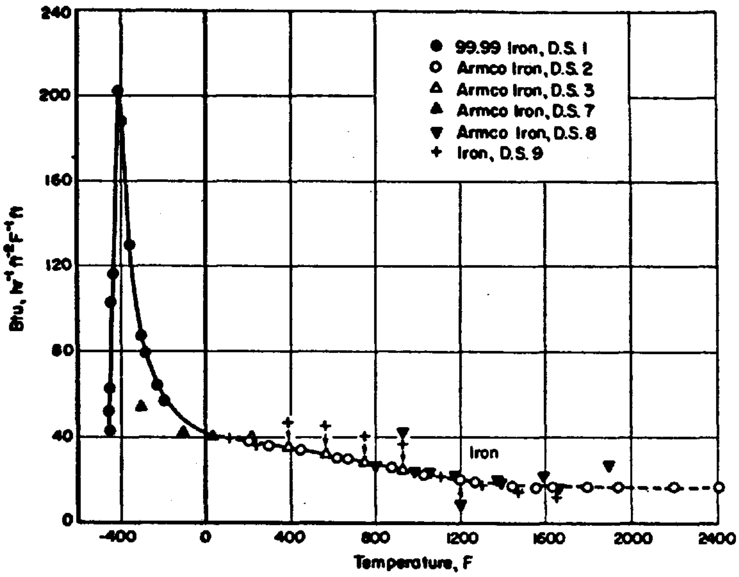
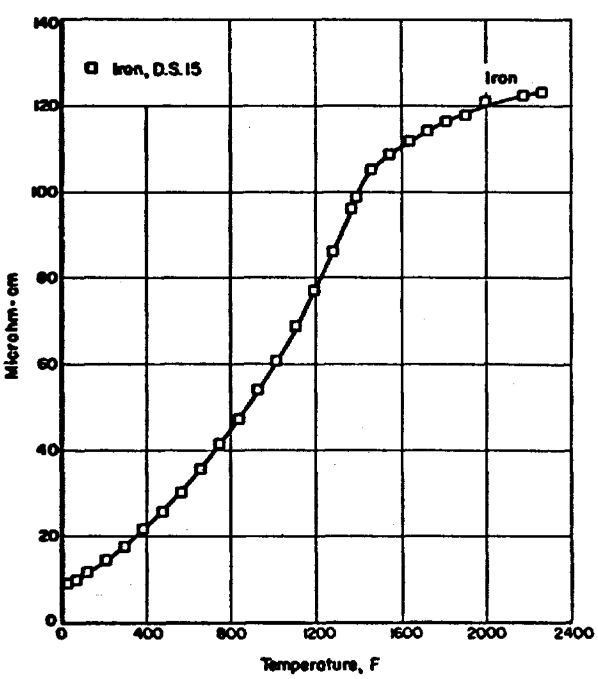
STP296-EB/Apr. 1961

IRON AND ITS ALLOYS

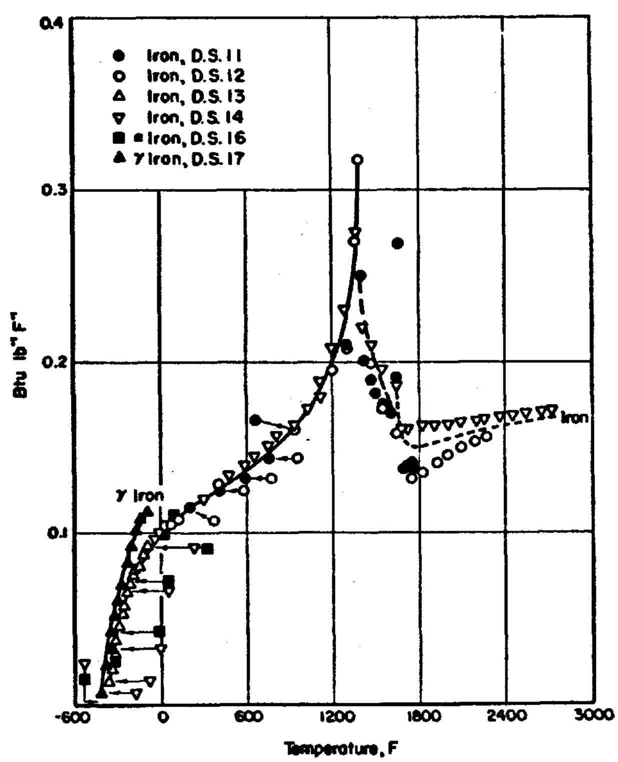
IRON



THERMAL CONDUCTIVITY OF IRON



ELECTRICAL RESISTIVITY OF IRON



SPECIFIC HEAT OF IRON

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

1

MATERIAL	Iron					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Fe								
	99.99								
REFERENCE	Rosenberg, H. M., Phil. Trans. Roy. Soc. (London) A247, (1955) pp. 441-497; Powers, R. W., Ziegler, J. B. and Johnston, H. L., TR 264-6, Cryogenics Laboratory, Ohio State University, (1951) p. 17; as found in "A Compendium of the Properties of Materials at Low Temperatures, Phase I", Part II, edited by Victor J. Johnson, NBS Cryogenic Engineering Laboratory, Boulder, Colorado (December, 1959).								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
-452	43.34	-424	116	-388	188	-280	79
-451	52.6	-406	202	-352	130	-226	64
-449	63	-402	202+	-307	87	-190	57
-442	103						
Values interpolated from graph.							

