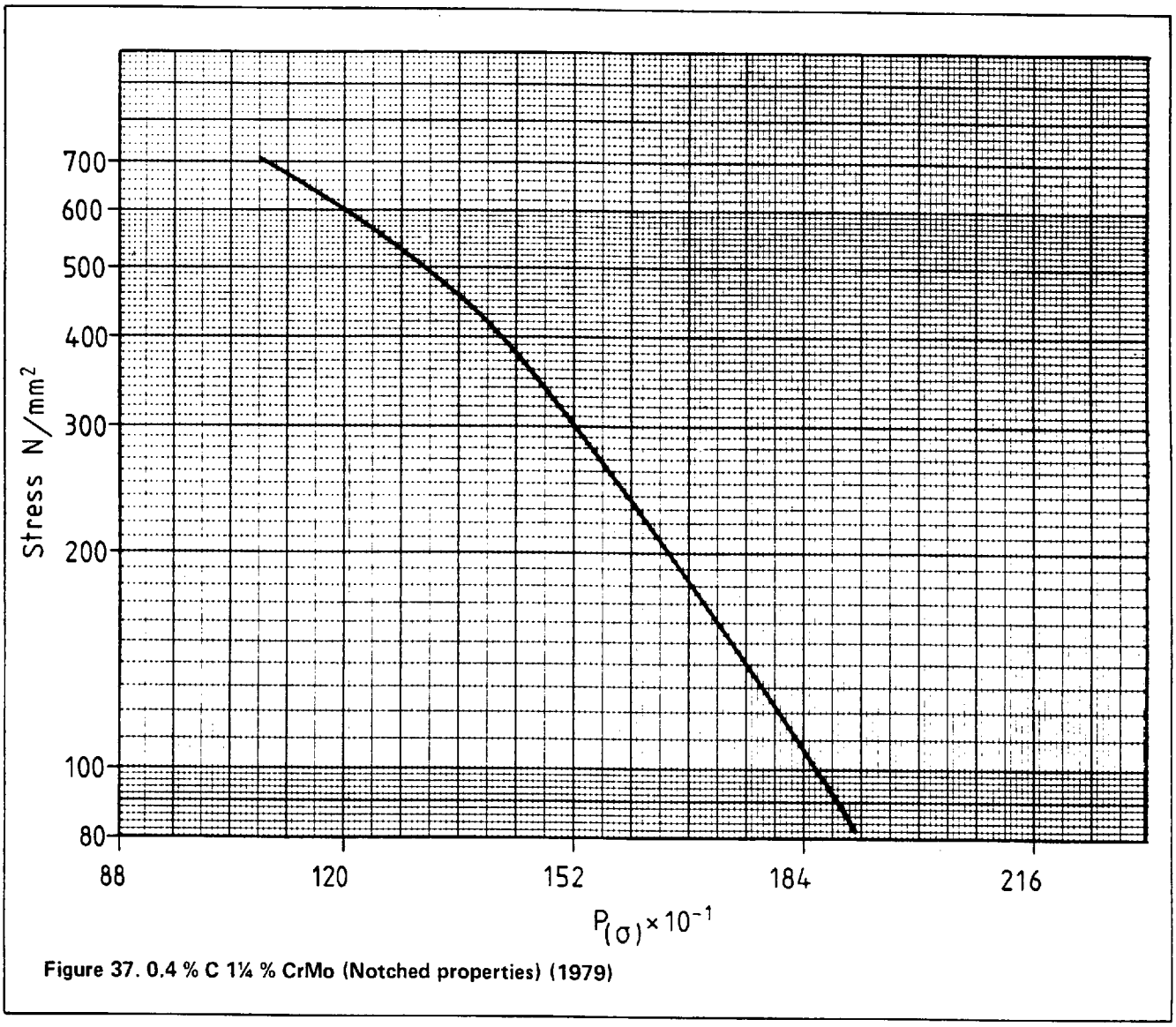

Figure 37. 0.4 % C 1¼ % CrMo (Notched properties) (1979)

