## REPORT ON

## **ELEVATED-TEMPERATURE PROPERTIES**

OF

# **CHROMIUM STEELS**

(12-27 per cent)

Data Compiled by and Issued Under the Auspices of

THE DATA AND PUBLICATIONS PANEL

of

THE ASTM—ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON THE PROPERTIES OF METALS

Prepared for the Panel by
WARD F. SIMMONS AND HOWARD C. CROSS

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# ELEVATED-TEMPERATURE PROPERTIES OF CHROMIUM STEELS

(12-27 per cent)

DATA COMPILED BY AND ISSUED UNDER THE AUSPICES OF THE DATA AND PUBLICATION PANEL\*

of

THE ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON THE PROPERTIES OF METALS

This report is a graphical summary of the elevated-temperature strength data for chromium steels. It includes summary curves for tensile strength; 0.2 per cent offset yield strength; per cent elongation and reduction of area; stresses to produce rupture in 100, 1000, 10,000, and 100,000 hours; and stresses for creep rates of 0.0001 and 0.00001 per cent per hour (one per cent in 10,000 and 100,000 hours). Data for 23 steels ranging from 12 to 27 per cent chromium are given.

This is one of a series of reports on the elevatedtemperature strength properties of various metallic materials being prepared under the auspices of the Data and Publications Panel of the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals. Other reports in this series have covered the high-temperature properties of austenitic stainless steels,1 the chromium-molybdenum steels,2 selected super-strength alloys,3 carbon steels,4 copper-base alloys,5 wrought medium-carbon alloy steels,6 the relaxation properties of steels and super-strength alloys,7 and the high-temperature strength of weldments.8 Other Data and Publica-

tions Panel projects which are expected to result in publications in the near future are the following:

- (1) Elevated-temperature properties of aluminum and magnesium alloys.
- (2) Physical properties of metals and alloys at low and high temperatures.
- (3) Survey of test facilities in the United States for mechanical and physical testing at low and high temperatures.

Data contained in this report came principally from data sheets supplied by the cooperating laboratories. However, to make this report more complete, and therefore more useful, some data have been taken from trade bulletins and the published technical literature. Data sheets were prepared from the data taken from these sources and are included with the data sheets contributed by the cooperating laboratories. The source of the data is given on each data sheet. The cooperating laboratories that supplied data for this report are the following:

Babcock and Wilcox Tube Company Crucible Steel Company of America Elliott Company Firth-Sterling Steel and Carbide Corporation General Electric Company Heppenstall Company-Wm. Jessop and Son National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory

<sup>\*</sup> Prepared by Ward F. Simmons and Howard C. Cross, Battelle Memorial Institute, Columbus, Ohio

1 Report on the Elevated-Temperature Properties of Stainless Steels (1952). (Issued as separate publication ASTM STP No. 124).

2 Report on the Elevated-Temperature Properties of Chromium-Molybdenum Steels (1953). (Issued as separate publication ASTM STP No. 1561).

3 Report on the Elevated-Temperature Properties of Selected Super-Strength Alloys (1954). (Issued as separate publication ASTM STP No. 1660).

<sup>160).

4</sup> Elevated-Temperature Properties of Carbon Steels (1955). (Issued as separate publication ASTM STP No. 180).

5 Elevated-Temperature Properties of Copper and Copper-Base Alloys (1956). (Issued as separate publication ASTM STP No. 181).

6 Report on Elevated-Temperature Properties of Wrought Medium-Carbon Alloy Steels (1957). (Issued as separate publication ASTM STP No. 199).

7 Polevation Properties of Steels and Super-Strength Alloys at Elevated No. 199).

7 Relaxation Properties of Steels and Super-Strength Alloys at Elevated Temperatures (1956). (Issued as separate publication ASTM STP No.

<sup>187).

&</sup>lt;sup>8</sup> The Elevated-Temperature Properties of Weld-Deposited Metals and Weldments (1957). (Issued as separate publication ASTM STP No. 228).

Titanium Alloy Manufacturing Division of National Lead Company

U. S. Naval Engineering Experiment Station

U. S. Steel Corporation University of Michigan University of Minnesota

Wright Air Development Center

The data were organized according to principal alloying elements into the general alloy groups as listed in the table of contents.

The figures have been drawn using various symbols for annealed, normalized, hot rolled, etc., to indicate the approximate processing that each heat of steel has received. The processing as indicated by the symbols cannot be given in detail, and is intended to serve only as a guide in using the data given in the figures. The details of heat treatment, chemical composition, etc., for each steel are given in the data sheets directly following the figures.

In the rupture-strength and creep-strength figures, the individual data points are identified by the corresponding data sheet numbers at the top of each figure. Thus, it is possible to refer to the proper data sheet to check chemical composition, heat treatment, etc., for any data point.

Some of the data sheets from General Electric Company include rupture strength data that have been extrapolated (or interpolated) by the Larson-Miller<sup>9</sup> parameter method as well as by the usual log-log curves. Both values, when available, are included in the data sheets. The values extrapolated by log-log curves are indicated by an asterisk (\*) and the values determined by the parameter method by the letter P. In the figures, a flag (\$\nleq\$) has been attached to the symbol to indicate a point determined by the parameter method.

To facilitate comparing the creep and rupture strengths, the average curves for rupture in 1000 and 100,000 hours, and creep strengths for 0.0001

and 0.00001 per cent per hour have been replotted in Figs. 1 and 2.

Figures 3 to 14 show stress versus rupture-time and creep-rate curves plotted on log-log coordinates. These curves are based on the average curves for the various steels including the extrapolated data for rupture in 10,000 and 100,000 hours.

### Acknowledgment:

The authors wish to thank the contributing organizations and their representatives for taking the time necessary to supply the data sheets on which this report is based. The authors also wish to thank the members of the Data and Publications Panel and the Project Committee for their suggestions and counsel, which were very helpful in preparing the data for publication.

### Members of the Project Committee

J. S. Worth, Chairman

G. V. Smith

S. Low W. F. Simmons

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A. L. Tarr, Corps of Engineers, Fort Belvoir

J. S. Worth, Bethlehem Steel Company, Inc.

H. W. Wyatt, Avco Manufacturing Company

R. D. Wylie, Babcock and Wilcox Company

<sup>&</sup>lt;sup>9</sup> F. R. Larson and James Miller, "A Time-Temperature Relationship for Rupture and Creep Stresses", *Transactions*, American Society of Mechanical Engineers, Vol. 74, No. 5, July, 1952, pp. 765-775.

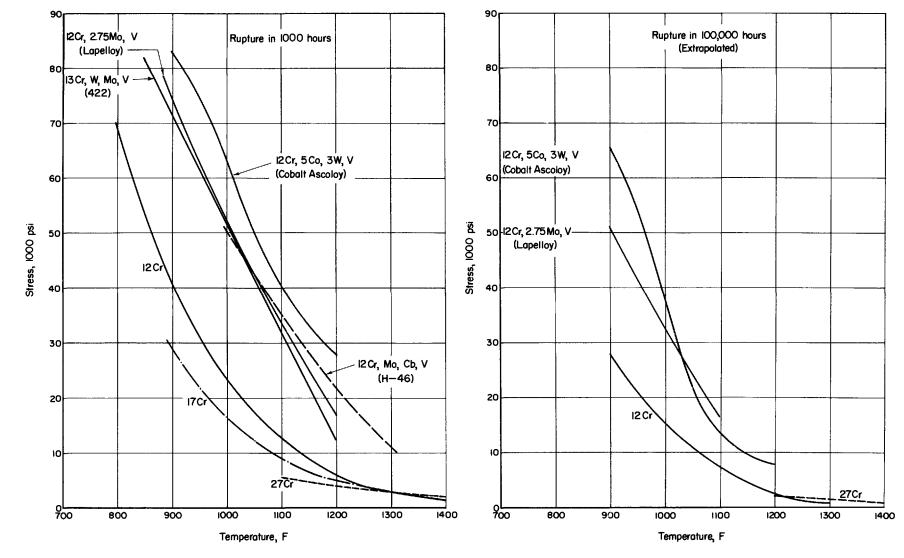


FIGURE I. AVERAGE RUPTURE STRENGTH CURVES

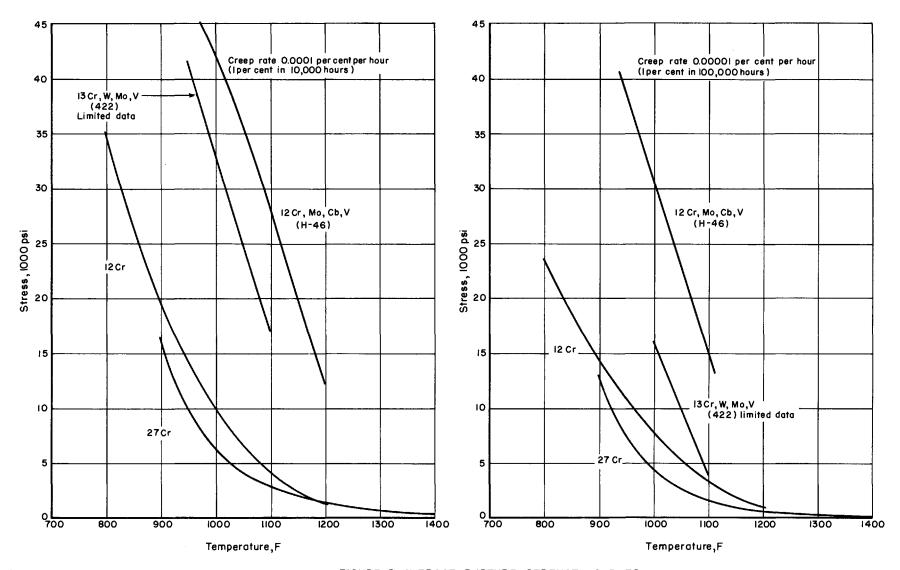


FIGURE 2. AVERAGE RUPTURE STRENGTH CURVES

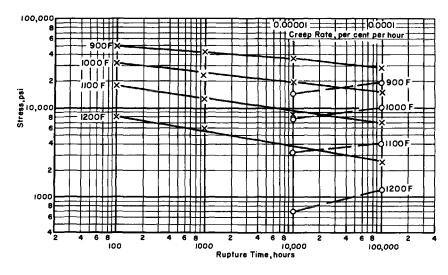


FIGURE 3. STRESS VERSUS RUPTURE-TIME AND CREEP-RATE CURVES FOR 12 Cr STEEL BASED ON AVERAGE DATA

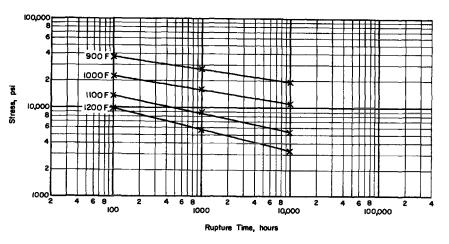


FIGURE 5. STRESS VERSUS RUPTURE-TIME CURVES FOR 12 Cr, 2 Ni STEEL BASED ON AVERAGE DATA FROM TWO HEATS

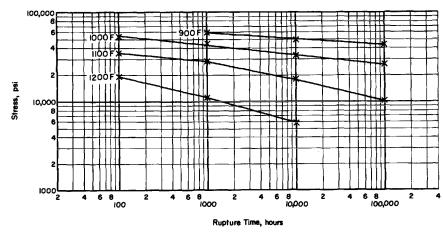


FIGURE 4. STRESS VERSUS RUPTURE-TIME CURVES FOR 13 Cr, 2 Ni, 3 W STEEL BASED ON AVERAGE DATA

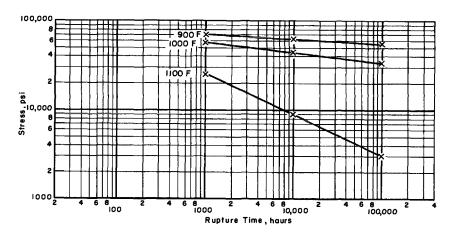


FIGURE 6. STRESS VERSUS RUPTURE-TIME CURVES FOR 12 Cr, Cb STEEL BASED ON AVERAGE DATA

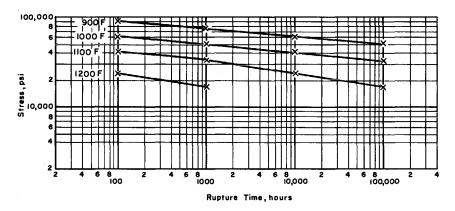


FIGURE 7. STRESS VERSUS RUPTURE- TIME CURVES FOR 12 Cr, 2.75 Mo, V STEEL BASED ON AVERAGE DATA

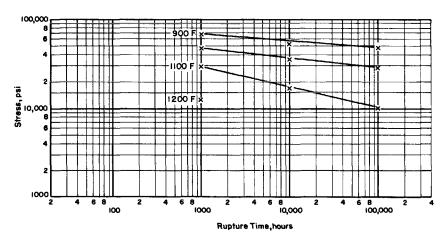


FIGURE 8. STRESS VERSUS RUPTURE-TIME CURVES FOR 12 Cr, 2.5 W, V STEEL BASED ON AVERAGE DATA

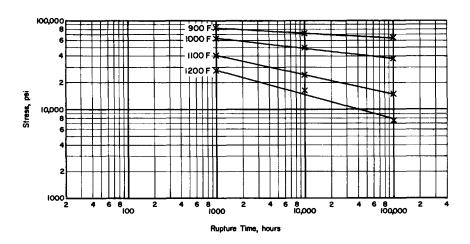


FIGURE 9. STRESS VERSUS RUPTURE—TIME CURVES FOR 12 Cr, 5 Co, 3 W, V STEEL BASED ON AVERAGE DATA

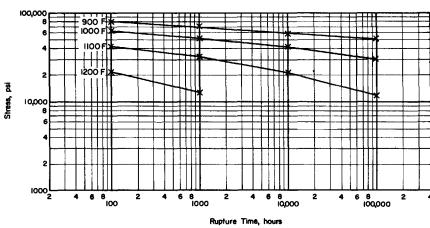


FIGURE IO. STRESS VERSUS RUPTURE-TIME CURVES FOR 13 Cr, W, Mo, V STEEL BASED ON AVERAGE DATA

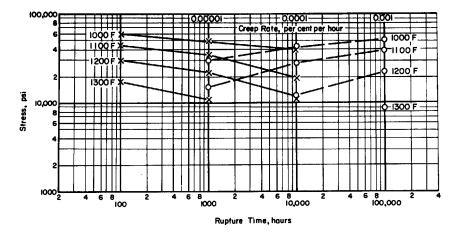


FIGURE II. STRESS VERSUS RUPTURE-TIME AND CREEP-RATE CURVES FOR 12 Cr, Mo, Cb, V STEEL BASED ON AVERAGE DATA

7

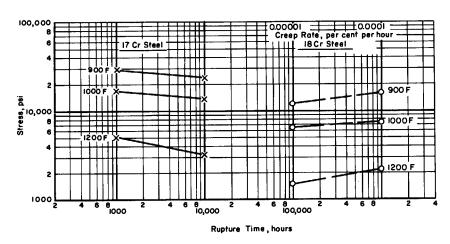


FIGURE 13. STRESS VERSUS RUPTURE-TIME AND CREEP-RATE CURVES FOR 17 Cr AND 18 Cr STEELS BASED ON LIMITED DATA

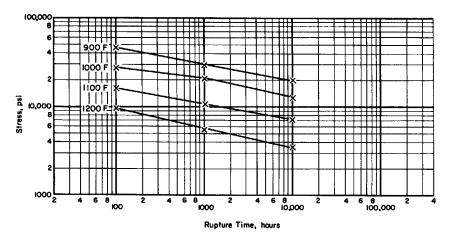


FIGURE 12. STRESS VERSUS RUPTURE-TIME CURVES FOR 16 Cr, 2 Ni STEEL BASED ON DATA FROM TWO HEATS

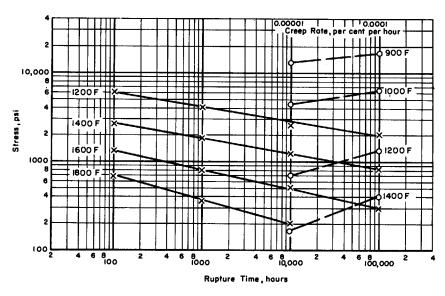
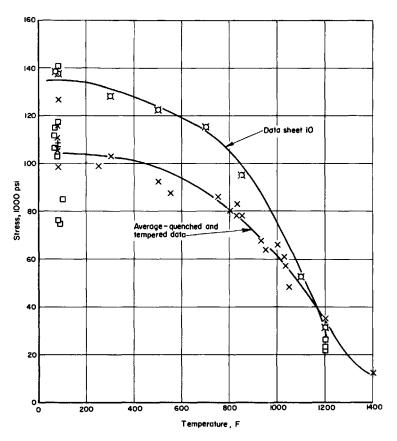


FIGURE 14. STRESS VERSUS RUPTURE-TIME AND CREEP-RATE CURVES FOR 27 Cr STEEL BASED ON LIMITED DATA

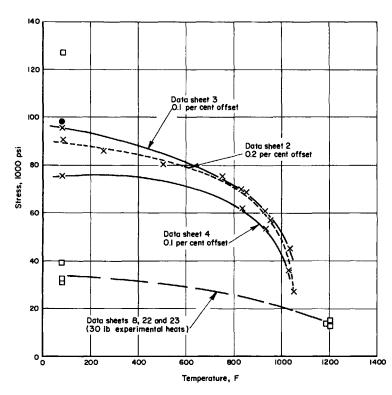


12 Chromium Steels



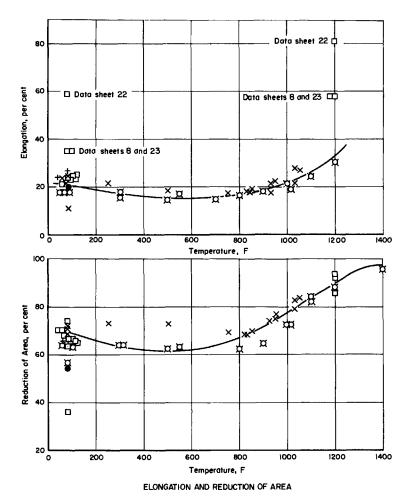
TENSILE STRENGTH

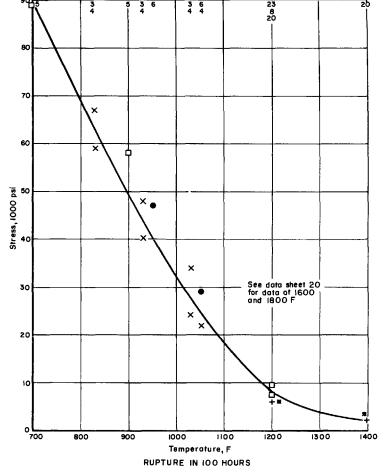
12 Cr STEEL



YIELD STRENGTHS

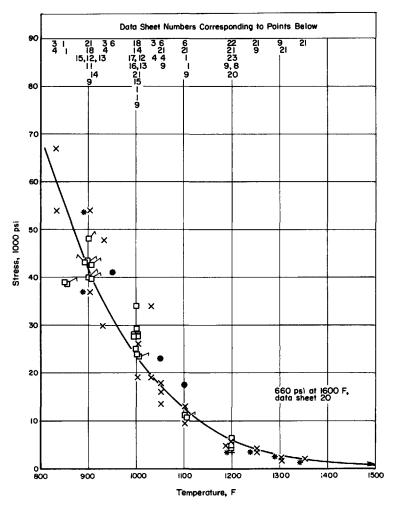
12 Cr STEEL





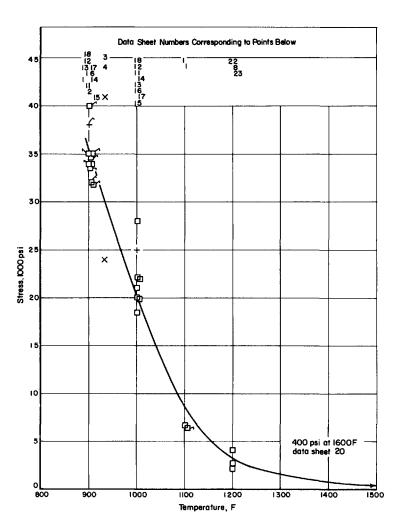
Data Sheet Numbers Corresponding to Points Below

12 Cr STEEL 12 Cr STEEL



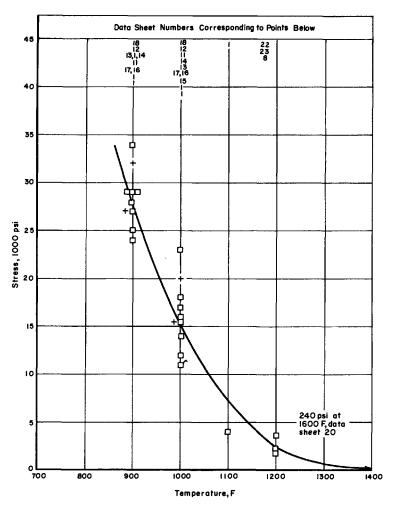
RUPTURE IN 1000 HOURS

12 Cr STEEL



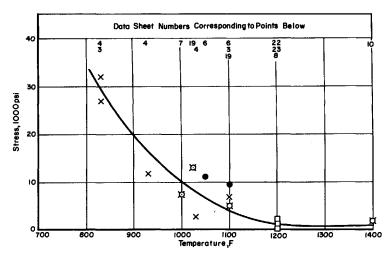
RUPTURE IN IO,000 HOURS (EXTRAPOLATED)

12 Cr STEEL

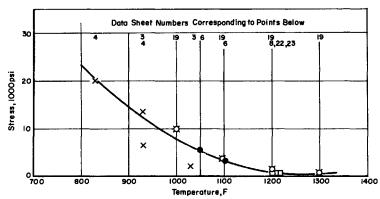


RUPTURE IN 100,000 HOURS (EXTRAPOLATED)

12 Cr STEEL



CREEP RATE 0.000I PER CENT PER HOUR (IPER CENT IN 10,000 HOURS)



CREEP RATE 0.00001 PER CENT PER HOUR (1 PER CENT IN 100,000 HOURS)

12 Cr STEEL



TYPE OF MATERIAL 12 Cr (Type 403)		TYPE OF MELTING FURNACE					SIZE OF HEAT Commercial				
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Мо			
PER CENT	0, 11	0,44			0.39	12.04	0.31				
DEOXIDATION											
FORM-CAST OR WROUGHT	Wrong	zht ]-9	5/16"	x 1-1	3/16"	Bar					
HEAT TREATMENT Finished	at 145	0 F, A	A. C.	With I	ans,	Temp	ered	150 F			
MICROSTRUCTURE											
GRAIN SIZE					Н	ARON	ESS				
SOURCE OF DATA General	Electr	ic Cor	mpany	,							

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT			106.4	24.0	64.2

### CREEP AND RUPTURE STRENGTHS

TEMP.,	STRE	SS FOR R	UPTURE IN 1 D, 1000 P.Ş.I.	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.00000 I %/HR.	0.0000I %/HR	0.0001 %/HR.	
900		39	34*	29*				
		39P	32P	24P				
1200		24	17	12*		I		
		2412	17P	11P				
1100		<u> </u>	6.8	4*				
		11P	6.8P		1			
P indie	ates stren	th value o	btained by u	e of Larso	n-Miller pa	rameter T(	25 + log t	

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	REDUC- TION IN AREA, %
800	57.0	654 R					17.0	78.0
800	55.0	2707 R					. 19.0	77.0
850	75.0	_ LR					8.0	68.0
850	66.0	2 R					5.0	70,0
850	54.0	28 R					3,0	74.0
900	50.0	68 R					19. 0	76.0
900	45.0	101 R					22.0	82.0
900	42.0	189 R					22,0	82,0
900	40.0	765 R					20,0	83.0
900	36.0	4044 R					20.0	84.0
900	35.0	5102 R					16.0	84.0
1000	35.0	42 R					27.0	84.0
1000	26.0	611 R					28.0	87.0
1000	22.0	1748 R	i				28.0	86.0
1000	18.0	7438 R		L			28.0	84.0
1100	20.0	46 R					31.0	88,0
1100	15.0	263 R					27.0	86.0
1100	12.0	690 R					58,0	90.0
1100	7.0	8356 R					37.0	91.0

# (2)

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF

TEN	WPERA			PROF						
TYPE OF MATERIAL 12 Cr		TYPÉ MELTII		RNACE	Ele	ctric trc	SIZE HE AT		13,50	00 1ъ
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Мо		
PER CENT	0.12	0.42	0.01	0.26	0.156	12.45	0.10			
DEOXIDATION										
FORM-CAST OR WROUGHT					_					
HEAT TREATMENT Quenche	1750	F, Te	mpere	ed 115	0 (2 H	г)А. (	:			
MICROSTRUCTURE										
GRAIN SIZE					H.	ARONE	SS 2	17-22	28 BHI	N
SOURCE OF OATA Available	High '	Tempe	ratur	e Cre	ep Ch	aracte	ristic	s of h	detals	& Alloys
ASME-	ASTM,	1938.								

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		90.0	105.9 (a)	24.2	71.0
250		85.4	99. 0 (b)	21,8	73, 1
500		80.6	92, 4 (a)	18.7	72.9
750		75.5	86.1 (a)	17.5	69. Z
851		69.4	78, 4 (a)	19, 2	69.9
950		57, 3	64. 2 (b)	22.3	77, 3
1050		74 5	40 4 (1)	37.5	02 0

# (a) Average of 3 tests. (b) Average of 2 tests.

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
850.	10-0	2205	0.0156	0.0000002		0.0154		
850	15.0	2730	0.0807	0,0000001		0.0812		
850	15.0	2019	0,0389	0.0000032		0.0457		
850	20,0	2020	0.0746	0.000012		0.0988		
850	25, 0	1200	0,1318	0.0000227		0,1588		
850	30.0	2227	0.1787	0.0000472		0.2843		
850	30.0	2736	0.208	0.0000430		0.325		ļ
85G	30.0	2040	0,318	0.0000470		0.414		
850	35.0	1489	0.605	0.00038		1.171		
850	. 40.0	1825	1, 105	0.000964		2,905		



# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr (Type 410)	TYPE OF MELTING FURNACE						SIZE OF HEAT Commercial			
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	T	
PER CENT	0.14	0.43	0.003	0.017	0.35	12.2	0.20			
DEOXIDATION								•		
FORM-CAST OR WROUGHT	7/8"	Wroug	ht Ba	rs						
HEAT TREATMENT 1800 F.	1/2 H	r, 00	- 120	0 F.	Hr, 1	FC				
MICROSTRUCTURE										
GRAIN SIZE					HA	ARDNE	SS	222	BHN	
SOURCE OF DATA U.S.N. Er	nginee	ring E	Experi	ment S	tation	1				

### SHORT TIME TENSILE PROPERTIES.

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (I) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT		95, 8 (6)	115.5	22	69
830		69,5 (6)	82.9	18	69
930		61, 0 (6)	70.2	81	75
1030		45.7 (6)	61.0	22	79
			-		
				<del></del>	

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE		UPTURE IN 0, 1000 P.S.I	STRESS FOR DESIGNAT CREEP RATE, 1000 P.S.				
•F ′	IOO HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.0000I %/HR	0.0001 %/HR.	
830	67	61						
930	48	44	41		1	13.5	27	
1030	34	29				2,2		
1100				L	1	l	. 7	

### ORIGINAL CREEP AND RUPTURE DATA

	The state of the s											
TEMP, °F	STRESS, 1000 P.S.I.	OURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (OREEP TEST), %	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING				
830	70.0	33 R					21.0					
830	60,0	1558 R					21.0					
930	50, 0	40 R					25.0					
930	45.0	895 R	1.38	0.0041	425		29.0					
930	40,0	10000 +	1.13	0.0012			See Note					
			NOTE: Sp	ecimen rem	oved at 8 4	elongation						
1030	40.0	14 R					33.0					
1030	35.0	83 R			40		33.0					
1030	30.0	625 R	0.32	0.011	370		32.0					
930	20,0	2112	0,083	0,000028		0,142						
930	13.0	3360	0,044	0.000009		0.077						
1030	7.0	2172	0.060	0.000030		0.123						
1030	5.0	2040	0.090	0,000020		0.130						
1030	2.5	1512	0.013	0.000011		0.031		L				
$\vdash$												
1100	10.0	2016	0.247	0.00020		0.650						
	L	L			L	L	L					

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

  (2) EXTRAPOLATED VALUES INDICATED BY \*

  (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

  (6) 0.1% OFFSET YIELD STRENGTH.

TYPE OF MATERIAL 12 Cr (Type 410		TYPE OF MELTING FURNACE					SIZE OF - HEAT Commercial				
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Mo		T	
PER CENT	0.11	0,36	0,010	0.020	0.17	12.78	0.01	Ι	<u>L</u> _	<u> </u>	
DEOXIDATION											
FORM-CAST OR WROUGHT	l" Wr	ought	Bars								
HEAT TREATMENT 1800 F,				0 F, 1	Hr,	FC					
MICROSTRUCTURE											
GRAIN SIZE					H	ARDN	ESS	210	BHN		
SOURCE OF DATA U.S.N.	Engine	ering	Expe	iment	Stati	on					

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 PS.1	OFFSET YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT		75, 8 (6)	98.5	24	72
830		63.0 (6)	78.5	18	69
930		53, 2 (6)	68.0	22	75
1030		36, 7 (6)	57.5	28	83
	1				

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN D, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
°F '	IOO HRS.	IOOO HRS.	10,000 HRS	100,000 HRS.	0.00000 I %/HR.	0.00001 %/HR	0.0001 %/HR.
830	59	54		1		20	32*
930	40	30	24*			6,5*	11, 7
1030	24	18					2,8
1050	22	16					

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
830	60.0	80 R		Ĺ			27.0	
830	55.0	623 R					24,0	
930	40.0	94 R					30.0	
930	35.0	210 R		L			44.0	
930	30,0	1187 R			·		38.0	
930	25.0	3384 +	Specimen	removed at	9.7% elonga	tion.		l
1030	30.0	45 R					42.0	
1030	25.0	75 R					35.0	
1030	20.0	308 R					55.0	
1030	18,0	862 R	-				51.0	
1050	30.0	10 R					39.0	
1050	25,0	38 R					52.0	
1050	18.0	377 R		L	L		62.0	

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr (Type 40		TYPE OF MELTING FURNACE						SIZE OF HEAT			
CHEMICAL COMPOSITION.	С	C Mn	P	s	Si	Cr	Ní	Mo	Al	Sn	
PER CENT	0,11	0,51	0,018	0,010	0,34	12,20	0,06	0.05	0,03	0,0089	
DEOXIDATION											
FORM-CAST OR WROUGHT	Wroug	ht									
HEAT TREATMENT Normali	zed at 16	75 F.	Heat	ed to 1	550 F	, Coo	led at	25° 1	Per H	our to	
	Soaked									ooled Fro	
GRAIN SIZE					H.	ARDNÉ	SS	24-26	R <sub>c</sub>		
SOURCE OF DATA Unive	sity of	Minne	enta:	Mecha	nics I	L Mate	riale				

### SHORT TIME TENSILE PROPERTIES

	TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
L	RT	29.5	127	141	11	36

### CREEP AND RUPTURE STRENGTHS

TEMP.,	STRE	SS FOR R	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
*F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
700	89						
900	58						

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

(2) EXTRAPOLATED VALUES INDICATED BY \*

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
700	90.0	16.3 R					17.8	
700	85.0	26.5						
700	85.0	93.1						
700	87.5	121.6						
700	90.0	7.4 R					18.1	
700	95.0	R			<u> </u>		13.9	
700	92.9	9,4 R					16.4	
700	94.0	1.8 R					17.2	
700	96.0	R					13.6	
700	40.0	189.0						
700	65.0	272.1						
700	92.5	4.0 R				L	17.4	
700	100.0	R					14. 2	
700	80.0	74.0				0.3		
700	80.0	124.5				4.6		
700	88.0	428.0				<u> </u>		
L								
900	65.0	1.3 R		L		l	22.2	
900	60.0	5.8 R					22,2	
900	55.0	21.6 R				1	23.2	
900	75.0	0.04R					18.3	
900	70.0	0.4 R		l			19.0	
900	50.0	49.1 R					31.2	
900	42.0	296. 2 R					24.2	

## (6)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr (Type 410)		TYPE (	OF NG FUF	NACE			SIZE		
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Mo	T
PER CENT Nominal	0, 15 Max					11.5			T
DEOXIDATION									
FORM-CAST OR WROUGHT	Precis	ion Ca	st Tes	t Bar	s				
HEAT TREATMENT 1800 F.	l Hr,	0Ω =	1200 F	, I H	r, A	С.			
MICROSTRUCTURE									
GRAIN SIZE					Н	ARDN	ESS	241 BHN	
SOURCE OF DATA U.S.N.	Engine	eering	Exper	imen	t Stat	ion			 

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RŤ		97.8	126.5	20	54
				İ	

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RL	PTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
*F ^	IOO HRS.	IOOO HRS.			0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
950	47	41			1		
1050	29	23				5, 5	11.0
1100		17,5				3.5	9.5

	ORIGINAL CREEP AND RUPTURE DATA													
TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	NTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING						
950	45 0	260 R					17.0							
950	40.0	2002 R	0.40	0.00184	550		29,0							
1050	25.0	.431 R					13.0							
1050	20.0	3300 R	1.20	0.0018	2000		13.0							
1100	15.0	3892 R	0,62	0.0011	1300		12.0							
1050	7.5	1704	0.185	0.000025		0.227								
1050	5.0	2040	_0,120	0.0000075		0, 135								
1100	7.5	2064	0.141	0.000045		0. 232								
1100	5.0	2607	0.128	0.000019		0.213								

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

TYPE OF MATERIAL 12 Cr		TYPE OF MELTING FURNACE						SIZE OF HEAT		
CHEMICAL COMPOSITION.	С	Mn	£	S	Si	Cr	Ni	Mo		
PER CENT	0.12	0,56			0,32	12.23				
DEOXIDATION										
FORM-CAST OR WROUGHT	Wroug	tht 3/4	" Bar	5						
HEAT TREATMENT Norma	lized 18	00 F,	Temp	ered	1100 1	F				
MICROSTRUCTURE										
GRAIN SIZE		-			н	ARDN	ESS	225 BH	N _	
							Cree	p Chara	cteristic	cs of
Metal	a 2. A11c	170 A	SMT.	ACTM	193	9				

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
			111.2	19.0	56.7
300	T		103-25	18.0	64.2
550			87.7	17.5	63.3
800			80,5	16.5	62.4
1000	I		65.7	21,5	73.8
1200			35,3	32.5	88, 1
1400			12,4	45.0	95, 6

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN	TIMES (2)	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
*F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1000							7.85	

### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
800	10.0	1000	0.034	0.000016		0.050		
800	20.0	750	0.075	0.000026	L	0.095		
800	30,0	750	0.175	0.000014		0.222		
800	40.0	750	0. Z48	0.00025		0.438		
1000	3.0,	6000	0.0825			0.0825		
1000	10.0	1000	0.110	0.000148		0.258		
1200	3, 0	750	0, 244	0.000021		0.260		
1400	1.0	1000	0.229	0.000034		0.266		

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr		YPE MELTI		RNACE	Indi	uction	SIZE		10 1ь	
CHEMICAL COMPOSITION.	С	Mn	P	S	Şi	C	Ni	Mo		
PER CENT	0.10	0.46	0.010	810,0	0,24	12,26				
DEOXIDATION										
FORM-CAST OR WROUGHT	Forge	to 1	Roun	ds						
HEAT TREATMENT Normal	zed Fr	om 17	50 F 1	Anne	aled I	From	1650	F		
MICROSTRUCTURE										
GRAIN SIZE 7/8 ASTM Fe	rrite Gr	ain Si	ize		H	ARDNE	SS	156-15	9 BHN	
SOURCE OF DATA Univers										_

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 PS.I.	OFFSET YIELD (1) STRENGTH, 1000 PS.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT		30, 9	76.1	35.0	70, 1
1200		12,5	23.5	58.0	92.1

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN 0, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F '	100 HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.0000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1200	7.8	4,8	2,9*	1. 75*		0,525*	0.140	

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1200	15.0	0.52 R					78.0	
1200	11.0	6.08 R					90.0	
1200	8.0	76. R					71.0	
1200	6.0	368 R		<u> </u>			75.0	
1200	5.0	824 B				ļ	75.5_	
1200	1.5	1260	0, 12	0.000116		0,264		
1200	1.0	1350	0.049	0.000045		0,112		
1200	0.78	1340	0,033	0.000024		0,065		

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr		YPE MELTI		RNACE			SIZE	OF		
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Мо	Cu	
PER CENT	0.086	0.43	0.018	0.009	0.39	12.52	0.09		0.03	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wroug	ht								
HEAT TREATMENT 1750 F	Quench	+ 11	50 F 1	empe	r					
MICROSTRUCTURE Tempe	red Ma	rtensi	te and	Delta	Ferr	ite				
GRAIN SIZE 6-8					H	ARDN	ESS	252 I	PH	
SOURCE OF DATA U.S. St	eel Cor	o. Re	search	Lab.						