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

2

MATERIAL	Armco Iron					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT									
FORM									
HEAT TREATMENT									
REFERENCE	WADC Technical Report 58-274; Armour Research.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
208	39.7	673	30.1	1269	19.1	1794	17.0
303	36.8	883	25.9	1439	17.0	1941	17.0
459	34.4	1035	22.5	1560	17.0	2199	17.5
620	30.1	1202	20.7	1630	17.0	2409	17.6

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

3

MATERIAL	Armco Iron					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cu	S	Mn	C	Ni	Fe			
	0.067	0.039	0.035	0.028	0.024	Bal			
FORM									
HEAT TREATMENT									
REFERENCE	Armstrong, L. D. and Dauphinee, T. M., "Thermal Conductivity of Metals at High Temperatures, Part I. Description of the Apparatus and Measurements on Iron" Canadian Journal of Research, Vol 25, Sec. A (November, 1947) pp. 357-374; As found in USAF Technical Report 6145-1.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
212	39.9	392	36.0	572	32.2	752	28.5
932	25.4						

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

4

MATERIAL	Armco Iron					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	P	Mn	C	S	Fe				
	0.082	0.03	0.02	0.005	Bal				
FORM									
HEAT TREATMENT									
REFERENCE	Shelton, S. M., "Thermal Conductivity of Some Irons and Steels Over the Temperature Range 100-500 C" National Bureau of Standards Journal of Research, Vol 12 (April, 1934) pp. 441-450; As found in USAF Technical Report 6145-1.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
212	38.5	392	35.1	572	31.7	752	28.3
932	25.2						

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

5

MATERIAL	Armco Iron					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cu	S	Mn	C	P	Si	Fe		
	0.035	0.026	0.015	0.014	0.004	"Nil"	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Lucks, C. F., et. al., "The Experimental Measurements of Thermal Conductivities, Specific Heats, and Densities of Metallic, Transparent and Protective Materials, Part I" USAF Technical Report No. 6145-1 (February, 1951).								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
212	39.9	392	36.0	572	32.2	752	28.5
932	25.4						

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

6

MATERIAL	Armco Iron					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Mn	S	C	Cu	Si	P	Fe		
	0.032	0.030	0.015	0.013	0.010	0.003	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Hattori, D., "Thermal Conductivity of Pure Iron" Science Reports. Tohoku Imperial University, Vol 26, (1937) pp. 190-204; As found in USAF Technical Report 6145-1.								
REMARKS									

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
212	38.5	392	34.8	572	30.7	752	26.9
932	24.0						

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

7

MATERIAL	Armco Iron					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cu	S	Mn	C	P	Si	Fe		
	0.056	0.026	0.017	0.011	0.006	0.002	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Kannuluik, W. G., "Thermal and Electrical Conductivities of Several Metals -183 to 100 C", Proc. Royal Soc. (London) Vol 141, (1933) p. 159-168; as found in USAF Technical Report 6145-1.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
-297	54.19	-108	41.36	32	40.83		

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

8

MATERIAL	Armco Iron	HEAT NUMBER
CHEMICAL COMPOSITION PER CENT		
FORM		
HEAT TREATMENT		
REFERENCE	Lucks, C. F. and Deem, H. W., "Thermal Conductivities, Heat Capacities and Linear Thermal Expansion of Five Materials", WADC Technical Report 55-496, (August, 1956)	

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
918	26.9	1121	23.5	1395	19.8	1805	19.4
1062	23.7	1335	22.0	1567	18.7		
Determination 1.							

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
811	27.9	1058	24.6	1382	20.5	1663	20.6
932	25.5	1175	22.1	1391	19.8	1889	27.0
984	24.3	1193	22.4	1589	22.1		
Determination 2.							

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
1033	23.6	1380	20.9	1560	21.7	1702	24.3
1202	21.8	1452	16.6	1630	22.9		
Determination 3.							

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
945	26.2	1189	22.0	1393	19.2	1519	19.2
1011	25.1	1206	22.0	1431	19.0	1603	20.3
1069	23.5	1346	22.1				
Determination 4.							

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
1017	24.2	1395	19.0	1504	19.1	1625	18.1
1186	22.0	1422	18.2	1585	19.4	1665	19.4
Determination 5.							

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
930	25.0	1197	21.7	1450	19.1	1612	20.5
1060	23.7	1348	19.6	1533	19.3	1688	21.3
Determination 6.							

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
887	23.0	1022	24.2	1324	20.3	1470	19.1
892	23.9	1164	23.3	1326	21.1	1537	23.1
1018	24.3	1170	23.3	1404	17.4	1596	23.5
Determination 7.							