Table 38. 0.4 % C 1¼ % CrMoV (Notched properties) (1975) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m*/*m*)	% (*m*/*m*)	% (*m*/*m*)
	C	0.36 to 0.40	0.30	0.45
	Si	0.25 to 0.32	0.10	0.35
	Mn	0.47 to 0.64	0.40	0.70
	P	0.013 to 0.032	–	0.040
	S	0.009 to 0.041	–	0.040
	Cr	1.20 to 1.30	1.00	1.50
	Mo	0.53 to 0.58	0.50	0.70
	V	0.22 to 0.24	0.20	0.30
Heat treatment	°C 940 to 960 OQ + T 690 to 710		°C 930 to 970 OQ + T 650 minimum	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
450	–	2(1)	(1)	(1)	–	–	–
500	19(3)	5	1	–	–	–	–
550	22(2)	3	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stressest

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
450	578	516	485*	452*	–	–	–
460	535	473	445*	405*	–	–	–
470	492	429	400*	360*	–	–	–
480	448	384	356*	313*	–	–	–
490	404	338	310*	266*	–	–	–
500	360	295	266*	221*	–	–	–
510	317	–	–	–	–	–	–
520	273	–	–	–	–	–	–
530	229	–	–	–	–	–	–
540	186	–	–	–	–	–	–
550	143	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
†Values obtained using non-standard extrapolation method. Values at 480 ° C to 490 ° C, 510 ° C to 540 ° C and for 50 000 h obtained by interpolation.
Values for times exceeding 100 000 h are not available.

