



## TECHNICAL REPORT 7468

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

# Summary of average stress rupture properties of wrought steels for boilers and pressure vessels

*Résumé des caractéristiques moyennes de contrainte de rupture pour les aciers corroyés pour chaudières et appareils à pression*

The information given in this document was obtained by co-operative testing amongst a number of the ISO member bodies represented in ISO Technical Committee 17, *Steel*. It was used as a basis for establishing International Standards ISO 2604/I to 2604/IV, which specify quality requirements for the various forms of the steels concerned. Because of the potential usefulness of the experimental data themselves, the ISO Council decided to publish them in a reference document.

This first edition of ISO/TR 7468 contains new and revised data, as described in the Introduction. It cancels and replaces the first and the second edition of ISO/DATA 1 which were published in 1975 and 1978.

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**Descriptors** : steels, rolled products, unalloyed steels, alloy steels, manganese steels, molybdenum steels, chromium-molybdenum steels, nickel-chromium-molybdenum steels, boilers, pressure vessels, mechanical properties, creep rupture strength, rupture stress.

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# Summary of average stress rupture properties of wrought steels for boilers and pressure vessels

## INTRODUCTION

ISO DATA No. 1 published in 1975 contained average stress rupture values for 19 grades of steel. Since that time, additional data have been analysed or assessed for several of these grades, and for 3 further grades. The new and revised stress rupture values and updated asterisks, as indicated in the following table, agreed by ISO/TC 17/SC 10 in May 1975, are included in this document, which therefore contains the stress rupture values for all boiler and pressure vessel steels at present in ISO 2604/I to ISO 2604/IV (1975). The master curves used for the derivation of the values, for times of 10 000 to 250 000 h, are also shown. The values contained in this document will be subject to review as more data become available.

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9 % Cr 1 % Mo steel		
– Annealed	Revised values	28
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18 % Cr 12 % NiMo steel	Updated asterisks	38

## Notes on tables

### 1 Chemical composition

The limits of chemical composition for which the properties apply are the ranges of chemical composition of the test material used in the assessment, except where these fall within the relevant range specified in ISO 2604/I to ISO 2604/IV (1975). In such cases the specified limit is listed.

### 2 Quantity and duration of data

The quantity and duration of data in these tables are the data used to derive the values in the average rupture stress tables. The asterisks in the average rupture stress tables are based on the total data available, which are given in the appropriate ISO/TC 17/SC 10/ETP documents, reference to which is made at the top of each set of tables.

3 Extrapolation

The values given in the tables are average stress rupture values derived in accordance with ISO/TC 17/SC 10/ETP – SG/N 58, and the data show a  $\pm 20\%$  scatter about this average value.

The extent to which test data can be reliably extrapolated 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  $\pm 25^\circ\text{C}$  about each test temperature, on the basis of a series of tests from at least five casts of steel, the longest test of each series exceeding a certain minimum duration.

a) EXTENDED TIME EXTRAPOLATION

The confidence which can be placed upon such properties will be related to the extent of extrapolation, and extrapolations exceeding approximately three times the above minimum duration are described as "extended time extrapolations". Stress rupture properties are normally listed at the time intervals shown in the table below, which defines where "extended time extrapolation" is applied.

Test duration (in hours) exceeded by data points from 5* casts at temperatures within $25^\circ\text{C}$ of that specified	80 000	70 000	50 000	30 000	20 000	10 000
Durations (in hours) <i>beyond</i> which the term "extended time extrapolation" is applied	250 000	200 000	150 000	100 000	50 000	30 000

\* Results from tests in progress may be included if above the lower 20 % scatter band limit at the appropriate duration. Values which have involved "extended time extrapolation" are marked with an asterisk in the table of estimated average rupture stresses contained in this report. 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 where values have been obtained by extending the parametric master curves to stresses beyond the range for which tests were carried out. Such values, which are subject to greater uncertainty compared with other values, are shown in parentheses. The numbers of test points shown in the tables of quantity and duration of data include results from tests still in progress where these lie above the lower 20 % scatter band limit.

Abbreviations used in the tables

- AC air cooled
- FC furnace cooled
- Q quenched
- OQ oil quenched
- WQ water quenched
- T tempered
- iso isothermally transformed
- thk thickness
- dia diameter
- sq square

**Symbols used in the equation of the parametric master curve**

$P(\sigma)$	creep rupture parameter
$T$	temperature, K
$\log t$	$\log_{10}$ of time to rupture, h
$\sigma$	stress, N/mm <sup>2</sup>

**NOTES**

- 1 Values read off the graphs presented in this report 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.
- 2 Throughout this document, a point is used as the decimal sign.

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**CARBON STEEL** (Semi killed and Si killed)

Properties agreed March 1974  
 (Based on ISO document ISO/TC17/SC10/ETP-SG(Secretariat 82) 100)  
 Supersedes ISO document ISO/TC17/SC10/ETP-SG(Secretariat 23) 28

**CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY**

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			min	max
Chemical Composition % (m/m)	C	0.07 - 0.24	-	0.30
	Si	0.005 - 0.330	-	0.50
	Mn	0.32 - 0.80	→ 0.40	-
	P	0.003 - 0.048	-	0.050
	S	0.003 - 0.050	-	0.050
Heat Treatment	1. 899 - 950°C AC 2. 850 - 920°C AC + T500 - 690°C		1. Normalised 2. Normalised and Tempered† 3. Hot Finished 4. Hot Finished and Tempered† † See page 10	
Products	Form	Size, mm	All wrought product forms	
	Plates	18 - 75 thk		
	Tubes	6.5 - 435 thk x 25 - 191 dia		
	Bars	178 - 305 thk + 16 - 25 dia		
	Forgings	25 - 146 thk x 575 - 1194 dia		

**QUANTITY AND DURATION OF DATA UPON WHICH THE PROPERTIES ARE BASED**

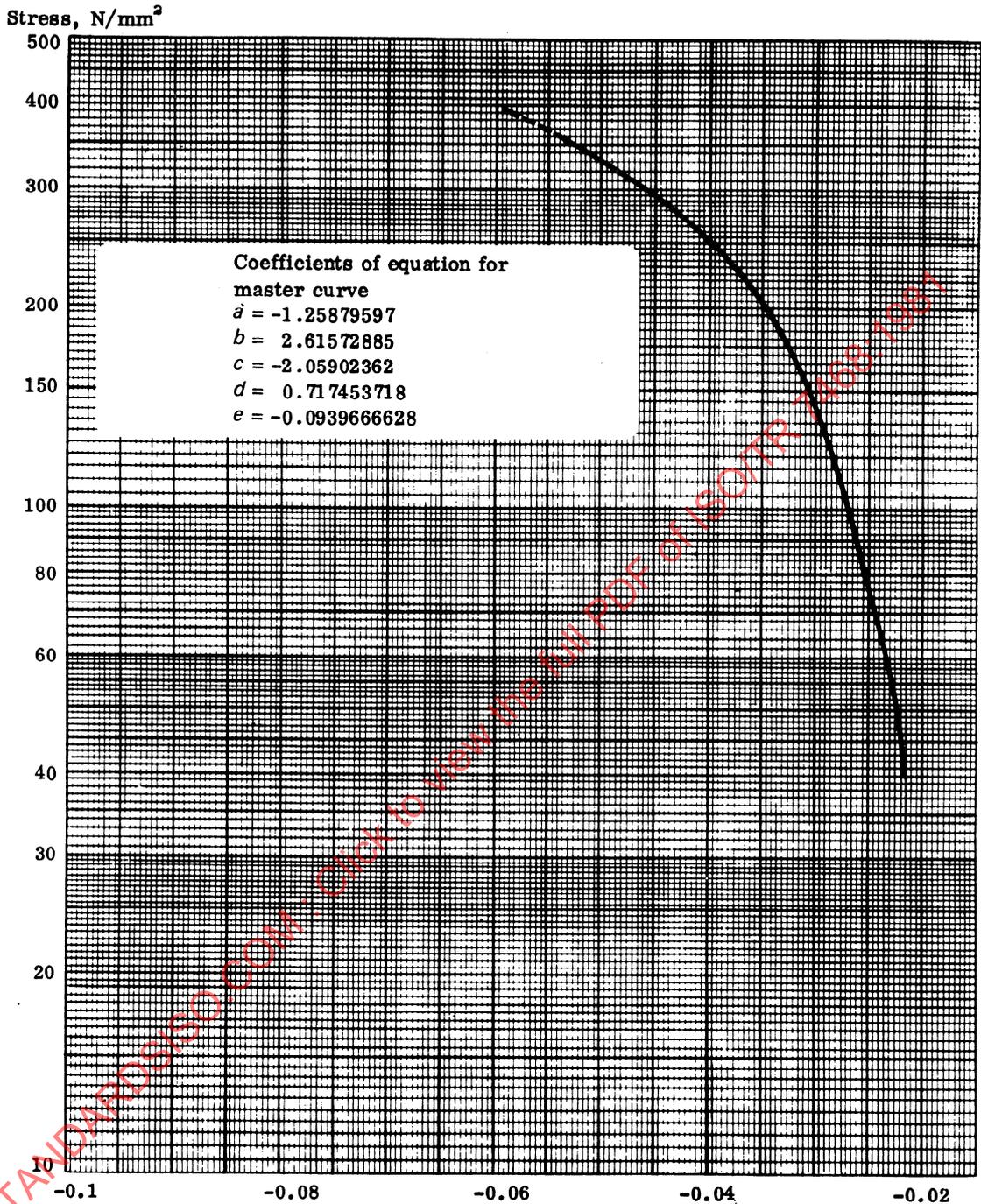
Temperature °C	Test Duration, h					
	<10 000	10 000 - 20 000	20 000 - 30 000	30 000 - 50 000	50 000 - 70 000	> 70 000
	Number of Test Points Available					
400	292	41	18	19	6	2
450	461	55	16	7	3	1
500	463	33	16	9	4	3

**AVERAGE RUPTURE STRESSES N/mm<sup>2</sup>**

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
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			
490	77	59	51				
500	68	51	41				
510	60	41					
520	52						

Note: \* Values which have involved extended time extrapolation )  
 () Values which have involved extended stress extrapolation ) See notes on page 2

→ This minimum Mn level was selected since lower levels are known to reduce stress rupture properties



$$P(\sigma) = \frac{\log t - 10.677261}{T - 500} = a + b (\log \sigma) + c (\log \sigma)^2 + d (\log \sigma)^3 + e (\log \sigma)^4$$

**C STEEL (SEMI AND SI KILLED) - TEMPERATURE RANGE 380-520°C**

(R/2159)

CARBON STEEL (Sl and Al killed)

Properties agreed March 1974

(Based on ISO document ISO/TC17/SC10/ETP-SG(Secretariat 82) 100)

Supersedes ISO document ISO/TC17/SC10/ETP-SG(Secretariat 23) 28

CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			<u>min</u>	<u>max</u>
Chemical Composition % (m/m)	C	0.10 - 0.185	-	0.30
	Si	0.01 - 0.32	-	0.50
	Mn	0.36 - 0.79	→ 0.40	-
	P	0.007 - 0.029	-	0.050
	S	0.011 - 0.028	-	0.050
	Al (sol)	0.016 - 0.102	0.015	-
Heat Treatment	1. 880 - 950°C AC		1. Normalised	
	2. 899 - 925°C AC + T 600°C		2. Normalised and Tempered† 3. Hot Finished 4. Hot Finished and Tempered† † See page 10	
Products	Form	Size, mm	All wrought product forms	
	Tubes	4 - 28 thk x 38 - 194 dia		
	Plates	15 - 50 thk		
	Bars	20 dia		
	Forgings	25 thk		

QUANTITY AND DURATION OF DATA UPON WHICH THE PROPERTIES ARE BASED

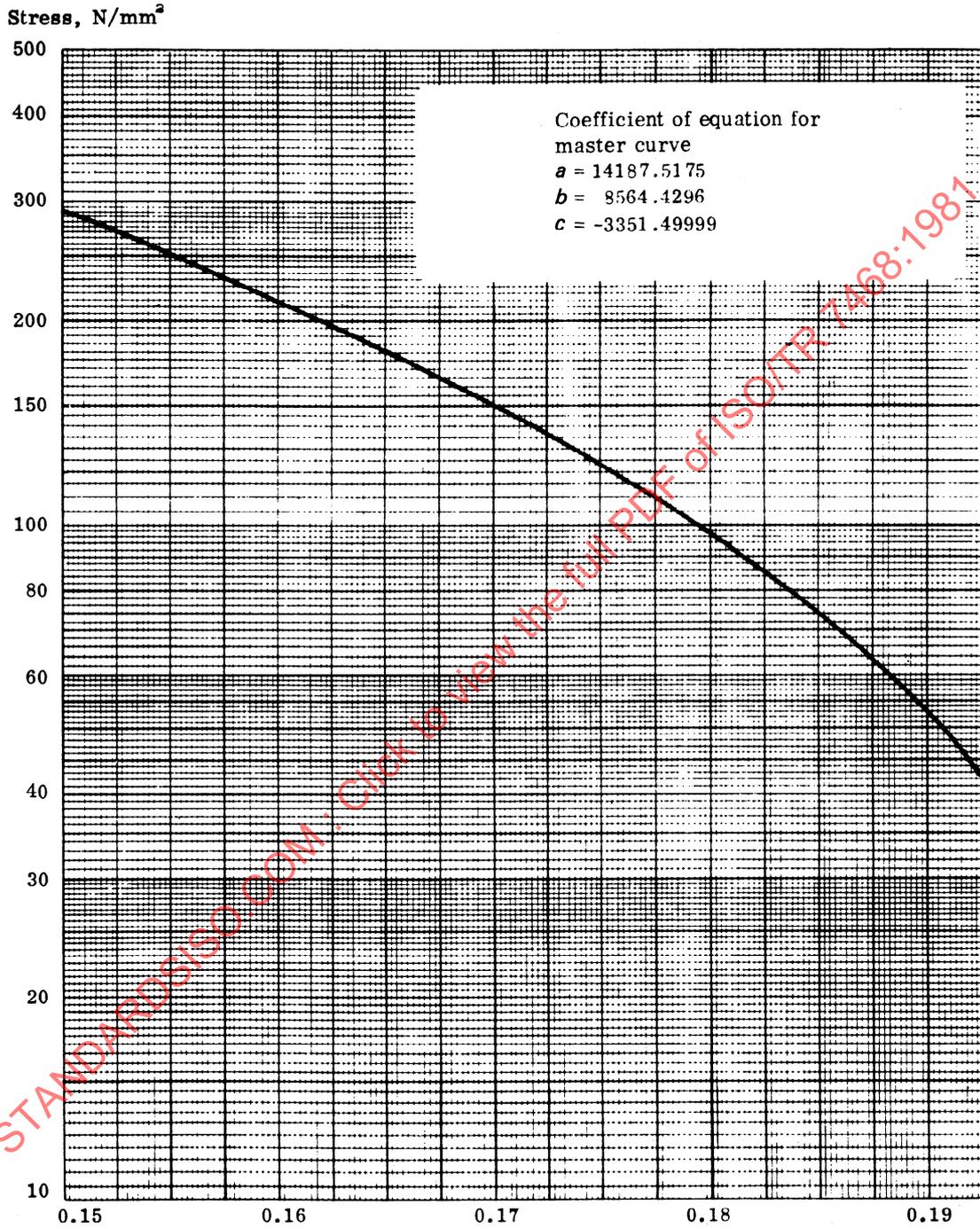
Temperature °C	Test Duration, h				
	<10 000	10 000 - 20 000	20 000 - 30 000	30 000 - 50 000	>50 000
	Number of Test Points Available				
400	30	7	6	2	
450	61	6	2	3	
500	24	3	2	2	