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

9

MATERIAL	Iron					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Si	C	P	Mn	S	Fe			
	0.028	0.026	0.021	0.02	0.011	Bal			
FORM									
HEAT TREATMENT	Annealed at 900 C.								
REFERENCE	Silverman, L., "Thermal Conductivity Data Presented for Various Metals and Alloys Up to 900 C", Journal of Metals, 5, pp. 631.								
REMARKS	Test Method: Comparative.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
122	39.9	212	38.3	392	35.0	572	31.9
752	28.5	932	25.3	1112	22.2	1292	19.1
1472	15.8	1652	12.7				

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

(10)

MATERIAL Iron **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

FORM

HEAT TREATMENT

REFERENCE Ebert 1928, Nix and MacNair 1941; As found in "A Compendium of the Properties of Materials at Low Temperatures, Phase I", Part II, edited by Victor J. Johnson, NBS Cryogenic Engineering Laboratory, Boulder, Colorado (December, 1959).

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
-459	0	-334	1.6	-172	4.8	8	6.28
-424	0.06	-316	1.9	-136	5.2	32	6.33
-406	0.17	-298	2.3	-100	5.56	44	6.39
-388	0.39	-280	2.7	- 64	5.8	68	6.44
-370	0.72	-244	3.5	- 28	6.06	80	6.5
-352	1.1	-208	4.2				

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

(11)

MATERIAL Iron **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Fe
99.99

FORM

HEAT TREATMENT

REFERENCE Awbery, J. H. and Griffiths, E., "Thermal Capacity of Pure Iron", Proc. Roy. Soc., Vol A 174, pp. 1 -15 (England).

REMARKS Test method: Guarded Sample.

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
212	0.114	392	0.124	572	0.132	752	0.143
932	0.160	1112	0.180	1292	0.209	1400	0.249
1436	0.200	1472	0.189	1508	0.181	1544	0.176
1580	0.172	1616	0.169	1652	0.190	1670	0.268
1688	0.137	1706	0.139	1724	0.141	1742	0.137

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

(12)

MATERIAL Iron **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Fe
99.99

FORM

HEAT TREATMENT Annealed specimen.

REFERENCE Pallister, P. R., "The Specific Heat and Resistivity of High-Purity Iron Up to 1250 C", Journal Iron and Steel Institute, Vol 161, pp. 87.

REMARKS Test method: Guarded specimen.

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
32	0.104	68	0.105	122	0.108	212	0.114
392	0.124	572	0.132	752	0.144	932	0.158
1112	0.180	1202	0.195	1292	0.217	1382	0.270
1400	0.318	1472	0.199	1562	0.174	1652	0.157
1742	0.132	1832	0.136	1922	0.140	2012	0.145
2102	0.149	2192	0.153	2282	0.156		

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

(13)

MATERIAL Iron **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

C	S	Si	Mn	P	Cu	Ni	O	N
<0.005	<0.004	<0.008	0.003	0.002	0.004	0.031	<0.001	nil
Fe								
Bal								

FORM

HEAT TREATMENT

REFERENCE Kelley, K. K., "The Specific Heat of Pure Iron at Low Temperatures", Jour. ci Chem. Phys., Vol 11, p 16.

REMARKS Annealed at 1190 C in dry hydrogen. Test method--guarded sample.

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
-370	0.013	-352	0.021	-334	0.029	-316	0.037
-298	0.045	-280	0.052	-262	0.058	-244	0.064
-226	0.069	-208	0.074	-190	0.078	-172	0.081
-136	0.087	- 99	0.092				

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

(14)

MATERIAL Iron **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

FORM

HEAT TREATMENT

REFERENCE Austin, J. B., "Heat Capacity of Iron", Industrial and Eng. Chem. Vol 24, p 1225.

REMARKS

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
-405	0.003	32	0.104	1022	0.172	1832	0.162
-385	0.007	77	0.108	1112	0.188	1922	0.162
-369	0.013	212	0.115	1202	0.208	2012	0.163
-324	0.032	302	0.121	1292	0.230	2102	0.164
-279	0.051	392	0.128	1382	0.276	2192	0.165
-234	0.065	482	0.134	1400	0.220	2282	0.166
-189	0.077	572	0.140	1472	0.210	2372	0.167
-144	0.086	662	0.146	1562	0.194	2462	0.168
- 99	0.092	752	0.151	1652	0.186	2552	0.169
- 54	0.097	842	0.157	1663	0.160	2642	0.170
- 9	0.101	932	0.163	1742	0.161	2732	0.171

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (15)

MATERIAL	Iron — HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Fe 99.99
FORM	
HEAT TREATMENT	Annealed specimen.
REFERENCE	Pallister, P. R., "The Specific Heat and Resistivity of High-Purity Iron Up to 1250 C", Journal Iron and Steel Institute, Vol 161, pp. 87.
REMARKS	Test method: Voltage drop.

