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HIGH-TEMPERATURE HIGH-STRENGTH NICKEL BASE ALLOYS

Nº 393



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NICKEL BASE ALLOYS

CONTENTS

		Page No.
Introduction		2
Cast Alloys		
Composition	Table 1	4
Physical Properties		
Density	Table 1	4
Melting Range	Table 1	4
Specific Heat	Table 2 and Fig. 22	6 and 48
Thermal Conductivity	Table 3 and Fig. 23	8 and 49
Mean Coefficient of Thermal Expansion	Table 4 and Fig. 24	9 and 49
Dynamic Modulus of Elasticity	Table 5 and Fig. 21	10 and 48
Mechanical Properties		
Yield Strength	Table 6 and Fig. 1	11 and 28
Ultimate Tensile Strength	Table 7 and Fig. 2	12 and 29
Tensile Elongation	Table 8 and Fig. 3	13 and 30
100 Hour 1.0 Per Cent Creep Strength	Fig. 4	31
100 Hour Rupture Strength	Table 9 and Fig. 5	14 and 32
1000 Hour Rupture Strength	Table 10 and Fig. 6	15 and 33
Wrought Alloys		
Composition	Table 11	16
Physical Properties		
Density	Table 11	16
Melting Range	Table 11	16
Specific Heat	Table 12 and Fig. 22	18 and 48
Thermal Conductivity	Table 13 and Fig. 23	19 and 49
Mean Coefficient of Thermal Expansion	Table 14 and Fig. 24	20 and 49
Dynamic Modulus of Elasticity	Table 15 and Fig. 21	21 and 48
Mechanical Properties		
Bar Materials—Yield Strength	Table 16 and Fig. 7	22 and 34
Bar Materials—Ultimate Tensile Strength	Table 17 and Fig. 8	23 and 35
Bar Materials—Tensile Elongation	Table 18 and Fig. 9	24 and 36
Bar Materials—100 Hour 0.2 Per Cent Creep Strength	Table 19 and Fig. 10	25 and 37
Bar Materials—1000 Hour 0.2 Per Cent Creep Strength	Fig. 11	38
Bar Materials—100 Hour Rupture Strength	Table 20 and Fig. 12	26 and 39
Bar Materials—1000 Hour Rupture Strength	Table 21 and Fig. 13	27 and 40
Bar Materials—10,000 Hour Rupture Strength	Fig. 14	41
Sheet Materials—Yield Strength	Fig. 15	42
Sheet Materials—Ultimate Tensile Strength	Fig. 16	43
Sheet Materials—Tensile Elongation	Fig. 17	44
Sheet Materials—100 Hour 0.2 Per Cent Creep Strength	Fig. 18	45
Sheet Materials—100 Hour Rupture Strength	Fig. 19	46
Sheet Materials—1000 Hour Rupture Strength	Fig. 20	47
Appendix		
Conversion Factors		50
Temperature Conversion Chart		51-52
Trademarks		53

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NICKEL BASE ALLOYS

Since the advent of the aircraft gas turbine, there has been a steadily increasing need for materials exhibiting higher strength at progressively higher temperatures. It is this industry, therefore, which provided the impetus to the high temperature alloy development which has resulted in a large number of useful alloys to meet a variety of needs.

This review will deal with nickel-base superalloys containing about 40 weight per cent or more of nickel, and will present condensed information on mechanical properties at room and elevated temperatures, as well as limited data on physical properties. Some of the important cobalt-base and iron-nickel alloys in this class are also included as a convenience of reference.

It should be pointed out that the properties shown on various tables and graphs represent "typical" properties as nearly as possible. The values selected have been obtained from manufacturer's bulletins and other publications, and to the extent possible, have been checked with the producers as presenting the most recent information. The product form selected was that considered to be the most frequently employed. Since the data are "typical," they are unsuitable for specification or design purposes and the alloy producers should be consulted directly for "guaranteed minimum properties."

Mention has been made of the impetus to alloy development provided by jet engine requirements. However, application of these high nickel superalloys is by no means confined to that application. The alloys treated herein are being used more and more in other areas where their outstanding high temperature strength characteristics make them useful. Such applications include not only the natural extension to the requirements of industrial, automotive and auxiliary gas turbines but to less related fields, including air frames and skins, rocket engines, missiles and various hot die applications.

The booklet has been divided into two sections representing cast and wrought alloys. The division is a natural one in view of the end use applications for each form and was necessitated by the large number of alloys added to the current revision.

The opportunity has been taken to include further alloys of European origin.

It is, of course, impossible to include every commercial and experimental alloy in a compilation of this type and an attempt was made to limit alloy selection to those alloys considered to be either of growing interest to industry or widely used at present.

Sincere appreciation is expressed to all companies and agencies who have reviewed the enclosed data and allowed publication of the information. A number of alloys shown in the compilation are covered by trademarks which are credited on the inside back cover page.

GENERAL DESCRIPTION OF HIGH NICKEL SUPERALLOYS

The alloys listed in this review are in the main "nickel-base," and most are of the Al-Ti age hardenable type. In these alloys, chromium is present to provide oxidation and sulfidation resistance along with some contribution to strength. Columbium, molybdenum, tungsten and

tantalum are often present, separately or in combination, to provide solid solution strengthening of the matrix. The major strengthening effect at high temperatures, however, is the result of the precipitation of the ordered fcc "gamma prime" phase, generally referred to as Ni₃(Al, Ti). In some of the alloys, cobalt is present to effect improvements in workability and enhance high temperature capability. In many of the alloys included in the compilation, boron and zirconium are purposeful addition elements imparting improvements in high temperature creep properties and/or increased malleability.

COMPOSITION OF ALLOYS

Tables 1 and 11 list the alloys included in this review showing composition, density, melting range, form and condition of the alloy for which data are presented.

PHYSICAL PROPERTIES

Data are presented in tabular form on dynamic modulus, specific heat, thermal conductivity and thermal expansivity up to 2000 F (1093 C) and the general trend in change of properties as a function of temperature and class of alloys is presented graphically in Figures 1 through 24, respectively. It is interesting to note that with few exceptions the nickel-base alloys have very similar expansivity, despite considerable variations in composition, and that many of the cobalt-base superalloys have matching expansivity.

MECHANICAL PROPERTIES

As noted previously, the properties of these alloys have been separated in graphs and tables into Cast and Wrought Alloy sections.

In the Wrought Alloy section, product forms include bar and sheet with bar being considered the normal product form to enable a comparison of heavier cross-section wrought alloys.

Many of the alloys traditionally regarded as wrought products have also been produced as castings. In some cases mechanical property data are available and both forms have been included in their respective sections.

METRICATION

All physical and mechanical property data have been presented in British and metric units using standard international nomenclature. In addition, tabulated and graphical data are given in both Fahrenheit and Celsius temperatures.

The stress units selected were the familiar psi (rather than lbf/in.²) and meganewtons per square meter, or MN/m². In converting the psi data to MN/m² for the tables, a four digit conversion was rounded to the nearest number five.

Conversion tables are provided in the Appendix.

TABLE 1 CAST ALLOYS

Ref. No.	Alloy Designation	NOMINAL COMPOSITION, WT %															
		Ni	Cr	Co	Mo	W	Ta	Cb	Al	Ti	Fe	Mn	Si	C	B	Zr	Other
Nickel Base																	
1	Alloy 713C	74	12.5	—	4.2	—	—	2.0	6.1	0.8	—	—	—	0.12	0.012	0.10	—
2	Alloy 713LC	75	12.0	—	4.5	—	—	2.0	5.9	0.6	—	—	—	0.05	0.010	0.10	—
3	B-1900	64	8.0	10.0	6.0	—	4.0	—	6.0	1.0	—	—	—	0.10	0.015	0.10	—
4	Cast Alloy 625	63	21.6	—	8.7	—	—	3.9	0.2	0.2	2.0	0.06	0.20	0.20	—	—	—
5	Cast Alloy 718	52.5	19.0	—	3.0	—	—	5.2	0.6	0.8	18.5	0.20	0.20	0.05	0.006	—	—
6	IN-100	60	10.0	15.0	3.0	—	—	—	5.5	4.7	—	—	—	0.18	0.014	0.06	1.0V
7	IN-162	73	10.0	—	4.0	2.0	2.0	1.0	6.5	1.0	—	—	—	0.12	0.020	0.10	—
8	IN-731	67	9.5	10.0	2.5	—	—	—	5.5	4.6	—	—	—	0.18	0.015	0.06	1.0V
9	IN-738	61	16.0	8.5	1.7	2.6	1.7	0.9	3.4	3.4	—	—	—	0.17	0.010	0.10	—
10	IN-792	61	12.4	9.0	1.9	3.8	3.9	—	3.1	4.5	—	—	—	0.12	0.020	0.10	—
11	M-21	74	5.7	—	2.0	11.0	—	1.5	6.0	—	—	—	—	0.13	0.020	0.12	—
12	M-22	71	5.7	—	2.0	11.0	3.0	—	6.3	—	—	—	—	0.13	—	0.60	—
13	MAR-M* 200	60	9.0	10.0	—	12.0	—	1.0	5.0	2.0	—	—	—	0.15	0.015	0.05	—
14	MAR-M* 200(DS)	60	9.0	10.0	—	12.0	—	1.0	5.0	2.0	—	—	—	0.13	0.015	0.05	—
15	MAR-M* 246	60	9.0	10.0	2.5	10.0	1.5	—	5.5	1.5	—	—	—	0.15	0.015	0.05	—
16	MAR-M* 247	60	8.2	10.0	0.6	10.0	3.0	—	5.5	1.0	—	—	—	0.16	0.020	0.09	1.5Hf
17	MAR-M* 421	61	15.8	9.5	2.0	3.8	—	2.0	4.3	1.8	—	—	—	0.15	0.015	0.05	—
18	MAR-M* 432	50	15.5	20.0	—	3.0	2.0	2.0	2.8	4.3	—	—	—	0.15	0.015	0.05	—
19	MC-102	64	20.0	—	6.0	2.5	0.6	6.0	—	—	—	0.30	0.25	0.04	—	—	—
20	NIMOCAST* alloy 75	73	20.0	—	—	—	—	—	0.2	0.4	5.0	0.4	0.4	0.10	—	—	—
21	NIMOCAST* alloy 80	71	20.0	—	—	—	—	—	1.3	2.4	5.0	0.4	0.4	0.07	—	—	—
22	NIMOCAST* alloy 90	53	20.0	17.5	—	—	—	—	1.3	2.4	5.0	0.4	0.4	0.09	—	—	—
23	NIMOCAST* alloy 242	57	20.5	10.0	10.5	—	—	—	0.2	0.3	1.0	0.3	0.3	0.34	—	—	—
24	NIMOCAST* alloy 263	55	20.0	20.0	5.8	—	—	—	0.5	2.2	0.5	0.5	—	0.06	0.008	0.04	—
25	NX188(DS)	74	—	—	18.0	—	—	—	8.0	—	—	—	—	0.04	—	—	—
26	RENÉ* 77	58	14.6	15.0	4.2	—	—	—	4.3	3.3	—	—	—	0.07	0.016	0.04	—
27	RENÉ* 80	60	14.0	9.5	4.0	4.0	—	—	3.0	5.0	—	—	—	0.17	0.015	0.03	—
28	TAZ-8A	68	6.0	—	4.0	4.0	8.0	2.5	6.0	—	—	—	—	0.12	0.004	1.00	—
29	TAZ-8B(DS)	64	6.0	5.0	4.0	4.0	8.0	1.5	6.0	—	—	—	—	0.12	0.004	1.00	—
30	TRW-NASA VI A	61	6.1	7.5	2.0	5.8	9.0	0.5	5.4	1.0	—	—	—	0.13	0.020	0.13	0.5Re,0.4Hf
31	UDIMET* 500	52	18.0	19.0	4.2	—	—	—	3.0	3.0	—	—	—	0.07	0.007	0.05	—
32	UDIMET* 710	55	18.0	15.0	3.0	1.5	—	—	2.5	5.0	—	—	—	0.07	0.020	0.05	—
33	WAZ-20(DS)	72	—	—	—	20.0	—	—	6.5	—	—	—	—	0.20	—	1.50	—
Cobalt Base																	
34	FSX-414	10.0	29.0	52	—	7.5	—	—	—	—	1.0	—	—	0.25	0.010	—	—
35	HAYNES* alloy 1002	16.0	22.0	Bal	—	7.0	3.75	—	0.3	0.2	1.5	0.70	0.40	0.60	—	0.30	0.05La
36	MAR-M* 302	—	21.5	58	—	10.0	9.0	—	—	—	—	—	—	0.85	0.005	0.20	—
37	MAR-M* 509	10.0	23.5	55	—	7.0	3.5	—	—	0.2	—	—	—	0.60	—	0.50	—
38	WI-52	—	21.0	63	—	11.0	—	2.0	—	—	2.0	0.25	0.25	0.45	—	—	—
39	X-40	10.5	25.5	54	—	7.5	—	—	—	—	—	0.75	0.75	0.50	—	—	—

* See inside back cover for trademarks.

Notes: (DS) Directionally Solidified.

FC = Furnace Cooled.

AC = Air Cooled.

HeQ = Helium Quenched.

²Liquidus temperature.

DENSITY		MELTING RANGE		Condition of Test Material	Alloy Designation	Ref. No.
lb/cu in.	g/cu cm	F	C			
0.286	7.91	2300-2350	1260-1290	As Cast	Alloy 713C	1
0.289	8.00	2350-2410	1290-1320	As Cast	Alloy 713LC	2
0.297	8.22	2325-2375	1275-1300	As Cast	B-1900	3
0.305	8.44	—	—	As Cast	Cast Alloy 625	4
0.297	8.22	2200-2450	1205-1345	2000F 1095C/1/AC+1750F 955C/1/AC+1325F 720C/8/FC at 100°F 38°C/hr to 1130F 620C/8/AC	Cast Alloy 718	5
0.280	7.75	2305-2435	1265-1335	As Cast	IN-100	6
0.292	8.08	2330-2380	1275-1305	As Cast	IN-162	7
0.280	7.75	—	—	As Cast	IN-731	8
0.293	8.11	2250-2400	1230-1315	2050F 1120C/2/AC+1550F 840C/24/AC	IN-738	9
0.298	8.25	—	—	2050F 1120C/2/AC+1550F 840C/24/AC	IN-792	10
0.308	8.53	—	—	As Cast	M-21	11
0.312	8.63	—	—	As Cast	M-22	12
0.308	8.53	2400-2500	1315-1370	1600F 870C/50/AC	MAR-M* 200	13
0.308	8.53	—	—	2250F 1230C/19/AC+1600F 870C/32/AC	MAR-M* 200(DS)	14
0.305	8.44	2400-2450	1315-1345	1550F 840C/50/AC	MAR-M* 246	15
0.308	8.53	—	—	1600F 870C/16/AC	MAR-M* 247	16
0.292	8.08	—	—	2100F 1150C/2/AC+1950F 1065C/4/AC+1400F 760C/16/AC	MAR-M* 421	17
0.295	8.16	—	—	1975F 1090C/4/AC+1400F 760C/16/AC	MAR-M* 432	18
0.319	8.84	—	—	2010F 1100C/4/AC+1380F 750C/16/AC	MC-102	19
0.305	8.44	2570 ^a	1410 ^a	1975F 1080C/4/AC	NIMOCAS ^t alloy 75	20
0.295	8.17	2390-2515	1310-1380	1975F 1080C/4/AC + 1290F 700C/16/AC	NIMOCAS ^t alloy 80	21
0.296	8.18	2390-2515	1310-1380	1975F 1080C/4/AC+1290F 700C/16/AC	NIMOCAS ^t alloy 90	22
0.303	8.40	2235-2445	1225-1340	As Cast	NIMOCAS ^t alloy 242	23
0.302	8.36	2370-2470	1300-1355	As Cast	NIMOCAS ^t alloy 263	24
0.296	8.19	—	—	2300F 1260C/2/AC	NX188(DS)	25
0.286	7.91	—	—	2125F 1165C/4/AC+1975F 1080C/4/AC+1700F 925C/24/AC+1400F 760C/16/AC	RENÉ* 77	26
0.295	8.16	—	—	2225F 1220C/2/HeQ+2000F 1095C/4/HeQ+1925F 1050C/4/FC +1550F 845C/16/AC	RENÉ* 80	27
0.312	8.63	—	—	As Cast	TAZ-8A	28
0.314	8.68	—	—	As Cast	TAZ-8B(DS)	29
0.317	8.77	2435-2490	1335-1365	As Cast	TRW-NASA VI A	30
0.290	8.02	2375-2540	1300-1395	2100F/1150C/4/AC+1975F 1080C/4/	UDIMET* 500	31
0.292	8.08	—	—	2100F 1150C/2/AC+1950F 1065C/4/AC+1400F 760C/7/AC	IDIMET* 710	32
0.326	9.02	—	—	As Cast	WAZ-20(DS)	33
0.3	8.3	—	—	2100F 1150C/4/FC to 1700F 925C/10/FC to 1000F 540C/AC	FSX-414	34
0.317	8.75	2380-2590	1305-1420	As Cast	HAYNES* alloy 1002	35
0.333	9.21	2400-2500	1315-1370	As Cast	MAR-M* 302	36
0.320	8.85	—	—	As Cast	MAR-M* 509	37
0.321	8.88	2425-2475	1330-1355	As Cast	WI-52	38
0.311	8.60	—	—	As Cast	X-40	39

TABLE 2 CAST ALLOYS

Ref. No.	Alloy Designation	SPECIFIC HEAT, Btu/lb/°F J/kg-K											
		70F	21C	200F	93C	400F	204C	600F	316C	800F	427C	1000F	538C
Nickel Base													
1	Alloy 713C	0.10	420	0.11	460	0.12	500	0.125	525	0.13	545	0.135	565
2	Alloy 713LC	0.105	440	0.11	460	0.12	500	0.125	525	0.13	545	0.135	565
3	B-1900												
4	Cast Alloy 625												
5	Cast Alloy 718												
6	IN-100											0.115	480
7	IN-162												
8	IN-731												
9	IN-738	0.10	420	0.11	460	0.12	500	0.125	525	0.13	545	0.135	565
10	IN-792												
11	M-21												
12	M-22												
13	MAR-M* 200	0.095	400	0.095	400	0.095	395	0.10	420	0.105	440	0.10	420
14	MAR-M* 200(DS)												
15	MAR-M* 246												
16	MAR-M* 247												
17	MAR-M* 421												
18	MAR-M* 432												
19	MC-102												
20	NIMOCAST* alloy 75												
21	NIMOCAST* alloy 80												
22	NIMOCAST* alloy 90												
23	NIMOCAST* alloy 242												
24	NIMOCAST* alloy 263												
25	NX188(DS)												
26	RENE* 77												
27	RENE* 80												
28	TAZ-8A												
29	TAZ-8B(DS)												
30	TRW-NASA VI A												
31	UDIMET* 500												
32	UDIMET* 710												
33	WAZ-20(DS)												
Cobalt Base													
34	FSX-414												
35	HAYNES* alloy 1002	0.10	420	0.105	440	0.112	470	0.117	490	0.122	510	0.126	530
36	MAR-M* 302												
37	MAR-M* 509												
38	WI-52	0.10	420	0.12	500								
39	X-40												

* See inside back cover for trademarks.
(DS) Directionally Solidified

SPECIFIC HEAT, Btu/lb/°F J/kg-K										Alloy Designation	Ref. No.
1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C		
0.14	585	0.15	625	0.16	670	0.165	690	0.17	710	Alloy 713C	1
0.14	585	0.15	625	0.16	670	0.165	690	0.17	710	Alloy 713LC	2
										B-1900	3
										Cast Alloy 625	4
										Cast Alloy 718	5
0.12	500	0.125	525	0.13	545	0.14	585	0.145	605	IN-100	6
										IN-162	7
										IN-731	8
0.14	585	0.15	625	0.16	670	0.17	710	0.17	710	IN-738	9
										IN-792	10
0.11	460	0.115	480	0.12	500	0.125	525	0.135	565	M-21	11
										M-22	12
										MAR-M* 200	13
										MAR-M* 200(DS)	14
										MAR-M* 246	15
										MAR-M* 247	16
										MAR-M* 421	17
										MAR-M* 432	18
										MC-102	19
										NIMOCAS* alloy 75	20
										NIMOCAS* alloy 80	21
										NIMOCAS* alloy 90	22
										NIMOCAS* alloy 242	23
										NIMOCAS* alloy 263	24
										NX188(DS)	25
										RENÉ* 77	26
										RENÉ* 80	27
										TAZ-8A	28
										TAZ-8B(DS)	29
										TRW-NASA VI A	30
										UDIMET* 500	31
										UDIMET* 710	32
										WAZ-20(DS)	33
0.132	555	0.138	580	0.146	615	0.151	635	0.154	645	FSX-414	34
										HAYNES* alloy 1002	35
										MAR-M* 302	36
										MAR-M* 509	37
										WI-52	38
										X-40	39

TABLE 3 CAST ALLOYS

Ref. No. Alloy Designation	THERMAL CONDUCTIVITY, Btu/ft ² /in./hr/°F																		W/m-K					
	70F	21C	200F	93C	400F	204C	600F	318C	800F	427C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C		
Nickel Base																								
1	Alloy 713C		76	10.9	85	12.2	96	13.8	107	15.4	118	17.0	129	18.6	142	20.4	155	22.3	169	24.3	183	26.4		
2	Alloy 713LC		74	10.7	84	12.1	95	13.7	106	15.3	116	16.7	127	18.3	139	20.0	151	21.7	164	23.1	176	25.3		
3	B-1900		(71)	(10.2)	81	11.7	91	13.1	102	14.7	113	16.3	126	18.1	139	20.0	152	21.9	160	23.0				
4	Cast Alloy 625																							
5	Cast Alloy 718																							
6	IN-100										120	17.3	131	18.9	151	21.7	175	25.2	200	28.8				
7	IN-162																							
8	IN-731																							
9	IN-738				82	11.8	95	13.7	108	15.6	123	17.7	137	19.7	149	21.5	162	23.3	176	25.3	189	27.2		
10	IN-792																							
11	M-21																							
12	M-22																							
13	MAR-M* 200		88	12.7	90	13.0	94	13.5	96	13.8	105	15.1	110	15.2	120	17.3	132	14.0	150	21.6	173	24.9	206	29.7
14	MAR-M* 200(DS)																							
15	MAR-M* 246									117	16.8	131	18.9	146	21.0	160	23.0	175	25.2	189	27.2	208	30.0	
16	MAR-M* 247																							
17	MAR-M* 421								121	17.4	137	19.1	154	20.0	170	24.5	187	26.9	207	29.8	229	32.0		
18	MAR-M* 432																							
19	MC-102																							
20	NIMOCAS ^t alloy 75																							
21	NIMOCAS ^t alloy 80																							
22	NIMOCAS ^t alloy 90																							
23	NIMOCAS ^t alloy 242																							
24	NIMOCAS ^t alloy 263																							
25	NX188 (DS)																							
26	RENÉ* 77																							
27	RENÉ* 80																							
28	TAZ-8A				76	10.9	85	12.2	96	13.8	107	15.4	121	17.4	135	19.4	150	21.0	(166)	(23.1)	(182)	(26.2)		
29	TAZ-8B (DS)																							
30	TRW-NASA VI A																							
31	UDIMET* 500																							
32	UDIMET* 710		(77)	(11.4)	84	12.1	94	13.5	104	15.0	115	16.6	126	18.1	136	19.6	147	21.2	158	22.8	168	21.2		
33	WAZ-20 (DS)																							
Cobalt Base																								
34	FSX-414																							
35	HAYNES* alloy 1002		76	11.0	86	12.4	102	14.8	119	17.2	134	19.4	151	21.8	167	24.2	182	26.3	200	28.9	207	30.0	222	32.1
36	MAR-M* 302		130	18.7	133	19.2	140	20.2	146	21.0	151	21.7	154	22.2	155	22.3	157	22.6	161	23.2	168	24.2		
37	MAR-M* 509									175	25.2	194	27.9	216	31.1	238	34.3	261	37.6	286	41.2	310	44.6	
38	WI-52		172	24.8	174	25.1	175	25.2	179	25.8	183	26.4	190	27.4	195	28.1	205	29.5	219	31.5	237	34.1	280	40.3
39	X-40		(82)	(11.8)	94	13.5	109	15.1	124	17.9	137	19.1	150	21.6	(158)	(22.8)								

*See inside back cover for trademarks.
 (DS) Directionally Solidified
 (Extrapolated values are shown in parentheses)

TABLE 4 CAST ALLOYS

Ref. No. Alloy Designation	MEAN COEFFICIENT OF THERMAL EXPANSION, (70F to Temp) x 10 ⁻⁶ /°F (20C to Temp) x 10 ⁻⁶ /°C																			
	200F	93C	400F	204C	600F	316C	800F	427C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C
Nickel Base																				
1 Alloy 713C	5.9	10.6	6.6	11.9	7.0	12.6	7.3	13.1	7.5	13.5	7.8	14.0	8.2	14.8	8.6	15.5	9.1	16.4	9.5	17.1
2 Alloy 713LC	5.6	10.1	7.0	12.6	7.6	13.7	8.3	14.9	8.75	15.8	8.9	16.0	9.0	16.2	9.3	16.7	9.8	17.0	10.5	18.9
3 B-1900	6.5	11.7	6.75	12.2	7.0	12.6	7.2	13.0	7.4	13.3	7.6	13.7	7.9	14.2	8.3	14.9	8.8	15.8	9.0	16.2
4 Cast Alloy 625																				
5 Cast Alloy 718																				
6 IN-100	7.2	13.0	7.2	13.0	7.3	13.1	7.5	13.5	7.7	13.9	8.0	14.4	8.3	14.4	8.8	15.5	9.3	16.8	10.1	18.1
7 IN-162	6.75	12.2	7.15	12.9	7.45	13.4	7.65	13.8	7.85	14.1	8.05	14.5	8.35	15.0	8.6	15.5	9.2	16.6	—	—
8 IN-731																				
9 IN-738	6.45	11.6	6.75	12.2	7.15	12.9	7.55	13.6	7.75	14.0	8.05	14.5	8.25	14.8	8.55	15.4	8.85	15.9	—	—
10 IN-792																				
11 M-21																				
12 M-22	6.9	12.4	6.9	12.4	7.1	12.8	7.3	13.1	7.4	13.3	7.6	13.7	7.9	14.2	8.2	14.8	8.6	15.5	—	—
13 MAR-M* 200	—	—	6.6	11.9	6.9	12.4	7.1	12.8	7.3	13.1	7.5	13.5	7.8	14.0	8.2	14.8	8.8	15.8	9.8	17.0
14 MAR-M* 200(DS)																				
15 MAR-M* 246	6.3	11.3	7.2	13.0	7.4	13.3	7.85	14.1	8.2	14.8	8.3	14.9	8.65	15.6	8.9	16.0	9.3	16.8	10.35	18.6
16 MAR-M* 247																				
17 MAR-M* 421							8.1	14.6	8.3	14.9	8.4	15.1	8.7	15.7	9.1	16.4	9.9	17.8	11.0	19.8
18 MAR-M* 432					7.85	14.1	8.0	14.4	8.3	14.9	8.6	15.5	8.7	15.7	9.2	16.6	9.7	17.5	10.7	19.3
19 MC-102	7.1	12.8	7.3	13.1	7.4	13.3	8.0	14.4	8.3	14.9	8.7	15.6	9.0	16.2	9.3	16.7	9.6	17.3	—	—
20 NIMOCAST* alloy 75	7.1	12.8	7.6	13.6	7.8	14.1	8.1	14.6	8.3	14.9	8.7	15.6	9.0	16.2	9.3	16.7	9.6	17.3	—	—
21 NIMOCAST* alloy 80	7.1	12.8	7.5	13.5	7.8	14.1	8.1	14.6	8.3	14.9	8.7	15.6	9.2	16.5	9.7	17.5	10.4	18.7	—	—
22 NIMOCAST* alloy 90	6.8	12.3	7.4	13.3	7.8	14.1	8.1	14.6	8.2	14.8	8.6	15.4	9.0	16.2	9.5	17.1	10.1	18.1	—	—
23 NIMOCAST* alloy 242	7.0	12.5	7.3	13.1	7.6	13.7	7.8	14.1	8.0	14.4	8.3	14.9	8.7	15.6	9.1	16.3	9.5	17.0	—	—
24 NIMOCAST* alloy 263	6.1	11.0	6.7	12.1	7.1	12.7	7.3	13.1	7.6	13.6	8.0	14.3	8.4	15.1	9.1	16.3	10.0	17.9	—	—
25 NX188(DS)																				
26 RENÉ* 77																				
27 RENÉ* 80																				
28 TAZ-8A																				
29 TAZ-8B(DS)																				
30 TRW-NASA VI A																				
31 UDIMET* 500	7.4	13.3																		
32 UDIMET* 710																				
33 WAZ-20(DS)																				
Cobalt Base																				
34 FSX-414																				
35 HAYNES* alloy 1002	6.8	12.2	7.1	12.8	7.5	13.5	7.8	14.0	8.0	14.4	8.3	14.9	8.7	15.7	8.9	16.0	9.2	16.6	—	—
36 MAR-M* 302	—	—	6.9	12.4	7.2	13.0	7.4	13.3	7.6	13.7	7.8	14	8.0	14.4	8.3	14.9	8.7	15.7	9.2	16.6
37 MAR-M* 509	—	—	—	—	8.1	14.6	8.5	15.3	8.85	15.9	9.0	16.2	9.3	16.7	9.55	17.2	9.8	17.6	10.1	18.2
38 WI-52	—	—	7.5	13.5	7.6	13.7	7.8	14.0	8.0	14.4	8.3	14.9	8.6	15.5	9.0	16.2	9.2	16.6	9.7	17.5
39 X-40	—	—	—	—	7.8	14.0	8.1	14.6	8.4	15.1	8.75	15.8	9.2	16.6	—	—	—	—	—	—

* See inside back cover for trademarks.
(DS) Directionally Solidified

TABLE 5 CAST ALLOYS

Ref. No.	Alloy Designation	DYNAMIC MODULUS OF ELASTICITY, X10 ⁶ psi GN/m ²																					
		70F	21C	200F	93C	400F	204C	600F	316C	800F	427C	1000F	538C	1200F	648C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C
Nickel Base																							
1	Alloy 713C	29.9	206	29.5	203	28.7	199	28.0	193	27.2	188	26.2	179	25.1	172	24.2	167	22.6	156	21.4	148	—	—
2	Alloy 713 LC	28.6	197	28.1	194	27.3	186	26.6	183	25.8	178	25.0	172	24.0	165	23.1	159	21.6	149	19.7	136	—	—
3	B-1900	31.0	214	30.5	210	29.7	205	28.9	199	28.0	193	27.0	183	26.0	179	24.9	172	23.7	163	22.4	154	—	—
4	Cast Alloy 625																						
5	Cast Alloy 718																						
6	IN-100	31.2	215	30.7	212	29.9	206	28.9	199	28.1	193	27.1	187	26.1	179	25.1	173	23.5	162	21.9	151	—	—
7	IN-162	28.5	197	28.0	193	27.3	188	26.6	183	25.8	179	24.9	172	24.0	165	23.0	159	21.8	150	20.4	141	—	—
8	IN-731																						
9	IN-738	29.2	201	28.3	195	27.6	190	26.8	185	26.0	179	25.4	175	24.3	168	23.2	160	21.9	151	20.3	140	—	—
10	IN-792																						
11	M-21																						
12	M-22																						
13	MAR-M* 200	31.6	218	31.2	215	30.9	213	28.6	197	27.7	191	26.7	184	25.6	176	24.5	169	23.3	161	21.0	145	—	—
14	MAR-M* 200(DS)	19.0	131	18.5	128	17.8	123	17.2	119	16.7	115	16.0	110	15.2	105	14.3	99	13.1	90	11.5	79	—	—
15	MAR-M* 246	29.8	205	29.3	202	28.5	197	27.6	190	26.8	185	25.8	178	24.8	171	23.7	164	22.6	156	21.7	150	21.1	145
16	MAR-M* 247																						
17	MAR-M* 421	29.4	203	—	—	28.1	194	—	—	26.5	183	—	—	24.4	168	23.2	160	21.9	151	—	—	20.4	141
18	MAR-M* 432																						
19	MC-102																						
20	NIMOCAST* alloy 75																						
21	NIMOCAST* alloy 80																						
22	NIMOCAST* alloy 90																						
23	NIMOCAST* alloy 242																						
24	NIMOCAST* alloy 263																						
25	NX188 (DS)																						
26	RENÉ* 77																						
27	RENÉ* 80	30.2	208																				
28	TAZ-8A																						
29	TAZ-8B (DS)																						
30	TRW-NASA VI A																						
31	UDIMET* 500																						
32	UDIMET* 710																						
33	WAZ-20 (DS)																						
Cobalt Base																							
34	FSX-414																						
35	HAYNES* alloy 1002	30.4	210	29.8	205	28.7	198	27.5	190	26.3	181	25.1	173	22.8	157	22.4	154	21.0	145	—	—	—	—
36	MAR-M* 302																						
37	MAR-M* 509	32.7	225	—	—	30.9	213	—	—	28.4	196	—	—	25.8	178	23.9	165	22.5	155	19.8	137	—	—
38	WI-52																						
39	X-40																						