AVERAGE RUPTURE STRESSES N/mm<sup>2</sup>

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
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*	(29)*	(23)*	
500	57	42	35*				
510	47	31					
520	37						

Note: \* Values which have involved extended time extrapolation ) See notes on page 2  
 () Values which have involved extended stress extrapolation )

→ This minimum Mn level was selected since lower levels are known to reduce stress rupture properties



$$P(\sigma) = T(\log t + 20.429050) = a + b(\log \sigma) + c(\log \sigma)^2$$

C STEEL, Si + Al KILLED - TEMPERATURE RANGE 380-520°C

(R/2162)

**CARBON MANGANESE STEELS** (Semi killed or fully killed carbon manganese steels including Nb treated steels)

Properties agreed March 1974  
(Based on ISO document ISO/TC17/SC10/ETP-SG  
(Secretariat 81)99)

Supersedes ISO document ISO/TC17/SC10/ETP-SG(Secretariat 23) 28

**CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY**

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			min	max
Chemical Composition % (m/m)	C	0.09 - 0.29	-	0.30
	Si	0.006 - 0.49	-	0.50
	Mn	0.80 - 1.64	0.80	-
	P	0.008 - 0.048	-	0.050
	S	0.001 - 0.103	-	0.050
	Nb	0.001 - 0.077	-	0.10
Heat Treatment	1. 860 - 960°C AC 2. 840 - 960°C AC + T550 - 720°C		1. Normalised 2. Normalised and Tempered† 3. Hot Finished 4. Hot Finished and Tempered† † See page 11	
Products	Form	Size, mm	All wrought product forms	
	Plates	1 - 133 thk		
	Tubes	6 - 66 thk x 6 - 273 dia		
	Forgings	25 - 150 thk + 25 - 1425 dia		

**QUANTITY AND DURATION OF DATA UPON WHICH THE PROPERTIES ARE BASED**

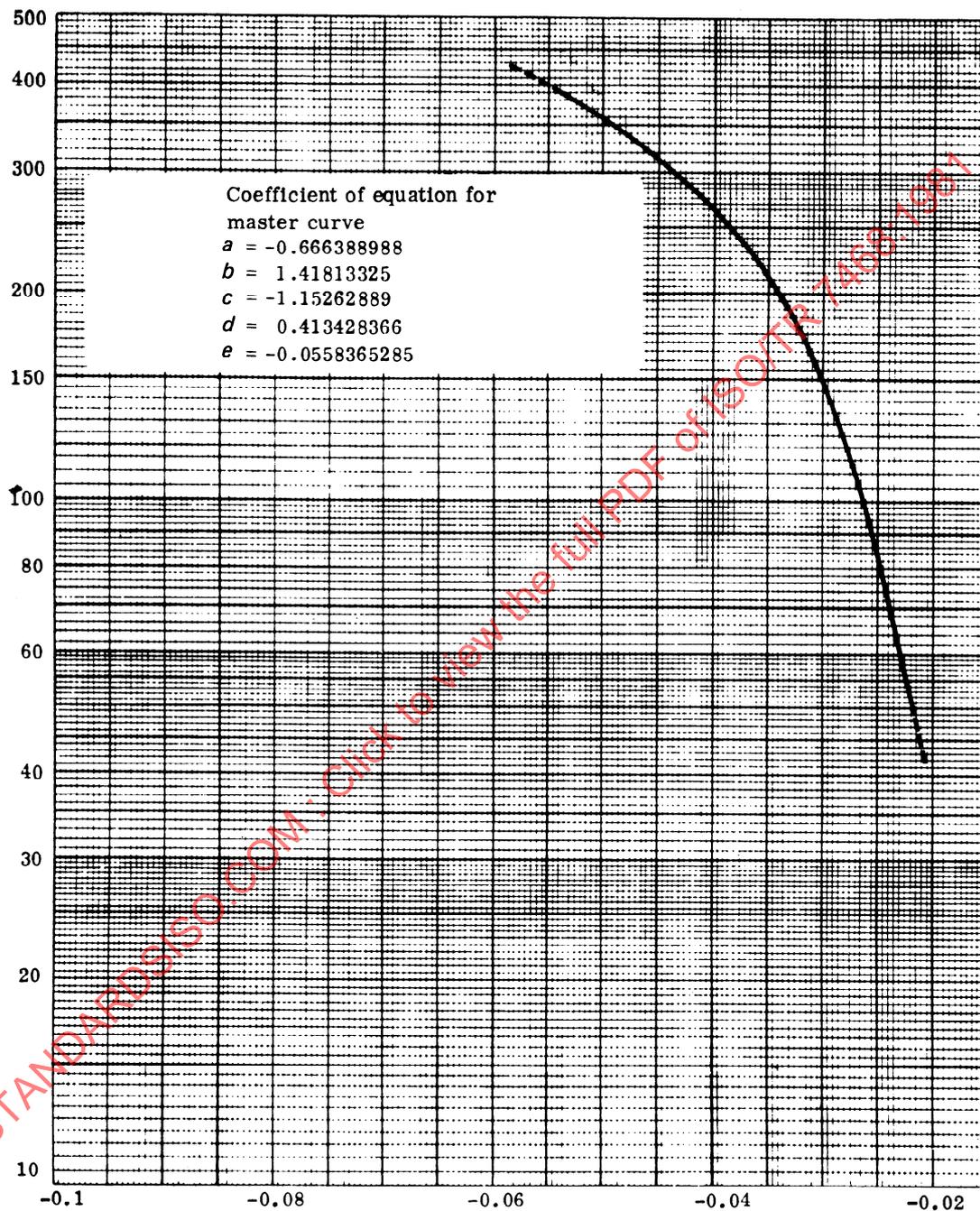
Temperature °C	Test Duration, h					
	<10 000	10 000 - 20 000	20 000 - 30 000	30 000 - 50 000	50 000 - 70 000	> 70 000
	Number of Test Points Available					
400	454	107	51	75	5	4
450	639	84	36	49	16	3
500	596	88	24	38	21	3

**AVERAGE RUPTURE STRESSES N/mm<sup>2</sup>**

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
380	291	262	248	227	215	206*	198*
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)	(44)*	(41)*
490	84	65	57	(47)	(42)	(37)*	(32)*
500	74	57	50	(41)	(34)		
510	65	50	(44)	(32)			
520	58	(44)	(37)				

Note: \* Values which have involved extended time extrapolation ) See notes on page 2  
( ) Values which have involved extended stress extrapolation )

Stress, N/mm<sup>2</sup>



$$P(\sigma) = \frac{\log t - 10.656877}{T - 500} = a + b (\log \sigma) + c (\log \sigma)^2 + d (\log \sigma)^3 + e (\log \sigma)^4$$

ALL C-Mn STEELS - TEMPERATURE RANGE 380-520°C

(R/2166)

CARBON STEEL

Semi killed, Si killed and Si + Al killed.  
Tempered stress relieved, or post weld heat treated  
for times in excess of 3 hours at 620°C.

Properties agreed:

May 1975

In the case of carbon steels which have been tempered,  
stress relieved or post weld heat treated for times in  
excess of 3 hours at 620°C or equivalent times at other  
temperatures, the average rupture stresses should be  
taken as 10% lower than the values given for Si + Al  
killed carbon steels as indicated below.

Temperature °C	Estimated Average Stress (N/mm <sup>2</sup> ) to Produce Rupture in:						
	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
380	192	173	165	154	148	143	140
390	177	158	150	140	134	130	126
400	163	145	137	127	121	117	113
410	149	132	124	114	109	104	102
420	136	120	113	103	97	94	91
430	124	108	101	92	86	83	80
440	113	96	90	81	76	72	69
450	101	86	79	70	66	62	59
460	90	76	69	60	56	52	50
470	80	66	59	51	47	43	41
480	70	57	49	42	37	33	31
490	60	47	41	32	26	21	
500	51	38	32				
510	42	28					
520	33						

No consideration has been given to the inclusion of asterisks but the properties are considered to be conservative.

CARBON MANGANESE STEEL

Semi killed, or fully killed carbon manganese steels including Nb treated steels. Tempered stress relieved or post weld heat treated for times in excess of 3 hours at 620°C.

Properties agreed:

May 1975

In the case of carbon manganese steels which have been tempered, stress relieved, or post weld heat treated for times in excess of 3 hours at 620°C or equivalent times at other temperatures, the rupture stresses should be taken as 10% lower than the values given for carbon manganese steels, as indicated below.

Temperature °C	Estimated Average Stress (N/mm <sup>2</sup> ) to Produce Rupture in:						
	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
380	262	236	223	204	194	185	179
390	239	213	201	183	171	163	157
400	219	193	180	161	150	141	135
410	199	173	159	141	130	122	115
420	180	154	139	122	112	104	97
430	162	136	122	105	95	87	82
440	145	119	106	90	80	74	69
450	129	104	92	77	68	63	59
460	113	89	78	66	59	54	49
470	99	77	68	57	49	47	(43)
480	86	67	59	50	(44)	(40)	(37)
490	76	59	51	(42)	(38)	(33)	(30)
500	67	51	45	(37)	(31)		
510	59	45	(40)	(29)			
520	52	(40)	(33)				

No consideration has been given to the inclusion of asterisks but the properties are considered to be conservative.

Note: ( ) Values which have involved extended stress extrapolation (see notes on page 2).

0.3% Mo STEEL

Properties agreed May 1975

(Based on ISO document ISO/TC17/SC10/ETP-SG(Secretariat 48) 55)

Updated as ISO document ISO/TC17/SC10/ETP-SG(Secretariat 97) 131

CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			min	max
Chemical Composition % (m/m)	C	0.13 - 0.20	0.12	0.25
	Si	0.17 - 0.40	0.10	0.40
	Mn	0.48 - 0.81	0.40	0.80
	P	0.005 - 0.027	-	0.040
	S	0.005 - 0.030	-	0.040
	Mo	0.25 - 0.35	0.25	0.35
	Al (met)	0.006 - 0.008	-	0.012
Heat Treatment	1. 890 - 925°C AC		1. 880/950°C AC	
	2. 900 - 950°C AC + T650°C		2. 880/950°C AC and Tempered 600/650°C	
Products	Form	Size, mm	All wrought product forms	
	Tubes	6.5 - 36 thk x 133 - 368 dia		
	Bars	25 dia		
	Plates	20 thk		
	Forgings	20 - 25 thk + 20 - 210 dia		

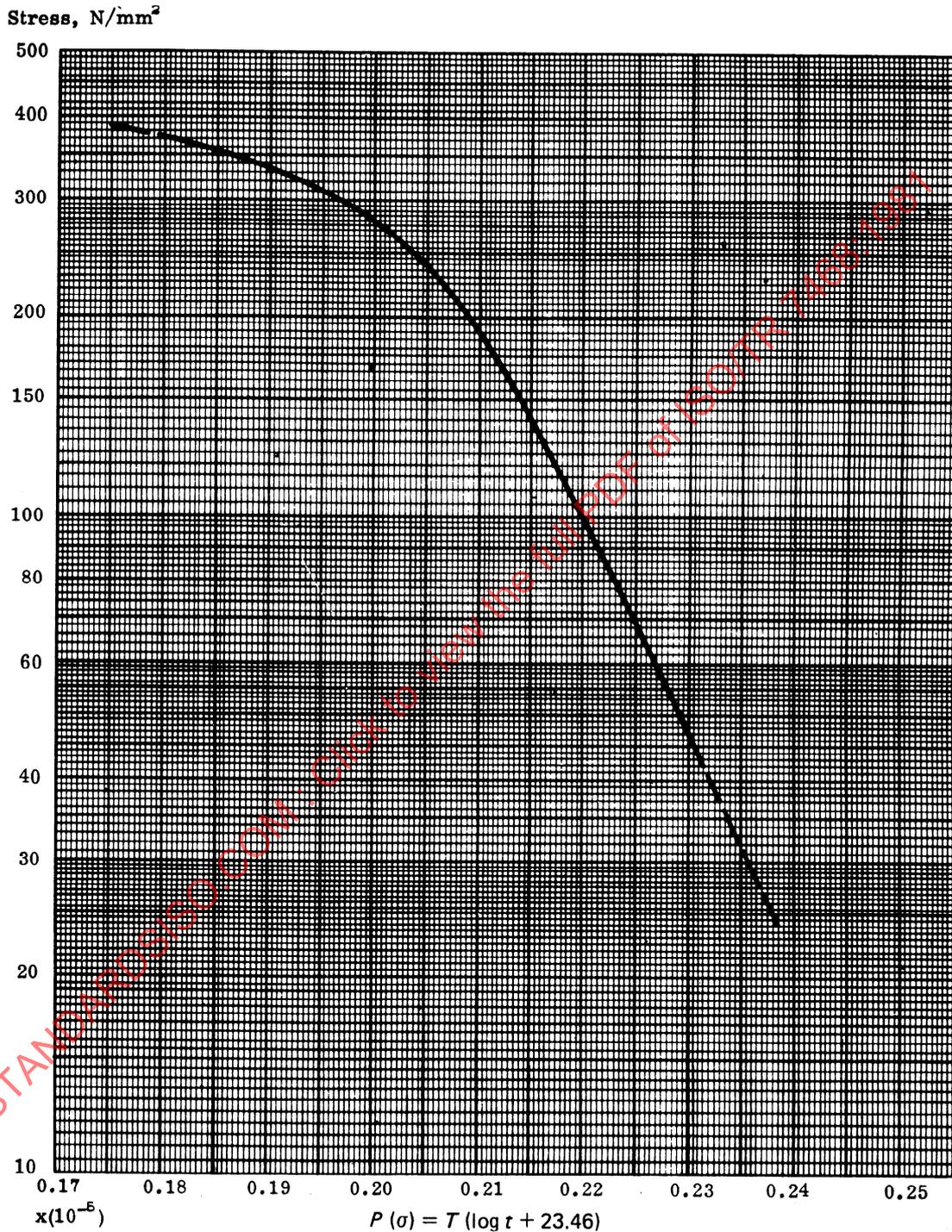
QUANTITY AND DURATION OF DATA ON WHICH THE PROPERTIES ARE BASED

Temperature °C	Test Duration, h				
	<10 000	10 000 - 20 000	20 000 - 30 000	30 000 - 50 000	>50 000
	Number of Test Points Available				
450	30	7	4	2	1
500	110	23	14	6	3
550	81	11	3	2	1