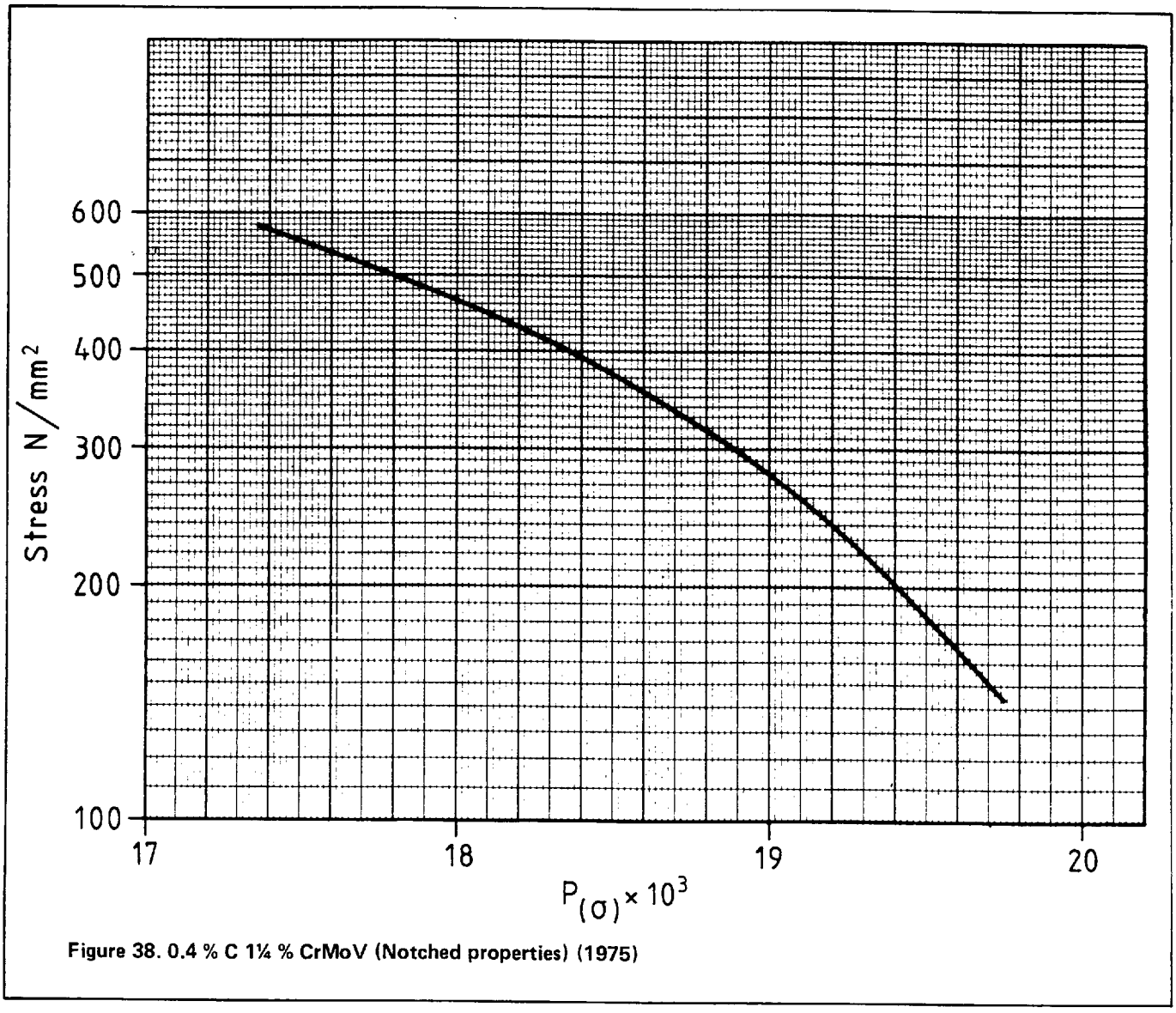

Figure 38. 0.4 % C 1¼ % CrMoV (Notched properties) (1975)

Table 39. 1 % CrMoVTiB (Notched properties) (1975) (note 1)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.185 to 0.24	0.17	0.23
	Si	0.20 to 0.35	0.10	0.35
	Mn	0.47 to 0.57	0.35	0.75
	P	0.010 to 0.023	–	0.020
	S	0.009 to 0.025	–	0.020
	Cr	0.90 to 1.07	0.90	1.20
	Mo	0.92 to 1.05	0.90	1.10
	Ni	0.10 to 0.26	–	0.20
	Al (tot.)	0.033 to 0.042	–	0.08
	As	–	–	0.020
	B	0.0022 to 0.0045	0.001	0.010
	Cu	–	–	0.20
	Sn	–	–	0.020
	Ti	0.044 to 0.10	0.07	0.15
	V	0.64 to 0.76	0.60	0.80
Heat treatment	°C 970 to 1010 OQ or WQ + T 680 to 740		°C 660 to 700 + 970 to 990 OQ or WQ + T 680 to 720	

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h > 100 000
	Number of test points available						
°C							
475	3	4	2(1)	4(1)	2	–	–
500	15(1)	2(3)	1	1	(1)	–	–
550	99(13)	11(7)	2(1)	4(2)	–	–	–
565	14(5)	–	–	–	–	–	–
575	5(7)	–	–	–	–	–	–
600	51(4)	–	–	–	–	–	–

( ) Figures in parentheses denote unbroken tests.

(c) Average rupture stresses†

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
480	509	434	399	340	–	–	–
490	468	393	356	298	–	–	–
500	429	353	315	259	–	–	–
510	392	315	280	222*	–	–	–
520	357	280	247	191*	–	–	–
530	322	248	216	165	–	–	–
540	290	220	191	143	–	–	–
550	264	200	171	126	–	–	–
560	238	180	–	–	–	–	–
570	215	–	–	–	–	–	–
580	194	–	–	–	–	–	–
590	175	–	–	–	–	–	–
600	160	–	–	–	–	–	–

*Values which have involved extended time extrapolation (see note 4(a)).
†Values obtained using non-standard extrapolation method. Values at 480 °C to 490 °C, 510 °C to 540 ° and 560 °C to 590 °C and for 50 000 h obtained by interpolation.
Values for times exceeding 100 000 h are not available.