*See inside back cover for trademarks.
(DS) Directionally Solidified

TABLE 6 CAST ALLOYS

Ref. No.	Alloy Designation	YIELD STRENGTH (0.2% Offset), 1000 psi MN/m ²													
		70F	21C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C
Nickel Base															
1	Alloy 713C	107	740	102	705	104	715	108	745	77	495	44	305		
2	Alloy 713LC	109	750	110	760	114	785	110	760	84	580	41	285		
3	B-1900	120	825	126	870	134	925	117	808	101	695	60	415	28	195
4	Cast Alloy 625	51	350	34	235	34	235	34	235	29	200	15	105		
5	Cast Alloy 718	133	915												
6	IN-100	123	850	128	885	129	890	125	860	101	695	54	370	(35)	(240)
7	IN-162	118	815	115	795	124	855	123	850	103	710	65	450		
8	IN-731	105	725			108	745	112	770	88	585	52	360	25	170
9	IN-738	138	950			118	815	115	795	80	550	50	345		
10	IN-792	154	1060					144	995	96	660				
11	M-21														
12	M-22	99	685	106	730	111	765	112	770	98	675	52	360		
13	MAR-M* 200	122	840	123	880	124	855	122	840	110	760	68	470		
14	MAR-M* 200(DS)	125	860	127	875	129	890	134	925	113	780	90	620		
15	MAR-M* 246	125	860	125	860	125	860	125	860	100	690	55	380		
16	MAR-M* 247	118	815	120	825	120	825	120	825	100	690	55	380		
17	MAR-M* 421	135	930	118	815	119	820	125	860	94	650	39	270		
18	MAR-M* 432	155	1070	132	910	132	910	132	910	88	605	41	285		
19	MC-102	88	605	78	540	76	525	77	530	35	250	19	130		
20	NIMOCAST* alloy 75	26	179	—	—	—	—	—	—	—	—	—	—	—	—
21	NIMOCAST* alloy 80	75	520	—	—	—	—	—	—	—	—	—	—	—	—
22	NIMOCAST* alloy 90	75	520	61	420	60	410	57	390	16	110	—	—	—	—
23	NIMOCAST* alloy 242	44	300	—	—	—	—	—	—	—	—	—	—	—	—
24	NIMOCAST* alloy 263	74	510	—	—	—	—	—	—	—	—	—	—	—	—
25	NX188(DS)	139	960			152	1050	166	1145	172	1185	85	585	50	345
26	RENÉ* 77														
27	RENÉ* 80														
28	TAZ-8A														
29	TAZ-8B(DS)														
30	TRW-NASA VI A	136	940			137	945	137	945	112	770	75	520	45	310
31	UDIMET* 500	118	815	105	725	102	705	102	705	87	600				
32	UDIMET* 710	130	895			121	835	119	820	91	630	43	295	25	170
33	WAZ-20(DS)														
Cobalt Base															
34	FSX-414														
35	HAYNES* alloy 1002	68	470	50	345	47	325	45	310	37	255	24	165	14	95
36	MAR-M* 302	100	690	73	505	65	450	56	385	45	310	31	215	22	150
37	MAR-M* 509	83	570	58	400	54	370	53	365	42	290	26	180		
38	WI-52	85	585	64	440	58	400	50	345	40	275	28	195	15	105
39	X-40	76	525	40	275	38	260								

*See inside back cover for trademarks
 (DS) Directionally Solidified
 (Extrapolated values are shown in parentheses)

TABLE 7 CAST ALLOYS

Ref. No.	Alloy Designation	ULTIMATE TENSILE STRENGTH, 1000 psi MN/m ²													
		70F	21C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093F
Nickel Base															
1	Alloy 713C	123	850	125	860	126	870	136	940	105	725	68	470		
2	Alloy 713LC	130	895	130	895	157	1085	138	950	109	750	68	470		
3	B-1900	141	970	146	1005	147	1015	138	950	115	793	80	550	38	270
4	Cast Alloy 625	103	710	74	510	71	490	62	430	40	275	20	140		
5	Cast Alloy 718	158	1090												
6	IN-100	147	1018	158	1090	161	1110	155	1070	128	885	82	565	(55)	(380)
7	IN-162	146	1005	148	1020	158	1090	146	1005	120	825	85	585		
8	IN-731	121	835			130	895	133	915	108	750	76	525	40	275
9	IN-738	159	1095			151	1085	140	965	112	770	66	455		
10	IN-792	170	1170					144	1130	122	840				
11	M-21														
12	M-22	106	730	113	780	121	835	132	910	129	885	79	545		
13	MAR-M* 200	135	930	137	945	138	950	135	930	122	840	80	550	47	325
14	MAR-M* 200(DS)	145	1000	147	1015	148	1020	152	1080	133	915	95	655		
15	MAR-M* 246	140	965	145	1000	150	1035	150	1035	125	860	80	550	50	345
16	MAR-M* 247	140	965	150	1035	152	1050	150	1035	120	825	80	550		
17	MAR-M* 421	157	1085	147	995	140	965	138	950	109	750	55	380		
18	MAR-M* 432	180	1240	160	1105	158	1090	156	1075	106	730	54	370		
19	MC-102	98	675	95	655	93	640	88	605	57	395	36	250		
20	NIMOCAS ^t * alloy 75	72	500	—	—	—	—	—	—	—	—	—	—	—	—
21	NIMOCAS ^t * alloy 80	106	730	—	—	—	—	—	—	—	—	—	—	—	—
22	NIMOCAS ^t * alloy 90	102	700	86	595	81	560	71	490	38	260	—	—	—	—
23	NIMOCAS ^t * alloy 242	67	460	—	—	—	—	—	—	—	—	—	—	—	—
24	NIMOCAS ^t * alloy 263	106	730	—	—	—	—	—	—	—	—	—	—	—	—
25	NX188(DS)	151	1040			157	1080	173	1195	176	1215	86	595	57	395
26	RENÉ [®] 77														
27	RENÉ [®] 80														
28	TAZ-8A	128	885					128	885	110	760	80	550	49	340
29	TAZ-8B(DS)	153	1055			172	1185	172	1185	125	860	80	550	43	295
30	TRW-NASA VI A	152	1050			165	1140	159	1095	126	870	86	595	49	340
31	UDIMET [®] 500	135	930	130	895	128	885	124	855	96	650	19	130		
32	UDIMET [®] 710	156	1075			161	1110	153	1055	106	730	60	415	35	240
33	WAZ-20(DS)	130	895			120	830	120	830	113	775	70	485	45	310
Cobalt Base															
34	FSX-414														
35	HAYNES [®] alloy 1002	112	770	81	560	82	565	73	500	47	325	29	200	17	115
36	MAR-M* 302	135	930	115	795	114	785	102	705	65	450	40	275	22	150
37	MAR-M* 509	114	785	83	570	81	560	83	570	51	352	31	215		
38	WI-52	109	750	108	745	107	740	88	605	60	415	40	275	23	160
39	X-40	108	745	80	550	74	515	70	485	47	325	29	200		

*See inside back cover for trademarks.
 (DS) Directionally Solidified
 (Extrapolated values are shown in parentheses)

TABLE 8 CAST ALLOYS

Ref. No.	Alloy Designation	TENSILE ELONGATION, %													
		70F	21C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C
Nickel Base															
1	Alloy 713C	8		10		7		6		14		20			
2	Alloy 713LC	15		11		11		11		12		22			
3	B-1900	8		7		6		4		4		7		11	
4	Cast Alloy 625	48		50		51		27		47		40			
5	Cast Alloy 718	11													
6	IN-100	9		9		6		6.5		6		6			
7	IN-162	7		6.5		5.5		5.5		6		5.5			
8	IN-731	6.5				5		4.5		3.5		6.5		7.5	
9	IN-738					7		6.5		11		13			
10	IN-792	4						4		8					
11	M-21														
12	M-22	5.5		4.5		5		5		4.5		5.5			
13	MAR-M* 200	7		5		4		3.5		4		4.5			
14	MAR-M* 200(DS)	10		10		9		4.5		4.5		8			
15	MAR-M* 246	5		5		5		5		5		8			
16	MAR-M* 247	7													
17	MAR-M* 421	4.5		3		4		2.5		6		22			
18	MAR-M* 432	6						3.5		8		21			
19	MC-102	5		9		9		4		11		12			
20	NIMOCAST* alloy 75	39		—		—		—		—		—		—	
21	NIMOCAST* alloy 80	15		—		—		—		—		—		—	
22	NIMOCAST* alloy 90	14		15		17		14		31		—		—	
23	NIMOCAST* alloy 242	8		—		—		—		—		—		—	
24	NIMOCAST* alloy 263	18		—		—		—		—		—		—	
25	NX188(DS)	5		4.5		3		1.5		2		3		3	
26	RENE* 77														
27	RENE* 80														
28	TAZ-8A	5						3		4		5		4	
29	TAZ-8B(DS)	9				7		7		12		10		22	
30	TRW-NASA VI A	4				4		4.5		2.5				5	
31	UDIMET* 500	13		13		13		9		8.5		50			
32	UDIMET* 710	8				12		18		23		27		25	
33	WAZ-20(DS)	13				5		4		5		10		12	
Cobalt Base															
34	FSX-414														
35	HAYNES* alloy 1002	6		8		9		10		19		24		28	
36	MAR-M* A302	2						8		11		15		21	
37	MAR-M* 509	4		6		7		10		20		26			
38	WI-52	5		7		8		9		11		20		35	
39	X-40	9		17		12		10		16		31			

*See inside back cover for trademarks.
(DS) Directionally Solidified

TABLE 9 CAST ALLOYS

Ref. No. Alloy Designation	100 HOUR RUPTURE STRENGTH, 1000 psi MN/m ²																			
	1200F	649C	1300F	704C	1400F	760C	1500F	816C	1600F	871C	1700F	927C	1800F	982C	1900F	1038C	2000F	1093C	2100F	1149C
Nickel Base																				
1	Alloy 713C				83	570	60	415	42	290	30	205	21	145	12	83	6.4	44		
2	Alloy 713LC				80	550	62	430	43	295	29	200	20	140						
3	B-1900						73	505	56	385	38	260	25	170	15	105	9.0	62		
4	51	350	39	270	28	195	19	130	14	97	9.0	62	5.0	34	—	—	—	—		
5	85	585	(62)	(430)																
6	IN-100				91	625	73	505	55	380	38	260	25	170	16	110	9.0	62		
7	IN-162				90	620	73	505	49	340	35	240	24	165	17	108				
8	IN-731						73	505			38	250	24	165	16	110				
9	IN-738				86	595	66	455	46	315	31	215	19	130						
10	IN-792				100	690	75	515	53	365	37	255	24	165						
11	M-21																			
12	M-22		105	725	97	670	87	600	75	515	57	395	41	285	29	200	20	140	12	83
13	MAR-M* 200				92	635	72	495	56	385	41	285	26	179	17.5	120				
14	MAR-M* 200(DS)				105	725	84	580	65	450	40	315	29	200	20	140				
15	MAR-M* 246				98	675	76	540	63	440	43	295	28	195	19	130				
16	MAR-M* 247 (MFB)				100	690			65	450	42	290	27	185	18	125				
17	MAR-M* 421				81	600	65	450	46	310	28	195	18	125	9.5	69	5.0	34		
18	MAR-M* 432				90	620	63	435	40	295	30	205	20	140	12	83				
19	78	540	54	370	38	260	28	195	21	145	15	105								
20	NIMOCAST* alloy 75		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	NIMOCAST* alloy 80		41	285	29	200	21	145	—	—	—	—	—	—	—	—	—	—	—	—
22	NIMOCAST* alloy 90		51	350	38	260	29	200	23	160	18	125	—	—	—	—	—	—	—	—
23	NIMOCAST* alloy 242		—	—	—	—	25	170	16	110	13	90	9.9	68	6.5	45	—	—	—	—
24	NIMOCAST* alloy 263		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	NX188 (DS)		—	—	—	—	—	—	—	—	—	—	26	180	—	—	14	97	—	—
26	RENÉ* 77								45	310			19	130						
27	RENÉ* 80								51	350			24	165						
28	(110)	(760)	(90)	(620)	(68)	(470)	(53)	(365)	(39)	(270)	(30)	(205)	(21)	(145)	15	105	(10)	(69)	(6)	(41)
29	(150)	(1085)	(135)	(930)	(100)	(690)	(74)	(510)	(54)	(370)	(38)	(260)	(26)	(180)	18	128	(12)	(83)	(6)	(41)
30	TRW-NASA VI A				(125)	(860)	(105)	(725)	(80)	(550)	(57)	(395)	44	330	31	215	21	145	(13)	(90)
31	UDIMET* 500				65	450	48	330	33	230	21	145	13	90						
32	UDIMET* 710			(106)	(730)	81	560	61	420	44	305	32	220	22	150	11	76			
33	(135)	(930)	(110)	(760)	(88)	(605)	(65)	(450)	(50)	(345)	(37)	(255)	(27)	(185)	(19)	(130)	(12.5)	(86)	(7)	(48)
Cobalt Base																				
34	FSX-414						23	160	16	110	12	83	8	55	5	34	3.5	24		
35	HAYNES* alloy 1002		—	—	—	—	46	315	35	240	25.5	175	19	130	14	95	9.5	65	6.7	46
36	MAR-M* 302						36	250	27	185	20	140	14	97	10	69	6.0	41		
37	MAR-M* 509				50	345	36.5	250	26	180	19.5	135	15	105	11.5	79	7.5	52		
38	WI-52								25	170	15	125	13	90						
39	56	385	40	340	38	260	27	185	20	140	16	110	11	76						

*See inside back cover for trademarks.
 (DS) Directionally Solidified
 (MFB) Test bar machined from blade.
 (Extrapolated values are shown in parentheses)

TABLE 10 CAST ALLOYS

Ref. No.	Alloy Designation	1000 HOUR RUPTURE STRENGTH 1000 psi MN/m ²																	
		1200F	849C	1300F	704C	1400F	760C	1500F	816C	1600F	871C	1700F	927C	1800F	982C	1900F	1036C	2000F	1093C
Nickel Base																			
1	Alloy 713C			(88)	(605)	65	458	44	305	28	195	18	125	13	90	(7.7)	(53)		
2	Alloy 713LC					60	415	45	310	30	205	19	130	13	90				
3	B-1900							55	380	37	255	25	120	15	105	8.8	61	4.9	34
4	Cast Alloy 625	44	305	34	235	24	165	16	110	11	76	7.0	48	4.0	28				
5	Cast Alloy 718																		
6	IN-100					75	515	55	380	37	255	25	170	15	105	8.5	59		
7	IN-162					76	525	54	370	37	255	25	170	16	110	13	90		
8	IN-731							53	365			23.5	160	15	105	7.0	48		
9	IN-738					69	475	48	335	31.5	215	20	140	12	83				
10	IN-792					79	545	55	380	38	260	24.5	170	15	105				
11	M-21																		
12	M-22					79	545	56	385	41	285	28	195	19	130	12	83	6.0	41
13	MAR-M* 200					84	580	60	415	43	295	29	200	18.5	130	12	83		
14	MAR-M* 200 (DS)					96	660							20	140	14	97		
15	MAR-M* 246					86	595	62	435	42	290	27	185	18	125				
16	MAR-M* 247 (MFB)									42	290	28	195	18	125				
17	MAR-M* 421					63	435	44	305	31	215	20	140	12	83	7.0	48	4.0	28
18	MAR-M* 432					70	485	48	330	31	215	22	150	14	97	7.5	52		
19	MC-102	60	415	38	260	27	185	21	145	15	105	9.0	62						
20	NIMOCAS ^t alloy 75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
21	NIMOCAS ^t alloy 80	29	200	21	145	15	105	—	—	—	—	—	—	—	—	—	—	—	—
22	NIMOCAS ^t alloy 90	44	305	32	220	23	160	17	110	12	83	—	—	—	—	—	—	—	—
23	NIMOCAS ^t alloy 242	—	—	—	—	16	110	12	83	8.6	59	6.2	43	—	—	—	—	—	—
24	NIMOCAS ^t alloy 263	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	NX188 (DS)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	RENÉ [®] 77									31.5	215			9.0	62				
27	RENÉ [®] 80									35	240			15	105				
28	TAZ-8A	(95)	(655)	(72)	(495)	(55)	(380)	(40)	(275)	(29)	(200)	(22)	(150)	(14)	(97)	(10)	(69)	(6.0)	(41)
29	TAZ-8B(DS)	(140)	(965)	(105)	(725)	(78)	(540)	(55)	(380)	(39)	(270)	(27)	(185)	(17)	(115)	(11.5)	(79)	(6.0)	(41)
30	TRW-NASA VI A					85	585	61	420	44	305	31	215	20	140				
31	UDIMET [®] 500			67	460	50	395	35	240	24	165	13	90						
32	UDIMET [®] 710	(109)	(750)	(87)	(600)	64	440	47	325	31	215	19	130	11	76				
33	WAZ-20 (DS)													15	105				
Cobalt Base																			
34	FSX-414					24	165	16.5	116	12	83	8.0	55	5.0	34	3.0	21		
35	HAYNES [®] alloy 1002	—	—	—	—	(36)	(250)	(26.5)	(180)	(19.5)	(135)	(14.3)	(100)	9.8	68	6.5	45	—	—
36	MAR-M* 302																		
37	MAR-M* 509					38	260	28	195	20	140	15	105	11.5	79	8.0	55	5.0	34
38	WI-52									21	145	15	105	10	69				
39	X-40	51	350	44	305	33	230	22	150	16	110	14	97	9.8	68				

*See inside back cover for trademarks.
 (DS) Directionally Solidified
 (MFB) Test bar machined from blade.
 (Extrapolated values are shown in parentheses)

TABLE 11 WROUGHT ALLOYS

		NOMINAL COMPOSITION, WT %															
Ref. No.	Alloy Designation	Ni	Cr	Co	Mo	W	Ta	Cb	Al	Ti	Fe	Mn	Si	C	B	Zr	Other
Nickel Base Alloys																	
1	Astroloy	55	15.0	17.0	5.3	—	—	—	4.0	3.5	—	—	—	0.06	0.030	—	—
2	D-979	45	15.0	—	4.0	4.0	—	—	1.0	3.0	27.0	0.25	0.20	0.05	0.010	—	—
3	HASTELLOY* alloy X	47	22.0	1.5	9.0	0.6	—	—	—	—	18.5	0.50	0.50	0.10	—	—	—
4	HASTELLOY* alloy S	67	15.5	—	14.5	—	—	—	0.20	—	1.0	0.50	0.40	0.02m	0.009	—	0.02La
5	INCONEL* alloy 600	76	15.5	—	—	—	—	—	—	—	8.0	0.5	0.2	0.08	—	—	—
6	INCONEL* alloy 601	60.5	23.0	—	—	—	—	—	1.4	—	14.1	0.5	0.2	0.05	—	—	—
7	INCONEL* alloy 617	54	22.0	12.5	9.0	—	—	—	1.0	—	—	—	—	0.07	—	—	—
8	INCONEL* alloy 625	61	21.5	—	9.0	—	—	3.6	0.2	0.2	2.5	0.2	0.2	0.05	—	—	—
9	INCONEL* alloy 690	60	30	—	—	—	—	—	—	—	9.5	—	—	0.03	—	—	—
10	INCONEL* alloy 706	41.5	16.0	—	—	—	—	2.9	0.2	1.8	40	0.2	0.2	0.03	—	—	—
11	INCONEL* alloy 718	52.5	19.0	—	3.0	—	—	5.1	0.5	0.9	18.5	0.2	0.2	0.04	—	—	—
12	INCONEL* alloy X750	73	15.5	—	—	—	—	1.0	0.7	2.5	7.0	0.5	0.2	0.04	—	—	—
13	INCONEL* alloy MA 754	78	20.0	—	—	—	—	—	0.3	0.5	—	—	—	0.05	—	—	0.6Y ₂ O ₃
14	IN-102	68	15.0	—	3.0	3.0	—	3.0	0.4	0.6	7.0	—	—	0.06	0.005	0.03	0.02Mg
15	IN-587	47	28.5	20.0	—	—	—	0.7	1.2	2.3	—	—	—	0.05	0.003	0.05	—
16	IN-597	48	24.5	20.0	1.5	—	—	1.0	1.5	3.0	—	—	—	0.05	0.012	0.05	0.02Mg
17	M-252	55	20.0	10.0	10.0	—	—	—	1.0	2.6	—	0.50	0.50	0.15	0.005	—	—
18	NIMONIC* alloy 75	76	19.5	—	—	—	—	—	—	0.4	3.0	0.30	0.30	0.10	—	—	—
19	NIMONIC* alloy 80A	76	19.5	—	—	—	—	—	1.4	2.4	—	0.30	0.30	0.06	0.003	0.06	—
20	NIMONIC* alloy 81	67	30.0	—	—	—	—	—	0.9	1.8	—	0.30	0.30	0.03	0.003	0.06	—
21	NIMONIC* alloy 90	59	19.5	16.5	—	—	—	—	1.45	2.45	—	0.30	0.30	0.07	0.003	0.06	—
22	NIMONIC* alloy 105	53	15.0	20.0	5.0	—	—	—	4.7	1.2	—	0.30	0.30	0.13	0.005	0.10	—
23	NIMONIC* alloy 115	60	14.3	13.2	3.3	—	—	—	4.9	3.7	—	—	—	0.15	0.160	0.04	—
24	NIMONIC* alloy 263	51	20.0	20.0	5.9	—	—	—	0.45	2.15	—	0.40	0.25	0.06	0.001	0.02	—
25	NIMONIC* alloy 942	49.5	12.5	—	6.0	—	—	—	0.6	3.7	bal.	0.20	0.30	0.03	0.010	—	—
26	NIMONIC* alloy PE11	38	18.0	—	5.2	—	—	—	0.8	2.3	35	0.20	0.30	0.05	0.03	0.2	—
27	NIMONIC* alloy PE16	43.5	16.5	—	3.2	—	—	—	1.2	1.2	34.4	—	—	0.05	0.003	0.04	—
28	NIMONIC* alloy PK33	56	19.0	14.0	7.0	—	—	—	1.9	2.0	—	—	—	0.04	0.003	—	—
29	PYROMET* 860	43	12.6	4.0	6.0	—	—	—	1.25	3.0	30.0	0.05	0.05	0.05	0.010	—	—
30	RENÉ 41*	55	19.0	11.0	10.0	—	—	—	1.5	3.1	—	—	—	0.09	0.005	—	—
31	RENÉ 41*																
32	RENÉ 95	61	14.0	8.0	3.5	3.5	—	3.5	3.5	2.5	—	—	—	0.15	0.010	0.05	—
33	RGT* 4	67	20.0	—	4.5	—	—	—	1.4	2.4	5.0m	—	—	0.06	0.004	—	—
34	RGT* 13	49	20.0	18.0	4.5	—	—	—	1.5	2.5	5.0m	—	—	0.06	0.004	—	—
35	TD Nickel	98	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.0Th ₂ O
36	TD Nickel																
37	TD NiCr	78	20.0	—	—	—	—	—	—	—	—	—	—	—	—	—	2.0Th ₂ O
38	UDIMET* 400	60	17.5	14.0	4.0	—	—	0.5	1.5	2.5	—	—	—	0.06	0.008	0.06	—
39	UDIMET* 500	54	18.0	18.5	4.0	—	—	—	2.9	2.9	—	—	—	0.08	0.006	0.05	—
40	UDIMET* 520	57	19.0	12.0	6.0	1.0	—	—	2.0	3.0	—	—	—	0.05	0.005	—	—
41	UDIMET* 630	50	18.0	—	3.0	3.0	—	6.5	0.5	1.0	18.0	—	—	0.03	—	—	—
42	UDIMET* 700	53	15.0	18.5	5.2	—	—	—	4.3	3.5	—	—	—	0.08	0.030	—	—
43	UDIMET* 710	55	18.0	15.0	3.0	1.5	—	—	2.5	5.0	—	—	—	0.07	0.020	—	—
44	UNITEMP* AF2-1DA	59	12.0	10.0	3.0	6.0	1.5	—	4.6	3.0	1.0m	—	—	0.35	0.014	0.10	—
45	UNITEMP* AF2-1DA																
46	WASPALOY*	58	19.5	13.5	4.3	—	—	—	1.3	3.0	—	—	—	0.08	0.006	0.06	—
47	WASPALOY*																
Cobalt Base Alloys																	
48	HAYNES* alloy No. 188	22.0	22.0	39	—	14.0	—	—	—	—	3.0m	1.25m	0.40	0.10	—	—	0.08La
49	L-605	10.0	20.0	53	—	15.0	—	—	—	—	—	1.50	0.50	0.10	—	—	—
Iron-Nickel Alloys																	
50	Alloy 901	42.5	12.5	—	5.7	—	—	—	0.2	2.8	36	0.10	0.10	0.05	0.015	—	—
51	A-286	26.0	15.0	—	1.3	—	—	—	0.2	2.0	54	1.35	0.50	0.05	0.015	—	—
52	DISCALOY*	26.0	13.5	—	2.7	—	—	—	0.1	1.7	54	0.90	0.80	0.04	0.005	—	—
53	HAYNES* alloy 556	20.0	22.0	20.0	3.0	2.5	0.9	0.1	0.3	—	29	1.50	0.40	0.10	—	—	0.2N,0.02La
54	INCOLOY* alloy 800	32.5	21.0	—	—	—	—	—	0.4	0.4	46	0.8	0.5	0.05	—	—	—
55	INCOLOY* alloy 801	32.0	20.5	—	—	—	—	—	—	1.1	44.5	0.8	0.5	0.05	—	—	—
56	INCOLOY* alloy 802	32.5	21.5	—	—	—	—	—	—	—	46	0.8	0.4	0.4	—	—	—
57	INCOLOY* alloy 807	40.0	20.5	8.0	0.1	5.0	—	—	0.2	0.3	25	0.50	0.40	0.05	—	—	—
58	INCOLOY* alloy 903	38.0	—	15.0	—	—	—	3.0	0.7	1.4	41	—	—	—	—	—	—
59	INCOLOY* alloy 904	32.5	—	14.5	—	—	—	—	0.8	2.3	35	0.20	0.30	0.05	0.03	0.20	—
60	N-155	20.0	21.0	20.0	3.0	2.5	—	1.0	—	—	30	1.50	0.50	0.15	—	—	0.15N
61	V-57	27.0	14.8	—	1.25	—	—	—	0.25	3.0	52	0.35	0.75	0.08	0.010	—	0.50V

* See inside back cover for trademarks.

m = maximum

^a Approximate solidus temperature

Notes: AC = Air Cooled

OQ = Oil Quenched

WQ = Water Quenched

RAC = Rapid Air Cooled

DENSITY		MELTING RANGE				Condition of Test Material	Alloy Designation	Ref. No.
Nb/cu in.	g/cu cm	Data Presented	F	C				
0.286	7.91	Bar	—	—	2150F 1175C/4/AC+1975F 1080C/4/AC+1550F 840C/24/AC+1400F 760C/16/AC	Astroloy	1	
0.296	8.19	Bar	2225-2530	1220-1390	1900F 1040C/1/OQ+1550F 840C/6/AC+1300F 705C/16/AC	D-979	2	
0.297	8.21	Sheet	2300-2470	1260-1355	2150F 1175C/1/RAC	HASTELLOY* alloy X	3	
0.316	8.76	Bar	2435-2515	1335-1380	1950F 1065C/AC	HASTELLOY* alloy S	4	
0.304	8.41	Bar	2470-2575	1355-1415	2050F 1120C/2/AC	INCONEL* alloy 600	5	
0.291	8.05	Bar	2375-2495	1300-1370	2100F 1150C/1	INCONEL* alloy 601	6	
0.302	8.36	Bar	2430-2510	1330-1375	2150F 1175C	INCONEL* alloy 617	7	
0.305	8.44	Bar	2350-2460	1290-1350	2100F 1150C	INCONEL* alloy 625	8	
0.294	8.14	Bar	2450-2510	1345-1375	1900F 1040C/1/AC	INCONEL* alloy 690	9	
0.292	8.08	Bar	2435-2500	1335-1370	1800F 980C/1/AC+1550F 840C/3/AC+1325F 720C/8/FC 1150 620C/8/AC	INCONEL* alloy 706	10	
0.297	8.22	Bar	2300-2435	1260-1335	1800F 980C/1/AC+1325F 720C/8/FC 1150F 620C/8/AC	INCONEL* alloy 718	11	
0.298	8.25	Bar	2540-2600	1395-1425	2100F 1150C/2AC+1550F 840C/24/AC+1300F 705C/20/AC	INCONEL* alloy X750	12	
0.300	8.30	Bar	2550 ^a	1400 ^a	Solution Annealed	INCONEL* alloy MA 754	13	
0.309	8.55	Bar	2410-2530	1320-1390	1800F 980C/1/RAC	IN-102	14	
0.292	8.08	Bar	—	—	2100F 1150C/4/AC+1560F 850C/16/AC	IN-587	15	
0.291	8.04	Bar	—	—	2100F 1150C/4/AC+1560F 850C/16/AC	IN-597	16	
0.298	8.25	Bar	2400-2500	1315-1370	1900F 1040C/4/AC+1400F 705C/16/AC	M-252	17	
0.302	8.37	Bar	—	—	1925F 1050C/1/AC	NIMONIC* alloy 75	18	
0.295	8.16	Bar	2480-2535	1360-1390	1975F 1080C/8/AC+1300F 705C/16/AC	NIMONIC* alloy 80A	19	
0.291	8.06	Bar	—	—	2010F 1100C/8/AC+1300F 705C/16/AC	NIMONIC* alloy 81	20	
0.296	8.19	Bar	2435-2480	1335-1360	1975F 1080C/8/AC+1300F 705C/16/AC	NIMONIC* alloy 90	21	
0.289	8.00	Bar	—	—	2100F 1150C/4/AC+1920-1950F 1050-1065C/16/AC+1560F 850C/16/AC	NIMONIC* alloy 105	22	
0.284	7.85	Bar	—	—	2175F 1190C/1 1/2/AC+2010F 1100C/6/AC	NIMONIC* alloy 115	23	
0.302	8.36	Sheet	—	—	2100F 1150C/10min/WQ+1470F 800C/8/AC	NIMONIC alloy 263	24	
0.296	8.19	Bar	2265-2370	1240-1300	1985F 1085C/3/WQ+1425F 775C/20/AC+1290F 700C/16/AC	NIMONIC* alloy 942	25	
0.290	8.02	Bar	2335-2460	1280-1350	1870F 1020C/2/AC+1470F 800C/2/AC+1290F 700C/16/AC	NIMONIC* alloy PE11	26	
0.290	8.02	Bar	—	—	1900F 1040C/4/AC+1470F 800C/2/AC+1290F 700C/16/AC	NIMONIC* alloy PE16	27	
0.297	8.21	Sheet	—	—	2010-2040F 1100-1115C/15 min /AC+1560F 850C/4/AC	NIMONIC* alloy PK33	28	
0.297	8.21	Bar	—	—	2000F 1095C/2/WQ+1525F 830C/2/AC+1400F 760C/24/AC	PYROMET* 860	29	
0.298	8.25	Bar	2400-2500	1315-1370	1950F 1065C/4/AC+1400F 760C/16/AC	RENE 41*	30	
—	—	Sheet	—	—	1950F 1065C/1/2/AC+1400F 760C/16/AC	RENE 41*	31	
—	—	Bar	—	—	Heat treated	RENE* 95	32	
0.296	8.20	Bar	—	—	1975F 1080C/8/AC+1310F 710C/16/AC	RG T* 4	33	
0.296	8.20	Bar	—	—	1975F 1080C/8/AC+1310F 710C/16/AC	RG T* 13	34	
0.322	8.90	Bar	2650	1455	1800-2000F 980-1090C/1/4-2/AC	TD Nickel	35	
0.306	8.41	Sheet	—	—	2150-2200F 1175-1200C/2/AC	TD Nickel	36	
0.296	8.19	Bar	—	—	1850F 1010C/4/OQ+1550F 840C/4/AC+1400F 760C/4/AC	TD NiCr	37	
0.290	8.02	Bar	2375-2540	1300-1395	1975F 1080C/4/AC+1550F 840C/24/AC+1400F 760C/16/AC	UDIMET* 400	38	
0.297	8.21	Bar	2300-2560	1260-1405	2025F 1105C/4/AC+1550F 840C/24/AC+1400F 760C/16/AC	UDIMET* 500	39	
0.304	8.41	Bar	—	—	1875F 1025C/4/AC+1400F 760C/8/AC+1200F 650C/10/AC	UDIMET* 630	41	
0.286	7.91	Bar	2200-2550	1205-1400	2150F 1175C/4/AC+1975F 1080C/4/AC+1550F 840C/24/AC+1400F 760C/16/AC	UDIMET* 700	42	
0.292	8.08	Bar	—	—	2150F 1175C/4/AC+1975F 1080C/4/AC+1550F 840C/24/AC+1400F 760C/16/AC	UDIMET 710	43	
0.299	8.26	Bar	—	—	2200F 1200C/2/AC+1950F 1065C/2/AC+1400F 760C/16/AC	UNITEMP* AF2-1DA	44	
—	—	Sheet	—	—	2225F 1235C/1/C+1950F 1065C/2/AC+1400F 760C/16/C (argon atm)	UNITEMP* AF2-1DA	45	
0.296	8.19	Bar	2425-2475	1330-1355	1975F 1080C/4/AC+1550F 840C/24/AC+1400F 760C/16/AC	WASPALLOY*	46	
—	—	Sheet	—	—	—	WASPALLOY*	47	
0.330	9.13	Sheet	2375-2425	1300-1330	2150F 1175C/RAC	HAYNES* alloy No. 188	48	
0.330	9.13	Sheet	2425-2570	1330-1410	2250F 1230C/1/RAC	L-605	49	
0.297	8.21	Bar	2250-2550	1230-1400	2000F 1095C/2/WQ+1450F 790C/2/AC+1325F 720C/24/AC	ALLOY 901	50	
0.286	7.91	Bar	2500-2550	1370-1400	1800F 980C/1/OQ+1325F 720C/16/AC	A-286	51	
0.288	7.97	Bar	2515-2665	1380-1465	1850F 1010C/2/OQ+1350F 730C/20/AC+1200F 650C/20/AC	DISCALOY*	52	
0.297	8.23	Sheet	—	—	2150F 1175C/RAC	HAYNES* alloy 556	53	
0.287	7.95	Bar	2475-2525	1355-1385	2100F 1150C	INCOLOY* alloy 800	54	
0.287	7.95	Bar	2475-2525	1355-1385	1750F 955C/1/WQ	INCOLOY* alloy 801	55	
0.283	7.83	Bar	2450-2500	1345-1370	Annealed	INCOLOY* alloy 802	56	
0.301	8.32	Bar	2325-2475	1275-1355	As extruded	INCOLOY* alloy 807	57	
0.294	8.14	Bar	2405-2540	1320-1395	1550F 845C/1/WQ+1325F 720C/8/FC+1150F 620C/8/AC	INCOLOY* alloy 903	58	
0.292	8.12	Bar	—	—	1560F 850C/2/AC+1110F 600C/24/AC	INCOLOY* alloy 904	59	
0.296	8.19	Bar	2325-2475	1275-1355	2150F 1175C/1/WQ+1500F 815C/4/AC	N-155	60	
0.287	7.94	Bar	—	—	1800F 980C/2-4/OQ+1350F 730C/16/AC	V-57	61	