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
32	8.9	572	30.2	1202	76.9	1742	113.9
68	9.8	662	35.3	1292	85.9	1832	115.8
122	11.5	752	41.0	1382	96.0	1922	117.5
212	14.5	842	47.0	1400	98.5	2012	119.0
302	17.9	932	53.7	1472	104.9	2102	120.4
392	21.6	1022	60.9	1562	108.7	2192	121.8
482	25.7	1112	68.7	1652	111.6	2282	123.1

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (16)

MATERIAL	α Iron — HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	
REFERENCE	Duyckaerts, G., Physica, 6, (1939) pp. 401-8; Keesom, W. H. and Kurrelmayer, B., Physica, 6, (1939) p. 633; Kelley, K. K., Journal of Chem. Phys., 11, (1943) pp. 16-18; As found in "A Compendium of the Properties of Materials at Low Temperatures, Phase I", Part II, edited by Victor J. Johnson, NBS Cryogenic Engineering Laboratory, Boulder, Colorado (December, 1959).

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
-458	0.000022	-433	0.00060	-334	0.029	-136	0.086
-456	0.000044	-424	0.0011	-316	0.037	-100	0.092
-454	0.000067	-415	0.0018	-298	0.044	- 64	0.096
-453	0.000091	-406	0.0030	-280	0.052	- 28	0.099
-451	0.000147	-388	0.007	-244	0.064	8	0.010
-449	0.00022	-370	0.013	-208	0.073	44	0.010
-442	0.00030	-352	0.021	-172	0.081	80	0.011

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (17)

MATERIAL	γ Iron — HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	
REFERENCE	Eucken, A. and Werth, H. Z. Anorg. u. Chem., 188, pp. 152-72; As found in "A Compendium of the Properties of Materials at Low Temperatures, Phase I", Part II, edited by Victor J. Johnson, NBS Cryogenic Engineering Laboratory, Boulder, Colorado (December, 1959).

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
-424	0.002	-352	0.033	-280	0.069	-172	0.102
-406	0.004	-334	0.043	-244	0.082	-136	0.108
-388	0.010	-316	0.052	-208	0.093	-100	0.112
-370	0.022	-298	0.061				

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (18)

MATERIAL	Ingot Iron — HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	
REFERENCE	U. S. Steel.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.6	70-600	7.4	70-1000	8.0	70-1200	8.2
70-400	7.1						

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (19)

MATERIAL	Electrolytic Iron — HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	Smooth Oxidized Surface.
REFERENCE	Levy, A., "Metals for Short Time Service at High Temperatures", Materials and Methods Manual No. 115, (April, 1955).

EMISSIVITY

TEMP, F	TOTAL NORMAL	TEMP, F	TOTAL NORMAL	TEMP, F	TOTAL NORMAL	TEMP, F	TOTAL NORMAL
260-980	0.78-0.82						

Assumed to be total emmissivity.

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (20)

MATERIAL	Iron — HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	Smooth Metallic Surface.
REFERENCE	Levy, A., "Metals for Short Time Service at High Temperatures", Materials and Methods Manual No. 115, (April, 1955).
REMARKS	

EMISSIVITY

TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL
1650-1900	0.55-0.60						
Assumed to total emmissivity.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (21)

MATERIAL	Iron — HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	Iron Plate, Pickled, then Rusted Red; Oxide Surface.
REFERENCE	Levy, A., "Metals for Short Time Service at High Temperatures", Materials and Methods Manual No. 115, (April, 1955).

EMISSIVITY

TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL
68	0.612						
Assumed to be total emmissivity.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (22)

MATERIAL	Iron — HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	Polished Metallic Surface.
REFERENCE	Levy, A., "Metals for Short Time Service at High Temperatures", Materials and Methods Manual No. 115, (April, 1955).

EMISSIVITY

TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL
800-1800	0.14-0.38						
Assumed to be total emmissivity.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (23)

MATERIAL	Iron — HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	Oxidized Surface.
REFERENCE	Levy, A., "Metals for Short Time Service at High Temperatures", Materials and Methods Manual No. 115, (April, 1955).

EMISSIVITY

TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL
212	0.736						
Assumed to be total emmissivity.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (24)

MATERIAL	Iron — HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	Oxide Surface.
REFERENCE	Levy, A., "Metals for Short Time Service at High Temperatures", Materials and Methods Manual No. 115, (April, 1955).

EMISSIVITY

TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL
930-2190	0.85-0.89						
Assumed to be total emmissivity.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (25)

MATERIAL	Ingot Iron — HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	Rough Oxide Surface.
REFERENCE	Levy, A., "Metals for Short Time Service at High Temperatures", Materials and Methods Manual No. 115, (April, 1955).
REMARKS	

EMISSIVITY

TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL
1700-2040	0.87-0.95						
Assumed to be total emmissivity.							

(26)

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

MATERIAL	Wrought Iron					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT									
FORM									
HEAT TREATMENT	Polished Metallic Surface.								
REFERENCE	Levy, A., "Metals for Short Time Service at High Temperatures", Materials and Methods Manual No. 115, (April, 1955).								
REMARKS									

EMISSIVITY

TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP F	TOTAL NORMAL
100-480	0.28						
Assumed to be total emmissivity.							