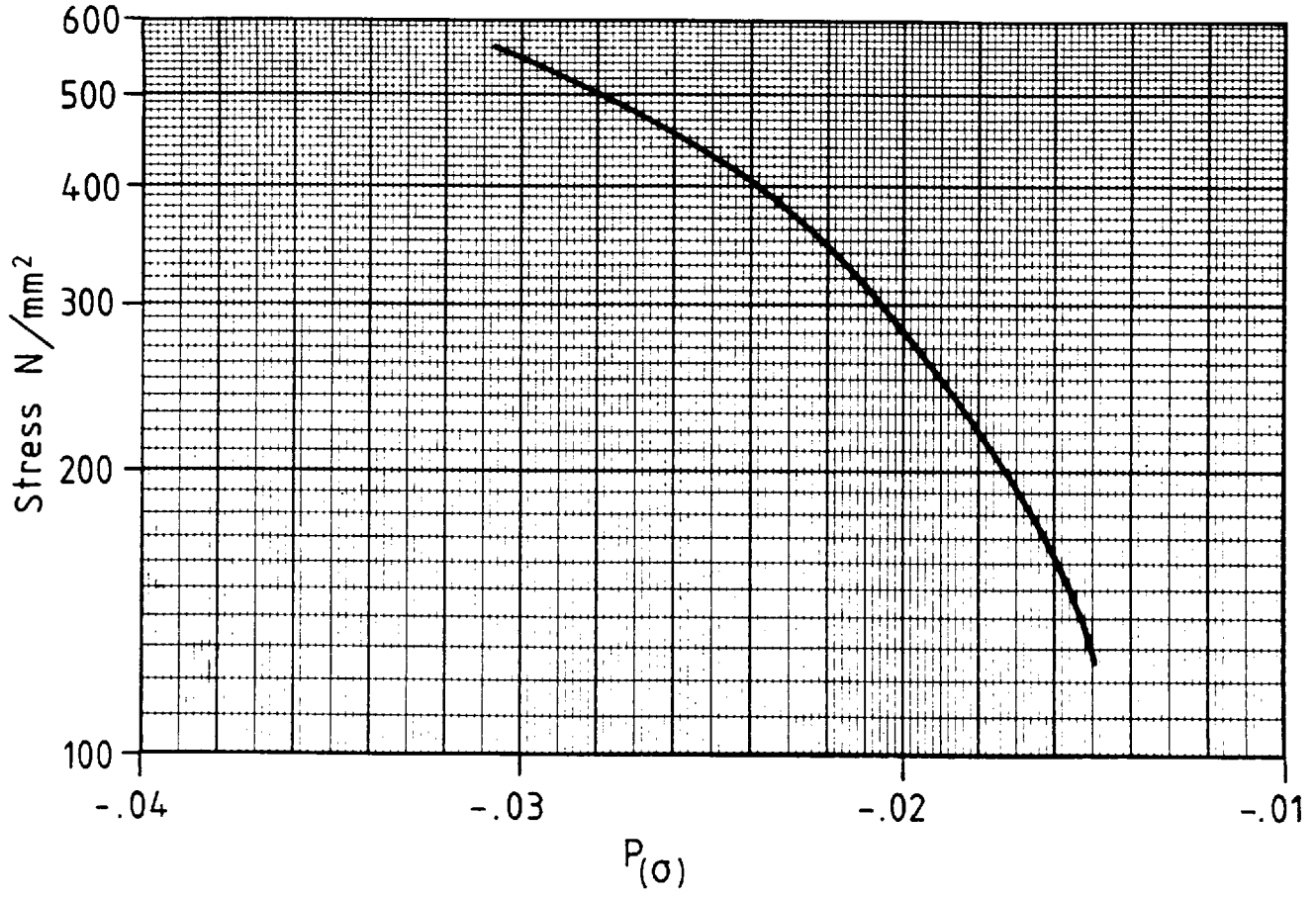

Figure 39. 1 % CrMoVTiB (Notched properties) (1975)

Table 40. Steel 91 (1992)

(a) Conditions of steel to which the properties apply

	Details of materials tested		Specified ranges (see note 2)	
			Minimum	Maximum
Chemical composition		% (*m/m*)	% (*m/m*)	% (*m/m*)
	C	0.08 to 0.12	0.08	0.12
	Si	0.08 to 0.67	0.20	0.50
	Mn	0.36 to 0.59	0.30	0.60
	P	0.001 to 0.021	–	0.020
	S	0.001 to 0.010	–	0.020
	Cr	8.05 to 9.45	8.00	9.50
	Mo	0.85 to 1.09	0.85	1.05
	Ni	0.02 to 0.29	–	0.40
	N	0.030 to 0.069	0.030	0.070
	Nb	0.054 to 0.15	0.06	0.10
	V	0.18 to 0.26	0.18	0.25
	Al	–	–	0.03
Heat treatment	°C 1. 1040 to 1120 Ac + T 735 to 780 2. 1040 to 1070 AC + T 730 to 760 + T 740 to 770		°C N 1040 to 1090 + T 730 to 790	

NOTE. The heat treatment maximum temperatures reflect the need for quality control and, for tempering, the need to reduce the risk of re-hardening.