TABLE 12 WROUGHT ALLOYS

		SPECIFIC HEAT, BTU/lb/°F J/Kg-K																								
Ref. No.	Alloy Designation	Form	70F	21C	200F	93C	400F	204C	600F	316C	800F	427C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C		
Nickel Base Alloys																										
1	ASTROLOY	Bar																								
2	D-979	Bar																								
3	HASTELLOY* alloy X	Sheet	0.116	485					0.119	500					0.139	585			0.167	700			0.205	810		
4	HASTELLOY* alloy S	Bar	0.097	405	0.102	425	0.107	450	0.112	470	0.115	480	0.118	495	0.120	505	0.142	595	0.142	595	0.143	600	0.144	605		
5	INCONEL* alloy 600	Bar	0.106	445	0.111	465	0.116	485	0.121	510	0.126	530	0.132	555	0.140	590	0.145	610	0.149	625						
6	INCONEL* alloy 601	Bar	0.107	450	0.112	470	0.119	500	0.126	530	0.133	560	0.140	590	0.147	620	0.155	650	0.162	680	0.169	710	0.176	740		
7	INCONEL* alloy 617	Bar	0.100	420	0.104	435	0.111	465	0.117	490	0.124	520	0.131	550	0.137	575	0.144	605	0.150	630	0.157	655	0.163	680		
8	INCONEL* alloy 625	Bar	0.098	410	0.102	425	0.109	455	0.115	480	0.122	510	0.128	535	0.135	565	0.141	590	0.148	620	0.154	645	0.160	670		
9	INCONEL* alloy 690	Bar																								
10	INCONEL* alloy 706	Bar	0.106	445	0.110	460	0.117	490	0.124	520	0.131	550	0.138	580	0.145	610	0.152	640	0.159	670	0.166	695	0.173	725		
11	INCONEL* alloy 718	Bar	0.102	430	0.106	455	0.113	475	0.120	500	0.126	530	0.133	560	0.140	590	0.146	615	0.153	645	0.160	670	0.167	700		
12	INCONEL* alloy X750	Bar	0.103	430	0.109	455	0.116	485	0.120	500	0.125	525	0.130	545	0.137	575	0.151	630	0.171	715						
13	INCONEL* alloy MA 754	Bar																								
14	IN-102	Bar																								
15	IN-587	Bar																								
16	IN-597	Bar																								
17	M-252	Bar																								
18	NIMONIC* alloy 75	Bar	0.11	460																						
19	NIMONIC* alloy 80A	Bar	0.11	460																						
20	NIMONIC* alloy 81	Bar	0.11	460	0.11	460	0.12	500	0.12	500	0.13	545	0.14	585	0.14	585	0.15	630	0.16	670	0.17	710				
21	NIMONIC* alloy 90	Bar	0.11	460	0.11	460	0.12	500	0.12	500	0.13	545	0.14	585	0.15	630	0.15	630	0.16	670	0.17	710				
22	NIMONIC* alloy 105	Bar	0.10	420	0.11	460	0.12	500	0.12	500	0.13	545	0.13	545	0.14	585	0.15	630	0.16	670	0.16	670				
23	NIMONIC* alloy 115	Bar	0.11	460																						
24	NIMONIC* alloy 263	Sheet	0.11	460																						
25	NIMONIC* alloy 942	Bar	0.10	420	0.11	460	0.11	460	0.12	500	0.13	545	0.13	545	0.14	585	0.15	630	0.15	630	0.16	670	0.17	710		
26	NIMONIC* alloy PE11	Bar	0.10	420	0.11	460	0.12	500	0.12	500	0.13	545	0.14	585	0.14	585	0.15	630	0.16	670	0.16	670	0.17	710		
27	NIMONIC* alloy PE16	Bar	0.13	545																						
28	NIMONIC* alloy PK33	Bar	0.10	420	0.11	460	0.11	460	0.12	500	0.12	500	0.13	545	0.14	585	0.15	630	0.16	670	0.16	670				
29	PYROMET* 860	Bar																								
30	RENÉ 41*	Bar					0.081	340	0.098	410	0.111	465	0.130	545	0.144	605	0.158	660	0.173	725	0.189	790	0.205	860		
31	RENÉ 41*	Sheet																								
32	RENÉ 95	Bar																								
33	RGT* 4	Bar	0.10	420																						
34	RGT* 13	Bar	0.11	460																						
35	TD Nickel	Bar																								
36	TD Nickel	Sheet	(0.107)	(450)	(0.107)	(450)																				
37	TD NiCr	Sheet																								
38	UDIMET* 400	Bar																								
39	UDIMET* 500	Bar																								
40	UDIMET* 520	Bar																								
41	UDIMET* 630	Bar					0.141	590	0.139	580	0.138	580	0.137	575	0.137	575	0.138	580	0.141	590	0.152	635	0.182	760		
42	UDIMET* 700	Bar																								
43	UDIMET* 710	Bar																								
44	UNITEMP* AF2-1DA	Bar	0.100	420	0.110	460																				
45	UNITEMP* AF2-1DA	Sheet																								
46	WASPALLOY*	Bar																								
47	WASPALLOY*	Sheet																								
Cobalt Base Alloys																										
48	HAYNES* alloy No. 188	Sheet	0.097	405	0.100	420	0.106	445	0.111	465	0.117	490	0.122	510	0.124	520	0.131	550	0.135	565	0.140	585	0.144	605		
49	L-605	Sheet	0.092	385																						
Iron-Nickel Alloys																										
50	Alloy 901	Bar																								
51	A-286	Bar	0.11	460																						
52	DISCALOY*	Bar	0.113	475																						
53	HAYNES* alloy 556	Sheet	0.107	450	0.114	480	0.118	495	0.122	510	0.126	530	0.129	540	0.132	555	0.139	585	0.140	590			0.166	695		
54	INCOLOY* alloy 800	Bar	0.108	455	0.112	470	0.119	500	0.126	530	0.133	550	0.141	590	0.148	620	0.155	650	0.162	680	0.169	710	0.176	740		
55	INCOLOY* alloy 801	Bar	0.108	455	0.113	475	0.120	500	0.127	535	0.134	565	0.141	590	0.148	620	0.155	650	0.162	680	0.170	715	0.177	745		
56	INCOLOY* alloy 802	Bar	0.106	445	0.111	465	0.118	495	0.125	525	0.132	555	0.139	585	0.146	615	0.153	640	0.160	670	0.167	700	0.174	730		
57	INCOLOY* alloy 807	Bar																								
58	INCOLOY* alloy 903	Bar	0.104	435	0.108	455	0.115	480	0.122	510	0.129	540	0.136	570	0.143	600	0.150	630	0.156	655	0.163	680	0.170	710		
59	INCOLOY* alloy 904	Bar	0.11	460	0.11	460	0.12	500	0.12	500	0.13	545	0.14	585	0.14	585	0.15	630	0.16	670	0.17	710	0.17	710		
60	N-155	Bar	0.103	430																						
61	V-57	Bar																								

*See inside back cover for trademarks.
(Extrapolated values are shown in parentheses)

TABLE 13 WROUGHT ALLOYS

Ref. No.	Alloy Designation	Form	THERMAL CONDUCTIVITY, BTU/ft ² /in./hr/°F W/m-K																					
			70F	21C	200F	93C	400F	204C	600F	316C	800F	427C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F1093C	
Nickel Base Alloys																								
1	Astrolby	Bar																						
2	D-979	Bar	87	12.6	92	13.3	101	14.6	110	15.9	119	17.2	128	18.5	138	19.9	147	21.2	—	—	—	—	—	—
3	HASTELLOY* alloy X	Sheet	63	9.1	76	11.0	88	12.7	100	14.4	119	17.2	136	19.6	151	21.8	166	24.0	180	26.0	195	28.1	—	—
4	HASTELLOY* alloy S	Bar					98	14.1	113	16.3	127	18.3	139	20.0	—	—	181	26.1	181	26.1	192	27.7	—	—
5	INCONEL* alloy 600	Bar	103	14.8	109	15.7	121	17.4	133	19.1	145	20.9	158	22.8	172	24.8	186	26.8	200	28.8	215	31.0	—	—
6	INCONEL* alloy 601	Bar	78	11.3	87	12.6	100	14.4	113	16.3	126	18.2	139	20.0	153	21.1	165	23.8	178	25.7	190	27.4	203	29.3
7	INCONEL* alloy 617	Bar	94	13.6	101	14.5	113	16.3	125	18.0	137	19.8	149	21.5	161	23.2	173	24.7	185	26.7	197	28.4	209	30.1
8	INCONEL* alloy 625	Bar	68	9.8	75	10.8	87	12.6	98	14.1	109	15.7	121	17.5	132	19.0	144	20.8	158	22.8	175	25.2	—	—
9	INCONEL* alloy 690 ^b	Bar	95	13.3	104	15.0	118	17.0	130	18.8	142	20.5	158	22.8	168	24.2	180	26.0	193	27.8	205	29.5	216	31.2
10	INCONEL* alloy 706	Bar	87	12.6	96	13.9	110	15.9	124	17.9	136	19.6	147	21.2	—	—	—	—	—	—	—	—	—	—
11	INCONEL* alloy 718	Bar	79	11.4	87	12.6	100	14.4	112	16.2	124	17.9	136	19.6	148	21.4	161	23.2	173	24.9	186	26.8	199	28.7
12	INCONEL* alloy X750	Bar	83	12.0	89	12.8	98	14.1	109	15.7	120	17.4	131	18.9	143	20.6	154	22.2	164	23.6	173	25.0	—	—
13	INCONEL* alloy MA 754 ^a	Bar	—	—	93	13.0	108	16.0	123	18.0	137	20.0	151	22.0	165	24.0	179	26.0	193	28.0	206	30.0	219	32.0
14	IN-102	Bar	78	11.3	86	12.4	99	14.3	113	16.3	125	18.0	—	—	—	—	—	—	—	—	—	—	—	—
15	IN-587	Bar																						
16	IN-597	Bar											126	18.2	135	19.5	145	20.9	—	—	—	—	—	—
17	M-252	Bar	82	11.8	90	13.0	99	14.3	108	15.6	116	16.7	—	—	—	—	—	—	—	—	—	—	—	—
18	NIMONIC* alloy 75	Bar																						
19	NIMONIC* alloy 80A	Bar	60	8.7	65	9.4	80	11.6	85	12.3	98	14.1	110	15.9	126	18.2	142	20.5	156	22.5	—	—	—	—
20	NIMONIC* alloy 81	Bar	75	10.8	87	12.6	96	13.9	109	15.7	122	17.6	133	19.2	145	20.9	157	22.6	174	25.1	186	26.8	—	—
21	NIMONIC* alloy 90	Bar	68	9.8	74	10.7	83	12.0	95	13.7	108	15.6	118	17.0	130	18.8	144	20.8	—	—	—	—	—	—
22	NIMONIC* alloy 105	Bar	75	10.8	84	12.1	94	13.6	104	15.0	114	16.5	129	18.6	142	20.5	154	22.2	166	24.0	181	26.1	—	—
23	NIMONIC* alloy 115	Bar	74	10.7	80	11.5	90	13.0	101	14.6	112	16.2	122	17.6	133	19.2	143	20.6	154	22.6	164	23.6	—	—
24	NIMONIC* alloy 263	Sheet	81	11.7	91	13.1	101	14.6	115	16.6	129	18.6	141	20.4	155	22.4	166	23.9	182	26.2	195	28.1	—	—
25	NINOMIC* alloy 942	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	NIMONIC* alloy PE11	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27	NIMONIC* alloy PE16	Bar	81	11.7	96	13.9	105	15.2	117	16.9	130	18.8	140	20.2	153	22.1	168	24.2	183	26.4	195	28.1	—	—
28	NIMONIC* alloy PK33	Sheet	74	10.7	87	12.6	96	13.9	107	15.4	122	17.6	133	19.2	145	20.9	154	22.2	171	24.7	186	26.8	—	—
29	PYROMET* 860	Bar																						
30	RENÉ 41*	Bar	62	9.0	71	10.2	86	12.4	102	14.7	115	16.6	125	18.0	136	19.6	148	21.4	160	23.1	172	24.8	183	26.4
31	RENÉ 41*	Sheet																						
32	RENÉ 95*	Bar	60	8.7	72	10.4	84	12.1	96	13.9	108	15.6	120	17.4	132	19.0	144	20.8	—	—	—	—	—	—
33	RGT* 4	Bar	76	11.0	83	12.0	93	13.4	99	14.3	109	15.8	120	17.4	131	18.9	144	20.8	—	—	—	—	—	—
34	RGT* 13	Bar	84	12.1	89	12.8	99	14.3	109	15.7	118	17.1	128	18.5	138	19.9	147	21.3	—	—	—	—	—	—
35	TD Nickel	Bar	572	82.6	515	74.4	425	61.3	355	51.2	320	46.1	305	44.0	305	44.0	310	44.7	335	48.4	360	52.0	—	—
36	TD Nickel	Sheet																						
37	TD NiCr	Sheet	155	22.4	164	23.7	181	26.1	193	27.9	209	30.2	218	31.5	234	33.8	250	36.1	263	38.0	276	39.8	288	41.6
38	UDIMET* 400	Bar																						
39	UDIMET* 500	Bar	77	11.1	82	11.8	91	13.1	102	14.7	114	16.5	127	18.3	142	20.5	155	22.4	170	24.5	178	25.7	—	—
40	UDIMET* 520	Bar																						
41	UDIMET* 630	Bar																						
42	UDIMET* 700	Bar	136	19.6	137	19.8	138	19.9	139	20.0	140	20.2	143	20.6	148	21.4	161	23.2	192	27.7	240	34.6	305	44.0
43	UDIMET* 710	Bar	(77)	(11.1)	84	12.1	94	13.6	104	15.0	115	16.6	126	18.2	136	19.6	147	21.2	158	22.8	168	24.2	—	—
44	UNITEMP* AF2-1DA	Bar	75	10.8	81	11.7	90	13.0	98	14.1	107	15.4	114	16.5	121	17.5	128	18.5	135	19.5	141	20.4	—	—
45	UNITEMP* AF2-1DA	Sheet																						
46	WASPALOY*	Bar	74	10.7	80	11.6	89	12.8	101	14.6	113	16.3	125	18.1	139	20.0	152	21.9	167	24.1	182	26.2	—	—
47	WASPALOY*	Sheet																						
Cobalt Base Alloys																								
48	HAYNES* alloy No. 188	Sheet	(72)	(10.3)	84	12.1	100	14.4	112	16.1	125	18.0	138	19.9	152	21.9	167	24.0	174	25.1	189	27.2	204	29.4
49	L-605	Sheet	65	9.4	75	10.8	90	13.0	105	15.2	120	17.3	135	19.5	150	21.6	165	23.8	181	26.1	197	28.4	—	—
Iron-Nickel Alloys																								
50	Alloy 901	Bar	92	13.3	97	14.0	103	14.9	111	16.0	117	16.9	(127)	(18.3)	(134)	(19.3)	(142)	(20.5)	—	—	—	—	—	—
51	A-286	Bar	88	12.7	100	14.4	115	16.6	128	18.5	140	20.2	156	22.5	172	24.8	—	—	—	—	—	—	—	—
52	DISCALOY*	Bar	92	13.3	97	14.0	108	15.6	120	17.3	134	19.3	146	21.1	158	22.8	—	—	—	—	—	—	—	—
53	HAYNES* alloy 556	Sheet	80	11.6	84	12.1	92	13.3	101	14.6	112	16.2	121	17.5	147	20.2	168	24.2	—	—	175	25.2	171	24.7
54	INCOLOY* alloy 800	Bar	80	11.6	89	12.8	103	14.9	115	16.6	127	18.4	139	20.1	152	22.0	166	24.0	181	26.1	214	30.9	—	—
55	INCOLOY* alloy 801	Bar	86	12.4	95	13.7	108	15.6	120	17.4	132	19.1	143	20.7	155	22.4	166	24.0	177	25.6	188	27.1	200	28.8
56	INCOLOY* alloy 802	Bar	82	11.9	91	13.1	103	14.9	114	16.5	126	18.2	137	19.8	148	21.4	158	22.9	168	24.2	177			

TABLE 14 WROUGHT ALLOYS

MEAN COEFFICIENT OF THERMAL EXPANSION (70F to Temp) X 10⁻⁶/°F (20C to Temp) x 10⁻⁶/°C

Ref. No.	Alloy Designation	Form	200F	30C	400F	204C	600F	316C	800F	427C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C
Nickel Base Alloys																						
1	Astrolloy	Bar	7.5	13.5	7.5	13.5	7.5	13.5	7.6	13.7	7.7	13.9	8.0	14.4	8.4	15.2	9.0	16.2	9.7	17.5	10.5	18.5
2	D-979	Bar	7.60	13.7	7.75	14.0	8.00	14.4	8.20	14.8	8.25	14.9	8.55	15.4	9.20	16.6	9.85	17.7	—	—	—	—
3	HASTELLOV* alloy X	Sheet	7.70	13.9	7.82	14.1	7.90	14.2	8.15	14.7	8.39	15.1	8.56	15.4	8.81	15.9	9.02	16.2	9.20	16.6	—	—
4	HASTELLOV* alloy S	Bar	6.4	11.6	6.8	12.2	7.1	12.8	7.3	13.1	7.4	13.3	7.6	13.7	8.0	14.4	8.3	14.9	8.55	15.4	8.8	15.8
5	INCONEL* alloy 600	Bar	7.4	13.3	7.7	13.9	7.9	14.2	8.1	14.6	8.4	15.1	8.6	15.5	8.9	16.0	9.1	16.4	9.3	16.7	—	—
6	INCONEL* alloy 601	Bar	7.6	13.7	8.0	14.4	8.1	14.6	8.3	14.9	8.5	15.3	8.9	16.0	9.2	16.5	9.5	17.1	9.8	17.6	10.2	18.3
7	INCONEL* alloy 617	Bar	6.4	11.6	7.0	12.6	7.4	13.3	7.6	13.7	7.7	13.9	8.0	14.4	8.4	15.1	8.7	15.7	9.0	16.2	9.2	16.6
8	INCONEL* alloy 625	Bar	7.1	12.8	7.3	13.1	7.4	13.3	7.6	13.7	7.8	14.0	8.2	14.8	8.5	15.3	8.8	15.8	9.2	16.6	—	—
9	INCONEL* alloy 690	Bar	7.5	13.5	—	—	8.5	15.3	—	—	—	—	9.0	16.2	—	—	—	—	9.8	17.6	—	—
10	INCONEL* alloy 706	Bar	7.4	13.3	8.1	14.6	8.4	15.1	8.6	15.5	8.7	15.7	9.0	16.2	—	—	—	—	—	—	—	—
11	INCONEL* alloy 718	Bar	6.8	12.2	7.4	13.3	7.6	13.8	7.8	14.0	8.0	14.4	8.3	14.9	—	—	—	—	—	—	—	—
12	INCONEL* alloy X750	Bar	7.0	12.6	7.1	12.9	7.5	13.4	7.8	14.0	8.1	14.6	8.4	15.1	8.8	15.9	9.3	16.8	9.8	17.6	—	—
13	INCONEL* alloy MA 754	Bar	6.9	12.4	7.4	13.3	7.6	13.8	7.9	14.3	8.1	14.6	8.4	15.2	8.8	15.9	9.1	16.3	9.3	16.8	9.6	17.3
14	IN-102	Bar	7.32	13.2	7.43	13.4	7.65	13.8	7.85	14.1	8.02	14.4	8.32	15.0	8.75	15.8	—	—	—	—	—	—
15	IN-587	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	IN-597	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	M-252	Bar	5.9	10.6	6.2	11.2	6.4	11.5	6.8	12.2	7.2	13.0	7.6	13.7	8.1	14.6	8.5	15.3	—	—	—	—
18	NIMONIC* alloy 75	Bar	6.35	11.4	6.91	12.4	7.48	13.5	7.86	14.2	8.16	14.7	8.47	15.3	8.90	16.0	9.44	17.0	10.30	18.4	—	—
19	NIMONIC* alloy 80A	Bar	7.0	12.6	7.2	13.0	7.4	13.3	7.6	13.7	7.7	13.9	7.9	14.2	8.2	14.8	8.6	15.5	—	—	—	—
20	NIMONIC* alloy 81	Bar	6.4	11.5	6.8	12.2	7.3	13.1	7.6	13.7	7.9	14.2	8.3	14.9	8.8	15.8	9.7	17.5	10.8	19.4	—	—
21	NIMONIC* alloy 90	Bar	6.4	11.5	7.0	12.6	7.2	13.0	7.5	13.5	7.7	13.9	8.1	14.6	8.5	15.3	9.0	16.2	—	—	—	—
22	NIMONIC* alloy 105	Bar	6.7	12.1	7.0	12.6	7.3	13.1	7.6	13.7	7.7	13.9	7.9	14.2	8.3	14.9	8.9	16.0	9.8	17.6	—	—
23	NIMONIC* alloy 115	Bar	6.4	11.5	6.5	11.7	6.8	12.2	7.2	13.0	7.4	13.3	7.9	14.2	8.5	15.3	9.1	16.4	9.8	17.6	—	—
24	NIMONIC* alloy 263	Sheet	6.3	11.3	6.6	11.9	7.0	12.6	7.4	13.3	7.6	13.7	7.9	14.2	8.3	14.9	9.0	16.2	9.6	17.3	—	—
25	NIMONIC* alloy 942	Bar	7.3	13.2	7.5	13.5	7.8	14.0	8.0	14.4	8.2	14.7	8.3	15.0	8.6	15.5	9.2	16.5	10.0	18.0	—	—
26	NIMONIC* alloy PE11	Bar	7.1	12.8	7.7	13.8	8.1	14.5	8.3	14.9	8.4	15.2	8.8	15.9	—	—	—	—	—	—	—	—
27	NIMONIC* alloy PE16	Bar	6.5	11.7	7.4	13.3	7.9	14.2	8.3	14.9	8.5	15.3	8.8	15.8	9.6	17.3	10.3	18.5	10.7	19.3	—	—
28	NIMONIC* alloy PK33	Sheet	6.1	11.0	6.4	11.5	6.8	12.2	7.2	13.0	7.3	13.1	7.6	13.7	8.1	14.6	9.0	16.2	10.0	18.0	—	—
29	PYROMET* 860	Bar	7.80	14.0	7.98	14.4	8.18	14.7	8.37	15.0	8.56	15.4	8.75	15.8	8.94	16.1	9.13	16.4	9.32	16.8	—	—
30	RENÉ 41*	Bar	6.63	11.9	6.81	12.2	7.05	12.7	7.23	13.0	7.51	13.5	7.80	14.0	8.20	14.8	8.68	15.6	9.26	16.7	9.86	17.7
31	RENÉ 41*	Sheet	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32	RENÉ 95	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33	RGT* 4	Bar	6.6	11.8	7.0	12.6	7.3	13.1	7.5	13.5	7.7	13.8	7.9	14.3	8.3	14.9	8.7	15.6	—	—	—	—
34	RGT* 13	Bar	6.4	11.5	7.0	12.6	7.3	13.1	7.5	13.5	7.7	13.8	8.1	14.6	8.7	15.6	9.3	16.7	—	—	—	—
35	TD Nickel	Bar	6.0	10.8	6.8	12.2	7.4	13.3	7.8	14.0	7.9	14.2	8.0	14.4	8.3	14.9	8.6	15.5	8.8	15.8	—	—
36	TD Nickel	Sheet	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
37	TD NiCr	Sheet	7.0	12.6	7.2	13.0	7.5	13.5	7.9	14.2	8.1	14.6	8.3	14.9	8.7	15.7	9.0	16.2	9.2	16.6	9.4	16.9
38	UDIMET* 400	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
39	UDIMET* 500	Bar	6.75	12.1	7.15	12.9	7.40	13.3	7.60	13.7	7.80	14.0	8.05	14.5	8.50	15.3	8.95	16.1	—	—	—	—
40	UDIMET* 520	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
41	UDIMET* 630	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
42	UDIMET* 700	Bar	7.50	13.5	7.50	13.5	7.52	13.5	7.60	13.7	7.74	13.9	7.98	14.4	8.35	15.0	8.95	16.1	9.65	17.4	10.30	18.5
43	UDIMET* 710	Bar	6.70	12.1	6.90	12.4	7.10	12.8	7.40	13.3	7.55	13.6	7.75	14.0	8.10	14.6	8.60	15.5	9.20	16.6	—	—
44	UNITEMP* AF2-1DA	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
45	UNITEMP* AF2-1DA	Sheet	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
46	WASPALOY*	Bar	6.8	12.2	7.1	12.8	7.4	13.3	7.6	13.7	7.8	14.0	8.0	14.4	8.5	15.3	8.9	16.0	9.8	17.6	10.4	18.7
47	WASPALOY*	Sheet	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cobalt Base Alloys																						
48	HAYNES* alloy No. 188	Sheet	6.6	11.9	7.0	12.2	7.4	13.3	7.8	14.0	8.2	14.8	8.6	15.5	9.0	16.3	9.4	17.0	9.9	17.7	10.3	18.5
49	L-605	Sheet	6.83	12.3	7.19	12.9	7.59	13.7	7.77	14.0	8.02	14.4	8.24	14.8	8.61	15.5	9.06	16.3	9.41	17.0	9.84	17.7
Iron-Nickel Alloys																						
50	Alloy 901	Bar	7.75	14.0	7.85	14.1	8.02	14.4	8.27	14.9	8.50	15.3	8.79	15.8	9.15	16.5	—	—	—	—	—	—
51	A-286	Bar	9.17	16.5	9.35	16.8	9.47	17.0	9.64	17.4	9.78	17.6	9.88	17.8	10.32	18.6	—	—	—	—	—	—
52	DISCALOY*	Bar	8.5	15.3	8.7	15.7	9.1	16.4	9.4	16.9	9.5	17.1	9.6	17.3	9.8	17.6	—	—	—	—	—	—
53	HAYNES* alloy 556	Sheet	7.8	14.0	8.3	14.7	8.6	15.2	8.8	15.8	9.0	16.2	9.3	16.7	9.5	17.1	9.7	17.5	9.9	17.7	—	—
54	INCOLOY* alloy 800	Bar	7.9	14.2	8.8	15.8	9.0	16.2	9.2	16.6	9.4	16.4	9.6	17.3	9.9	17.8	10.2	18.4	—	—	—	—
55	INCOLOY* alloy 801	Bar	7.8	14.0	8.7	15.7	9.2	16.6	9.4	16.9	9.6	17.3	9.8	17.6	10.1	18.2	10.4	18.7	10.5	18.9	—	—
56	INCOLOY* alloy 802	Bar	7.8	14.0	8.7	15.7	8.9	16.0	9.1	16.4	9.3	16.7	9.5	17.1	9.8	17.6	10.1	18.2	—	—	—	—
57	INCOLOY* alloy 807	Bar	6.55	1																		

TABLE 15 WROUGHT ALLOYS

Ref. No.	Alloy Designation	Form	DYNAMIC MODULUS OF ELASTICITY, X 10 ⁶ psi GN/m ²																					
			70F	21C	200F	93C	400F	204C	600F	316C	800F	427C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C
Nickel Base Alloys																								
1	Astroloy	Bar																						
2	D-979	Bar	30.0	207	29.8	206	29.3	202	28.6	197	27.5	190	25.8	178	24.2	167	22.6	156	21.2	146	—	—	—	—
3	HASTELLOY* alloy X	Sheet	28.6	197	28.1	194	26.9	186	25.8	178	24.6	170	23.4	161	22.3	154	21.1	146	19.9	137	18.5	128	—	—
4	HASTELLOY* alloy S	Bar	30.8	212									26.4	182	25.2	174	24.1	166			19.2	132	—	—
5	INCONEL* alloy 600	Bar	31.1	214	30.5	210	29.7	205	28.8	199	27.8	192	26.7	184	25.5	176	24.3	168	22.8	157	21.0	145	—	—
6	INCONEL* alloy 601	Bar	30.0	207	29.4	203	28.5	196	27.6	190	26.6	184	25.4	175	24.1	166	22.5	155	20.5	141	18.4	127	16.2	112
7	INCONEL* alloy 617	Bar	30.4	210	29.8	205	28.8	199	27.8	192	26.7	184	25.6	176	24.4	168	23.2	160	21.8	150	20.2	139	—	—
8	INCONEL* alloy 625	Bar	30.1	208	29.6	204	28.7	198	27.8	192	26.9	186	25.9	179	24.7	170	23.3	161	21.4	148	—	—	—	—
9	INCONEL* alloy 690	Bar	30.5	210	30.0	207	29.1	201	28.1	194	27.1	187	26.0	180	24.8	171	23.5	162	22.2	153	—	—	—	—
10	INCONEL* alloy 706	Bar	30.4	210	29.9	206	29.0	200	27.9	192	27.0	186	25.9	179	24.7	170	—	—	—	—	—	—	—	—
11	INCONEL* alloy 718	Bar	29.0	200	28.4	196	27.6	190	26.7	184	25.8	178	24.8	171	23.7	163	22.3	154	20.2	139	17.4	120	14.3	99
12	INCONEL* alloy X750	Bar	31.0	214	30.0	207	29.2	202	28.3	195	27.4	189	26.7	184	25.5	176	24.0	166	22.1	153	20.0	138	—	—
13	INCONEL* alloy MA 754	Bar	21.0	145	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	IN-102	Bar	29.7	205	29.1	201	28.1	194	27.2	188	26.2	181	25.2	184	24.1	166	22.6	156	21.1	146	—	—	—	—
15	IN-587	Bar	32.1	222																				
16	IN-597	Bar	27.0	186									(23.0)	(159)	(21.7)	(150)	(19.7)	(136)	—	—	—	—	—	—
17	M-252	Bar	29.8	206	29.6	204	29.0	200	28.1	194	27.2	188	25.7	177	24.4	168	22.6	156	21.0	145	—	—	—	—
18	NIMONIC* alloy 75	Bar	32.0	221	31.2	215	30.5	210	29.2	202	28.2	195	27.0	186	25.5	176	24.6	170	22.6	156	20.5	141	—	—
19	NIMONIC* alloy 80A	Bar	31.8	219	31.2	215	30.2	208	29.3	202	28.3	195	27.2	188	26.0	179	24.6	170	22.7	157	—	—	—	—
20	NIMONIC* alloy 81	Bar	28.4	196	28.1	194	27.3	188	26.2	181	25.3	175	24.2	167	23.1	159	22.0	152	20.0	138	18.3	126	—	—
21	NIMONIC* alloy 90	Bar	32.7	226	31.8	219	30.9	213	29.9	206	28.8	199	27.6	190	26.3	181	24.7	170	22.9	158	20.8	144	—	—
22	NIMONIC* alloy 105	Bar	32.3	223	31.8	219	30.7	212	29.9	206	28.0	193	27.0	186	25.8	178	24.4	168	22.5	155	20.0	138	—	—
23	NIMONIC* alloy 115	Bar	32.4	224	31.8	219	31.0	214	29.6	204	28.2	195	27.2	188	26.3	181	25.1	173	23.8	164	22.2	153	—	—
24	NIMONIC* alloy 263	Sheet	32.1	222	31.7	219	30.7	212	29.6	204	28.5	197	27.5	190	26.2	181	24.8	171	22.9	158	21.1	146	—	—
25	NIMONIC* alloy 942	Bar	28.4	196	27.9	192	26.9	186	25.9	179	25.1	173	24.1	166	22.9	158	21.8	150	20.0	138	17.7	122	—	—
26	NIMONIC* alloy PE11	Bar	28.7	198	28.0	193	27.0	186	26.1	180	25.1	173	24.0	166	22.8	157	—	—	—	—	—	—	—	—
27	NIMONIC* alloy PE16	Bar	28.8	199	28.0	193	27.1	187	26.1	180	25.0	173	23.9	165	22.7	157	21.3	147	19.9	137	18.0	124	—	—
28	NIMONIC* alloy PK33	Sheet	32.1	222	31.6	218	30.6	211	29.7	205	28.6	197	27.6	191	26.5	183	25.1	173	23.5	162	20.7	143	—	—
29	PYROMET* 860	Bar	29.0	200																				
30	RENÉ 41*	Bar	31.9	220	31.3	216	30.4	210	29.5	204	28.6	197	27.7	191	26.4	182	25.1	173	23.6	163	—	—	—	—
31	RENÉ 41*	Sheet																						
32	RENÉ 95	Bar	30.3	209	30.0	207	29.3	202	28.5	197	27.5	190	26.5	183	25.5	176	24.3	168	—	—	—	—	—	—
33	RGT* 4	Bar																						
34	RGT* 13	Bar																						
35	TD Nickel	Bar	22.0	152	21.0	145	19.5	135	18.2	126	17.4	120	16.8	116	16.2	112	15.6	108	14.7	101	13.2	92	11.7	82
36	TD Nickel	Sheet																						
37	TD NiCr	Sheet																						
38	UDIMET* 400	Bar																						
39	UDIMET* 500	Bar	32.1	222	31.6	218	30.6	211	29.8	206	28.8	199	27.7	191	26.5	183	25.1	173	23.4	161	21.0	145	—	—
40	UDIMET* 520	Bar																						
41	UDIMET* 630	Bar																						
42	UDIMET* 700	Bar	32.4	224	32.0	221	31.2	215	30.2	208	29.1	201	28.1	194	27.0	186	25.7	177	24.2	167	22.1	153	—	—
43	UDIMET* 710	Bar	32.1	222																	23.3	161	—	—
44	UNITEMP* AF2-1DA	Bar	34.0	235																				
45	UNITEMP* AF2-1DA	Sheet																						
46	WASPALOY*	Bar	30.9	213	30.4	210	29.5	204	28.6	197	27.7	191	26.7	184	25.6	177	24.3	168	22.9	158	21.1	146	—	—
47	WASPALOY*	Sheet																						
Cobalt Base Alloys																								
48	HAYNES* alloy No. 188	Sheet	31.4	216	(31.0)	(214)	30.3	209	(29.6)	(204)	28.8	199	(27.9)	(192)	26.8	185	(25.4)	(175)	24.0	166	(22.5)	(155)	20.6	142
49	L-605	Sheet	32.6	225	32.2	222	30.8	212	28.5	197	28.2	195	27.0	186	25.5	176	24.3	168	23.0	159	21.5	148	—	—
Iron-Nickel Alloys																								
50	Alloy 901	Bar	29.9	206	29.5	204	28.5	197	26.5	183	25.9	179	24.2	167	22.1	153	—	—	—	—	—	—	—	—
51	A-286	Bar	29.1	201	28.3	195	27.1	187	26.0	179	24.8	171	23.5	162	22.2	153	20.6	142	18.9	130	—	—	—	—
52	DISCALOY*	Bar	28.4	196	27.6	190	26.3	182	25.0	173	23.6	163	22.3	154	21.0	145	—	—	—	—	—	—	—	—
53	HAYNES* alloy 556	Sheet	29.5	203	28.8	199	27.6	190	26.3	181	25.1	173	23.9	165	22.6	156	21.1	146	19.9	137	18.7	129	—	—
54	INCOLOY* alloy 800	Bar	28.4	196	27.6	190	26.6	184	25.4	175	24.4	168	23.4	161	22.3	154	21.1	146	20.0	138	18.7	129	17.2	119
55	INCOLOY* alloy 801	Bar	30.1	208	29.4	203	28.2	194	27.0	186	25.8	178	24.7	170	23.5	162	22.3	154	20.9	144	19.6	135	17.8	123
56	INCOLOY* alloy 802	Bar	29.7	205	29.0	200	27.9	192	26.8	185	25.7	177	24.5	169	23.4	161	22.6	156	22.0	152	—	—	—	—
57	INCOLOY* alloy 807	Bar	26.6	184	26.2	181	25.4	175	24.5	169	23.4	161	2											