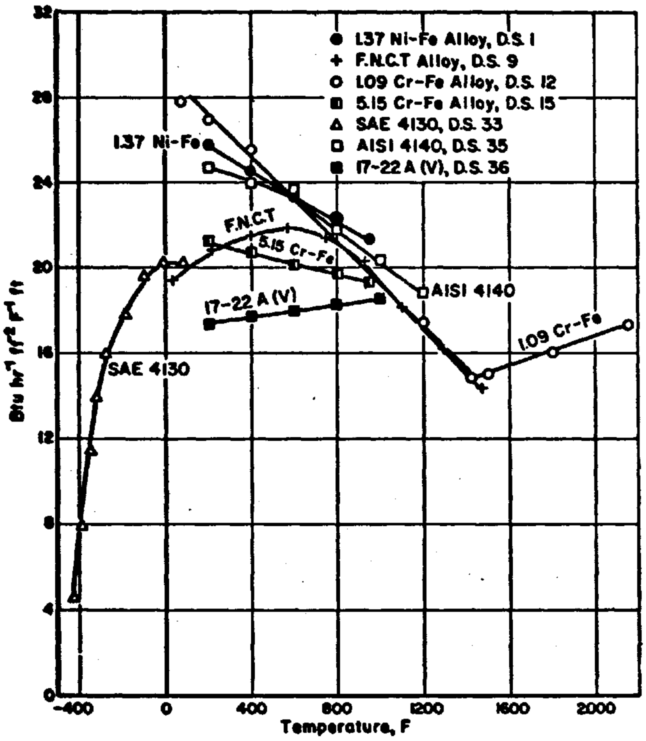
(27)

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

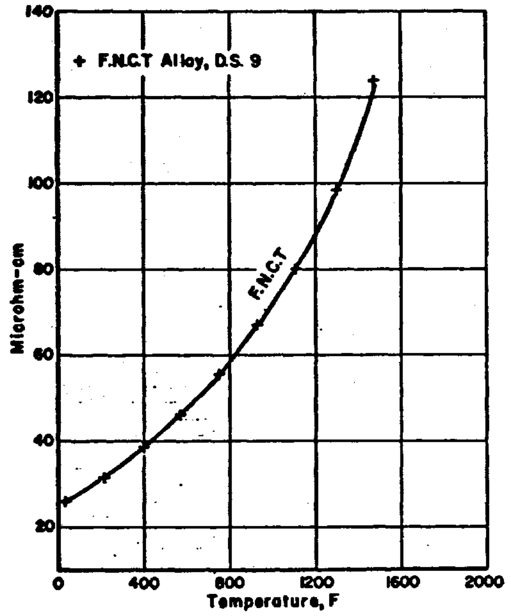
MATERIAL	Wrought Iron					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT									
FORM									
HEAT TREATMENT	Dull Oxidized Surface.								
REFERENCE	Levy, A., "Metals for Short Time Service at High Temperatures", Materials and Methods Manual No. 115, (April, 1955).								
REMARKS									

EMISSIVITY

TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL
70-680	0.94						
Assumed to be total emmissivity.							



THERMAL CONDUCTIVITY OF ALLOY STEELS



ELECTRICAL RESISTIVITY OF ALLOY STEELS

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (1)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Ni	Mn	Cr	C	S	Si	P	Fe	
	1.37	0.50	0.46	0.35	0.020	0.02	0.015	Bal	
FORM									
HEAT TREATMENT									
REFERENCE	Shelton, S. M., "Thermal Conductivity of Some Irons and Steels Over the Temperature Range 100-500 C", Journal of Research, 12 (1934) p. 441.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	25.8	400	24.6	600	23.3	800	22.3
950	21.3						
Values interpolated from graph.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (2)

MATERIAL	Iron Alloy--SAE No. 3120					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Ni	Cr	Fe						
	1.5	0.75	Bal						
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Steel.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.4	70-600	7.1	70-1000	7.7	70-1200	8.0
70-400	6.7	70-800	7.4				

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (3)

MATERIAL	Iron Alloy--4340					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Ni	Cu	Cr	C	Si	Mo	Fe		
	1.5	0.085	0.75	0.38	0.30	0.25	Bal		
FORM	1-3/4 in. dia. bar.								
HEAT TREATMENT									
REFERENCE	U. S. Naval Engineering Experiment Station, Annapolis, Maryland.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	7.3	100-1000	7.7	1360-1460	-.0018 *		
* inch/inch (contraction in trans.)							
Method: absolute, Leitz dilatometer; heating rate 5.0 or 5.6 F per minute.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (4)

MATERIAL	Iron Alloy--4340					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Ni	Cr	Mn	C	Si	Mo	Fe		
	1.65	0.7	0.6	0.38	0.2	0.2	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Materials Data Book No. 1, General Electric Company.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
400	6.70	800	7.40	1000	7.80	1200	8.27
600	7.05						
Values interpolated from graph and assumed to be instantaneous coefficients.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (5)