(b) Quantity and duration of data used in assessment (see note 3)

Temperature	Test duration						
	h < 10 000	h 10 000 to 20 000	h 20 000 to 30 000	h 30 000 to 50 000	h 50 000 to 70 000	h 70 000 to 100 000	h >100 000
	Number of test points available						
°C							
500	61 (3)	5 (3)	(4)	(6)	1 (3)	(1)	–
538/40	16 (1)	4 (3)	1 (1)	(4)	(3)	1 (1)	–
550	163 (13)	9 (11)	5	4 (1)	1 (1)	–	–
593	36 (1)	7 (1)	2 (5)	3	1	–	–
600	197 (10)	8 (3)	3 (1)	2 (8)	2 (4)	(4)	–
646/649/650	200 (6)	15 (5)	7	–	–	–	–
700/704	27	3	1	–	–	–	–

( ) Figure in parentheses denote unbroken tests.

(c) Average rupture stresses

Temperature	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
490	302	284	276	265	259	254*	250*
500	283	266	258	247	240	236*	232*
510	265	248	240	229	222	218*	214*
520	248	231	223	212	205	200*	197*
530	230	213	205	194	188	183*	180*
540	214	197	189	178	171	167*	163*
550	197	181	173	162	155	151*	147*
560	182	165	157	146	140	136*	132*
570	166	150	142	132	126*	121*	118*
580	151	135	128	118	112	108*	105*
590	137	122	115	105	100	96*	93*
600	124	109	102	94	89	85*	83*
610	111	97	91	83	78	75*	73*
620	99	87	81	74	69	67*	64*
630	89	77	72	65*	61*	58*	56*
640	79	68	64	57*	54*	51*	49*
650	71	60	56	50*	46*	43*	41*
660	63	53	49	42*	37*	–	–
670	55	46	41	–	–	–	–
680	48	37	–	–	–	–	–
690	41	–	–	–	–	–	–

* Values which have involved extended time extrapolation (see note 4(a)).