TABLE 16 WROUGHT ALLOYS

Ref. No.	Alloy Designation	Form	YIELD STRENGTH (0.2% OFFSET), 1 000 psi								MN/m ²					
			70F	21C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C
Nickel Base Alloys																
1	Astrolloy	Bar	152	1050	140	965	140	965	132	910	100	690	40	275	—	—
2	D-979	Bar	146	1005	134	925	129	890	95	655	44	305	—	—	—	—
3	HASTELLO [®] alloy X	Sheet	52	360	42	290	40	275	38	260	26	180	16	110	8.0	55
4	HASTELLO [®] alloy S	Bar	56	385	41	280	40	275	39	270	34	235	20	140	9.0	62
5	INCONEL [®] alloy 600	Bar	41	285	32	220	30	205	26	180	11	75	6	41	—	—
6	INCONEL [®] alloy 601	Bar	66	455	51	350	45	310	32	220	16	110	8	55	4	28
7	INCONEL [®] alloy 617	Bar	43	295	29	200	25	170	26	180	28	195	20	140	8	55
8	INCONEL [®] alloy 625	Bar	71	490	60	415	61	420	60	415	40	275	20	140	11	76
9	INCONEL [®] alloy 690	Bar	45	310	36	250	31	215	24	165	—	—	—	—	—	—
10	INCONEL [®] alloy 706	Bar	146	1005	132	910	125	860	96	660	—	—	—	—	—	—
11	INCONEL [®] alloy 718	Bar	163	1125	148	1020	140	965	116	800	—	—	—	—	—	—
12	INCONEL [®] alloy X750	Bar	118	815	105	725	103	710	—	—	—	—	—	—	—	—
13	INCONEL [®] alloy MA 754	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	IN-102	Bar	73	505	58	400	58	400	56	385	29	200	—	—	—	—
15	IN-587	Bar	102	705	90	620	89	615	88	605	58	400	15	105	—	—
16	IN-597	Bar	110	760	104	720	98	675	96	665	—	—	—	—	—	—
17	M-252	Bar	122	840	111	765	108	745	104	720	70	485	—	—	—	—
18	NIMONIC [®] alloy 75	Bar	41	285	29	200	29	200	23	160	13	90	7.3	50	—	—
19	NIMONIC [®] alloy 80A	Bar	90	620	77	530	80	550	73	505	38	260	9.0	62	—	—
20	NIMONIC [®] alloy 81	Bar	87	600	73	505	72	495	65	450	—	—	—	—	—	—
21	NIMONIC [®] alloy 90	Bar	117	810	105	725	99	685	78	540	38	260	9.0	62	—	—
22	NIMONIC [®] alloy 105	Bar	120	830	112	775	111	765	107	740	71	490	30	205	—	—
23	NIMONIC [®] alloy 115	Bar	125	865	115	795	118	815	116	800	80	550	35	240	—	—
24	NIMONIC [®] alloy 263	Sheet	84	580	70	485	70	485	67	460	26	180	12	83	—	—
25	NIMONIC [®] alloy 942	Bar	154	1060	141	970	145	1000	125	860	—	—	—	—	—	—
26	NIMONIC [®] alloy PE11	Bar	105	720	100	690	97	670	81	560	—	—	—	—	—	—
27	NIMONIC [®] alloy PE16	Bar	77	530	70	485	70	485	54	370	20	140	7.3	50	—	—
28	NIMONIC [®] alloy PK33	Sheet	113	780	105	725	105	725	97	670	61	420	19	130	—	—
29	PYROMET [®] 860	Bar	121	835	122	840	123	850	121	835	—	—	—	—	—	—
30	RENÉ 41 [®]	Bar	154	1060	147	1020	145	1000	136	940	80	550	38	260	—	—
31	RENÉ 41 [®]	Sheet	148	1020	136	940	130	895	121	835	74	510	25	175	—	—
32	RENÉ 95	Bar	190	1310	183	1260	178	1225	160	1105	—	—	—	—	—	—
33	RGT [®] 4	Bar	106	730	100	690	98	675	85	585	(30)	(205)	—	—	—	—
34	RGT [®] 13	Bar	113	780	108	745	105	725	87	600	(63)	(435)	—	—	—	—
35	TD Nickel	Bar	80	550	43	295	36	250	31	215	26	180	20	140	16	110
36	TD Nickel	Sheet	45	310	30	205	26	180	23	160	19	130	17	115	12	83
37	TD NiCr	Sheet	89	615	65	450	53	365	38	260	26	180	19	130	15	105
38	UDIMET [®] 400	Bar	135	930	120	830	—	—	—	—	—	—	—	—	—	—
39	UDIMET [®] 500	Bar	122	840	115	795	110	760	106	730	72	495	33	230	—	—
40	UDIMET [®] 520	Bar	125	860	120	830	115	795	105	725	75	520	45	310	—	—
41	UDIMET [®] 630	Bar	190	1310	170	1170	160	1105	125	860	—	—	—	—	—	—
42	UDIMET [®] 700	Bar	140	965	130	895	124	855	120	830	92	635	44	305	12	83
43	UDIMET [®] 710	Bar	132	910	123	850	125	860	118	815	92	635	39	270	—	—
44	UNITEMP [®] AF2-1DA	Bar	155	1070	160	1105	158	1090	145	1000	105	725	50	345	—	—
45	UNITEMP [®] AF2-1DA	Sheet	132	910	—	—	142	980	131	905	88	605	40	275	—	—
46	WASPALOY [®]	Bar	115	795	105	725	100	690	98	675	75	520	20	140	—	—
47	WASPALOY [®]	Sheet	122	840	120	830	—	—	—	—	—	—	—	—	—	—
Cobalt Base Alloys																
48	HAYNES [®] alloy No. 188	Sheet	70	485	44	305	44	305	42	290	38	260	24	165	12	83
49	L-605	Sheet	67	460	36	250	35	240	38	260	35	240	23	160	12	83
Iron-Nickel Alloys																
50	Alloy 901	Bar	130	895	113	780	110	760	92	635	—	—	—	—	—	—
51	A-286	Bar	105	725	88	605	88	605	62	430	—	—	—	—	—	—
52	DISCALOY [®]	Bar	106	730	94	650	91	630	62	430	—	—	—	—	—	—
53	HAYNES [®] alloy 556	Sheet	57	395	35	240	34	235	33	230	27	185	17	115	7.5	52
54	INCOLOY [®] alloy 800	Bar	36	250	26	180	26	180	22	150	—	—	—	—	—	—
55	INCOLOY [®] alloy 801	Bar	56	385	45	310	44	305	42	290	—	—	—	—	—	—
56	INCOLOY [®] alloy 802	Bar	42	290	28	195	29	200	29	200	22	150	13	90	9	62
57	INCOLOY [®] alloy 807	Bar	55	380	37	255	35	240	32.5	225	26.5	185	14.5	100	—	—
58	INCOLOY [®] alloy 903	Bar	160	1105	—	—	130	895	—	—	—	—	—	—	—	—
59	INCOLOY [®] alloy 904	Bar	110	760	—	—	—	—	—	—	—	—	—	—	—	—
60	N-155	Bar	58	400	49	340	43	295	36	250	25	175	—	—	—	—
61	V-57	Bar	120	830	110	760	108	745	70	485	—	—	—	—	—	—

*See inside back cover for trademarks.
(Extrapolated values are shown in parentheses)

TABLE 17 WROUGHT ALLOYS

Ref. No.	Alloy Designation	Form	ULTIMATE TENSILE STRENGTH, 1000 psi								MN/m ²					
			70F	21C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C
Nickel Base Alloys																
1	Astrolloy	Bar	205	1415	180	1240	190	1310	168	1160	112	775	60	415	—	—
2	D-979	Bar	204	1410	188	1295	160	1105	104	720	50	345	—	—	—	—
3	HASTELLOY* alloy X	Sheet	114	785	94	650	83	570	63	435	37	255	22	150	13	90
4	HASTELLOY* alloy S	Bar	123	850	106	730	99	680	79	545	53	365	33	230	17	115
5	INCONEL* alloy 600	Box	96	660	81	560	65	450	38	260	20	140	11	76	—	—
6	INCONEL* alloy 601	Bar	112	770	93	640	72	495	37	255	18	125	9	62	5	35
7	INCONEL* alloy 617	Bar	107	740	84	580	82	565	64	440	40	275	22	150	12	83
8	INCONEL* alloy 625	Bar	140	965	132	910	121	835	80	550	40	275	20	140	11	76
9	INCONEL* alloy 690	Bar	103	710	84	580	68	470	43	295	—	—	—	—	—	—
10	INCONEL* alloy 706	Bar	190	1310	166	1145	150	1035	105	725	—	—	—	—	—	—
11	INCONEL* alloy 718	Bar	198	1365	173	1195	160	1105	124	855	—	—	—	—	—	—
12	INCONEL* alloy X750	Bar	174	1200	152	1050	136	940	—	—	—	—	—	—	—	—
13	INCONEL* alloy MA 754	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14	IN-102	Bar	139	960	120	830	103	710	64	440	31	215	—	—	—	—
15	IN-587	Bar	171	1180	150	1035	146	1005	120	830	76	525	25	170	—	—
16	IN-597	Bar	177	1220	165	1140	154	1060	135	930	—	—	—	—	—	—
17	M-252	Bar	180	1240	178	1230	168	1160	137	945	74	510	—	—	—	—
18	NIMONIC* alloy 75	Bar	108	745	98	675	78	540	45	310	22	150	12	83	—	—
19	NIMONIC* alloy 80A	Bar	145	1000	127	875	115	795	87	600	45	310	11	76	—	—
20	NIMONIC* alloy 81	Bar	152	1050	124	855	119	820	100	690	45	310	15	105	—	—
21	NIMONIC* alloy 90	Bar	179	1235	156	1075	136	940	95	655	48	330	11	76	—	—
22	NIMONIC* alloy 105	Bar	171	1180	164	1130	159	1095	135	930	96	660	33	230	—	—
23	NIMONIC* alloy 115	Bar	180	1240	158	1090	163	1125	157	1085	120	830	67	460	—	—
24	NIMONIC* alloy 263	Sheet	141	970	116	800	112	775	94	650	40	275	18	125	—	—
25	NIMONIC* alloy 942	Bar	204	1405	189	1300	180	1240	131	900	—	—	—	—	—	—
26	NIMONIC* alloy PE11	Bar	157	1080	145	1000	136	940	110	760	—	—	—	—	—	—
27	NIMONIC* alloy PE16	Bar	128	885	107	740	96	660	74	510	31	215	13	90	—	—
28	NIMONIC* alloy PK33	Sheet	171	1180	145	1000	145	1000	128	885	74	510	74	510	27	185
29	PYROMET* 860	Bar	188	1295	182	1255	161	1110	132	910	—	—	—	—	—	—
30	RENÉ 41*	Bar	206	1420	203	1400	194	1340	160	1105	90	620	42	290	—	—
31	RENÉ 41*	Sheet	185	1275	174	1200	164	1130	140	965	88	605	40	275	—	—
32	RENÉ 95	Bar	235	1620	228	1570	218	1500	170	1170	—	—	—	—	—	—
33	RGT* 4	Bar	170	1170	155	1070	142	980	107	740	60	415	—	—	—	—
34	RGT* 13	Bar	178	1230	160	1105	146	1005	112	775	82	565	—	—	—	—
35	TD Nickel	Bar	100	690	45	310	38	260	33	230	28	195	24	165	20	140
36	TD Nickel	Sheet	65	450	33	230	28	195	25	170	21	145	18	125	14	97
37	TD NiCr	Sheet	137	945	99	685	63	435	39	270	27	185	20	140	16	110
38	UDIMET* 400	Bar	190	1310	172	1185	—	—	—	—	—	—	—	—	—	—
39	UDIMET* 500	Bar	190	1310	180	1240	176	1215	151	1040	93	640	42	290	—	—
40	UDIMET* 520	Bar	190	1310	180	1240	170	1175	105	725	75	515	45	310	—	—
41	UDIMET* 630	Bar	220	1520	200	1380	185	1275	140	965	—	—	—	—	—	—
42	UDIMET* 700	Bar	204	1410	185	1275	180	1240	150	1035	100	690	52	360	15	105
43	UDIMET* 710	Bar	172	1185	167	1150	187	1290	148	1020	102	705	55	380	—	—
44	UNITEMP* AF2-1DA	Bar	205	1415	205	1415	195	1345	170	1170	120	830	65	450	—	—
45	UNITEMP* AF2-1DA	Sheet	198	1365	—	—	191	1315	161	1110	111	765	62	430	—	—
46	WASPALLOY*	Bar	185	1275	170	1170	162	1115	115	795	76	525	28	195	—	—
47	WASPALLOY*	Sheet	190	1310	160	1105	—	—	—	—	—	—	—	—	—	—
Cobalt Base Alloys																
48	HAYNES* alloy No. 188	Sheet	139	960	107	740	103	710	92	635	61	420	37	255	19	130
49	L-605	Sheet	146	1005	116	800	103	710	66	455	47	325	34	235	19	130
Iron-Nickel Alloys																
50	Alloy 901	Bar	175	1205	149	1030	139	960	105	725	—	—	—	—	—	—
51	A-286	Bar	146	1005	131	905	104	720	64	440	—	—	—	—	—	—
52	DISCALOY*	Bar	145	1000	125	865	104	720	70	485	—	—	—	—	—	—
53	HAYNES* alloy 556	Sheet	119	820	96	660	85	585	66	455	43	295	27	185	14	97
54	INCOLOY* alloy 800	Bar	86	595	74	510	59	405	34	235	—	—	—	—	—	—
55	INCOLOY* alloy 801	Bar	114	785	96	660	78	540	47	325	—	—	—	—	—	—
56	INCOLOY* alloy 802	Bar	100	690	87	600	76	525	58	400	28	195	17	115	12	83
57	INCOLOY* alloy 807	Bar	95	655	68	470	64	440	51	350	32	220	22	150	—	—
58	INCOLOY* alloy 903	Bar	190	1310	—	—	145	1000	—	—	—	—	—	—	—	—
59	INCOLOY* alloy 904	Bar	134	925	—	—	—	—	—	—	—	—	—	—	—	—
60	N-155	Bar	118	815	94	650	79	545	62	430	38	260	—	—	—	—
61	V-57	Bar	170	1170	145	1000	130	895	90	620	—	—	—	—	—	—

*See inside back cover for trademarks.

TABLE 18 WROUGHT ALLOYS

Ref. No.	Alloy Designation	Form	TENSILE ELONGATION, %													
			70F	21C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C
Nickel Base Alloys																
1	Astroloy	Bar		16		16		18		21		25		30		—
2	D-979	Bar		15		15		21		17		18		—		—
3	HASTELLOYS* alloy X	Sheet		43		45		37		37		50		45		40
4	HASTELLOYS* alloy S	Bar		55		61		59		69		57		62		69
5	INCONEL* alloy 600	Bar		45		41		49		70		80		115		—
6	INCONEL* alloy 601	Bar		40		34		33		78		128		137		125
7	INCONEL* alloy 617	Bar		70		68		75		84		118		123		89
8	INCONEL* alloy 625	Bar		50		50		34		45		125		155		—
9	INCONEL* alloy 690	Bar		34		31		25		31		—		—		—
10	INCONEL* alloy 706	Bar		20		19		24		32		—		—		—
11	INCONEL* alloy 718	Bar		21		20		20		30		—		—		—
12	INCONEL* alloy X750	Bar		27		26		10		—		—		—		—
13	INCONEL* alloy MA 754	Bar		—		—		—		—		—		—		—
14	IN-102	Bar		47		48		64		110		110		—		—
15	IN-587	Bar		28		22		21		20		16		35		—
16	IN-597	Bar		15		15		15		16		—		—		—
17	M-252	Bar		16		15		11		10		18		—		—
18	NIMONIC* alloy 75	Bar		41		40		41		62		64		59		—
19	NIMONIC* alloy 80A	Bar		39		37		21		17		30		—		—
20	NIMONIC* alloy 81	Bar		36		36		28		24		—		—		—
21	NIMONIC* alloy 90	Bar		33		28		14		12		23		70		—
22	NIMONIC* alloy 105	Bar		16		22		24		25		27		37		132
23	NIMONIC* alloy 115	Bar		27		18		23		24		16		23		—
24	NIMONIC* alloy 263	Sheet		39		42		27		21		25		30		—
25	NIMONIC* alloy 942	Bar		10		12		9		11		—		—		—
26	NIMONIC* alloy PE11	Bar		21		23		12		19		—		—		—
27	NIMONIC* alloy PE16	Bar		37		26		30		42		80		—		—
28	NIMONIC* alloy PK33	Sheet		30		30		26		18		24		50		—
29	PYROJET* 860	Bar		22		15		17		18		—		—		—
30	RENÉ 41*	Bar		14		14		14		11		19		36		—
31	RENÉ 41*	Sheet		15		17		14		10		14		20		—
32	RENÉ 95	Bar		15		12		14		15		—		—		—
33	RGT* 4	Bar		20		12		11		13		18		—		—
34	RGT* 13	Bar		30		29		26		18		17		—		—
35	TD Nickel	Bar		25		14		12		11		9		7		6
36	TD Nickel	Sheet		15		6		5		4		4		4		6
37	TD NiCr	Sheet		20		14.5		11		5		3		2		1.5
38	UDIMET* 400	Bar		30		26		—		—		—		—		—
39	UDIMET* 500	Bar		32		28		28		39		20		22		—
40	UDIMET* 520	Bar		21		20		17		15		20		—		—
41	UDIMET* 630	Bar		15		15		7		5		—		—		—
42	UDIMET* 700	Bar		17		16		16		20		27		32		35
43	UDIMET* 710	Bar		7		10		15		25		29		27		—
44	UNITEMP* AF2-1DA	Bar		15		14		11		9		10		15		—
45	UNITEMP* AF2-1DA	Sheet		10		—		10		9		14		14		—
46	WASPALLOY*	Bar		25		23		34		28		35		—		—
47	WASPALLOY*	Sheet		30		30		—		—		—		—		—
Cobalt Base Alloys																
48	HAYNES* alloy No. 188	Sheet		56		70		61		43		73		72		47
49	L-605	Sheet		64		59		35		12		35		41		34
Iron-Nickel Alloys																
50	Alloy 901	Bar		14		14		13		19		—		—		—
51	A-286	Bar		25		19		13		19		—		—		—
52	DISCALOY*	Bar		19		16		19		—		—		—		—
53	HAYNES* alloy 556	Sheet		54		61		54		45		43		44		42
54	INCOLOY* alloy 800	Bar		44		38		51		83		—		—		—
55	INCOLOY* alloy 801	Bar		30		28		26		55		—		—		—
56	INCOLOY* alloy 802	Bar		44		39		25		15		38		53		53
57	INCOLOY* alloy 807	Bar		48		40		35		34		71		56		—
58	INCOLOY* alloy 903	Bar		14		—		18		—		—		—		—
59	INCOLOY* alloy 904	Bar		19		—		—		—		—		—		—
60	N-155	Bar		40		33		32		32		33		—		—
61	V-57	Bar		26		19		22		34		—		—		—

*See inside back cover for trademarks.

TABLE 19 WROUGHT ALLOYS

		100 HOUR 0.2% CREEP STRENGTH, 1000 psi MN/m ²																							
Ref. No.	Alloy Designation	Form	1200F	849C	1300F	704C	1400F	760C	1500F	818C	1600F	871C	1700F	927C	1800F	982C	1900F	1036C	2000F	1093C	2100F	1199C	2200F	1204C	
Nickel Base Alloys																									
1	Astroloy	Bar																							
2	D-979	Bar																							
3	HASTELLOY* alloy X	Sheet	20	140	13	90	8	55	5	35	3.1	22	1.9	13	1.2	8									
4	HASTELLOY* alloy S	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—									
5	INCONEL* alloy 600	Bar	19	130	13	90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
6	INCONEL* alloy 601	Bar	24	165	11	76	6.3	43	4.3	30	3.2	22	—	—	1.2	8	—	—	—	—	—	—	0.7	5	
7	INCONEL* alloy 617	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
8	INCONEL* alloy 625	Bar	56	385	31	215	19	130	11	76	5.5	38	—	—	1.6	11	—	—	—	—	—	—	—	—	
9	INCONEL* alloy 690	Bar	7.8	54	5.3	37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
10	INCONEL* alloy 706	Bar	80	550	58	400	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
11	INCONEL* alloy 718	Bar	90	620	62	425	33	230	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
12	INCONEL* alloy X750	Bar	76	525	—	—	—	—	22	150	12	83	—	—	—	—	—	—	—	—	—	—	—	—	
13	INCONEL* alloy MA 754	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
14	IN-102	Bar																							
15	IN-587	Bar					46	315																	
16	IN-597	Bar																							
17	M-252	Bar	51	350	43	295	31	215	13	90															
18	NIMONIC* alloy 75	Bar	11	76	7.3	50	4.5	31	2.6	18	1.5	10	0.9	6											
19	NIMONIC* alloy 80A	Bar	72	495	56	385	39	270	20	140															
20	NIMONIC* alloy 81	Bar			40	275	25	170	15	105															
21	NIMONIC* alloy 90	Bar	72	495	62	425	36	250	21	145	12	83													
22	NIMONIC* alloy 105	Bar	91	630	73	505	52	360	35	240	23	160	13	90	4.1	28									
23	NIMONIC* alloy 115	Bar					60	415	43	295	26	180	15	105	6.4	44									
24	NIMONIC* alloy 263	Sheet	—	—	48	330	28	195	15	105	7.5	52	—	—	—	—	—	—	—	—	—	—	—	—	
25	NIMONIC* alloy 942	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
26	NIMONIC* alloy PE11	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
27	NIMONIC* alloy PE16	Bar	48	330	34	235	22	150	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
28	NIMONIC* alloy PK 33	Sheet			44	305	29	200	17	115	9.7	67	—	—	—	—	—	—	—	—	—	—	—	—	
29	PYROMET* 860	Bar	76	525	55	380	38	260	25	170	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
30	RENE 41*	Bar																							
31	RENE 41*	Sheet					60	415	36	250	16	110	—	—											
32	RENE* 95	Bar																							
33	RG T* 4	Bar	80	550	59	405	40	275	23	160	13	90	—	—											
34	RG T* 13	Bar	80	550	58	400	38	260	23	160	13	90	—	—											
35	TD Nickel	Bar																							
36	TD Nickel	Sheet																							
37	TD NiCr	Sheet	25	170	—	—	18	125	—	—	13.5	93	—	—	9.0	62	7.0	48	5.8	40	4.8	33	4.3	30	
38	UDIMET* 400	Bar																							
39	UDIMET* 500	Bar					44	305	30	205															
40	UDIMET* 520	Bar																							
41	UDIMET* 630	Bar																							
42	UDIMET* 700	Bar																							
43	UDIMET* 710	Bar			(86)	(595)	(65)	(450)	—	—	—	—	(19)	(130)											
44	UNITEMP* AF2-1DA	Bar			98	675	70	480	50	345	35	240	23	160											
45	UNITEMP* AF2-1DA	Sheet																							
46	WASPALLOY*	Bar																							
47	WASPALLOY*	Sheet																							
Cobalt Base Alloys																									
48	HAYNES* alloy No. 188	Sheet					13.5	93	—	—	6.3	43	—	—	2.4	17									
49	L-605	Sheet																							
Iron-Nickel Alloys																									
50	Alloy 901	Bar																							
51	A-286	Bar	50	345																					
52	DISCALOY*	Bar																							
53	HAYNES* alloy 556	Sheet	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
54	INCOLOY* alloy 800	Bar	22	150	14	97	8.6	59	—	—	5	34	3	21	—	—	—	—	—	—	—	—	—	—	
55	INCOLOY* alloy 801	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
56	INCOLOY* alloy 802	Bar	25	170	—	—	17	115	—	—	9.1	63	5.1	35	3.1	21	—	—	—	—	—	—	—	—	
57	INCOLOY* alloy 807	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
58	INCOLOY* alloy 903	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
59	INCOLOY* alloy 904	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
60	N-155	Bar																							
61	V-57	Bar	65	450	41	285																			

*See inside back cover for trademarks.
(Extrapolated values are shown in parentheses)

TABLE 20 WROUGHT ALLOYS

Ref. No.	Alloy Designation	Form	100 HOUR RUPTURE STRENGTH, 1000 psi MN/m ²																							
			1200F	649C	1300F	704C	1400F	760C	1500F	816C	1600F	871C	1700F	927C	1800F	982C	1900F	1038C	2000F	1093C	2100F	1149C	2200F	1204C		
Nickel Base Alloys																										
1	Astrolloy	Bar	125	860	105	725	78	540	58	405	37	255	25	175	15	105	—	—	—	—	—	—	—	—	—	—
2	D-979	Bar	90	620	71	490	55	380	33	230	20	140	—	—	—	—	—	—	—	—	—	—	—	—	—	—
3	HASTELLOY* alloy X	Sheet	42	290	31	215	21	145	14	97	9.0	62	6.0	41	3.8	26	2.2	15	1.2	8	—	—	—	—	—	—
4	HASTELLOY* alloy S	Bar	57	395	38	260	24	165	15	105	9.5	66	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	INCONEL* alloy 600	Bar	—	—	—	—	—	—	8.0	55	5.3	37	—	—	2.8	19	—	—	1.4	10	1.1	8	—	—	—	
6	INCONEL* alloy 601	Bar	38	260	21	145	13	90	9.8	68	7.0	48	—	—	3.4	23	—	—	1.6	11	1.2	8	—	—	—	
7	INCONEL* alloy 617	Bar	68	470	44	305	30	205	20	140	13	90	9.5	66	6.0	41	4.2	29	2.7	19	—	—	—	—	—	
8	INCONEL* alloy 625	Bar	64	440	46	315	32	220	18	125	11	76	—	—	4.6	32	—	—	1.8	12	—	—	—	—	—	
9	INCONEL* alloy 690	Bar	25	170	16	110	9.4	65	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
10	INCONEL* alloy 706	Bar	100	690	74	510	43	295	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
11	INCONEL* alloy 718	Bar	105	725	74	510	44	305	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
12	INCONEL* alloy X750	Bar	80	550	—	—	—	—	26	180	12	83	8.2	57	3.2	22	—	—	—	—	—	—	—	—	—	
13	INCONEL* alloy MA 754	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	19	131	—	—	—	—	—	
14	IN-102	Bar	67	460	37	255	20	140	12	83	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
15	IN-587	Bar	—	—	79	545	58	400	40	275	23	160	—	—	—	—	—	—	—	—	—	—	—	—	—	
16	IN-597	Bar	—	—	88	605	67	460	48	330	30	205	17	115	15	66	—	—	—	—	—	—	—	—	—	
17	M-252	Bar	98	675	73	505	52	360	35	240	23	160	—	—	—	—	—	—	—	—	—	—	—	—	—	
18	NIMONIC* alloy 75	Bar	37	255	20	140	11	76	5.7	39	3.6	25	2.1	14	1.4	10	0.8	6	—	—	—	—	—	—	—	
19	NIMONIC* alloy 80A	Bar	86	595	64	440	45	310	23	195	14	97	7.0	48	2.0	14	—	—	—	—	—	—	—	—	—	
20	NIMONIC* alloy 81	Bar	70	485	54	370	35	240	20	140	10	69	—	—	—	—	—	—	—	—	—	—	—	—	—	
21	NIMONIC* alloy 90	Bar	86	595	66	455	49	340	32	220	18.5	130	8.5	59	2.5	17	—	—	—	—	—	—	—	—	—	
22	NIMONIC* alloy 105	Bar	115	815	90	620	70	485	46	320	29	200	18	125	8.8	61	4.4	30	—	—	—	—	—	—	—	
23	NIMONIC* alloy 115	Bar	—	—	96	660	76	525	58	400	41	285	27	185	16	110	9.0	62	4.4	30	2.0	14	—	—	—	
24	NIMONIC* alloy 263	Sheet	73	505	54	370	38	260	24	165	13	90	6.0	41	2.4	17	—	—	—	—	—	—	—	—	—	
25	NIMONIC* alloy 942	Bar	93	640	73	500	51	350	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
26	NIMONIC* alloy PE11	Bar	65	445	47	325	31	215	17.5	120	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
27	NIMONIC* alloy PE16	Bar	68	470	47	325	28	195	16	110	7.3	50	—	—	—	—	—	—	—	—	—	—	—	—	—	
28	NIMONIC* alloy PK33	Sheet	102	705	80	550	61	420	43	300	25	175	13	90	5.4	37	—	—	—	—	—	—	—	—	—	
29	PYROMET* 860	Bar	98	675	74	510	52	360	35	240	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
30	RENE 41*	Bar	110	760	95	665	68	470	45	310	28	195	18	125	10	69	—	—	—	—	—	—	—	—	—	
31	RENE 41*	Sheet	92	635	75	515	55	380	40	275	26	180	18	125	9.0	62	—	—	—	—	—	—	—	—	—	
32	RENE* 95	Bar	150	1035	105	725	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
33	RGT* 4	Bar	85	585	66	455	45	310	28	195	15	105	—	—	—	—	—	—	—	—	—	—	—	—	—	
34	RGT* 13	Bar	85	585	69	475	50	345	35	240	22	150	—	—	—	—	—	—	—	—	—	—	—	—	—	
35	TD Nickel	Bar	28	195	26	180	23	160	21	145	19	130	17	115	15	105	13	90	11	76	9.0	62	8.0	55		
36	TD Nickel	Sheet	22	150	20	140	18	125	16	110	14	97	13	90	12	83	10	69	8.6	55	6.5	45	5.0	35		
37	TD NiCr	Sheet	—	—	—	—	—	—	—	—	—	—	12	83	9.5	65	7.5	52	6.6	41	5.0	35	4.5	31		
38	UDIMET* 400	Bar	110	760	85	585	62	430	43	295	26	180	14	97	—	—	—	—	—	—	—	—	—	—	—	
39	UDIMET* 500	Bar	135	930	99	680	66	455	44	305	29	200	20	140	12	83	—	—	—	—	—	—	—	—	—	
40	UDIMET* 520	Bar	—	—	81	560	65	450	47	325	32	220	21	145	—	—	—	—	—	—	—	—	—	—	—	
41	UDIMET* 630	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
42	UDIMET* 700	Bar	—	—	98	675	78	540	58	400	43	295	27	185	16	110	8.0	55	—	—	—	—	—	—	—	
43	UDIMET* 710	Bar	—	—	93	780	89	600	61	440	45	310	30	205	19	130	—	—	—	—	—	—	—	—	—	
44	UNITEMP* AF2-1DA	Bar	150	1035	120	830	95	655	70	485	52	360	36	250	22	150	—	—	—	—	—	—	—	—	—	
45	UNITEMP* AF2-1DA	Sheet	145	1000	115	815	90	620	70	485	52	360	36	250	18	125	—	—	—	—	—	—	—	—	—	
46	WASPALOY*	Bar	110	760	85	585	60	415	40	275	25	175	14	97	6.5	45	—	—	—	—	—	—	—	—	—	
47	WASPALOY*	Sheet	110	760	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Cobalt Base Alloys																										
48	HAYNES* alloy No. 188	Sheet	—	—	47	325	33	230	23	160	15	105	10	69	6.0	41	3.8	26	2.2	15	—	—	—	—	—	
49	L-605	Sheet	48	330	39	270	29	195	22	150	15	105	10	69	7.0	48	4.8	33	2.8	19	—	—	—	—	—	
Iron-Nickel Alloys																										
50	Alloy 901	Bar	92	635	70	485	44	305	24	165	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
51	A-286	Bar	61	420	44	305	27	185	13	90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
52	DISCALOY*	Bar	49	340	30	220	18	125	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
53	HAYNES* alloy 556	Sheet	53	365	37	255	26	180	17	115	11.5	80	7.5	52	4.7	32	2.8	19	1.6	11	—	—	—	—	—	
54	INCOLOY* alloy 800	Bar	33	230	22	150	13	90	9.2	63	6.0	41	4.3	30	3.1	21	—	—	—	—	—	—	—	—	—	
55	INCOLOY* alloy 801	Bar	37	255	—	—	—	—	9.2	63	—	—	—	—	2.4	16	—	—	—	—	—	—	—	—	—	
56	INCOLOY* alloy 802	Bar	36	250	—	—	—	—	—	—	14	97	9.5	66	7	48	—	—	3	21	2					