MATERIAL	Iron Alloy--SAE No. 4615					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Ni	Mo	Fe						
	1.65	0.3	Bal						
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Steel.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.4	70-600	7.1	70-1000	7.7	70-1200	8.0
70-400	6.7	70-800	7.4				

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (6)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Ni	Cr	Fe						
	3.20	1.5	Bal						
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Steel.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.5	70-600	7.3	70-1000	8.0	70-1200	8.3
70-400	6.8	70-800	7.7				

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

(7)

MATERIAL Iron Alloy--SAE 9310 **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Ni	Cr	Mn	Mo	C	Fe
3.25	1.2	0.55	0.1	0.1	Bal

FORM Bar

HEAT TREATMENT Austenized at 152 F (1 hr) and oil quenched followed by tempering at 325 F (2 hr) and air cooled.

REFERENCE "Report on Materials for Use at Liquid Hydrogen Temperature", Prepared for the 63rd Annual Meeting of the American Society for Testing Materials.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
78-(-104)	5.1	78-(-320)	5.0	78-(-410)	4.6		

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

(8)

MATERIAL Iron Alloy--SAE No. 2330 **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Ni	Fe
3.5	Bal

FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.0	70-600	6.7	70-1000	7.4	70-1200	7.7
70-400	6.3	70-800	7.1				

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

(9)

MATERIAL F.N.C.T. Steel **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Ni	Cr	Mn	C	Si	S	P	Fe
3.55	0.85	0.64	0.39	0.21	?	?	Bal

FORM

HEAT TREATMENT Oil hardened and tempered 830/600 C.

REFERENCE Powell, R. W., "The Thermal and Electrical Conductivities of Metals and Alloys: Part 2, Some Heat-Resistant Alloys From 0 to 800 C", Proc. of the Physical Society, 48 (1936) pp. 381.

REMARKS

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
32	19.4	572	21.8	932	20.3	1292	16.2
212	20.8	752	21.3	1112	18.1	1472	(14.3)
392	21.5						

Method: Comparative

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
32	(26.0)	212	31.7	392	38.4	572	46.3
752	55.7	932	67.0	1112	80.3	1292	98.4
1472	(124)						

Method: voltage drop.

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

(10)

MATERIAL Iron Alloy--SAE No. 52100 **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Cr	C	Fe
1	0.85	Bal

FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.3	70-600	7.2	70-1000	7.8	70-1200	8.1
70-400	6.8	70-800	7.5				

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

(11)

MATERIAL Iron Alloy--SAE No. 6120 **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Cr	Va	Fe
1	0.18	Bal

FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.3	70-600	7.2	70-1000	7.8	70-1200	8.1
70-400	6.8	70-800	7.5				

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

(12)

MATERIAL Iron Alloy **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Cr	Mn	C	Si	Ni	Cu	P	S	As
1.09	0.69	0.315	0.20	0.073	0.066	0.039	0.036	0.028
Mo	Al	Fe						
0.012	0.005	Bal						

FORM

HEAT TREATMENT Anneal 860 C.

REFERENCE Powell, R. W., "The Physical Properties of a Series of Steels. Section 111d. Notes on the Estimation of Thermal Conductivity of Steels", Journal of the Iron and Steel Institute, 154 (1946) p. 116.

REMARKS

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
68	27.8	800	22.3	1418	14.8	1800	16.0
200	27.0	1200	17.4	1500	15.0	2150	17.3
400	25.5						

Values interpolated from graph.

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

(13)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	C	Fe
	4-6	max. 0.10	Bal

FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.1	70-600	6.8	70-1000	7.3	70-1200	7.4
70-400	6.4	70-800	7.0				

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

(14)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	C	Fe
	4-6	max. 0.20	Bal

FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.1	70-600	6.8	7(-1000	7.3	70-1200	7.4
70-400	6.4	70-800	7.0				

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

(15)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Mn	Si	C	S	P	Fe
	5.15	0.45	0.18	0.10	0.017	0.013	Bal

FORM

HEAT TREATMENT

REFERENCE Shelton, S. M., "Thermal Conductivity of Some Irons and Steels Over the Temperature Range 100-500 C", NBS Journal of Research, 12, (1934), p. 441.

REMARKS

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	21.2	600	20.1	800	19.7	950	19.3
400	20.7						

Values interpolated from graph.