### CREEP AND RUPTURE STRENGTHS

TEMP.,	STRE	SS FOR RU	PTURE IN	TIMES	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
•F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
_900		37.0*						
1000		19.0	[	l .	L			
1050		13.7	L					
1100		9.8						
1200		4.9		1				
1250	l	3.5*	L	<u> </u>	1			
1300		2.5*				1		

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING						
1000	50.0	1.5 R		3.46										
1000	40.0	7.3 R		1.01			43.0							
1000	30.0	84R		0.106			52.0	L						
1000	25.0	200.5 R		0,062			60.0							
1000	15.0	5358. R		0.0019										
1200	15.0	3.66R	0.77	3.26			64.0							
1200	10.0	47.2 R	0.38	0,256										
1200	7.0	120. R	0.60	0.105										
1200	5. 50	680. R	0.85	0.0134			79.0							
1200	4.00	2608. R	0.73	0.00354			89.0							

## (10)

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr		YPE (	OF IG FU	RNAC	E		SIZE OF HEAT				
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo			
PER CENT	0.10	0.48			0.24	11.87					
DEOXIDATION											
FORM-CAST OR WROUGHT	Wroug	ht 1"	Bars								
HEAT TREATMENT Anneale	d 1350,	Norm	alize	d 1700	) F, T	empe	red 10	000 F			
MICROSTRUCTURE											
GRAIN SIZE					Н	ARDNE	SS	00 BHN			
SOURCE OF DATA Compilat							Сгеер	Charact	eristics of		
Metals	& Allos	a AS	ME.A	STM	1938						

### SHORT TIME TENSILE PROPERTIES

	3110111	LIME LEMOIL	E FROFERI	ic3	
TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
70			138. 15	19.0	64. Z
70			138,70	19.5	64.3
300			128,55	_ 15.5	64.7
500			122.60	15.0	62.3
700			115.60	15.0	56, 3
900	L		95, 10	18.0	64.9
1000			75, 10	20.0	73.4
1100 1200	··· -		52,95 36.20	24, 5 30, 5	82, 4 88. 9

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
*F `	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR	0.00001 %/HR	0.0001 %/HR.
1400							2.0
				1	l		

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

(2) EXTRAPOLATED VALUES INDICATED BY \*

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

(8)

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.J.	OURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
800	35.0	250	0, 140	0.00024		0.20		
1000	15.0	250	0.215	0.00214		0.758	<b></b>	
1200	5.0	500		0.1710	<u> </u>	50.0		L
1400	0.25	250	0,077	0.000142		0.112		
1400	0,50		0.033	0.00043		0.142	<u> </u>	<u> </u>
1400	1 - 6	1	1 35	0.04000	T	9.95	]	

(11)

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr (Type 403)		TYPE OF MELTING FURNACE					SIZE		mmercial	
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Mo		L
PER CENT	0.10	0.43			0.31	12,67	0.41	0.32		<u> </u>
DEOXIDATION										
FORM-CAST OR WROUGHT	Wrou	tht Bar	1-7/	16" х	5-1/	16"				
HEAT TREATMENT Finished	Rolled	at 14	50 F,	Temp	pered	1150 I				
MICROSTRUCTURE										
GRAIN SIZE					Н	ARDNÍ	SS			
SOURCE OF DATA General	Electr	ic Cor	npany							

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,OOO P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80			114.9	23.0	67. 5
800	25.0				
900	23.1				
1000	19, 1				
1100	16. 2				

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN D, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
•F	100 HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000 %/HR
900		40P	34P	28P	1		
1000		28	22*	18*			ļ
P indic	tes streng	th value ob	tained by us	e of Larson	Miller par	ameter T(2	+ log t

ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),		REDUC- TION IN AREA. %
1000	40.0	11 R					18.0	85.0
1000	32.0	201 R					19.0	82.0
1000	28.0	577 R		L			16.0	84.0
1000	26,3	3442 R				_	17.0	76.0
1000	24.0	4751 R			L		18.0	72.0

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## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr (Type 403)		TYPE (		RNACI	E		SIZE HEAT		mercial
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	
PER CENT	0.13	0.43			0.28	12.44	0.44	0.30	
DEOXIDATION									
FORM-CAST OR WROUGHT	Wrong	ht 3/4	"xl-	1/8"	Bar				
HEAT TREATMENT Air Co	oled Fr	om Ro	lls						
MICROSTRUCTURE								_	
GRAIN SIZE					H	ARDNE	SS		
SOURCE OF OATA General	Electri	c Com	nanıı						

SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,000 PS.I.	OFFSET (a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		80.9	107.9	26.5	70.0
(2) 0.07% ()	set vield strene				

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

(2) EXTRAPOLATED VALUES INDICATED BY

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRES	S FOR RU	PTURE IN T	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
°F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.0000001 %/HR.	0.00001 %/HR.	0.0001 %/HR.
900		43P	38P	32P	L		
1000		31	2.5*	20*	ļ <u> </u>		
P indica	tes strengt	n value obt	ained by use	of Larson	Miller par	meter T(2	+ log t).

### ORIGINAL CREEP AND RUPTURE DATA

			0, ., 0 .,					
TEMP. °F.	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %		REDUC- TION IN AREA, %
1000	42.0	15 R					18.0	85.0
1000	36.0	222 R		L			18.0	85.0
1000	32.0	815 R		L			18.0	82.0
1000	30.0	920 R					18.0	87.0
1000	27.0	4409 R					17.0	88.0

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr (Type 403)		TYPE .		RNAC	E		SIZE HEAT		omme	rcial
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Мо		
PER CENT	0.10	0.35			0.34	12.43	0.29		]	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wrou	ght 1-	1/8" >	4-11	/ 16"	Ваг				
HEAT TREATMENT Finish F	Colled	1450 F	, A.C	., 11	75 F	- 15 H	r, 110	0 F -	- 15 H	r
MICROSTRUCTURE										
GRAIN SIZE					Н	ARDNE	SS			
SOURCE OF DATA General	Electi	ric Co	mpany	,						

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80			111.4	21.5	67.5

CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
•F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000 %/HR	
900		42P	35P	29P				
1000		28	21*	16*				
	tes strengt				Miller par	meter T(2	+ 1	

ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),		REDUC- TION IN AREA, %
1000	42.0	12 R	L				15.0	82,0
1000	32.0	410 R					16.0	86.0
1000	28.0	683 R					17.0	83.0
2000	26.0	1743 R					16.0	81.0
1000	22.0	6762 R					17.0	66.0

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr (Type 403)		YPE (		RNAC	E		SIZE		Comm	ercial
CHEMICAL COMPOSITION.	AL 12 Cr (Type 403)   MELTING FURNACE   HEAT   Commercia									
	0.10	0.43			0.31	12.67	0.41	0.32		
DEOXIDATION								•		
FORM-CAST OR WROUGHT	Wroug	ht Bar	1-1/4	1" x i	2-11/1	611				
HEAT TREATMENT Finished 1	Rolled	at 145	0 F,	Temp	ered	1150 1	-			
MICROSTRUCTURE										
GRAIN SIZE					Тн	ARDN	ESS			
SOURCE OF DATA General	Elect	ric Co	mpany	,						

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (I) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT			117.4	23.0	67. 0

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRES	S FOR RU	PTURE IN 1 , 1000 P.S.I.	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
•F	HRS.	IOOO HRS.	IO,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
900		40P	34P	29P	<u> </u>			
1000		29	22*	17*	ļ <u>.</u>			
P indica	tes strengt	value obta	ined by use	of Larson	Miller par	meter T(2	+ log t).	

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN .	TIMES	STRESS CREEP	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F,	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.00000 I %/HR.	0.00001 %/HR	0.0001 %/HR.			
900			35P	27P	1	L				
1000		27	20*	15.5*	ļ	<b></b>				
P indica	tes strengt	value obt	ined by use	of Larson	Miller par	meter T(2	+ log t).			

### ORIGINAL CREEP AND RUPTURE DATA

TEMP, °F.	STRESS 1000 P.S.I.	OURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG (RUPTURE TEST),%	REDUC- TION IN AREA, %
1000	40.0	14 R					21.0	84.0
1000	32.0	268 R	L				18.0	82.0
1000	28.0	1174 R			L		14.0	76.0
1000	26.0	2293 R					16.0	72.0
1000	24.0	4561 R					12.0	60.0

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. ICPEEP TEST),	TECT) N	REDUC- TION IN AREA. %
1000	36.0	67 R					24.0	86.0
1000	32.0	214 R				<u> </u>	30.0	85.0
1000	26.0	1337 R					23.0	85.0
2000	22.0	5324 R					20.0	84.0

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr (Type 403)		TYPE (		RNACI	E		SIZE	OF	Comm	ercial	
CHEMICAL COMPOSITION,	С	Mn	Р	S	Si	Cr	Ni	Мо	Τ	Γ_	
PER CENT	0.11	0.44			0.39	12.04	0.31		T	Ι	
DEOXIDATION											
FORM-CAST OR WROUGHT		ght 1-									
HEAT TREATMENT Finished	Rolled	at 145	0 F,	A.C.	With	Fans,	Tem	pered	1150	F	$\equiv$
MICROSTRUCTURE											
GRAIN SIZE					H	ARDN	ESS				
SOURCE OF DATA General I	lectri	c Com	pany								

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

17

TYPE OF MATERIAL 12 Cr (Type 40:		TYPE WELTH		RNACI			SIZE HEAT		ommer	cial
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Мо	V	
PER CENT	0.13	0.40		$\Box$	0.27	12.36	0.18	0.45	0.03	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wrough	at 2-1	/16" ×	8" B	ar					
HEAT TREATMENT Air Co	oled Fr	om Re	lls							
MICROSTRUCTURE		_						_		
GRAIN SIZE					H	ARDNE	SS			
SOURCE OF DATA Genera	Electi	ric Co	mpan	7						

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80			103.9	24.0	66.3

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,OOO P.S.I.	OFFSET (4) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		79.4	106. 2	24.5	67.2
(a) 0,02% Of	set yield streng	h			

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN T	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
°F	IOO HRS.	0.00001 %/HR	0.0001 %/HR.				
900		42P	32P	25P			
1000		25	18.5*	14*			
P indic	ates strengt	value obt	ined by use	of Larson	-Miller par	meter T(2	+ log t)

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN T	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
•F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000 %/HR
900			35P	27P			
1000		27	20*	15.5*		L	
P indica	tes strengt	h value obta	ined by use	of Larson	Miller para	meter T(25	+ log t).

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	REDUC- TION IN AREA, %
1000	40.0	18 R					17, 0	85.0
1000	34.0	42 R					21.0	84.0
1000	30.0	198 R		l			23.0	86.0
1000	24.0	1390 R					20.0	86.0
1000	20.0	5946 R					20.0	84.0

## ORIGINAL CREEP AND RUPTURE DATA

EMP. °F	P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	REDUC TION IN AREA,
1000	36.0	67 R					24.0	86.0
1000	32.0	214 R					30.0	85.0
1000	26.0	1337 R					23.0	85.0
1000	22.0	5324 R					20.0	84.0
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				L				
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# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr (Type 403		YPE (		RNAC	E		SIZE OF HEAT Commercia			cial
CHEMICAL COMPOSITION,	С	Mn	Р	S	Si	Cr	Ni	Mo		
PER CENT	0.09	0.50			0.28	12,35	0.41	0.29		
DEOXIDATION								,		
FORM-CAST OR WROUGHT	Wrough	t 3/4"	x I-	1/8" 1	Ваг					
HEAT TREATMENT Finished	at 1450	F, A.	C. W	ith Fa	ns, T	emper	ed 11	50 F		
MICROSTRUCTURE										
GRAIN SIZE			_		H.	ARDNE	SS			
SOURCE OF DATA General	Electr:	c Con	nanv							

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

  (2) EXTRAPOLATED VALUES INDICATED BY \*

  (3) DURATION OF FEST (INDICATED BY R.).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80			112.4	24.0	67.9

TYPE OF MATERIAL 12 Cr (Type 403)		TYPE OF MELTING FURNACE					SIZE OF HEAT Commercial				
CHEMICAL COMPOSITION,	C	Mn	P	S	Si	Cr	Ni	Mo			
PER CENT	0.13	0.35			0.32	12.31	0.36	0.19		Ĺ	
DEOXIDATION											
FORM-CAST OR WROUGHT	Vrough	t 1-3/	16" ×	5-7/	16™ Ba	т					
HEAT TREATMENT Finish Ro	lled 14	50 F,	A. C.	With	Fans,	1175	F -	15 Hr,	1100	F - 1	Hr
MICROSTRUCTURE											
GRAIN SIZE					H	ARDN	ESS				
SOURCE OF DATA General	Elect	ric Co	mpan	y							

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET (a) YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, IOOO P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		92.9	114.9	24,5	66.3
(a) 0.02% Of	set yield streng	:h			

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN 0, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
°F.	IOO HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
900		48P	40P	34P			
1000		34	28	23*			<u> </u>
P indica	tes strengt	h value ob	ained by us	e of Larson	Miller par	meter T(2	+ log t).

### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),		REDUC- TION IN AREA, %
1000	50.0	6 R		I			14.0	80.0
1000	42.0	57 R	L	İ			17.0	82.0
1000	32.0	1811 R					16.0	84.0
1000	29.0	6624 R					21.0	87.0

# (19)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr		YPE (		RNAC	É		SIZE OF HEAT				
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo			
PER CENT	0.11	0.45		. —	0.30	13,22			$\Box$		
DEOXIDATION											
FORM-CAST OR WROUGHT	Wro	ight								-	
HEAT TREATMENT Normal	ized an	d Tem	pered								
MICROSTRUCTURE											
GRAIN SIZE					H	ARDN	ESS	_			
SOURCE OF DATA "Propert	ies of C	arbon	& Al	loy Se	amles	s Stee	l Tub	ing for	High '	Temper	
ture and	i High I	ressu	re Se	rvice	,'' Ba	bcock	& Wi	lcox T	ube Co	mpany.	

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	UPTURE IN D, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
*F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1000			1			10.0	13.0	
1100	1					4.0	5.2	
1200						1.5	2.1	
1300						0.9	1.4	



## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr + N <sub>2</sub>		YPE MELTII		RNACE	:		SIZE OF HEAT			
CHEMICAL COMPOSITION,	С	Mn	P	S	Si	Cr	Ni	Mo	N <sub>2</sub>	
PER CENT	0.105	0.38	0.020	0.010	0.36	26.12	0.20	0.02	0.125	
DEOXIDATION						•				
FORM-CAST OR WROUGHT	Hot I	Rolled	Bar				_			
HEAT TREATMENT As Ho	t Rolled									
MICROSTRUCTURE										
GRAIN SIZE 4-6 ASTM	errite	Grain	Size		Н	ARDNE	SS	167	BHN	
SOURCE OF DATA Universi										

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RE	OPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F	IOO HRS.	IOOO HRS	IO,000 HRS	100,000 HRS.	0.00000 I %/HR.	0.00001 %/HR	0.0001 %/HR.	
1200	6.2*	4.3*		1				
1400	2.3*			1		L		
1600	1.10	0.66	0.40*	0.24*				
1800	0.59*		1	L.—	<u> </u>	<u> </u>		

### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1200	5.0	390.0R					64.0	
1400	2.25	125.5R					56.0	
1600	1.00	181.5R				l	74.0	
1600	0.75	579.5R					85.0	
1600	0.65	1143.0R					85.0	
1800	0.65	65.0					108.5	

(21)

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12Cr-1/2Mo		TYPE OF MELTING FURNACE						SIZE OF HEAT				
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo				
PER CENT	0.08	0.37	0.022	0.021	0.22	12.14	0.19	0.49				
DEOXIDATION												
FORM-CAST OR WROUGHT	Wroug	ht										
HEAT TREATMENT 1750 F Q	iench t	- 1220	F Ter	nper								
MICROSTRUCTURE Temper	ed Ma	rtensi	te and	Delta	Ferr	ite						
GRAIN SIZE 5-8					H	ARDNI	ESS	231 D	₽ <b>H</b>			
SOURCE OF DATA U.S. St	eel Co	rp. R	esearç	h Lab								

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
•F `	HRS.	IOOO HRS,	10,000 HRS.	100,000 HRS.	0.00000 I %/HR.	0.00001 %/HR	0.0001 %/HR.	
900		54.*		1				
1000		26.			1			
1050		18.						
1100		13.0				L		
1200		6.0	L					
1250		4.2						
1300		2.9						
1350	I	2.0*		1				

### ORIGINAL CREEP AND RUPTURE DATA

TEMP, °F.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	50.0	1.8 R		3.0			55.0	
1000	45.0	6.2 R		1.03			33.0	
1000	40.0	20.2 R						
1000	35.0	83.3 R		0.10			41.0	
1000	25.0	1457. R	_					
1100	35.0	1. 25 R		5,74				
1100	30.0	5. 5 R		1.55				
1100	20.0	100. R		0.056				
1100	15.0	522. 5 R		0.023				
1100	12.0	1692. R		0.0072				
1300	15,0	0.33 R						
1300	10.0	4.25 R		2.7		-		
1300	7.2	19.5		0.45				
1300	4.5	158.5 R		0.075				
1300	3,0	711. R		0.014				
			_					

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

  (2) EXTRAPOLATED VALUES INDICATED BY \*

  (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

## (22)

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr + 0.5 Mo +		TYPE MELTA		RNACE	Ind	uction	SIZE		30 lb		
HEMICAL COMPOSITION,	С	Mn	P	S	Si	Cr	Ni	Mo	N <sub>2</sub>	Co	
PER CENT	0.10	0.51	0.014	0.016	0.24	12.33		0.50	0.091	1.11	
DEOXIDATION											
FORM-CAST OR WROUGHT	Forg	ed to	l" Rou	nd Ba	rs						
HEAT TREATMENT Normaliz	ed 1750	Fan	d Anne	aled	1650	F					Ξ
MICROSTRUCTURE											
GRAIN SIZE 8 ASTM Fer	rite Gr	ain Si	ze		H	ARONE	SS I	70-17	BHN		_
SOURCE OF DATA Univers	ity of N	lichig	an								

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT	I	39.0	85.0	81.0	70.3
1200		14.35	26, 25	59.0	93.4

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
•ŧ	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.00000 t %/HR.	0.00001 %/HR	0.0001 %/HR.	
1200	9.6	6.2	4,1*	2.7*		0.63*	2.1*	
				<del>                                     </del>				
			-					
			<del>                                     </del>		<u> </u>			
			-		<u> </u>			
			<u>t                                     </u>	<u> </u>	<u> </u>			

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- (2) EXTRAPOLATED VALUES INDICATED BY \*

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr + 0.50 Mo +	N <sub>2</sub>	YPE	OF NG FU	RNACE	Indu	ction	SIZE		30 lb	
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ní	Mo	N <sub>2</sub>	
PER CENT	0.11	0.38	0.019	0.021	0.18	12.34		0.42	0.131	T
DEOXIDATION										
FORM-CAST OR WROUGHT	Forge	d to 1	" Rou	nds						
HEAT TREATMENT Normalized	d From	m 175	0 Far	d Ann	ealed	1650	F			
MICROSTRUCTURE										
GRAIN SIZE 7/8 ASTM Fer	rite (	Grain	Size		H	ARDN	ESS	140-14	6 BHN	
SOURCE OF DATA University	of M	ichiga	n							

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (I) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT.		32.0	75.5	35.0	74.3
1200		13.0	22.6	58.0	91.3

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
•f	100 HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000i %/HR.
1200	8.5	5, 6	3.5*	2, 1*		0.57*	1.85*
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- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- (2) EXTRAPOLATED VALUES INDICATED BY

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1200	19.0	0.4 R					62.0	
1200	14.0	6.3 R					65.0	
1200	9.5	106.0 R					63.0	
1200	7.0	547.0 R					65.0	
1200	6.0	1288. 5 R					71.0	
1200	1.5	1500	0. 120	0.000052	1	0.197		
1200	1.0	1275	0.072	0.000024		0.103		
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- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

### ORIGINIAL CREED AND RUPTURE DATA

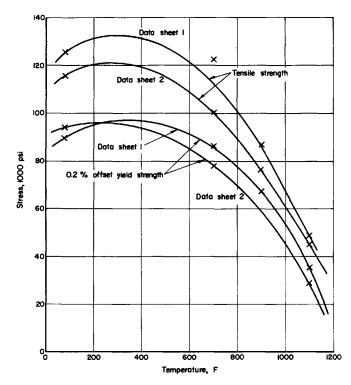
T-140	STRESS	DISTIN	WITE COECUT	MINIMUM	TRANSITION	TOTAL FXT	TOTAL FLONG	HARDNESS
°F.	1000 P.S.J.	HOURS(3)	(4)	MINIMUM CREEP RATE, %/HR.	TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	AFTER TESTING
1200	15.0	2.5 R	l				58.0	
1200	8.0	151.0 R					68.0	L
1200	6.75	452.0 R		<u> </u>	L		65.0	
1200	5.5	1118.0 R	L			L	66.0	
1200	1.5	1290.0	0.049	0.000065	L	0.131		
1200	1.0	1237.0	0.046	0.000033		0.087		
1200	0.78	1340.0	0.042	0.000018	ļ	0.066		
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- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

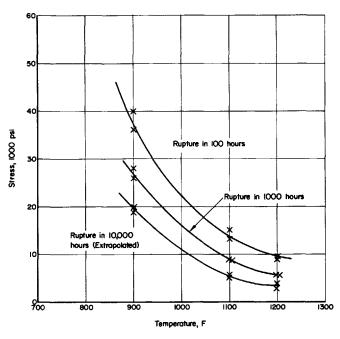
  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

12 Chromium, 2 Nickel Steels



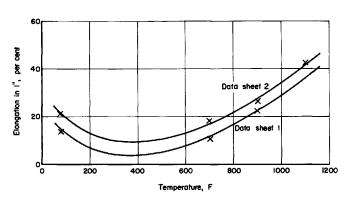
TENSILE AND YIELD STRENGTH DATA

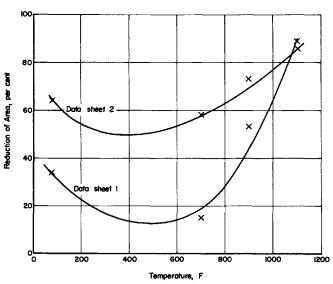
12 C4 2 Ni STEEL



RUPTURE STRENGTH DATA

12 Cr, 2 Ni STEEL





ELONGATION AND REDUCTION IN AREA

(1)

TYPE OF MATERIAL 12 Cr, 2 Ni (Typ	e 414)	TYPE MELTH	OF NG FU	RNACE	Indu	ction	SIZE		30 1Ь	
CHEMICAL COMPOSITION.	С	Mn	P	S	Şi	Cr	Ni	N <sub>2</sub>		
PER CENT	0.13	0.58	0.022	0.017	0.52	12.37	1.82	0.124		
DEOXIDATION										
FORM-CAST OR WROUGHT	Wrou	ght, 5	/8-an	<u>d</u> 1-1;	/2"-Se	quare	Forge	d Bar	s	
HEAT TREATMENT 1800 F,	1/2 Hr	. OQ;	1225 1	, 4 H	r, oc	2				
MICROSTRUCTURE Tempere	d and t	Jntem	pered	Marte	nsite					
GRAIN SIZE Austenitic Grain	n Size,	ASTN	A No.	6 to 7	H	ARDNE	SS	21	Rc	
SOURCE OF DATA U.S. Stee	l Corp	. Res	earch	and D	evelo	pment	Lab.			

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT (a)		90.4	126.8	14.0	34.7
700 (b)		86.5	122.5	11.0	15.0
900 (b)		67.0	87,0	22.5	53.0
1100 (ь)		35.4	49.7		89.0
	ameter specime				

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN 1	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
•F '	IOO HRS.	IOOO HRS.	IO,000 HRS.	100,000 HRS.	0.00000 I %/HR	0.00001 %/HR	0.0001 %/HR.
900	40.0	28.0	20.0*				
1100	15.2	8.8	5.1*	l		l	
1200	9, 5	5, 6	3.2*				
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- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- (2) EXTRAPOLATED VALUES INDICATED BY \*

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2 Ni (Type	414)	TYPE MELTI	OF NG FU	RNACE	Indu	ction	SIZE		100 lb	
CHEMICAL COMPOSITION,	C	Mn	Р	Ş	Si	Cr	Ni	Mo	N <sub>2</sub>	
PER CENT	0.13	0.78	0.008	0.017	0.71	12.31	1.88		0.015	
DEOXIDATION									-	
FORM-CAST OR WROUGHT	Wroug	ht_ 5/	8 - and	1-1/	2"-Sq	uare :	Forge	d Bar	s	
HEAT TREATMENT 1800 F, 1	Z Hr.	OQ; 1	225 F	4 H	r, ΟΩ					
MICROSTRUCTURE Temper	ed Ma	rtensi	te							
GRAIN SIZE Austenitic Grain	n Size,	ASTN	A No.	6 to 7	Н	ARDN	ESS .	22 R <sub>c</sub>		
SOURCE OF DATA U.S. Ste	el Cor	p. Res	earch	and	Devel	pmer	it Lab			

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (I) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT (a)		94.0	116.4	21.5	64.6
700 (Б)	L	78.4	101.3	18.0	58.7
900 (Ъ)	l		77.2	26.3	73.3
1100 (b)		29.6	45.7	42.3	86.6

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN 0, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
*F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.00000 i %/HR.	0.00001 %/HR	0.0001 %/HR.
900	36.0	26.0	19.2*				
1100	13.3	8.7	5, 6*				
1200	9.7	6.3	4.0*				
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- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- (2) EXTRAPOLATED VALUES INDICATED BY

### ORIGINAL CREEP AND RUPTURE DATA

TEMP, °F.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	NTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. ICREEP TEST),	TOTAL ELONG. (RUPTURE TEST), %	HARDNESS AFTER TESTING
900	60.0	1.43		5.71	0.75		31.8	Rb 98.3
900	50.0	11.1		0.971	4.6		40,0	Rb 97.7
900	45.0	29.3	İ	0.364	<u> </u>		39. <u>6</u>	Rb 96.3
900	40.0	103.3		0.127	38.0		43.8	Rb 96.5
900	35.0	212.0	i	0.047	125.0	L	25.2	<u>Rъ 95.8</u>
900	30.0	712.0		0.021	415.0		58.0	Rb 95.1
1100	30.0	1.5		7.46	0.65		48.0	Rb 95.2
1100	20.0	16.9		0.899	5.8		56.2	Rb 94.6
1100	15.0	108.0		0,170	47.5	_	66.2	Rb 90.5
1100	10.0	596.0		0.0316	348.0		80.4	Rb 84.8
1100	8.5	1212.8		0.0138	758.0		78.0	Rb 83.8
1200	30.0	_0.12		105.6			50.2	Rb 94.6
1200	20.0	0.90		16.0			61.4	Rb 90.1
1200	10.0	78.0		0. 248	29.2		95.2	Rb 88.6
1200	8.5	114.0		0.146	42.0		82.4	Rb 88.5
1200	8.14	266.8		0.0678	94.5		73.6	Rb 87.3
1200	6.5	404.5		0.0473	228.0		89.4	Rb 88.4
1200	5.22	1295.0		0.0137	863.0		82.0	Rb 86.3
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- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

### ORIGINAL CREEP AND RUPTURE DATA

	STRESS	DURATION,	INTERCEPT,	MINIMUM CREEP RATE,	TRANSITION	TOTAL EXT.	TOTAL ELONG.	HARDNES AFTER
<b>°</b> F.	P.S.I.	HOURS(3)	%(4)	%/HR	TIME, HRS.(5)	%	TEST),%	TESTING
900	55.0_	2.1		2. 92	0.9		33.8	Rb 96.1
900	47.0	9.7		0.870	5.6		36.4	Rb 95.6
900	40.0	42.5		0. 232	18.0		39.6	Rb 95.5
900	32.0	223.0		0.0553	131.3		46.0	Rb 93.1
900	27,5	730.5		0.0228	427.0		50.0	Rb 93.5
1100	30.0	0.6		16.0	0.25	-	46.4	Rb 92.7
1100	20.0	11, 2		0. 986	4.8	i –	52.6	Rb 91.3
1100	15.0	53.0		0.204	17.6		70.2	Rb 89.2
1100	9, 5	610.0		0.0202	313.0		70.2	Rb 86.2
1100	8.0	1520.0		0.0097	847.0		92.0	Rb 85.4
1200	20,0	1, 2		11.52	0,6		50.8	Rb 91.8
1200	15,0	8. 5		1, 52	3.3		52.6	Rb 91.4
1200	10.0	91.5	i	0.1181	40.4		60.2	Rb 90.8
1200	8.5	213, 8		0.0571	96.0		72.2	Rb 88.5
1200	7.5	420.3		0.0218	180.0		78.2	Rb 88.3
1200	6.0	1298.0		0.0081	900.0		78.0	Rb 85.3
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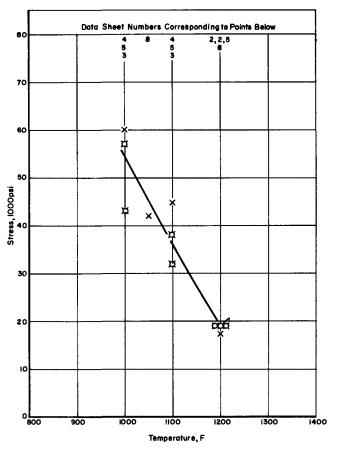
- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

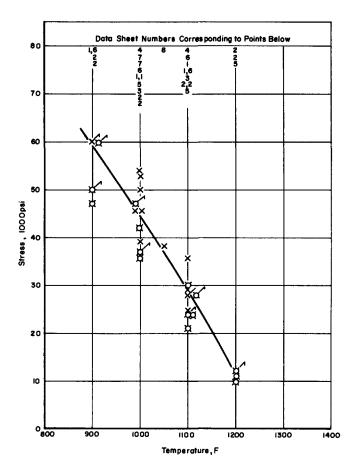
  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.



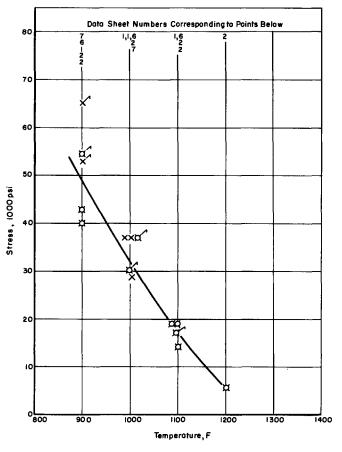
13 Chromium, 2 Nickel, 3 Tungsten Steels (Greek Ascoloy)



RUPTURE IN 100 HOURS

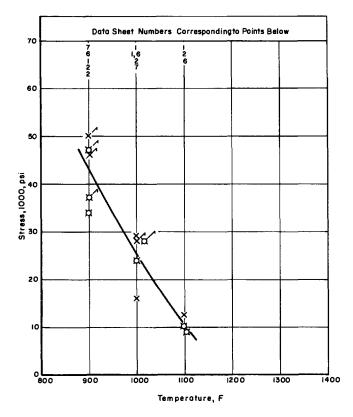


RUPTURE IN 1000 HOURS



RUPTURE IN 10,000 HOURS (EXTRAPOLATED)

13 Cr, 2 Ni, 3W STEEL



RUPTURE IN 100,000 HOURS (EXTRAPOLATED)

I3Cr, 2Ni, 3W STEEL

(2)

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, 2 Ni, 3 W		TYPE OF MELTING FURNACE					SIZE OF HEAT Commercial				
CHEMICAL COMPOSITION.	C	Mn	Р	\$	Şi	۲	Ni	Мо	w		
PER CENT	0.07	0.29			0.30	12.25	2.05		2.82		
DEOXIDATION											
FORM-CAST OR WROUGHT											
HEAT TREATMENT 2050 F. 1	Hr, C	Q; 120	00 F,	2 Hr	A.C.						
MICROSTRUCTURE											
GRAIN SIZE					Н	ARDNE	SS				
SOURCE OF DATA Gener	al Elec	ctric (	Compa	ny							

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN 1000 P.S.I.	TIMES (2)	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
*F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	D.0001 %/HR.	
900		60P	53P	46P				
1000		46P	37P	28P				
		46	37*	29*				
1100		28P						
		29	19*	12.5*	ļ		L	
P indica	tes strengt	n value obta	ined by us	e of Larson	Miller par	meter T(2	+ log t)	

### ORIGINAL CREEP AND RUPTURE DATA

				L OILLI -				
TEMP,	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),		REDUC- TION IN AREA, %
1000	66.0	1_R					13.4	73.0
1000	60.0	8 R					13.9	76.0
1000	50.0	283 R					13.9	76.5
1000	45.8	1167_R					13.4	76.0
1000	42.8	2278 R					10.6	72.5
1000	38.0	7695 R					10.4	61.0
1100	50.0	1 R					14.6	81.0
1100	44.0	17 R					14.6	81.0
1100	37.0	179 R					10.5	75. 5
1100	32.0	552 R				Ī	9.8	75.0
1100		1772 R					14.6	83.0

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF

TYPE OF MATERIAL 13 Cr, 2 Ni, 3 W		TYPE OF SIZE O						OF		
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	w	
PER CENT	0.12	0.37	0.006	0.008	0.24	11.88	2.08		2.98	
DEOXIDATION										
FORM-CAST OR WROUGHT										
HEAT TREATMENT 1/2 Hr,	1800 F	`, A.C	.; 1-	1/2 Hr	, 126	0 F, A	L. C.			
MICROSTRUCTURE										
GRAIN SIZE					H/	ARDNE	SS			
SOURCE OF DATA General	Elect	ric Co	mpan	у						

### SHORT TIME TENSILE DOODEDTIES

	JHORI	LIME LEMOIT	E PROPERT	ES	
TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80			130.0	21	62
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### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RUINDICATED	PTURE IN T	IMES	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.0000i %/HR	0.0001 %/HR.		
900		_50P	43P	37P					
900	L	47	40*	34*					
1000		37P	30P	24P					
1000		_ 36							
1100		24P	18P	10P					
1100	1	24	14.3*			T			
1200	19P	12P				r			
1200	19	11.9	5.9*						
P indic	ates strengt	h value obta	ined by use	of Larson	Miller para	meter T(2	+ log t).		