TABLE 21 WROUGHT ALLOYS

		1000 HOUR RUPTURE STRENGTH, 1000 psi MN/m²																								
Ref. No.	Alloy Designation	Form	1200F	649C	1300F	704C	1400F	760C	1500F	816C	1600F	871C	1700F	927C	1800F	982C	1900F	1038C	2000F	1093C	2100F	1149C	2200F	1204C		
Nickel Base Alloys																										
1	Astrolloy	Bar	112	770	84	580	62	430	42	290	25	175	16	110	8.0	55	—	—	—	—	—	—	—	—	—	—
2	D-979	Bar	75	515	55	380	36	250	21	145	10	69	—	—	—	—	—	—	—	—	—	—	—	—	—	
3	HASTELLOY* alloy X	Sheet	31	215	22	150	15	100	10	69	6.0	41	3.6	25	2.0	14	1.1	8	0.6	4	—	—	—	—	—	
4	HASTELLOY* alloy S	Bar	39	270	25	170	15.5	105	9.5	68	5.5	38	—	—	—	—	—	—	—	—	—	—	—	—	—	
5	INCONEL* alloy 600	Bar	—	—	—	—	—	—	5.6	39	3.5	24	—	—	1.8	12	—	—	0.9	6	—	—	—	—	—	
6	INCONEL* alloy 601	Bar	28	195	13	90	9.1	63	6.2	43	4.3	30	—	—	2.1	14	—	—	1.0	7	0.8	6	—	—	—	
7	INCONEL* alloy 617	Bar	52	360	32	220	24	165	14	97	9.2	63	6.2	43	3.8	26	2.7	19	1.5	10	—	—	—	—	—	
8	INCONEL* alloy 625	Bar	54	370	35	240	23	160	13	90	7.1	49	—	—	2.6	18	—	—	—	—	—	—	—	—	—	
9	INCONEL* alloy 690	Bar	14.5	100	9.3	64	6.0	41	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
10	INCONEL* alloy 706	Bar	84	580	53	365	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
11	INCONEL* alloy 718	Bar	86	595	53	365	28	195	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
12	INCONEL* alloy X750	Bar	68	470	—	—	—	—	15	105	6.5	45	3.0	21	—	—	—	—	—	—	—	—	—	—	—	
13	INCONEL* alloy MA 754	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17.9	125	—	—	—	—	—	
14	IN-102	Bar	52	360	26	180	13	90	7.4	51	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
15	IN-587	Bar	—	—	63	435	41	285	24	165	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
16	IN-597	Bar	—	—	75	515	49	340	31	215	18	125	—	—	—	—	—	—	—	—	—	—	—	—	—	
17	M-252	Bar	82	565	60	415	39	270	23	160	14	97	—	—	—	—	—	—	—	—	—	—	—	—	—	
18	NIMONIC* alloy 75	Bar	25	170	14	97	7.0	48	4.0	28	1.0	7	0.7	5	0.5	3	0.4	3	0.3	2	—	—	—	—	—	
19	NIMONIC* alloy 80A	Bar	61	420	39	270	23	160	12	83	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
20	NIMONIC* alloy 81	Bar	53	365	35	240	21	145	11	76	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
21	NIMONIC* alloy 90	Bar	66	455	47	325	30	205	16	110	8.8	61	—	—	—	—	—	—	—	—	—	—	—	—	—	
22	NIMONIC* alloy 105	Bar	—	—	—	—	48	330	34	235	19	130	9.0	62	4.4	30	—	—	—	—	—	—	—	—	—	
23	NIMONIC* alloy 115	Bar	—	—	—	—	61	420	41	285	27	185	16	110	9.5	66	—	—	—	—	—	—	—	—	—	
24	NIMONIC* alloy 263	Sheet	60	415	42	275	26	175	13	90	6.3	63	—	—	—	—	—	—	—	—	—	—	—	—	—	
25	NIMONIC* alloy 942	Bar	75	520	58	400	39	270	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
26	NIMONIC* alloy PE11	Bar	49	335	36	245	21	145	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
27	NIMONIC* alloy PE16	Bar	50	345	34	235	22	150	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
28	NIMONIC* alloy PK33	Sheet	95	655	70	485	45	310	29	200	13	90	—	—	—	—	—	—	—	—	—	—	—	—	—	
29	PYROMET* 860	Bar	79	545	53	365	36	250	20	140	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
30	RENÉ 41*	Bar	102	705	80	550	50	345	29	200	17	115	11	76	—	—	—	—	—	—	—	—	—	—	—	
31	RENÉ 41*	Sheet	82	565	60	415	40	275	28	195	17	115	11	76	—	—	—	—	—	—	—	—	—	—	—	
32	RENÉ 95	Bar	125	865	76	525	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
33	RGT* 4	Bar	70	485	49	340	29	200	15	105	8.0	55	—	—	—	—	—	—	—	—	—	—	—	—	—	
34	RGT* 13	Bar	72	495	56	385	37	255	23	160	12	83	—	—	—	—	—	—	—	—	—	—	—	—	—	
35	TD Nickel	Bar	26	180	23	160	21	145	18	125	16	110	14	97	12	83	10	69	8.5	59	7.5	52	6.0	41		
36	TD Nickel	Sheet	21	145	18.5	130	16.5	115	15	105	13	90	12	83	10	69	8.5	59	7.0	48	6.0	41	4.5	31		
37	TD NiCr	Sheet	—	—	—	—	—	—	—	—	—	—	10	69	8.0	55	6.5	45	5.0	35	4.0	28	3.5	24		
38	UDIMET* 400	Bar	87	600	64	440	44	305	28	195	16	110	—	—	—	—	—	—	—	—	—	—	—	—	—	
39	UDIMET* 500	Bar	110	760	74	510	47	325	30	205	18	125	12	83	—	—	—	—	—	—	—	—	—	—	—	
40	UDIMET* 520	Bar	85	585	69	475	50	345	33	230	22	150	—	—	—	—	—	—	—	—	—	—	—	—	—	
41	UDIMET* 630	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
42	UDIMET* 700	Bar	102	705	83	575	62	430	43	295	29	200	16	110	7.5	52	—	—	—	—	—	—	—	—	—	
43	UDIMET* 710	Bar	(126)	(870)	(94)	(650)	67	460	45	310	29	200	17	115	10	69	—	—	—	—	—	—	—	—	—	
44	UNITEMP* AF2-1DA	Bar	(130)	(895)	(102)	(705)	76	525	55	380	38	260	22	150	—	—	—	—	—	—	—	—	—	—	—	
45	UNITEMP* AF2-1DA	Sheet	115	790	99	685	73	500	54	370	36	250	18	125	—	—	—	—	—	—	—	—	—	—	—	
46	WASPALLOY*	Bar	89	615	65	450	42	290	26	180	16	110	—	—	—	—	—	—	—	—	—	—	—	—	—	
47	WASPALLOY*	Sheet	(90)	(620)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Cobalt Base Alloys																										
48	HAYNES* alloy No. 188	Sheet	—	—	35	240	24	165	16	110	10	69	6.0	41	3.6	25	2.2	15	1.3	9	—	—	—	—	—	
49	L-605	Sheet	39	270	32	220	24	165	17.5	120	10.5	72	6.4	44	3.6	25	—	—	—	—	—	—	—	—	—	
Iron-Nickel Alloys																										
50	ALLOY 901	Bar	76	525	53	365	30	205	12	83	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
51	A-286	Bar	46	315	29	200	15	105	7.7	53	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
52	DISCALOY*	Bar	40	275	22	150	8.5	59	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
53	HAYNES* alloy 556	Sheet	(40)	(275)	(27.5)	(190)	(18)	(125)	(12.5)	(85)	(7.6)	(52)	(4.5)	(31)	(2.8)	(19)	(1.5)	(10)	—	—	—	—	—	—	—	
54	INCOLOY* alloy 800	Bar	24	165	16	110	9.5	66	6.8	47	4.4	30	3	21	1.9	13	—	—	—	—	—	—	—	—	—	
55	INCOLOY* alloy 801	Bar	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
56	INCOLOY* alloy 802	Bar	25	170	—	—	16	110	—	—	10	69	5.5	38	3.5	24	—	—	1.2	8	0.7	5	—	—	—	
57	INCOLOY* alloy 807	Bar	—	—	23.5	160	15	105	10	69																

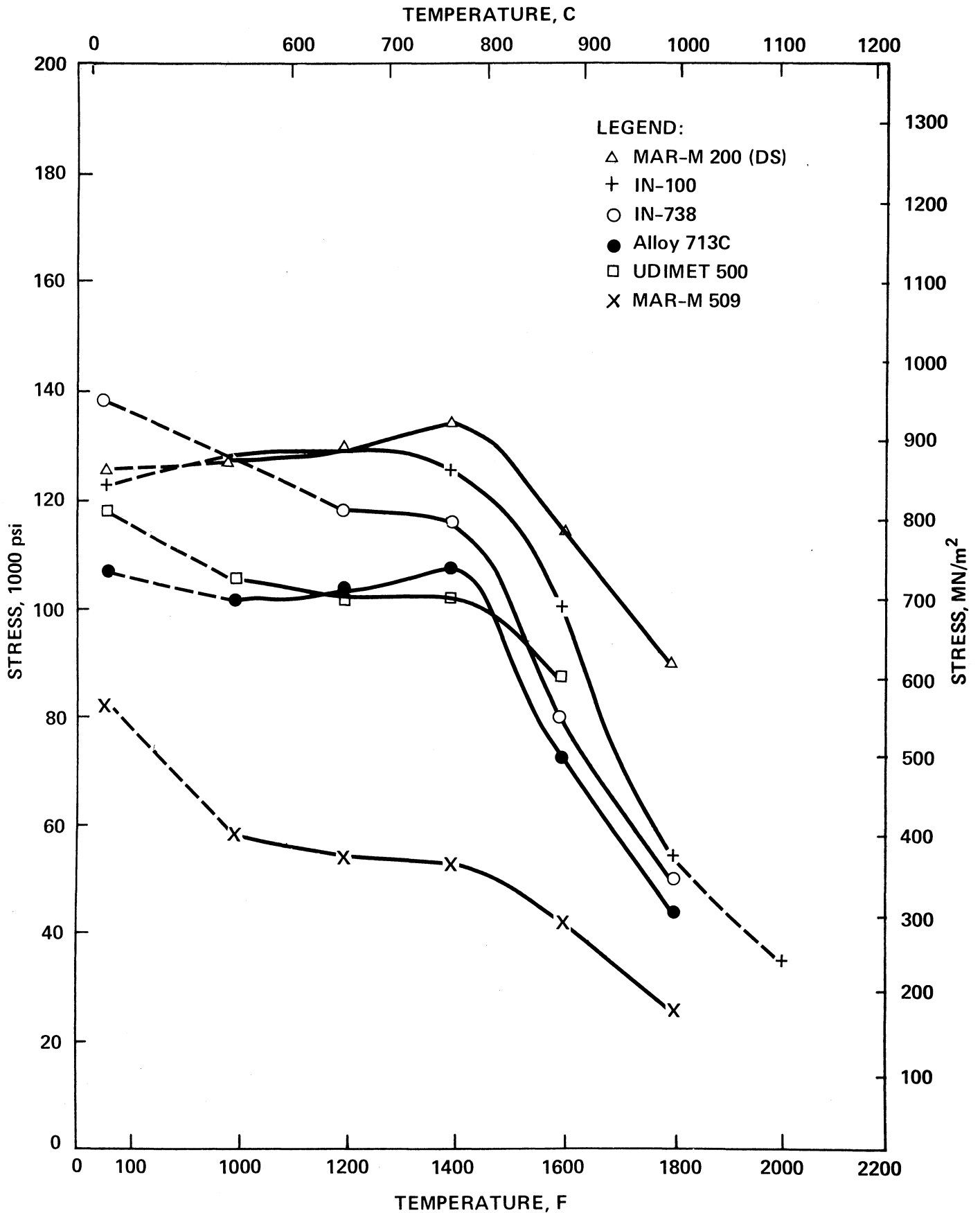


Figure 1—Cast Materials—Yield Strength (0.2% Offset)

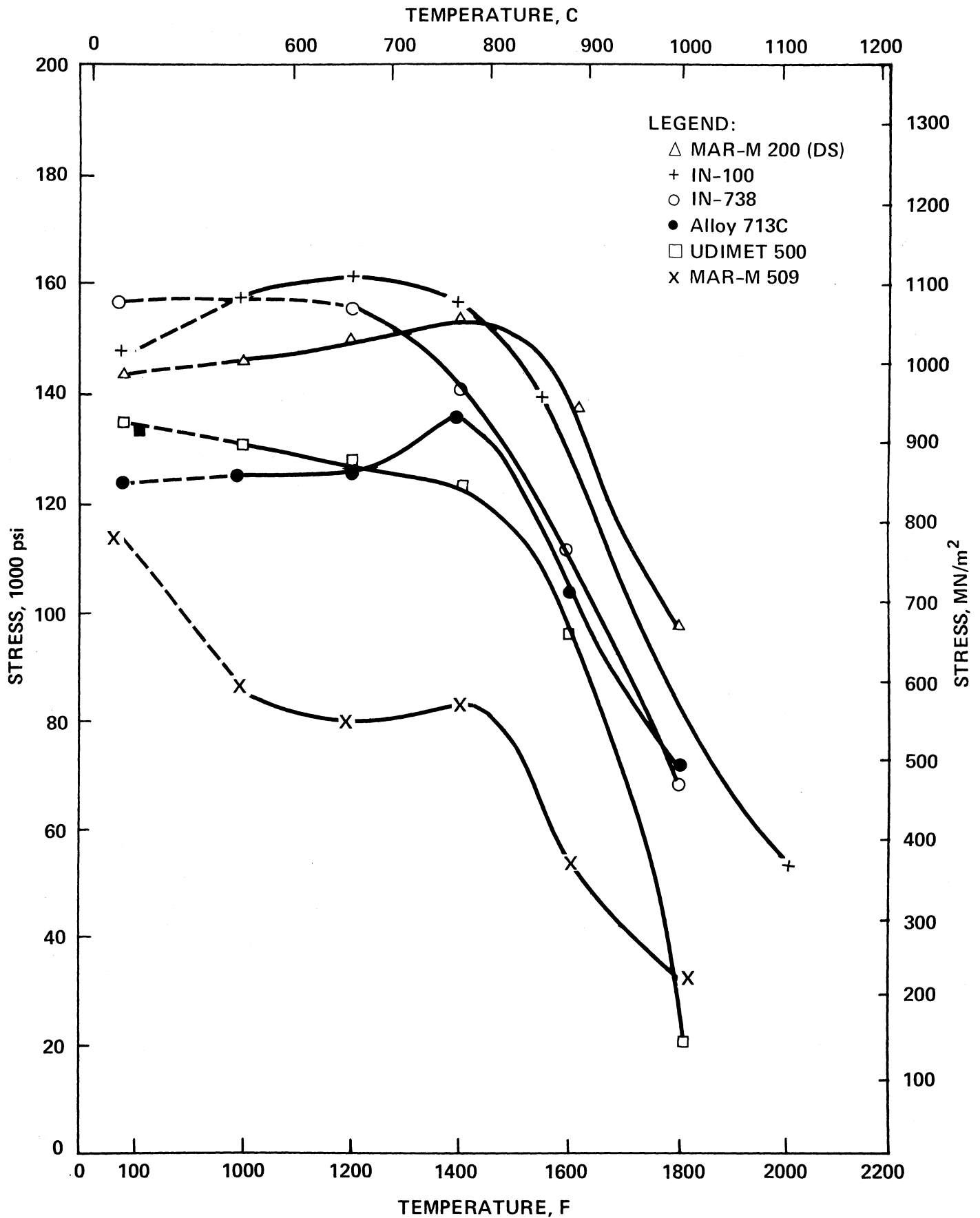


Figure 2—Cast Materials—Ultimate Tensile Strength

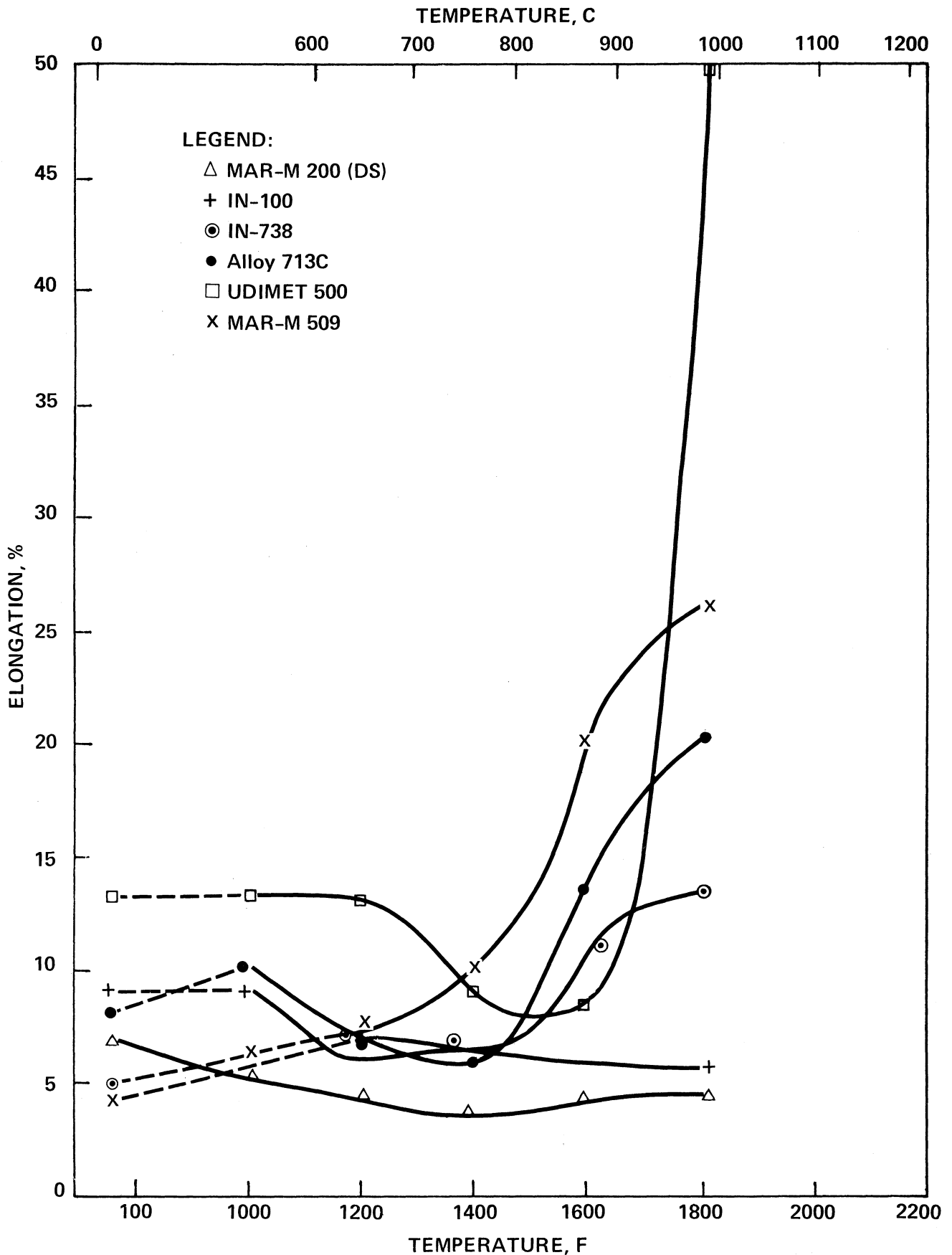


Figure 3—Cast Materials—Tensile Elongation.

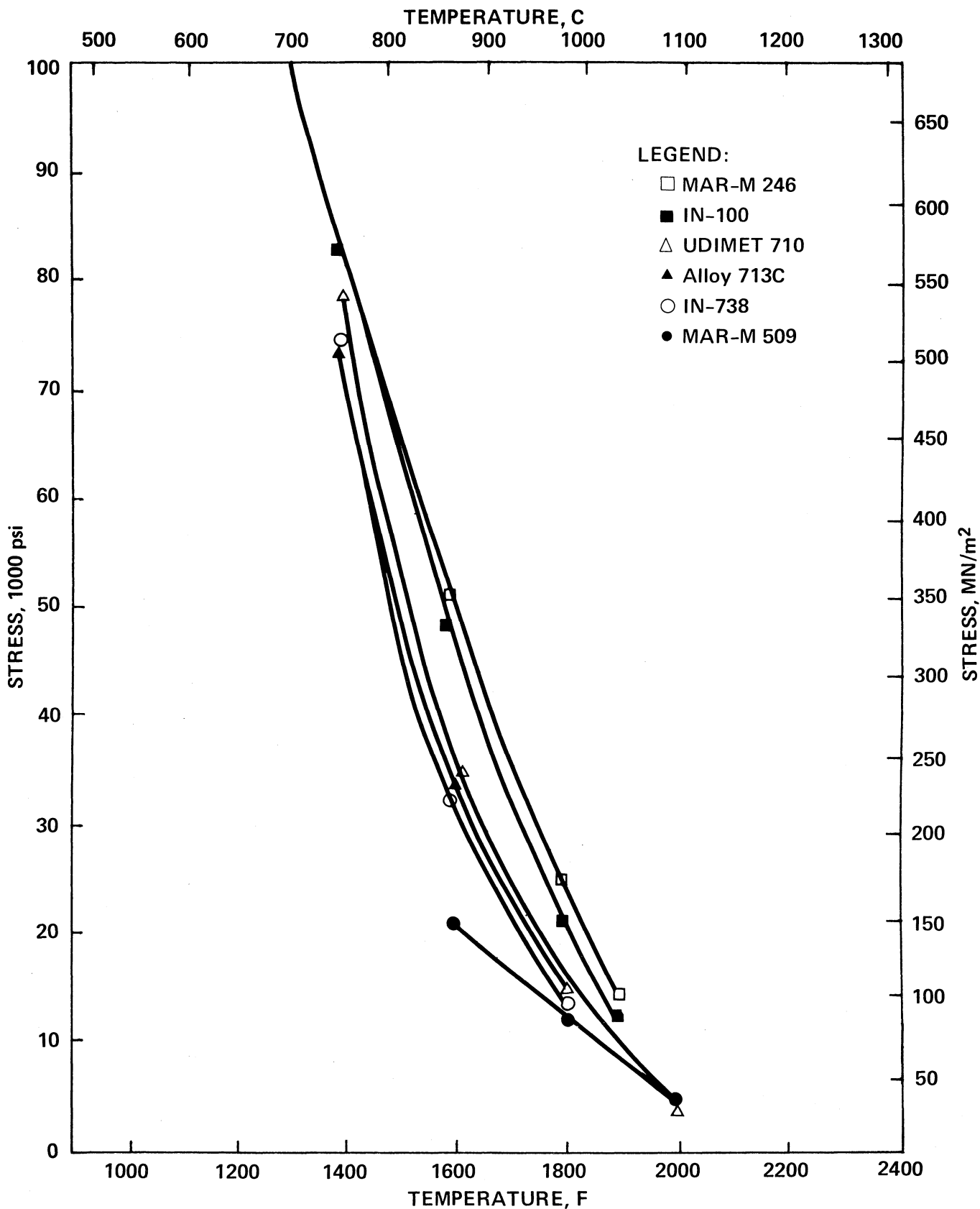


Figure 4—Cast Materials—100 Hour 1.0% Creep Strength.

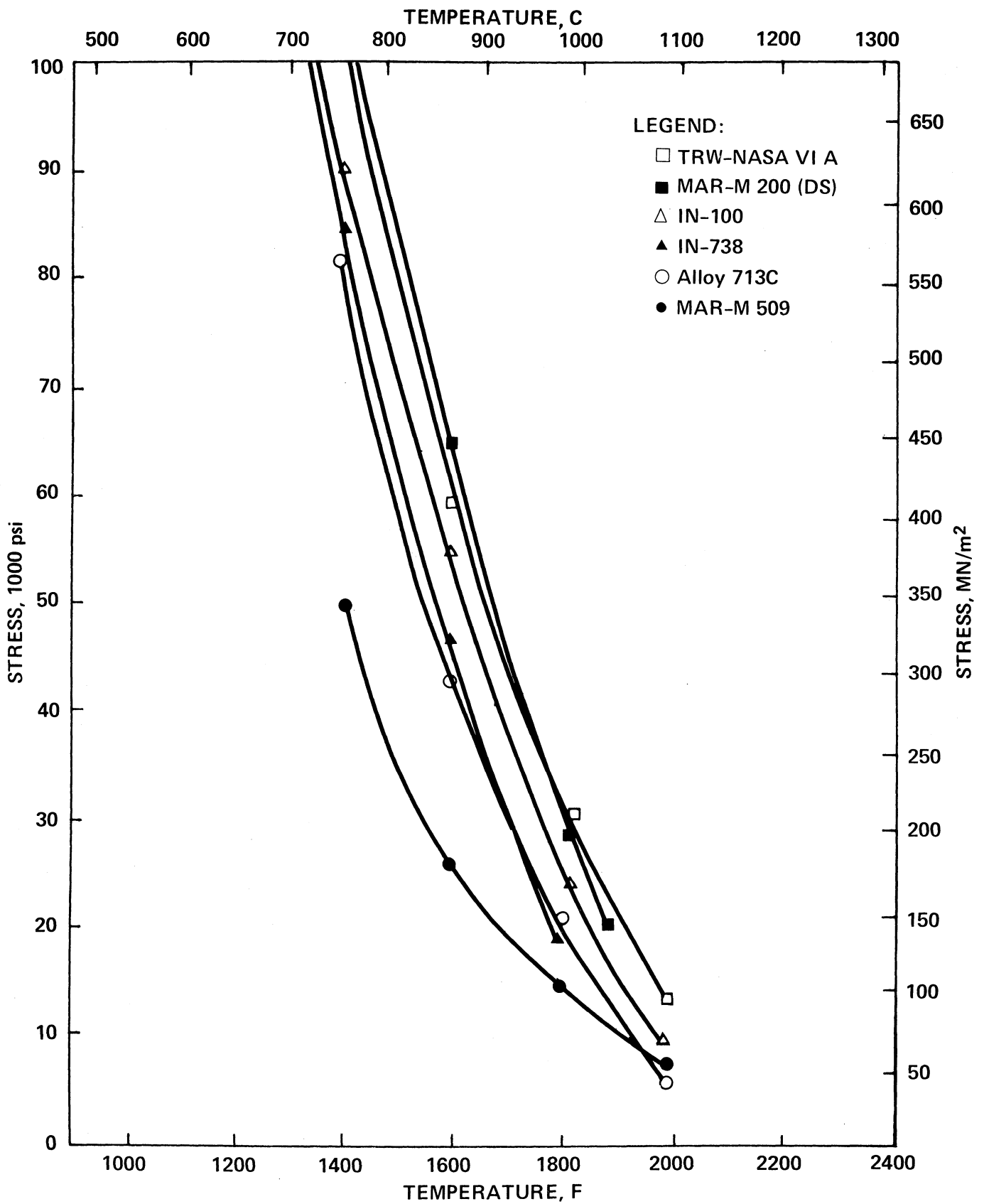


Figure 5—Cast Materials—100 Hour Rupture Strength.

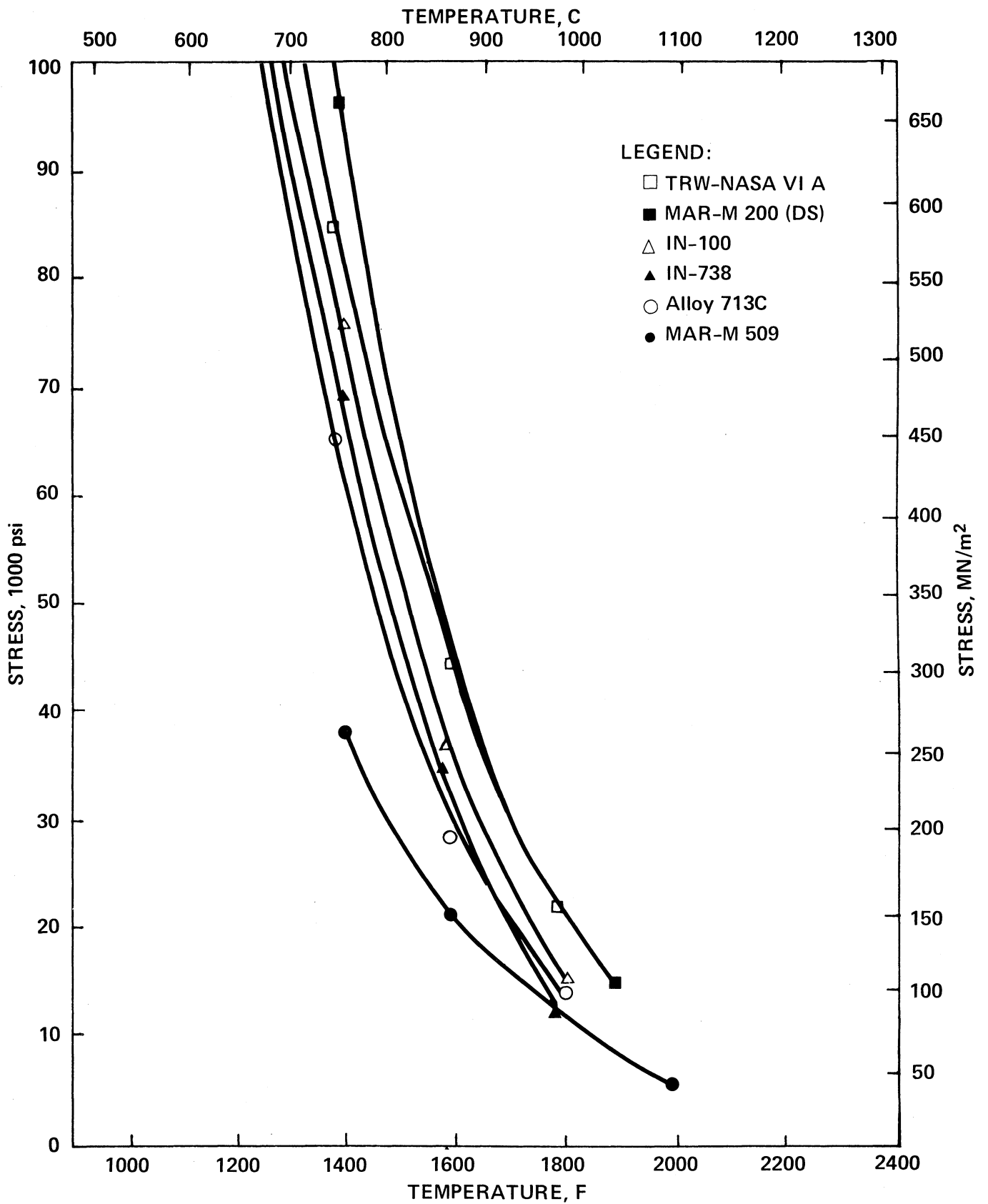


Figure 6—Cast Materials—1000 Hour Rupture Strength.

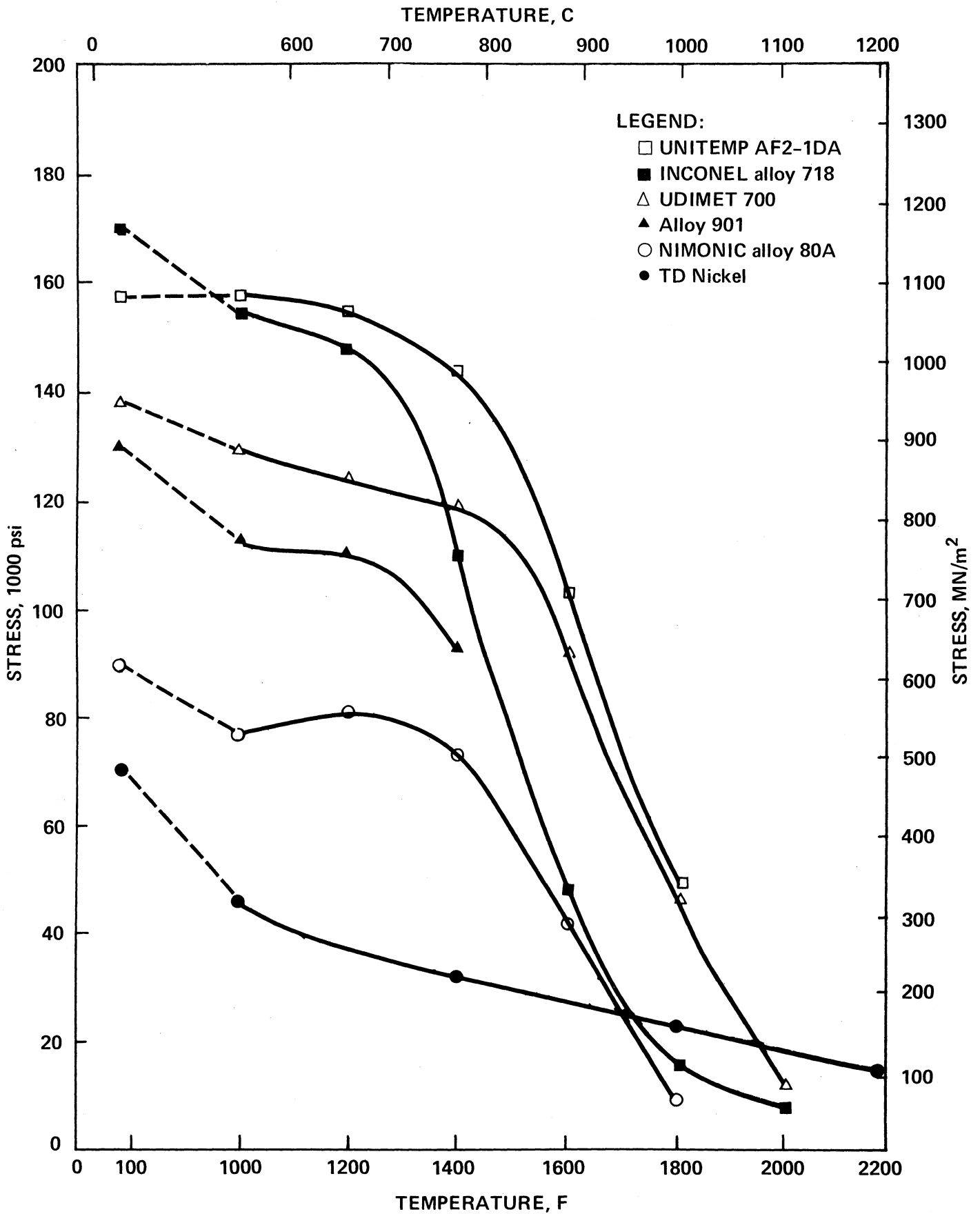


Figure 7—Bar Materials—Yield Strength (0.2% Offset).

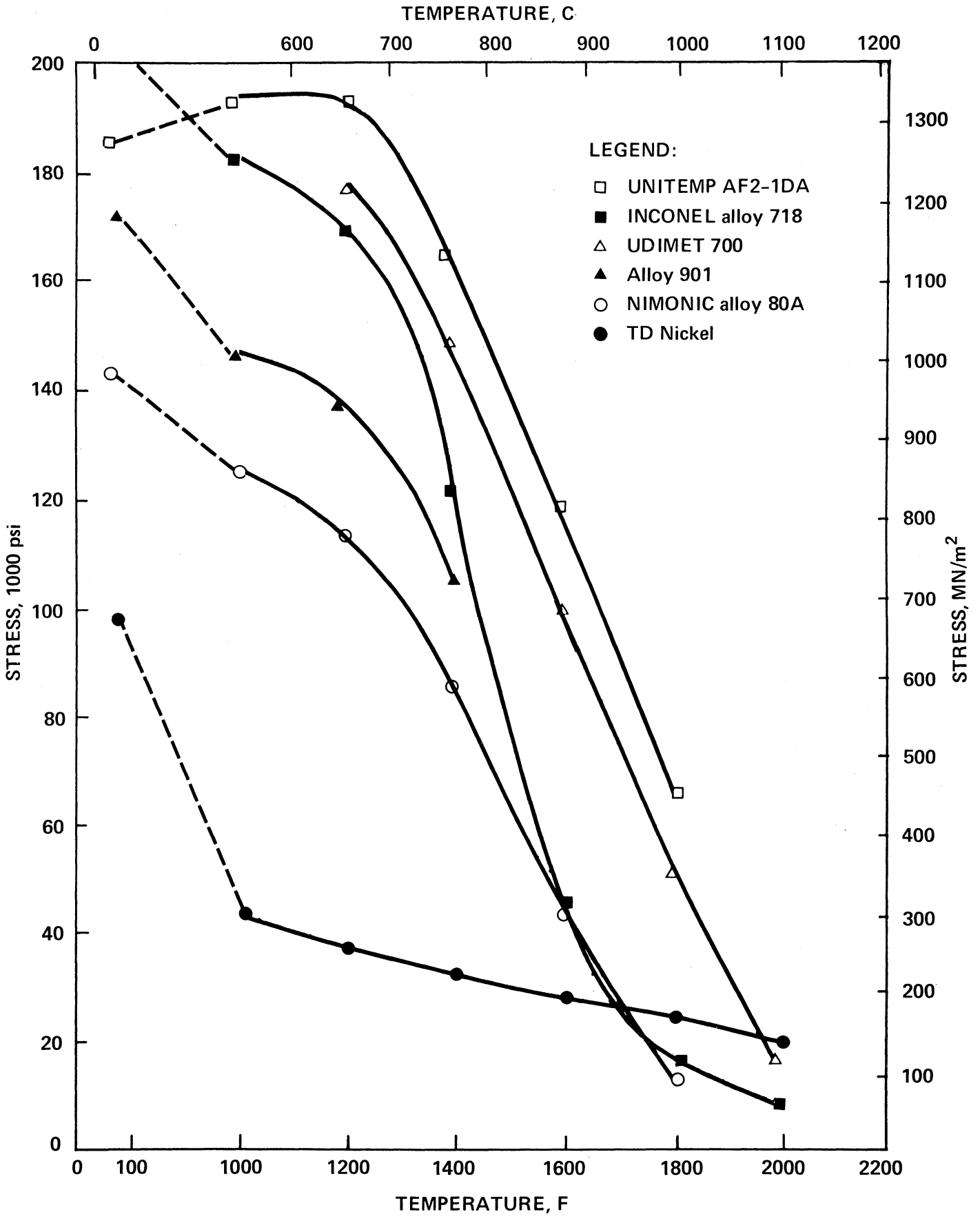


Figure 8—Bar Materials—Ultimate Tensile Strength.