AVERAGE RUPTURE STRESSES N/mm<sup>2</sup>

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
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)*	(39)*	(36)*	(33)*
550	64	49	(42)	(34)*			

Note: \* Values which have involved extended time extrapolation ) see notes on page 2  
 () Values which have involved extended stress extrapolation )



0.3% Mo STEEL - TEMPERATURE RANGE 450-550°C

(R/7909)

0.5% Mo STEEL

Properties agreed May 1975  
 (Based on ISO document ISO/TC17/SC10/ETP-SG  
 (Secretariat 96) 130)

CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			<u>min</u>	<u>max</u>
Chemical Composition % (m/m)	C	0.07 - 0.26	0.08	0.25
	Si	0.01 - 0.34	-	0.40
	Mn	0.42 - 0.78	0.40	0.80
	P	0.008 - 0.036	-	0.040
	S	0.007 - 0.048	-	0.040
	Mo	0.40 - 0.61	0.40	0.65
	Al (total)	0.002 - 0.018	-	0.012
Heat Treatment	1. Cold drawn + T720°C 2. 720 - 871°C FC 3. 900 - 1100°C AC 4. 880 - 1093°C AC T600 - 710°C		1. 900/1000°C AC 2. 900/1000°C AC and Tempered 600/700°C	
Products	Form	Size, mm	All wrought product forms	
	Plates	22 - 116 thk		
	Tubes	7.6 - 35 thk x 51 - 2000 dia		
	Bars	10 - 25 dia		
	Forgings	20 - 355 dia		

QUANTITY AND DURATION OF DATA ON WHICH THE PROPERTIES ARE BASED

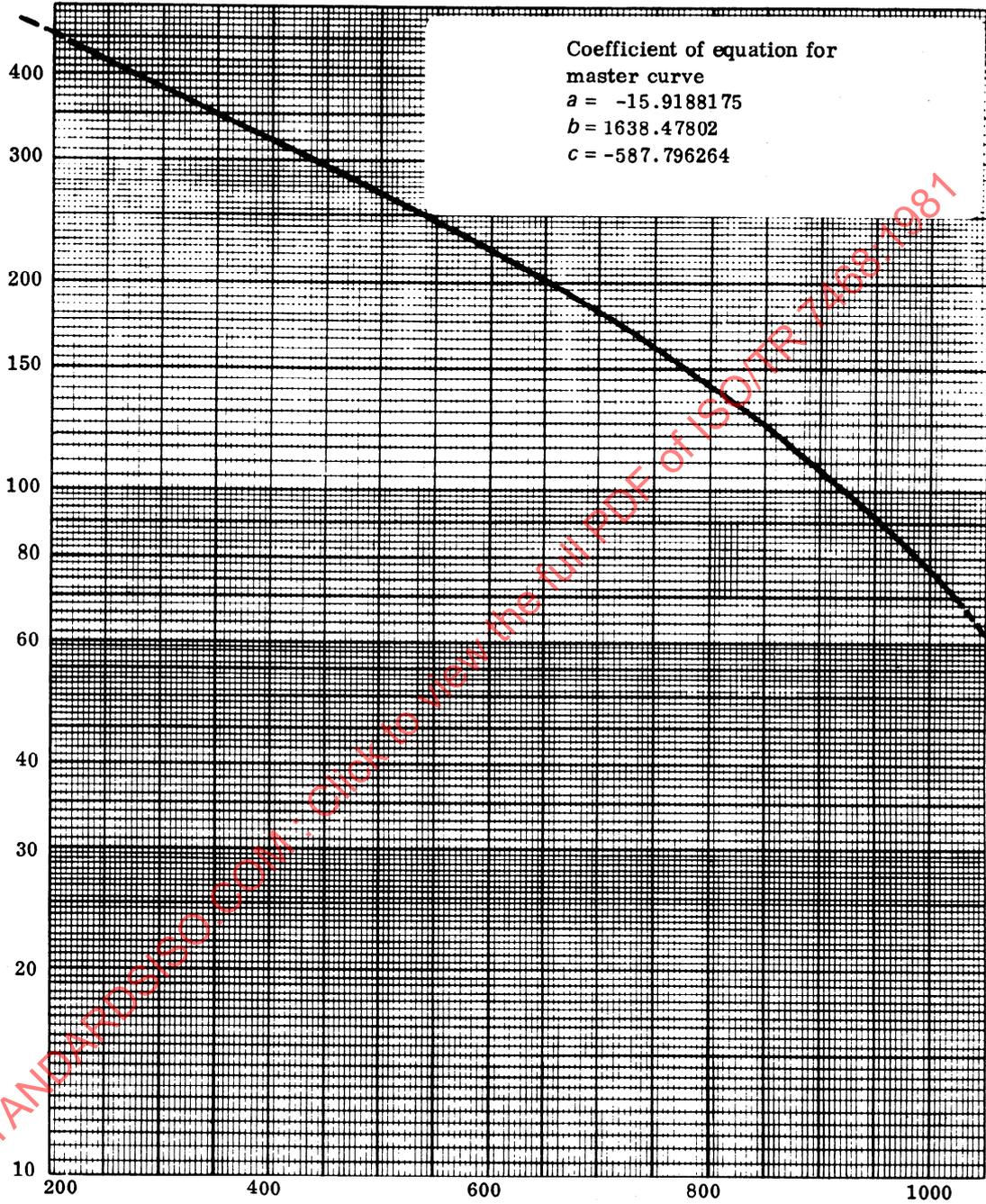
Temperature °C	Test Duration, h				
	< 10 000	10 000 - 20 000	20 000 - 30 000	30 000 - 50 000	> 50 000
	Number of Test Points Available				
450/454	47	20	8	11	12
500	97	22	18	7	3
550	83	17	7	4	3

AVERAGE RUPTURE STRESSES N/mm<sup>2</sup>

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
450	327	307	298	286	280	275*	271*
460	297	276	267	254	247	242*	238*
470	269	247	237	224	217	212*	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						

Note: \* Values which have involved extended time extrapolation )  
 () Values which have involved extended stress extrapolation ) See notes on page 2

Stress, N/mm<sup>2</sup>



$$P(\sigma) = (T - 650) (\log t + 1.3147382) = a + b (\log \sigma) + c (\log \sigma)^2$$

0.5% Mo STEEL - TEMPERATURE RANGE 450-570°C

(R/2164)

1/2% Cr, 1/2% Mo, 1/4% V STEEL

Properties agreed May 1975  
 (Based on ISO document ISO/TC17/SC10/ETP-SG(Secretariat 9) 9)  
 Updated as ISO document ISO/TC17/SC10/ETP-SG(Secretariat 105) 139

CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			min	max
Chemical Composition % (m/m)	C	0.085 - 0.17	0.08	0.18
	Si	0.12 - 0.42	0.10	0.40
	Mn	0.36 - 0.71	0.40	0.70
	P	0.007 - 0.035	-	0.040
	S	0.004 - 0.043	-	0.040
	Cr	0.25 - 0.66	0.30	0.60
	Mo	0.40 - 0.70	0.40	0.70
	V	0.17 - 0.35	0.22	0.35
	Al (met)	0.0009 - 0.020	-	0.020
	Ni	0.03 - 0.57	-	-
Heat Treatment	910 - 1000°C AC + T660 - 750°C		930/980°C AC and Tempered 670/720°C	
Products	Form	Size, mm	All wrought product forms	
	Plates	25 - 75 thk		
	Tubes	8 - 89 thk x		
		82 - 1000 dia		
	Bars	20 - 35 thk + 15 - 380 dia		
Forgings	4 - 713 dia			

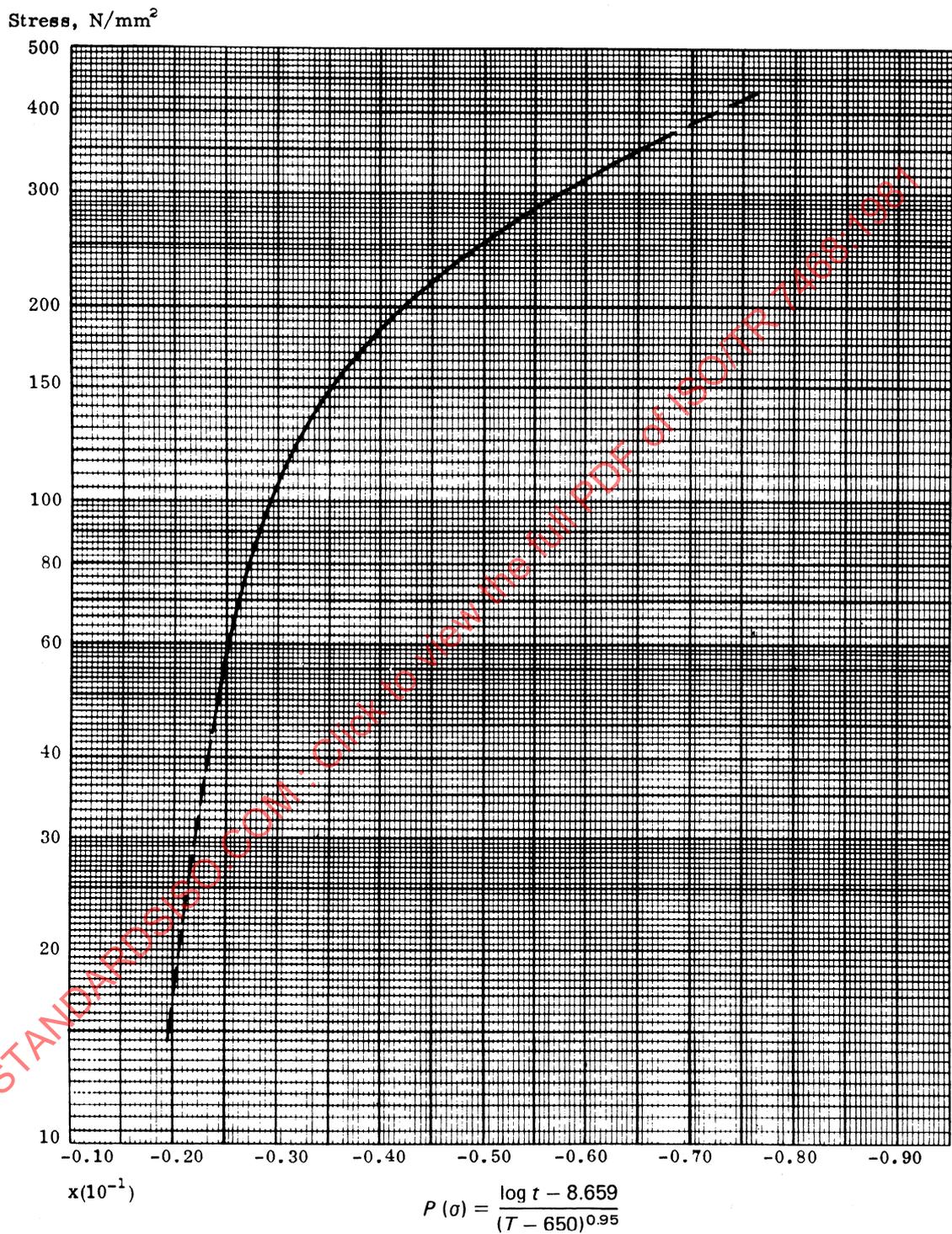
QUANTITY AND DURATION OF DATA ON WHICH THE PROPERTIES ARE BASED

Temperature °C	Test Duration, h					
	<10 000	10 000 - 20 000	20 000 - 30 000	30 000 - 50 000	50 000 - 70 000	>70 000
	Number of Test Points Available					
500	208	44	13	10	2	4
525	52	16	5	6		
550	392	96	40	28	2	4
575	232	47	6	12	5	1
600	394	54	15	4	2	

AVERAGE RUPTURE STRESSES N/mm<sup>2</sup>

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
480	299	261	243	218	205	194*	185*
490	268	232	217	191	179	169*	160*
500	241	209	193	170	156	146*	138*
510	219	187	172	150	136	127*	119*
520	198	168	153	131	119	109*	101*
530	179	152	136	116	101	91*	83*
540	164	135	121	100	85	76*	68*
550	148	121	107	85	70	61*	54*
560	134	107	92	72	57	(48)*	(42)*
570	121	93	78	59	(45)	(37)*	(32)*
580	108	80	66	(46)	(35)	(28)*	
590	95	67					
600	78	(50)					