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

(2) EXTRAPOLATED VALUES INDICATED BY \*

### ORIGINAL CREEP AND RUPTURE DATA

		_	ONIONA	AL ONLLE	NO KUP I UN	LPAIA		
TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.		TOTAL EXT. (CREEP TEST), %	TOTAL ELONG (RUPTURE TEST), %	HARDNESS AFTER TESTING
900	70.0	5 R						
900	65.0	11 R						
900	60.0	34 R		L				
900	55.0	110 R						
900	45.0	2850 R		L				
1000	45.0	51 R						
1000	35.0	1630 R			L			
1100	35.5	17 R_			L			
1100	33.0	65 R						
1100	30.0	165 R			<u> </u>			
1100	28.0	345 R						
1100	24.0	830 R			ļ			
1100	20.0	2250 R						
1200	25.0	28 R						
1200	20.0	63 R			<u> </u>			ļ
1200	17.3	295 R						
1200	15.0	450 R		1	<b>1</b> ——			<b></b>
1200	12.5	710 R			L			L
1200	10.0	1850 R			<u> </u>	<u> </u>	L	L

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, 2 Ni, 3 W							SIZE HEAT	SIZE OF HEAT Commercial			
CHEMICAL COMPOSITION,	С	Mn	۵.	s	Si	Cr	Ni	Mo	w		
PER CENT	0.12	0.31			0.31	13.18	1.99		2.98		
DEOXIDATION											
FORM-CAST OR WROUGHT											
HEAT TREATMENT 1800 F, 3	Hr, C	Q: 130	0 F, 1	Hr,	A.C.						
MICROSTRUCTURE	_					-					
GRAIN SIZE					Н	ARDNI	ESS .	245 B	HN		
SOURCE OF DATA U.S.N.	Engin	eering	Expe	rimen	t Stati	ion					

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT	28.9	92.8	120.6	24	66
1000	18.4	53.0	69.8	21	76
1100	16.9	43.5	57.6	28	84

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE		UPTURE IN			FOR DESIG	
*F	100 HRS.	1000 HRS.	IO,000 HRS	100,000 HRS.	0.00000 I %/HR.	0.00001 %/HR	0.0001 %/HR.
1000	43	39					
1100	32	2.5	1	1	T -	3.5	8.0

### ORIGINAL CREEP AND RUPTURE DATA

TEMP	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	50.0	10 R					38.0	
1000	45.0	39 R					41.0	
1000	40.0	684 R	1.75	0.0094	370		30.0	
1100	40.0	12 R					30.0	
1100	30.0	310 R	L				29.0	
1100	27.0	234 R					26.0	
1100	12.0	2016	0.245	0.000287		0.821		
1100	7.5	2040	0.126	0.000079		0.287		
1100	5, 5	1872	0,173	0.000034		0.234		
			-				<del></del>	

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

4

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, 2 Ni, 3 V		TYPE OF MELTING FURNACE					SIZE OF HEAT Commercial			rcial
CHEMICAL COMPOSITION.	С	Mn P	S	S Si	Si Cr	Ni	Мо	w		
PER CENT	0.15	0.25	0.014	0.004	0.22	13.09	1.95	1	3.01	
DEOXIDATION										
FORM-CAST OR WROUGHT			nt Bar							****
HEAT TREATMENT 1800 F, 1	Hr, O	2; 120	0 F,	Hr,	A. C.					
MICROSTRUCTURE				-						
GRAIN SIZE					Н	ARDN	SS	270 B	HN	
SOURCE OF DATA U.S.N	Engir	eerin	g Expe	rimer	t Sta	tion				

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT		118.6	135.0	22	66
1000		71.4	84.5	22	76
1100	<del> </del>	51.5	67.6	26	82
	}				

### CREEP AND RUPTURE STRENGTHS

ſ	TEMP.,	STRE	SS FOR R	UPTURE IN D, 1000 P.S.I	TIMES .(2)	STRESS FOR DESIGNATE CREEP RATE, 1000 PS.I				
	•F	100 HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0,0001 %/HR.		
	1000	60	54	1		1		21.0		
	1100	45	36	I			4.3	12.0		

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	OURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	63.0	49 R					32.0	
1000	55.0	638 R	0.85	0.0048	300	_	27.0	
1100	45.0	113 R					31.0	
1100	35.0	1333 R	0.77	0.0022	750		22.0	
1000	25.0	2016	0.135	0.000198	1650?	0. 570		
1100	15.0	2064	0,192	0.000164	1100?	0.620		
1100	11.0	2016	0.144	0.000080		0.305		
1100	8.0	2016	0.110	0.000039		0.189		

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, 2 Ni, 3 W		TYPE MELTI		RNACE	Ele	ectric	SIZE	OF	Comr	nercia	ıl
CHEMICAL COMPOSITION,	С	Мп	Р	S	Si	Cr	Ni	Mo	Al	w	Cu
PER CENT	0.12	0.35			0.31	12.88	1.98	0.05	0.04	2.86	0.11
DEOXIDATION											
FORM-CAST OR WROUGHT	Hot Re	olled l	" Bar	s Anne	ealed						
HEAT TREATMENT 1800 F, 2	Hr, A	. C. ;	050 F	, 2 H	r, A.	C.					
MICROSTRUCTURE									_		
GRAIN SIZE					Н	ARDNE	SS	36 R			
SOURCE OF DATA NACA	Lewis	Labor	atory								

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
1000			102.0		70
1100			78.4		76
	1			i	

### CREEP AND RUPTURE STRENGTHS

IGNATED DO P.S.I.(2)
0.0001 %/HR.
_

### ORIGINAL CREEP AND RUPTURE DATA

			ONIONA	IL UNCEP A	100 100 101	C DAIA		
TEMP.	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.		TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	REDUC- TION IN AREA, %
1000	40.0	1687 R						21.0
1000	45.0	649 R						36.0
1000	50.0	308 R				L		44.1
1000	54.0	188 R			·	1		53.5
1000	58.0	65.5 R	i		I			66.0
1000	68.0	7.4 R						73.0
1000	77.0	2.8 R				L		65.0
1000	90.0	0.13R						66.0
1100	20.0	834 R						12.0
1100	25.0	662 R						12.0
1100	29.0	421 R				ļ		21.0
1100	34.0	178 R						30.0
1100	37.0	100 R			ļ			40.0
1100	40.0	36.9 R						59.0
1100	44.0	8.6 R				L		69.0
1100	50.0	1.3 R		<u></u>				78.0
1200	8.0	1493 R			<b></b>			20.0
1200	10.0	848 R	<u> </u>	<u> </u>				21.0
1200	15.0	225 R						24.0
1200	20.0	78.1 R		Ļ	<u> </u>	-		32.0
1200	24.0	31.1 R	ļ		<u> </u>			50.0
1200	27, 0	13.2 R					L	63.0
1200	30.0	2.2 R	<u> </u>	ļ				74.0
1200	36.0	0.4 R			<b>1</b>	L	<u> </u>	78.0

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, 2 Ni, 3 W		TYPE MELTI		RNAC	Ē		SIZE		Comme	cial
CHEMICAL COMPOSITION.	С	Mn	P	s	Si	Cr	Ni	Мо	w	
PER CENT	0.17	0.28			0.28	12.03	1.78		2.93	
DEOXIDATION										
FORM-CAST OR WROUGHT										
HEAT TREATMENT 2012 F,	4 Hr,	A. C.;	1202	F, 4	Hr, A	.C.;	1112 F	, 2 H	r, F.C.	
MICROSTRUCTURE									-	
GRAIN SIZE				-	H	ARDNE	SS			_
SOURCE OF DATA Genera	l Elec	tric C	ompan	ıγ						

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET (a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		87.5	143.4	16.4	40
(a) 0.02% Of	set yield streng	th.			
					-

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN 0, 1000 P.S.I	F STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR.	0.000I %/HR.	
900		60P	54P	47P				
1,000		47P	3.7P	28P				
1100	i	_ 28P						
		30	19*	12*				
P indica	tes strengt	n value ob	ained by us	e of Larson	Miller par	meter T(2	+ log t).	

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	60.0	8.0 R						
1000	50.0	295.0 R						
1000	40.0	5500 R						
1100	40.0	58 R						
1100	30.0	1000 R	<u> </u>		L			
1100	25,0	265 <u>0</u> R					L	
	20.0	7300 R	<u> </u>	ļ				

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

  (2) EXTRAPOLATED VALUES INDICATED BY \*

  (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

TYPE OF MATERIAL 13 Cr, 2 Ni, 3 V	v ]	TYPE OF MELTING FURNACE					SIZE HE AT		Comme	rcial
CHEMICAL COMPOSITION.	C	Mo	P	5	Si	Cr	Ni	Mo	w	
PER CENT	0.12	0.67		Π.	0.37	12.90	2.1		3.1	
DEOXIDATION										
FORM-CAST OR WROUGHT										
HEAT TREATMENT 1800 F,	OQ - 100	0 F, A	. C. ;	1000	F, A.	c.		_		
MICROSTRUCTURE										
GRAIN SIZE					H.	ARDNE	SS			
SOURCE OF DATA Genera	1 Elect	ric Co	mpan	y						

### SHORT TIME TENSILE PROPERTIES

STORY THE TENSILE THE ENTRE										
TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT					
			30.74							

### CREEP AND RUPTURE STRENGTHS

		UPTURE IN D, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
		65P	50P			
	50P					
	53	29*	16*			
			4			
	HRS.	HRS. HRS. 50P 53	HRS. HRS. HRS. 65P 50P 53 29*	HRS. HRS. HRS. HRS. 50P 50P 53 29* 16*	HRS. HRS. HRS. HRS. %/HR.  65P 50P  50P  53 29* 16*	HRS. HRS. HRS. HRS. %/HR, %/HR. 50P 50P

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS,	DURATION,	INTERCEPT,	MINIMUM CREEP RATE, %/HR.	TRANSITION	TOTAL EXT.	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER
	P.S.I.	1100110107	,,,,	%/HR.	HRS.(5)	%	TEST),%	TESTING
1000	65.0	138 R					10, 0	
1000	55.0	700 R			l	İ	8.0	
1000	45.0	1550 R					8.0	
1000	40.0	3450 R					5. 0	
1000	35.0	4500 R					4. 0	
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# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, 2 Ni, 3 W		TYPE OF MELTING FURNACE					SIZE OF HEAT			
CHEMICAL COMPOSITION,	С	Mn	P	S	Si	Cr	Ni	Mo	w	
PER CENT	0.15					13.0	2.0		3.0	
DEOXIDATION										
FORM-CAST OR WROUGHT										
HEAT TREATMENT 1750 F,	1/2 H	, OQ;	1200	F, 4	Hr, A	L. C.				
MICROSTRUCTURE										
GRAIN SIZE .					ĮΗ	ARDN	ESS	28	R <sub>C</sub>	
SOURCE OF DATA Firth-St	erling	Steel	and C	arbid	Cor	р.				

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RE	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
•F '	10 HRS.	100 HRS.	500 THRS.	1000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
1050	48	42	39	38			
1200	2.5	17.5	11				
Notch	ed: 60°, 50	% reductio	n of area.	005" rad	ius.		
1050	71	60	54		1		
1200	32	22	13.5	1			
				1	.1		
			1				

ORIGINAL CREEP AND RUPTURE DATA											
TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	REDUC- TION IN AREA, 9			
				Heat	S-509						
1050	50.0	2.8 R					27.2	77.7			
1050	47, 0	12.3 R					22.0	77.5			
1050	44.0	66.5 R					35.7	77.4			
1050	38.0	760.9 R					32.2	77.0			
1200	27.0	5.2 R					34.1	86.4			
1200		55.3 R		ļ	ļ		27.3				
1200	18.0	90.7 R			ļ		29.5	=			
1200	16.0	149.1 R			<del></del>		29.3	84.3			
1200	14.0	287.4 R			<b>-</b>		53.2	87.2			
1200	12.0	417.2 R					42.5	81.8			
1050			<u> </u>	Heat 5-5	09 Notched		<u> </u>				
1050 1050	70.0	13.8		<del> </del>							
1050	65.0	49.5 146.4									
1050	55.0	220.9									
	55.0	312.9		l							
1200	32.0	12.4									
1200	30.0	18.3									
1200	24.0	61.2									
1200	20.0	148.4									
1200	15.0	325.9									
$\Box$				Heat	S-771						
1050	57.0	1.3					31.0	78.0			
1050	44, 0	75.4				ļ	27.9	82.1			
1050	41.0	136.8			ļ		29.0	81.8			
1200	27.0	2.7					33.3	85.0			
1200	24.0	6.3	<del> </del>	<del></del>	<del></del>	ļ	23.6	88.0			
1200 1200	20.0	55.9 109.7					25.0 36.0	85. 5			
1200	18.0	161.0					25.6	88.1			
1200	14.0	296.9			<del> </del>		44. 8	91.4			
1200	12.0	343.3	-		<u> </u>		38.5	90. 2			
	1270			Heat S-7	71 Notched	-	50. 5	70,2			
1050	70.0	20.3		near B-	I						
1050		39. 2									
1050	60.0	225.5									
1050	55.0	321.5									
1200	34.0	0.05									
1200	30.0	367									
1200	24.0	70, 7									
1200	20.0	197.0			ļ						
1200	15,0	438.5									
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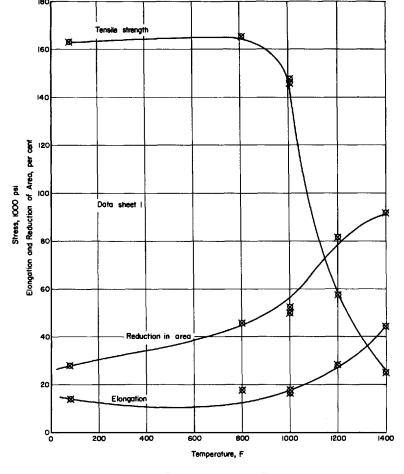
- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- (2) EXTRAPOLATED VALUES INDICATED BY \*

  (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R),

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

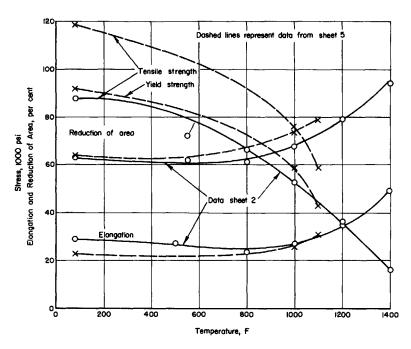
  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

12 Chromium, 3 Tungsten Steels



SHORT-TIME TENSILE DATA

12 Cr, 3W STEEL



SHORT-TIME TENSILE DATA

12 Cr, 3W STEEL

TYPE OF MATERIAL 12 Cr, 3 W		YPE WELTIN		RNACI	É		SIZE			
CHEMICAL COMPOSITION,	С	Mn	Р	S	Si	Cr	Ni	Мо	w	
PER CENT	0.09	0.57			0.37	12.0		Ι	3.0	
DEOXIDATION										
FORM-CAST OR WROUGHT	l" Ba	rs, W	ought							
HEAT TREATMENT Norm	alized	2000 I								
MICROSTRUCTURE										
GRAIN SIZE					Н	ARDNI	ESS .	315 B	HN	
SOURCE OF DATA Compila							Cree	Char	acteristi	cs Of
Metals	& Allo	Vs. A	5ME -	ASTM	. 193	8.				

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
70			163.0	14.0	28.6
800			165.4	17.5	45.5
1000			147.2	18.0	52.2
1000			146.6	17.0	49.8
1200			57.8	28.5	81.5
1400			25.0	44.0	91.1

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN	TIMES .(2)	STRESS CREEP	FOR DESIGNATE, 1000	NATED P.S.I.(2)
°F	IOO	IOOO	10,000	100,000	0.00000 I	0.00001	0.0001
	HRS.	HRS.	HRS.	HRS.	%/HR.	%/HR	%/HR.

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
800.	30.0	250	0.025	0.000017		0.029		
900	30.0	500	0.107	0.000136		0.171		
1000	30.0	500	0.400	0.00058		0.685		
1200	3.0	250	0.039	0.000084		0.059		
1200	10.0	250	0.174	0.000456		0.286		
1300	3.0	250	0.025	0.000121		0.086		
L								
		L	l					

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 3 W		MELTIN		RNAC	É		SIZE			
CHEMICAL COMPOSITION.	С	M	P	S	Si	Cr	Ni	Mo	w	
PER CENT	0.09	0.57			0.37	12.0	T		3.0	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wrough	ht 1" I	ars							
HEAT TREATMENT Anneale	d 1550 :	F.								
MICROSTRUCTURE								•		
GRAIN SIZE					H	ARDNI	ESS	180 B	HN	
SOURCE OF DATA Compilat	ion of	vailal	ole Hi	gh Te	mpera	ture	Стеер	Char	acteristic	s of
Metals	& Alloy	s, A5	ME-A	STM,	1938.					

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
70			87.7	29.5	63.5
550			72.4	27.5	62.1
800			66.4	23.5	61.1
1000		l	53.8	27.2	67. 9
1200			36.9	35.0	79.7
1400	ļ		16.5	50.0	94.5
1400	-		16.5	50.0	

		CREE	AND RUP	TURE ST	RENGTHS		
TEMP.	STRE	SS FOR RI	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
°F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.00000 I %/HR.	0.00001 %/HR	0.0001 %/HR.
			<u> </u>				
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#### ORIGINAL CREEP AND RUPTURE DATA

FEMP.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
900	30.0	250	0.100	0.000167		0.141		
1200.	3.0	250	0.007	0.000083		0.028		
1300	3.0	250	0.095	0.000092		0.118		
1400	1.0,	500	0.042	0.000290		0.093		
1400	3.0	500	0	0.00178		0.890	L	
1500	1.0	500	0.056	0.000660		0.391		
		_						
_								
	<u></u>	L	l	l	J	L	L	

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 3 W		YPE ÆLTII	OF NG FUI	RNACE	Ē		SIZE OF HEAT			
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Mo	w	
PER CENT	0.084	0.43	0.012	0.016	0.113	11.61	0,114		3.01	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wroug	ht Ba	rlx	4" x 5	' Plat	te				
HEAT TREATMENT Furi	nace C	ooled	1472 1	-						
MICROSTRUCTURE										
GRAIN SIZE					H	ARDNE	ESS			
SOURCE OF DATA Compilation	on of A	vaila	le Hig	th Ter	npera	ture (	reep	Chara	cteristi	cs of
Metals &	Alloy	s, AS	ME-A	STM,	1938					

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80	ļ		99.2	25.5	66.8
					***
	-				

#### CREEP AND RUPTURE STRENGTHS

TEMP.,	STRE	SS FOR R	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
•F '	IOO HRS.	ICOO HRS.			0.00000 I %/HR.	0.00001 %/HR	0.0001 <b>%/</b> HR.
				ļ			-
<del></del>		1	+	<del> </del>	<del> </del>		

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

(2) EXTRAPOLATED VALUES INDICATED BY #

(2)

### ORIGINAL CREEP AND RUPTURE DATA

(4)

$\overline{}$	TEMP STRESS DURATION INTERCEPT. MINIMUM TRANSITION TOTAL EXT. TOTAL ELONG HARDNESS AFTER TIME. ICREEP TESTI, (RUPTURE AFTER HRS.(5) % TESTI,% TESTING												
TEMP. °F.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. ICREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING					
1022	7.5	9700	0.182	0.000001		0.193							
1022	10.0	9700	0.332	0.000005		0.382							
1022		9700	0.527	0.000004	<u> </u>	0.574							
1022	15.0	700	0,582_	0.000235		0.740		-					
			_										
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-				<u> </u>									
-		<del></del>											
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- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 3 W (Type	418)	TYPE MELTI	OF NG FU	RNACE			SIZE	OF	Commer	cial
CHEMICAL COMPOSITION,	C Mn P S Si					Cr	Ni	Ni Mo	w	
PER CENT	0.10	0,39	0.010	0.021	0.33	13.23	0.27		3.09	
DEOXIDATION										
FORM-CAST OR WROUGHT	7/8" V	Vroug	ht Bar	8						
HEAT TREATMENT 1800 F, 1	Hr, O	Q; 120	00 F,	l Hr,	A.C.					
MICROSTRUCTURE										
GRAIN SIZE					Н	ARDNI	ESS	235 E	BHN	
SOURCE OF DATA U.S.N.	Engine	ering	Expe	iment	Stati	on.				

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET YIELD (I) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA PER CENT
RT		92.0	118.6	23	64
1000		58.8	76.2	26	74
1100		43.0	58.8	31	79
		ļ			

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN D, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1000	51	47						
1100	33	26					10	
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- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- (2) EXTRAPOLATED VALUES INDICATED BY \*

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 3 W		MELTII		RNAC	Ė		SIZE			
CHEMICAL COMPOSITION,	C	Mn	Р	S	Si	Cr	Ni	Mo	w	
PER CENT	0.09	0.32			0.34	13.05		T	2.76	Т
DEOXIDATION										
FORM-CAST OR WROUGHT	Wroug	ght								
HEAT TREATMENT Anneale	d									
MICROSTRUCTURE							-			
GRAIN SIZE					Н	ARDNE	SS			
SOURCE OF DATA "Propertie										
turo one	High	Drees	ure S	ervice	. " Bo	bcock	A. Wi	leav T	Tube Com	20.20

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (I) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT

#### CREED AND PURTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN D, 1000 P.S.	TIMES	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2			
°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.00000 I %/HR.	0.00001 %/HR	0.000I %/HR.	
1200						3.0	5.2	
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- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- (2) EXTRAPOLATED VALUES INDICATED BY #

TEMP.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	55.0	19 R					19.0	
1000	48.0	729 R	0.38	0.014	100		29.0	
1100	35.0	62 R					35.0	
1100	33,0	95 R		_			45.0	
1100	27.0	8 <u>79 R</u>	2.14	0.0032	410		22.0	
1100	20.0	1800	0.51	0.00065	,	,		
1100	12.0	2016	0.227	0.00016		0.543		
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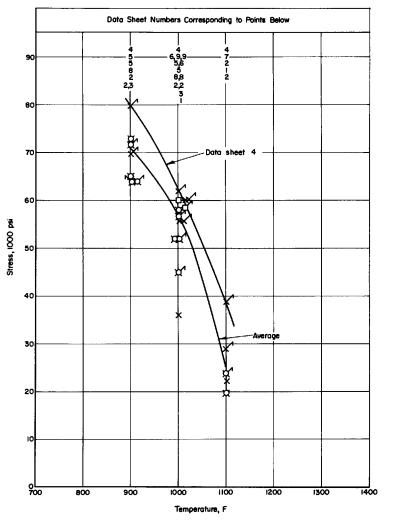
- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

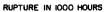
  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

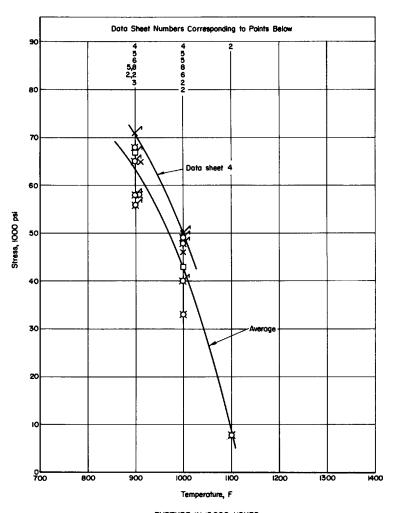
STP228-EB/Jul. 1958

12 Chromium, Columbium Steels



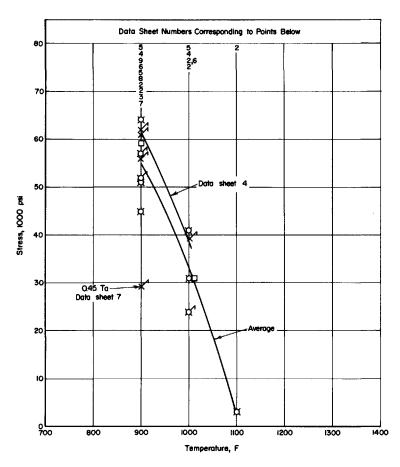


12 Cr, Cb STEEL



RUPTURE IN IQOOO HOURS (EXTRAPOLATED)

12 Cr, Cb STEEL



RUPTURE IN IOO,OOO HOURS (EXTRAPOLATED)

12 Cr, Cb STEEL

### $\binom{1}{2}$

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 12 Cr, Cb MATERIAL (Type 410 Cb)		YPE	OF NG FU	RNACE	_		SIZE HEAT		omme	cial
CHEMICAL COMPOSITION,	C	Мп	P	s	Si	ភ	Ni	Мо	СЪ	
PER CENT	0.07	0.43	0,018	0.018	0.32	13.72	0.16		0.40	
DEOXIDATION										
FORM-CAST OR WROUGHT	1-1/8	" Wro	ught E	Bars						
HEAT TREATMENT 1800 F,	l Hr,	OQ: I	200 F	, 1 H	r, A.	c.				
MICROSTRUCTURE										
GRAIN SIZE					Н	ARDNE	SS	231	вни	
SOURCE OF DATA U.S. N.	Engine	eering	Expe	rimer	t Stat	ion				

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE, °F	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT_		84.6	103.0	24	70
1000		52.8	65, 2	24.	74
1100		41,6	52,0	28	79

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN	TIMES .(2)	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.C				
°F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.		
1000	41	36	1	1		13	20		
1100	29	22		I		3, 8	8, 5		

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	50.0	2 R					27.0	
1000	40.0	220 R	0.45	0.0095	.100		26.0	
1000	37.0	794 R	0.53	0.0044	250		32.0	
1100	35. Q	9 R					24.0	
1100	30.0	79 R					33.0	
1100	26.0	277 R	0.16	0.0046	90	L	20.0	
1100	23.0	686 R	0.19	0,0032	275		32.0	
1000	20.0	2016	0. 236	0.000062		0.363		
1000	15,0	2016	0.140	0,000031		0.202		-
1100	17. 0	840	0.287	0.00061	300	1.13		
1100	10.0	2040	0.062	0.00028	470	1.16		
1100	6,5	2040	0.042	0.000043		0.129		

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr. Cb		YPE				ction	SIZE	OF ,				
MATERIAL 12 Cr, Cb	MELTING FURNACE Induc						ction HEAT Experimental					
CHEMICAL COMPOSITION,	С	Mn	P	S	Si	Cr	Ni	Mo	Сь			
PER CENT	0.09	0.42			0.42	13,42	0.77		0.32			
DEOXIDATION												
FORM-CAST OR WROUGHT					_							
HEAT TREATMENT 2012 F, 2	Hr,	A. C. ;	1200	F, 2	Hr, F	, C.						
MICROSTRUCTURE												
GRAIN SIZE					H.	ARDNE	SS					
SOURCE OF DATA General E	lectric	Com	рапу									

#### SHORT TIME TENSILE PROPERTIES

	3110111	THE TENSIE	L THOILINI	LJ	-
TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80			137.9	16	49

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	JPTURE IN 0, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)					
•F	IOO HRS.	HOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000i		
900		65P	58P	52P					
		64	58*	51*					
1000		52P	40P	24P					
		52_	33*	31*					
1100		24P							
		20	8*	3.1*					
P indica	tes strengt	n value obt	lined by na	of Larson	Miller nav	matar T/2	+ 100 th		

#### ORIGINAL CREEP AND RUPTURE DATA

			OHIOHIE	-	101101			
TEMP,	STRESS 1000 P.S.I.	DURATION HOURS(3)	NTERCEPT, %(4)	MINIMUM CREEP RATE %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	REDUC- TION IN AREA, %
900	78.0	11 R					7.5	
900	72.0	430 R	l		<u> </u>		7.5	
900	66.0	3000 R					7, 5	
900	63.0	1100 R					7.0	
900	60.0	4000 R		1			5, 5	
1000	70.0	1.5R					8, 2	
1000	64.0	178					6,0	
1000	58.0	580 R					9.0	
1000	52, 0	870 R	1				6.0	
1000	47.0	1700 R			1		8, 0	
1000	40.0	3700 R	I				9.0	
1100	46.0	150 R	<u> </u>		<u> </u>		4,0	
1100	26.0	540 R	L		<b>↓</b>		9.0	
1100	14.0	2600 R					17.0	
1200	20,0	46 R	<u> </u>	L		1	12,5	78.0

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, Cb		YPE (		RNACE	Indu		SIZE HEAT		Experi	mental
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Мо	СЪ	
PER CENT	0.06	0.50			0.40	12,17	0,70		0,30	
DEOXIDATION										
FORM-CAST OR WROUGHT										
HEAT TREATMENT 2012 F.	Z Hr,	A.C.	1200	F, 2	Hr, I	F. C.				
MICROSTRUCTURE					_					
GRAIN SIZE					H.	ARDN	SS			
SOURCE OF DATA Genera	1 Elect	ric Co	mpar	y						

#### SHORT TIME TENSILE PROPERTIES

		3110111	LIME LEIGHT	L I NOI LIVI	LU	_
	TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.1.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
١	80			117.0	21	62
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1						_
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### CREEP AND RUPTURE STRENGTHS

**F	1 0.00001 0.000
000 (17 (17 117	
900 64P 56P 45P	
1000 45P	

1								REDUC-
TEMP	STRESS,	DURATION.	INTERCEPT.	MINIMUM CREEP RATE,	TRANSITION	TOTAL EXT.	TOTAL ELONG.	
°F.	1000	HOURS(3)	%(4)	CREEP RATE,	TIME, HRS.(5)	(CREEP TEST),	(RUPTURE	TION IN
	P.S.I.			76 / FIR.	HAS.(57	%	TEST),%	AREA, %
1000	66.0	2, 5 R				<u> </u>	12,0	57.0
1000	58.0	72 R					6.0	54.0
1000	56.0	247 R				L	2, 0	11.0
1000	52.0	114 R					8, 0	71.0
1000	48.0	325 R					6.0	69.0
1100	46.0	22 R					7, 0	50.0
1000	42,0	1640 R					9, 0	77, 0
1000	38.0	2468 R					6, 0	73.0
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- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

- (1) C.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

  (2) EXTRAPOLATED VALUES INDICATED BY \*

  (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

(5)

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Gr, Cb		YPE		RNACE	Indu	ction	SIZE HEAT		Experin	nental
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Мо	Сь	
PER CENT	0.11	0.49	0.011	0.015	0.38	12.09	0.12		0.32	
DEOXIDATION										-
FORM-CAST OR WROUGHT										
HEAT TREATMENT 2125 F,	1/2 Hr,	OQ;	1200 1	F, 2 H	r, A.	C.; 1	200 F,	2 Hr	, A.C.	
MICROSTRUCTURE							_			
GRAIN SIZE					TH.	ARONI	SS			
SOURCE OF DATA Genera	1 Electr	ic Co	mpany							

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,OOO P.S.I.	OFFSET (a) YIELD (I) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		103.5	143.5	18	60
(a) 0.02% Of	set yield streng	th.			

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRES	S FOR RU	PTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
*F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.0000i %/HR	0.0001 %/HR.	
900		80P	71P	62P				
1000		62P	50P	39P				
1100		39P						
P indica	tes strengt	value obt	ined by use	of Larson	Miller par	meter T(2	+ log t).	

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATI HOURS	ON,	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),		REDUC- TION IN AREA, %
1000	65.0	414	R					7.0	62.0
1000	60.0	1196	R					6.0	52,0
1000	55.0	2394	R					5.0	45.0
1200	45.0	12.	R					6.0	21.0
1200	40.5	19.	9 R			1		9.0	25.0
1200		1	_				1	7.0	14.0

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF

16	MPERA	IURE	ON	PROF	ENII	E3 U	L IAIC"	ALS			_
TYPE OF MATERIAL 12 Cr, Cb		YPE		RNACI	Indu		SIZE HEAT		Experi	nental	
CHEMICAL COMPOSITION,	C	Mn	Р	S	Si	Cr	Ni	Мо	СЪ		
PER CENT	0.09	0.30			0.36	12.72	0.39		0.32		
DEOXIDATION											
FORM-CAST OR WROUGHT	Wrou	ght l'	D								
HEAT TREATMENT 2012 F,	2 Hr, 2	A.C.;	1200	F, 21	lr, F	.c.					
MICROSTRUCTURE	_										
GRAIN SIZE					Н	ARDNI	SS				
SOURCE OF DATA Genera	Electr	ic Cor	npany								

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY,	OFFSET YIELD (I) STRENGTH,	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
	1,000,000 P.S.I.	1000 P.S.I.	1000 F. S.I.	PER CENT	PER CENT
80			131.9	18	56

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
900		72P	65P	57P			
		73	68	64*			
1000		57P	48P				
		58	49*	41*			
P indica:	es strength	value obt	a ned by use	of Larson	Miller para	meter T(25	+ log t).

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
900	82.0	17 R					6.0	
900		2500 R					7.0	
900	67.0	19100 R					1.9	
1000	66, 0	33 R					6.0	
1000	58.0	790 R	[			I	7.0	
1000	52.0	4000 R			L		4.0	

<sup>(1) 0.2</sup> PER CENT OFFSET UNLESS OTHERWISE INDICATED.

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, Cb	1	TYPE OF MELTING FURNACE						SIZE OF HEAT Commercial		
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	Сь	l_
PER CENT	0,12	0.42	0.012	0.010	0.32	12.10	0.27	L	0.31	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wheel	and S	haft F	org.						
HEAT TREATMENT										
MICROSTRUCTURE										
GRAIN SIZE					H	ARDN	ESS			
SOURCE OF DATA Genera	l Electr	ic Co	mpany							

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		98.0	134,5	20	59
(a) 0.02% Off	et yield strengt	h.		ļ	

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN	TIMES .(2)	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000 %/HR		
900			67P	59P					
1000		58P		T					
		60	43*	31*	T				
P indicate	s strength v	alue obtain	ned by use o	Larson-N	iller param	eter T(25 +	log t).		

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	66, 0	132 R					6.8	67.5
1000	60.0	1134 R					7,4	68. 0
1000	56.0	2071 R					6.8	60, 0
1000	52.0	2311 R					7.4	59. 0
1000	48.0	5282 R					7, 0	55.0

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, Ta		TYPE MELTII	OF NG FU	RNACE	Indu	ction	SIZE		xperimen	tal
CHEMICAL COMPOSITION,	С	Mn	Р	S	Si	Cr	Ni	Mo	Ta	
PER CENT	0.15	0.52	0.016	0.014	0.20	12.8			0.45	
DEOXIDATION										
FORM-CAST OR WROUGHT										
HEAT TREATMENT 2000 F.	1 Hr,	OQ; 1	200 F	2 Hr	, A. C	J				
MICROSTRUCTURE										
GRAIN SIZE		-			H	ARDNI	ESS			_
SOURCE OF DATA General	Electr	ic Cor	npany							

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET (a) YIELD (II) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		103.0	135.75	17	60
(a) 0.02% Of	set vield streng	h	<u> </u>		

### CREEP AND RUPTURE STRENGTHS

TEMP.,	STRE	SS FOR R	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.				
°F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000I
1000				29P	T		
1100		29P					
P indica	tes strengt	value obt	ained by use	of Larson	Miller para	meter T(25	+ log t).

### ORIGINAL CREEP AND RUPTURE DATA

TEMP.		DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT.	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1200	40.0	9.9 R					21.0	
1200	30.0	24.2 R					13, 0	
1200	25.0	24.2 R					20.0	
1200	20.0	58. 1 R					30.0	
	(b) Te	st specim	en with 1"	gage length	and 0, 160"	liameter.		

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

39

<sup>(2)</sup> EXTRAPOLATED VALUES INDICATED BY \*

### (8)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, Cb	1	YPE (	OF IG FU	RNACI	Indu	ıction	SIZE	OF E	xperi	mental
CHEMICAL COMPOSITION.	C	Mn	e.	S	Si	Cr	Ni	Мо	СР	
PER CENT	0.15	0.52				12.56			0.46	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wrough	t l" D								
HEAT TREATMENT 2050 F,	OQ: 1	200 F,	A.C	; 120	0 F,	A.C.				
MICROSTRUCTURE										
GRAIN SIZE					ŢΗ	ARON	ESS			
SOURCE OF DATA General I	Clectri	Com	pany							

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,000 P.S.I.	OFFSET (a) YIELD (;) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		99.0	135.0	18	64
(a) 0.02% Of	set yield streng	ih.			
				<del>                                     </del>	

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRES	SS FOR RU	PTURE IN T	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
•F .	100 HRS.	1000 HRS.	ID,000 HRS.	100,000 HRS.	0.000001 0.00001 %/HR. %/HR.		0.0001 %/HR.	
900		70P	65P	56P				
1000		56P						
	-	56	46*					
Pindica	tes strengt	value obta	ined by use	of Larson	Miller para	meter T(2	+ log t).	

- (1) 0.2 PER CENT DFFSET UNLESS OTHERWISE INDICATED.
  (2) EXTRAPOLATED VALUES INDICATED BY \*

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

(9)

TYPE OF MATERIAL 12 Cr, Cb	[	TYPE (	OF IG FU	RNACE	Ind	uction	SIZE	OF E	xperime	ntal
CHEMICAL COMPOSITION.	C	Mn	Р	S	Si	Cr	Ni	Мо	Сь	
PER CENT	0.15	0.53				12.28			0.26	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wroug	ht 1" I	)							
HEAT TREATMENT 2000	F, OQ;	1200	F, A.	c.						
MICROSTRUCTURE										
GRAIN SIZE					н	ARDN	SS			
SOURCE OF DATA General	Electi	ric Co	mpany	,						

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET(A) YIELD (I) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		103.0	138.0	20	64
(a) 0,02% Offs	et yield strength.				