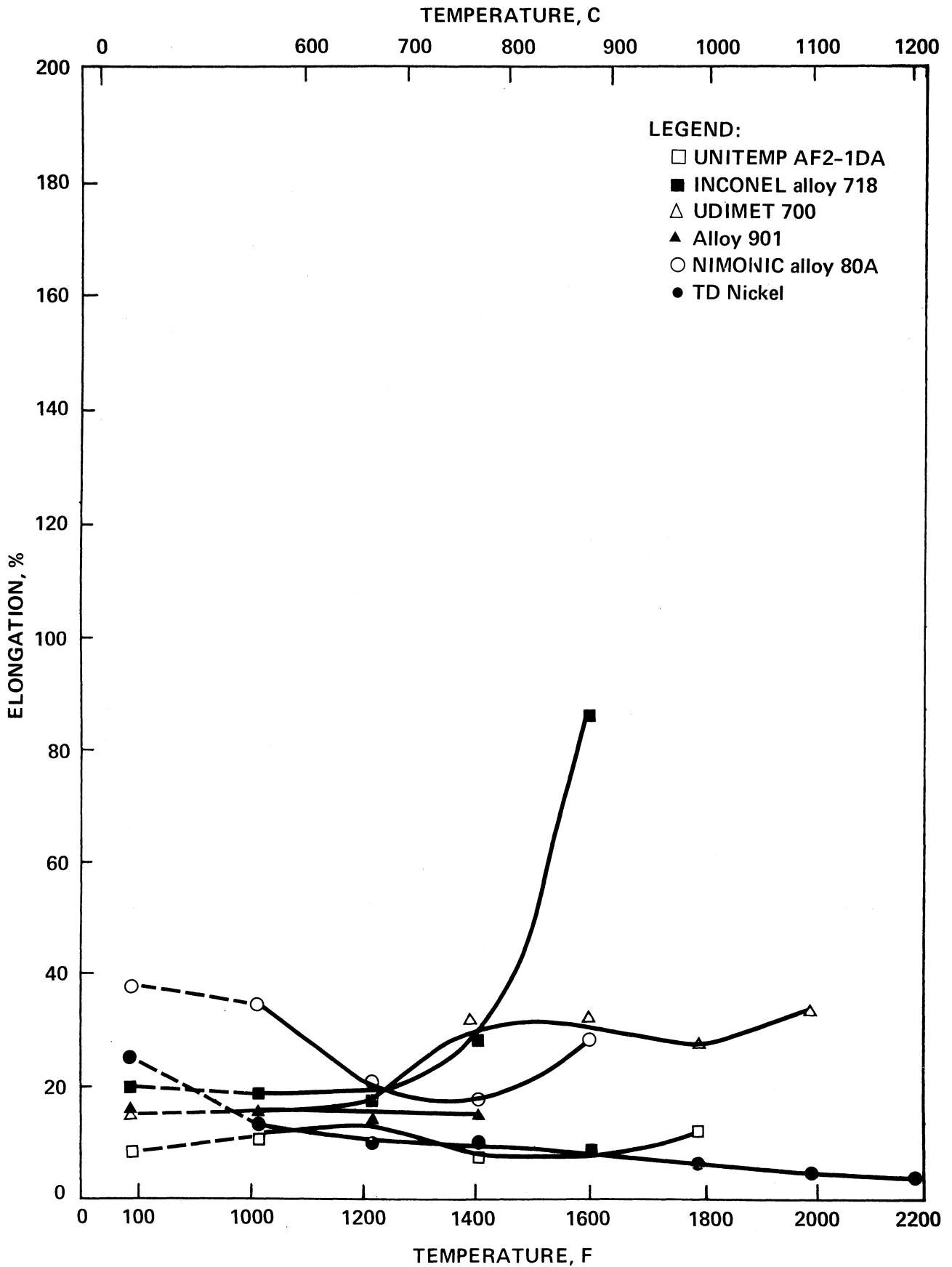


Figure 9—Bar Materials—Tensile Elongation.

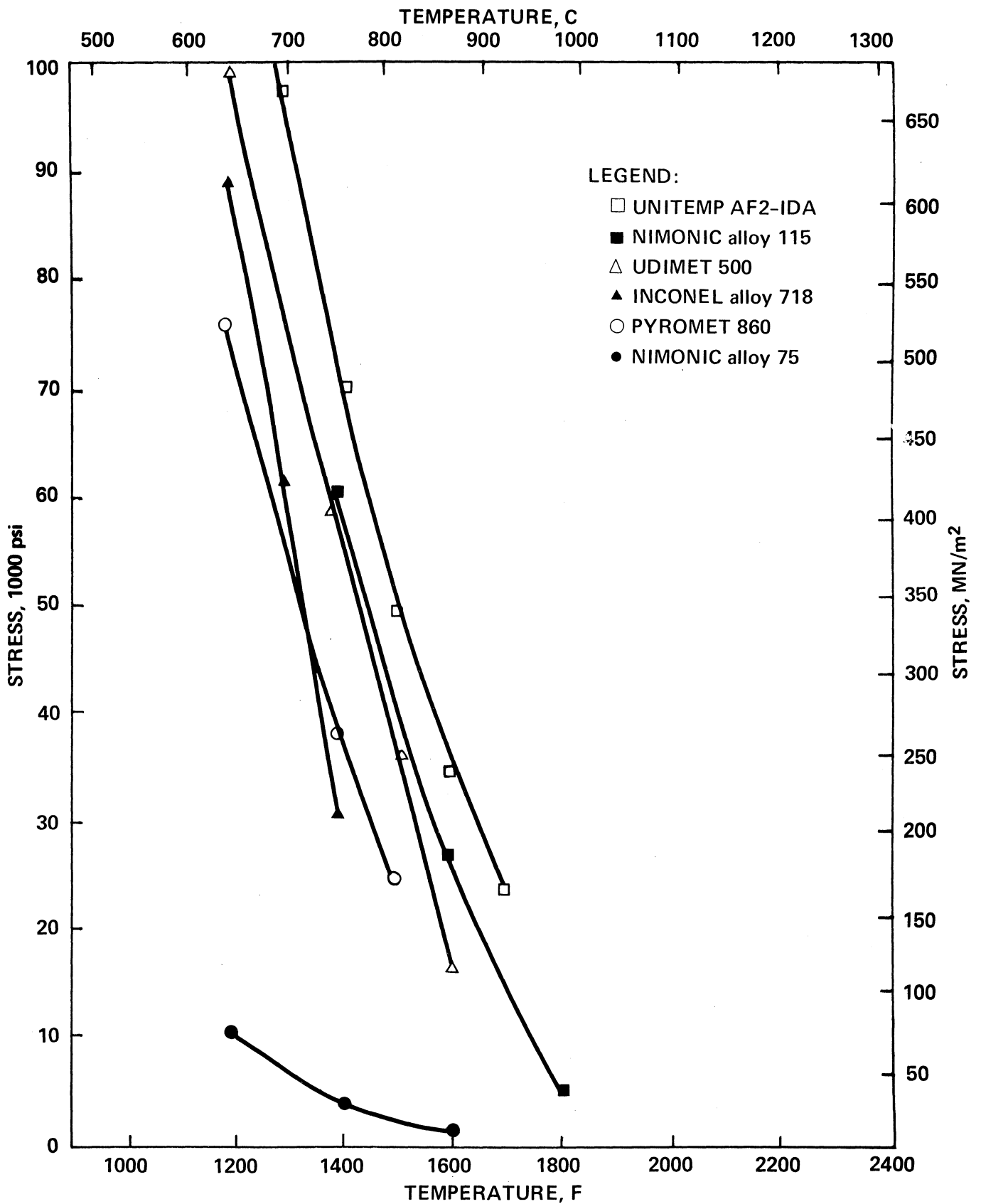


Figure 10—Bar Materials 100 Hour 0.2% Creep Strength.

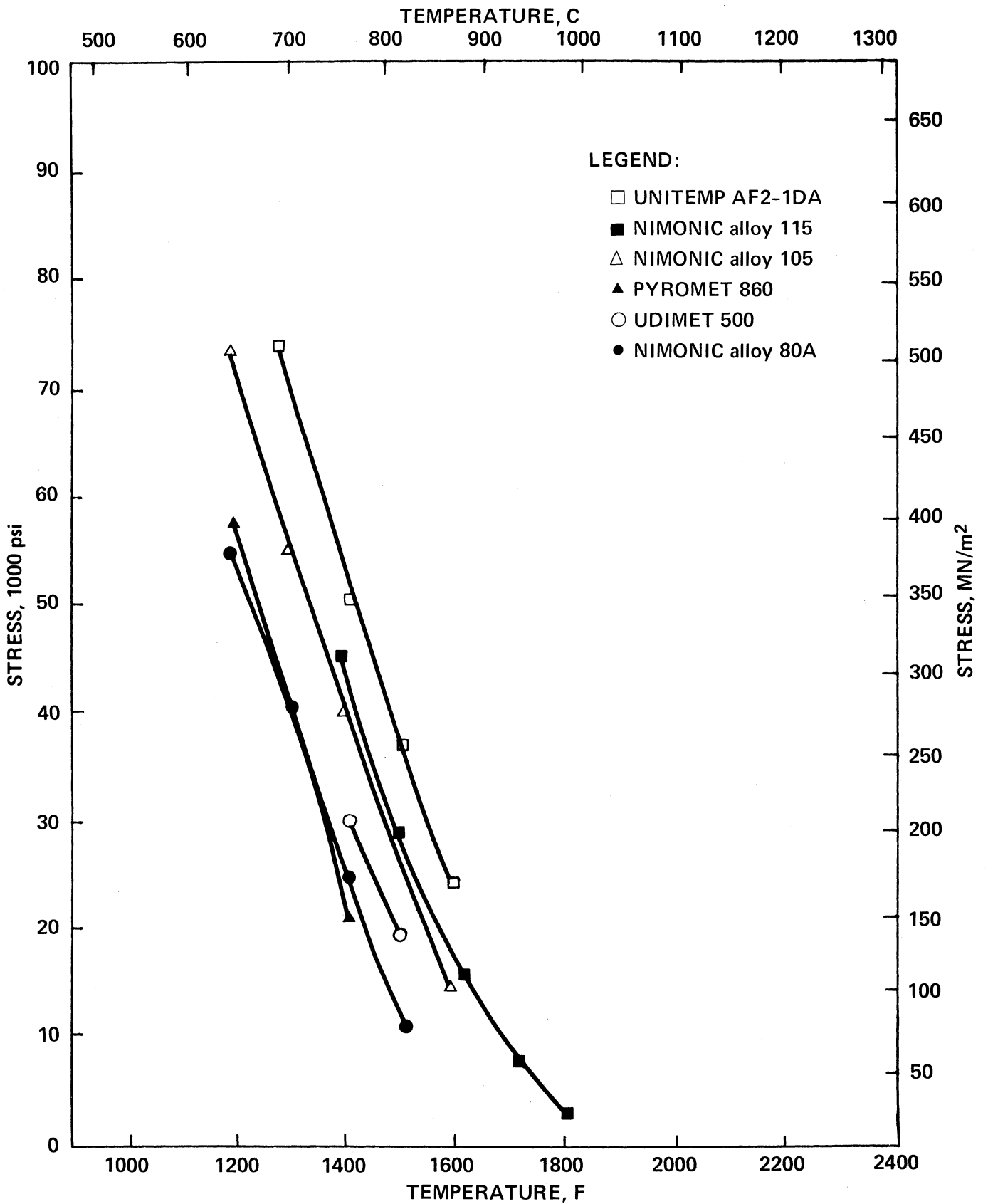


Figure 11 – Bar Materials – 1000 Hour 0.2% Creep Strength.

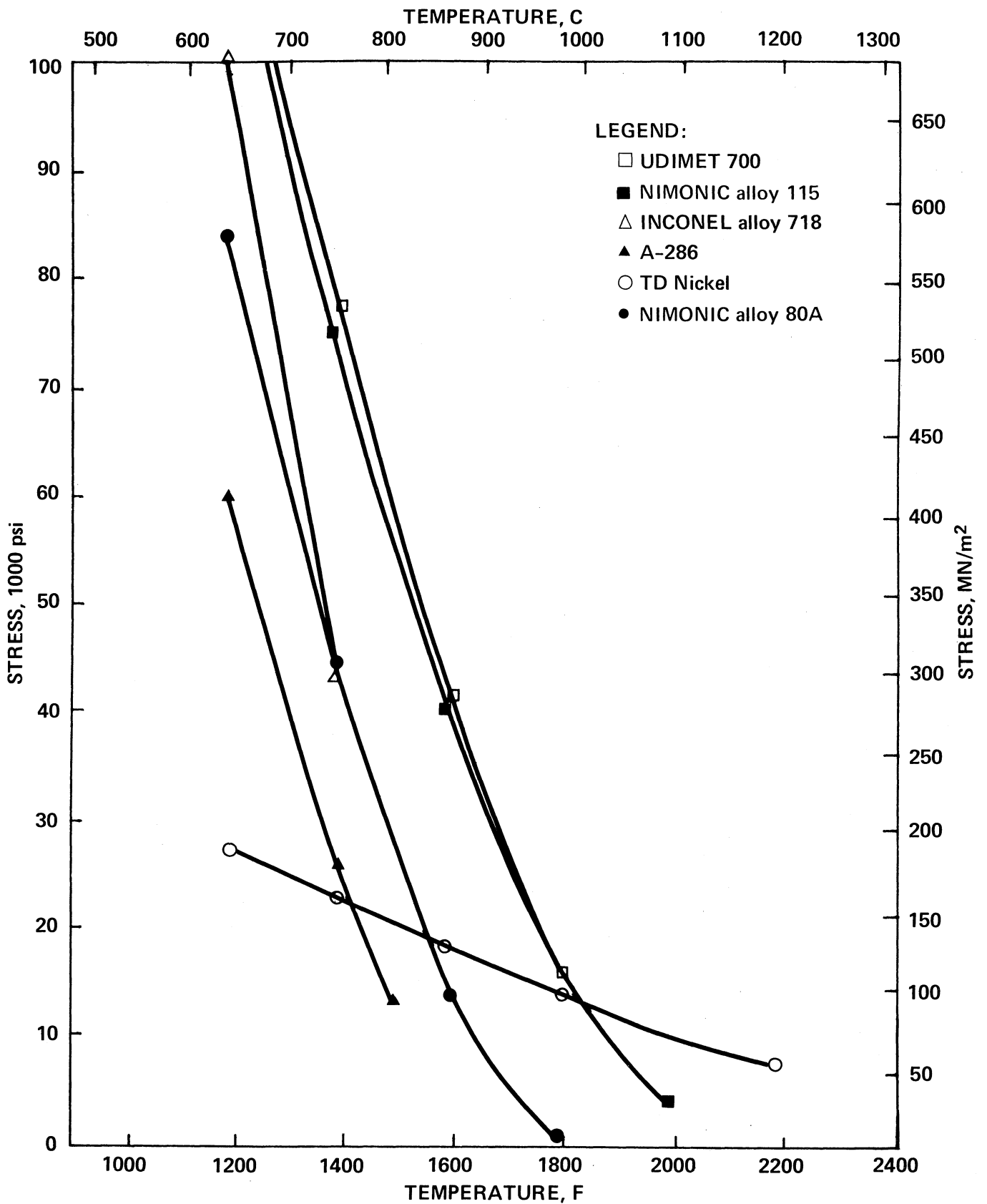


Figure 12—Bar Materials—100 Hour Rupture Strength.

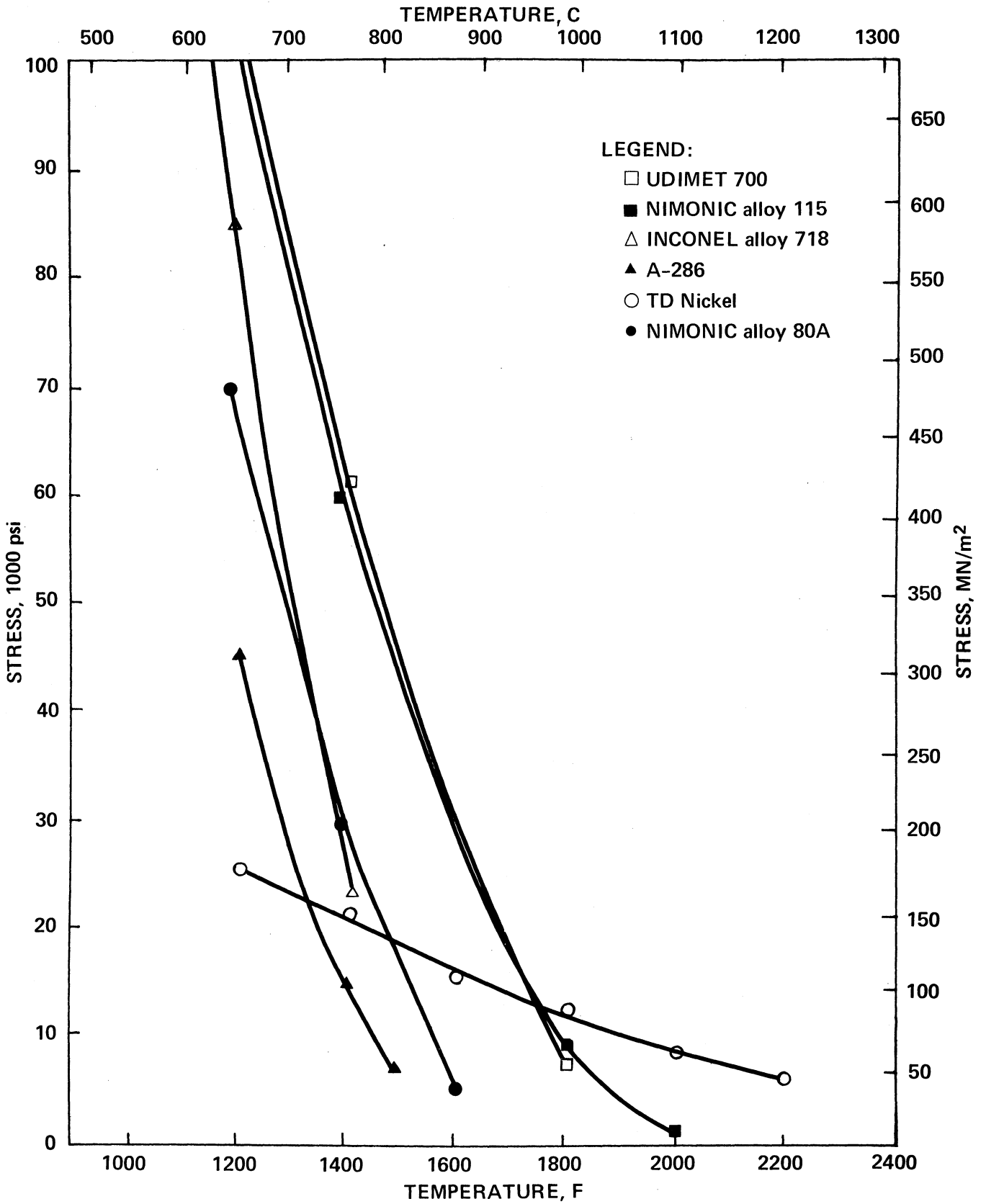


Figure 13—Bar Materials—1000 Hour Rupture Strength.

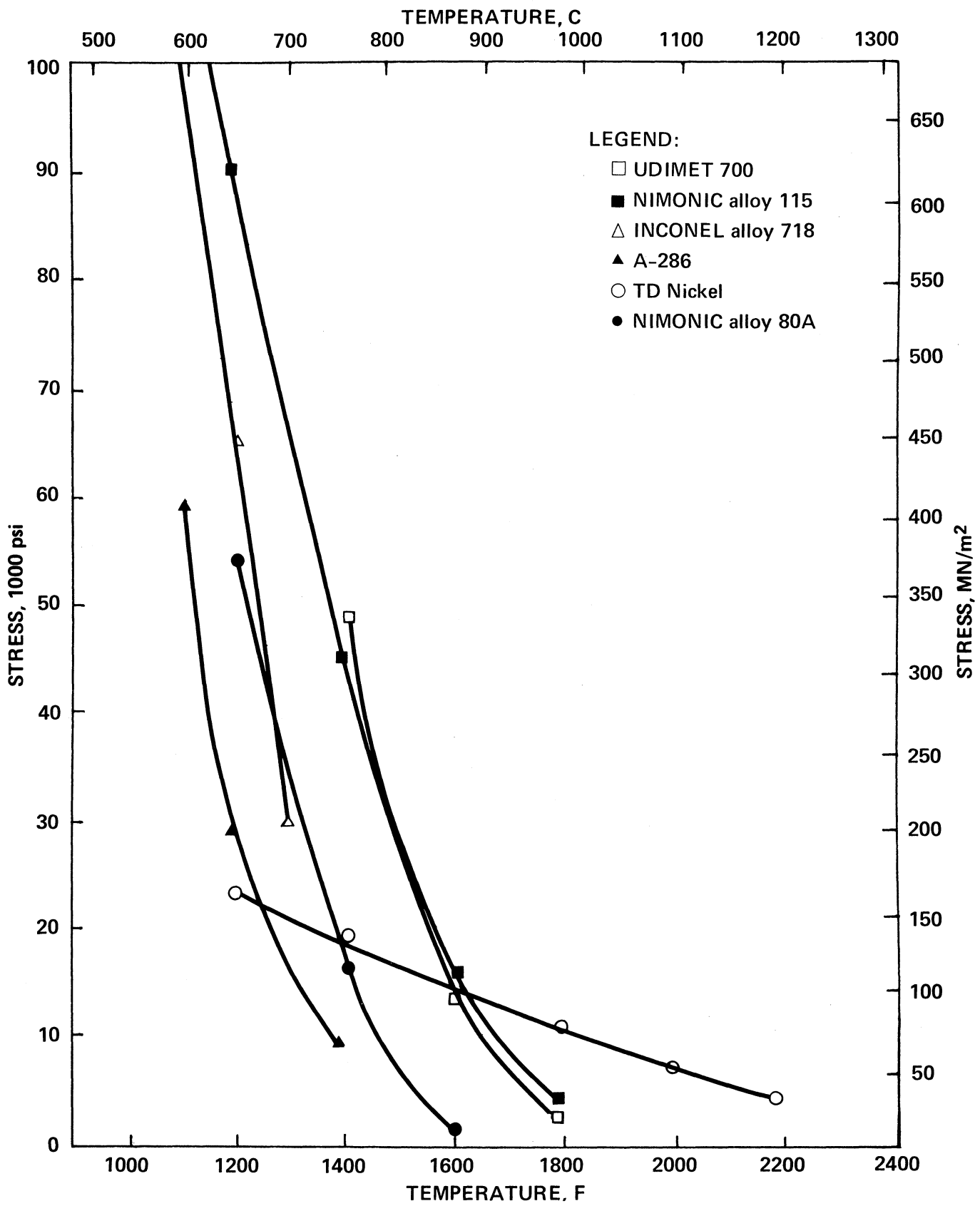


Figure 14—Bar Materials—10,000 Hour Rupture Strength.

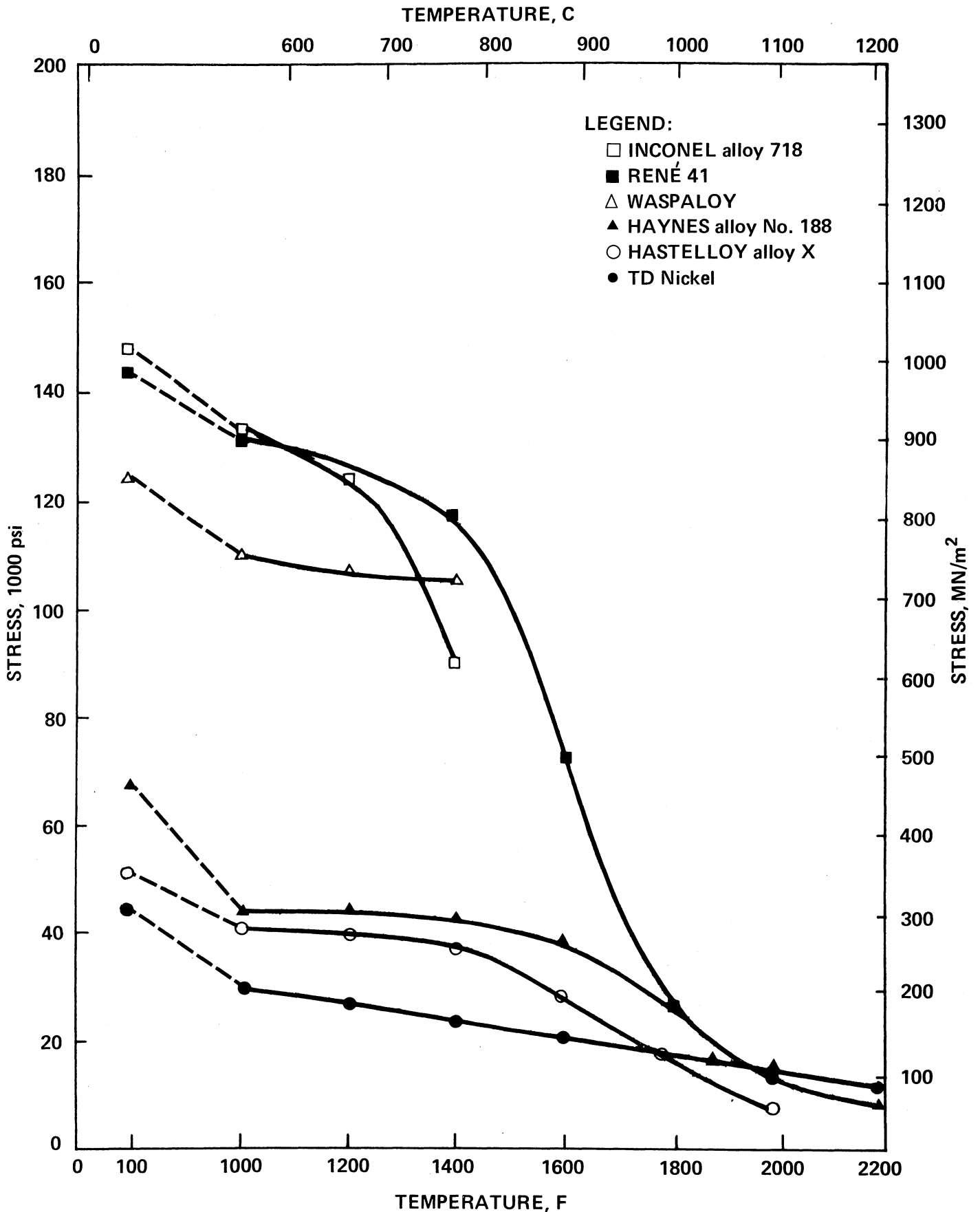


Figure 15—Sheet Materials—Yield Strength (0.2% Offset).

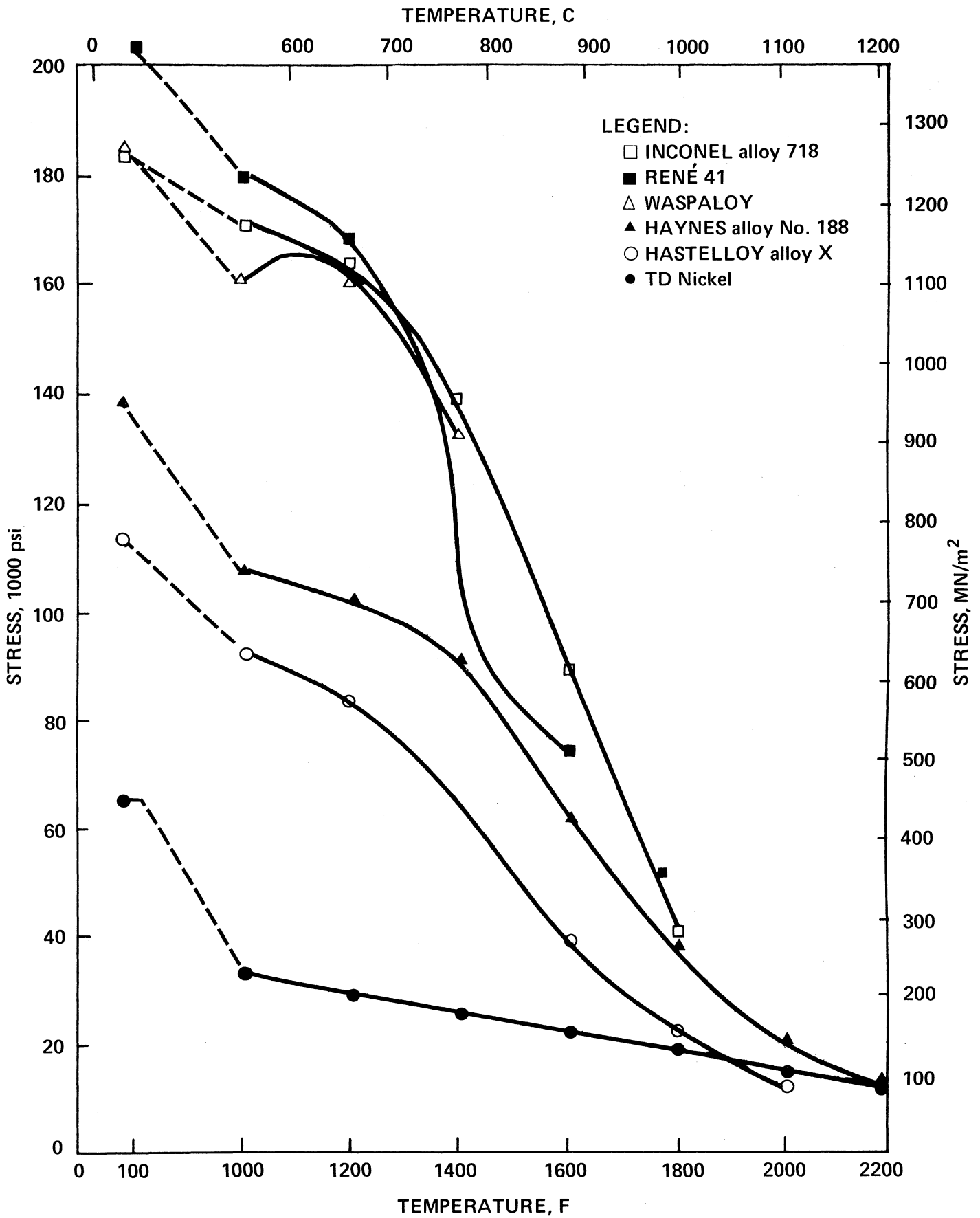


Figure 16—Sheet Materials—Ultimate Tensile Strength.

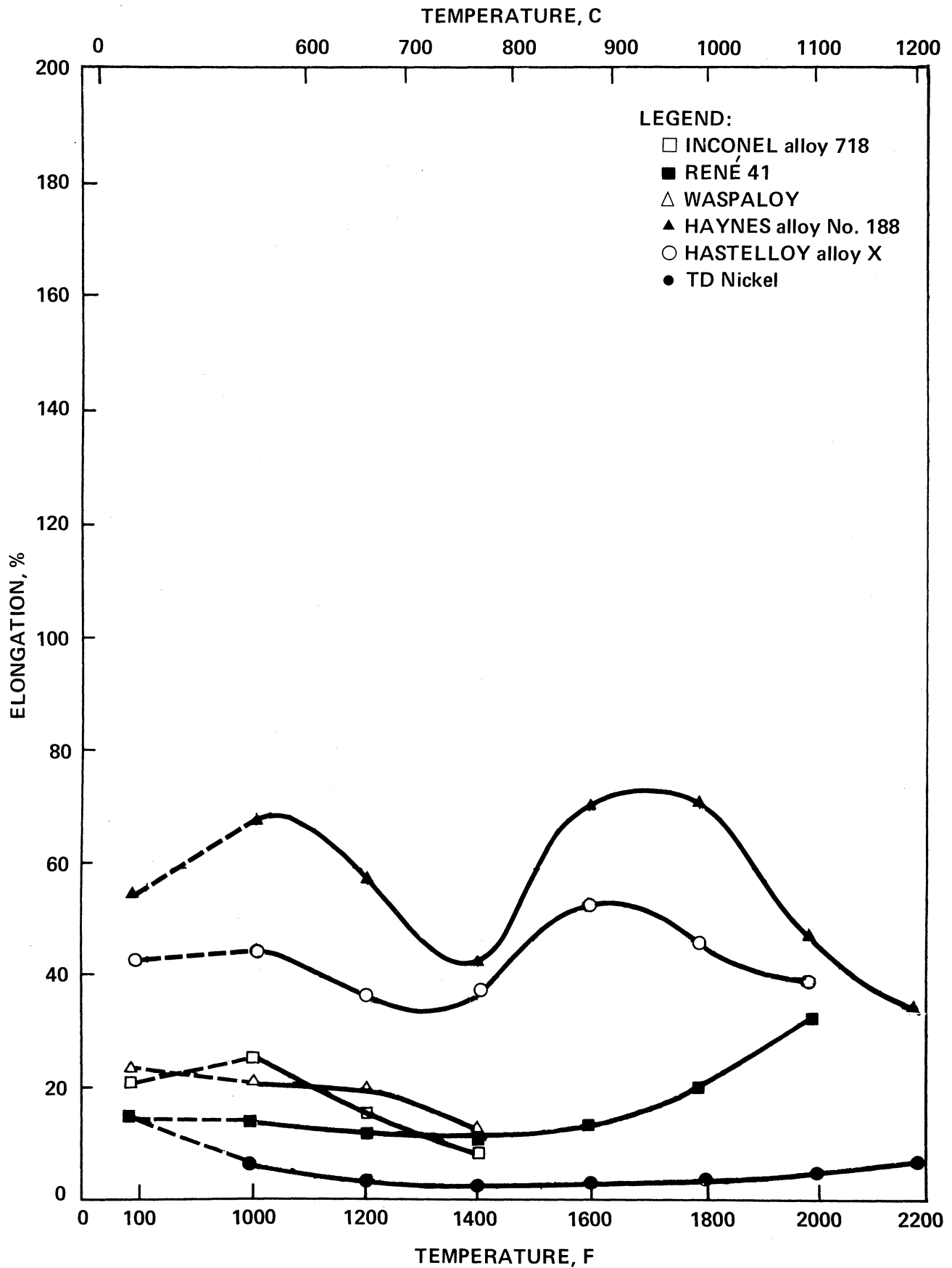


Figure 17—Sheet Materials—Tensile Elongation.

