

NiDI

Nickel
Development
Institute

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

1995 SUPPLEMENT

Nº 393

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NICKEL BASE ALLOYS – Data Supplement

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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

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