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN 1	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
°F ′	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001. %/HR	0.0001 %/HR.
900				61 P			
1000		60P					
		60					
P indicate	sstrength	alue obtain	ed by use o	Larson-A	iller param	eter T(25 <u>+</u>	log t).
		L					
				L			

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- (2) EXTRAPOLATED VALUES INDICATED BY #

#### ORIGINAL CREEP AND RUPTURE DATA

					NO ROFTOR			
TEMP, °F.	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	REDUC- TION IN AREA, %
1000	70.0	13.0 R			<u> </u>		8.0	69.0
1000	60.0	520.0 R					9.0	69.0
1000	52.0	2566 R					8.0	68.0
_								
_								
		<u> </u>						<u> </u>
			-		-			

- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

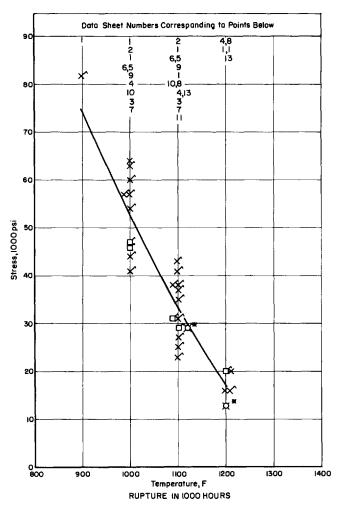
TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	REDUC- TION IN AREA, %
1000	65.0	414 R	L				7.0	62.0
1000	60.0	1196 R					6.0	52.0
1000	55,0	2394 R					5, 0	45, 0
			_					
				l	<u> </u>	1		
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<u></u>	<b></b> _	L	L	L	L	L	L	

- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

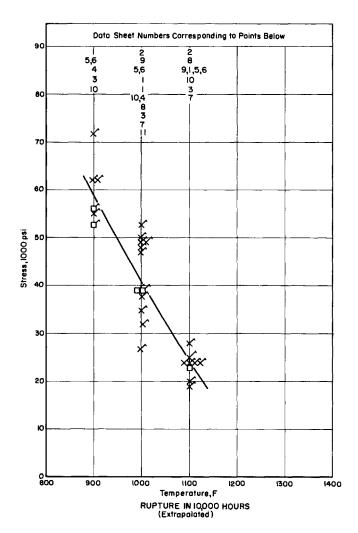
  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

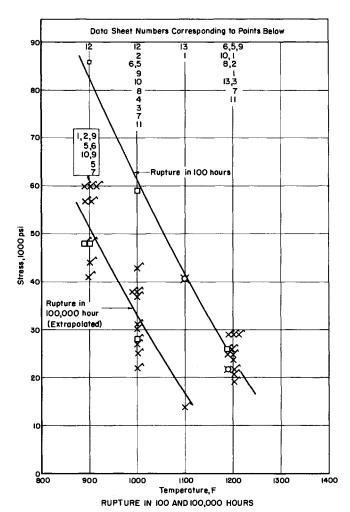
12 Chromium, 2.75 Molybdenum, Vanadium Steels (Lapelloy)



12Cr,2.75 Mo, V STEEL



12Cr, 2.75 Mo, V STEEL



I2Cr, 2.75 Mo,VSTEEL

TYPE OF MATERIAL 12 Cr, 2.75 Mo, 1	/ 1	TYPE MELTI		RNACE			SIZE HEAT		Comme	rcial
CHEMICAL COMPOSITION.	C	Mri	P	S	Si	Cr	Ni	Мо	V	
PER CENT	0.27	1.08	0.024	0.027	0.27	11.75	0.21	2.88	0.25	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wrou	ght 3/	8" Sq	аге						
HEAT TREATMENT 2000 F,	l Hr, (	OQ; 1	300 F,	2 Hr,	A. C					
MICROSTRUCTURE										
GRAIN SIZE					[H	ARDNE	SS			
SOURCE OF DATA Gene	ral Ele	ectric	Comp	any						

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET (a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		101. 9	149.3	19.0	44.1
(a) 0.02% Oi	set yield streng	th.		<del>                                     </del>	

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN	TIMES	STRESS CREEP	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
۰۴ .	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000 %/HR			
900		82P	_72P	60P	1					
1000		60P	47P							
1000		64	48*		Ţ					
1100		35P	24P	14P						
		41								
1200	26P	16P		1						
	24	15.7			$\Gamma$					

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP, °F.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.		TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	100.0	0.074 R		L	<u></u>		21.0	
1000	80.0	21.0 R					24.0	
1000	90.0	1.3 R					22.0	
1000	70.0	82.0_R					24.0	
1000	60.0	3121 R					17.0	
1000	50.0	>7800					>3.0	
900	100,0	318 R					10.0	
_	60.0	10 F				\	32.0	
1100	100.0	0.0014R				l	18.0	
1100	90.0	0.017 B				I	17.0	
1100	80.0	0.15 B					25.0	
1100	70,0	2,7_B					22.0	
1100	50.0	163.6 F					21.0	
1100	40.0	1922 R					14.0	
1100	30.0	3819 F					17.0	
1200	60.0	0.067 F					38.0	
1200	50.0	0.50 F					54.0	
1200	40.0	4.4 F	¥ .				33.0	
1200	30.0	73.0 F					28.0	
1200	25.0	90.0 F			1		19.0	
1200	20.0	280.0 F					20.0	
1200	15.0	1203 F	<u> </u>				26.0	
1350	50.0	0.001 F	<u> </u>			<u> </u>	30.0	
1350	40.0	0.016 F				L	34.0	
1350	30.0	0.14 F					21.0	
1350	20.0	0.8 F				L	65.0	
1350	15.0	2.7 I					60.0	
1350	10.0	25.2 F	<u> </u>	<u> </u>			50.0	
$\sqsubseteq$	All te	st specim	ns had l''	age length	nd 0. 160"	lameter.		<u> </u>

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2, 75 Mo,	V N	YPE MELTI	OF NG FU	RNACÉ	Indu	ction	SIZE HEAT		xperim	ental
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	v	
PER CENT	0.173	1.23	0.008	0.028	0.57	11,11	0.12	2.81	0.26	
DEOXIDATION										
ORM-CAST OR WROUGHT	Wroug	ht 1-3	/8" R	ound						
HEAT TREATMENT 2000 F,	1 Hr, 0	ος; 1	100 F,	3 Hr,	A. C		_			
MICROSTRUCTURE										
SRAIN SIZE					H	ARDNE	SS			
SOURCE OF DATA General I	Clectri	c Com	pany							

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET (a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		107. 5	156.25	16.5	41.0
(a) 0.02% Off	set yield streng	h.			

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	JPTURE IN 0, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)					
°F ′	IOO HRS.		10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.0000I %/HR	0.0001 %/HR.		
900			I	60P					
1000		60P	53P	43P					
1100		43P	28P						
1200	25P								
P indic	ates strengtl	value obt	ined by us	of Larson	Miller para	meter T(25	+ log t}.		

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP, °F.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. ICREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1100	60.0	11.7R					29.0	
1100	50.0	208.7R			<u> </u>		24.0	
1200	40.0	30.3 R		İ			23.0	
1200	30.0	111.9R					27.0	
1200	20.0	270.0R					30.0	
	All te	t specime	ns had l" j	age and 0.1	00" diamete	r		

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2.75 Mo, V MELTING FURNACE SIZE OF HEAT Comme										cial
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	v	
PER CENT	0.31	1.05	0019	0.014	0.28	11.12	0.20	2.84	0.23	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wrou	ght 3-	3/4"	Round				_		
HEAT TREATMENT 2000 F, 1	Hr, C	Q; 13	25 F,	2 Hr,	A.C.					
MICROSTRUCTURE										
GRAIN SIZE					TH.	ARDNE	SS			
SOURCE OF DATA General	Electr	ic Co	mpany							

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET (a) YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		76.0	129. 25	17.5	34.71
(a) 0.02% Of	set vield streng	h,			

#### CREEP AND RUPTURE STRENGTHS

	0.00001 0.0001 %/HR %/HR.
900 55P 44P	70/11 To 70/11 T.
1000 44P 35P 27P	
1100 27P 20P	
1200 22P	

TEMP,	STRESS 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST), %	HARDNESS AFTER TESTING
1100	60. Q	_1, 7R		L			32.0	
1100	50.0	6.9R					44.0	
1200	40.0	0.4R					40,0	
1200	30.0	9,3 R			L		33.0	
1200	20.0	337.9R					26,0	
	All te	t specime	ns had l''g	age and 0.0	6" diamete	r.		

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

- (2) EXTRAPOLATED VALUES INDICATED BY\*

  (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

(5)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2.75 Mo,	v.						SIZE HEAT		Commercial		
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Mo	v		
PER CENT	0.27	1.08	0.024	0.027	0.27	11.75	0.21	2.88	0.25		
DEOXIDATION											
FORM-CAST OR WROUGHT	Wroug	ht 4"	Round								
HEAT TREATMENT 2000 F, 6	Hr, C	Q; 13	00 F,	6 Hr,	A.C.						
MICROSTRUCTURE											
GRAIN SIZE					H.	ARDNE	SS				
SOURCE OF DATA General	Electr	ic Co	mpany							_	

#### SHORT TIME TENSILE PROPERTIES

T PER CENT
31,8

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN 0, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)					
•F	100 HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0000001 %/HR.	0.00001 %/HR.	0.0001 %/HR.		
900			56P	48P					
1000		47P	39P	28P					
1100		29P	T						
1200		_20P							
. P indica	tes strengt	h value ob	tained by us	e of Larson	Miller par	meter T(2	+ log t).		

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1100	60.0	0.7 R					34,0	
1100	50.0	9.0 R					34.0	
1200	40.0	1.8 R					30.0	
1200	30.0	18.6 R					46.0	
1200	20.0	100.0 R					26,0	
	All tes	t specime	ns had l" g	age length a	nd 0, 160" d	ameter.		

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2.75 Mo,	<u> </u>	TYPE OF MELTING FURNACE					SIZE OF HEAT Commercial				
CHEMICAL COMPOSITION,	С	Mn	P	S	Si	Cr	Ní	Мо	V	1	
PER CENT	0.30	0.93			0.31	11.64	0,13	2,60	0,28		
DEOXIDATION											
FORM-CAST OR WROUGHT	Wroug	ht 1" I	Round								
HEAT TREATMENT 2000 F.	l Hr,	OQ; 13	25 F,	2 Hr							
MICROSTRUCTURE											
GRAIN SIZE					H	ARDNE	SS				
SOURCE OF DATA General	Electi	ric Co	mpany	ř							

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET (a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		95.0	143.75	15,0	33.10
(a) 0.02% O	fiset yield streng	th.			

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRES	S FOR RU	JPTURE IN	STRESS CREEP	FOR DESIG	NATED P.S.I.(2)		
*F '	IOO HRS.	1000 HRS.	IO,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
900			62P	57P			_	
1000	i	57P	49P	38P				
1100		38P	24P	1				
1200	29P			-	ļ		-	
P indic	ates strengt	h value ob	ained by us	of Larson	-Miller par	ameter T(2	+ log t)	

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
(2) EXTRAPOLATED VALUES INDICATED BY

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1100	60.0	4.4 R					13.0	
1100	50.0	127.7 R					13.0	
1200	30.0	52.3 R					19.0	
1200	20.0	384.0 R					18.0	
	All tes	t specime	ns had l''g	age and 0.0	6" diamete	r.		1

(6)

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2.75 Mo,	TYPE OF MELTING FURNACE							OF C	Comme	rcial
CHEMICAL COMPOSITION.	С	C Mn	Mn P	S	Si	Cr	Ni	Mo	V	
PER CENT	0.26	1.04			0.30	11.10	0.11	2.54	0.24	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wrough	t l" P	lound							
HEAT TREATMENT 2000 F. 1	Hr, C	Q; 13	52 F,	2 Hr	A.C.					
MICROSTRUCTURE										
GRAIN SIZE					H	ARDN	ESS			
SOURCE OF DATA General	Electr	ic Cor	npany							

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET (a) YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		94.0	140.25	15,0	36.94
(a) 0.02% Of	set yield streng	ih.			
	-				

#### CREED AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN 1	IMES (2)	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
°F '	IOO HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0,00001 %/HR	0.0001 %/HR.	
900			62P	57P				
1000		57P	49P	38P				
1100		38P	24P					
1200	29P							
P indica	tes strengt	value obt	ained by use	of Larson	Miller par	meter T(2	+ log t).	

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1100	60.0	3. 1 R					34.0	
1100	40.0	434. I R					26,0	
1200	30.0	24, 2 R					36.0	
1200	20,0	207.8 R					45.0	
	All te	t specime	ns had l" g	age and 0.0	16" diamete	r.		

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2.75 Mo,		TYPE (		RNAC	É		SIZE		ommer	cial
CHEMICAL COMPOSITION,	С	Mn	ρ	S	Si	Cr	Ni	Mo	V	
PER CENT	0.26	0,95		l	0.18	11.06	0.15	2.58	0.28	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wroug	ht 1-1	3/16"	x 2-5	5/ 16"					
HEAT TREATMENT 2000 F,										
MICROSTRUCTURE										
GRAIN SIZE			_		H	ARDNE	SS			
SOURCE OF DATA General	Electr	ic Con	pany							

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET(a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		78.75	124. 75	19.5	39.7
(a) 0,02% Of	set yield streng	th.			

CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN T	IMES	STRESS CREEP	FOR DESIG	NATED P.S.I.(2)
*F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
900		_		41P	I		
1000		41P	32P	2 5P			
1100		25P	19P				
12 00	21P						
P indic	ates strengt	value obta	ined by use	of Larson	Miller par	meter T(2	+ log t).

ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT,	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1100	50.0	3.3 R					40.0	
1200	40.0	0.2 R					34.0	
1200	30.0	1.6 R					37.0	
1200	20.0	160.9 R					30.0	
	All te	st specime	ns had l'' g	age length a	nd 0. 160'' d	iameter.		

(8)

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

EOXIDATION ORM-CAST OR WROUGHT Wrought 3-1/2" Round EAT TREATMENT 2000 F, 6 Hr, OQ; 1300 F, 6 Hr, A.C.										
CHEMICAL COMPOSITION	С	Mn	P	S	Si	Cr	Ni	Mo	٧	ſ
PER CENT	0.32	1.08	0.018	0.015	0.40	11.58	0.18	2.57	0.25	
DEOXIDATION	-									
FORM-CAST OR WROUGHT	Wroug	ht 3-	1/2" R	ound						
HEAT TREATMENT 2000 F.	Hr, C	OQ; 13	00 F,	6 Hr,	A.C					
MICROSTRUCTURE										
GRAIN SIZE	•				H/	ARDN	55			
SOURCE OF DATA General	Electr	ic Co	mpany	-						

SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET(a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		87.5	143.5	17.0	45. 4
(a) 0.02% Of	set yield streng	th.			

CREEP AND RUPTURE STRENGTHS

TEMP.	STRES	SS FOR RU	PTURE IN T	IMES	STRESS CREEP	FOR DESIG	NATED P.S.I.(2)	
°F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.00000 I %/HR.	0.00001 %/HR	0.000i %/HR.	
1000			38P	30P				
1100		31P	25P					
1200	25	20						
P indic	ates strengt	h value obt	ined by use	of Larson	Miller par	meter T(2	+ log t)	

ORIGINAL CREEP AND RUPTURE DATA

TEMP, °F.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. ICREEP TEST), %	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1200	30.0	30.0R					39.0	
1200	25.0	113.7R					22.0	
1200	20.0	1061.8R		ļ <del></del>			22.0	
	All tes	t specime	ns had l''g	age length a	nd 0. 160" d	lameter.		



### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2.75 Mo.	v	YPE MELTII	OF NG FU	RNACE	Indu		SIZE		Experim	ental
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Мо	v	T
PER CENT	0.247	1.18	0.007	0.026	0.50	11.22	0.13	2.78	0.26	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wroug	ht 1-	1/8" F	lound						
HEAT TREATMENT 2000 F,	l Hr, O	Q; 120	00 F,	2 Hr.	A. C.					
MICROSTRUCTURE										
GRAIN SIZE					TH/	ARDNE	SS			
SOURCE OF DATA Genera	Flectr	c Cor	nnanu							

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

(2) EXTRAPOLATED VALUES INDICATED BY #

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,OOO P.S.I.	OFFSET(a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		107.5	154.5	16.5	41.0
(a) 0.02% Of	set yield streng	ih.			
	<b>-</b>			<del></del>	

CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN 1	TIMES (2)	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000000 I %/HR.	0.00001 %/HR	0.0001 %/HR	
900	T			60P	1			
1000		59P	50P	37P				
1100		37P	24P					
1200	29P							
P indic	ates strengt	value obta	ined by use	of Larson	Miller para	meter T/2	+ log t).	

ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS LOO P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARONES AFTER TESTING
1100	60.0	11.5 R					19.0	
1100	50.0	293.2 R					11.0	
1200	40.0	14.5 R					21.0	
1200	30.0	56.8 R					20.0	
1200	20.0	300.5 R		ļ			21.0	
	All te	st specime	ns had l'';	age and D.O	16" diamete	r		

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 12 Cr, 2.75 Mo,		TYPE MELTI		RNACE	:		SIZE HEAT		Com	nercial
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Мо	v	
PER CENT	0.27	1.08	0.024	0.027	0.27	11.75	0.21	2.88	0.25	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wroug	tht 4"	Round							
HEAT TREATMENT										
MICROSTRUCTURE		_	_				_		_	
GRAIN SIZE		_			H,	ARDNE	SS			
SOURCE OF DATA General	Electr	ic Con	npany							

SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,OOO P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
				-	

CREEP AND RUPTURE STRENGTHS

TEMP.	STRES	SS FOR RU	PTURE IN 1	IMES (2)	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000I %/HR.	
900			53P	47P				
1000		46P	39P	31P				
.1100		31P	23P					
1200	26P							
P indic	tes strengt	value obta	ined by use	of Larson	-Miller par	meter T(2	+ log t)	

ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS 1000 P.S.I.	DURATION, HOURS(3)	iNTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST), %	HARONESS AFTER TESTING
1100	50,0	5. 6 R					23,0	
1200	30.0	38.3 R					29.0	
1200	20.0	438.3 R					28.0	
	All te	t specime	ns had 1" s	age length a	nd 0, 160" d	iameter.		<del></del>



TYPE OF MATERIAL 12 Cr, 2.75 Mo,		TYPE MELTII		RNACE			SIZE HEAT		Comm	ercial
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	ç	Ni	Мо	v	
PER CENT	0.30	0.90	0.020	0.023	0.30	12.16	0,34	2.80	0.28	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wroug	ht 6-1	/4" R	ound						
HEAT TREATMENT 2000 F, 6	Hr, C	Q; 13	00 F.	6 Hr,	A. C.					
MICROSTRUCTURE										
GRAIN SIZE					H	ARDNE	SS			
SOURCE OF DATA General	Electri	ic Con	npany							

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET(a) YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		71.0	107.0	22.5	46.9
(a) 0.02% Oi	set yield streng	h.			

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN T	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
•F '	IOO HRS,	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
1000			27P	22P			
1100		23P					
1200	2.9P						
P indic	tes strengt	value obta	ined by use	of Larson	Miller par	meter T(2	+ log t).

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1200	30.0	0.9 R					57.0	
1200	25.0	4.4 R			L		49.0	
1200	20.0	57. 2 R					34.0	
	All ter	t specime	ns had l" g	age and 0.0	6" diamete	r		

### (12)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 12 Cr, 2.75 M MATERIAL (Lapellov)		TYPE MELTI		RNACE	:		SIZE HEAT	OF			
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	v		
PER CENT	0,3	1.05	0.019	0.024	0.35	12.12	0.22	2.87	0.28		
DEOXIDATION											
FORM-CAST OR WROUGHT											
HEAT TREATMENT 45 Min	at 2000 ]	F in Sa	it Ba	th, Qu	enche	d in 5	00 F S	Salt Ba	th for	30 M	in,
MICROSTRUCTURE Rehe	ated to 13	20 F f	or 4 l	Hr, T)	hen A.	C. to	Room	Tem	peratu	re.	
GRAIN SIZE					H	ARDNE	SS	27-30	Rc		
SOURCE OF DATA Unive	rsity of b	dinnes	ota								

### SHORT TIME TENSILE PROPERTIES

	0110111	111112 121121			
TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
ŖT		100	136	20.0	49.5
<del></del>			<b></b>	<b>-</b>	
	<del> </del>		<del></del>	<del> </del>	
	1				

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN	STRESS CREEP	FOR DESIG	NATED P.S.I.(2)	
•F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
900	86						
1000	59						

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

(2) EXTRAPOLATED VALUES INDICATED BY #

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
900	100.0	0.05 R					15.1	
900	90.0	16,3 R					15.5	
900	85.0	140.0 R						
900	95.0	1.8 R					13.8	
900	98.0	0.3 R					16.9	
900	90.0	10.9 R					19.8	
900	95.0	2.8 R					17.4	
900	87.0	51.2 R					14.7	<u> </u>
1000	80.0	0.6 R				-	17.7	<del></del>
1000	65.0	19.6 R					17.9	
1000	72.0	4.8 R					21.6	
1000	86.0	0.2 R					19.5	
1000	88.0	0.04 R				L	17.4_	
1000	58.0	160.5 R			1	<u> </u>	27.2	
1000	65.0	18.8 R				L	17. 4	

### (13)

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 12 Cr, 2.75 Mo, MATERIAL (Lapelloy)		TYPE MELTI	OF NG FU	RNACE	•		SIZE HE AT	OF :	l Ton	
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	v	T
PER CENT	0.26	1.12	0.015	0.019	0.68	12.17	0.19	2.25	0.30	Т
DEOXIDATION										
FORM-CAST OR WROUGHT										
HEAT TREATMENT 1 Hr at 17	50 F,	4. C.	+ l Hr	1900	F, A.	C. +	Temp	er 4 H	Ir at 1300	F.
MICROSTRUCTURE Temper	ed Mar	tensit	e and	Delta	Ferri	te.				
GRAIN SIZE					H	ARDN	ESS			
SOURCE OF DATA Univers	ity of h	dichig	an							

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,OOO P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT

### CREEP AND RUPTURE STRENGTHS

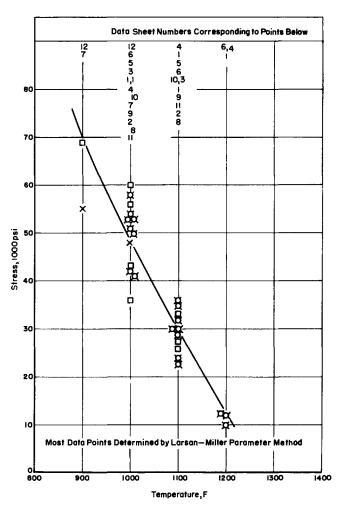
TEMP.	STRESS FOR RUPTURE IN TIMES STRESS FOR DESI-				NATED P.S.I.(2)		
*F	IOO HRS.	HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
1100	41.5	29.0*					
1200	22.0	13,0*			I		

### ORIGINAL CREEP AND RUPTURE DATA

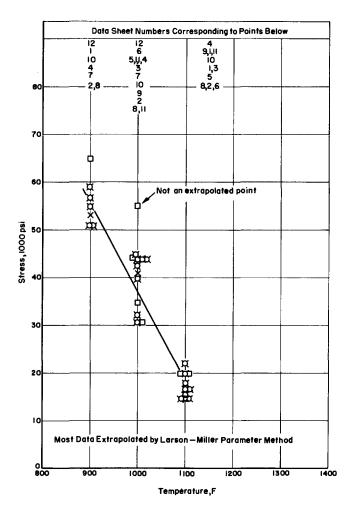
TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1100	50.0	11.9R					27.0	
1100	46.0	31.3R					26.0	
1100	39.0	350. R					23,5	
1100	36.0	399, R		L			28.5	
1100	33.0	543. R					21.5	
1200	33.0	15.6 R					32.0	
1200	27.0	41.3R					29.0	
1200	16.0	423. R					47. 5	
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						L		



12 Chromium, 2.5 Tungsten, Vanadium Steels

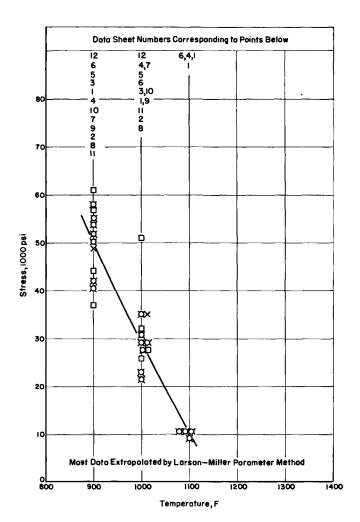


RUPTURE IN 1000 HOURS



RUPTURE IN 10,000 HOURS (EXTRAPOLATED)

12 Cr, 2.5 W, V STEEL



RUPTURE IN 100,000 HOURS (EXTRAPOLATED)

12 Cr, 2.5 W, V STEEL

(1)

TYPE OF MELTING FURNACE SIZE OF TYPE OF MATERIAL 12 Cr, 2.5 W, V Commercial C Mn P S Si Cr Ni Mo V W CHEMICAL COMPOSITION, PER CENT 0.32 1.29 0.020 0.015 0.42 12.5 0.21 0.07 0.26 2.44 DEOXIDATION
FORM-CAST OR WROUGHT Wrought 2-9/16" D
HEAT TREATMENT 1885 F, A. C.; 1200 F, 12 Hr, A. C MICROSTRUCTURE GRAIN SIZE
SOURCE OF DATA General Electric Company HARDNESS

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET(a) YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
08		126. 2	156.3	14.5	41.0
(a) 0.02% Of	set yield streng	th.			

#### CREEP AND RUPTURE STRENGTHS

TEMP.,	STRE	SS FOR RU INDICATED	PTURE IN 1	IMES	STRESS CREEP	FOR DESIG	NATED P.S.J.(2)
•F '	IOO HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000I %/HR.
900			59P	54P			
1000		53P	44P	28P	L		
1000		53	44*				
1100		29P	17P	9.4P			
1100		35(a)	20*(a)	11*(a)			
1200	19P	10P					
P indica	tes strengt	n value obta	ined by use	of Larson	Miller par	meter T(2	+ log t)
(a) Note	hed.						

#### ORIGINAL CREEP AND RUPTURE DATA

	ORIGINAL CREEP AND ROFTCRE DATA											
TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	REDUC- TION IN AREA, %				
1000	60.0	82 R					14.0	39.3				
1000	54.0	1118 R					11.0	41.0				
1000	50.0	4195 R					9.0	41.8				
1050	58.0	17 R					18.0	39.6				
1050	50.0	407 R					11.0	41.7				
1050	45.0	762 R	L				11.0	42.1				
1050	32.0	4422 R					7. 0	43.3				
1100	35.0	427 R					11.0	43.1				
1200	35.0	2 R					20.0	42.0				
1200	25.0	15 R					18.0	43.5				
1200	20.0	88 R			<b>-</b>		17.0	44.7				
1300	10.0	32 R					36.0	46.6				
1100	56.0	96 R					Notched(b)					
1100	46.0	336 R			]		Notched(b)					
1100	34.0	1197 R					Notched(b)					
1100	24.0	4920 R					Notched(b)					
	(b) No	tched bar	with 0,253	root diam	ter, 0.357	major diam	eter, 60 degi	ee notch,				
	ar	d C. 011"	otched rad	us.			L	L				

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF

TEN	IPERA	TURE	ON	PROF	2RII	ES O	- ME	IALS			
TYPE OF MATERIAL 12 Cr, 2.5 W, V	] A	YPE (		RNACI	Ē		SIZE HEAT	OF	Com	nercia	1
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Mo	w	v	
PER CENT	0.28	1.33			0.32	12.68	0.16		2.54	0.23	
EOXIDATION											
FORM-CAST OR WROUGHT	Forg	ed Buc	ket								
HEAT TREATMENT 1900 F.	4 Hr,	A.Q.	1200	F, 12	Hr,	A.C.					
MICROSTRUCTURE											
GRAIN SIZE					Н	ARDNE	SS				
SOURCE OF DATA General	Electri	c Con	pany								

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET(a) YIELD (1) STRENGTH, 1000 P.S.).	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		100.0	151. Z	18.0	47.2
(a) 0.02% O	fset yield streng	th.			

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RUINDICATED	PTURE IN 1, 1000 P.S.I	TIMES .(2)	STRESS CREEP	FOR DESIG	OO P.S.I.(2)		
°F ,	100 HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.		
900			51P	42P					
1000		42P	32 P	_23P					
1100		24P	15P				[		
1200	17P		-	-	<del></del>				
P indic	ates strengt	h value obt	ined by us	e of Larson	Miller par	ameter T(2	5 + log t).		

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP, °F.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),		REDUC- TION IN AREA, %
1050	56.0	4 R					9.0	
1050	26.0	10, 787 R					9.0	47.0
1100	26.0	701 R		l	L			
1150	40.0	4 R					16.0	
1200	11.0	298 R		i			34,0	
1250	20.0	7 R					27.0	
1300	11.8	10 R					37.0	
	Tests	pecimens	0. 160" dia:	neter, 1-inc	h gage leng	th.		

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2.5 W, V		TYPE OF MELTING FURNACE					SIZE		Comm	ercial	
CHEMICAL COMPOSITION, PER CENT	С	Mn	Р	S	Si	Cr	Ni	Mo	w	v	
PER CENT	0.28	1.43			0.47	12.74	0.12		2.37	0.26	
DEOXIDATION											
FORM-CAST OR WROUGHT	Forge	d Buc	ket								
HEAT TREATMENT 1900 F, 4	Hr, A	.Q.; 1	200 F	, 12	Hr, A.	C.					
MICROSTRUCTURE											
GRAIN SIZE					H	ARDN	ESS	_			
SOURCE OF DATA General	Electr	ic Co	mpany								

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET(a) YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		105.0	149.2	18.0	47.8
(a) 0.02% Of	set yield streng	lh.			

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN 0, 1000 P.S.I	IMES STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
°F '	IOO HRS.	IOOO HRS	10,000 HRS	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000 %/HR
900			1	55P			
1000		54P	43P	29P			
1100		30P	17P				
1200	20P						
P indica	tes strengt	h value obt	ained by us	e of Larson	Miller par	meter T(25	+ log t)

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1050	55.0	94 R					12.0	
1100	35.4	473 R					19.0	
1150	40.0	39 R					11.0	
1150	10.0	4517	Discontin	ped				
1200	11.0	592 R				1		
1250	20.0	16 R					21.0	
1300	11.8	11 R					34.0	
	Test s	pecimens	0.160" dia:	neter. 1-in	h gage leng	th		

- | 1 Test specimens (0.160" diameter. L-indh gage length.
  | (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
  | (2) EXTRAPOLATED VALUES INDICATED BY \$\Pi\$
  | (3) DURATION OF TEST (SUPPLIED ET INDICATED BY R).
  | (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.
  | (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.



(5)

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2.5 W, V								IZE OF EAT Commercial				
CHEMICAL COMPOSITION,	С	Mn	Р	s	Si	Cr	Ni	Мо	w	v		
PER CENT	0.27	1.18			0.33	12.58	0.12		2.35	0.18		
DEOXIDATION												
FORM-CAST OR WROUGHT I	orged	Bucke	≥t								-	
HEAT TREATMENT 1900 F, 4	Hr, A	Q.; I	200 F	, 12	Hr, A	. c.						
MICROSTRUCTURE					_							
GRAIN SIZE					TH	ARDNE	SS					
SOURCE OF DATA General I	Clectri	Com	pany									

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET(a) YIELD (1) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		104.0	150.0	17.0	45.2
(a) 0.02% O	fset vield streng	th.		-	

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RUINDICATED	PTURE IN T	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
•F '	100 HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
900			55P	52P				
1000		51P	44P	35P				
1100		36P	22P	11P				
1200	26P	12P						
P indica	tes strengt	h value obt	ined by use	of Larson	-Miller par	ameter T(2	+ log t).	

#### ORIGINAL CREEP AND RUPTURE DATA

PEMP,	STRESS, 1000 P.SJ.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1050		8 R					16.0	
1050	38.0	5151 R	L		I		6.0	[
1100	37.0	396 R					18.0	
1150	40.0	168 R					13.0	
1200	15.8	461 R						
1250	20.0	38 R					19.0	
1300	12.0	32 R			<u> </u>	<u> </u>	38.0	
	Test S	pecimens	0. 160" dia	neter, 1-in-	h gage leng	th.		

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2.5 W, V		TYPE MELTIN		RNACI	É		SIZE OF HEAT Commercial				
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Mo	v	w	
PER CENT	0.29	1.00			0.26	11.68	0.12		0.25	2.42	
DEOXIDATION											
FORM-CAST OR WROUGHT	Wrough	ht 4-1	16" I	$\overline{}$							
HEAT TREATMENT 1900 F.	A. C. ;	1200 F	16	Hr. A	. C.;	1150 F	, 20 F	ir, A	. ¢.		
MICROSTRUCTURE							_		_		
GRAIN SIZE					Н	ARDNE	SS				
SOURCE OF DATA General	Electri	c Com	pany								

### SHORT TIME TENSILE PROPERTIES

	JHORT	IIME IEMSIE	L THOTEIN	LJ	
TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET(a) YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		103.0	153.5	16	41.4
(a) 0.02% Of	iset yield streng	th.			

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRES	SS FOR RU	PTURE IN T	IMES (2)	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
•F ,	100 HRS.	IOOO HRS.	10,000 HRS	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
900				57P				
1000		56P	44P	32P				
1100		33P	2 1P					
1200	24P							
P indic	ates strengt	n value obta	ined by use	of Larson	Miller par	meter T(2	+ log t).	

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	60.0	393 R					13.0	70.0
1050	55.0	192 R					12.0	73.0
1100	45.0	167 R					12.0	77.0
1200	35.0	7 R					17.0	85.0
1200	T .	44 R					P4. 0	85.0
1200	20.0	227 R					16.0	83.0
1350	13.0	4 R					30.0	93.0

### 6

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2.5 W, V							SIZE OF HEAT Commercial				
CHEMICAL COMPOSITION.	С	Mn	Ρ	S	Si	Cr	Ni	Mo	w	v	
PER CENT	0.30	1.24				12.34			2.72	0.24	
DEOXIDATION											
FORM-CAST OR WROUGHT	Forge	d Buck	cet								
HEAT TREATMENT 1900 F,	4 Hr, /	1.Q.;	1200	F, 12	Hr,	A.C.					
MICROSTRUCTURE											
GRAIN SIZE					TH	ARDNE	ESS				
SOURCE OF DATA General	Electr	ic Con	npany								

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,000 P.S.I.	OFFSET(a) YIELD (1) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		106.2	159.0	16.0	37.9
(a) 0.02% Of	set yield streng	th.			

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RUINDICATED	PTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
*F '	IOO HRS.	0 1000 10,000 100,000 485. 44P. 31P. 32P. 20P. 11P.	0.00001 %/HR	0.0001 %/HR.				
900	1			58P				
1000		58P	44P	31P				
1100		32P	20P	11P				
1200	23P	12.5P		<b> </b>	<b>_</b>			
P_indicat	es strength	value obtai	ned by use	of Larson-	Miller paras	neter T(25	log t).	

TEMP, °F.	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1050		154 R					14.0	
1050	33.0	8293 R					7.0	
1100	37.0	501 R		<u> </u>			15.0	
1150	40.0	140 R					11.0	
1200	16.0	233 R						
1250	20.0	28 R					21.0	
1300	11.8	30 R					44.0	
_								

- (1) Q.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

  (2) EXTRAPOLATED VALUES INDICATED BY \*

  (3) DURATION OF TEST (UNLEST THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

TYPE OF MATERIAL 12 Cr, 2.5 W, V		TYPE (		RNACI	Ė		SIZE		Comm	ercial
CHEMICAL COMPOSITION.	С	Mn	Ρ	S	Si	Cr	Ni	Mo	w	V
PER CENT	0.34	0.46				12.47	•		2.93	0.24
DEOXIDATION										
FORM-CAST OR WROUGHT	Wroug	ht l"I	iame	ter Ba	ar .					
HEAT TREATMENT 2050 F,	0, Q.;	1400 F	`, A.	c						
MICROSTRUCTURE										
GRAIN SIZE					Н	ARDN	ESS			
SOURCE OF DATA General	Electr	ic Cor	npany							

#### SHORT TIME TENSILE PROPERTIES

ONOTH THE TENSIES THOSE STATES												
TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT							
80			133.0	17.0	38.0							
					L							
				<b>-</b>	ļ							
		····		<del></del>	<u> </u>							
				<u> </u>								

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN 1 D, 1000 P.S.I	STRESS CREEP	FOR DESIG	NATED P.S.I.(2)	
•F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
900	]	55P	53P	49P			
1000		48	41*	35*	-		
P indica	tes strengt	value obt	ained by use	of Larson	Miller par	meter T(2	+ log t)

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	REDUC- TION IN AREA, %
1000	60.0	17 R					21.0	65.0
1000	56.0	11 R					19. 0	72. 0
1000	52.0	83 R					15.0	66.0
1000	50.0	594 R					16.0	71.0
1000	40.0	13,000	Discontin	ıed				



### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2.5 W, V	7	YPE (	OF IG FU	RNACI	Ė		SIZE OF HEAT Commercial					
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Мо	w	v		
PER CENT	0.30	1.26			0.40	12,65	0.16		2.31	0.26		
DEOXIDATION												
FORM-CAST OR WROUGHT	Forge	d Buc	ket									
HEAT TREATMENT 1900 F, 4	Hr, A	.Q.;	1200 1	F, 12	Hr, A	c.						
MICROSTRUCTURE												
GRAIN SIZE					H	ARDNE	SS					
SOURCE OF DATA General E	lectric	Com	pany									

### SHORT TIME TENSILE DRODERTIES

	SHORT	THE TENSIE	E PROFERIT		
TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET(a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		111.2	162.0	14.5	34. 1
(a) 0.02% Of	set yield streng	h			

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN T	STRESS CREEP	FOR DESIG	NATED P.S.I.(2)	
°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR
900			51P	41P			
1000		41P	♦31P	ZZP			
1100		23P	15P				
1200	17P						
P indic	ates strengt	h value obta	ined by use	of Larson	-Miller par	meter T(2	+ log t).

<sup>(1) 0.2</sup> PER CENT OFFSET UNLESS OTHERWISE INDICATED.

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS 1000 P.S.I.	DURATIO	ON, (3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	HARONESS AFTER TESTING
1050	55.0	7	R					22.0	
1100	26.0	712	R					24,0	
1150	40.0	3.5	R					19.0	
1200	11.0	433	R					29.0	
1250	20.0	7	R					27. 0	
1300	12.0	9	R					38.0	
	Tests	pecime	ns	0. 160" dia:	neter, 1-in	h gage leng	th.		



### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2.5 W, V		YPE (		RNACI	E		SIZE OF HEAT Commercial				
CHEMICAL COMPOSITION,	С	Mn	Р	S	Si	Cr	Ní	Mo	v	w	
PER CENT	0.29	1.00			0.26	11.68	0.12	Ī	0.25	2.42	
DEOXIDATION											
FORM-CAST OR WROUGHT V	Vroug	ht 4-1	/16" I								
HEAT TREATMENT 1900 F, A	. C. i	200 F	, 16 I	Ir, A	, C.;	1150 F	, 20 F	Ir, A.	C., 1	300 F,	5 H
MICROSTRUCTURE A.C.											
GRAIN SIZE					Н	ARDNE	SS				
SOURCE OF DATA General E	lectri	c Corr	pany								

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET(a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		93.0	142.0	19.5	49.8
(a) 0.02% O	set vield streng	h.			
	-				

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN 1	IMES	STRESS CREEP	FOR DESIG	NATED P.S.I.(2)
°F ′	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
900				44P			
1000		43P	35P	28P			
1100		28P	20P				
1200	23P	<del></del>			<b>-</b>	_	
P indic	ates strengt	value obt	ined by use	of Larson	Miller par	meter T(2	+ log t).