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

(16)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Al	C	Fe
	9.36	6.41	0.01	Bal

FORM

HEAT TREATMENT

REFERENCE Unpublished Battelle Memorial Institute measurements.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	7.0	68-800	7.3	68-1200	7.9	68-1600	8.5
68-400	7.1	68-1000	7.5	68-1400	8.2	68-1800	8.8
68-600	7.1						

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

(17)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Al	C	Fe
	10.59	8.06	0.034	Bal

FORM

HEAT TREATMENT

REFERENCE Unpublished Battelle Memorial Institute measurements.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	6.4	68-800	7.5	68-1200	8.1	68-1600	8.7
68-400	6.8	68-1000	7.8	68-1400	8.4	68-1800	9.1
68-600	7.2						

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

(18)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Al	C	Fe
	14.03	5.40	0.01	Bal

FORM

HEAT TREATMENT

REFERENCE Unpublished Battelle Memorial Institute measurements.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	6.1	68-800	6.9	68-1200	7.4	68-1600	8.1
68-400	6.4	68-1000	7.2	68-1400	7.8	68-1800	8.5
68-600	6.6						

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

(19)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Al	C	Fe
	15.60	8.87	0.021	Bal

FORM

HEAT TREATMENT

REFERENCE Unpublished Battelle Memorial Institute measurements.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	6.7	68-800	7.7	68-1200	8.4	68-1600	9.1
68-400	7.0	68-1000	8.0	68-1400	8.8	68-1800	9.5
68-600	7.3						

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

(20)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Al	C	Fe
	17.69	6.67	0.006	Bal

FORM

HEAT TREATMENT

REFERENCE Unpublished Battelle Memorial Institute measurements.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	5.2	68-800	7.3	68-1200	7.7	68-1600	8.4
68-400	6.8	68-1000	7.4	68-1400	8.0	68-1800	8.7
68-600	7.1						

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

(21)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Al	C	Fe
	18.63	8.55	0.009	Bal

FORM

HEAT TREATMENT

REFERENCE Unpublished Battelle Memorial Institute measurements.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	6.7	68-800	7.7	68-1200	8.5	68-1600	9.3
68-400	6.7	68-1000	8.0	68-1400	8.9	69-1800	9.6
68-600	7.3						

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

(22)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Al	Si	C	Fe
	19.89	6.08	0.236	0.010	Bal

FORM

HEAT TREATMENT

REFERENCE Unpublished Battelle Memorial Institute measurements.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	5.6	68-800	6.6	68-1200	7.3	68-1600	8.0
68-400	6.0	68-1000	6.9	68-1400	7.6	68-1800	8.3
68-600	6.3						

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

(23)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Al	C	Fe
	20.03	9.85	0.022	Bal

FORM

HEAT TREATMENT

REFERENCE Unpublished Battelle Memorial Institute measurements.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	6.0	68-800	7.7	68-1200	8.7	68-1600	9.5
68-400	6.6	68-1000	8.2	68-1400	9.1	68-1800	9.8
68-600	7.1						

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

(24)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Al	Si	C	Fe				
	21.67	6.19	0.503	0.004	Bal				

FORM

HEAT TREATMENT

REFERENCE Unpublished Battelle Memorial Institute measurements.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	6.2	68-800	7.0	68-1200	7.7	68-1600	8.3
68-400	6.5	68-1000	7.3	68-1400	8.0	68-1800	8.6
68-600	6.8						

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

(25)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Al	Si	C	Fe				
	22.07	5.86	0.135	0.019	Bal				

FORM

HEAT TREATMENT

REFERENCE Unpublished Battelle Memorial Institute measurements.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	5.9	68-800	6.9	68-1200	7.6	68-1600	8.3
68-400	6.3	68-1000	7.3	68-1400	8.0	68-1800	8.7
68-600	6.6						

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

(26)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Al	Si	C	Fe				
	22.62	5.84	0.326	0.005	Bal				

FORM

HEAT TREATMENT

REFERENCE Unpublished Battelle Memorial Institute measurements.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	6.1	68-800	7.1	68-1200	7.8	68-1600	8.4
68-400	6.5	68-1000	7.4	68-1400	8.1	68-1800	8.7
68-600	6.8						

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

(27)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Al	Si	C	Fe				
	23.45	5.51	0.157	0.025	Bal				

FORM

HEAT TREATMENT

REFERENCE Unpublished Battelle Memorial Institute measurements.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	6.6	68-800	6.8	68-1200	7.2	68-1600	8.0
68-400	6.6	68-1000	6.9	68-1400	7.6	68-1800	8.4
68-600	6.6						

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

(28)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Al	Si	C	Fe				
	23.73	5.37	0.210	0.035	Bal				

FORM

HEAT TREATMENT

REFERENCE Unpublished Battelle Memorial Institute measurements.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	6.2	68-800	7.0	68-1200	7.8	68-1600	8.5
68-400	6.5	68-1000	7.4	68-1400	8.2	68-1800	8.8
68-600	6.7						

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

(29)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Al	C	Fe					
	24.13	9.54	0.035	Bal					

FORM

HEAT TREATMENT

REFERENCE Unpublished Battelle Memorial Institute measurements.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	6.7	68-800	8.0	68-1200	8.9	68-1600	9.9
68-400	7.1	68-1000	8.5	68-1400	9.5	68-1800	10.3
68-600	7.6						

(30)

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

MATERIAL	Iron Alloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Al	C	Fe					
	24.18	5.26	0.002	Bal					
FORM									
HEAT TREATMENT									
REFERENCE	Unpublished Battelle Memorial Institute measurements.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	6.4	68-800	7.3	68-1200	7.8	68-1600	8.5
68-400	6.8	68-1000	7.6	68-1400	8.2	68-1800	8.8
68-600	7.1						