Note: \* Values which have involved extended time extrapolation ) See notes on page 2  
 () Values which have involved extended stress extrapolation )



½% Cr, ½% Mo, ¼% V STEEL - TEMPERATURE RANGE 480-600°C

(R/7910)

1Cr 1Mo STEEL

Properties agreed May 1969  
 (Based on ISO document ISO/TC17/SC10/ETP-SG  
 (Secretariat 17) 22)

CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			min	max
Chemical Composition % (m/m)	C	0.08 - 0.18	0.10	0.20
	Si	0.14 - 0.67	-	0.40
	Mn	0.42 - 0.80	0.40	0.70
	P	0.005 - 0.039	-	0.040
	S	0.004 - 0.050	-	0.040
	Cr	0.72 - 1.17	0.70	1.20
	Mo	0.39 - 0.66	0.40	0.65
Heat Treatment	1. 900°C FC		1. 900 - 960°C AC	
	2. 920°C FC T 720°C		2. 900 - 960°C AC and Tempered 620-720°C	
	3. 920 - 940°C cc 40-60°C			
	4. 920-950°C cc T 680°C			
	5. 875 - 1000°C AC			
	6. 900 - 970°C AC T 585 - 750°C			
	7. 920 - 925°C OQ T 630 - 720°C			
Products	Form	Size, mm	All wrought product forms	
	Bars	15 - 70 dia		
	Plates	18 - 150 thk		
	Tubes	6 - 88 thk		
	Forgings	20 - 462 sq		

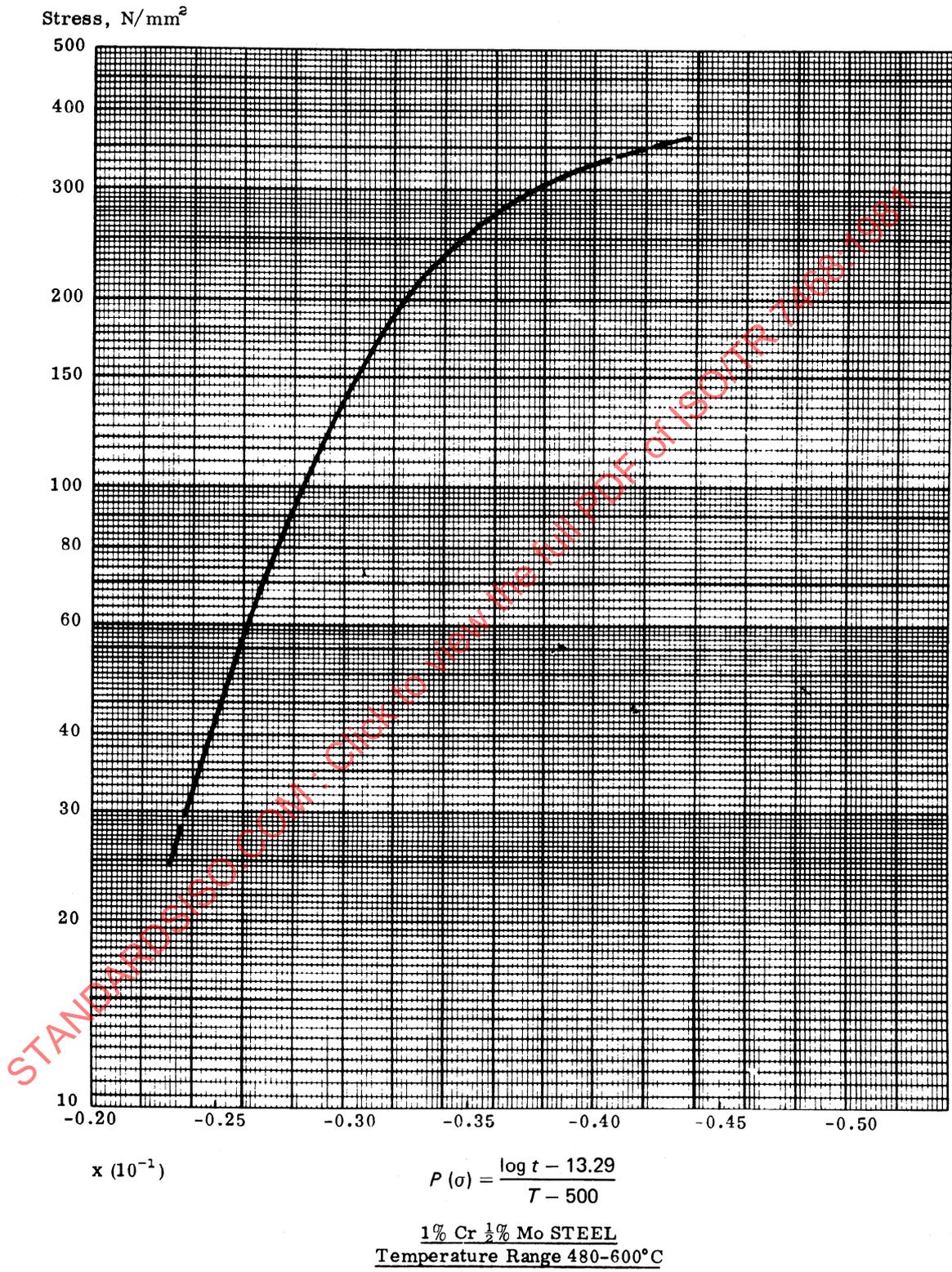
QUANTITY AND DURATION OF DATA UPON WHICH THE PROPERTIES ARE BASED

Temperature °C	Test Duration, h				
	< 10 000	10 000- 20 000	20 000- 30 000	30 000- 50 000	>50 000
	Number of Test Points Available				
500	278	34	13	11	3
550	384	33	10	7	5
600	185	7			

AVERAGE RUPTURE STRESSES, N/mm<sup>2</sup>

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
480	304	267	239	210	194*	180*	170*
490	273	233	207	177	161*	148*	139*
500	239	200	177	146	132*	122*	114*
510	209	169	149	121	108*	99*	91*
520	179	140	124	99	87*	79*	74*
530	154	116	101	81	71	64*	59*
540	129	96	82	67	57	52*	48*
550	109	79	68	54	46	42*	39*
560	91	66	55	43	38	34*	32*
570	76	54	45	35	(31)	(28)*	(26)*
580	64	44	-	-	-	-	-
590	53	36	-	-	-	-	-
600	44	(29)	-	-	-	-	-

\* Values which have involved extended time extrapolation )  
 ( ) Values which have involved extended stress extrapolation ) See notes on page 2



(7911)

2½Cr 1Mo STEEL (Annealed or normalised and tempered at temperatures up to 780°C)

Properties agreed May 1969

(Based on ISO document ISO/TC17/SC10/ETP-SG (Secretariat 16) 21)

CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			min	max
Chemical Composition % (m/m)	C	0.03 - 0.15	0.08	0.15
	Si	0.07 - 0.50	-	0.50
	Mn	0.29 - 0.63	0.40	0.70
	P	0.005 - 0.026	-	0.040
	S	0.004 - 0.034	-	0.040
	Cr	2.00 - 2.52	2.00	2.50
	Mo	0.84 - 1.13	0.90	1.20
	Al <sub>met</sub>			0.02
Heat Treatment	1. 900 - 1030°C AC, T 750 - 775°C		1. 900 - 960°C FC	
	2. 890 - 980°C FC, to 500 - 720°C		2. 900 - 960°C AC and tempered 650 - 780°C	
Products	Form	Size, mm	All wrought product forms	
	Bars Tubes	6 - 60 dia 6.4 - 63.5 thk		

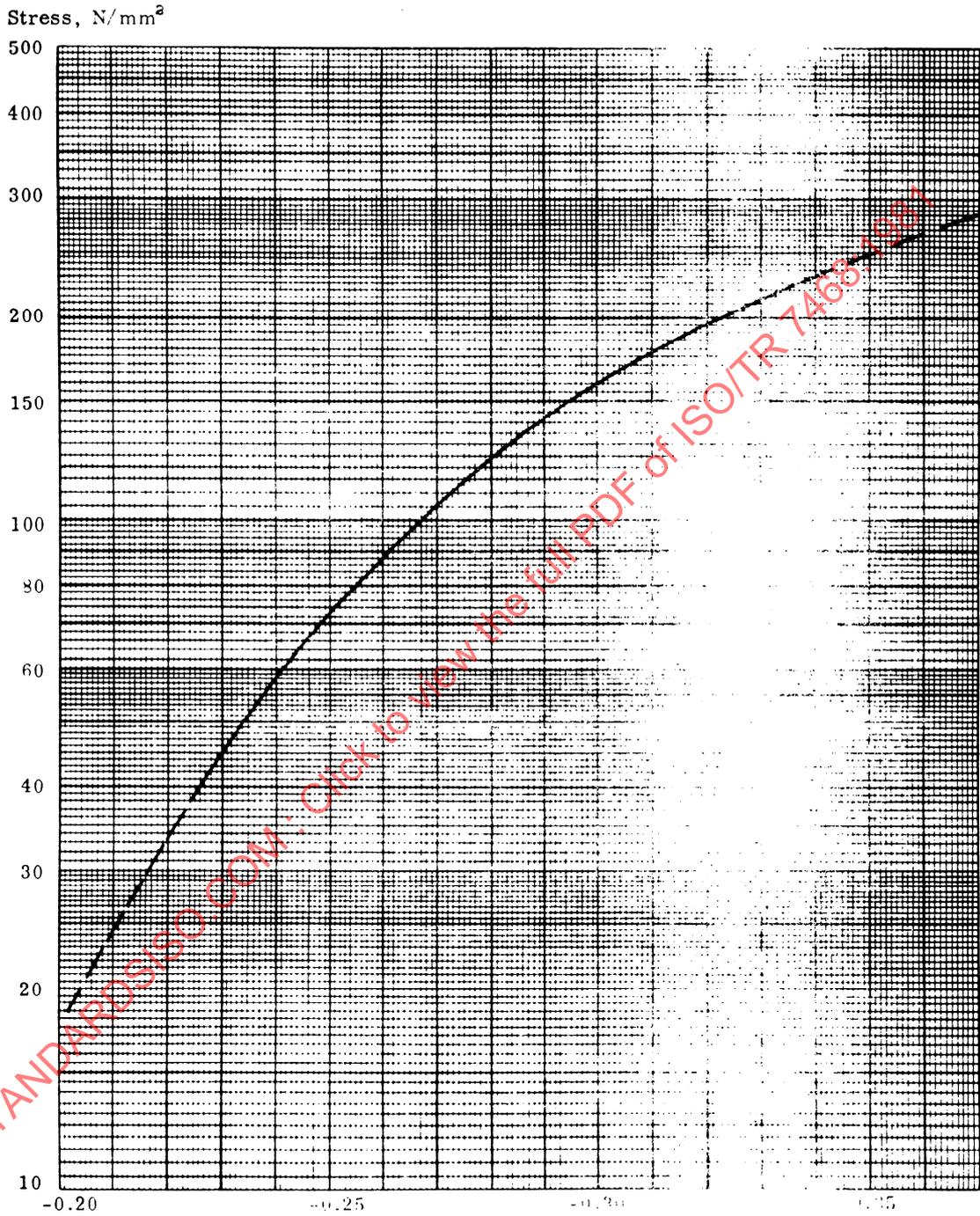
QUANTITY AND DURATION OF DATA UPON WHICH THE PROPERTIES ARE BASED

Temperature °C	Test Duration, h				
	< 10 000	10 000-20 000	20 000-30 000	30 000-50 000	> 50 000
	Number of Test Points Available				
500	44	4		3	
530	22				
538	36	1	1		
550	102		5	4	1
560	27	1			
570	47	9	1	2	
575	75	7	4	3	
590	22	3			
593	31	3	1		
600	90	10	7	4	
649/650	27				

AVERAGE RUPTURE STRESSES, N/mm<sup>2</sup>

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
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)*	(32)*	(30)*
600	61	48	42	(34)*	(30)*	(28)*	(26)*

\* Values which have involved extended time extrapolation )  
 ( ) Values which have involved extended stress extrapolation ) See notes on page.2



$x (10^{-2})$

$$P(\sigma) = \frac{\log t - 15.41}{T - 400}$$

2¼ % Cr 1% Mo STEEL (ANNEALED OR NORMALISED AND TEMPERED AT TEMPERATURES UP TO 780 °C)  
Temperature Range 450-600 °C

(7912)

2½Cr 1Mo STEEL (Normalised and tempered at temperatures up to 750°C)

Properties agreed May 1969  
 (Based on ISO document ISO/TC17/SC10/ETP-SG  
 (Secretariat 16) 21)

CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
Chemical Composition % (m/m)	C	0.075 - 0.195	<u>min</u> 0.08	<u>max</u> 0.15
	Si	0.11 - 0.65	-	0.50
	Mn	0.29 - 0.75	0.30	0.80
	P	0.005 - 0.030	-	0.040
	S	0.004 - 0.037	-	0.040
	Cr	2.01 - 2.67	2.00	2.50
	Mo	0.86 - 1.28	0.90	1.20
	Al <sub>met</sub>		-	0.020
Heat Treatment	1. 898 - 1025°C, T 625 - 750°C 2. 885 - 980°C FC, T 500 - 700°C		1. 900 - 1030°C AC and Tempered 650 - 750°C	
Products	Form	Size, mm	All wrought product forms	
	Bars	6 - 127 dia		
	Plates	60 - 152 thk		
	Tubes	8 - 85.7 thk		