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),		REDUC- TION IN AREA. %
1100	45.0	9 R					10.0	81.0
1200	35.0	3 R					21.0	85.0
1200	30.0	19 R					18,0	83.0
1200	20.0	192 R					8.0	80.0



### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 2.5 W, V		TYPE MELTIN		RNAC	E		SIZE HEAT	OF	Comn	nercia	1
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Мо	w	٧	
PER CENT	0.28	1.33			0.35	12.86	0.12		2.54	0.23	
DEOXIDATION											
FORM-CAST OR WROUGHT F	orged	Bucke	t								
HEAT TREATMENT 1900 F. 4	Hr, A	.Q.;	1200 1	r, 12	Hr, A	C.					
MICROSTRUCTURE											
GRAIN SIZE					Н	ARDNE	SS				
SOURCE OF DATA General	Electr	ic Co	mpany	,							

#### SHORT TIME TENSUE PROPERTIES

	3,10111	111112 . 2.1012	E THO EITH		
TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET(a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		117. 0	158.2	18,5	44.0
(a) 0.02% O	feet yield streng	th		<del>                                     </del>	

<sup>(2)</sup> EXTRAPOLATED VALUES INDICATED BY

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN T	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)					
•F	IOO HRS.	IOOO HRS.	ID,000 HRS.	100,000 HRS.	0.0000001 %/HR.	0.00001 %/HR	0.00DI %/HR.		
900			57P	50P		I			
1000		50P	40P	2 9P					
1100		30P	18P						
1200	21P		_ <del></del>						
P indica	tes strengt	n value obta	ined by use	of Larson	Miller par	meter T(2	+ log t).		

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.SJ.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	REDUC- TION IN AREA, %
1050	56.0	16 R					14.0	
1100	48.0	24 R			L		17.0	
1150	35. 5	73 R					13.0	
1100	34.9	512 R					19.0	
1100	33.0	709 R					22.0	
1050	33.0	6467 R					11.0	37
1200	28.0	29 R					19.0	
1250	20.0	20 R					20.0	
1300	16.0	5 R					29.0	
1200	14. 2	465 R					29.0	
1300	12.0	12 R	L		L		42.0	
1150	10.0	4516+					Discontinued	
	Test s	pecimens	l" gage ler	gth, 0.160	diameter.			

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF

(11)

TYPE OF MATERIAL 12 Cr, 2.5 W, V								SIZE OF HEAT Commercial			
HEMICAL COMPOSITION,	C	Mn	P	S	Si	Cr	Ni	Mo	w	v	
PER CENT	0.29	1.00			0.26	11.68	0.12		2.42	0.25	
DEOXIDATION	-					•					
FORM-CAST OR WROUGHT	Wrou	ght 4-	/16"	D							
HEAT TREATMENT 1900 F, A	. C.; 1	200 F,	16 H	r, A.	C.; 1	150 F,	20 H	r, A.	C.; 14	00 F.	5 H
MICROSTRUCTURE A.C.											
GRAIN SIZE					н	ARDNE	SS				
SOURCE OF DATA General E	lectri	c Com	pany								

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET(a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		93.0	126. 25	23.5	52.5
(a) 0.02% Y	ield strength.				

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RUINDICATED	PTURE IN 1	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
*F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000I %/HR.	
900				37P				
1000		36P	31P	26P				
1100		26P	20P					
1200	22P				ļ			
P indic	ates strengt	value obt	ined by use	of Larson	Miller para	meter T(25	+ log t).	

### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),		REDUC- TION IN AREA, %
1150	40.0	1_R					21.0	81.0
1200	35.0	1 R					23.0	85.0
1200	20.0	171 R					16.0	84.0
			<u> </u>					
					L			L

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

(12)

TYPE OF MATERIAL 12 Cr. 2.5 W,	v	YPE (	OF IG FU	RNACI	Indu	tion	SIZE	OF	Exper	imenta	al.
CHEMICAL COMPOSITION.	С	Mn	Ρ	S	Si	Cr	Ni	Mo	w	v	Г
PER CENT	0.20	0.25			0.33	13.14			3.14	0.22	Г
DEOXIDATION											
FORM-CAST OR WROUGHT	Wrou	tht 1/2	"-Dia	ımete	r Bar						Т
HEAT TREATMENT 2010 F,	4 Hr, A	.C.;	200 I	, 2 F	r, A.	C.; 1	110 F	2 Hr	, A.C		
MICROSTRUCTURE											
GRAIN SIZE					H/	ARDN	SS				_
SOURCE OF DATA Genera	ıl Electi	tic Co	mna n	,							_

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS DF ELASTICITY, I,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80			146, 5	19.0	43.6
	<del>                                     </del>			<u> </u>	
			<u> </u>		

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	S FOR RI	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F	IOO HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000 %/HR	
900		69P	65P	61P				
1000		60	55	51*				
Pindica	tes strengt	value obt	dined by us	e by Larson	-Miller par	meter T(2	b + log t	
			<del> </del>	<del>                                     </del>	<del> </del>			
				<del>                                     </del>	<del>                                     </del>			

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
(2) EXTRAPOLATED VALUES INDICATED BY \*

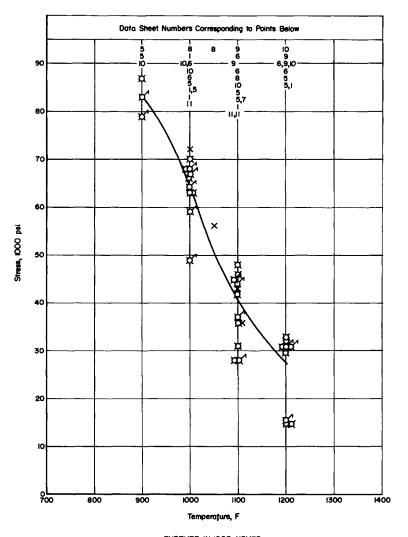
#### ORIGINAL CREEP AND RUPTURE DATA

TEMP, °F.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	REDUC- TION IN AREA, %
1000	69.0	13 R					15.0	65.0
1000	60.0	1817 R			L		12.0	60.0
1000	55.0	11,913 R					8. 0	35.0
				1				
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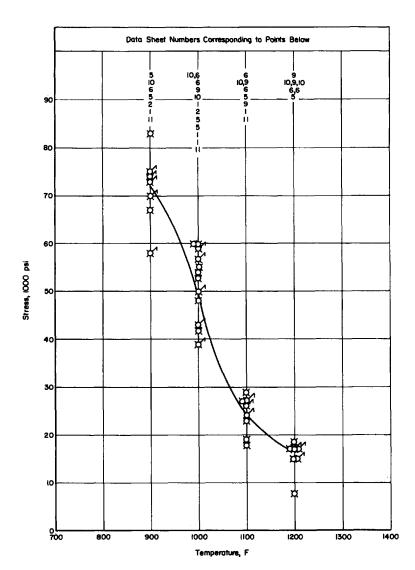
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12 Chromium, 5 Cobalt, 3 Tungsten, Vanadium Steels (Cobalt Ascoloy)



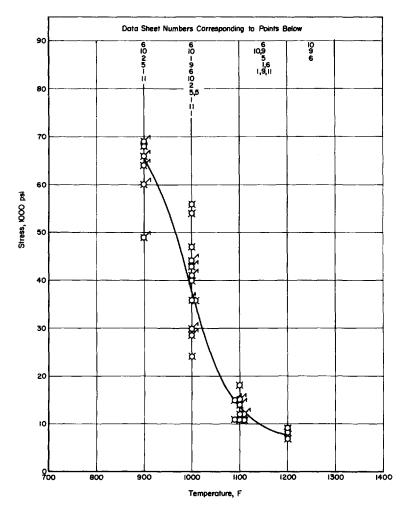


12Cr, 5Co, 3W, V STEEL



RUPTURE IN IO,000 HOURS (EXTRAPOLATED)

12 Cr, 5Co, 3W, V STEEL



RUPTURE IN 100,000 HOURS (EXTRAPOLATED)

12Cr, 5Co, 3W, V STEEL

TYPE OF MATERIAL 12 Cr, 5 Co, 3	w, v	TYPE . MELTII	OF NG FU	RNAC	Ε		SIZE	OF	Comm	nercia	ıl
CHEMICAL COMPOSITION.	С	Mn	Р	s	Si	Cr	Ni	Mo	Co	v	w
PER CENT	0.18	1.15			0.38	11.61	0.24	0.07	5.13	0.27	3.35
DEOXIDATION											
FORM-CAST OR WROUGHT	Wrough	at 4-1/	4" D								
HEAT TREATMENT 1742 F, 5	Hr, A	.C.; 1	200 F	, 8 н	r, A.	<u>z.</u>					
MICROSTRUCTURE											
GRAIN SIZE					H	ARDNE	SS				
SOURCE OF DATA General	Electi	ric Co	mpany								

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80			163.4	17.5	48.1
	<del> </del> -				
				<del>                                     </del>	

#### CREEP AND RUPTURE STRENGTHS

TEMP.,	STRE	SS FOR RU INDICATED	PTURE IN T	IMES (2)	STRESS FOR DESIGNAT CREEP RATE, 1000 P.S.				
•F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000i %/HR.		
900			67P	60P	L				
1000		59P	43P	30P					
1000		63	54*	47*					
1900		70(a)	42*(a)	24*(a)					
1100		3.1	19*	12*					
1200	25	15*							
P indic	ates strengt	h value obta	ined by use	of Larson	Miller para	meter T(2	+ log t)		
(a.) No	tched.								

#### ORIGINAL CREEP AND RUPTURE DATA

			CITIONIA	L OREEP A				
TEMP. °F	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST), %	REDUC- TION IN AREA, %
1000	70.0	29 R					12.0	65.0
1000	66.0	478 R					14.0	66.0
1000	64.0	559 R					12.0	63.0
1000	62. 0	1421 R					10.0	60.0
1000	59, 0	2704 R					9.0	54.0
1100	52.0	15 R					12.0	76.0
1100	46.0	139 R				L	11.0	69.0
1100	42.0	171.R				L	11.0	72.0
1100	38.0	383 R					31.0	72.0
1100	32.0	804 R					5.0	11.0
1100	24.0	3410 R					12.0	54.0
1100	21.0	2591 R					13.0	46.0
1200	35.0	8 R		L			15.0	84.0
1200	32.0	27.R					14.0	81.0
1200	28.0	68 R					14.0	80.0
1200	24.0	110 R					17.0	79.0
1200	22.0	211 R					17.0	80.0
1000	76.0	474 R					Notched(b)	
1000	74.0	751 R					Notched(b)	
1000	70.0	1088 R				L	Notched(b)	
1000	60.0	2022 R					Notched(b)	
1000	50.0	4190 R			ļ		Notched(b)	2.0
					ter, 0.357	major diam	eter, 60 degr	ee notch,
	ar	41 0. 011" z	otch radiu	<b>∮</b> ∙	<u> </u>	L	l	J

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 12 Cr, 5 Co, 3	w, v 1	YPE MELTIN	OF NG FU	RNAC	É		SIZE		Comm	ercial	
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Mo	Co	v	w
PER CENT	0.20	1,23			0.56	12.66	0.43	0.12	5.32	0.21	2.68
DEOXIDATION									-		
FORM-CAST OR WROUGHT	W	rough	t 1-3/	4" x	3-1/8	Bar					
HEAT TREATMENT 1750 F.	1-1/2 F	ir, A,	C.; 1	200 F	'. 5 H	r, A.					
MICROSTRUCTURE											
GRAIN SIZE					Н	ARONE	SS				
SOURCE OF DATA General	Electr	ic Co	mpany	_							

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RUINDICATED	PTURE IN 1000 P.S.I.	TIMES (2)	STRESS CREEP	FOR DESIGNATE, 1000	NATED P.S.I.(2)
°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
		Ī	Double Pir	Shear			
1000		39	30	24*	<del> </del>		
Test sp	cimen - re	duced test	section 0.1	60" diamet	er. 4" gage	length.	
900	l		70P	66P			L
1000		66	53*	40*			
P indica	tes strengt	value obt	ained by use	of Larson	-Miller para	meter T(2	+ log t).
				l			

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP, °F	STRESS, 1000 P.S.J.	OURATIO HOURS	N INTER	AL ILMEE!	PRATE T	ME, CREE	TEST). (RUF	FLONG REDUC- TURE TION IN AREA, 5
	0	. 187" d	ameter	pin loaded	in double s	hear with a c	levis-type fix	sture.
1000	54.0	2.5	R					
1000	45.0	44	R					
1000	40.0	804	R					
1000	38.0	821	R					
1000	35.0	2873	R					
1000	30.0	9361	R				_	
850	120.0	0.5	R					5.0 <sup>(d)</sup> 45.0
850	100.0	1498	R					7.0 <sup>(d)</sup> 51.0
1000	74.0	32	R	I			1	1.0 66.0
1000	70.0	171	R					0.0 60.0
1000	64.0	1787	R					6.0 21.0
1000	61.0	2918	R					5.0 15.0
1000	58.0	4170	R					4.0 10.0
	(d) Te	st speci	men red	uced section	on 0, 160" d	iameter, 4"	gage length.	

### (5)

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 5 Co, 3 W		TYPE MELTI		RNAC	E	_	SIZE	OF ,	Comme	rcial	
CHEMICAL COMPOSITION,	С	Mn	Р	s	Si	Cr	Ni	Mo	Co	W	v
PER CENT	0.20	1.23			0.56	12.66	0.43		5.32	2.6	0.21
DEOXIDATION											
FORM-CAST OR WROUGHT	Wrou	ght l-	3/4" x	3-1/	8"						
HEAT TREATMENT 2000 F, 1	-1/2 F	ir, A.	C.; 12	00 F	, 3-1/	2 Hr,	F.C.				
MICROSTRUCTURE											
GRAIN SIZE					H.	ARDNE	SS				
SOURCE OF DATA Gen	eral El	ectric	Comp	any							

### SHORT TIME TENSILE PROPERTIES

MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
	-	166. 9	12.0	22. 3
		-	-	
			<del></del>	
	OF ELASTICITY,	OF YIELD (1) ELASTICITY, STRENGTH, 1,000,000 P.S.I.	OF YIELD (1) TENSILE STRENGTH, LOOO,000 PS.I. 1000 PS.I.	OF YIELD (1) TENSILE ELONGATION IN 2", LOOO,000 PS.I. 1000 PS.I. 1000 PS.I. PER CENT

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN T	IMES (2)	STRESS FOR DESIGNATE CREEP RATE, 1000 P.S.I				
•F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.00000 I %/HR.	0.00001 %/HR	0.0001 %/HR		
900		83P	73P	64P	I	I			
900	T .	87	83*						
1000		64P	50P	36P					
1000		63	48	36*					
1100		37P	24P	14P		i			
1100_	I	36							
1200	27P	15. 5P							
1200	27	15	8						
P indic	ates strengt	n value obta	ined by use	of Larson	Miller par	meter T(2	+ log t)		

- (1) O.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
  (2) EXTRAPOLATED VALUES INDICATED BY\*
- (2) EXTRAPOLATED VALUES INDICATED BY \*

  (3) DURATION OF TEXT (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

(2)

(8)

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF

TYPE OF MATERIAL 12 Cr, 5 Co, 3 W,		TYPE MELTII		RNACE	-		SIZE HEAT	OF			
CHEMICAL COMPOSITION.	С	Mn	P	5	Şi	Çr	Ni	Мо	w	v	c
PER CENT	0.18	1.21	0.009	0.004	0.51	11.67	0.12	0.03	2.98	0.21	5,24
DEOXIDATION											
FORM-CAST OR WROUGHT	l" Wro	ught I	Заг								
HEAT TREATMENT 1800 F.	1 Hr. (	OQ: 12	00 F.	l Hr.	A. C						
MICROSTRUCTURE											
GRAIN SIZE					Н.	ARDNE	SS	345 B	HN		
SOURCE OF DATA U.S.N.	Engine	ering	Expe	iment	Stati	on					

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA PER CEN
RT		145.0	171.4	16	51
·	-				
					•

#### CREEP AND RUPTURE STRENGTHS

_	_		<b>4.188</b>							
ſ	TEMP.	STRE	SS FOR RUINDICATED	PTURE IN TIMES STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)						
	°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.		
	1050	66	56		I		6.5	19		
L	1100	, 52	36					10		

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.J.	OURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1050	70.Q	50 R					25.0	
1050	60.0	968 R	0.95	0.002	600		17.0	
1050	55.0	814 R	1.00	0.002	375		17,0	
1050	45.0	2386 R	0.42	0.0009	1650		10.0	
1100	60.0	32 R					21.0	
1100	45.0	420 R	0.73	0.001	160		13.0	
1100	35.0	1086 R	0.46	0.001	350		15.0	
1050	10.0	2088	0.062	0.000023		0.107		
1050	7.5	2040	0.047	0.000014		0.076		
1100	7. 0	2064	0.087	0.000059		0, 208		
1100	5.0	1272	0.037	0.000039		0.087		

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr., 5 (	Co, 3 W,		YPE		RNACE	: -	-	SIZE	OF			
CHEMICAL COMPOSIT	ION,	C	Mn	P	S	Si	Cr	Ni	Мо	w	v	. Co
PER CENT	•	0.18	1.21	0.009	0.004	0.51	1-1.67	0.12	0.03	2.98	0.21	5.24
DEOXIDATION												
FORM-CAST OR WRO	DUGHT	l" Wr	ought	Bars								
HEAT TREATMENT	800 F, 1	Hr, C	XQ; 13	00 F,	l Hr,	A. C						
MICROSTRUCTURE												
GRAIN SIZE						H	ARDNE	SS	320 B	HN		
SOURCE OF DATA	U, S. N.	Engin	eering	Expe	rimer	t Stat	ion					

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT		133.7	157.8	20	54
1000		80.1	99.1	2.5	74
1100		63.6	83.0	26	78

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN D, 1000 P.S.I	TIMES .(2)	FOR DESIG	ESIGNATED 1000 P.S.I.(2)			
°F	JOO HRS.	HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.		
1000	78	72		1	1				
1100	54	43		1		6	16		

#### ORIGINAL CREEP AND RUPTURE DATA

	ONIONIAL ONE INC. TOTAL ONE												
TEMP.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	REDUC- TION IN AREA, %					
900	90.0	164 R					8. 0	41.0					
900	85. 0	3982 R					7.0	16.0					
1000	70.0	64 R					12.0	48.0					
1000	64.0	727 R					7.0	20.0					
1000	60.0	1635 R					4.0	14.0					
1000	56.0	2840 R					2.0	4, 0					
1000	50.0	7192 R					3.0	10.0					
1100	52.0	105 R				L	7.0	45.0					
1100	48.0	151 R			]		7. 0	45.0					
1100	38.0	828 R					5.0	24.0					
1100	32.0	2368 R				İ	6.0	18.0					
1100	28.0	3383 R					4.0	11.0					
1100	25.0	3772 R	i				6.0	20.0					
1200	35.0	30 R					12.0	71.0					
1200	28.0	104 R					11.0	64.0					
1200	25.0	138 R					11.0	65, 0					
1200	18, 0	585 R					10.0	36.0					
1200	12.0	2161 R					10.0	25.0					
1200	9.0	6686 R			L		10.0	18.0					

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

(6)

TYPE OF MATERIAL 12 Cr, 5 Co, 3 W,	V N	YPE (	OF NG FU	RNACE	Indu	iction	SIZE HEAT	OF ,	Екрегі	imenta	.1
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	Co	w	v
PER CENT	0.24	0.78			0.36	12.19		0.26	5.23	2.98	0.26
DEOXIDATION											
FORM-CAST OR WROUGHT	Wroug	ht 7/8	" x 7/	8! Ba	E						
HEAT TREATMENT 2010 F. 3	Hr. C	ool at	1800	F/Hr.	1200	F. 3	Hr. F	`. C.			
MICROSTRUCTURE											
GRAIN SIZE					H/	ARDNE	SS				
SOURCE OF DATA General	Electr	ic Cor	mnany	, –							

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 PS.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80			165. 9	12.0	23.0

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRES	SS FOR RU	PTURE IN 1 , 1000 P.S.I.	STRESS CREEP	FOR DESIG	NATED P.S.(.(2)	
°F '	IOO HRS.	HRS. HRS. HRS. %/HR. %/1		0.00001 %/HR	0.0001 %/HR.		
900			74P	69P			
1000		68P	59P	43P			
1000		66	60*	56*			
1100		44P	26P	12P			
1100		46	29*	18*			
1200		3 1P	15P				
1200		30	15	7.1*			
P indica	tes strengt	value obta	ined by use	of Larson	Miller para	meter T(25	+ log t).

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	REDUC- TION IN AREA, %
1000	76, 0	23 R					9. 0	51.0
1000	74.0	1748 R					4.0	12.0
1000	69.0	468 R					9.0	Z9.0
1000	64.0	3510 R					5. 0	14.0
1100	64.0	57 R					9.0	41.0
1100	50.0	424 R					4.0	16.0
1100	40.0	1992 R			<u> </u>		4.0	9.0
1100	35.0	3667 R					4.0	4.0
1200	37.3	51 R					7.0	36.0
1200	30.0	92 R					7, 0	32,0
1200	20.0	330 R			<u> </u>	L	9.0	32.0
1200	12.0	1822 R	Ī				14.0	36.0

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

(2) EXTRAPOLATED VALUES INDICATED BY \*

<sup>1.100 | 54 | 43 | 6 | 16
(3)</sup> DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. ICREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING					
1000	75.0	364 R	1,43	0.012	270		22.0						
1000	70.0	1993 R	2.18	0.0012	1200	<u> </u>	18.0						
1100	62.0	14 R					24.0						
1100	50.0	404 R	0.83	0,005	290	L	20.0						
1100	40.0	1623 R	0,39	0.00086	850		18.0	<u> </u>					
1100	13.0	2040	0.092	0.000068		0.229							
1100	9.0	2064	0.069	0.000022		0.113							

### (9)

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 5 Co, 3 W,	v	TYPE   MELTII	OF NG FU	RNAC	E Indu	ction	SIZE	OF I	Схрег	imenta	1
CHEMICAL COMPOSITION.	C	Mn	P	S	Si	Cr	Ni	Mo	Co	v	w
PER CENT	0.2	1.0			0.4	12			5.0	0.25	3.0
DEOXIDATION											
FORM-CAST OR WROUGHT	Wrou	ght l"	x 1" ]	Bar							
HEAT TREATMENT 2010 F.	3 Hr.	Cool a	t 180	F. )	Hr; l	200 I	. 3 н	r, F.	Ξ.		
MICROSTRUCTURE											
GRAIN SIZE					(H	ARDN	ESS				
SOURCE OF DATA General	Electr	ic Cor	npany								

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80			157.4	16.0	37.9

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRES	S FOR RU	PTURE IN T	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
•F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000I %/HR.
1000			57P	44P			
1100		45P	27P	15P			
1100		48	23	11*			
1200		31P	17P				
1200		32	18	8. 7*			
P indica	tes strengt	value obta	ined by use	of Larson	Miller para	meter T(2	+ log t).

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.J.	DURATION HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. ICREEP TEST),		REDUC- TION IN AREA, %
	60.0	62 F	1				9. 0	54, 0
1100	50.0	497 F					4.0	12.0
1100	41.0	1655 F					2, 5	_7,0
1100	20.0	16.413 F					3.0	8.0
1200	46.0	1.5F	4				13.0	80.0
1200	30.0	175 B					5.0	48.0
1200	20.0	709 F					10.0	48.0
1200	12.0	2590 B					18.0	25.0
1200	10.0	6406 R					8.0	15.0



## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 12 Cr, 5 Co, 3 W,	v	TYPE MELTI		RNAC	É		SIZE		Comme	rcial	
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Мо	Co	v	w
PER CENT	0.25	1.0		[	0.38	12.08	·	T "	5.03	0.28	2.78
DEOXIDATION											
FORM-CAST OR WROUGHT	Wroug	ht 3/4	" x 3/	4" Ba	r						
HEAT TREATMENT 2010 F, 4	Hr, C	ool at	1900	F/Hr;	1200	F, 4	Hr, F	. c.			
MICROSTRUCTURE											
GRAIN SIZE					H	ARDNI	ESS				
SOURCE OF DATA Genera	1 Elect	ric Co	mpan	v —							

	SHORT	LIME LEMPIN	E PROPERII	ES	
TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 PS.1.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80			167.4	13.5	24.4

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN 1000 P.S.I	TIMES	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
°F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000i %/HR	
900		79P	75P	68P				
1000		67P	55P	41P				
1000		68	60*	54*				
1100		42P	27P	15P				
1200		31P	17P	T				
1200		33	17	9*	L		ļ	
Pindica	tes strengt	value obta	ined by use	of Larson	Miller para	meter T(2	+ log t)	

#### ORIGINAL CREEP AND RUPTURE DATA

	ONIONIAL ONCE: THE NO. TOTAL DATA										
TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. CREEP TEST),		REDUC- TION IN AREA, %			
1000	80.0	4 R					12.0	52.0			
1000	75.0	109.R		l			10.0	36.0			
1000	68.0	832 R					5. 0	12.0			
1000	62.0	5013 R					4.0	9.0			
1200	40.0	16 R					10.0	71.0			
1200	30.0	158 R					10,0	32.0			
1200	20,0	585 R					12.0	18.0			
1200	14.0	2010 R					10.0	23.0			



# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 5 Co, 3 W	, v	TYPE MELTI	OF NG FU	RNAC	E		SIZE OF HEAT Commercial				
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	Co	v	w
PER CENT	0.18	0.35			0.24	12.34	0.16	0.12	4.5	0.25	4.69
DEOXIDATION											
FORM-CAST OR WROUGHT	Wroug	ht 4" I	Diame	ter B	ar						
HEAT TREATMENT 1775 F.	Hr. A	. C. i	1200 E	. 12	Hr, A	. c.					
MICROSTRUCTURE											
GRAIN SIZE					Н	ARDNE	SS				
SOURCE OF DATA Genera	Llect	ric Co	mpan	,							

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET (a) YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		100.0	147.8	15.7	39. 4
(a) 0,02% Of	set yield streng	h			

### CREEP AND RUPTURE STRENGTHS

TEMP.,	STRE	SS FOR RU	JPTURE IN 5, 1000 P.S.1	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000000 I %/HR.	0.00001 %/HR	0.000 %/HR
900			58P	49P			
1000		49P	39P	28P			
1100		28P		T			
1100		28	18*	11*			
P indica	tes strengt	value obt	ained by us	of Larson	-Miller para	meter T(25	+ log

TEMP.	STRESS. 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	(RUPTURE	REDUC- TION IN AREA, %			
1000	65.0	33 R					10.0	68.0			
1000	60.0	79 R					7.0	67. 0			
1000	58.0	1087 R			l		12.0	63.0			
1100	42.0	68 R					14.0	74.0			
1100	35.0	298 R					_12.0	72.0			
1100	28.0	1042 R					13,0	68.0			
1100	22.0	3411 R					9.0	29.0			

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

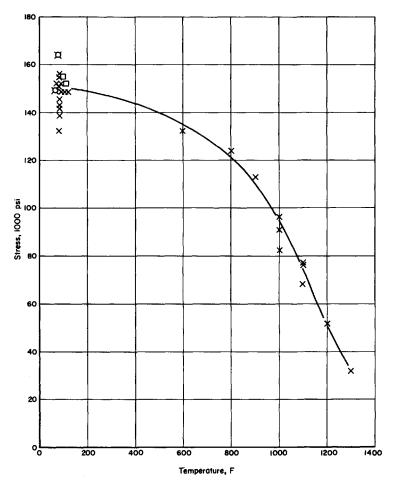
  (2) EXTRAPOLATED VALUES INDICATED BY \$\frac{\psi}{2}\$ (2) EXTRAPOLATED VALUES INDICATED BY \$\frac{\psi}{2}\$ (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

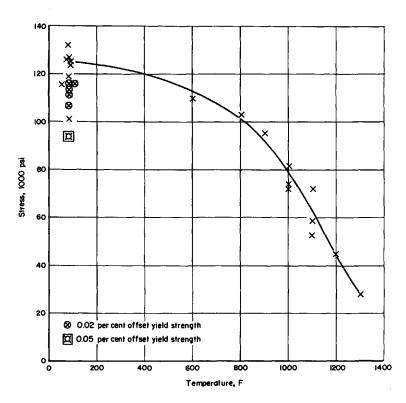
QT	D22	o =	D/	li il	1958
. 7 1	ヒノノ	α- <b>⊢</b>	Ы/.	1111	างกร

13 Chromium, Tungsten, Molybdenum, Vanadium Steels (422)



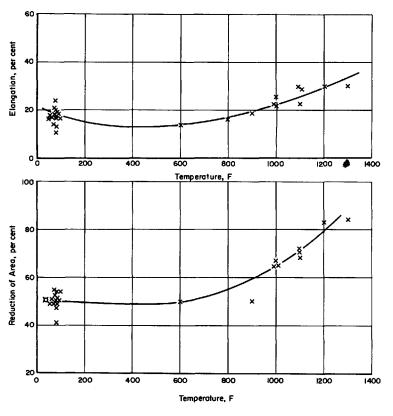
TENSILE STRENGTH

13 Cr. W. Mo, V STEEL



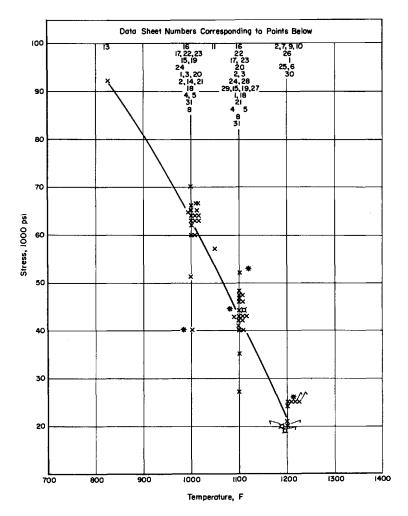
0.2 PER CENT OFFSET YIELD STRENGTH

13 Cr. W. Mo. V STEEL



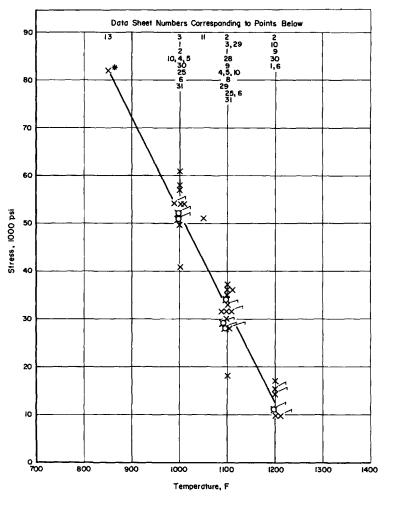
ELONGATION AND REDUCTION OF AREA

13 Cr, W, Mo, V STEEL



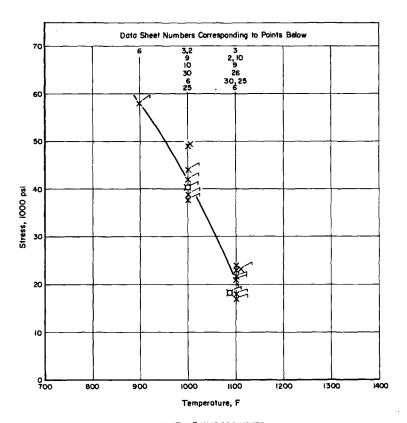
RUPTURE IN 100 HOURS

13 Cr, W, Mo, V STEEL



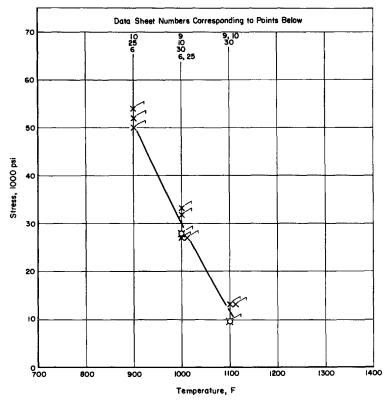
RUPTURE IN 1000 HOURS

13 Cr, W, Mo, V STEEL



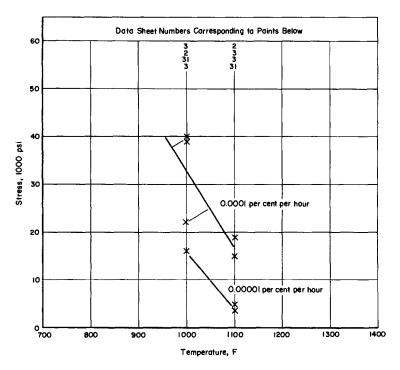
RUPTURE IN IO,000 HOURS (EXTRAPOLATED)

13 Cr, W, Mo, V STEEL



RUPTURE IN 100,000 HOURS (EXTRAPOLATED)

13 Cr, W, Mo, V STEEL



CREEP STRENGTHS

13 Cr, W, Mo, V STEEL

TYPE OF MATERIAL 13 Cr, W, Mo, V	(422)	TYPE MELTI	OF NG FU	RNAC	E Ele	ctric	SIZE	OF ,	Comm	ercial	
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr.	Ni	Mo	w	v	
PER CENT	0.23	0.81			0.022	13.19	0.65	1.03	0.84	0.25	
DEOXIDATION											
FORM-CAST OR WROUGHT	" Hot	Rolled	and A	nneal	led						
HEAT TREATMENT 1900 F,	/2 Hr,	00;	1200 E	, 2 H	ir, A.	с.					
MICROSTRUCTURE											
GRAIN SIZE				-	H	ARDNI	ESS	33 R <sub>C</sub>			_
SOURCE OF DATA MACA I	-unio T	abora	torv				_				

### CREEP AND RUPTURE STRENGTHS

			~,	A10 110	TOIL OIL			
Γ	TEMP.	STRE	SS FOR RI	UPTURE IN	TIMES .(2)	STRESS CREEP	FOR DESIG RATE, 1000 0.00001 %/HR	NATED P.S.1.(2)
	°F ′	IOO HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.		0.000i %/HR.
	1000	64	58*					
	1100	42	35					
	1200	21	10					

### ORIGINAL CREEP AND RUPTURE DATA

_				C ONCE A	TO NOT TON			DEBUG
TEMP,	STRESS,	DURATION,	INTERCEPT,	MINIMUM CREEP RATE, %/HR.	TRANSITION	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	REDUC-
°F.	P.S.I.	HOURS(3)	%(4)	%/HR.	TIME, HRS.(5)	%'ES,',	TEST),%	AREA, %
975	65.0	358 R						
975	65.0	358 R 496 R					<u> </u>	62. 0 63. D
		376 R						
1000	60.0						<u> </u>	64,0
1000	65.0	60.4 R					<del></del>	70.0
1000	65.0	72.4 R				<u> </u>		66. D
1000	70.0	7.7 R					<u></u>	78.0
1000	85.0	0.16 R				ļ		63.0
1025	65.0	16.2 R						66.0
1040	65.0	5.0 R					<u> </u>	70.0
1080	40.0	750 R						60.0
1100	35.0	984 R						49.0
1100	40.0	276 R						64.0
1100	40.0	296 R		<u> </u>				59.0
1100	50.0	8.0 R						76.0
1100	65.0	0.22 R						69.0
1125	40.0	63.4 R		<u> </u>				67.0
1125	40.0	62.1 R						67.0
1150	40.0	24.2 R						69.0
1150	40.0	17.8 R			I			70.0
1275	22.0	1134 R						53.0
1165	22.0	486 R					·	62.0
1175	22.0	328 R	· · · · ·	***				65.0
1175	22.0	392 R						62.0
1180	40.0	3.6 R						75.0
1200	8.0	2842 R			<del> </del>			70.0
	_			· ·	-			10.0
1200	10.0	712 R						
1200	15.0	307 R		-		<del></del>		75.0
1200	22.0	117 R						70.0
1200	22.0	79 R					<del></del>	71.0
200	30.0	19.2 R	<u> </u>					73.0
1200	45.0	0.8 R				-		78.0
1200	55.0	0.042R				ļ	ļ	76.0
1200	56.3	0.016R					ļ	76.0
1225	10.0	745 R						72.6
1225	22.0	39.1 R				L		72.0
1225	22.0	33.2 R		l			<u></u>	74.0
1250	10.0	294 R						76,5
1250	22.0	16.3 R		<u> </u>				78.0
1250	22.0	13 R						78.5
1255	40.0	0.32 R						78. 2
1275	10.0	95.5 R						86.0
1275	10.0	62,1 R		l				88. 0
1275	40.0	0.12 R					T	81.0
1295	22.0	3.1 R		T		T		85.0
1300	10.0	24.7 R					·-·	88. 0
1300	10.0	41 R				i -	<u> </u>	87. 0
1325	22.0	1.8 R	<del></del>	<del></del>		1	l —	87.0
1340	10.0	11 R		<del>                                     </del>		<b></b>	<del> </del>	92.0
_				<del> </del>		<del> </del>	<del> </del>	91.0
1340	10.0			<del> </del>	<del> </del>	<del></del>	<del></del>	
1350	22.0	0.7 R		<del></del>	<del></del>	<del></del>	-	90.0
1390	10.0	3.2 R			<u> </u>	<del></del>	<del></del>	91.0
1400	10.0	2.7 R		<del>                                     </del>		<del></del>	<del> </del>	94.0
1400	22.0	0, 1 R		<del> </del>	<u> </u>		<del></del>	93.0
1400	22.0	0.084R		<del></del>	<u> </u>	<del> </del>	<u> </u>	92.5
1445	10.0	1.3 R		<del></del>	<del></del>	<b></b>	<b>_</b>	91.0
Щ.	<u> </u>	<u>l</u>		L	<u> </u>	<u> </u>	L	<u></u>

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, W, Mo, V	(422)	TYPE MELT!	OF VG FU	RNACE	Indu	ction	SIZE HEAT	OF	1 Te	on	
CHEMICAL COMPOSITION,	C	Mn	Ρ	S	Si	Cr	Ni	Мо	w	v	
PER CENT	0.19	0.83			0.28	13.13	0.73	1.03	1.11	0.34	
DEOXIDATION											Ξ.
FORM-CAST OR WROUGHT	Wrou	ght 1"	Round								_
HEAT TREATMENT 1900 F.	l Hr,	OQ; 12	00 F,	2 Hr,	A.C.		Hea	t No.	1590-	1.5	_
	red Ma										_
GRAIN SIZE					JH/	ARDN	SS	34.5	Rc		_
SOURCE OF DATA Crucib	le Steel	Corne	any								_

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		125	149	18.5	52
1000		82	96	25	67
1100		72	76	29.5	69
1200		45	52	30	83
1300		28	32	30	84
80 <sup>(a)</sup>		127	152	19	45
80(P)		121	151	15	43
80(c)		109	138	16	45
	me tensile prope		above were on	creep specime	ns which ha
been ex	osed as follows:				
(a) At 1000	F, 40,000 psi for	2150 Hr.			İ
(b) At 1000	F. 30,000 psi for	7240 Hr.			
(c) At 1100	R. 20 000 psi for	3330 Hr.			