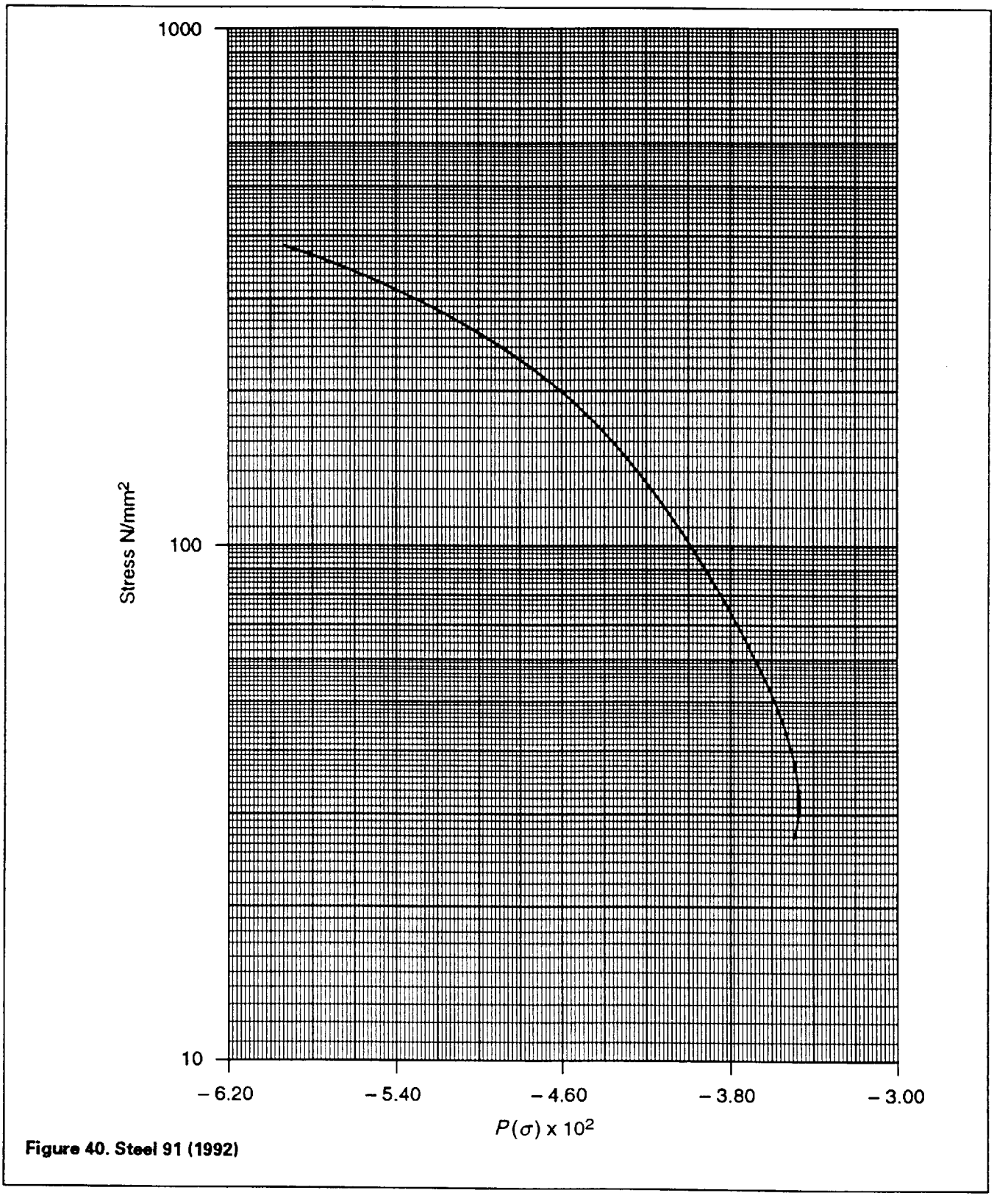

Figure 40. Steel 91 (1992)

Appendices

Appendix A. Request form for stress rupture/creep data (see 3.1)

Please provide stress rupture/creep data according to the following categories, and send to : British Standards Institution, ISM/73/-/1 Secretariat, 3 York Street, Manchester. M2 2AT.

1. Manufacturing details

Cast No.:

Code No.:

Steelmaker:

Testing laboratory:

Steelmaking process, including any secondary process:

De-oxidation practice:

Concast/ingot size:

Concast/ingot weight:

Product form:

Product dimensions:
(Outside diameter and thickness for tube)

Product process route:

2. Chemical composition

(a) State whether information provided is cast or product composition:

(b) Detailed chemical composition data to include*:

C, Si, Mn, P, S, Cr, Mo, Ni, Al, As, B, Bi, Co, Cu, N, Nb, Pb, Sb, Sn, Ti, V, W, Zr.

*Where known.

3. Heat treatment of test sample or piece

(a) Pretreatments*:

(b) Austenitizing treatment*:
(Solution treatment)

Actual temperature*:

Time at temperature*:

Cooling medium*:

Cooling rate and temperature range over which measured if controlled cooled*:

(c) Tempering treatment*:

Actual temperature*:

Time at temperature*:

Cooling medium*:

Cooling rate and temperature range over which measured if controlled cooled*:

(d) Any subsequent treatments, e.g. post-weld heat treatment(s)*:

4. Test results

(a) Test piece location,:
e.g. transverse

(b) Test piece dimensions:

(c) Elevated temperature stress rupture/creep data:
(to include test temperature, stress, duration, A, Z)
(Please state whether test is completed or test piece unbroken at duration stated.)
(Please state the time to specific creep strain(s) ,
e.g. 0.05 %, 0.1 %, 0.2 %, 0.5 %, 1 %.)

(d) Testing standard:

(e) Laboratory accreditation:

(f) Test atmosphere:

NOTE. Whenever possible, the room and elevated temperature proof and tensile properties for the same batch of material should also be provided.

*Indicate if treatments are works or laboratory treatments.

Appendix B. Constants for the equation of the master curve and constants to the parametric equation

The constants for the equation of the master curve and to the parametric equation are as follows (see clause 5).