QUANTITY AND DURATION OF DATA UPON WHICH THE PROPERTIES ARE BASED

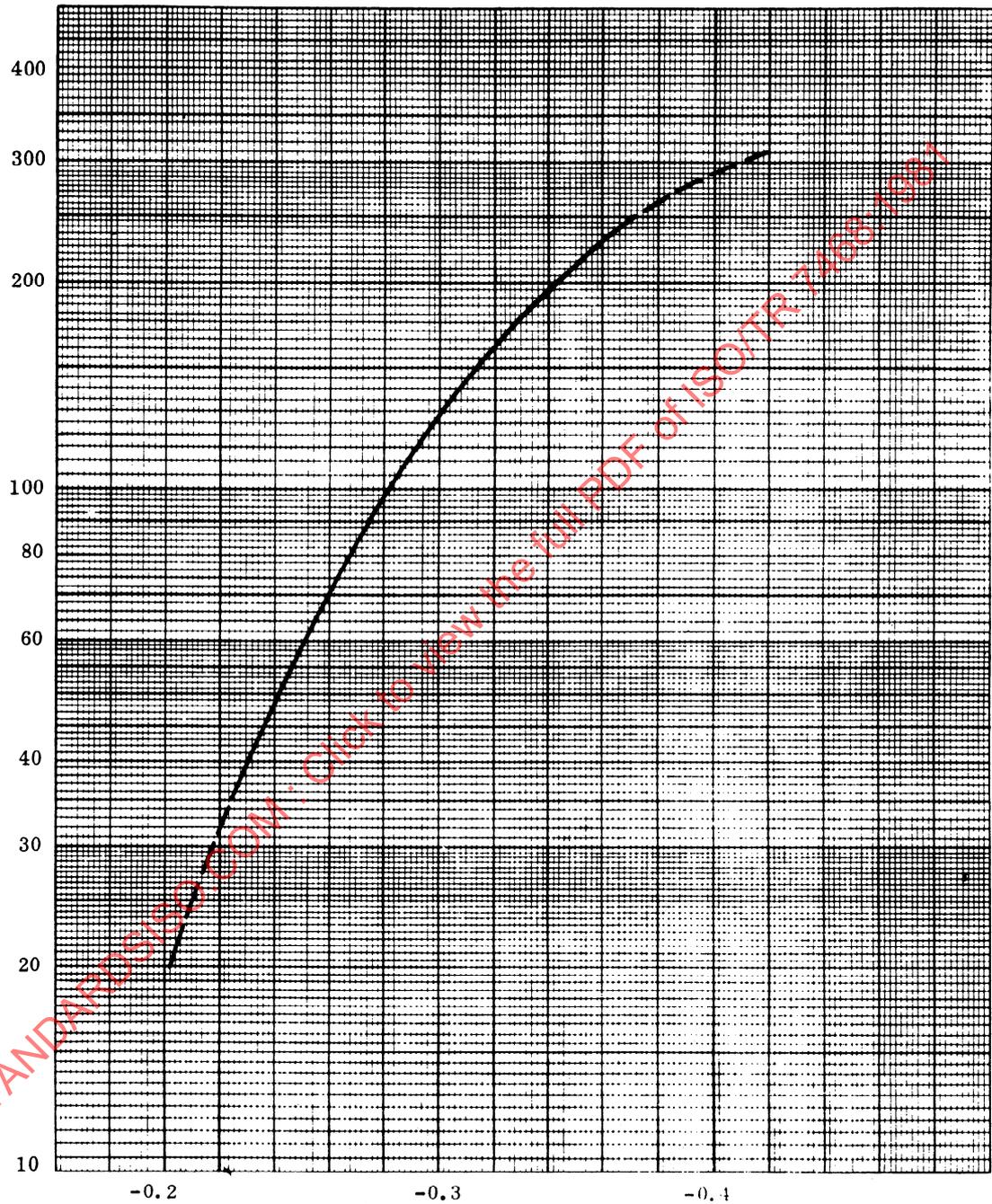
Temperature °C	Test Duration, h				
	<10 000	10 000- 20 000	20 000- 30 000	30 000- 50 000	> 50 000
	Number of Test Points Available				
500	71	8	2	1	
525	32				
538	50	2	1	1	
550	204	19	10	1	3
565/566	54	15	4	4	
570	102	5	1		
575	51	5	4	2	
593	57	7	7	5	5
600	206	12	5	4	2
625	30				
650	46				

AVERAGE RUPTURE STRESSES, N/mm<sup>2</sup>

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
450	(309)	(276)*	(257)*	221*	209*	203*	198*
460	(285)	(254)*	236*	204*	192*	186*	181*
470	(263)	233*	217*	186*	175*	169*	164*
480	240	213	197*	170*	158**	152*	147*
490	219	192	177*	153*	141*	135*	130*
500	196	172	158*	137*	126*	119*	113*
510	176	152	139*	122*	110*	103*	98*
520	155	134	123*	107*	95*	89*	84*
530	137	118	107	93	82*	77*	74*
540	122	103	93	79	73*	68*	64*
550	108	90	80	69	63*	58*	55*
560	96	79	71	59	54*	50*	47*
570	85	70	62	51	47	43*	41*
580	76	61	54	44	40	(37)*	(35)*
590	68	54	47	(38)	(35)	(32)*	(30)*
600	61	48	42	(34)	(30)	(28)*	(26)*

\* Values which have involved extended time extrapolation )  
 ( ) Values which have involved extended stress extrapolation ) See notes on page 2

Stress, N/mm<sup>2</sup>



x (10<sup>-1</sup>)

$$P(\sigma) = \frac{\log t - 13.36}{T - 500}$$

2 1/4% Cr 1% Mo STEEL (NORMALISED AND TEMPERED AT TEMPERATURES UP TO 750°C )  
Temperature Range 450-600°C

(7923)

5% CrMo STEEL (Annealed)

Properties agreed March 1974  
(Based on ISO document ISO/TC17/SC10/ETP-SG  
(Secretariat 72) 88)

CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			<u>min</u>	<u>max</u>
Chemical Composition % (m/m)	C	0.06 - 0.14	-	0.18
	Si	0.27 - 1.53	-	0.50
	Mn	0.32 - 0.56	0.30	0.60
	P	0.008 - 0.030	-	0.040
	S	0.005 - 0.021	-	0.040
	Cr	4.31 - 5.44	4.00	6.00
	Mo	0.44 - 0.92	0.45	0.65
Heat Treatment	1. 880 - 920°C + T550 - 700°C 2. 920°C 3. 920 - 930°C iso 720 °C 4. 900 - 910°C FC		850/920°C Furnace Cooled	
Products	Form	Size, mm	All wrought product forms	
	Plates	15 - 20 thk		
	Tubes	8 - 20 thk x 101 - 236 dia		
	Bars	19 - 25.5 thk		
	Forgings	25 thk		

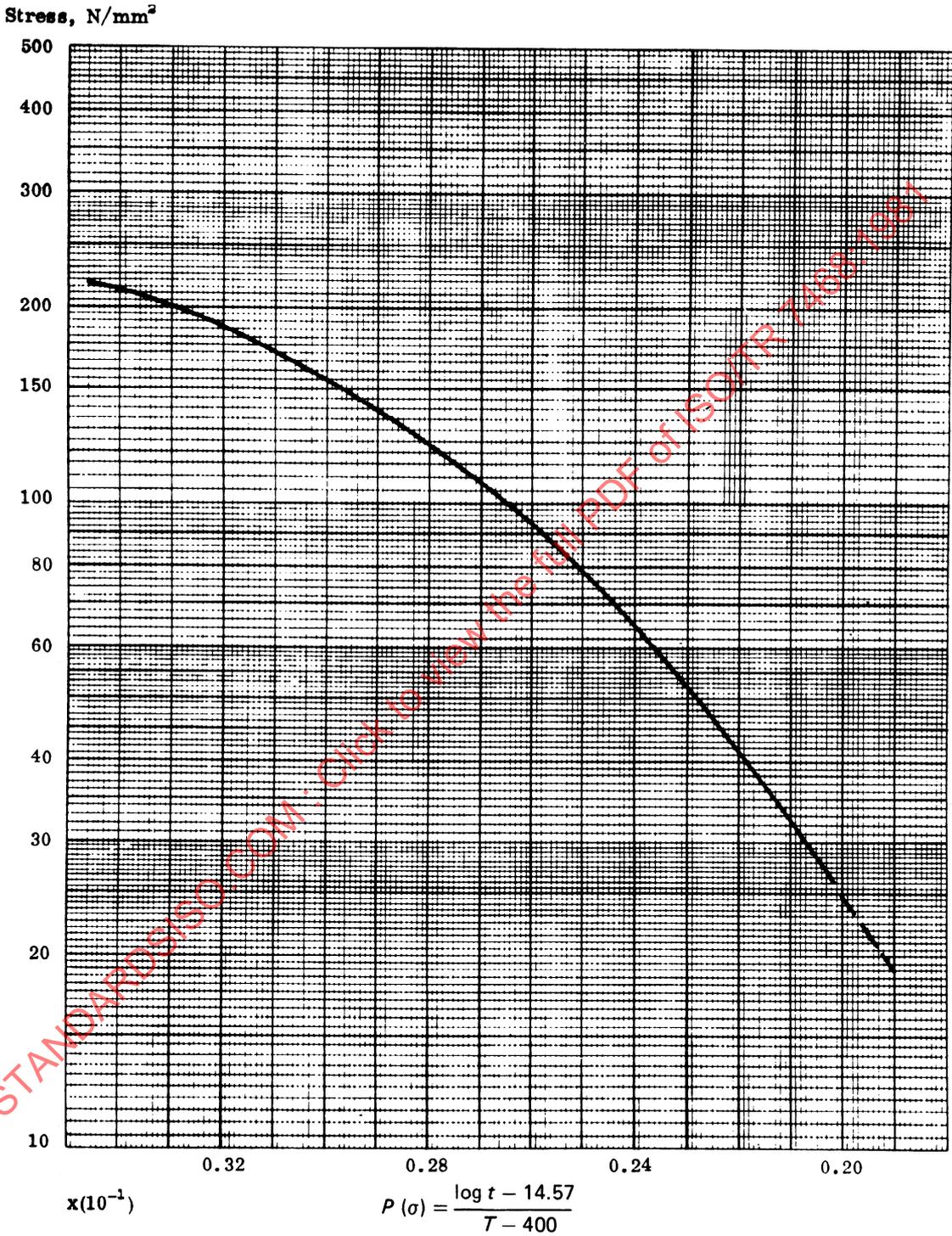
QUANTITY AND DURATION OF DATA UPON WHICH THE PROPERTIES ARE BASED

Temperature °C	Test Duration, h				
	<10 000	10 000 - 20 000	20 000 - 30 000	30 000 - 50 000	>50 000
	Number of Test Points Available				
500	55	12	4	12	
550	62	12	9	2	1
600	92	12	7		1
650	22				

AVERAGE RUPTURE STRESSES N/mm<sup>2</sup>

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
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)						

Note: \* Values which have involved extended time extrapolation ) See notes on page 2  
( ) Values which have involved extended stress extrapolation )



5% CrMo STEEL (ANNEALED) - TEMPERATURE RANGE 450-650°C

(R/2160)

**5% CrMo STEEL** (Normalised and tempered)

Properties agreed March 1974  
 (Based on ISO document ISO/TC17/SC10/ETP-SG  
 (Secretariat 72) 86)

**CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY**

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			min	max
Chemical Composition % (m/m)	C	0.08 - 0.13	-	0.18
	Si	0.24 - 1.43	-	0.50
	Mn	0.26 - 0.49	0.30	0.60
	P	0.011 - 0.025	-	0.040
	S	0.003 - 0.023	-	0.040
	Cr	4.61 - 5.44	4.00	6.00
	Mo	0.44 - 0.58	0.45	0.65
Heat Treatment	1. 950°C WQ + T680°C 2. 900 - 960°C AC + T650 - 760°C 3. 900°C AC 4. 980°C OQ + T730°C		900/975°C AC or WQ and Tempered 650/750°C	
Products	Form	Size, mm	All wrought product forms	
	Tubes	7 - 20 thk x 114 - 400 dia		
	Bars	15 - 25 dia		
	Forgings	60 - 330 dia		

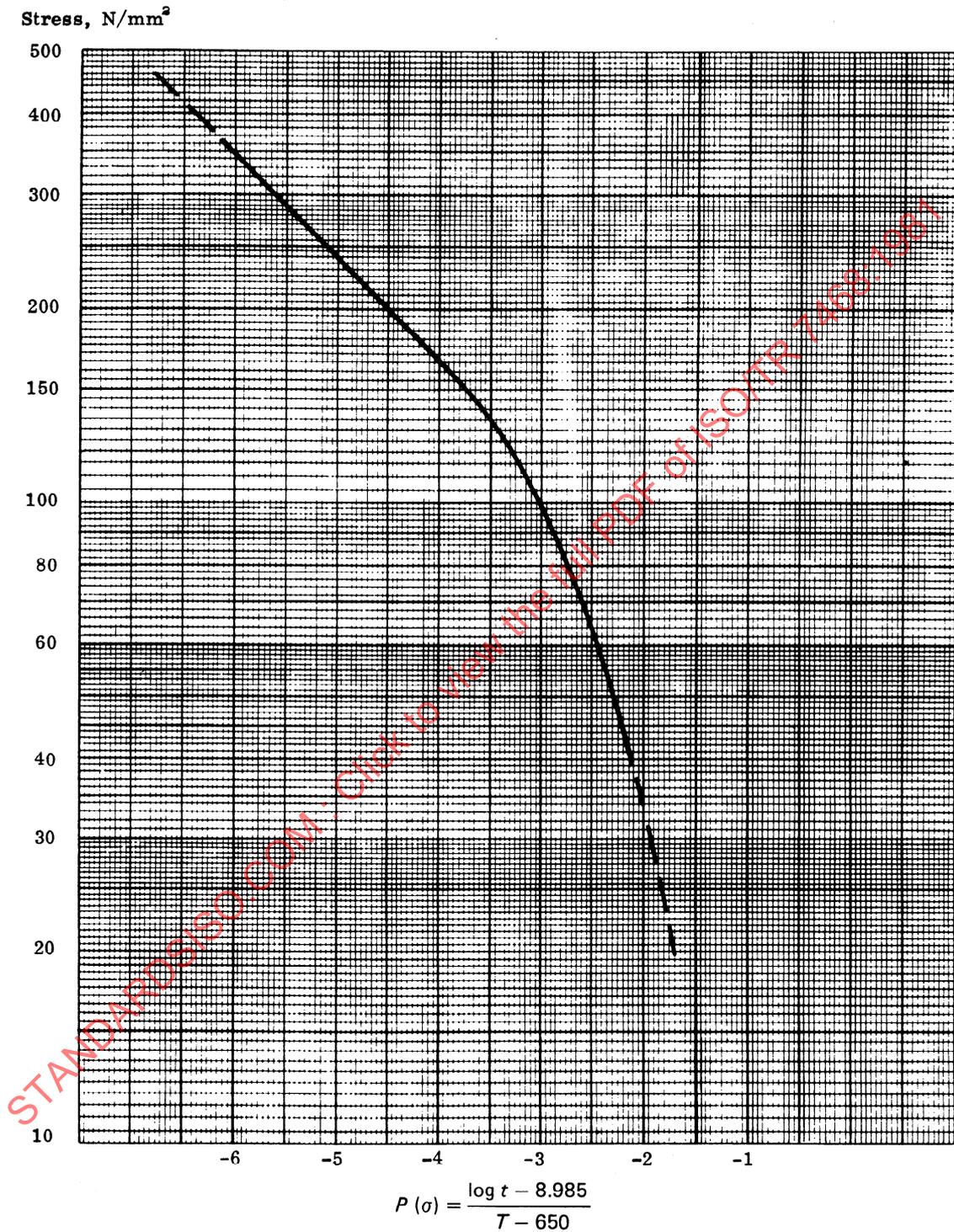
**QUANTITY AND DURATION OF DATA UPON WHICH THE PROPERTIES ARE BASED**

Temperature °C	Test Duration, h				
	<10 000	10 000 - 20 000	20 000 - 30 000	30 000 - 50 000	>50 000
	Number of Test Points Available				
500	36	8	2	1	
550	90	6	1		
575	37	6	2		
600	80	13	2		