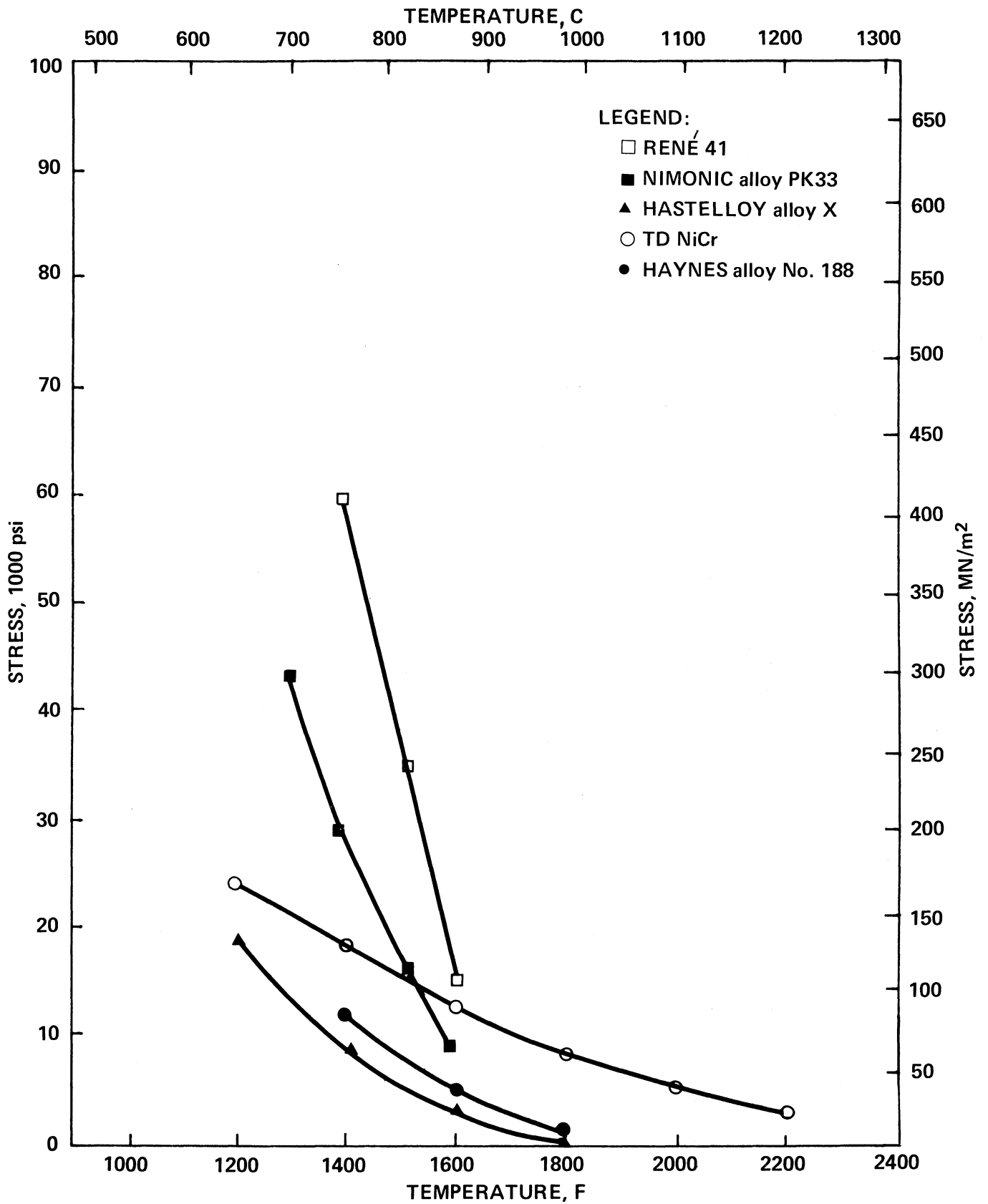


Figure 18—Sheet Materials—100 Hour 0.2% Creep Strength.

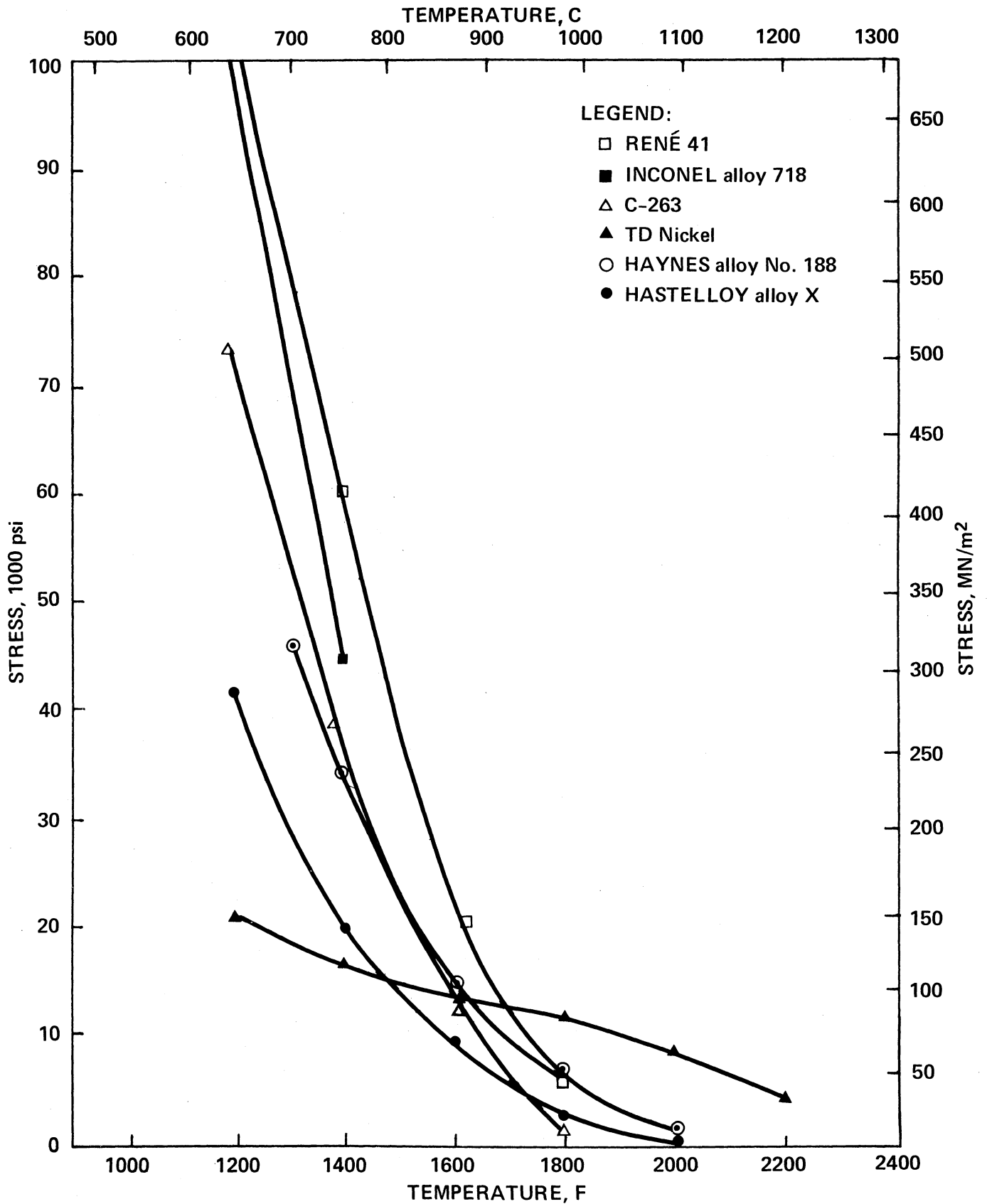


Figure 19—Sheet Materials—100 Hour Rupture Strength.

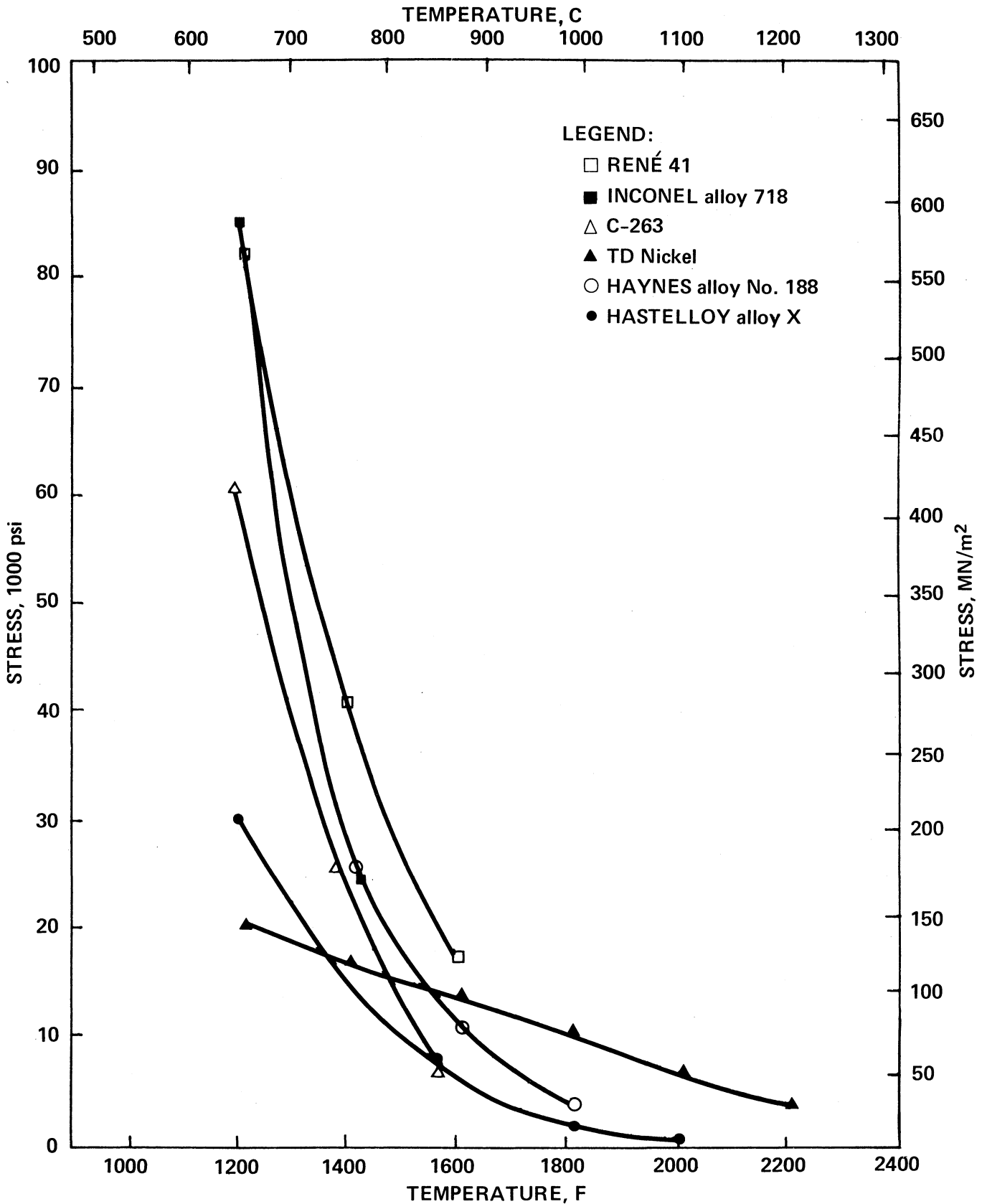


Figure 20—Sheet Materials—1000 Hour Rupture Strength.

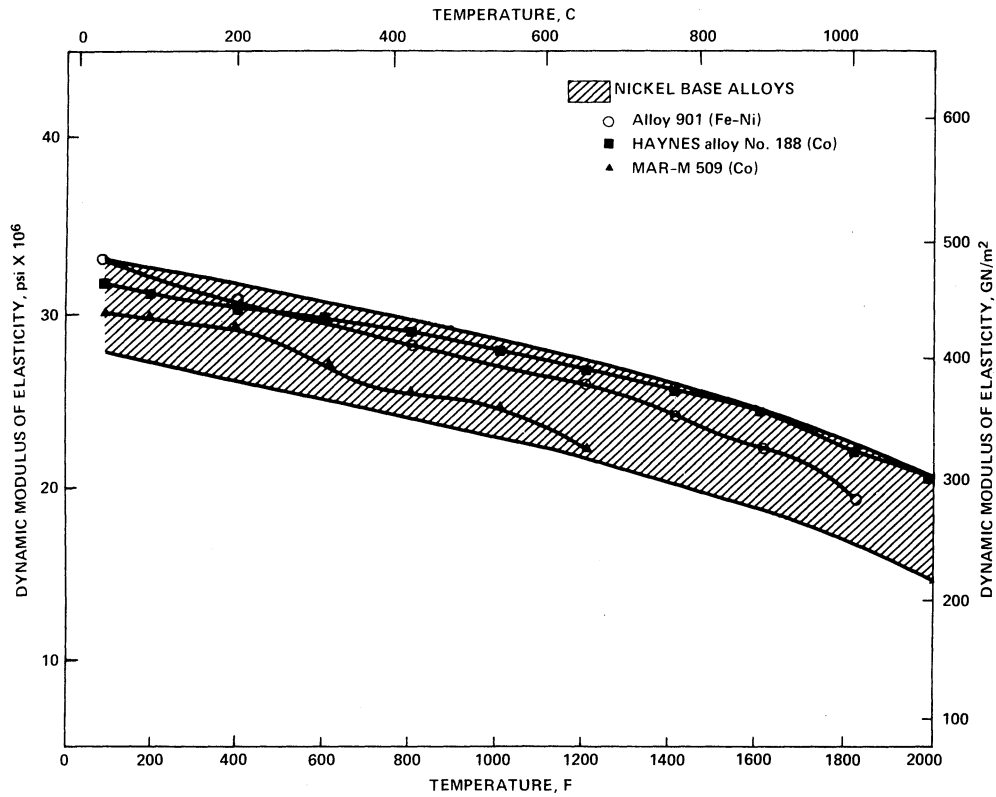


Figure 21 – Dynamic Modulus of Elasticity.

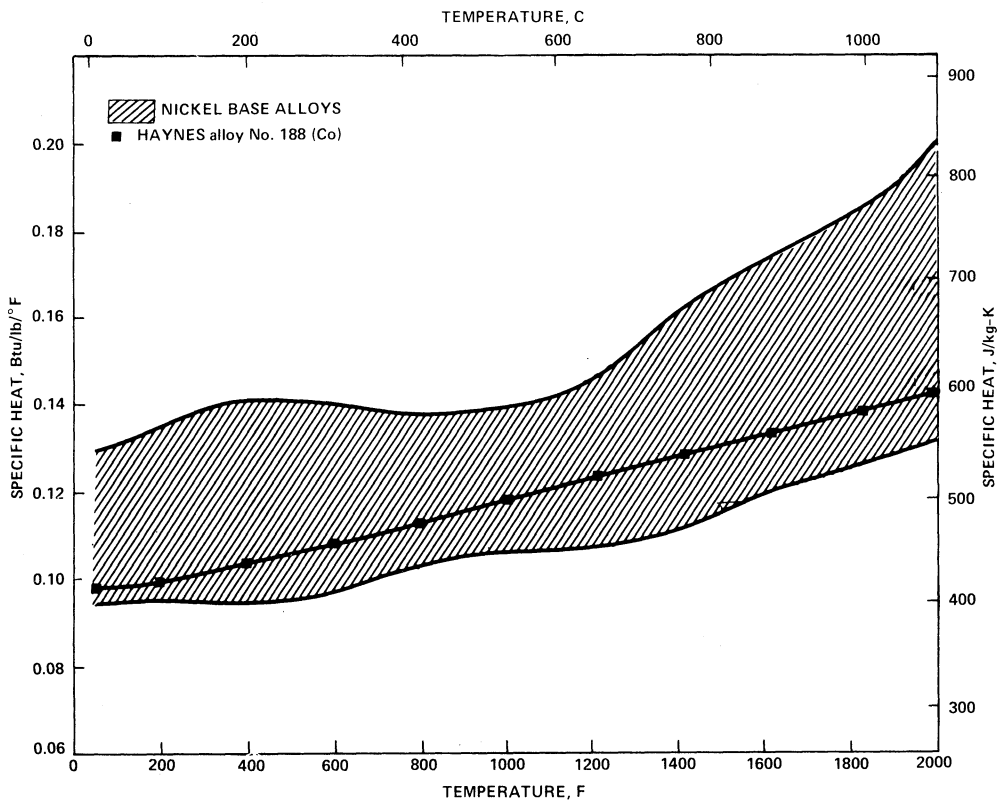


Figure 22 – Specific Heat.

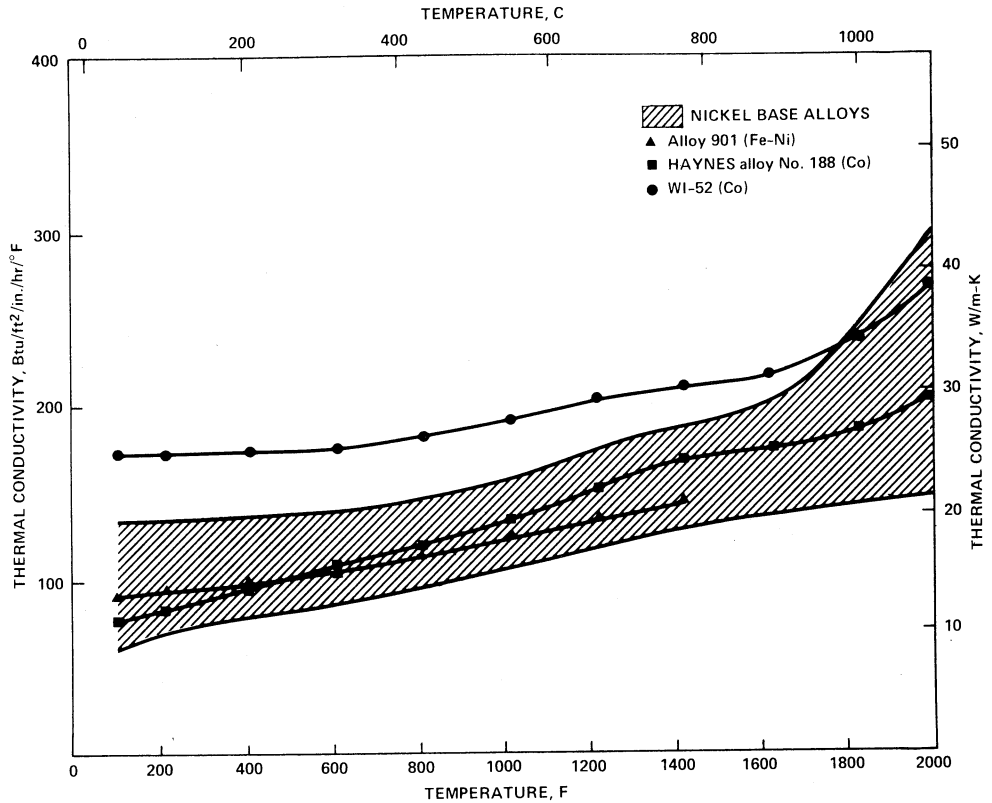


Figure 23—Thermal Conductivity.

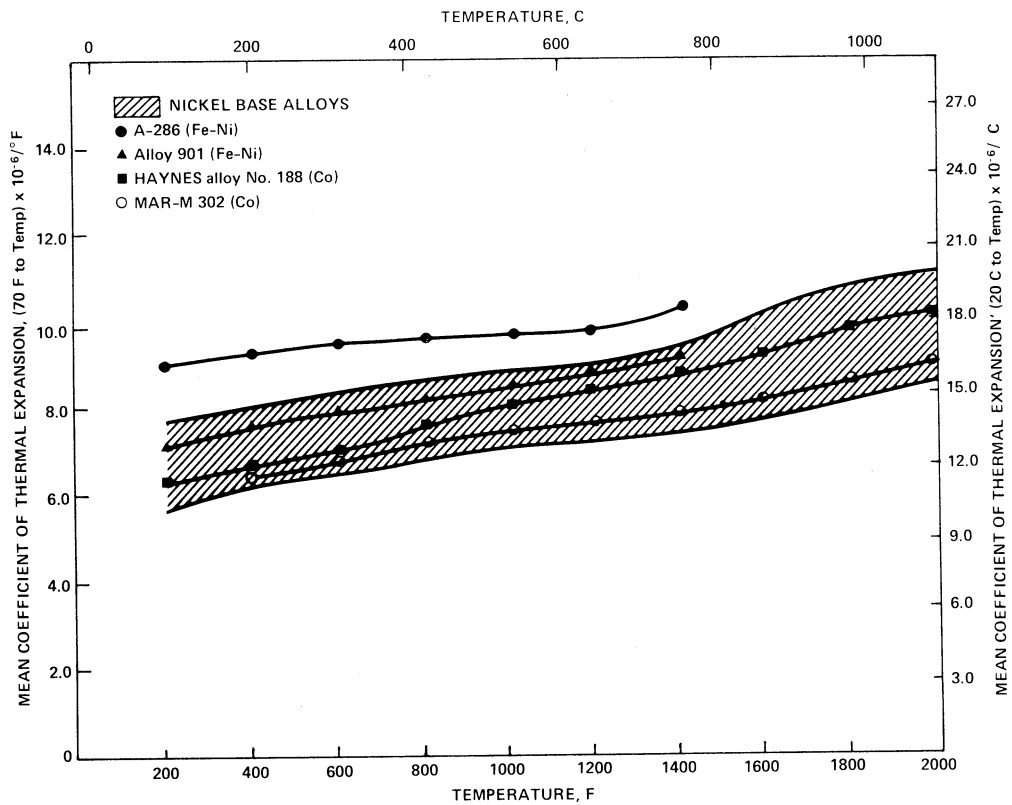


Figure 24—Mean Coefficient of Thermal Expansion.

APPENDIX

CONVERSION FACTORS

Because of the variety of metric and non-metric units employed for stress values, and the possibility of further changes, conversion factors are given below only for the more important of these, to and from SI metric units.

Note that meganewton per square meter (MN/m^2), newton per square millimeter (N/mm^2) and megapascal (MPa) are arithmetically identical.

Stress.

$$\begin{aligned}1 \text{ hbar} &= 10 \text{ MN}/\text{m}^2 = 10 \text{ N}/\text{mm}^2 = 10 \text{ MPa} \\1 \text{ kgf}/\text{mm}^2 &= 9.807 \text{ MN}/\text{m}^2 = 9.807 \text{ MPa} = 9.807 \text{ N}/\text{mm}^2 \\10^3 \text{ psi} &= 10^3 \text{ lbf}/\text{in.}^2 = 6.895 \text{ MN}/\text{m}^2 = 6.895 \text{ N}/\text{mm}^2 = 6.895 \text{ MPa} \\1 \text{ tonf}/\text{in.}^2 &= 15.44 \text{ MN}/\text{m}^2 = 15.44 \text{ N}/\text{mm}^2 = 15.44 \text{ MPa} \\&(\text{long ton} = 2240 \text{ lb}) \\1 \text{ MN}/\text{m}^2 &= 0.1 \text{ hbar} \\&= 0.145 \times 10^3 \text{ psi} \\1 \text{ N}/\text{mm}^2 &= 0.145 \times 10^3 \text{ lbf}/\text{in.}^2 \\1 \text{ MPa} &= 0.0647 \text{ tonf}/\text{in.}^2 \\&= 0.102 \text{ kgf}/\text{mm}^2\end{aligned}$$

Elastic Modulus.

$$\begin{aligned}10^6 \text{ psi} &= 10^6 \text{ lbf}/\text{in.}^2 = 6.895 \text{ GN}/\text{m}^2 = 6.895 \text{ kN}/\text{mm}^2 = 6.895 \text{ GPa} \\10^3 \text{ kgf}/\text{mm}^2 &= 9.807 \text{ GN}/\text{m}^2 = 9.807 \text{ kN}/\text{mm}^2 = 9.807 \text{ GPa} \\1 \text{ GN}/\text{m}^2 &= 0.145 \times 10^6 \text{ psi} \\1 \text{ kN}/\text{mm}^2 &= 0.145 \times 10^6 \text{ lbf}/\text{in.}^2 \\1 \text{ GPa} &= 0.102 \times 10^3 \text{ kgf}/\text{mm}^2\end{aligned}$$

Specific Heat.

$$1 \text{ Btu}/\text{lb}/^\circ\text{F} = 4201 \text{ J}/\text{kg}\cdot\text{K}$$

Thermal Conductivity.

$$1 \text{ Btu}/\text{ft}^2/\text{in.}/\text{hr}/^\circ\text{F} = 0.1443 \text{ W}/\text{m}\cdot\text{K}$$

Thermal Expansion.

$$1 \text{ microinch}/\text{in.}/^\circ\text{F} = 1.8 \text{ micron}/\text{m}/^\circ\text{C}$$

Temperature Conversion Table

-459.4 to 0			0 to 100						100 to 1000					
C		F	C		F	C		F	C		F	C		F
-273	-459.4		-17.8	0	32	10.0	50	122.0	38	100	212	260	500	932
-268	-450		-17.2	1	33.8	10.6	51	123.8	43	110	230	266	510	950
-262	-440		-16.7	2	35.6	11.1	52	125.6	49	120	248	271	520	968
-257	-430		-16.1	3	37.4	11.7	53	127.4	54	130	266	277	530	986
-251	-420		-15.6	4	39.2	12.2	54	129.2	60	140	284	282	540	1004
-246	-410		-15.0	5	41.0	12.8	55	131.0	66	150	302	288	550	1022
-240	-400		-14.4	6	42.8	13.3	56	132.8	71	160	320	293	560	1040
-234	-390		-13.9	7	44.6	13.9	57	134.6	77	170	338	299	570	1058
-229	-380		-13.3	8	46.4	14.4	58	136.4	82	180	356	304	580	1076
-223	-370		-12.8	9	48.2	15.0	59	138.2	88	190	374	310	590	1094
-218	-360		-12.2	10	50.0	15.6	60	140.0	93	200	392	316	600	1112
-212	-350		-11.7	11	51.8	16.1	61	141.8	99	210	410	321	610	1130
-207	-340		-11.1	12	53.6	16.7	62	143.6	100	212	413.6	327	620	1148
-201	-330		-10.6	13	55.4	17.2	63	145.4	104	220	428	332	630	1166
-196	-320		-10.0	14	57.2	17.8	64	147.2	110	230	446	338	640	1184
-190	-310		- 9.4	15	59.0	18.3	65	149.0	116	240	464	343	650	1202
-184	-300		- 8.9	16	60.8	18.9	66	150.8	121	250	482	349	660	1220
-179	-290		- 8.3	17	62.6	19.4	67	152.6	127	260	500	354	670	1238
-173	-280		- 7.8	18	64.4	20.0	68	154.4	132	270	518	360	680	1256
-169	-273	-459.4	- 7.2	19	66.2	20.6	69	156.2	138	280	536	366	690	1274
-168	-270	-454	- 6.7	20	68.0	21.1	70	158.0	143	290	554	371	700	1292
-162	-260	-436	- 6.1	21	69.8	21.7	71	159.8	149	300	572	377	710	1310
-157	-250	-418	- 5.6	22	71.6	22.2	72	161.6	154	310	590	382	720	1328
-151	-240	-400	- 5.0	23	73.4	22.8	73	163.4	160	320	608	388	730	1346
-146	-230	-382	- 4.4	24	75.2	23.3	74	165.2	166	330	626	393	740	1364
-140	-220	-364	- 3.9	25	77.0	23.9	75	167.0	171	340	644	399	750	1382
-134	-210	-346	- 3.3	26	78.8	24.4	76	168.8	177	350	662	404	760	1400
-129	-200	-328	- 2.8	27	80.6	25.0	77	170.6	182	360	680	410	770	1418
-123	-190	-310	- 2.2	28	82.4	25.6	78	172.4	188	370	698	416	780	1436
-118	-180	-292	- 1.7	29	84.2	26.1	79	174.2	193	380	716	421	790	1454
-112	-170	-274	- 1.1	30	86.0	26.7	80	176.0	199	390	734	427	800	1472
-107	-160	-256	- 0.6	31	87.8	27.2	81	177.8	204	400	752	432	810	1490
-101	-150	-238	0.0	32	89.6	27.8	82	179.6	210	410	770	438	820	1508
- 96	-140	-220	0.6	33	91.4	28.3	83	181.4	216	420	788	443	830	1526
- 90	-130	-202	1.1	34	93.2	28.9	84	183.2	221	430	806	449	840	1544
- 84	-120	-184	1.7	35	95.0	29.4	85	185.0	227	440	824	454	850	1562
- 79	-110	-166	2.2	36	96.8	30.0	86	186.8	232	450	842	460	860	1580
- 73	-100	-148	2.8	37	98.6	30.6	87	188.6	238	460	860	466	870	1598
- 68	- 90	-130	3.3	38	100.4	31.1	88	190.4	243	470	878	471	880	1616
- 62	- 80	-112	3.9	39	102.2	31.7	89	192.2	249	480	896	477	890	1634
- 57	- 70	- 94	4.4	40	104.0	32.2	90	194.0	254	490	914	482	900	1652
- 51	- 60	- 76	5.0	41	105.8	32.8	91	195.8				488	910	1670
- 46	- 50	- 58	5.6	42	107.6	33.3	92	197.6				493	920	1688
- 40	- 40	- 40	6.1	43	109.4	33.9	93	199.4				499	930	1706
- 34	- 30	- 22	6.7	44	111.2	34.4	94	201.2				504	940	1724
- 29	- 20	- 4	7.2	45	113.0	35.0	95	203.0				510	950	1742
- 23	- 10	14	7.8	46	114.8	35.6	96	204.8				516	960	1760
- 17.8	0	32	8.3	47	116.6	36.1	97	206.6				521	970	1778
			8.9	48	118.4	36.7	98	208.4				527	980	1796
			9.4	49	120.2	37.2	99	210.2				532	990	1814
						37.8	100	212.0				538	1000	1832

Look up temperature to be converted in middle column. If in degrees Celsius, read Fahrenheit equivalent in right-hand column; if in Fahrenheit degrees, read Celsius equivalent in left-hand column.

Temperature Conversion Table (continued)

1000 to 2000						2000 to 3000					
C		F	C		F	C		F	C		F
538	1000	1832	816	1500	2732	1093	2000	3632	1371	2500	4532
543	1010	1850	821	1510	2750	1099	2010	3650	1377	2510	4550
549	1020	1868	827	1520	2768	1104	2020	3668	1382	2520	4568
554	1030	1886	832	1530	2786	1110	2030	3686	1388	2530	4586
560	1040	1904	838	1540	2804	1116	2040	3704	1393	2540	4604
566	1050	1922	843	1550	2822	1121	2050	3722	1399	2550	4622
571	1060	1940	849	1560	2840	1127	2060	3740	1404	2560	4640
577	1070	1958	854	1570	2858	1132	2070	3758	1410	2570	4658
582	1080	1976	860	1580	2876	1138	2080	3776	1416	2580	4676
588	1090	1994	866	1590	2894	1143	2090	3794	1421	2590	4694
593	1100	2012	871	1600	2912	1149	2100	3812	1427	2600	4712
599	1110	2030	877	1610	2930	1154	2110	3830	1432	2610	4730
604	1120	2048	882	1620	2948	1160	2120	3848	1438	2620	4748
610	1130	2066	888	1630	2966	1166	2130	3866	1443	2630	4766
616	1140	2084	893	1640	2984	1171	2140	3884	1449	2640	4784
621	1150	2102	899	1650	3002	1177	2150	3902	1454	2650	4802
627	1160	2120	904	1660	3020	1182	2160	3920	1460	2660	4820
632	1170	2138	910	1670	3038	1188	2170	3938	1466	2670	4838
638	1180	2156	916	1680	3056	1193	2180	3956	1471	2680	4856
643	1190	2174	921	1690	3074	1199	2190	3974	1477	2690	4874
649	1200	2192	927	1700	3092	1204	2200	3992	1482	2700	4892
654	1210	2210	932	1710	3110	1210	2210	4010	1488	2710	4910
660	1220	2228	938	1720	3128	1216	2220	4028	1493	2720	4928
666	1230	2246	943	1730	3146	1221	2230	4046	1499	2730	4946
671	1240	2264	949	1740	3164	1227	2240	4064	1504	2740	4964
677	1250	2282	954	1750	3182	1232	2250	4082	1510	2750	4982
682	1260	2300	960	1760	3200	1238	2260	4100	1516	2760	5000
688	1270	2318	966	1770	3218	1243	2270	4118	1521	2770	5018
693	1280	2336	971	1780	3236	1249	2280	4136	1527	2780	5036
699	1290	2354	977	1790	3254	1254	2290	4154	1532	2790	5054
704	1300	2372	982	1800	3272	1260	2300	4172	1538	2800	5072
710	1310	2390	988	1810	3290	1266	2310	4190	1543	2810	5090
716	1320	2408	993	1820	3308	1271	2320	4208	1549	2820	5108
721	1330	2426	999	1830	3326	1277	2330	4226	1554	2830	5126
727	1340	2444	1004	1840	3344	1282	2340	4244	1560	2840	5144
732	1350	2462	1010	1850	3362	1288	2350	4262	1566	2850	5162
738	1360	2480	1016	1860	3380	1293	2360	4280	1571	2860	5180
743	1370	2498	1021	1870	3398	1299	2370	4298	1577	2870	5198
749	1380	2516	1027	1880	3416	1304	2380	4316	1582	2880	5216
754	1390	2534	1032	1890	3434	1310	2390	4334	1588	2890	5234
760	1400	2552	1038	1900	3452	1316	2400	4352	1593	2900	5252
766	1410	2570	1043	1910	3470	1321	2410	4370	1599	2910	5270
771	1420	2588	1049	1920	3488	1327	2420	4388	1604	2920	5288
777	1430	2606	1054	1930	3506	1332	2430	4406	1610	2930	5306
782	1440	2624	1060	1940	3524	1338	2440	4424	1616	2940	5324
788	1450	2642	1066	1950	3542	1343	2450	4442	1621	2950	5342
793	1460	2660	1071	1960	3560	1349	2460	4460	1627	2960	5360
799	1470	2678	1077	1970	3578	1354	2470	4478	1632	2970	5378
804	1480	2696	1082	1980	3596	1360	2480	4496	1638	2980	5396
810	1490	2714	1088	1990	3614	1366	2490	4514	1643	2990	5414
			1093	2000	3632				1649	3000	5432

To convert to the corresponding absolute scales: Kelvin = Celsius + 273. Rankine = Fahrenheit + 459.4

C	F	C	F	C	F
0.6	1	1.8	2.2	4	7.2
1.1	2	3.6	2.8	5	9.0
1.7	3	5.4	3.3	6	10.8
			5.0	9	16.2

Trademarks

DISCALOY	Westinghouse Corporation
HASTELLOY	Haynes Alloys International
HAYNES	Haynes Alloys International
INCOLOY	Inco Alloys International
INCONEL	Inco Alloys International
MAR-M	Martin Metals Corporation
NIMOCAST	Inco family of Companies
NIMONIC	Inco Alloys International
PYROMET	Carpenter Technology Corporation
RENÉ	General Electric Corporation
RENÉ 41	Teledyne Allvac
RGT	Stahlwerke Rochling-Burback
UDIMET	Special Metals Corporation
UNITEMP	Cytemp Specialty Steel
WASPALLOY	Pratt & Whitney Aircraft Division United Technologies Corporation

NiDI

Nickel
Development
Institute

**HIGH-TEMPERATURE
HIGH-STRENGTH
NICKEL
BASE ALLOYS**

1995 SUPPLEMENT

Nº 393

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high-temperature

high-strength

NICKEL BASE ALLOYS – Data Supplement

CONTENTS

		Page No.
Introduction		2
Cast Alloys		
Composition	Table 1	3
Physical Properties		
Density	Table 2	4
Typical Modulus of Elasticity	Table 2	4
Mean Coefficient of Thermal Expansion	Table 3	4
Mechanical Properties		
Yield Strength	Table 4	5
Ultimate Tensile Strength	Table 5	6
Tensile Elongation	Table 6	7
100 Hour Rupture Strength	Table 7	8
1000 Hour Rupture Strength	Table 8	9
Wrought Alloys		
Composition	Table 9	10
Physical Properties		
Density	Table 10	11
Typical Modulus of Elasticity	Table 10	11
Melting Temperature	Table 10	11
Mean Coefficient of Thermal Expansion	Table 11	12
Mechanical Properties		
Yield Strength	Table 12	13
Ultimate Tensile Strength	Table 13	14
Tensile Elongation	Table 14	15
100 Hour Rupture Strength	Table 15	16
1000 Hour Rupture Strength	Table 16	17
Listing of Equivalent UNS Number by Alloys		18
Trademark Identification		19

high-temperature

high-strength

NICKEL BASE ALLOYS – Data Supplement

The Nickel Development Institute publication number 393, “high temperature — high strength NICKEL BASE ALLOYS”, containing data on these cast and wrought nickel base alloys, dates back to 1984. Since that time there have been a significant number of new alloys that have come into use for high temperature applications.