Steel	Page No.	Constants for the equation of the master curve					Constants for the parametric equation		
		a	*b*	*c*	*d*	*e*	*r*	*Ta*	log *ta*
C Semi and Si killed	11	−1.258375287	2.614840508	−2.058339119	0.7172185779	−0.09393693507	1	500	10.678713799
C Si and Al killed	13	12083.43750	11945.41016	−5041.642090	277.0161743	–	−1	0	−20.580183029
C-Mn	15	−0.6656401157	1.416657686	−1.151554346	0.4130830467	−0.05579527840	1	500	10.658872604
0.3 % Mo	17	–	–	–	–	–	−1	0	−23.46
0.5 % Mo	19	−15.9188175	1638.47802	−587.796264	–	–	−1	650	−1.3147382
NiCrMoV	–	–	–	–	–	–	–	–	–
MnCrMoV	–	–	–	–	–	–	–	–	–
½ % Cr ½ % Mo ¼ % V	25	−1.730246782	3.300741434	−2.387772322	0.7668237090	−0.09273781627	1	520	13.783925056
1 % CrMo (Norm.)	27	7297.777344	−7238.721680	3306.159668	−568.9218750	–	−1	600	−2.6099286079
1 % CrMo (Norm.+ T)	29	0.0666840937	−0.1434341073	0.07376483083	−0.01308391150	–	1	280	20.328840256
1¼ % CrMo (Norm. + T)	31	0.0666840937	−0.1434341073	0.07376483083	−0.01308391150	–	1	280	20.328840256
0.4 % C 1¼ % CrMo	33	−58488.13213	107347.2301	−71847.65041	21171.74394	−2332.020504	−1	650	−1.1164713224
0.4 % C 1¼ % CrMoV	35	−29.54915810	49.96889496	−31.70220566	8.939930916	−0.9461904168	1	650	8.9767904282
1 % CrMoVTiB	37	−231.7584540	402.8051885	−262.3310961	75.87412322	−8.224261141	1	750	6.4636992905
2¼ % CrMo (Annealed)	39	–	–	–	–	–	1	400	15.41
2¼ % CrMo (Norm. + T ⩽ 720 °C)	41	−1.386920571	2.832926035	−2.196207523	0.7565333843	−0.09841170162	1	610	10.395759583
2¼ % CrMo (Norm. + T ⩽ 750 °C)	43	−0.5246057510	1.046909690	−0.8198743463	0.2890807092	−0.03939661011	1	610	10.360854149
5 % CrMo (Annealed)	45	–	–	–	–	–	1	400	14.57
5 % CrMo (Norm. + T)	47	–	–	–	–	–	1	650	8.985
9 % CrMo (Annealed)	49	−0.8064230084	1.757547379	−1.457643270	0.5326023102	−0.07343267649	1	600	11.695010185
9 % CrMo (Norm. + T)	51	0.1114614084	−0.2219061404	0.1145877466	−0.01637363806	−0.001907426864	1	560	14.172191620
12 % CrMoV (R_m 690 N/mm² to 840 N/mm²)	53	−0.4286341369	0.9403277040	−0.8039016724	0.3014570773	−0.04262292758	1	610	12.751610756
18 % Cr 8 % Ni	55	0.2020732909	−0.4409566820	0.3286471069	−0.1085945144	0.01317540463	1	0	25.241230011
18 % Cr 8 % NiN	57	−0.07566214353	0.06060781330	−0.01138103660	−0.001937349210	–	1	500	10.873614311
Steel 91 (1992)	87a	−0.4938277900	0.9749886394	−0.7671017051	0.2668407261	−0.03513864124	1	370	24.755538940