**AVERAGE RUPTURE STRESSES N/mm<sup>2</sup>**

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
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	(34)*				
600	46	(35)					
610	40						
620	(36)						

Note: \* Values which have involved extended time extrapolation ) See notes on page 2  
 () Values which have involved extended stress extrapolation )



5% CrMo STEEL (NORMALISED AND TEMPERED) - TEMPERATURE RANGE 450-620°C

(R/2161)

9% Cr, 1% Mo STEEL (Annealed)

Properties agreed March 1974

(Based on ISO document ISO/TC17/SC10/ETP-SG(Secretariat 79) 97)

Supersedes ISO document ISO/TC17/SC10/ETP-SG (Secretariat 25) 30

CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			min	max
Chemical Composition % (m/m)	C	0.075 - 0.16	-	0.18
	Si	0.22 - 0.61	-	1.00
	Mn	0.34 - 0.54	0.30	0.60
	P	0.008 - 0.026	-	0.030
	S	0.006 - 0.034	-	0.030
	Cr	7.60 - 9.85	7.50	10.00
	Ni	0.06 - 0.31	-	-
	Mo	0.87 - 1.07	0.80	1.20
	Al (met)	-	-	-
Heat Treatment	843 - 950°C FC		850/950°C FC	
Products	Form	Size, mm	All wrought product forms	
	Tubes	5.9 - 15 thk x 38 - 168 dia		
	Plates	15 thk		
	Bars	19 - 25 dia		
	Forgings	not stated		

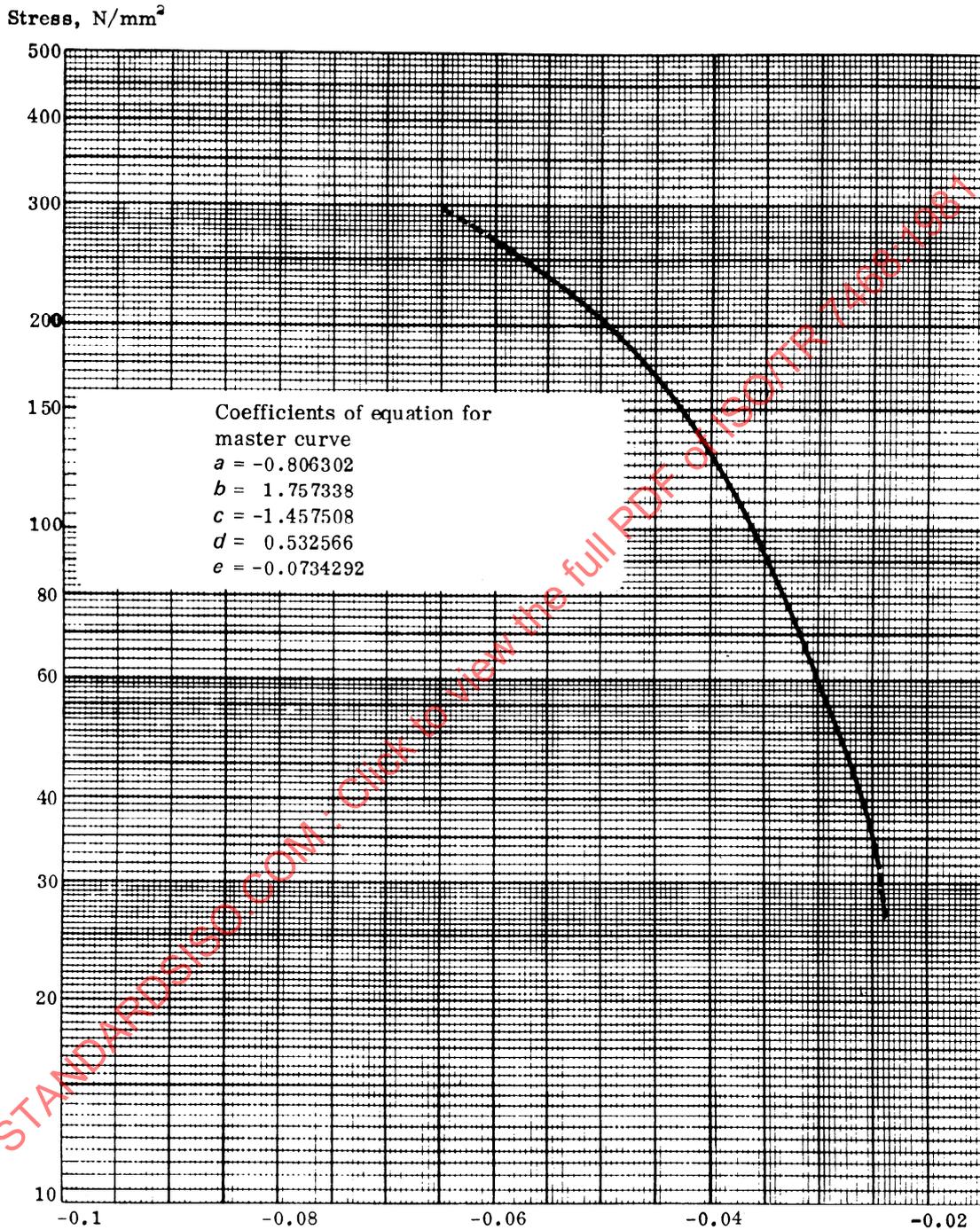
QUANTITY AND DURATION OF DATA UPON WHICH THE PROPERTIES ARE BASED

Temperature °C	Test Duration, h				
	<10 000	10 000 - 20 000	20 000 - 30 000	30 000 - 50 000	> 50 000
	Number of Test Points Available				
500	31	6			
550	40	10	5	2	
600	80	9	1	1	
650	29		2		

AVERAGE RUPTURE STRESSES N/mm<sup>2</sup>

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
450	278	250	245*	229*	220*	214*	209*
460	250	228	218*	203*	194*	188*	182*
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*	(29)*			
620	43	35	(31)*				
630	39	(30)*					
640	35	(26)*					
650	(30)						

Note: \* Values which have involved extended time extrapolation ) See notes on page 2  
 () Values which have involved extended stress extrapolation )



$$P(\sigma) = \frac{\log t - 11.692613}{T - 600} = a + b(\log \sigma) + c(\log \sigma)^2 + d(\log \sigma)^3 + e(\log \sigma)^4$$

9% Cr, 1% Mo STEEL (ANNEALED) - TEMPERATURE RANGE 450-650°C

(R/2163)

9% Cr, 1% Mo STEEL (Normalised and tempered)

Properties agreed May 1975  
 (Based on ISO document ISO/TC17/SC10/ETP-SG  
 (Secretariat 98) 132)

Supersedes ISO document ISO/TC17/SC10/ETP-SG(Secretariat 25) 30

CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			<u>min</u>	<u>max</u>
Chemical Composition % (m/m)	C	0.06 - 0.18	-	0.18
	Si	0.10 - 0.85	-	1.00
	Mn	0.33 - 0.60	0.30	0.60
	P	0.010 - 0.028	-	0.030
	S	0.004 - 0.034	-	0.030
	Cr	8.24 - 9.81	7.50	10.00
	Mo	0.80 - 1.22	0.80	1.20
	Al (met)	0.001 - 0.020	-	0.020
	Ni	0.05 - 0.37	-	-
Heat Treatment	900 - 1010°C AC · T700 - 800°C		900/1000°C AC and Tempered 700/800°C	
Products	Form	Size, mm	All wrought product forms	
	Tubes	3.25 - 11 thk x 28 - 70 dia		
	Bars	20 - 190 dia		
	Forgings	12 - 20 thk		

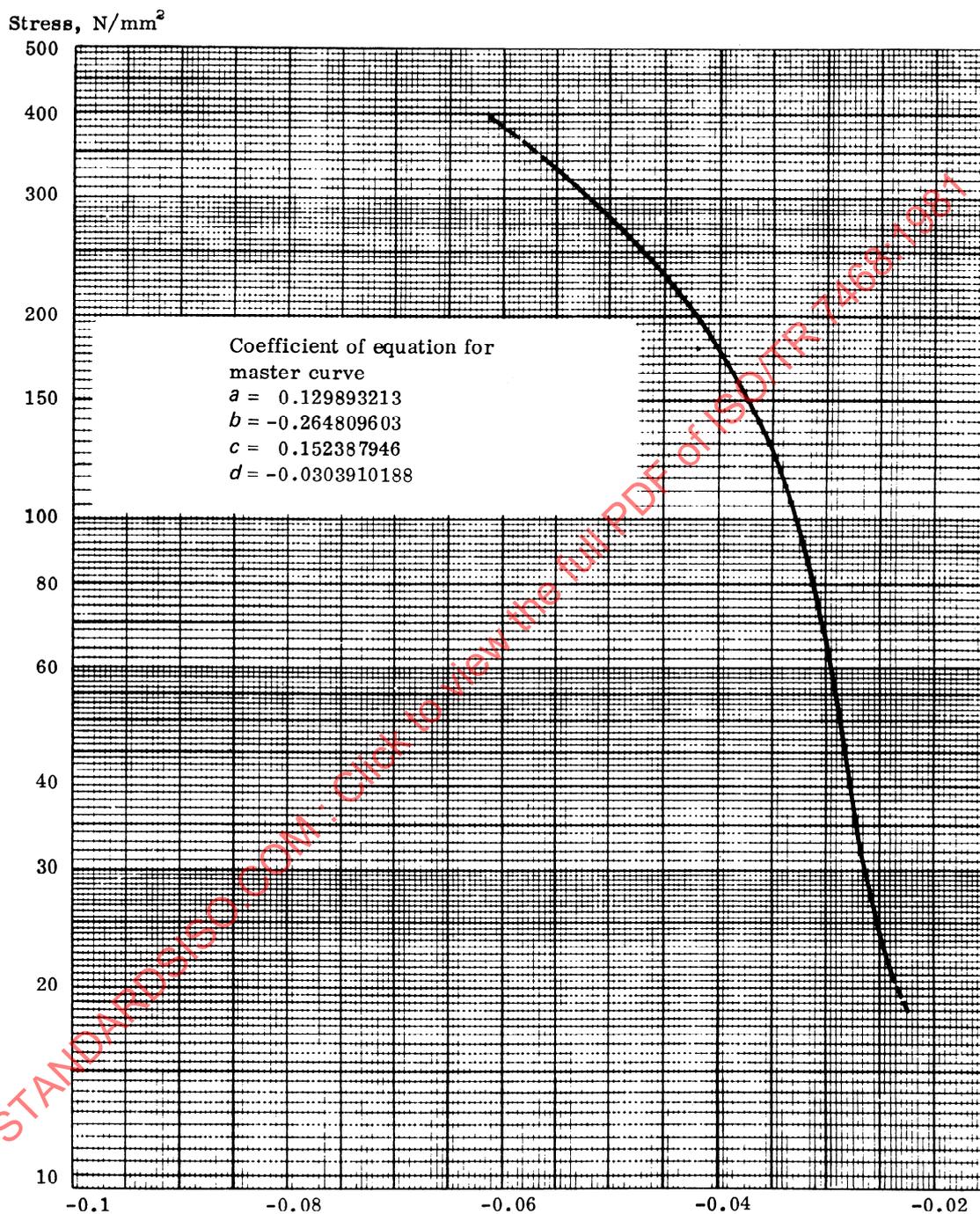
QUANTITY AND DURATION OF DATA UPON WHICH THE PROPERTIES ARE BASED

Temperature °C	Test Duration, h				
	<10 000	10 000 - 20 000	20 000 - 30 000	30 000 - 50 000	> 50 000
	Number of Test Points Available				
500	150	31	9	5	1
550	167	26	15	12	2
600	157	20	3	1	
650	38	5	1		