This supplement has been published in order to provide an updated data compilation on the newer alloys since 1984. Also some of the older alloys, that have been available but had not been included in the original 1984 publication, have been added to this supplement.

In order to have a complete NiDI data publication package on the Nickel Base Alloys (including some cobalt base alloys as well) the user needs both the original 1984 date publication, NiDI #393, and this 1995 supplement.

Please note that the data contained herein has been gathered from a variety of sources including published literature, alloy producers and users, as well as by private communications. Their cooperation in accomplishing this compilation has been most helpful and is greatly appreciated.

In some instances tradenames, or trademarks, have been used to identify an alloy, even though the alloy may be made by a variety of producers other than the trademark source. This is because such names are widely recognized and in many instances no UNS numbers have been assigned to the alloys. Credit for these tradenames, or trademarks, is shown on the last page of this supplement. A listing of alloys with equivalent UNS numbers where such are in existence is also provided for reference.

For some alloys data are not complete, or not available. Some of the data is considered proprietary and is not open for general information, or has not yet been developed.

Lastly, the data shown here are believed to be typical values for the alloys covered. Mechanical property values are for the typical “as supplied” heat treated condition, solution annealed and/or aged when applicable to that alloy. Values shown do not represent guaranteed minimum or maximum values but are intended as guides for comparison of the alloys one to another. Neither the sources providing the data nor the Nickel Development Institute are responsible for errors or variations in data shown here from values encountered in actual applications.

CAST ALLOYS

TABLE 1
NOMINAL COMPOSITION — WT. %

Ref. No.	ALLOY	Ni	Cr	Co	Mo	W	Ta	Nb	Al	Ti	Fe	Mn	Si	C	B	Zr	Hf	Re	Y	La
1	C-1023	58	15	10	8.5	—	—	—	4.2	3.6	—	—	—	.16	.006	—	—	—	—	—
2	CMSX-2	33	8	5	.6	8	6	—	5.6	1	—	—	—	—	—	—	—	—	—	—
3	CMSX-3	33	8	5	.6	8	6	—	5.6	1	—	—	—	—	—	—	0.1	—	—	—
4	CMSX-4	62	7	10	.6	6	6	—	5.6	1	—	—	—	—	—	—	0.1	3	—	—
5	CMSX-6	70	10	5	3	—	2	—	4.8	4.7	—	—	—	—	—	—	0.1	—	—	—
6	CM 186LC	63	6	9	.5	8	3	—	5.7	.7	—	—	—	.07	.015	.005	1.4	3	—	—
7	CM 247LC	62	8	9	.5	10	3.2	—	5.6	.7	—	—	—	.07	.015	.01	1.4	—	—	—
8	GMR 235	63	15	—	5.3	—	—	—	3	2	10	.3	.6	.15	.06	—	—	—	—	—
9	Haynes 230	57	22	5mx	2	14	—	—	.3	—	2	.5	.4	.10	—	—	—	—	—	.02
10	IN 939	48	22	19	—	2	1.4	1	1.9	3.7	—	—	—	.15	.009	.09	—	—	—	—
11	PWA 1480	62	10	5	—	4	12	—	5	1.5	—	—	—	—	—	—	—	—	—	—
12	PWA 1484	63	5	10	1.9	5.9	8.7	—	5.6	—	—	—	—	—	—	—	.10	3	—	—
13	Rene 125	59	8.9	10	2	7	3.8	—	4.8	2.5	—	—	—	.11	.015	.05	1.5	—	—	—
14	Rene 220C	56	19	12	3.2	—	3.2	5.2	.5	1	—	—	—	.03	.004	—	—	—	—	—
15	Rene N4	62	9.8	7.5	1.5	6	4.8	.5	4.2	3.5	—	—	—	.06	.004	—	.15	—	—	—
16	Rene N5	63	7	7.5	1.5	5	6.5	—	6.2	—	—	—	—	.05	.004	—	.15	3	.015	—

CAST ALLOYS

**TABLE 2
PHYSICAL PROPERTIES**

Ref No.	ALLOY	DENSITY		*TYPICAL MODULUS OF ELASTICITY 10 ⁶ psi				
		lbs./cu.in.	gm./cm.cu.	70F	1000F	1200F	1400F	1800F
1	C-1023	—	—	28.9	26.0	24.9	24.1	21.0
2	CMSX-2	.309	8.56	18.5	16.0	15.3	14.4	12.6
3	CMSX-3	.309	8.56	18.5	16.0	15.3	14.4	12.6
4	CMSX-4	.314	8.7	18.5	16.0	15.3	14.4	12.6
5	CMSX-6	.288	7.98	18.5	16.0	15.3	14.4	12.6
6	CM 186LC	.314	8.7	18.5	16.0	15.3	14.4	12.6
7	CM 247LC	.308	8.54	18.5	16.0	15.3	14.4	12.6
8	GMR 235	.291	8.0	28.9	26.0	24.9	24.1	21.0
9	Haynes 230	.324	8.9	28.9	26.0	24.9	24.1	21.0
10	IN-939	.295	8.2	28.9	26.0	24.9	24.1	21.0
11	PWA 1480	.314	8.7	18.5	16.0	15.3	14.4	12.6
12	PWA 1484	.323	8.8	18.5	16.0	15.3	14.4	12.6
13	Rene 125	.308	8.5	28.9	26.0	24.9	24.1	21.0
14	Rene 220C	.308	8.5	28.9	26.0	24.9	24.1	21.0
15	Rene N4	.307	8.4	18.5	16.0	15.3	14.4	12.6
16	Rene N5	.312	8.6	18.5	16.0	15.3	14.4	12.6

* Note: Modulus values are approximate and are based upon typical characteristics of alloy family.

Alloys used for Single Crystal castings:

Rene N4 & N5
PWA 1480 & 1484
CMSX-2, 3, 4, 6

Alloys used for Directional Solidification:

CM 186LC, CM 247LC

**TABLE 3
MEAN COEFFICIENT of THERMAL EXPANSION**

Data for the individual alloys are not available. In general, for the cast alloys listed in this supplement, the thermal expansion values are as follows:

Mean Coefficient of Thermal Expansion 70°F to Temp. x 10⁻⁶

1000F (540C)	1200F (650C)	1400F (760C)	1600F (870C)	1800F (980C)
7.9	8.1	8.4	8.8	9.2

Note: These are "typical" values as generally in the proper range for nickel base cast alloys. The values are not exact and may be used as a guide only.

CAST ALLOYS

TABLE 4
YIELD STRENGTH — ksi & MPa

Ref. No.	ALLOY	70F 21C	1000F 538C	1200F 649C	1400F 760C	1600F 871C	1800F 982C	2000F 1093C
1	C-1023	— —	— —	— —	— —	— —	— —	— —
2	CMSX-2	165 1135	181 1245	— —	— —	125 860	— —	58 400
3	CMSX-3	— —	— —	— —	— —	— —	— —	— —
4	CMSX-4	140 966	— —	— —	— —	— —	— —	— —
5	CMSX-6	— —	— —	— —	— —	— —	— —	— —
6	CM 186LC	— —	— —	— —	— —	— —	— —	— —
7	CM 247LC	— —	— —	— —	— —	— —	— —	— —
8	GMR 235	93 640	— —	82 565	— —	— —	43 295	— —
9	Haynes 230	47 324	33 227	32 221	33 227	25 172	24.8 171	12.6 87
10	IN-939	116 800	— —	101 695	92 635	58 400	30 205	— —
11	PWA 1480	130 895	128 881	132 910	131 905	106 730	72 495	40 276
12	PWA 1484	130 895	128 881	132 910	132 910	111 767	78 539	45 311
13	Rene 125	128 883	128 883	128 883	121 834	108 745	70 483	— —
14	Rene 220C	119 821	104 717	100 690	92 635	— —	— —	— —
15	Rene N4	145 1000	120 828	138 952	149 1028	100 690	62 428	— —
16	Rene N5	124 855	119 821	125 862	128 883	115 793	90 621	50 345

CAST ALLOYS

TABLE 5
ULTIMATE TENSILE STRENGTH — ksi & MPa

Ref. No.	ALLOY	70F	21C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C
1	C-1023	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	CMSX-2	172	1187	—	—	—	—	188	1296	148	1020	—	—	—	—
3	CMSX-3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	CMSX-4	152	1050	—	—	—	—	—	—	—	—	—	—	—	—
5	CMSX-6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	CM 186LC	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	CM 247LC	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	GMR-235	103	710	—	—	96	660	—	—	—	—	—	—	—	—
9	Haynes 230	89	615	65.6	453	70	482	55.8	386	41	283	29.4	203	12.9	89
10	IN-939	152	1050	—	—	143	985	133	915	93	640	47	325	—	—
11	PWA 1480	—	—	—	—	165	1140	164	1130	144	995	99	685	—	—
12	PWA 1484	139	957	138	950	142	978	144	992	136	937	101	696	57	393
13	Rene 125	156	1078	158	1092	163	1126	150	1036	120	829	82	567	—	—
14	Rene 220C	158	1092	141	974	135	933	110	760	—	—	—	—	—	—
15	Rene N4	150	1036	150	1036	156	1078	182	1258	143	988	94	650	—	—
16	Rene N5	156	1078	148	1023	152	1050	163	1126	138	954	108	746	55	380

CAST ALLOYS

TABLE 6
TENSILE ELONGATION % AT TEMPERATURE SHOWN

Ref. No.	ALLOY	70F 21C	1000F 538C	1200F 649C	1400F 760C	1600F 871C	1800F 982C	2000F 1093C
1	C-1023	—	—	—	—	—	—	—
2	CMSX-2	10	—	—	17	20	—	—
3	CMSX-3	—	—	—	—	—	—	—
4	CMSX-4	—	—	—	—	—	—	—
5	CMSX-6	—	—	—	—	—	—	—
6	CM-186LC	—	—	—	—	—	—	—
7	CM-247LC	—	—	—	—	—	—	—
8	GMR-235	3	—	3	—	—	18	—
9	Haynes 230	38	38	44	32	19	26	41
10	IN-939	5	—	7	7	18	25	—
11	PWA 1480	4	4.8	5.5	7.9	12	19.5	32
12	PWA 1484	28	23	18	18	20	22	22
13	Rene 125	7.4	6.9	6.8	6.5	6.3	6.2	—
14	Rene 220C	8	12	12	9.5	—	—	—
15	Rene N4	7	3.5	2	5	17	26	—
16	Rene N5	17	11	9.5	13	19	25	27

CAST ALLOYS

TABLE 7
100-HOUR RUPTURE STRENGTH — ksi & MPa

Ref. No.	ALLOY	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C
1	C-1023	—	—	—	—	—	—	—	—	—	—
2	CMSX-2	—	—	—	—	—	—	—	—	—	—
3	CMSX-3	—	—	—	—	—	—	—	—	—	—
4	CMSX-4	—	—	—	—	—	—	—	—	—	—
5	CMSX-6	—	—	—	—	—	—	—	—	—	—
6	CM 186LC	—	—	—	—	—	—	—	—	—	—
7	CM 247LC	—	—	—	—	—	—	—	—	—	—
8	GMR 235	—	—	—	—	—	—	—	—	—	—
9	Haynes 230	—	—	23.8	164	12.5	86.3	6.4	44	3	21
10	IN 939	111	766	73.1	504	40.2	277	16.2	112	—	—
11	PWA 1480	—	—	—	—	68	466	33.5	231	15.2	105
12	PWA 1484	—	—	—	—	81	559	43.9	303	21.6	149
13	Rene 125	—	—	98	672	60	412	29	199	—	—
14	Rene 220C	105	724	57	393	—	—	—	—	—	—
15	Rene N4	—	—	97	669	63	435	31	214	13.5	93
16	Rene N5	—	—	122	842	80	552	37	255	19.5	134

CAST ALLOYS

TABLE 8
1000-HOUR RUPTURE STRENGTH — ksi & MPa

Ref. No.	ALLOY	1200F 649C	1400F 760C	1600F 871C	1800F 982C	2000F 1093C
1	C-1023	— —	— —	— —	— —	— —
2	CMSX-2	— —	— —	50 345	25 170	13 90
3	CMSX-3	— —	— —	— —	— —	— —
4	CMSX-4	— —	— —	— —	— —	— —
5	CMSX-6	— —	— —	— —	— —	— —
6	CM 186LC	— —	— —	— —	— —	— —
7	CM 247LC	— —	— —	— —	— —	— —
8	GMR 235	— —	— —	26 180	11 75	— —
9	Haynes 230	— —	18.3 126	9.3 64	4.4 30	1.8 12.4
10	IN 939	— —	62 425	28 195	9 60	— —
11	PWA 1480	— —	94.9 655	47.6 328	21.6 149	9.1 65
12	PWA 1484	— —	101 697	59.9 413	29.5 204	— —
13	Rene 125	— —	84 579	44 304	18 124	— —
14	Rene 220C	88 607	46 317	— —	— —	— —
15	Rene N4	— —	79.5 549	46 317	19 131	9.3 64
16	Rene N5	— —	105 724	58 400	24 166	14 96

WROUGHT ALLOYS

TABLE 9
NOMINAL COMPOSITION — WT. %

Ref. No.	ALLOY	Ni	Cr	Co	Mo	W	Ta	Nb	Al	Ti	Fe	Mn	Si	C	B	Zr	Other
HAYNES																	
1	HR-120	37	25	3*	1	1	—	.7	.1	—	33	.7	.6	.05	—	—	N .2
2	150	—	28	50	—	—	—	—	—	—	21	1*	1*	.1*	—	—	
3	HR-160	37	28	29	—	—	—	—	—	—	2	.5	2.8	.05	—	—	
4	214	75	16	—	—	—	—	—	4.5	—	3	.2	.1	.05	—	—	Y.01
5	230	57	22	5*	2	14	—	—	.3	—	.3*	.5	.4	.10	—	—	La.02
6	242	65	8	1	25	—	—	—	.5*	—	2*	.8*	.8*	.02	.01	.003	
7	556	20	22	18	3	2.5	.6	—	.2	—	31	1	.4	.10	—	.02	La.02 N .2
8	Ultimet	9	26	54	5	2	—	—	—	—	3	.8	.3	.05	.015	—	N.08
INCO																	
9	DS	38	18	—	—	—	—	—	—	.2*	40	1.2	2.3	—	—	—	
10	MA-758	69	30	—	—	—	—	—	.3	.5	1	—	—	.05	—	—	Y .6
11	MA-956	—	20	—	—	—	—	—	4.5	.5	74	—	—	—	—	—	Y .5
12	800HT	33	21	—	—	—	—	—	.4	.4	46	.8	.5	.08	—	—	
13	803	35	27	—	—	—	—	—	.3	.4	37	.8	.5	.07	—	—	
14	907	38	—	13	—	—	—	4.7	.03	1.5	42	—	.15	—	—	—	
15	909	38	—	13	—	—	—	4.7	—	1.5	42	—	.4	.01	.001	—	
MISCELLANEOUS ALLOYS																	
16	MAR M918	20	20	52	—	—	7.5	—	—	—	—	—	—	.05	—	.1	
17	MP-35N	35	20	35	10	—	—	—	—	—	—	—	—	—	—	—	
18	MP-159	26	19	36	7	—	—	.6	.2	3	9	—	—	—	—	—	
19	Rene 88DT	56	16	13	4	4	—	.7	2	4	—	—	—	.04	.016	.05	
NIMONIC																	
20	86	65	25	—	10	—	—	—	—	—	—	—	—	.05	—	—	Ce.05 Mg.015
21	901	43	12	1*	6	—	—	—	.2	3	35	.5*	.4*	.05	—	—	
UDIMET																	
22	720CR	55	18	15	3	1.3	—	—	2.5	5	—	—	—	.03	.03	.03	
23	720LI	57	16	15	3	1.3	—	—	2.5	5	—	—	—	.015	.015	.03	

Notes: * Denotes max. value
Y Denotes Y₂O₃

WROUGHT ALLOYS

TABLE 10 PHYSICAL PROPERTIES

Ref. No.	ALLOY	Density		Typical Modulus of Elasticity 10 ⁶ psi					Melting Temp. °C
		lbs./cu.in.	gm./cm.cu.	70F	1000F	1200F	1400F	1600F	
HAYNES									
1	HR-120	.291	8.05	28.6	—	—	—	—	1330
2	150	.291	8.05	31.5	—	—	—	—	—
3	HR-160	.292	8.08	30.6	—	—	—	—	1320
4	214	.291	8.05	31.6	—	—	—	—	1355
5	230	.324	8.97	30.6	—	—	—	—	1350
6	242	.327	9.05	33.2	—	—	—	—	1340
7	556	.297	8.23	29.5	23.9	22.6	21.1	19.9	1360
8	Ultimet	.33	8.6	—	—	—	—	—	1390
INCO									
9	DS	.284	7.92	—	—	—	—	—	1371
10	MA-758	.294	8.14	—	—	—	—	—	—
11	MA-956	.260	7.2	—	—	—	—	—	1468
12	800HT	.287	7.95	28.5	—	—	—	—	1370
13	803	.275	7.61	—	—	—	—	—	1360
14	907	.299	8.28	23.9	23.9	23	—	—	1350
15	909	.296	8.20	23.0	—	—	—	—	1410
MISCELLANEOUS ALLOYS									
16	MAR M918	.320	8.9	32.6	27.0	25.8	24.4	22.5	1400
17	MP 35N	.304	8.4	—	—	—	—	—	1416
18	MP-159	.301	8.3	30	—	—	—	—	1427
19	Rene 88DT	.302	8.3	—	—	—	—	—	—
NIMONIC									
20	86	.309	8.54	30.5	—	—	—	—	1356
21	901	.294	8.14	30.0	—	—	—	—	1321
UDIMET									
22	720CR	.292	8.1	—	—	—	—	—	—
23	720LI	.292	8.1	—	—	—	—	—	—

WROUGHT ALLOYS

TABLE 11
COEFFICIENT OF THERMAL EXPANSION
70° F to TEMPERATURE SHOWN x 10⁻⁶

Ref. No.	ALLOY	200F 93C	400F 204C	600F 316C	800F 427C	1000F 538C	1400F 760C
HAYNES							
1	HR-120	—	—	—	8.8	9.0	9.5
2	150	—	—	—	—	—	—
3	HR-160	7.2	7.6	7.9	8.1	8.3	8.4
4	214 (sheet)	—	7.4	—	7.9	8.2	9.0
5	230	7.0	7.2	7.4	7.6	7.9	8.3
6	242	6.0	6.3	6.5	6.7	6.8	7.7
7	556	8.1	8.2	8.4	8.6	8.8	9.2
8	Ultimet	7.1	—	—	—	—	—
INCO							
9	DS	8.3	—	—	—	—	—
10	MA-758	6.9	7.16	7.44	7.72	7.91	8.35
11	MA-956	—	—	—	—	—	—
12	800HT	7.9	8.8	9.0	9.2	9.4	9.9
13	803	—	—	—	—	—	—
14	907	4.4	4.5	4.3	4.3	5.05	—
15	909	4.4	4.5	4.3	4.3	5.1	—
MISCELLANEOUS ALLOYS							
16	MAR M918	—	—	—	—	—	—
17	MP 35N	—	—	—	—	—	—
18	MP-159	7.9	—	7.9	8.1	8.4	—
19	Rene 88DT	6.75	6.9	7.1	7.3	7.48	8.15
NIMONIC							
20	86	7.05	7.16	7.28	7.55	7.78	8.33
21	901	7.5	7.89	7.94	8.0	8.27	8.55
UDIMET							
22	720CR	6.8	—	—	7.6	7.88	8.45
23	720LI	6.8	—	—	7.6	7.88	8.45

WROUGHT ALLOYS

TABLE 12
YIELD STRENGTH — ksi & MPa

Ref. No.	ALLOY	70F	21C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C
HAYNES															
1	HR-120	46	317	25.7	179	25	172	25.4	175	27	186	19.4	134	9.1	63
2	150	46	317	—	—	23	160	—	—	—	—	—	—	—	—
3	HR-160	46	317	25.5	176	25.7	177	24.7	170	22.1	152	10.8	74	5	34
4	214 (sheet)	83	573	—	—	85.4	588	79.6	548	56.6	390	7.9	54	2.7	19
5	230	57	393	40.3	278	39.5	272	42.5	293	37.3	257	21.1	145	10.8	74
6	242	121	833	79.8	550	79.5	547	45	310	—	—	—	—	—	—
7	556	55	379	30.6	211	30.6	211	29.3	202	27.9	192	18.5	127	8.7	60
8	Ultimet	80	551	—	—	—	—	—	—	—	—	—	—	—	—
INCO															
9	DS	40	276	—	—	—	—	—	—	—	—	—	—	—	—
10	MA-758	81	558	62	427	55	379	39	269	—	—	22	152	—	—
11	MA-956(sheet)	80	555	41	285	25	170	20	140	17	115	—	—	—	—
12	800HT	35	241	19	131	17	117	18	124	18	124	—	—	—	—
13	803	37	255	—	—	—	—	—	—	18	124	10	69	6	41
14	907	162	1116	137	944	126	868	82	565	—	—	—	—	—	—
15	909	148	1020	137	945	126	870	78	540	—	—	—	—	—	—
MISCELLANEOUS ALLOYS															
16	MAR M918 (sheet)	130	896	—	—	—	—	—	—	—	—	—	—	—	—
17	MP 35N	235	1620	—	—	—	—	—	—	—	—	—	—	—	—
18	MP-159	265	1825	217	1495	205	1415	—	—	—	—	—	—	—	—
19	Rene 88DT(forged)	165	1137	152	1047	148	1020	140	964	—	—	—	—	—	—
NIMONIC															
20	86	62	427	35	243	34	239	—	—	24	170	—	—	—	—
21	901	130	896	115	792	115	792	100	689	50	345	—	—	—	—
UDIMET															
22	720CR	126	868	110	758	116	799	115	792	80	551	—	—	—	—
23	720LI	—	—	—	—	—	—	—	—	—	—	—	—	—	—

WROUGHT ALLOYS

TABLE 13
ULTIMATE TENSILE STRENGTH — ksi & MPa

Ref. No.	ALLOY	70F	21C	1000F	538C	1200F	649C	1400F	760C	1600F	871C	1800F	982C	2000F	1093C
HAYNES															
1	HR-120	106	731	80	552	73	503	64	441	48	276	28	193	15	103
2	150	134	935	—	—	47	325	—	—	23	155	—	—	—	—
3	HR-160	111	765	82	565	76	524	62	427	38	207	20	138	11	76
4	214(sheet)	135	930	—	—	120	827	102	703	75	517	15	103	7.5	52
5	230	125	861	102	703	98	620	88	606	63	434	35	241	19	131
6	242	187	1290	157	1083	145	1000	100	690	—	—	—	—	—	—
7	556	116	800	90	620	83	572	68	469	49	338	31	214	16	110
8	Ultimet	145	1000	—	—	—	—	—	—	—	—	—	—	—	—
INCO															
9	DS	90	620	—	—	—	—	—	—	—	—	—	—	—	—
10	MA-758	138	951	109	751	81	558	62	427	—	—	25	172	—	—
11	MA-956(sheet)	94	645	54	370	33	230	23	160	18	125	—	—	—	—
12	800HT	83	572	70	482	60	413	40	276	20	138	—	—	—	—
13	803	89	613	—	—	—	—	—	—	27	186	14	96	7.5	52
14	907	195	1344	164	1130	151	1040	94	648	—	—	—	—	—	—
15	909	190	1310	168	1160	149	1025	89	615	—	—	—	—	—	—
MISCELLANEOUS ALLOYS															
16	MAR M918 (sheet)	130	895	—	—	—	—	—	—	—	—	—	—	—	—
17	MP 35N	294	2025	—	—	—	—	—	—	—	—	—	—	—	—
18	MP-159	275	1895	227	1565	223	1540	—	—	—	—	—	—	—	—
19	Rene 88DT (forged)	227	1566	213	1470	215	1483	169	1166	—	—	—	—	—	—
NIMONIC															
20	86	122	842	95	658	78	540	—	—	46	315	—	—	—	—
21	901	175	1207	150	1035	140	966	120	828	70	483	—	—	—	—
UDIMET															
22	720CR	164	1132	181	1249	185	1276	150	1035	102	704	—	—	—	—
23	720LI	—	—	—	—	—	—	—	—	—	—	—	—	—	—

WROUGHT ALLOYS

TABLE 14
TENSILE ELONGATION % AT TEMPERATURE SHOWN

Ref. No.	ALLOY	70F 21C	1000F 538C	1200F 649C	1400F 760C	1600F 871C	1800F 982C	2000F 1093C
HAYNES								
1	HR-120	50	61	59.8	49.5	50.8	80.8	89.3
2	150	8	—	—	—	—	—	—
3	HR-160	68	76	70	73	85	90	88
4	214 (sheet)	42	—	31	15	30	72	100
5	230	49.6	53	55.3	52.5	65.4	83.1	82.7
6	242	47	53	47.5	41	38.5	37	—
7	556	51.4	60.3	57.4	52.6	69.1	83.9	95.2
8	Ultimet	35	—	—	—	—	—	—
INCO								
9	DS	45	—	—	—	—	—	—
10	MA-758	27	24	28	41	—	29	—
11	MA-956(sheet)	10	20	20	14	9	—	—
12	800HT	49	46	40	40	88	—	—
13	803	52	—	—	—	60	74	70
14	907	15	13.8	10.2	20.9	—	—	—
15	909	16	14	24	34	—	—	—
MISCELLANEOUS ALLOYS								
16	MAR M918 (sheet)	48	—	—	—	—	—	—
17	MP 35N	10	—	—	—	—	—	—
18	MP-159	8	8	7	—	—	—	—
19	Rene 88DT (forged)	20	16	18	13	—	—	—
NIMONIC								
20	86	—	54	55	—	69	—	—
21	901	15	15	15	15	30	—	—
UDIMET								
22	720CR	5	12	11	24	22	—	—
23	720LI	—	—	—	—	—	—	—

WROUGHT ALLOYS

TABLE 15
100-HOUR RUPTURE STRENGTH — ksi & MPa

Ref. No.	ALLOY	1200F 649C		1400F 760C		1600F 871C		1800F 982C		2000F 1093C	
HAYNES											
1	HR-120	—	—	24	164	11	75	5.4	37	2.0	14
2	150	—	—	—	—	—	—	—	—	—	—
3	HR-160	32.2	221	16.4	113	8.4	58	4.4	30	—	—
4	214 (sheet)	—	—	23.5	161	10.1	69	3.0	21	—	—
5	230	56	384	27	185	13.7	94	6.0	41	2.1	14.4
6	242	—	—	—	—	—	—	—	—	—	—
7	556	53	364	25	172	11.5	79	4.8	33	—	—
8	Ultimet	—	—	—	—	—	—	—	—	—	—
INCO											
9	DS	—	—	—	—	—	—	—	—	—	—
10	MA-758	—	—	—	—	—	—	—	—	19	130
11	MA-956	—	—	—	—	—	—	—	—	—	—
12	800HT	32	220	15	103	7.0	48	3.0	21	1.1	7.5
13	803	—	—	—	—	—	—	3.0*	21*	—	—
14	907	79	542	—	—	—	—	—	—	—	—
15	909	72	494	—	—	—	—	—	—	—	—
MISCELLANEOUS ALLOYS											
16	MAR M918	—	—	—	—	—	—	—	—	—	—
17	MP 35N	—	—	—	—	—	—	—	—	—	—
18	MP-159	—	—	—	—	—	—	—	—	—	—
19	Rene 88DT (forged)	145	995	92	631	—	—	—	—	—	—
NIMONIC											
20	86 (sheet)	—	—	—	—	8.0	55	4.4	31	—	—
21	901	87	597	15	377	12	82	—	—	—	—
UDIMET											
22	720CR	—	—	89.5	614	47.5	326	18	123	—	—
23	720LI	—	—	—	—	—	—	—	—	—	—

Note: * 145-hour test, not 100 hours for alloy 803.

WROUGHT ALLOYS

TABLE 16
1000-HOUR RUPTURE STRENGTH — ksi & MPa

Ref. No.	ALLOY	1200F 649C		1400F 760C		1600F 871C		1800F 982C		2000F 1093C	
HAYNES											
1	HR-120	—	—	17	117	8.0	55	3.5	24	0.8	5.5
2	150	—	—	5.8	40	—	—	—	—	—	—
3	HR-160	22.4	154	11	76	5.5	38	2.8	19	—	—
4	214 (sheet)	—	—	19.8	136	6.7	46	1.9	13	1	7
5	230	42.5	293	20	138	9.5	65	3.0	21	1.0	6.9
6	242	—	—	—	—	—	—	—	—	—	—
7	556	38	262	17.5	120	7.5	52	3.0	21	—	—
8	Utimet	—	—	—	—	—	—	—	—	—	—
INCO											
9	DS	—	—	—	—	—	—	—	—	—	—
10	MA-758	—	—	—	—	—	—	—	—	16	110
11	MA-956(sheet)	—	—	16	110	12	85	10	68	—	—
12	800HT	25	172	10	68	4.9	34	2.0	14	0.7	4.8
13	803	—	—	—	—	4.0*	28*	—	—	—	—
14	907	41	282	—	—	—	—	—	—	—	—
15	909	47	324	—	—	—	—	—	—	—	—
MISCELLANEOUS ALLOYS											
16	MAR M918	—	—	9.0	60	3.0	20	1.0	5.0	—	—
17	MP 35N	—	—	—	—	—	—	—	—	—	—
18	MP-159	—	—	—	—	—	—	—	—	—	—
19	Rene 88DT(forged)	—	—	—	—	—	—	—	—	—	—
NIMONIC											
20	86(sheet)	—	—	—	—	7.3	50	2.6	18	—	—
21	901	65	448	29	200	—	—	—	—	—	—
UDIMET											
22	720CR	—	—	70	480	32	219	10	68	—	—
23	720LI	—	—	—	—	—	—	—	—	—	—

Note: * 903-hour test, not 1000 hours for alloy 803.

LISTING OF EQUIVALENT UNS NUMBER BY ALLOY

ALLOY	UNS NUMBER
A-286	S66286
Hastelloy G	N06007
Hastelloy C-22	N06022
Hastelloy C-276	N10276
Hastelloy X	N06002
Haynes 214	N07214
Haynes 230	N06230
Haynes 188	R30188
IN-102	N06102
Incoloy 800	N08800
Incoloy 800 H	N08810
Incoloy 800HT	N08811
Incoloy 825	N08825
Incoloy 907	N19907
Incoloy 909	N19909
Inconel 600	N06600
Inconel 625	N06625
Inconel 690	N06690
Inconel 702	N07702
Inconel 718	N07718
Inconel X750	N07750
L-605	R30605
M 252	N07252
N-155	R30155
Nimonic 80A	N07080
Nimonic 901	N09901
Rene 41	N07041
Udimet 500	N07500
Ultimet	R31233
Waspaloy	N07001

Trademark Identification

Cannon - Muskegon Corporation

CMSX-2, CMSX-3, CMSX-4, CMSX-6
CM 186LC, CM 247LC

General Electric Corporation

Rene 88DT, Rene 125, Rene 220C
Rene N4, Rene N5

Haynes Alloys International

HR-120, 150, HR-160, 214, 230, 242, 556
Ultimet

INCO Alloys International

Incoloy DS, Inconel MA-758, Incoloy MA-956
Incoloy 800HT, Incoloy 803, Incoloy 909
Nimonic 86, Nimonic 901

Martin Metals Corporation

MAR M918

Pratt & Whitney Aircraft Div., United Technologies

PWA 1480
PWA 1484

Special Metals Corporation

Udimet 720CR, Udimet 720LI

Standard Pressed Steel Co.

MP 35N, MP 159