### CREEP AND RUPTURE STRENGTHS

O IOO S. HR		0.000000 I %/HR.	0.0001 %/HR	LENGTH TEST, HR
57	49*		39	7820
37	23*		19	3330
17*				

TEMP	STRESS, 1000 P.S.I.	DURATIO HOURS	N, 3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	70.0	13	R					18.0	
1000	65 <u>. 0</u>	63	R					16.0	
1000	60.0	301	R					14.0	
1000	55,0	1720	R		0.0025			11.0*	
1000	50. D	7820 F		0.96	0.0003	4400		12.0*	
1000	40,0	Discont 2184	in.	0.47	0.00012			0.67	34
1000	30.0	7240	in.	0.32	0.00002			0.49	34
1100	60.0	1.3	R					23.0	
1100	50.0	3.1	R					19.0	
1100	45.0	251	R					16.5	
1100	42.0	502	R					21.0	
1100	39.0	725.	R				L	24.0	L
1100	30, 0	2720	R	0, 40	0.0005	1280		11.0*	
1100	20.0	Diacont 33330nt	in.	0.40	0.00011			0.66	29
1200	30.0	36	R					17.0	
1200	27.0	49	R					14.0	
1200	25.0	133	R					19.0	<u></u>
1200	20.0	336	R					22.0	
	*Cree	Specin	ne.	1 - 2. 25" g	age length.	(Others 1.4	7		
	_		-						
									_
			$\exists$						
			4						

- (1) O.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

  (2) EXTRAPOLATED VALUES INDICATED BY \*

  (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

### (3)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 13 Cr, W, Mo, V	(422)	TYPE MELTI	OF NG FU	RNACE			SIZE		omme	rcial	
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Мо	w	V	
PER CENT	0.19	0.84			0.32	13.85	0.74	0.98	1.13	0.24	
DEOXIDATION		_									
FORM-CAST OR WROUGHT	l" Wr	ought l	Bar								
HEAT TREATMENT 1900 F,				1 Hr,	OΩ						
MICROSTRUCTURE											
GRAIN SIZE					Н	ARDN	ESS	290 BH	IN		
SOURCE OF DATA U.S.N.	Engine	ering	Expe	rimen	Stat	ion					

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT		124.4	149,2	18	52
1000		74.6	91.4	22	65
1100		59. 2	77.2	25	71
	i	1		I	i

### CREEP AND RUPTURE STRENGTHS

TEMP.,	STRE	SS FOR R	UPTURE IN D, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)					
°F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.		
1000	64	61	49	I		16	40		
1100	46	36	24			5. 3	15		

### ORIGINAL CREEP AND RUPTURE DATA

						<u></u>		
TEMP,	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST), %	HARDNESS AFTER TESTING
1000	65.0	74 R					31.0	
1000	62.0	1382 R	1.07	0.0030	975		19.0	
1000	60.0	1285 R	1.03	0.0026	925		19.0	
1000	50.0	8753 R	0.63	0.00043	7000		22.0	
1100	50.0	36 R					28.0	
1100	45.0	146 R					26,0	<u> </u>
1100	39.0	656 R	0.45	0.0030	350		21.0	
1100	35.0	1210 R	0.58 _	0.0012	500		23.0	
1100	30.0	2802 R	0.22	0.00059	1750		21.0	
1000	34.0	2040	0.183	0.000033		0.250		
1000	30.0	2016	0.120	0.000036		0.193		
1000	28.0	2016	0.169	0.000030		0.229		
1000	20.0	2040	0.052	0.000014		0.080		
1000	18.5	2040	. 0. 100	0.000017		0.137		
1100	10.0	2016	0.064	0.000054		0.172		
1100	6.0	2088	0.030	0.000012		0.055		ļ

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF

I EM	PERA	UKE	ON	PROF	TRI	E5 U	r ME	IALS			
TYPE OF MATERIAL 13 Cr, W, Mo, V	(422)	YPE MELTII	OF NG FU	RNACE	<u> </u>		SIZE HEAT				
CHÉMICAL COMPOSITION,	С	Mn	P	S	Si	Cr	Ni	Mo	w	V	
PER CENT	0.23	0.81	0.011	0.022	0.16	13.19	0.65	1.03	0.84	0.25	
DEOXIDATION											
FORM-CAST OR WROUGHT D	isc F	orging	12-1	/8" di	amete	r x 3.	1/8"	thick			
HEAT TREATMENT 1900 F. O	): 120	0 F.	2 Hr								
MICROSTRUCTURE											
GRAIN SIZE					Н	ARDN	ESS				
SOURCE OF DATA Elliott Co	mpan	y									

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MOOULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT		132	155	17.0	50.2
RT		127	152	14.0	39.6

### CREEP AND RUPTURE STRENGTHS

_			0.146	7410 1101	10112	12.10.1.0		
	TEMP.	STRE	SS FOR RU				FOR DESIG	
	•F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
	1000	60	54					
1	1100	40	32					I

<sup>(1) 0.2</sup> PER CENT OFFSET UNLESS OTHERWISE INDICATED.

#### ORIGINAL OPEED AND BUILDINGS DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.		TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	70.0	2 R					21.0	
1000	65,0	12 R					21.0	
1000	60.0	40 R					16.0	
1000	55.0	615 R					17.0	
1000	54.0	620 R					18.0	
1000	53.0	1894 R					15. 0	
1100	50.0	14 R					23.0	
1100	45.0	120 R					21.0	
1100	43.0	88 R					21.0	
1100	42.0	192 R		L			23.0	
1100	42.0	136 R					21.0	
1100	36.0	318 R						
1100	35.0	295 R		l			18.0	
1100	32.0	405 R				<u> </u>	10.0	
1100	30.0	911 R					16.0	
	All tes	t bars cut	tangentiall	from rim	of forging.	l" gage leng	th x 0.250" d	iameter.

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 13 Cr, W, Mo, MATERIAL (1420WM)	v i	Type OF   SIZE OF   HEAT									
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Mo	w	V	
PER CENT	0.19	0.83	0.023	0.026	0.22	12.69	0.78	0.98	0.83	0.29	
DEOXIDATION											
FORM-CAST OR WROUGHT	Disc F	orgin	g, 12-	1/8" 6	liame	ter x	3-1/8	" thicl	k		
HEAT TREATMENT											
MICROSTRUCTURE											
GRAIN SIZE					H	ARDN	SS				
SOURCE OF DATA Elliott	Company	y									

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,OOO P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT		126	152	19.0	49.9
RT _		126	155	16.0	49.2

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR	
1000	60	54						
1100	40	32		L				

### ORIGINAL CREEP AND RUPTURE DATA

$\overline{}$						Γ.		
TEMP, °F.	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG (RUPTURE TEST),%	HARDNES AFTER TESTING
1000	65.0	21 R					19.0	
1000	62.0	72 R					19.0	
1000	59.0	377 R					19.0	
1000	57.0	383 R					18.0	
1000	55.0	843 R					18.0	
1000	52.0	5340 R					6.0	
1100	46.0	29 R				<del></del>	25.0	
1100	44.0	55 R					15.0	
1100	42.0	89 R					16.0	
1100	41.0	257 R		-	1		19.0	
1100	39.0	246 R					17.0	İ
1100	37.0	398 R					16.0	
1100	35.0	649 R					9.0	
1100	31.0	1296 R					9. 0	
	All tes	t bars cut	tangential	y from rim	of forging.	I" gage leng	th x 0.250" d	iameter.

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

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<sup>(2)</sup> EXTRAPOLATED VALUES INDICATED BY

TYPE OF MATERIAL 13 Cr, W, Mo, V		TYPE OF MELTING FURNACE					SIZE OF HEAT Commercial				
CHEMICAL COMPOSITION,	C	Mn	Р	S	Si	Cr	Ni	Мо	W	v	L
PER CENT	0.22	0.81	0.011	0.022	0,16	13.19	0.65	1.03	0.84	0.25	L
DEOXIDATION											
FORM-CAST OR WROUGHT	Forge	i Buck	et								
HEAT TREATMENT 1900 F.	Hr,	A.Q.;	1200	F, 12	Hr, A	.c.					
MICROSTRUCTURE											
GRAIN SIZE					Н	ARDN	ess				
SOURCE OF DATA Genera	l Elec	tric C	ompan	Y							

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET(a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		114. 2	149.2	24.0	51.7
(a) 0.02% Of	set yield streng	ih.			
	<b></b>				

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
•F	HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000 %/HR	
900			58P	50P				
1000		50P	39P	27P	1	L		
1100		28P	17P	<b>_</b>	<u> </u>	L		
1200	20P	10P	ļ	<del> </del>	<del> </del>	<u> </u>	<u> </u>	
Pindica	tes strengt	h value obt	ined by us	e of Larson	Miller par	meter T(2	+ log t	

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1050	56. 0	21 R					_13.0	
1100	47.3	13 R			<u> </u>		16.0	
1100	30.0	591 R					19.0	
1100	32, 3	676 R	L				21.0	
1150	35.0	24 R					19.0	
1150	12. 0	4517	Discontinu	ed	Ĺ			
1200	28. 0	31 R			l		17.0	
1200	15.8	241 R					30.0	
1200	13.5	554 R					27.0	
1250	20.0	19 R			Ĺ		20.0	
1300	15,8	7 R			Ĺ	L	L <del>-</del>	
1300	11.8	17 R	<del></del>	<del> </del>	<del> </del>	<del> </del>	39.0	<del> </del>
	Test s	pecimens	0, 160" diar	neter, l" ga	ge length.			
<u> </u>	L		L	L	ــــــــــــــــــــــــــــــــــــــ	L	L	L

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 13 Cr, W, Mo, V	(422)	TYPE (	OF NG FU	RNAC	E Indu	ction	SIZE		1 To	,	
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	w	v	Г
PER CENT	0.21	0.82			0.29	13.12	0.72	1.03	1.08	0.34	Г
DEOXIDATION											
FORM-CAST OR WROUGHT	Wrough	ht 1" F	ound								
HEAT TREATMENT 1900 F.	0Q + I	300 F,	2 Hr	, A.	Ş	He	at 15	91-A5			_
MICROSTRUCTURE											
GRAIN SIZE					Н	ARDNE	SS	31 R			_
SOURCE OF DATA Crucib)	e Steel	Comp	any								

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 PS.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
, 80	Ļ	116	142	20	54
				<b> </b>	
<del> </del>				<del></del>	

<sup>(1) 0.2</sup> PER CENT OFFSET UNLESS OTHERWISE INDICATED.

### CREEP AND RUPTURE STRENGTHS

TEMP	HRS. HRS. HRS. HRS. %/HR. % 58 44	FOR DESIGNATE, 1000	NATED P.S.I.(2)				
TEMP., °F						0.00001 %/HR	0.0001 %/HR.
1000	58			ļ	Ļ	ļ	<b></b>
1100	44	<u> </u>			ļ	<b>-</b>	<b>├</b> ——
1200	25*		1		L	L	

#### ORIGINAL CREEP AND RUPTURE DATA

				ONIGHAE	IL UNCEP M	NO NOT TO	L DAIA		
TEMP.	STRESS 1000 P.S.I.	DURATIO HOURS(	N, 31	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG (RUPTURE TEST),%	HARONESS AFTER TESTING
1000	65.0	6.5	R					13.0	
1000	60.0	47	R					15.0	
1000	57.0	147	R					18.0	
1100	45.0	73	R					20.0	
1100	40.0	442	R			<del> </del>		15.0	
1200	30.0	17	R					16.0	
1200	27.0	51	R					22.0	

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

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TYPE OF MATERIAL 13 Cr. W. Mo. V	(422)	TYPE	OF NG FU	RNAC	E Indus	tion	SIZE	OF	1 Ton		
HEMICAL COMPOSITION, ER CENT EOXIDATION ORM-CAST OR WROUGHT EAT TREATMENT 1900 F. ICROSTRUCTURE	С	Mn	Р	S	Si	Cr	Ni	Mo	w	V	Г
PER CENT	0.21	0.82			0.29	13.12	0.72	1.03	1.08	0.34	Γ
DEOXIDATION											
FORM-CAST OR WROUGHT	Wrou	ght l"	Roun	d							
HEAT TREATMENT 1900 F.	00 + 13	50 F.	2 Hr.	A.C		E	eat 1	91-A	5		
MICROSTRUCTURE											
GRAIN SIZE					H.	ARDN	SS	29 R			
SOURCE OF DATA Crucib	le Steel	Comp	anv								

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (I) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		101	132	20	54
L	L	L	L	L	

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN D, 1000 P.S.	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F '	100 HRS.	NOOO HRS.	10,000 HRS.	100,000 HRS	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1000	40*				Ī			
1100	35	30						

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS,	DURATION, HOURS(3)	INTERCEPT,	CREEP RATE.	TRANSITION	(CREEP TEST).		AFTER
-	P.S.I.			%/HR.	HRS.(5)	%	TEST),%	TESTING
1000	65.0	5.3 R			L		22.0	
1000	60.0	24 R		<b> </b>			21.0	
1000	55.0	51 R		<u> </u>	<del> </del>		19.0	
1100	45.0	1.8 R			i		24.0	
1100	40.0	7.5 R					17.0	
1100	32.0	446 R					14.0	
1100	29.0	1314 R	0.81	0.00217	560		14.0	
1200	30	5.7 R					25, 0	
			<u> </u>					
<u> </u>			<u> </u>		<del>  </del>		ļ	
<u> </u>	<u> </u>		<u></u>	l	L	l	L	L

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

<sup>(2)</sup> EXTRAPOLATED VALUES INDICATED BY

DEOXIDATION FORM-CAST OR WROUGHT Wrought Bar 2-9/16" HEAT TREATMENT 1900 F, 3 Hr, OΩ; 1150 F, 12 H MICROSTRUCTURE	RNACE	SIZE OF Commercial									
MATERIAL 19 CF, M, MO, V HEMICAL COMPOSITION, FER CENT ECOXIDATION ORM—CAST OR WROUGHT LEAT TREATMENT 1900 F, MICROSTRUCTURE FRAIN SIZE	C Mn P S Si Cr					Cr	Ni	Mo	w	V	
PER CENT	0.19	0.77	<b>0</b> .020	0.018	0.20	12.79	0.77	1.03	1.15	0.24	
DEOXIDATION											
FORM-CAST OR WROUGHT	Wrou	tht Ba	r 2-9	/ 16" E	iame	ter					
HEAT TREATMENT 1900 F, 3	Hr, (	χΩ; 11	50 F,	12 Hr							
MICROSTRUCTURE											
GRAIN SIZE					H.	ARDNE	SS				
SOURCE OF DATA General	Electr	ic Co	mpany	7 _							

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,				ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		107.3	143.5	18.5	49.2
(a) 0.02% Of	set yield streng	th.			
	OF VIELD (1) TENSILE ELONGATION REDUCTION STRENGTH, 1000 PS.L. 107.3 143.5 18.5 49.2				

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN 1 1000 P.S.I.	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
*F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1000			44P	33P	T			
1100		33P	22P	13P				
1200	25P	14.5P				<u> </u>		
P indic	ates strengt	value obta	ined by use	of Larson	Miller par	meter T(2	+ log t).	

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	(RUPTURE	REDUC- TION IN AREA, 9
1050	50.0	327 R					24.0	75.0
1050	49.0	548 R					23.0	72.0
1100	32.0	1293 R	l				23.0	72.0
1200	30,0	36 R			l	_	27.0	86.0
1200	20.0	300 R					37.0	88.0
1300	15.0	22 R					40.0	83.0
1300	10,0	103 R	I			Γ -	52.0	92.0

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## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, W, Mo, V	TYPE OF MELTING FURNACE					SIZE OF HEAT Commercial				_	
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	w	V	Γ
PER CENT	0.22	0.80	0.022	0.015	0.30	13.59	0,61	1.02	1.02	0.25	Γ
DEOXIDATION											_
DRM-CAST OR WROUGHT Wrought Bar 1-5/16" Diameter											
HEAT TREATMENT 1900 F, C	Ω; 11	50 F	Tempe	r							
MICROSTRUCTURE				-							
GRAIN SIZE					H	ARDNE	SS				_
SOURCE OF DATA General H	Clectr	ic Cor	mpany								_

### SHORT TIME TENSILE PROPERTIES

TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
152.2	19.5	50.6
_		

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RL	PTURE IN 1	IMES (2)	STRESS CREEP	FOR DESI RATE, IOO 0.00001 %/HR	GNATED D P.S.I.(2)		
*F	100 HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.		0.0001 %/HR.		
900	l			54P	Ι		L		
1000		54P	42P	32P	I				
1100		32P	23P	13P	L				
1200	25P	15P			<del> </del>	<del>                                     </del>			
P indic	ates strengt	ı value obt	ined by use	of Larson	Miller par	meter T(2	+ log t).		

<sup>(1) 0.2</sup> PER CENT OFFSET UNLESS OTHERWISE INDICATED.

### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),		REDUC- TION IN AREA, %
1050	60.0	40 R					14.0	70.0
1150	50.0	3 R					16.0	78.0
1150	40.0	29 R			1		18.0	78.0
1150	30.0	170 R					17.0	82.0
1200	25.0	109 R		-			22.0	83.0
1200	20.0	359 R					18.0	84.0
1300	15.0	15 R			1		27.0	91.0
1300	10.0	73 R		1			41.0	93. 0

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### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 13 Cr, W, Mo, V	(422)	TYPE	OF NG FU	RNAC	E A	RC	SIZE		3 Tor	ьв	
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Mo	w	v	
PER CENT	0.22	0.80	L		0.37	13.63	0.61	1.02	1.02	0.28	
DEOXIDATION											
FORM-CAST OR WROUGHT	Wroug	ht l'	Round								
HEAT TREATMENT 1900 F,	OQ +	1200 F	, 2 H	г		Heat	No. W	4543			
MICROSTRUCTURE											
GRAIN SIZE					TH.	ARDN	ESS				
SOURCE OF DATA Crucib	e Stee	Com	any								

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
600		_110	132	14	50
800	I:	103	124	16	52
900		95	113	19	50
			L		

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN D, 1000 P.S.I	TIMES	STRESS	FOR DESIG	P.S.I.(2)
•F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
1050	57	51			I		

### ORIGINAL CREEP AND RUPTURE DATA

STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
65.0	16 R					24.0	
60.0	53 R					29.0	
55.0	193 R	L				20.0	
50.0	1173 R		L			19.0	
45.0	1258 R	0,78_	0.00162	840		8,0*	
*2.25	inch gage	length.					
	65.0 60.0 55.0 50.0 45.0	65. 0 16 R 60. 0 53 R 55. 0 193 R 50. 0 1173 R 45. 0 1258 R	65.0 16 R 60.0 53 R 55.0 193 R 50.0 1173 R 45.0 1258 R 0.78	PSJ	65.0 16 R 60.0 53 R 55.0 193 R 50.0 1173 R 45.0 1258 R 0.78 0.00162 840	65.0 16 R 60.0 53 R 55.0 193 R 50.0 1173 R 45.0 1258 R 0.78 0.00162 840	65.0     16 R       60.0     53 R       55.0     193 R       50.0     1173 R       45.0     1258 R       0.00162     840       8.0*

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## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, W, Mo, V		YPE MELTI	OF NG FU	RNACE	<u> </u>		SIZE HEAT	OF (	Comm	ercial	
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	v	w	
PER CENT	0.19	0.77	0.020	0.018	0.20	12.79	0.77	1.03	0.24	1.15	
DEOXIDATION											
FORM-CAST OR WROUGHT	Z*1	x 3" 1	Wroug	ht Bar				_			
HEAT TREATMENT 1900, OQ;	1150 1	r, A.	c,								
MICROSTRUCTURE											
GRAIN SIZE					Н	ARDNE	SS				
SOURCE OF DATA General E	lectri	c Cor	npany								

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,OOOPS.I.	OFFSET(a) YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		116.0	146.0	17.5	47.5
(a) 0,02% Of	set yield streng	ih.			

(a) 0.02% Offset Vield Strength.

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

<sup>(2)</sup> EXTRAPOLATED VALUES INDICATED BY

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT.	LICINE EFFINS:	REDUC- TION IN AREA, %
3100	45.0	117 R					19.0	76.0
	30.0	65 R					81.0	21.0
	22.0_	246 R					18.0	79.0
_	15.0	52 R					29.0	88.0_

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## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, W, Mo, V	(422)	TYPE MELTI	OF NG FU	RNACI	_ AI	ıc	SIZE	OF	15 T	ons	
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	w	v	
PER CENT	0.23	0.87		$\Box$		13.1	6 0.70	1.01	1.20	0.25	1
DEOXIDATION											_
FORM-CAST OR WROUGHT	Wroug	ht 1"	b								
HEAT TREATMENT 1900 F. C	Q: 115	0 F, Z	Hr								
MICROSTRUCTURE											
GRAIN SIZE					Н	ARDN	ESS	33. 5 F	ξ.		
SOURCE OF DATA Cruc	ble Ste	el Cor	npany								

COPED AND DISTURE STRENGTHS

		CHEEK	L WALL KOL	TOKE SIT	ILINO I III S				
TEMP.	STRE	SS FOR R	UPTURE IN	TIMES .(2)	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
•f	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.		
850	92	82*	L	L					

ORIGINAL CREEP AND RUPTURE DATA

TEME	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
850	104.0	2 R					15.0	
850	95.0	51 R_					15.0	
850	90.0	227 R	<u></u>				17.0	
850	85.0	554 R		L	L		20.0	



## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr., W. Mo	, V (422)	TYPE MELTI	OF NG FU	RNACI	E ARC	;	SIZE		15 To	ns	
CHEMICAL COMPOSITION,	С	Mn	N <sub>2</sub>	S	Si	Cr	Ni	Mo	Al	w	v
PER CENT		0.84	0.03			13.05	0.68	1.09	0.008	1.01	0.22
DEOXIDATION											
FORM-CAST OR WROUGH	IT Wro	ught l	"Squa	re							
HEAT TREATMENT 1800	F, OQ and	1200	F, 21	lr_		Heat 1	No. W	6184			
MICROSTRUCTURE Ter	mpered Ma	rtens	ite and	15%	Ferr	te					
GRAIN SIZE					Н	ARDN	ESS 3	l R <sub>c</sub>			
SOURCE OF DATA Cr	ucible Ste	el Cor	npany								

CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1000	63.5		T					
1100	43							

ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	69.0	16 R					19.0	
1000	62.0	151 R					20.0	
1100	52.5	5 R				<u> </u>	23.0	
1100	40.0	356 R					22.0	<u></u>
$\vdash$	-							<del> </del>
		<del></del>	<del>├</del>	<del> </del>	<del> </del>		<u></u>	

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
(2) EXTRAPOLATED VALUES INDICATED BY

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cz, W, Mo, V	` ' ' '	MCC:	40 . 0	******			HEAT			
CHEMICAL COMPOSITION.	С	Mn	N <sub>2</sub>	\$	Si	Cr	Ni	Mo	w	V
PER CENT	0.23	0.79	0.04			13.1	0.69	1.05	0.97	0.26
DEOXIDATION										
FORM-CAST OR WROUGHT	Wrot	ight l'	Squar	re		He	at No.	400	51	
HEAT TREATMENT 1800 F.	ΟΩ; 1	200 F,	2 Hr							
MICROSTRUCTURE Temper	ed Mar	tensit	e and	18 <b>%</b> F	errite	•				
GRAIN SIZE					H.	ARDN	ESS	32	R <sub>c</sub>	
SOURCE OF DATA Cruci	ble Ste	al Co	mnany					_		

CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
•F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR	
1000	65							
1100	43							

ORIGINAL CREEP AND RUPTURE DATA

	GROWING CHEEF AND HOT TOKE DATA												
TEMP.	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT.	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING					
1000	69.0	12 R					21.0						
1000	62.0	534 R					19.0						
1100	52.5	5 R					22.0						
1100	40.0	252 R					19.0						

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## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 13 Cr, W, Mo, V	(422)	TYPE MELTII	OF IG FU	RNACE		ARC	SIZE		15 To	ns	
CHEMICAL COMPOSITION,	С	Mn	P	S	Si	Cr	Ní	Mo	w	v	N <sub>2</sub>
PER CENT	0,23	0.79				13.18	0.69	1.05	0.97	0.26	0.04
DEOXIDATION											
FORM-CAST OR WROUGHT	Wrou	ght l"	Squar	·e							
HEAT TREATMENT 1900 F.						He	at No.	4005	1		
MICROSTRUCTURE Tempe	red Ma	rtensi	te and	10% F	`erri	ite					
GRAIN SIZE					TH	ARDN	ESS	34.	Rc		
SOURCE OF DATA Cruci	ble Stee	el Con	pany								

CREEP AND RUPTURE STRENGTHS

TEMP.,	STRE	SS FOR R	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F	100 HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1000	70			1				
1100	52*							

ORIGINAL CREEP AND RUPTURE DATA

EMP,	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARONES AFTER TESTING
000	73.0	35 R					18.0	
1000	69.0	215 R					18.0	
1100	58.0	5 R					23.0	Ī_
100	52.5	75 R					21.0	
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		-					<del>                                     </del>	<b>-</b>
							<del> </del>	<del></del>

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

TYPE OF MATERIAL 13 Cr. W. Mo,	V (422)	TYPE MELTI	OF NG FU	RNACE	A	RC	SIZE	OF ,	5 Ton	6	
CHEMICAL COMPOSITION,	С	Min	P	S	Si	Cr	Ni	Mo	w	v	N2
PER CENT	0.23	0.77	П			13,18	0.69	1.05	0.97	0.26	0.04
DEOXIDATION											
FORM-CAST OR WROUGHT	_ Wrou	ght l"	Squar	e							
HEAT TREATMENT 1900	F, 0Q;	1200	F, 2 H	lr			Heat	No. 4	0050		
MICROSTRUCTURE Temp	ered Ma	rtensi	e and	1% F	rrite						
GRAIN SIZE					. Н	ARDN	SS	34 R	c		
SOURCE OF DATA Crue	ible Stee	l Con	pany								

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F	100 HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000I %/HR.	
1000	66				L			
1100	47	I			I		L	

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	69.0	29 R					24. 0	
1000	65. 0	213 R	L				19. 0	
1100	52.5	26 R					25.0	
1100	46.0	118 R					21.0	

(18)

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, W, Mo, V	(422)	YPE WELTI	OF NG FU	RNACE	A	RC	SIZE	OF	15 T	ons	
CHEMICAL COMPOSITION,	С	Mn	N <sub>2</sub>	S	Si	Cr	Nì	Mo	Al	v	w
PER CENT	0.21	0.82	0.03			13.12	0.70	1.01	0.012	0.30	1.03
DEOXIDATION											
FORM-CAST OR WROUGHT	Wroug	ht l"	Square	,					_		
HEAT TREATMENT 1800 F.	00: 120	00 F.	2 Hr			Hea	t No.	W 601	9		
MICROSTRUCTURE Tempe	red Ma	rtensi	te and	16% F	erri	te					
GRAIN SIZE					Н	ARDN	ESS	31 1	Rc		
SOURCE OF DATA Cruci	ble Stee	l Cor	npany								

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)					
*F	100 HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.		
1000	62			1	T				
1100	42						L		

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS 1000 P.S.I.	OURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	69.0	19 R			<u> </u>		20.0	
1000	62.0	95 R					24.0	
1100	52.5_	3 R_					23.0	
1100	40.0	242 R			I		20.0	

(19)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr. W. Mo, V	(422)	TYPE MELTI	OF NG FU	RNACE	A	RC	SIZE		15 To	ons	
CHEMICAL COMPOSITION,	C	Mn	NZ	S	Si	Cr	Ni	Mo	A1	W	V
PER CENT	0,21	0.82	0,03			13.1	2 0.70	1.01	0.012	1.03	0.30
DEOXIDATION											
FORM-CAST OR WROUGHT	Wroug	ht l"	Square								
HEAT TREATMENT 1900 F.	OQ; 12	00 F,	2 Hr				Heat N	o. W	6019		
MICROSTRUCTURE Temper	ed Mar	tensí	e and	7% Fe	rrite						
GRAIN SIZE					Н	ARDN	ESS	32. 5	Re		
SOURCE OF DATA Crucib	le Steel	Com	pany								

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	STRESS CREEP	FOR DESIGNATE, HOOD	NATED P.S.I.(2)		
*F	IOO HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.		0.0001 %/HR.
1000	65						
1100	43				T		

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	69.0	18 R					26.0	
1000	62.0	473 R					17.0	
1100	52.5	4 R					23.0	
1100	40.0	412 R	<u> </u>				23.0	

(20)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 13 Cr. W. Mo, V	(422)	TYPE MELTI	OF NG FU	RNACE	AF	lC	SIZE		15 T	ons	
CHEMICAL COMPOSITION.	C	Mn	Р	S	Si	Cr	Ni	Мо	w	v	Nz
PER CENT	0.23	0.81				13.16	0.82	1.03	1.09	0.26	0.04
DEOXIDATION											
FORM-CAST OR WROUGHT	Wrou	zht l"	Squar	e _							
HEAT TREATMENT 1900 F, C	)SI;QX	0 F, 2	Hr			I	leat N	o. 40	058		
MICROSTRUCTURE Temper	ed Ma	rtensit	e and	2% Fe	rrite						
GRAIN SIZE					Н	ARDN	ESS	33.	Rc		
SOURCE OF DATA Cruci	ble Ste	el Cor	npany								

CREEP AND RUPTURE STRENGTHS

TEMP.			UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F '	IOO HRS.	IOOO HRS.	10,000 HRS	100,000 HRS.	0.00000 I %/HR.	0.00001 %/HR	0.0001 %/HR	
1000	64							
1100	46.5							

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	69.0	11 R					23.0	
1000	62.0	334 R					26.0	
1100	52.5	14 R					21.0	
1100	46.0	121 R					19.0	

(21)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

MATERIAL 13 Cr, W, Mo, V	(422)	TYPE MELTII	OF NG FU	RNACE	AF	RC	SIZE		15 T	ons	
CHEMICAL COMPOSITION.	C	Ma	P	S	Si	Cr	Ni	Mo	w	v	N <sub>2</sub>
PER CENT	0.23	0.81				13.16	0.82	1.03	1.09	0.26	0.04
DEOXIDATION								-			
FORM-CAST OR WROUGHT	Wrough	ht 1" 5	Square	,							
HEAT TREATMENT 1800 F.							Heat	No. 4	0058		
MICROSTRUCTURE Tempere	d Mar	tensit	e and	10% F	errit	e					
GRAIN SIZE					Н	ARDNE	SS 3	2 R.			
SOURCE OF DATA Crucib	in Stee	1 Cor	nnang								

		~	7410 1101	1011E 311	LIVOINIS			
TEMP.	STRE	SS FOR RE	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F	IOO HRS.	HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1000	63		1	T				
1100	41							

### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	69.0	11 R					18.0	
1000	62.0	178 R					19.0	
1100	52.5	6 R					21.0	
1100	40.0	130 R					20.0	

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

(2) EXTRAPOLATED VALUES INDICATED BY \*

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

(22)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 13 Cr, W, Mo, V	(422)	YPE MELTI	OF NG FU	RNACE	A	RC	SIZE	OF	13 7	l'ons	
CHEMICAL COMPOSITION,	C	Mn	Р	S	Si	Cr	Ni	Mo	w	v	N <sub>2</sub>
PER CENT	0,23	0.77				12.7	6 0.76	0.98	1.11	0.26	0.04
DEOXIDATION											
FORM-CAST OR WROUGHT	Wroug	ht 1" 5	Square	·							
HEAT TREATMENT 1900 F.	OQ; 12	00 F,	2 Hr				He	at No	. K661	71	
MICROSTRUCTURE Temper	ed Mar	tensit	e								
GRAIN SIZE						ARDN	ESS 3	4. 5 R	·c		
SOURCE OF DATA Cruci	ble Ste	e) Cor	npany								

#### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN 0, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR	0.00001 %/HR	0.0001 %/HR.	
1000	66.5				L			
1100	48	48						

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.SJ.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TOTAL EXT. ICREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	69.0	45 R				17.0	Ĺ
1000	66.0	133 R				19.0	
1100	52. 5	17 R				20.0	
1100	46.0	205 R	T			18.0	

(23)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, W, Mo, V (422) MELTING FURNACE ARC SIZE OF 13 Tons												
CHEMICAL COMPOSITION,	С	Mn	P	S	Si	Cr	Ni	Mo	w	V	N <sub>2</sub>	
PER CENT	0.23	0.77				12.76	0,76	0,98	1.11	0.26	0.04	
DEOXIDATION												
FORM-CAST OR WROUGHT	Wrot	ight l'	Squa	re								
HEAT TREATMENT 1800 F,	OQ; 12	200 F,	2 Hr				Hea	t No.	K667			
MICROSTRUCTURE Tempere	ed Mar	tensit	e and	4% Fe	rrite							
GRAIN SIZE					TH	ARON	SS	33.5	Rc			
SOURCE OF DATA Crucil	bie Ste	el Con	ngany									

### CREEP AND RUPTURE STRENGTHS

1	TEMP.	STRE	SS FOR RI	UPTURE IN D, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
	*F *	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000000 i %/HR.	0.00001 %/HR	0.0001 %/HR.	
	1000	65.5				<u> </u>			
L	1100	47	L			l			

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. ICREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	69. 0	26 R					. 17.0	
1000	63.0	253 R					17,0	
1100	52.5	22 R					19.0	
1100	46.0	127 R					20.0	

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## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, W, Mo, V	(422)	TYPE MELTII	OF NG FU	RNACE		ARC	SIZE		15 Ton	15	•
CHEMICAL COMPOSITION,	С	Mn	P	S	Si	Cr	Ni	Mo	w	v	N <sub>2</sub>
PER CENT	0.23	0.77	_			13.1	0.69	1.05	0.97	0.26	0.04
DEOXIDATION									,_,,,		
FORM-CAST OR WROUGHT	Wroug	ht 1" 8	Square	e							
HEAT TREATMENT 1800 F, C						1	leat N	o. 40	050		
MICROSTRUCTURE Tempere	d Mart	ensite	and (	5% Fer	rite						
GRAIN SIZE					TH	IARDN	ESS 3	3 Rc			
SOURCE OF DATA Crucil	ble Ste	el Con	npany								

CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1000	64.5				†			
1100	44*						i ———	

#### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	69.0	6 R	Ī				21.0	
1000	64.0	144 R					24.0	
1100							27.0	
1100	_						20.0	

(25)

## ASTM-ASME JOINT COMMITTEE ON EFFECT DF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 13 Cr, W, h	40, V	TYPE OF MELTING FURNACE					SIZE OF Commercial				
CHEMICAL COMPOSITION	N C	Mn	Р	S	Si	Ċr	Ni	Mo	w	٧	
PER CENT		0.81	0,011	0.022	0.16	13.19	0.65	1.03	0.84	0.25	
DEOXIDATION						- '-					
FORM-CAST OR WROU	GHT Wrou	ght Ba	r 3-1/	2" Di	amete	r					
HEAT TREATMENT 190	0 F, A.C.;	1100 1	F, 4 H	r, A.	C.; 1	200 F	, 5 Hr	, F.C	;		
MICROSTRUCTURE											
GRAIN SIZE					H/	ARDN	ESS				
SOURCE OF DATA Ge	neral Elect	ric Co	mpany						_		

SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,OOO P.S.I.	OFFSET(a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		94.0	149.0	18.5	50.4
(a) 0.02% Of	fset yield streng	th.			

CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	PTURE IN 1	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
*F	IOO HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR
900				52P	I		
1000		51P_	38P	27P			
1100		28P	18P				
1200	20P						
P indic	ates strengt	h value ob	ained by us	of Larson	Miller par	meter T(2	5 + log t)

ORIGINAL CREEP AND RUPTURE DATA

TEMP, °F.	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	RUPTURE	REDUC- TION IN AREA, %
1100	50.0	19 R					16.0	71.0
1200	25.0	34 R					17.0	85.0
1200	15.0	415 R				L	19.0	89.0

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 13 Cr, W, Mo,		TYPE WELTH		RNACE	:		SIZE	OF	Com	nercia	1
CHEMICAL COMPOSITION,	С	Mn	Р	S	Si	Cr	Ni	Mo	w	v	
PER CENT	0.20	0.73	0.017	0.011	0.26	12.85	0.77	1,02	1,15	0.26	
DEOXIDATION											
FORM-CAST OR WROUGHT	Wrou	ght B	ar 4-9	/16" I	Diame	ter					
HEAT TREATMENT 1900 F,	OQ; 11	50 F,	12 Hz	, F.C							
MICROSTRUCTURE											
GRAIN SIZE					H,	ARDNE	SS				_
SOURCE OF DATA Gene	ral Elec	tric (	Omba	nv							_

SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET(a) YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		116.8	156.0	17.0	41.4
(a) 0.02% O	set vield streng	th.			

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

(2) EXTRAPOLATED VALUES INDICATED BY \*

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
*F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.0000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
1100			21P				
1200	24P				<u> </u>		
P indic	tes strengt	h value ob	tained by us	of Larson	Miller par	meter T(2	+ log t).

### ORIGINAL CREEP AND RUPTURE DATA

	CRIGHTAL CREEF ALD ROFTURE DATA												
TEMP,	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),		REDUC- TION IN AREA, %					
1200	25.0	82 R					24.0	83.0					
1250	18.0	46 R					20.0	89.0					
1250	13.0	107 R					26.0	91.0					
	[		1					: 1					

### (27)

## ASTM-ASME JOINT COMMITTEE ON EFFECT DF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, W, Mo, V	(422)	TYPE WELTH	OF NG FUI	RNACE	A	RC	SIZE	OF	15 To	ne	
CHEMICAL COMPOSITION,	С	Mn	N <sub>2</sub>	S	\$i	Cr	Ni	Mo	Al	w	v
PER CENT	0.21	0.84	0.03			13.05	0.68	1.09	0.008	1.01	0.22
DEOXIDATION											
FORM-CAST OR WROUGHT	Wroug	ht l"	Square								
HEAT TREATMENT 1900 F,	OQ; 12	00 F,	2 Hr			He	at No	W61	84		
MICROSTRUCTURE Tempere	d Mart	ensite	and 4	% Fer	rite						
GRAIN SIZE					H	ARDNI	ESS 3	2.5 R	ķ.		
SOURCE OF DATA Crucil	ble Ste	el Cor	npany								

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
*F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.00000 I %/HR.	0.00001 %/HR	0.0001 %/HR.
1100	43						
-	L	L		1			

### ORIGINAL CREEP AND RUPTURE DATA

TEMP, °F.	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	69.0	20 R				<u> </u>	24.0	
1100	52.5	3 R					26.0	
1100	40.0	405 R					19.0	
				L				

### (28)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr, W, Mo, V	(422)	YPE I	OF IG FU	RNĄCI	Ē		SIZE HEAT	OF	Comm	nercia	1
CHEMICAL COMPOSITION.	C	Mn	۵	S	Si	Cr	Ni ·	Мо	w	v	
PER CENT	0.23	0.81			0.16	13.19	0.65	1.03	0.84	0.25	
DEOXIDATION	-										_
FORM-CAST OR WROUGHT	3/4" F	lound									_
HEAT TREATMENT A.C. F	rom 19	00 F.	Temi	ered	24 Hr	at 12	00 F				_
MICROSTRUCTURE Marten	site										_
GRAIN SIZE					H.	ARDNE	SS	299-3	06		_
SOURCE OF DATA Wright	Air De	velopr	nent (	Center	- Un	ivers	ty of l	Michi	ya n		_

### CREEP AND RUPTURE STRENGTHS

			710 1101		ILIO IIIO		
TEMP.,	STRE	SS FOR RI	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
<b>°</b> F ′	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000l %/HR.
1100	44.0	34.0		<b>_</b>	ļ		
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<sup>(1) 0.2</sup> PER CENT OFFSET UNLESS OTHERWISE INDICATED.

### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1100	39.0	366 R		0.00628			20.9	
1100				0.00224	300		19.6	
1100		Γ .	0.40	0.00088	840	1.51		
1				Г				

29

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF

TYPE OF MATERIAL 13 Cr, W, Mo, V	(422)	YPE (	OF NG FU	RNAC	E		SIZE		Com	nercia	1
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Mo	v	w	_
PER CENT	0.23	0.81			0.16	13.19	0.65	1.03	0.25	0.84	_
DEOXIDATION											
FORM-CAST OR WROUGHT	3/4"	Round									
HEAT TREATMENT OQ Fro	m 1900	F, T	empe:	red 4	Hr at	1200	F				
MICROSTRUCTURE Marten	site										
GRAIN SIZE		_			[H	ARDNI	ESS	307			_
SOURCE OF DATA Wrigh	t Air D	evelo	oment	Cent	er - U	niver	sity o	f Mich	igan		

### SHORT TIME TENSILE PROPERTIES

	0.10111				
TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 PS.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
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### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
*F	IOO HRS.	HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1100	43.0	36.0		T				
						1		

### ORIGINAL CREEP AND RUPTURE DATA

EMP.	TRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNES AFTER TESTING
1100	30.0	1003	0.50	0.00049		0.99		
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(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

<sup>(2)</sup> EXTRAPOLATED VALUES INDICATED BY

MATERIAL 13 Cr, W, Mo, V		TYPE MELTII		RNACE			SIZE		Com	nercia	1
CHEMICAL COMPOSITION.	С	Mn	P	S	Sì	Ċ	Ni	Mo	W	v	
PER CENT	0.23	0.81	0.011	0.022	0.16	13.19	0.65	1,03	0.84	0.25	
DEOXIDATION											
FORM-CAST OR WROUGHT	Wrou	ght B	r 3-1	/2" D	iamet	er					
HEAT TREATMENT 1900 F,											
MICROSTRUCTURE											
GRAIN SIZE					H/	ARDN	SS	-	_		_
SOURCE OF DATA General	Elect	ric Co	mpan	<del>y</del>							

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOCO,OCO P.S.I.	OFFSET(a) YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		117.8	164.0	18.5	46.6
(a) 0.02% Of	set yield streng	th.			

### CREEP AND RUPTURE STRENGTHS

STRES	S FOR RU	PTURE IN T	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
IOO HRS.	HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR	0.00001 %/HR	0.0001 %/HR.	
	52P	40P	28P				
	29P	18P	9.6P				
20P	11P						
tes strengt	value obti	ined by use	of Larson	Miller par	meter T(2	i + log t).	
$\vdash$							
	IOO HRS.	100 HRS. HRS. 52P 29P 20P 11P	100   1000   10,000   HRS.   HRS.   10,000   HRS.   12,000   HRS.   12,000   HRS.   12,000   12,000   13,000	HRS. HRS. HRS. HRS.  52P 40P 28P 29P 18P 9.6P 20P 11P	100	100	

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED. (2) EXTRAPOLATED VALUES INDICATED BY

### ORIGINAL CREEP AND RUPTURE DATA

_	CHIGINAL CREEP AND HOP TORE DATA  END STRESS DURATION INTERCEPT, MINIMUM TRANSITION TOTAL EXT. TOTAL ELONG REDUCTION IN TIME, CREEP RATE, HRS.(5) % (4) CREEP RATE, HRS.(5) % (7) AREA, %											
TEMP, °F.	STRESS, 1000 P.SJ.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	REDUC- TION IN AREA, %				
1100	50.0	28 R					14.0	74.0				
1100	35.0	595 R					10.0	62.0				
1200	35.0	4 R					20.0	85.0				
1200	25. 0	43 R		i			16.0	85.0				
1200	20.0	133 R				i	16.0	79.0				
1200	15.0	257 R			<u> </u>		19.0	85.0				
1300	10.0	29 R					30.0	94.0				
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				L			L	L				

- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

### ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 13 Cr., W., Mo, V	(420)	TYPE (	OF IG FU	RNACE	_		SIZE	OF	Comr	nercia	1
CHEMICAL COMPOSITION,	C	Mn	Р	S	Si	Cr	Ni	Мо	w	V	
PER CENT	0.22	0.55			0.22	13.44	0.38	0.48	0.23	0.19	Г
DEOXIDATION									-		
FORM-CAST OR WROUGHT	7/8"	Wroug	ht Ba	rs							
HEAT TREATMENT 1800 F.	l Hr. C	XQ: 12	00 F.	1 Hr.	A.C.						_
MICROSTRUCTURE							-				
GRAIN SIZE					TH/	ARONE	SS	282 B	HN		
SOURCE OF DATA U.S.1	I. Engi	neerin	g Exp	erime	at Sta	tion					_

#### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT		118.9	139.0	17	54
1000		72.0	82.0	22	65
1100		52.6	68.4	23	72
			- "		

### CREEP AND RUPTURE STRENGTHS

TEMP.,	STRE	SS FOR RINDICATE	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
•F	IOO HRS.	IOOO HRS.	IO,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1000	51	42					22.0	
1100	27	18				3,8*	6.4	
					1	1		
			I -					
							-	

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- .(2) EXTRAPOLATED VALUES INDICATED BY \*

### ODICINIAL OPERS AND BURTURE DATA

EMP.	TRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1000	55.0	45 R					25.0	
1000	40.0	1904 R	0.60	0.00248	1050		29.0	
1100	35. 0	21 R					38.0	
1100	25.0	346 R					48.0	
1100	22.0	243 R					34.0	
1100	22.0	385 R					44.0	
1100	20.0	409 R	0.25	0.0094	100		45.0	
1000	20.0	1896	0.297	0.000058		0.408		-
1100	10.0	1270	0.174	0.00074	800	1.42		
1100	6.0	2064	0.205	0.000072		0.355		ļ
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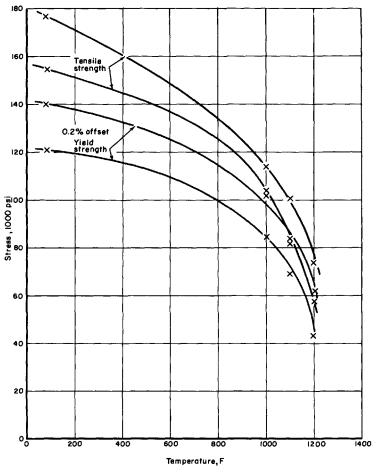
- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

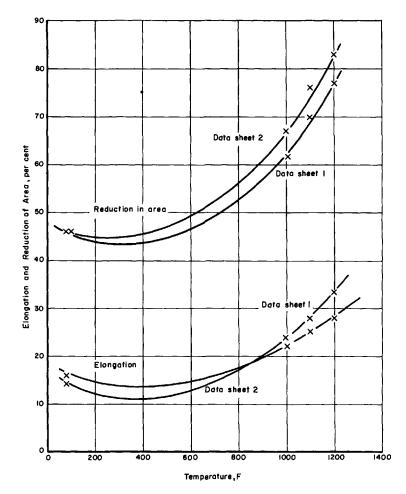
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12 Chromium, 2 Tungsten, 2 Molybdenum, Vanadium Steels (422M)



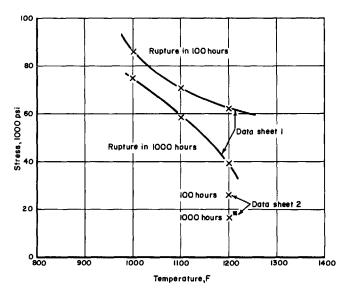
TENSILE AND YIELD STRENGTHS

12Cr, 2W, 2Mo, V STEEL



ELONGATION AND REDUCTION IN AREA

12 Cr, 2W, 2Mo, V STEEL



RUPTURE STRENGTHS

12Cr,2W,2Mo,V STEEL

TYPE OF 12 Cr, 2 W, 2 Mo MATERIAL (Modified 422)	, v	TYPE MELTI	OF NG FU	RNAC	Indu	ction	SIZE	OF	l Tor	7	
CHEMICAL COMPOSITION.	С	Mn	Р	s	Si	Cr	Ni	Mo	w	v	N
PER CENT	0.27	0.84			0.24	11.81	0.19	2.23	1.72	0.49	0.06
DEDXIDATION											
FORM-CAST OR WROUGHT	Wro	ught 5	/8" R	und							
HEAT TREATMENT 2000 F, C	Q + 12	00 F.	2 Hr			He	at No	7747	A3		
MICROSTRUCTURE Temper	ed Ma	rtensi	te and	10%	Ferrit	e					
GRAIN SIZE					H	ARDN	ESS	38 R <sub>c</sub>			
SOURCE OF DATA Crucil	ole Ste	el Cor	nDany								

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80		140.0	, 177. 0	16	46
1000		102.0	119.0	22_	62
1100		84.0	101.0	2.5	70
1200		62,0	74, 0	28	77
		02.0	74.0	28.	
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### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RE	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
•F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1000	L _86 _	75		L			50*	
1100	71	58			T			
1200	62	39	<del> </del> -	<del>                                     </del>			20.5*	
			<b> </b>	+				
			<u> </u>		<u> </u>			

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- (2) EXTRAPOLATED VALUES INDICATED BY \*

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 12 Cr, 2 W, 2 Mo MATERIAL (Modified 422)	, v	TYPE MELTII	OF NG FU	RNACI	É Indu	ction	SIZE		1 To	D	
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Мо	W	V	N <sub>2</sub>
PER CENT	0.27	0,84			0,24	11.81	0.19	2,23	1.72	0.49	0.06
DEOXIDATION											
FORM-CAST OR WROUGHT	Wron	ght 5/	8" Ro	ind							
HEAT TREATMENT 2000 F. C	XQ; 13	00 F,	2 Hr			He	at No	7747	'A 3		
MICROSTRUCTURE Tempe	red M	artens	ite ar	d 109	Ferr	ite					
GRAIN SIZE					H.	ARDN	ESS	33 Rc			
SOURCE OF DATA Crucit	le Ste	el Con	npany								

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,  *F	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80	T	121	155	14.5	46
1000		85	104	23.5	67
1100		69	8,3	28	76
1200	1	43	58	33,5	83

### CREEP AND RUPTURE STRENGTHS

TEMP.,	STRE	SS FOR RU	PTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
*F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0,000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1200	26	17*	<del></del>	F				
		<del>                                     </del>	<del></del>	<del> </del>	<del> </del>	<b></b>		
		L	L	L				

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
  (2) EXTRAPOLATED VALUES INDICATED BY

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. KOREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	AFTER TESTING
1000	90.0	12 R					18.0	
1000	85.0	177 R					18.0	
1000	80.0	338 R			L		14.0	
1000	75. 0	1332 R					19.0	
1000	70.0	2326 R	1.00	0.0013	1375		11.0 <sup>(a)</sup>	
1000	60.0	Discontinued 4846	0.77	0.00035	1360		2.64 <sup>(a)</sup>	
1050	80, 0	15 R					24.0	
1050	75.0	34 R			L		23.0	
1050	70.0	164 R					22.0	
1050	65.0	641 R	1				17.0	
1050	55. 0	1652 R	0.82	0,0014	725		11.0(a)	
1100	70, 0	16 R		<u> </u>			20.0	
1100	65.0	53 R	L	L	L		23.0	
1100	60.0	157 R			<u> </u>		19.0	
1100	60.0	160 R				L	21.0	
1100	55.0	278 R			<u> </u>		22.0	
1100	50.0	378 R	0,66	0.00517	175		9. 5(a)	
1100	40.0	974 R	0,35	0.00160	425	L	7.5 <sup>(a)</sup>	
1100	40.0	1341 R	0.38	0.00152	350	L	11.0 <sup>(a)</sup>	
1100	30.0	2734 R	0.34	0.00038	840		6.0 <sup>(a)</sup>	Fractured Shoulder
	(a) C:	eep speci	mens - 2.	gage leng	th. / Others	.4".)		
<u> </u>	├	-	<del> </del>		<del> </del>	<del> </del>	<del> </del>	<del>                                     </del>
<del> </del>	t. –							
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-	$\vdash$			<del> </del>		<del> </del>		†
	T	1	1	1	_			

- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

TEMP.	TRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1200	40.0	2.38	L				34.5	
1200	30.0	49 R					34.0	
1200	25,0	132 R					33.5	
1200	20.0	456 R					45.5	
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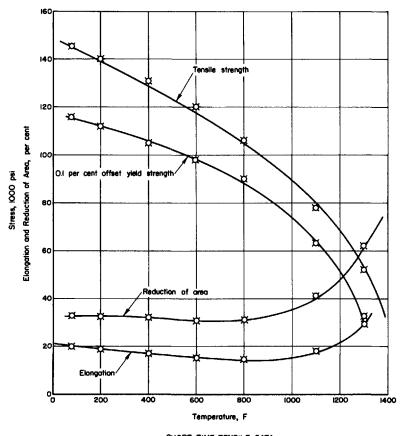
- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

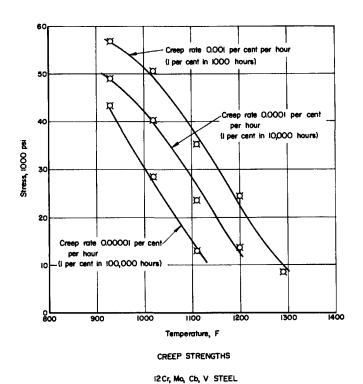
  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

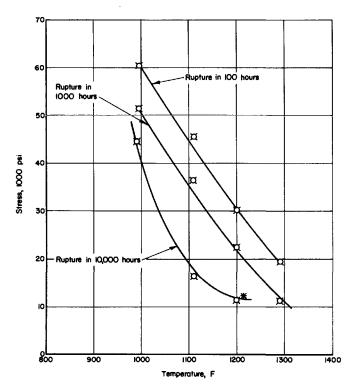
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5	ΓP2	//	<b>ყ</b> −	-ı	3/	. II	ш	1	y:	2	×

12 Chromium, Molybdenum, Columbium, Vanadium Steels (H-46)



SHORT-TIME TENSILE DATA





RUPTURE STRENGTHS

12 Cr, Mo, Cb, V STEEL

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

	Cr, Mo, Cb, 1 1-46)		TYPE OF MELTING FURNACE					SIZE HE AT			
CHEMICAL CO	MPOSITION,	С	Mn	Р	S	Si	Cr	Ni	Mo	Съ	v
PER CENT	Nominal	0.15	0.57			0.4	11.5		0.45	0,25	0.30
DEOXIDATION											
FORM-CAST	R WROUGHT	Wroug	ht Bar	and	Discs			-			
HEAT TREATM	ENT 2100 F,	A. C.,	Temp	red	200 F						
MICROSTRUCT											
GRAIN SIZE						Н	ARDNE	SS			
SOURCE OF (	ATA William	n Jesso	D and	Con .	Ltd .	Data	Sheets	- Henr	an eta l	1 Com	na nv

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET(a) YIELD (I) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
80	31, 6	116.5	145, 5	20.0	33.0
200	31.0	112.2	140.5	19.0	33.0
400	30,0	105.6	131.0	17.6	32,0
600	28.9	98.3	120.5	15.7	31.0
800	27.8	90.0	106.8	15.0	31.2
1100	24.0	63.6	78.3	18.7	40, 9
1300	20.9	33.0	52. 1	29.6	62.4
1470			16.5	50.0	85.0

# (a) 0,1% Offset yield strength. CREEP AND RUPTURE STRENGTHS (b)

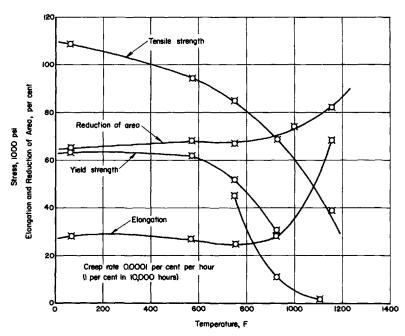
RESS FO	R R	UPTURE IN 1	STRESS	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
		10,000 HRS.	100,000 HRS.	0.00001 %/HR.	0,0001 %/HR	0.001 %/HR	
1		.1		43.7	49.2	57.1	
51.	5	44.8		28.7	40.4	50.5	
36.	5	16.5		13.0	23.6	35, 2	
22.	4	11.5*			13.9	24.6	
11.	4					8.7	
verage da	ta f	rom bars an	gas turl	oire discs.			
rerage da	ta f	rom bars an	gas tur	bire discs.	E		
_	51. 36. 22.	51.5 36.5 22.4	1000 HRS. 10,000 HRS. 51.5 44.8 36.5 16.5 22.4 11.5*	HRS. HRS. HRS.  51.5 44.8  36.5 16.5  22.4 11.5*	1000   10,000   100,000   0,00001   1885.	IOOO   IO,000   IO,000   W/HR.   0.0001   W/HR.   W/	

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

(2) EXTRAPOLATED VALUES INDICATED BY



14 Chromium Steels



SHORT-TIME TENSILE AND CREEP DATA

14 Cr STEEL



TYPE OF MATERIAL 14 Cr		TYPE WELTH		RNACE			SIZE HEAT	OF		
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Ç	Ni	Mo		
PER CENT	0.29	0.27	0,013	0.019	0,79	13.71	0.23			
DEOXIDATION										
FORM-CAST OR WROUGHT	Wroug	ht Bar	s 5/8	" Diar	neter					
HEAT TREATMENT Hardene	d and 7	empe	red							
MICROSTRUCTURE										
GRAIN SIZE					H.	ARDN	SS ;	225 BF	ΙN	
SOURCE OF DATA Compilat							Creep	Char	acteri	stics of
Metals	k Alloy	78, AS	ME-	ъTМ,	1938					

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,OOO PS.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
65		64.1	109.0	28	65.5
572	<u> </u>	61.9	94.5	27	_68
752		52.0	84. 9	25	67
932		25, 7	68.8	28	74
1160	1		39.0	68	82

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN D, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
•F .	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.0000001 %/HR.	FOR DESIGNATE, 1000 0.00001 %/HR	0.0001 %/HR
752					1		45, 0
932							11.2
1112		<del> </del> -	+	<del> </del>	<del>                                     </del>		1.85
			+	+	<del> </del>		

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- (2) EXTRAPOLATED VALUES INDICATED BY

TEMP STRESS QUESTION INTERCEPT (REP) RATE (R		CHISTIAL CALLY ALE NOTICE DATA											
152   53.75   500   0.70   0.6014   1.40   1.40   752   47.0   500   0.40   0.00019   0.50   0.50   752   42.6   500   0.14   0.00005   0.17   0.182	TEMP,	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	CREEP RATE.	TRANSITION TIME, HRS.(5)	ICREEP TEST).	(RUPTURE	AFTER				
752 47.0 500 0.40 0.00019 0.50 752 42.6 500 0.14 0.00005 0.17 752 42.6 1000 0.16 0.000022 0.182 932 26.88 852 8 0.0082 9.35 0.0034 0.70 932 15.68 500 0.40 0.00020 0.50 932 11.2 500 0.14 0.00011 0.20 932 11.2 500 0.08 0.00088 0.125 1112 6.72 1080 8 0.0090 51.0	752	67.2	180 R		0.0460			23.5					
752 42.6 500 0.14 0.0005 0.17  752 42.6 1000 0.16 0.00022 0.182  932 26.88 852 A 0.0082 35.0  932 17.92 500 0.53 0.0034 0.70  932 15.68 500 0.40 0.00020 0.50  932 11.2 500 0.14 0.00011 0.20  932 10.07 500 0.08 0.0008 0.125  1112 6.72 1080 R 0.0090 51.0  1112 4.48 500 0.22 0.0266 1.55	752	53.75	500	0.70	0.0014		1,40						
752         42.6         1000         0.16         0.00022         0.182           932         26.88         852 A         0.0082         35.0           932         17.92         500         0.53         0.00034         0.70           932         15.66         500         0.40         0.00020         0.50           932         11.2         500         0.14         0.00011         0.20           932         10.07         500         0.08         0.0008         0.125           1112         6.72         1080 R         0.0090         51.0           1112         4.48         500         0.22         0.0266         1.55	752	47.0	500	0.40	0.00019		0.50						
932     26.88     852 /t     0.0082     35.0       932     17.92     500     0.53     0.00034     0.70       932     15.68     500     0.40     0.0020     0.50       932     11.2     500     0.14     0.00011     0.20       932     10.07     500     0.08     0.0008     0.125       1112     6.72     1080 /t     0.0090     51.0       1112     4.48     500     0.22     0.0266     1.55	752	42.6	500	0.14	0.00005		0.17						
932         17. 92         500         0.53         0.00034         0.70           932         15.68         500         0.40         0.00020         0.50           932         11.2         500         0.14         0.00011         0.20           932         10.07         500         0.08         0.0008         0.125           1112         6.72         1080 R         0.0090         51.0           1112         4.48         500         0.22         0.00266         1.55	752	42.6	1000	0.16	0.000022		0.182						
932     15.68     500     0.40     0.00020     0.50       932     11.2     500     0.14     0.0011     0.20       932     10.07     500     0.08     0.0008     0.125       1112     6.72     1080 R     0.0090     51.0       1112     4.48     500     0.22     0.0266     1.55	932	26.88	852 R		0.0082			35.0					
932     11.2     500     0.14     0.00011     0.20       932     10.07     500     0.08     0.0008     0.125       1112     6.72     1080 R     0.0090     51.0       1112     4.48     500     0.22     0.0266     1.55	932	17. 92	500	0.53	0.00034		0.70						
932 10.07 500 0.08 0.0008 0.125 1112 6.72 1080 R 0.0090 51.0 1112 4.48 500 0.22 0.00266 1.55	932	15.68	500	0.40	0.00020		0.50						
1112 6.72 1080 R 0.0090 51.0 1112 4.48 500 0.22 0.00266 1.55	932	11.2	500	0, 14	0.00011		0.20						
1112 4.48 500 0.22 0.00266 1.55	932	10.07	500	0.08	0.00008		0.125						
	1112	6.72	1080 R		0.0090			51.0					
1112 2.24 500 0.12 0.00020 0.225	1112	4.48	500	0.22	0.00266		1.55						
	1112	2.24	500	0. 12	0.00020		0. 225						
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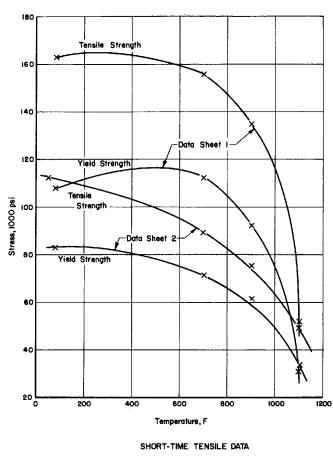
- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

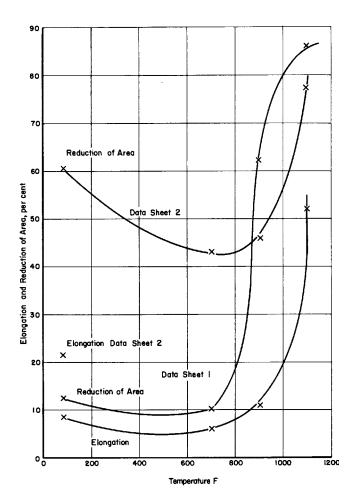
  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.



16 Chromium, 2 Nickel Steels

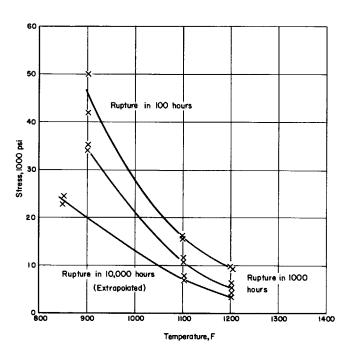




16 Cr, 2 Ni Steel

ELONGATION AND REDUCTION OF AREA

l6 Cr, 2 Ni Steel



RUPTURE STRENGTHS

16 Cr, 2 Ni Steel

### (2)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

1

TYPE OF 16 Cr, 2 Ni MATERIAL (Type 431)		TYPE MELTII		RNACE	Indu	ction	SIZE		30 1ь	
CHEMICAL COMPOSITION,	С	Mn	P	S	Si	Cr	Ni	Mo	N <sub>2</sub>	
PER CENT	0.16	0.58	0.021	0.022	0.53	16.13	1.82		0.063	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wrong	ht 5/8	- and	1-1/2	"-Squ	are F	orged	Bars		
HEAT TREATMENT 1800 F										
MICROSTRUCTURE Temper										
GRAIN SIZE Austenitic Gra	in Siz	e, AST	M No	. 8	H	ARDNI	ESS	36.7	R <sub>c</sub>	
SOURCE OF DATA U.S. Ste					Deve	lopme	nt La	borat	ory	

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT(a)		107.8	163, 1	8. 0	12, 7
700 <sup>(b)</sup>	L	112. 2	156.4	6.0	10.0
900(p)		92. 2	135, 0	11.0	62, 0
1100 <sup>(b)</sup>		31,0	51.4	52.5	86.0
	meter specimen				

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RE	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
*F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000i %/HR.	
900	50.2	34, 5	24,0*		1			
1100	16.5	10.8	7, 1*					
1200	9.6	6.0	3.7*	<del> </del>	<del> </del>	-		
-								
				<b>†</b>				

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- (2) EXTRAPOLATED VALUES INDICATED BY #

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 16 Cr, 2 Ni MATERIAL (Type 431)	T	YPE MELTII	OF NG FUI	RNACE	Elec	tric	SIZE		ommer.	cial
CHEMICAL COMPOSITION,	С	Mn	Р	S	Si	Cr	Ni	Mo	N <sub>2</sub>	
PER CENT	0.11	0.37	0.007	0.018	0,17	15.60	1.87		0,010	
DEOXIDATION	_									
FORM-CAST OR WROUGHT	Wrong	ht 3/4	ı"- Dia	meter	Forg	ed Ba	ar 6			
HEAT TREATMENT 1800 F.	1/2 Hr	, QQ;	1225	F, 41	Hr. O	Q				
MICROSTRUCTURE Temper	ed Ma	rtensi	te							
GRAIN SIZE Austenitic Grain	Size.	AST	M No.	6	H	ARDNI	ESS 2	22, 0 1	Rc.	
SOURCE OF DATA U.S. Ste	el Cor	p., R	esear	ch and	d Deve	lopm	ent La	borat	ory	

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT <sup>(a)</sup>		83.2	112,5	21.5	60,4
700(b)		71.5	89. 8		43, 5
900(b)		61,8	75. 2		46.0
1100(b)		33. 2	49, 1		77, 5
(a) 0.254" Di	ameter specime	ıs, l" gage ler	gth.		
(b) 0,505" Di	ameter specime	s. 2" gage len	gth.	1	

### CREEP AND RUPTURE STRENGTHS

TEMP.,	STRE	SS FOR R	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
*F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.0000I %/HR	0.0001 %/HR.
900	42,0	34.0	23.0*				
1100	16.2	10.5	6.8*				
1200	9.1	5, 7	3.5*				
			-				
					1		

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- (2) EXTRAPOLATED VALUES INDICATED BY

### ORIGINAL CREEP AND RUPTURE DATA

TEN °F	7 10	ESS, XXX S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
90	0 9	0.0	1.0		4, 54	0, 5		15, 8	Rc 30.5
_90	0 7	9.4	4.6		1,20	2, 2		21.6	R <sub>c</sub> 27. 9
90	0 7	0.0	13.8		0.546	6.0		24.4	R <sub>C</sub> 23. 9
90	0 5	9, 4	20, 0		0.358	7.1		34, 4	R <sub>C</sub> 22. 2
90	0 4	9.4	108.0		0, 112	51,0		44.6	R <sub>C</sub> 20.8
90	10 44	4. 4	211.7		0.0541	99.0		44.2	Rc 20, 1
90	0 34	4.4	1559. 0		0,0128			53,0	Rb 98.7
<u> </u>	-		2.1		4, 38	1.1		53. 8	Rb 99.8
	10 31	5. O	9, 5			3. 6		53.8	Rb 98.8
ш		7, 5			1.422	37.0		57.6	Rb 97. 6
110		5, O			0, 205	50. 0·	_	78.4	Rb 96, 4
111			1087. 0		0. 0200	50.0		84.0	Rb 90.6
-	1	<u> </u>			0.0200	<del></del>		84.0	KD 70, 0
120	0 2	5, 0	0.55		23.6	0. 25		50.4	Rb 98.2
120	10 2	0.0	2, 1		7.29			62.0	Rb 98.8
120	10 1	5. 0	12.6		1.26	4.0		78, 2	Rb 95.6
120	0 1	0. 0	88. 25		0.17	24.6		82. 2	Rb 94.5
120	0	7, 5	298,0		0.0521	63.0		79, 2	Rb 92.5
120	0 0	6, 8.	550, 0		0,0280	98.2		66, 0	Rb 90.8
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$\vdash$	+							<u> </u>	
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- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

TEMP, °F.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.		TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
900	60, 0	1.16		4.80	0, 5		29.6	Rb 97.2
900	50.0	11,3		0.595	4.8		31.4	Rb 95.7
900	40.0	176.7		0. 0685	31.2		37, 6	Rb 95.0
900	35, 0	882, 0		0.0189	603. 0		38. 2	Rb 96.3
900	30. 0	2042.0		0,00807	1742.0		48.0	Rb 94.9
1100	30.0	1.35		4.3	0.55		53.0	Rb 95.4
1100	20, 0	31.25		0.352	15.4		52.6	Rb 91.7
1100	15.0	150.75		0.0747	65.0		56.8	Rb 88, 8
1100	10.0	1223. 1		0. 0162			62, 0	Rb 84.1
1200	20.0	1,0		12, 8	0,4		48. 2	Rb 90.8
1200	15.0	6,7		1. 79	2.6		63.8	Rb 88, 8
1200	10.0	62.8		0, 252	10.7		91.6	Rb 85.0
1200	6. 85	425.0		0. 032	131.0		69.6	Rb 84, 9
1200	6.0	735.5		0. 0202	154.0		85, 0	Rb 82.8
_								
<u> </u>		L						

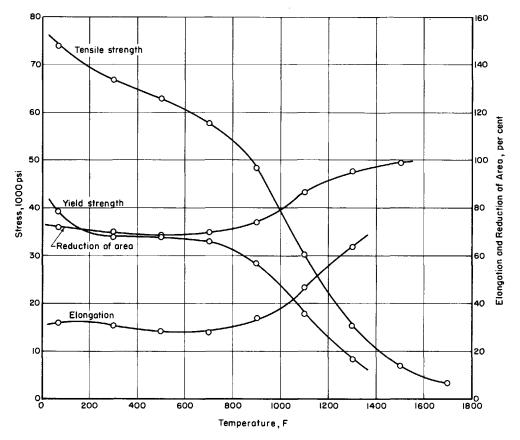
- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

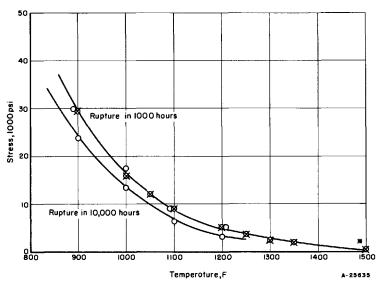


17 Chromium Steels



SHORT-TIME TENSILE DATA

17 Cr STEEL



RUPTURE STRENGTHS

I7 Cr STEEL



TYPE OF MATERIAL 17 Cr (Type 430)	TYPE OF MELTING FURNACE				SIZE OF HEAT					
CHEMICAL COMPOSITION,	C	Mn	Р	S	Si	Cr	Ni	Mo		
PER CENT	0.12 Max	1.00 Max	0.03 Max	0.03 Max	0.75 Max	14.0-	0.50 Max			_
DEOXIDATION										
FORM-CAST OR WROUGHT										_
HEAT TREATMENT Annealed	1400-	1500 F								
MICROSTRUCTURE										
GRAIN SIZE		_			H	ARDNE	SS			_
SOURCE OF DATA U.S. Stee	l Publi	cation	ı - "S	teels	For E	levate	d Ten	nperatur	e Service	,

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOG,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
70		39.5	74. 0	32	72
300		34.0	67.0	31	70
500		34.0	63.0	28	69
700		33.0	58.0	28	70
900		28,5	48.5	34	74
1100		18.0	30.5	47	87
1300		8.0	15.5	64	96
1500			7.0	83	99
1700			3, 5		

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	PTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
*F `	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
800								
900		30.0	24.0	1		12,0	15.4	
1000	L	17.5	13,5	1		6, 7	8,6	
1100		9.1	6.5	]		3.4	4.3	
1200		5.0	3.4			1,5	2,2	
1300						0.9	1.4	
1400				T	I	0, 6	0.9	
1500					L			
1600			L	L				

<sup>(1) 0.2</sup> PER CENT OFFSET UNLESS OTHERWISE INDICATED.