AVERAGE RUPTURE STRESSES N/mm<sup>2</sup>

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
420	(463)*	(428)*	(412)*	(390)*	(377)*	(368)*	(361)*
430	(416)*	(384)*	(369)*	(349)*	(337)*	(329)*	(322)*
440	(375)*	(345)*	(331)*	(313)*	302*	295*	289*
450	(340)	(312)	299	282*	272*	265*	259*
460	(308)	282	270	254*	245*	238*	233*
470	281	256	245	229*	220*	214*	209*
480	256	232	222	207	198*	192*	187*
490	233	211	201	187	178*	172*	168*
500	213	191	181	168	160*	154*	149*
510	194	173	164	150	143*	137*	132*
520	176	156	147	134	126*	121*	116*
530	160	141	131	118	111*	105*	101*
540	145	126	116	104	96*	90*	86*
550	130	111	102	89	81*	76*	71*
560	117	98	88	75	68*	62*	58*
570	103	84	75	62	55*	50*	46*
580	90	71	62	50*	44*	40*	37*
590	78	59	50	40*	36*	33*	31*
600	66	48	41	34*	30*	29*	27*
610	54	39	34	29*	27*	25*	24*
620	45	33	30	26*	24*	23*	(22)*
630	37	29	26	23*	(22)*	(21)*	(20)*
640	32	26	24	(22)*	(21)*	(20)*	(19)*
650	28	24	(22)	(20)*	(19)*		
660	25	(22)	(20)	(19)*			
670	23	(20)	(19)	(18)*			

Note: \* Values which have involved extended time extrapolation )  
 () Values which have involved extended stress extrapolation ) See notes on page 2



$$P(\sigma) = \frac{\log t - 13.843828}{T - 550} = a + b(\log \sigma) + c(\log \sigma)^2 + d(\log \sigma)^3$$

9% Cr, 1% Mo STEEL (NORMALISED AND TEMPERED) - TEMPERATURE RANGE 420-670°C

(R/2165)

12CrMoV(W) STEEL ( $R_m = 690/840 \text{ N/mm}^2$ )

Properties agreed May 1969

(Based on ISO document ISO/TC17/SC10/ETP-SG (Secretariat 24) 29)

CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			<u>min</u>	<u>max</u>
Chemical Composition % (m/m)	C	0.16 - 0.24	0.17	0.23
	Si	0.17 - 0.50	-	0.50
	Mn	0.32 - 1.20	-	1.00
	P	0.005 - 0.034	-	0.030
	S	0.004 - 0.024	-	0.030
	Cr	10.50 - 13.30	10.00	12.50
	Ni	0.02 - 0.90	0.30	0.80
	Mo	0.51 - 1.39	0.80	1.20
	V	0.21 - 0.40	0.25	0.35
	W	0.40 - 0.82	-	0.70
Heat Treatment	1000 - 1120°C AC + T 700- 800°C		1020 - 1070°C AC and tempered 680 - 780°C	
Products	Form	Size, mm	Tubes Thin section forgings	
	Bars	18 - 190 dia		
	Tubes	4.78 - 40 thk		
	Forgings	16.5 - 25 dia		

QUANTITY AND DURATION OF DATA UPON WHICH THE PROPERTIES ARE BASED

Temperature °C	Test Duration, h				
	<10 000	10 000- 20 000	20 000- 30 000	30 000- 50 000	>50 000
	Number of Test Points Available				
500	35	8	2	4	2
550	129	32	7	6	3
600	127	27	12	3	2
650	58	3			

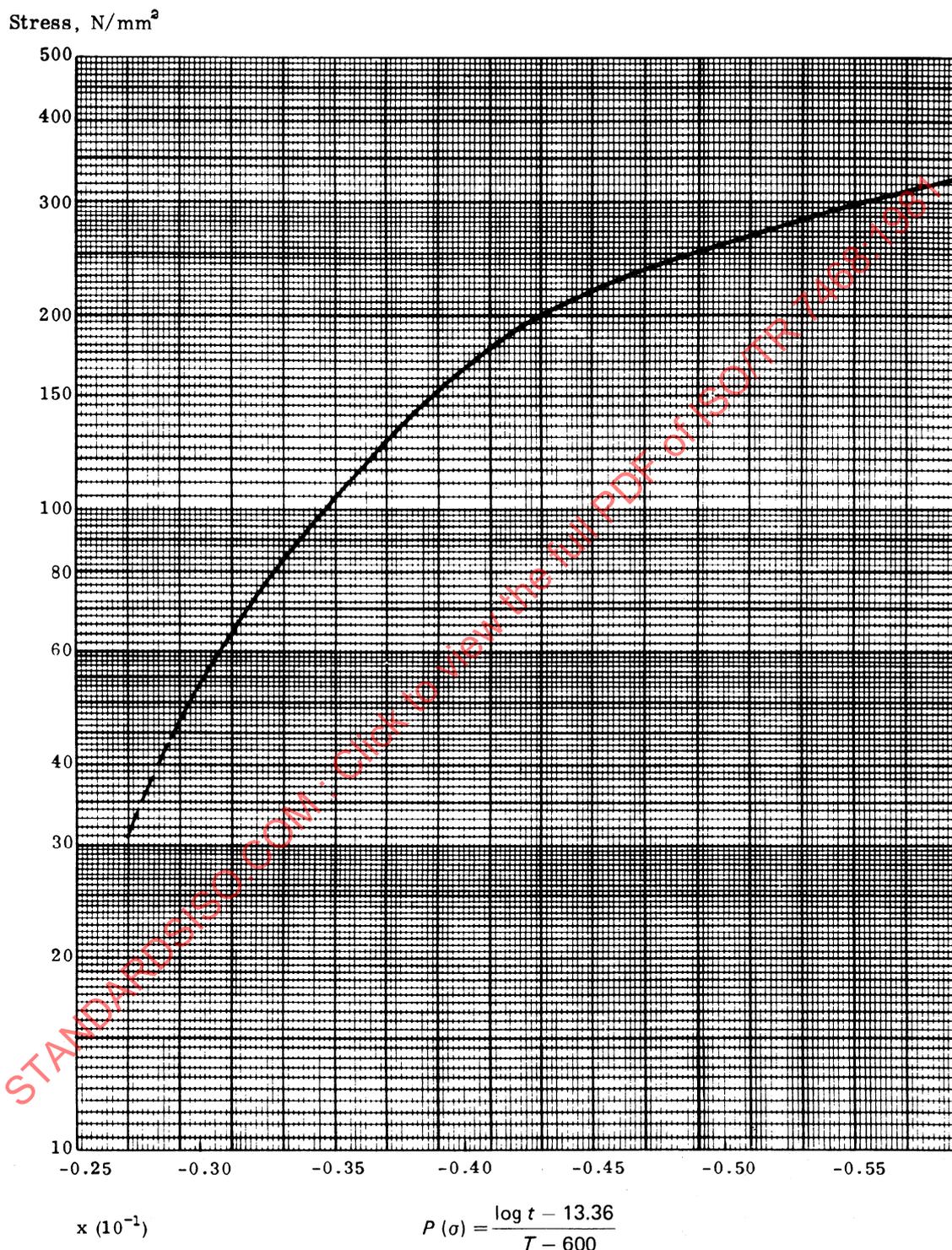
AVERAGE RUPTURE STRESSES,  $\text{N/mm}^2$

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
500	294	271	261	248	239*	234*	229*
510	274	250	238	225	219*	213*	208*
520	253	228	217	202	197*	190*	185*
530	232	208	195	180	175*	167*	161
540	213	187	175	159	150*	143*	137
550	192	168	155	139	128*	122*	117*
560	173	148	136	121	110*	104*	100*
570	154	130	119	104	94*	89*	84*
580	136	113	102	88	80*	76*	72*
590	119	97	87	75	68*	64*	60*
600	101	81	74	63	57*	53*	50*
610	87	70	62	52	48*	(44)*	(41)*
620	74	58	51	(43)	(39)*	(36)*	(33)*
630	63	49*	(42)*	-	-	-	-
640	53	(41)*	(35)*	-	-	-	-
650	46	(36)*	(30)*	-	-	-	-

\* Values which have involved extended time extrapolation )

) See notes on page 2

( ) Values which have involved extended stress extrapolation )



12% Cr-Mo-V-(W) STEEL ( $R_m = 690/840 \text{ N/mm}^2$ )

Temperature Range 500-650°C

**12CrMoV(W) STEEL** ( $R_m = 790/940 \text{ N/mm}^2$ )

Properties agreed May 1969

(Based on ISO document ISO/TC17/SC10/ETP-SG (Secretariat 24) 29)

**CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY**

Chemical Composition % (m/m)	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			<u>min</u>	<u>max</u>
C	0.18 - 0.25		-	0.23
Si	0.21 - 0.50		0.15	0.40
Mn	0.37 - 1.39		0.30	1.00
P	0.011 - 0.027		-	0.040
S	0.008 - 0.027		-	0.040
Cr	10.50 - 13.50		11.00	12.50
Ni	0.02 - 0.78		0.30	1.0
Mo	0.95 - 1.35		0.70	1.20
V	0.15 - 0.48		0.20	0.35
W	0.40 - 0.59		-	0.70
Heat Treatment	1000 - 1150°C AC + T 600 - 750°C		1020 - 1070°C OQ or WQ tempered 680 - 780°C	
Products	Form	Size, mm	Thick section forgings	
	Bars	19 - 150 dia		
	Forgings	16.5 - 23 dia		

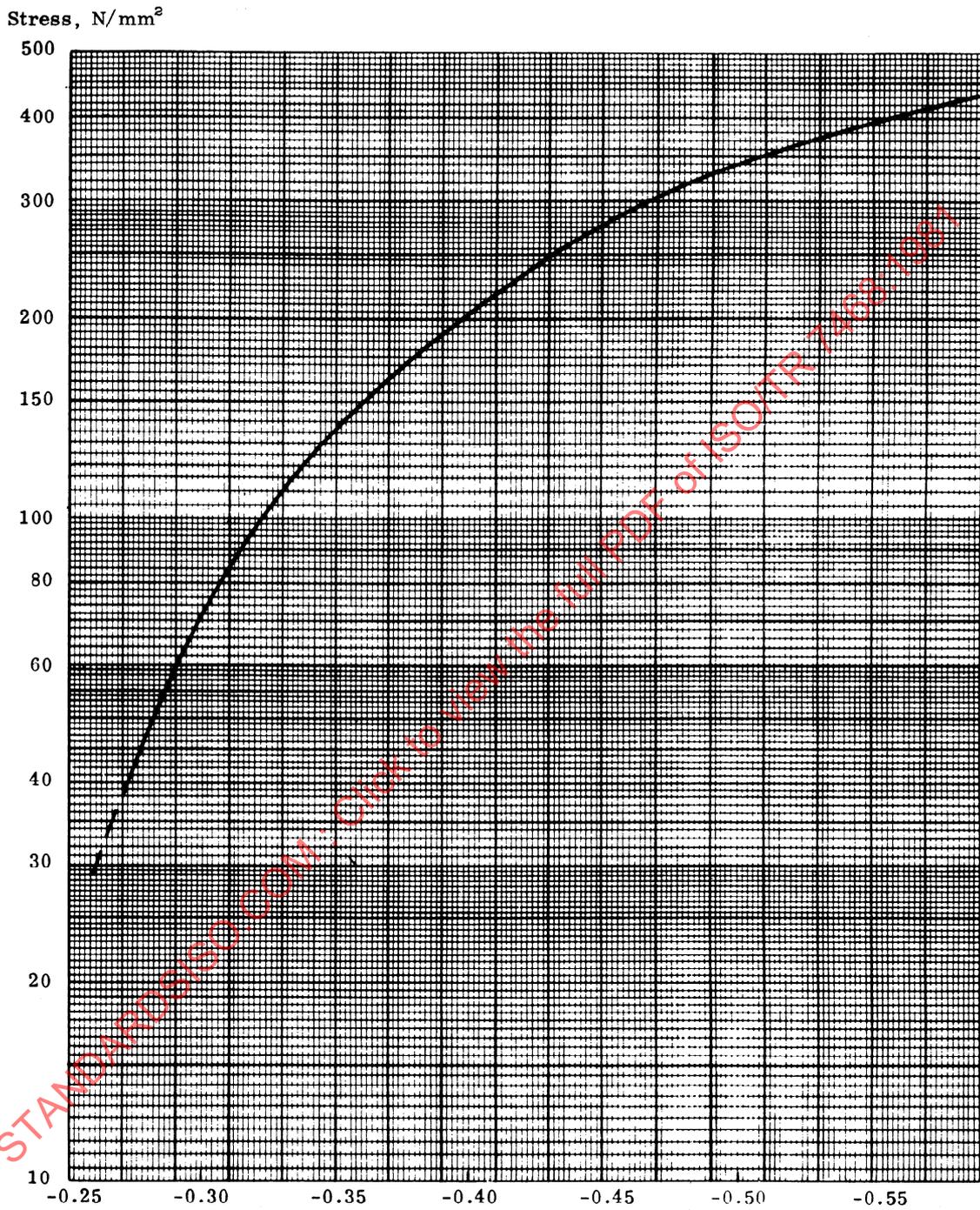
**QUANTITY AND DURATION OF DATA UPON WHICH THE PROPERTIES ARE BASED**

Temperature °C	Test Duration, h				
	<10 000	10 000- 20 000	20 000- 30 000	30 000- 50 000	>50 000
	Number of Test Points Available				
500	7	2	1	1	1
550	56	14	4	5	4
600	53	6	2		1
650	19				

**AVERAGE RUPTURE STRESSES,  $\text{N/mm}^2$**

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
500	362	333*	322*	301*	286*	276*	268*
510	331	301*	287*	265*	249*	239*	231*
520	303	272*	256*	231*	218*	208*	201*
530	274	242	226	201	190*	182*	176*
540	246	215	199	176	166*	158*	151*
550	221	190	175	152	142*	134*	128*
560	197	168	153	132	122*	115*	109*
570	174	146	132	113	104*	97*	92*
580	153	127	113*	95*	87*	80*	76*
590	132	107	95*	79*	72*	66*	61*
600	113	90	78*	66*	58*	52*	48*
610	97	75	63*	52*	46*	41*	(38)*
620	81	60	49*	-	-	-	-
630	68	48*	-	-	-	-	-
640	57	(38)*	-	-	-	-	-
650	48	(32)*	-	-	-	-	-

\* Values which have involved extended time extrapolation )  
 ( ) Values which have involved extended stress extrapolation )  
 See notes on page 2