Steel	Page No.	Constants for the equation of the master curve					Constants for the parametric equation		
		a	*b*	*c*	*d*	*e*	*r*	*Ta*	log *ta*
18 % Cr 12 % NiMo	59	−0.03349032626	0.05688297004	−0.06532787532	0.02911172807	−0.004703271668	1	0	25.763597489
18 % Cr 12 % NiMoB	61	0.5363081694	−1.045994639	0.7316621542	−0.2258302420	0.02557507460	1	0	26.223617554
18 % Cr 12 % NiMoN	63	379488.5625	−683745.1875	464988.6875	−139595.5625	15554.23242	−1	550	−6.0411744118
18 % Cr 10 % NiTi (Heat treatment 950 °C to 1070 °C)	65	0.005118919536	−0.03954263031	0.02576294728	−0.007168778218	0.0005460219108	1	0	21.785516739
18 % Cr 10 % NiTi (Heat treatment 1070 °C to 1140 °C)	67	20463.96289	−13077.15625	−2728.328125	4433.528320	−974.2594604	−1	510	−3.9669008255
18 % Cr 12 % NiNb (Heat treatment 950 °C to 1070 °C)	69	0.02552033961	−0.1317141056	0.1342087686	−0.05484899506	0.007650834508	1	340	14.446140289
18 % Cr 12 % NiNb (Heat treatment 1070 °C to 1125 °C)	71	−108856.8984	252363.5625	−182577.3125	57694.46875	−6863.740723	−1	0	−14.445973396
18 % Cr 10 % NiNbN	73	−2.290895700	4.143799305	−2.824598551	0.8542976975	−0.09702614695	1	400	14.914063454
15 % Cr 10 % Ni 6 % MnNbV	75	−336414.5313	799872.0625	−654687.0625	234517.4219	−31193.52930	−1	0	18.431352615
16 % Cr 16 % NiMoNb	77	–	–	–	–	–	1	700	8.715
30 % Ni 20 % CrTiAl	79	–	–	–	–	–	−1	250	12.5485
25 % Cr 20 % Ni	81	2380.403320	4522.662109	−7219.988281	3388.112793	−539.2338867	−1	710	−1.4756911993
0.4 % C 1¼ % CrMo (Notched properties)	83	−36536.66406	70050.70313	−47128.35156	13944.21484	−1546.441406	−1	550	−2.8784015179
0.4 % C 1¼ % CrMoV (Notched properties)	85	–	–	–	–	–	−1	0	20
1 % CrMoVTiB (Notched properties)	87	–	–	–	–	–	1	600	8.3204

Publications referred to

BS 1501	Steels for pressure purposes : plates Part 1 Specification for carbon and carbon manganese steels Part 2 Specification for alloy steels Part 3 Specification for corrosion and heat resisting steels
BS 1502	Specification for steels for fired and unfired pressure vessels : sections and bars
BS 1503	Specification for steel forgings (including semi-finished forged products) for pressure purposes
BS 1506	Specification for carbon, low alloy and stainless steel bars and billets for bolting material to be used in pressure retaining applications
BS 3059	Specification for steel boiler and superheater tubes Part 2 Carbon, alloy and austentic stainless steel tubes with specified elevated temperature properties
BS 3500	Methods for creep and rupture testing of metals Part 1 Tensile rupture testing
BS 3602	Specification for steel pipes and tubes for pressure purposes : carbon and carbon manganese steel with specified elevated temperature properties Part 1 Specification for seamless and electric resistance welded and induction welded tubes Part 2 Submerged arc welded tubes
BS 3604	Specification for steel pipes and tubes for pressure purposes : ferritic alloy steel with specified elevated temperature properties
BS 3605	Specification for seamless and welded austenitic stainless steel pipes and tubes for pressure purposes
ISO 6303	Pressure vessel steels not included in ISO 2604, Parts 1 to 6 — Derivation of long-time stress rupture properties [Summary of average stress rupture properties of wrought steels for boilers and pressure vessels

*Referred to in the foreword only.

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to PD 6525 : Part 1 : 1990

Elevated temperature properties for steels for pressure purposes
Part 1. Stress rupture properties

Instructions for the insertion of new and revised pages

The issue number on the attached pages indicates the relationship of the page to the original standard. Issue 2 indicates a revised page to replace the original page of the same number. Vertical sidelining on replacement pages indicates that a change (or changes) has been made at that point. Where only one of two backed-up pages has been revised, the appropriate text has been reprinted on the reverse so that the original sheet may be removed from the standard.

Page	
3 and 4	Replace existing pages
9	Replace existing page (page 10 unchanged on back)
87a	Insert new page (page 87 unchanged on front)
87b	Insert new page (page 88 unchanged on back)
90	Insert new page (page 89 unchanged on front)

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