## (2)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 17 Cr (Type 430)	TYPE OF MELTING FURNACE						SIZE OF HEAT				
CHEMICAL COMPOSITION.	C	Mn	P	S	Si	Ċ	Ni	Mo	N <sub>2</sub>	Al	
PER CENT	0.09	0.41	0,010	0.014	0.237	16.87	0.15	0.02	0.078	0.004	
DEOXIDATION											
FORM-CAST OR WROUGHT	Wro	ıght									
HEAT TREATMENT 1425 F	A, C,										
MICROSTRUCTURE Ferrite Pearli			Carb	ide Pr	recipi	tate;	Partia	lly Spi	heroid	ized	
GRAIN SIZE 5-6					H/	ARDN	ESS	158 D	PH		
SOURCE OF DATA U.S. S	teel C	orp. 1	Reseat	rch La	borat	ory					

### SHORT TIME TENSILE PROPERTIES

	MODULUS	OFFSET		T	
TEMPERATURE,	OF ELASTICITY, LOOO,OOO P.S.I.	YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
	-				
				<del> </del>	_

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN , 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
•F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.0000I %/HR.	0.000I %/HR.	
900		29.5						
1000		16,0						
1050		12.0		I	1			
1100		9.0						
1200		5.0			I			
1250		3.8						
1300		2,8						
1350		2, 1			T			
1500		0.88*			1			

<sup>(1) 0.2</sup> PER CENT OFFSET UNLESS OTHERWISE INDICATED.

EMP.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. ICREEP TEST),	TOTAL ELONG. (RUPTURE TEST), %	HARDNESS AFTER TESTING
900	45.0	2,8 R		4. 56			41.0	
900	40.0	29. 3 R		0.51			53.0	
900	35.0	92.3 R		0.15			58.0	
900	30,0	944.5 R		0.023			54.0	
050	25,0	4.4 R		2, 92			57, 0	
1050	20.0	17.3 R		0.942			60.0	<u> </u>
050	15.0	400. R		0. 035			81.0	
1050	12,0	1283. R		0. 011			66.0	_
200	15,0	1.2 R		11.1			65.0	
1200	10,0	23.2 R		0.62			87.0	
1200	6.0	418. R		0, 03		L	90.0	
1200	4,0	2871. R		0.0038		_	103.0	
1350	8,0	0,66R					81.0	
1350	5,0	10.6 R		0.876			92.0	
1350	3, 0	150. R		0.062			84, 0	
1350	2, 0	1620. R				<u> </u>	88.0	
					L			
					L			
					<u> </u>			
				<u> </u>	L			
							l	
		l						
				1				
		l	l					
							L	
						1	1	

<sup>(2)</sup> EXTRAPOLATED VALUES INDICATED BY \*

<sup>(2)</sup> EXTRAPOLATED VALUES INDICATED BY \*

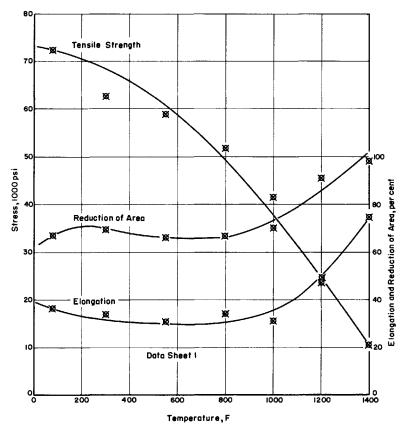
<sup>(3)</sup> DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

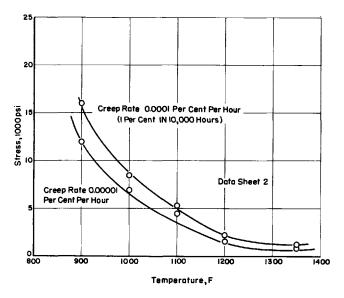


18 Chromium Steels



SHORT-TIME TENSILE DATA

IS Cr STEEL



CREEP STRENGTHS

18 Cr STEEL

### (1)

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 18 Cr		TYPE OF MELTING FURNACE			Ė	SIZE OF HEAT					
CHEMICAL COMPOSITION,	С	Mn	P	S	Si	Cr	Ni	Mo			
PER CENT	0.10	0.44			0,23	18.0	8				
DEOXIDATION											_
FORM-CAST OR WROUGHT	3/4"	Bars	- Wr	ought							
HEAT TREATMENT Norma	lized 1	800 F									
MICROSTRUCTURE	_										_
GRAIN SIZE					Н.	ARDN	ESS	150 BH	IN		_
SOURCE OF DATA Compilat						ture	Creep	Chara	cteris	tics of	_
Metals	& Alloy	s, AS	ME-A	STM,	1938						_

### SHORT TIME TENSILE PROPERTIES

	0.10111		E FIIO EII		
TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
70			72.4	36.5	67.1
300			62.8	34, 0	69, 8
550			59.0	31.0	66.9
800			52.0	34.5	68.5
1000			41.7	31.5	70.5
1200			23.9	49.5	91.1
1400			10.7	75. 5	98.8

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN 0, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
•F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
				-			
			<u>†                                     </u>		<u> </u>		

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- (2) EXTRAPOLATED VALUES INDICATED BY \*

### ORIGINAL CREEP AND RUPTURE DATA

TENESTRESS OF BATION INTERCEPT MINIMUM TRANSITION TOTAL EXT. TOTAL ELONG HARDNESS												
TEMP, °F.	STRESS 1000 PSJ	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING				
90Q	10.0	2 50	0.032	0.000248		0.094						
950	10.0	250	0.009	0.000136		0.042						
1000	3.01	1000	0.028	0.000038		0.066						
1000,	10.0	500	0.013	0.000442		0.234						
1050	10.0	250	0.210	0.00218		0.760						
1200	3.0	750	0.164	0.000195		0.310						
1300.	1.0	250	0.002	0. 000032		0.009						
1400	1.0	500	0.004	0.000150		0.079						
1500	1.0	500	0,033	0,000638		0.352						
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-		<b>├</b> ──		-	-	<b></b>	<del> </del>	<del> </del>				
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	<u> </u>			ļ		<u> </u>						
		L						<b> </b>				
	L					L						
			I				I	1				

- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

## ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 18 C+		TYPE OF MELTING FURNACE					SIZE OF HEAT			
CHEMICAL COMPOSITION,	С	Mn	P	S	Si	Cr	Ni	Mo		
PER CENT	0.10	0.31			0.86	17.30	T			
DEOXIDATION							•			
FORM-CAST OR WROUGHT	Wroug	ht								
HEAT TREATMENT Anneal	ed									
MICROSTRUCTURE										
GRAIN SIZE	HARDNESS									
SOURCE OF DATA "Propert	ies of C	arbon	and A	lloy	Seamb	ess St	eel Tu	bing for	High T	em-

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT

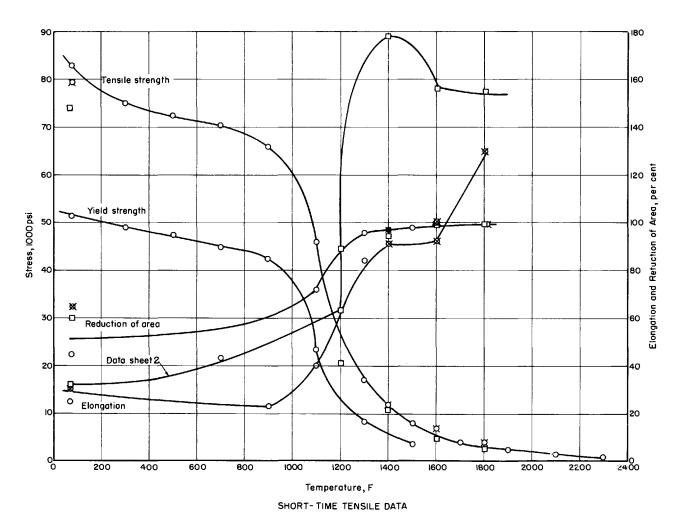
### CREEP AND RUPTURE STRENGTHS

TEMP,	STRE	SS FOR RI	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 % /HR.	0.00001 %/HR	0.0001 %/HR
900		L				12.0	16.0
1000						7.0	8.5
1100						4.5	5, 2
1200						1,6	2,1
1350		-			-	0.9	1.2
				<u> </u>			
	i	1	1	1	1	1	_

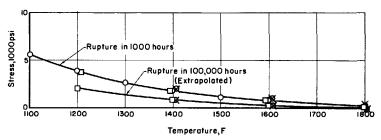
- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
  (2) EXTRAPOLATED VALUES INDICATED BY \*



27 Chromium Steels



27Cr STEEL



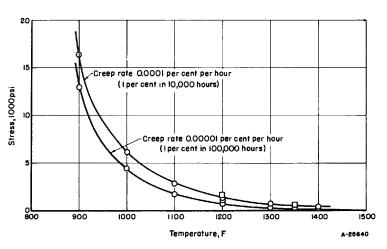
Rupture in 100 hours
(Extropolated)

Temperature, F

A-25841

RUPTURE STRENGTHS

27Cr STEEL



CREEP STRENGTHS

27Cr STEEL



# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 27 Cr		YPE WELTI		RNAC	Ė		SIZE HEAT	OF			
CHEMICAL COMPOSITION.	C	Mn	P	S	Si	Cr	Ni	Мо	N <sub>2</sub>		
ER CENT Nominal	0.20 Max	1.50 Max	0.03 Max	0.03 Max	0.75 Max	23.0- 30.0	0.50 Max		0.10-		
DEOXIDATION											
FORM-CAST OR WROUGHT											
HEAT TREATMENT Annea	led 14!	50-160	00 F a	nd Co	ol Rap	idly					
MICROSTRUCTURE						_					
GRAIN SIZE					H	ARDNE	255				
SOURCE OF DATA U.S. S	eel Pu	blicati	ion -	"Stee	for E	levate	d Ten	ipe ra	ture Se	rvice	"

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,OOO P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
70		51.5	83.0	25	45
300		49.0	75.0		
500		47.5	72.5		
700		45,0	70.5		
900		42.5	66.0	23	43
1100		23.5	46.0	40	72
1300		8.5	17.0	84	91
1500		3.5	8.0		98
1700			4.0		
1900	T		2.5		
2100			1.5	L	
2300	1		1.0	l	

### CREEP AND RUPTURE STRENGTHS

			710 110						
TEMP.	STRE	SS FOR RI	UPTURE IN	TIMES .(2)	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
•F	IOO HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0,0001 %/HR.		
900		Ţ			Ι	13.0	16.4		
1000		T	]			4,5	6, 1		
1100		5.6	3.0		Γ	1,8	2.8		
1200		4.0	2, 2			0, 8	1.4		
1300		2.7	1.6		T	0.3	0, 7		
1400		1.8	1.1		T	0, 1	0.3		
1500		1.2	0.8		T				
1600		0.8	0,5						

# (2)

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 27 Cr	TYPE OF MELTING FURNACE						SIZE			
CHEMICAL COMPOSITION.	C	Mn	P	S	Si	Cr	Ni	Mo	N <sub>2</sub>	
PER CENT	0.12	0.45	0.014	0.009	0.47	25.40	Γ	Ī	0.125	П
DEOXIDATION										
FORM-CAST OR WROUGHT	1" Ro	and Ba	irs							
HEAT TREATMENT										
MICROSTRUCTURE										
GRAIN SIZE 3-5 ASTM Fe	rrite Gr	ain S	ze		н	ARDNE	SS	160-1	70 BHN	
SOURCE OF DATA Unive	raity of	Mich	igan							

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT		47.0	74. 125	32.0	60.3
1200			20.9	63.0	89. Z
1400			10,55	179.0	94. 8
1600			4, 75	156.0	98. 5
1800			2,875	155.0	99, 2
				<del> </del>	

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR R	UPTURE IN	TIMES .(2)	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.0000I %/HR	0.000t %/HR.		
1200	5.9	4. 1	2.9*	2.0*					
1400	2.4	1.7	1,2*	0.85*					
1600	1.2	0.74	0.46*	0.29*	Γ.				
1800	0.67	0.39	0.23*	0.14*	F				
			1						
				L	L	L	L		

<sup>(1) 0.2</sup> PER CENT OFFSET UNLESS OTHERWISE INDICATED.

### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME HRS.(5)	TOTAL EXT. ICREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING
1200	12.5	_1.3R					54.0	
1200	10.0	_3, 3R_	I				57. 5	
1200	9.0	6. 3R					75.0	
1200	6.0	88. OR						
1200	4.8	361.0R			I		64.5	
1200	4.0	1173. OR					66.0	
1400	6.0	0.4R					130.0	
1400	4.5	_1.9R					108.0	L
1400	3.5	9.4R					147. 0	
1400	2.0	331. OR					67.0	<u> </u>
1400	1.65	1316. OR					55.0	
1600	3.0	0. 4R					146.0	
1600	2.5	1. 5R					138.0	
1600	2.0	7. OR					173.0	
1600	1.25	95, OR	1		]		87.0	
1600	0.9	308.5R					66.0	
1600	0.66	1867. OR					66.0	
1800	1.7	0. 8R	<u> </u>	<u> </u>	-	<del> </del>	161.0	
1800	1.45	1. 7R		<u> </u>	1 — —	<del></del>	215.0	
1800	1,2	6.7R		i	1		184.0	
1800	0.7	90. 5R			1	1	84.0	
1800	0.45	381. OR	i	<u> </u>			62.0	
1800	0.34	2026. OR					84.0	
					1			
				<b> </b>				L
		<del></del>		ļ	<del> </del>			ļ
		<u> </u>	L	L	L	L		L

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

<sup>(2)</sup> EXTRAPOLATED VALUES INDICATED BY \*

## (3)

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 27 Cr		TYPE MELTI		RNACE	Ele	ctric	SIZE	OF		
CHEMICAL COMPOSITION.	C	Мп	Р	S	Si	Cr	Ni	Mo	N <sub>2</sub>	$\perp$
PER CENT	0.17	0.56	0.009	0.015	0.31	25.70			0.13	
DEOXIDATION										
FORM-CAST OR WROUGHT	Hot-R	olled								
HEAT TREATMENT Norma	lized F	rom l	750 E							
MICROSTRUCTURE				-						
GRAIN SIZE 1_3 ASTM	Ferrite	Grain	Size		H	ARDN	SS	170 B	HN	
SOURCE OF DATA Univers										

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,OOO P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT	
RT		50,0	79.5	31.0	65, 3	
1400			11. 75	91.0	97.3	
1600			7. 1	92.0	99.4	
1800			4. 075	130.0	99. 7	
	L					

### CREEP AND RUPTURE STRENGTHS

TEMP.,	STRE	SS FOR R	UPTURE IN D, 1000 P.S.I	STRESS CREEP	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.0000I %/HR	0.0001 %/HR.		
1400	2, 75	1.90	1.35*	0.93*					
1600	1.30	0.86	0.58*	0.38*	L				
1800	0,70	0.40	0.23*	0,13*	-				
			F	<del>-</del>	-				
					ļ				
				<del> </del>					

- (1) O.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
  (2) EXTRAPOLATED VALUES INDICATED BY \*

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.J.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1400	7, 0	0. 2R					51.0	
1400	5.7	1.3R					55.5	
1400		3.4R					134.0	
1400	3,0	28.5R					14.0	
1400	2.5	193.OR					57.5	
1400	2.0	814. OR					67. 0	
1400	0.78	1173	0.08	0.00045		0.60		
1600	4. 0	0, 2R					117.0	
1600	3.0	1,0R					87, 0	
1600	2.2	2.5R				L	_69. D	
1600	1.2	218. OR					61.0	
1600	1.0	274. OR					28.0	
1600	0, 875	916. OR			<u> </u>		49.0	
1600	D. 729	2904. OR				<del> </del>	42.0	
1800	2.5	0, 1 R					64.0	
1800	1,6	2.8R		L			137.0	
1800	1.3	7,4R					105.0	
1800		260. OR	L				60.0	
1800	0, 65	119.0R	L				123.0	
1800	D. 5	408. OR	<b></b> _	<u> </u>	ļ		83.0	
1800	0.45	584. OR					61.0	
<u> </u>			<del></del>		-	<del> </del>	-	
-			-	<del> </del>	<del> </del>	<del> </del>	<del> </del>	-
			l			l "		

- (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

  (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

  (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 27 Cr		TYPE OF MELTING FURNACE					SIZE			
CHEMICAL COMPOSITION.	C	Mn	P	S	Si	Cr	Ni	Mo		T
PER CENT	0.20	0.80		Γ	0.36	26.94		П		
DEOXIDATION										
FORM-CAST OR WROUGHT	Wroug	ht								
HEAT TREATMENT Annea	led									
MICROSTRUCTURE										
GRAIN SIZE					H	ARON	ESS			
SOURCE OF DATA "Propert	ies of C	Carbon	and A	Alloy	Seaml	ess T	ubing	for Hig	h Temp	era-

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT

### CREEP AND RUPTURE STRENGTHS

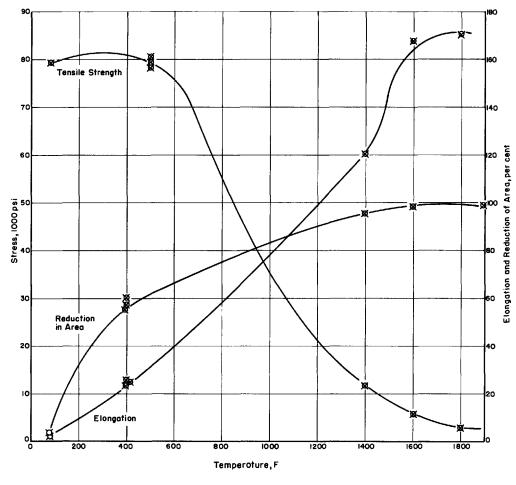
TEMP.	STRE	SS FOR RI	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
*F	IOO HRS.	IOOO HRS.	iO,000 HRS	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
1200						1.0	1,6
1350						0.18	0,4
			ļ		<del></del>		
		<del></del>	<del> </del>		<del></del>		
			<del> </del>	+			
			<del> </del>	<del>                                     </del>			
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					1		

- (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
- (2) EXTRAPOLATED VALUES INDICATED BY #



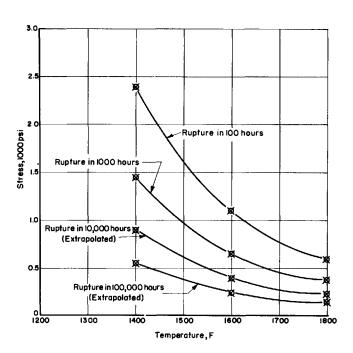
STP228-EB/Jul. 1958

27 Chromium, Molybdenum Steels





27 Cr, Mo STEEL



RUPTURE STRENGTHS

27 Cr, MO STEEL



# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

MATERIAL 27 Cz + Mo	MELTING FURNACE				Ele	Electric HEAT				
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	N <sub>2</sub>	
PER CENT	0.12	0.65	0.011	0.013	0.49	28,20		0.63	0.11	
DEOXIDATION										
FORM-CAST OR WROUGHT	Hot Ro	lled								
HEAT TREATMENT Normali	zed Fr	om 17	50 F							
MICROSTRUCTURE		•								
GRAIN SIZE 4-6 ASTM Fet	rite Gr	ain Si	ize		Тн	ARON	ESS	170	BHN	
SOURCE OF DATA Univer	sity of	Michi	ran							

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE, °F	MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (I) STRENGTH, IOOO P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT		55.0	69.5	3.0	3, 5
400			70.5	24.0	57.3
400			68.8	25. 0	56, 2
400			69.6	25.5	60.0
1400			12.0	121.0	95.9
1600			5, 9	168.0	98.7
1800			3, 1	171.0	99.7

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN D, 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
°F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0,000001 %/HR.	0.00001 %/HR	0.000 %/HR
1400	2,40	1.45	0.90*	0,56*	L		
1600	1.10	0.66	0.40*	0. 24*			
1800	0.60	0.38	0.24*	0.15*	<del> </del>		
				<b>1</b>			
		<b> </b>	ļ —	<del> </del>	<u> </u>		

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.
(2) EXTRAPOLATED VALUES INDICATED BY \*

### ORIGINAL CREEP AND RUPTURE DATA

	ORIGINAL GREEP AND ROPTURE DATA													
TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING						
1400	7. 0	0.6R					147.0	95.9						
1400	5, 6	1.8R					126.0	96. 0						
1400	4.5	5, 3R	L				187.0	97, 1						
1400	2.2	146.0R					130.0	97.8						
1400	1.5	884. OR					111.0	93, 9						
1400	0. 78	1114.	0.052	0.0011		1.3								
1600	3. 5	0.6R					138.0	99. 0						
1600	2.8	1.4R					146.0	99.1						
1600	2, 0	6,8R					185.0	98.7						
1600	1.0	125. OR					148.0	98.9						
1600	0.8	433, OR	l				124.0	97.1						
1600	0.6	1683. OR					96, 0	92.0						
1800	1, 8	0.5R					177.0	99. 7						
1800	1, 3	2.0R			L		152.0	99.5						
1800	0. 925	17. IR					159.0	99.4						
1800	0.60	93, OR					80.0	97.7						
1800	0.4	726. OR			ļ		73,0	83.3						
-														
		-	<u> </u>		l									
					-									
<u> </u>	ļ .	ļ	<del> </del> _	ļ		<del> </del>								
<u> </u>	<b></b>	<del> </del>	<del> </del>	<u> </u>			<u> </u>							
		l												
L	<u> </u>	L	L	L	l	<u></u>	i	L						

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.



### Miscellaneous 12 Chromium Steels

12 Chromium, Titanium Steels12 Chromium, 3 Molybdenum Steels12 Chromium, Aluminum Steels12 Chromium, 3 Molybdenum, 2 Nickel Steels12 Chromium, Molybdenum, Aluminum Steels12 Chromium, 2 Tungsten Steels

 $(\cdot)$ 

(2)

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr. Ti		TYPE OF MELTING FURNACE Induction					SIZE OF HEAT 30 1b				
CHEMICAL COMPOSITION.	С	Mn	Р	S	Si	Cr	Ni	Мо	Ti	В	
PER CENT	0.107	0.37			0.28	12.8			0.90	0.013	
DEOXIDATION 1 Lb Al Per Ton											
FORM-CAST OR WROUGHT	Forged	. The	n Roll	ed to	5/8" 1	Diame	ter		·		
HEAT TREATMENT A.C. F	rom 21	00 F,	Tem	pered	at 110	0 F					
MICROSTRUCTURE Ferrit	MICROSTRUCTURE Ferrite and TiC										
GRAIN SIZE	IZE HARONESS										
SOURCE OF DATA Titani	Titanium Alloy Mfg. Div. of National Lead Co.										

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU INDICATED	PTURE IN , 1000 P.S.I.	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
*F *	IOO HRS.	HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
1100	21.0	17.0*						

### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS, 1000 P.S.I.	OURATION, HOURS(3)	INTERCÉPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST), %	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
1100	20.0	158 R					13.0	
1100	25.0	6.R					21.0	
1100	25.0	8 R	i .	ļ		<u> </u>	19.0	
1100	30.0	7 R				I	28.0	
1100	35.0_	<1 R					17,0	
1100		<1 R					28.0	

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, Ti							SIZE OF HEAT 30 1b			
CHEMICAL COMPOSITION,	C	Mn	P	S	Si	Cr	Ni	Mo	Ti	В
PER CENT	0.119	0.37			0.28	12.8	4.01		0.72	0.016
DEOXIDATION	1 Lb	Al Pe	Ton							
FORM-CAST OR WROUGHT	Forge	i, The	n Rol	led to	5/8"	Diam	ter			
HEAT TREATMENT A.C. P	om 2	100 F.	Tem	pered	at 110	00 F				
MICROSTRUCTURE Ferrite	and T	iC			-					
GRAIN SIZE					H	ARDN	ESS			
SOURCE OF DATA Titaniur	Titanium Alloy Mfg. Div. of National Lead Co.									

### CREEP AND RUPTURE STRENGTHS

ł	TEMP.,	STRE	SS FOR RU INDICATED	PTURE IN , 1000 P.S.I	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
		IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.00000 I %/HR.	0.00001 %/HR	0.0001 %/HR.	
ı	1100	20.0	13.0*						

### ORIGINAL CREEP AND RUPTURE DATA

	CRIGHNAL CREEP AND ROPTURE DATA													
TEMP, °F.	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING						
1100	20.0	104 R					58.0							
1100	25.0	16 R					19. 0							
1100	25.0	25 R					35.0							
1100	30.0	ZZ R					38.0							
1100	30, 0	17 R					38.0							
1 100	35.0	5 R					27.0							
<u> </u>														
<u> </u>														
	L													

(1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED.

(2) EXTRAPOLATED VALUES INDICATED BY \*\*

(3) DURATION OF TEST (RUPTURE TEST INDICATED BY R).

(4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE.

(5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, A1 (Type 4		TYPE OF MELTING FURNACE					SIZE				
CHEMICAL COMPOSITION,	С	C Mn	Р	S	Sí	Cr	Ni	Mo	Al		
PER CENT	0.07	0.44	0.026	0.012	0.41	12.09	0.26		0.27		
DEOXIDATION											
FORM-CAST OR WROUGHT	1" S	quare	Bars								
HEAT TREATMENT Pack ar	neale	1 3-1/	2 Hra	t 1550	F, F	`. C. 1	.06 Hr	to 11	00 F,	Temp	ered
MICROSTRUCTURE 2 Hr a	t 1200	F, F	. C. to	300 E	r.						
GRAIN SIZE					H	ARDNI	ESS	150 I	BHN		
SOURCE OF DATA Univers	ity of	Michi	gan, 1	imke	n Roll	er Be	aring	Co.			

### SHORT TIME TENSILE PROPERTIES

MODULUS OF ELASTICITY, 1,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
		74.7	32.5	70.2
		75.6	34.5	70.9
		55. 9	26.0	69. 1
		47. 3	35.5	74.2
	,	40.5	43.5	75.8
	29.4	37.6	34.0	80.7
	OF ELASTICITY,	OF ELASTICITY, 1,000,000 PS.I. 1000 PS.I.	OF YIELD (1) TENSILE STRENGTH, 1000 PS.I. 10	OF ELASTICITY, 1000 P.S.I. TENSILE STRENGTH, 1000 P.S.I. 1000 P.S.

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRESS FOR RUPTURE IN TIMES STRESS FOR DESIGNATION CREEP RATE, 1000 P.S.I. (21 CREEP RATE, 1000 P.S.I.									
*F '	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.0000I %/HR	0.0001 %/HR.			
800					10.0	23.0	40.0*			
900						17.5	30.0*			
- 1000	21.5	16.5	13.0*		L	4.5*	8.4*			

### ORIGINAL CREEP AND RUPTURE DATA

			001.45	45 01/55				
TEMP,	STRESS, 1000 P.S.I.	DURATION HOURS(3	I, INTERCEPT,	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARONESS AFTER TESTING
800	35.0	1079	0.410	0.000030		0.460		
800	20.0	1053	0.089	0.000005		0.095		
800	10.0	1027	0.051	0.0000010		0.057		
900	25.0	1006	0.410	0.000027		0.440		
900	17.5	983	0.188	0.000010		0. 196		
900	10.0	1054	0.061	0.000003		0.064		
900	6.0	1081	0.030	0.000007		0.040		
					l	ļ	l	L
1000	30.0	6.6 F	1	Ţ			31.0	
1000	22.5	85 E	1				35.5	
1000	19.0	204 F	١.				38.0	
1000	16.0	1548 E	2			L	33.0	
1000	12.0	1050	0.135	0.000390	3 50	0.743		
1000	10.0	1006	0,100	0.000017	400	0.322		
1000	7.0	1103	0.061	0.000056		0.124		
1000	5. 5	1178	0.104	0.000100		0,228		
1000	5.0	1010	0.061	0.000004		0.065		

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF 12 Cr, Mo, A1 MATERIAL (Type 405 + Mo)		TYPE MELTII		RNACE	:		SIZE OF HEAT				
CHEMICAL COMPOSITION.	С	Mn	P	S	Si	Cr	Ni	Mo	Al		
PER CENT	0.06	0.46	0.009	0.009	0.29	11.72	0.24	0.49	0.27		
DEOXIDATION											
FORM-CAST OR WROUGHT	0, 890	Thic	k Roll	ed Pla	te						
HEAT TREATMENT Anneals						: Ten	преге	1 1 Hr	1200	F. and	
MICROSTRUCTURE Tempe	red Z	Hr 12	00 F a	nd F.	C. to	300 F				. 7	
GRAIN SIZE					H	ARDNE	SS	163 E	HN		
SOURCE OF DATA Unive	raity o	f Mich	igan	Timbe	n Pa	11a- B	AD Tine	* C •			

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, I,000,000 P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
RT		43.5	71.9	27.5	57.0
RT.			71.8	30,5	58.3
RT			71.3	32,5	61.1
800			50, 7	27.0	59. 5
900			46.8	29.0	60.5
1000			39.2	41.0	70.0
1000		25.7	37.3	33.5	71, 3

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RU	PTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)				
»F	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.	
800					T	19.0	28.0	
900			ĺ			12.5	19.5	
1000	23,0	17.0*	13.0*		<u> </u>	2.6*	7. 3	

### ORIGINAL CREEP AND RUPTURE DATA

TEMP,	STRESS, 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. ICREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARDNESS AFTER TESTING
800	30.0	1053	0.530	0.000150		0.702		
800	22.5	1100	0.159	0.000025	Ĺ	0.185		
800	15.0	1055	0.094	0.000003		0.099		
900	20.0	1175	0.390	0. 000120		0.537		
900	16.0	1100	0.130	0.000035		0.167		L
900	10.0	1155	0.056	0. 000003		0.059		
1000	31.0	1. 2 R					38. 0	
1000	24.0	· 67.0 R				L	42.0	
1000	21.0	233.0 R					39.0	
1000	18.0	649. 5 R		L			41.5	L
1000	10.0	1005	0.200	0.000176		0.372		
1000	7.0	1103	0.162	0.000116		0.309		L
1000	5.5	1053	0.062	0.000051		0.119	<u> </u>	L
1000	4.0	1081	0.038	0.000025		0.066		

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

(5)

TYPE OF MATERIAL 12 Cr, 3 Mo		TYPE MELTI	OF NG FU	RNACE	:		SIZE HEAT			
CHEMICAL COMPOSITION,	C	Mn	P	S	Si	Cr	Ni	Mo		
PER CENT	0,15	0.76	0.023	0.015	1.22	11,84	0.25	3.00		
DEOXIDATION							_			
FORM-CAST OR WROUGHT	Bars	tock								
HEAT TREATMENT Norma	lized at	1900	F. Te	mpere	d 6 H	rat l	150 F			
MICROSTRUCTURE Temp	ered M	arten	site P	lus De	lta Fe	errite				
GRAIN SIZE					H	ARDN	SS	321-35	2 BHN	
SOURCE OF DATA Unive	raity o	Mich	igan							

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	O, KOOO P.S.I.	TIMES .(2)	CREEP RATE, 1000 P.S.					
*F	100 HRS.	1000 HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0,0001 %/HR.			
1000	70.0	60.0	52.0*	T		9.1*	44.5*			
1100	44.5	28.0	16.0*		<u> </u>	3.2*	10.5			

### ORIGINAL CREEP AND RUPTURE DATA

TEMP.	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.		TOTAL EXT. ICREEP TEST),	TOTAL ELONG. (RUPTURE TEST),%	HARONESS AFTER TESTING
1000	78.0	28 R					20,5	
1000	72.0	36 R					27.0	
1000	65.0	377 R		L		L	23.5	
1000	62.0	658 R			L	L	22.0_	
1000	57, 0	2409 R				L	16.0	
1000	27.5	1237	0.33	0.000050		0.40		
1000	17.5	1250	0.17	0.000026		0.19		
1100	50.0	35 R					23, 0	
1100	40.0	247 R		L	L		18.5	
1100	35. 0	397 R		<u></u>			15.0	
1100	32.0	505 R					6,5	
1100	28.0	1257 R					16.0	
1100	15.0	1222	0.21	0.000195		0.44		
1100	7,0	1312	0.08	0.000046	<del></del>	0.15	<del> </del>	
1200	27.0	40 R					34. 0	
L	1	1	l		L	1		

# (1) 0.2 PER CENT OFFSET UNLESS OTHERWISE INDICATED. (2) EXTRAPOLATED VALUES INDICATED BY ® (3) DURATION OF TEST (RUPTURE TEST INDICATED BY R). (4) THE INTERCEPT IS THE PROJECTION BACK TO ZERO TIME FROM THE PORTION OF THE TEST SHOWING THE MINIMUM OR SECOND-STAGE CREEP RATE. (5) THE TRANSITION TIME IS THE BEGINNING OF THE THIRD STAGE, OR AN ACCELERATING CREEP RATE.

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

TYPE OF MATERIAL 12 Cr, 3 Mo,								SIZE OF HEAT				
CHEMICAL COMPOSITION,	С	Mn	P	S	Si	Cr	Ni	Mo				
PER CENT	0.16	1.43	0.018	0.025	1.05	11.85	1.52	2.85		Т		
DEOXIOATION												
FORM-CAST OR WROUGHT	Bar	stock										
HEAT TREATMENT Norm	alized !	From	1850 I	and	Temp	ered	2 Hra	£ 1200	F			
MICROSTRUCTURE Ten	pered 1	Marte	nsite I	Plus F	errite	Stri	igers					
GRAIN SIZE					H/	ARDN	ESS	321-33	BHN	_		
SOURCE OF DATA Unive	rsity of	Mich	igan									

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,OOO P.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.L	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT

### CREEP AND RUPTURE STRENGTHS

TEMP.	STRE	SS FOR RI	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 1000 P.S.I.(2)			
• •	IOO HRS.	IOOO HRS.	10,000 HRS.	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.000i %/HR.
1000	64.0	49.0	37.5*				21.0*
1100	32.0	21.0	13.5*	I		L "	5, 0*

### ORIGINAL CREEP AND RUPTURE DATA

	CANONIAL ORDER AND NOTIONE DATA									
TEMP, °F.	STRESS 1000 P.S.I.	DURATION, HOURS(3)	INTERCEPT, %(4)	MINIMUM CREEP RATE, %/HR.	TRANSITION TIME, HRS.(5)	TOTAL EXT. (CREEP TEST),	TOTAL ELONG (RUPTURE TEST),%	HARDNESS AFTER TESTING		
1000	68. 0	58 R					21.5			
1000	60.0	174 R					22.0			
1000	55. 0	66 R					28. 5			
1000	55. 0	72 R					32.0			
1000	50.0	864 R	l				21.0			
1000	17. 5	1407	0.25	0.000052	<b> </b>	0.33				
1100	42.0	24 R					30.0			
1100	35.0	40 R					39.0			
1100	27.0	276 R	Ĺ				33.0			
1100	23.0	697 R					31.5			
1100	20.0	1192 R					33.0			
1100	7.0	1407 R	0.26	0.000170	L	0.50				

# ASTM-ASME JOINT COMMITTEE ON EFFECT OF

TYPE OF	WPERA	YPE		FRO	EKII		SIZE			
MATERIAL 12 Cr, 2 W		MELTIN	iG FU	RNACE	Ė		HEAT			
CHEMICAL COMPOSITION.	С	Min	Ρ	5	Si	Cr	Ni	Mo	W	П.
ER CENT	0.07	0.42			0.25	11.75			1,83	
DEOXIDATION										
FORM-CAST OR WROUGHT	Wro	ught								
HEAT TREATMENT Ann	ealed									
MICROSTRUCTURE										
GRAIN SIZE						ARDNE			-	
SOURCE OF DATA "Proper	ies of (	Carbon	and.	Alloy	Seam	ess S	teel T	ubing	for High	Tem-
peratur	and H	igh Pr	essur	e Ser	vice",	Babo	ock L	Wile	ube	Compar

### SHORT TIME TENSILE PROPERTIES

TEMPERATURE,	MODULUS OF ELASTICITY, LOOO,OOOP.S.I.	OFFSET YIELD (1) STRENGTH, 1000 P.S.I.	TENSILE STRENGTH, 1000 P.S.I.	ELONGATION IN 2", PER CENT	REDUCTION IN AREA, PER CENT
			<del></del>		
	<del> </del>				

### CREEP AND RUPTURE STRENGTHS

TEMP., ◆F	STRE	SS FOR R	UPTURE IN	STRESS FOR DESIGNATED CREEP RATE, 4000 P.S.I.(2)			
	IOO HRS,	IOOO HRS.	10,000 HRS	100,000 HRS.	0.000001 %/HR.	0.00001 %/HR	0.0001 %/HR.
800						23.0	33.0
1000				T		7.2	10.0
1100				T		4, 2	6.0

7

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"Report on the Elevated-Temperature Properties of Stainless Steels"—ASTM STP No. 124

"Report on the Elevated-Temperature Properties of Chromium-Molybdenum Steels"—ASTM STP No. 151

"Report on the Elevated-Temperature Properties of Selected Super-Strength Alloys"—ASTM STP No. 160

"Report on the Elevated-Temperature Properties of Carbon Steels"—ASTM STP No. 180

"Report on Elevated-Temperature Properties of Coppers and Copper-Base Alloys"—ASTM STP No. 181

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