$\times (10^{-1})$

$$P(\sigma) = \frac{\log t - 13.04}{T - 600}$$

12% Cr-Mo-V-(W) STEEL ( $R_m = 790/940 N/mm^2$ )

Temperature Range 500-650°C

(7917)

18Cr 8Ni STEEL

Properties agreed May 1969  
(Based on ISO document ISO/TC17/SC10/ETP-SG (Secretariat 26) 31)

CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			min	max
Chemical Composition % (m/m)	C	0.04 - 0.10	0.04	0.10
	Si	0.18 - 0.90	-	1.00
	Mn	0.34 - 1.92	-	2.00
	P	0.012 - 0.034	-	0.045
	S	0.004 - 0.031	-	0.030
	Cr	15.59 - 19.67	17.00	20.00
	Ni	7.79 - 12.70	8.00	13.00
Heat Treatment	1. 1050°C AC 2. 982-1135°C Q 3. 1093°C WQ + T 871-995°C		980 - 1100°C AC OQ or WQ	
Products	Form	Size, mm	All wrought product forms	
	Bars	12.5 - 40 dia		
	Plates	75 thk		
	Tubes	8.5 - 25 thk		
	Forgings	52 thk		

QUANTITY AND DURATION OF DATA UPON WHICH THE PROPERTIES ARE BASED

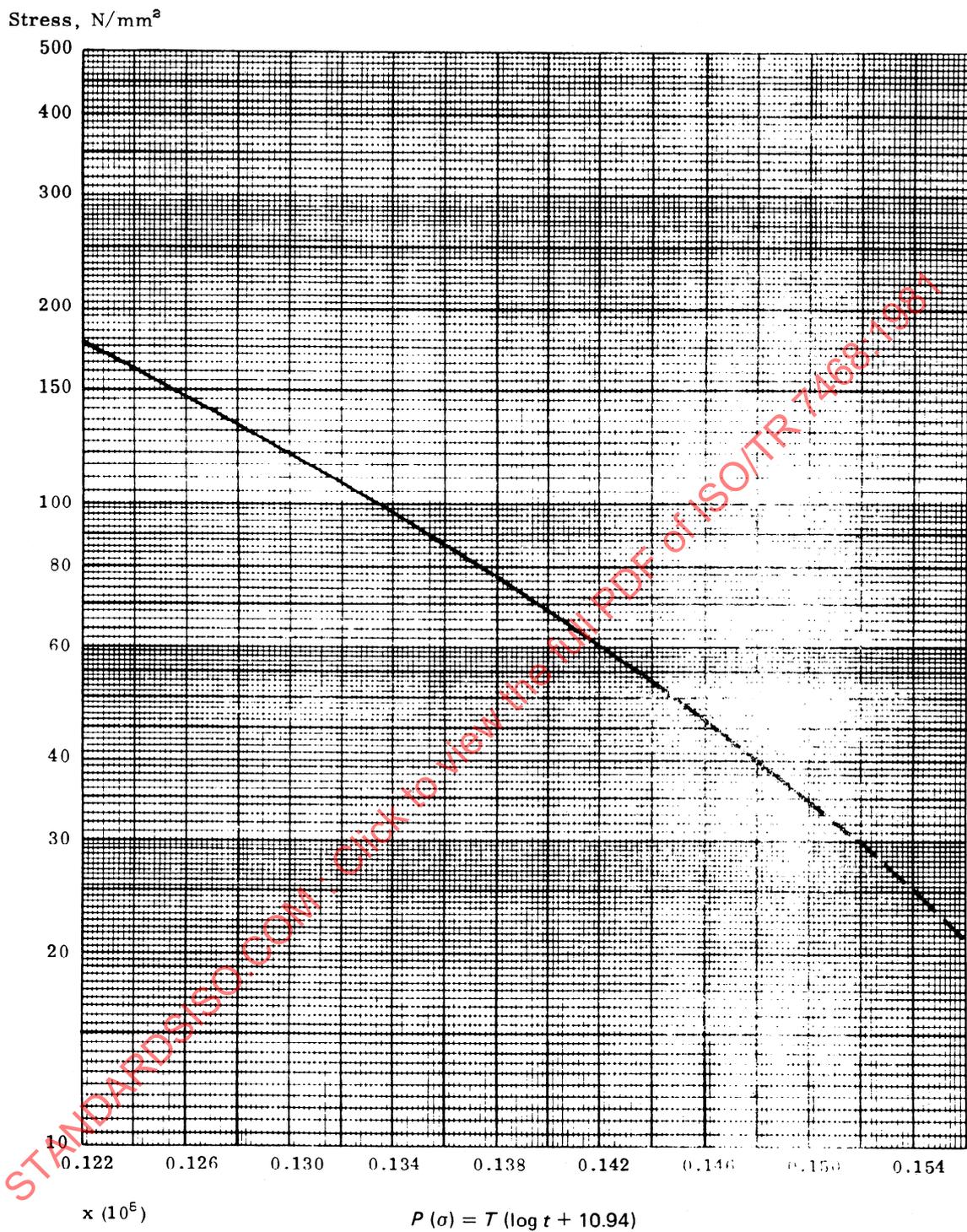
Temperature °C	Test Duration, h				
	< 10 000	10 000 - 20 000	20 000 - 30 000	30 000 - 50 000	> 50 000
	Number of Test Points Available				
566	19	1		1	
600	27	1			
649-650	179	6			
700	29	1			
732	18	1		1	

AVERAGE RUPTURE STRESSES, N/mm<sup>2</sup>

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
550	176	147*	134*	115*	108*	102*	97*
560	164	135*	123*	105*	99*	93*	88*
570	152	126*	113*	98*	89*	84*	79*
580	142	115*	103*	89*	81*	76*	73*
590	131	105*	94*	81*	74*	69*	66*
600	122	96*	85*	74*	67*	62*	59*
610	113	88*	78*	68*	60*	56*	53*
620	104	80*	72*	61*	54*	50*	47*
630	95	74	65*	55*	49*	45*	42*
640	87	67	58*	50*	43*	(40)*	(37)*
650	79	61	52*	45*	(39)*	(35)*	(33)*
660	73	55	47*	(40)*	(34)*	(31)*	(29)*
670	67	50	41*	(35)*	(30)*	(27)*	(25)*
680	61	44*	(36)*	(30)*	(26)*	(24)*	(22)*
690	55	(40)*	(32)*	(26)*	(23)*	(21)*	-
700	48	(35)*	(27)*	(23)*	(20)*	-	-

In analysing the data on austenitic steels, the Secretariat made no differentiation between boron-containing and boron-free casts. However, attention is drawn to the fact that boron-containing steels normally exhibit higher properties than boron-free steels.

\* Values which have involved extended time extrapolation )  
( ) Values which have involved extended stress extrapolation ) see notes on page 2



18% Cr 8% Ni STEEL  
 Temperature Range 550-700°C

(7918)

18% Cr, 12% NiMo STEEL

Properties agreed May 1975

(Based on ISO document ISO/TC17/SC10/ETP-SG(Secretariat 27) 32)

Updated as ISO document ISO/TC17/SC10/ETP-SG(Secretariat 104) 138

CONDITIONS OF STEEL TO WHICH THE PROPERTIES APPLY

	Details of Materials Actually Tested		Range for which Data are Expected to Apply Agreed by TC17/SC10/ETP	
			min	max
Chemical Composition % (m/m)	C	0.018 - 0.10	0.04	0.10
	Si	0.18 - 0.84	-	1.00
	Mn	0.30 - 2.08	-	2.00
	P	0.009 - 0.044	-	0.045
	S	0.003 - 0.035	-	0.030
	Cr	15.80 - 19.02	16.00	18.50
	Mo	2.00 - 3.35	2.00	3.00
	Ni	8.99 - 14.70	10.00	15.00
	B	0.0001 - 0.008	-	-
	N	0.015 - 0.070	-	-
Heat Treatment	1. 927 - 1400°C AC 2. 1000 - 1125°C OQ 3. 1050°C AC + T600 - 850°C 4. 1000 - 1200°C OQ + T700 - 850°C 5. 925 - 1083°C FC		950/1100°C AC, OQ or WQ	
Products	Form	Size, mm	All wrought product forms	
	Plates	1.5 - 47 thk		
	Bars	12 - 50 dia + 20 - 57 thk		
	Tubes	6 - 73 thk x 25 - 346 dia		
	Forgings	50 - 260 dia + 137 - 850 thk		

QUANTITY AND DURATION OF DATA ON WHICH THE PROPERTIES ARE BASED

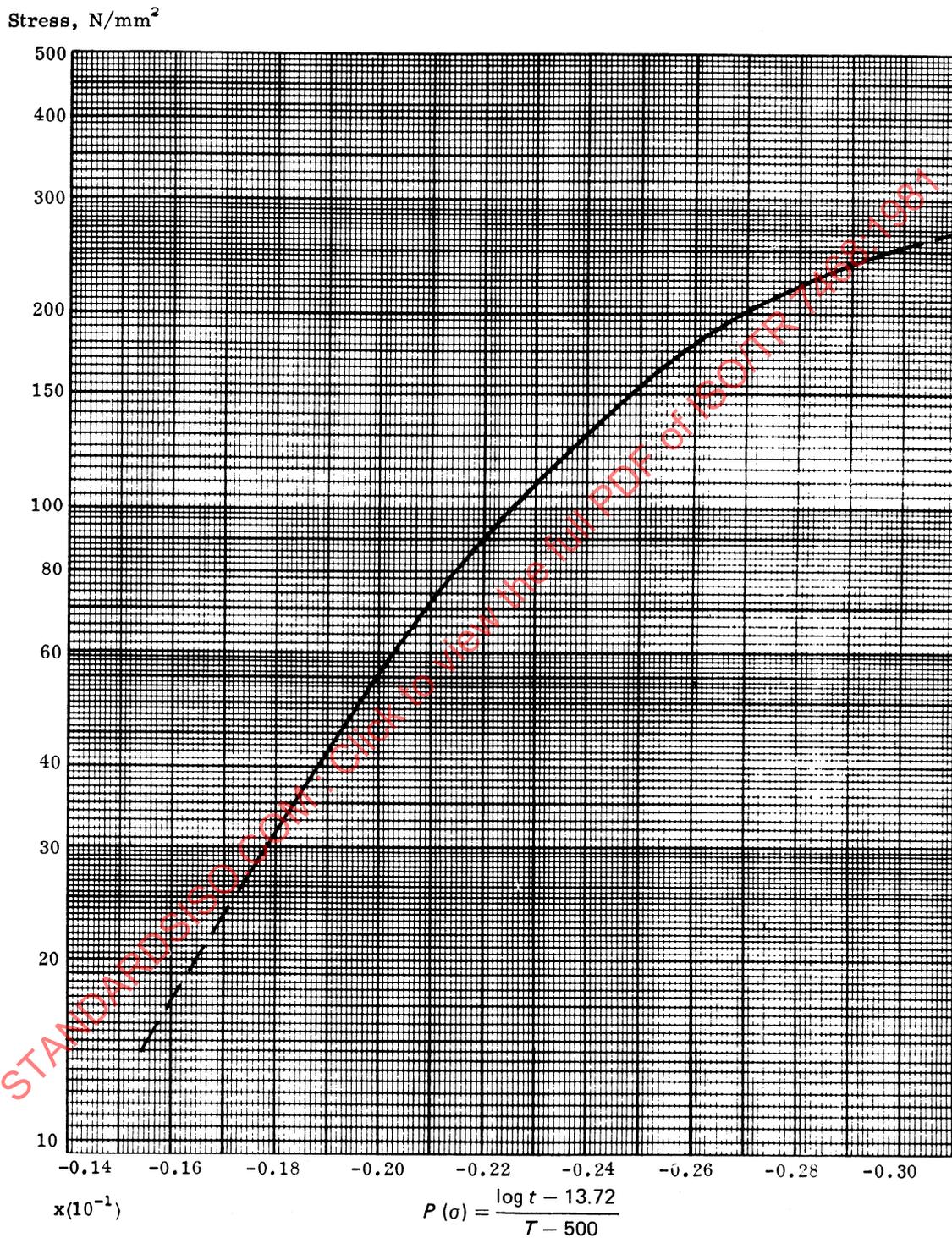
Temperature °C	Test Duration, h					
	<10 000	10 000 - 20 000	20 000 - 30 000	30 000 - 50 000	50 000 - 70 000	>70 000
	Number of Test Points Available					
600	531	97	42	37	17	10
625	100	42	22	15	6	
650	774	110	43	26	15	5
675	74	7	4	6	3	
700	461	67	11	12		1
732	54	1				
816	70	2				

AVERAGES RUPTURE STRESSES N/mm<sup>2</sup>

Temperature °C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
550	260	243	226	196*	187*	181*	176*
560	245	224	208	180*	171*	165*	159*
570	228	204	192	160*	152*	146*	140*
580	211	187	175	147	139	133	127*
590	195	171	158	132	124	116	110*
600	179	155	142	118	110	103	97*
610	164	139	128	106	97	91	86*
620	149	125	115	96	86	80	76*
630	136	112	103	86	76	71	67*
640	123	100	91	76	68	63	59*
650	111	89	80	69	60	56	52*
660	99	79	72	60	53	49	46*
670	89	72	63	53	47	43	40*
680	80	64	56	46	41*	38*	35*
690	74	57	50	41	36*	33*	31*
700	65	51	45	37	32*	29*	28*
710	59	46	40	33	28*	(26)*	(25)*
720	53	41	36	30	(25)*	(24)*	(23)*
730	48	37*	32*	27*	(24)*	(22)*	(21)*
740	44	33*	29*	(25)*	(21)*	(20)*	(19)*
750	39	30*	(26)*	(23)*			

In analysing the data, the Secretariat made no differentiation between boron-containing and boron-free steels. However, attention is drawn to the fact that boron-containing steels normally exhibit higher properties compared with boron-free steels.

Note: \* Values which have involved extended time extrapolation ) See notes on page 2  
( ) Values which have involved extended stress extrapolation )



18% Cr, 12% NiMo STEEL - TEMPERATURE RANGE 550-750°C

(R/7919)