(31)

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

MATERIAL	Iron Alloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Al	C	Fe					
	25.79	6.91	0.03	Bal					
FORM									
HEAT TREATMENT									
REFERENCE	Unpublished Battelle Memorial Institute measurements.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	6.6	68-800	7.5	68-1200	8.1	68-1600	8.8
68-400	6.8	68-1000	7.8	68-1400	8.5	68-1800	9.2
68-600	7.2						

(32)

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

MATERIAL	Iron Alloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Al	C	Fe					
	30.90	6.43	0.021	Bal					
FORM									
HEAT TREATMENT									
REFERENCE	Unpublished Battelle Memorial Institute measurements.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-200	6.0	68-800	7.0	68-1200	7.8	68-1600	8.5
68-400	6.3	68-1000	7.5	68-1400	8.2	68-1800	8.9
68-600	6.7						

(33)

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

MATERIAL	Iron Alloy--4130						HEAT NUMBER		
CHEMICAL COMPOSITION PER CENT	Cr	Mn	C	Si	Ni	Mo	Fe		
	0.99	0.52	0.33	0.2	0.2	0.2	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Powers, R. W., Ziegler, and Johnston, H. L., TR 264-6, Cryogenic Laboratory, Ohio State University, 17 (1951); As found in "A Compendium of the Properties of Materials at Low Temperatures, Phase I" Part II, edited by Victor J. Johnson, NBS Cryogenic Engineering Laboratory, Boulder, Colorado, (December, 1959).								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
-417	4.45	-316	13.9	-190	17.7	-10	20.2
-388	7.86	-280	15.9	-100	19.6	80	20.2
-352	11.3						
Values interpolated from graph.							

(34)

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

MATERIAL	Iron Alloy--SAE No. 4130X					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Mo	Fe						
	1	0.50	Bal						
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Steel.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.3	70-600	7.2	70-1000	7.8	70-1200	8.1
70-400	6.8	70-800	7.5				

(35)

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

MATERIAL	Iron Alloy--4140					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT									
FORM									
HEAT TREATMENT									
REFERENCE	Thomson Laboratory Data, General Electric Company.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
200	24.7	600	23.6	1000	20.3	1200	18.8
400	23.9	800	21.7				
Values interpolated from graph.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
200	6.20	600	6.94	800	7.28	1000	7.60
400	6.58						

Values interpolated from graph and assumed to be instantaneous coefficients.

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

(36)

MATERIAL Iron Alloy--17-22A HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	V	Mn	Si	Mo	C	Fe
	1.25	0.85	0.75	0.65	0.50	0.28	Bal

FORM

HEAT TREATMENT

REFERENCE Timken Data Sheet, General Electric Company.

REMARKS Nominal Composition taken from DMIC Memo 42.

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
200	17.36	600	17.94	800	18.22	1000	18.52
400	17.67						

Values interpolated from graph.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
400	7.05	800	7.62	1000	7.84	1200	8.05
600	7.34	900	7.74	1100	7.94		

Values interpolated from graph.

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

(37)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Si	Mo	Fe
	2	1	0.50	Bal

FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.3	70-600	7.2	70-1000	7.8	70-1200	8.1
70-400	6.8	70-800	7.5				

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

(38)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Mo	Fe
	2	1	Bal

FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.3	70-600	7.2	70-1000	7.8	70-1200	8.1
70-400	6.8	70-800	7.5				

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

(39)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Si	Mo	Fe
	3	1.5	0.50	Bal

FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.2	70-600	7.0	70-1000	7.7	70-1200	7.9
70-400	6.6	70-800	7.4				

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

(40)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Mo	Fe
	4-6	max. 0.50	Bal

FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.1	70-600	6.8	70-1000	7.3	70-1200	7.4
70-400	6.4	70-800	7.0				

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

MATERIAL	Iron Alloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Mo	Ti	Fe					
	4-6	0.50	0.30	Bal					
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Steel.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.1	70-600	6.8	70-1000	7.3	70-1200	7.4
70-400	6.4	70-800	7.0				

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

MATERIAL	Iron Alloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Si	Mo	Fe					
	5	1.5	0.50	Bal					
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Steel.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.1	70-600	6.8	70-1000	7.3	70-1200	7.4
70-400	6.4	70-800	7.0				

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

MATERIAL	Iron Alloy--Thermold A					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Mo	Si	V	Mn	C	Fe		
	5.0	1.40	1.0	0.45	0.4	0.35	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Universal Cyclops Steel Corporation.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-800	6.68	100-1000	6.90	100-1200	7.11		

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.282						
Data assumed to be at room temperature.							

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

MATERIAL	Iron Alloy--Thermold J						HEAT NUMBER		
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	V	Si	C	Mn	Fe	
	5.0	1.5	1.4	1.0	1.0	0.50	0.4	Bal	
FORM									
HEAT TREATMENT									
REFERENCE	Universal Cyclops Steel Corporation.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-800	6.65	100-1000	6.88	100-1200	7.06		

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.281						
Data assumed to be at room temperature.							

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

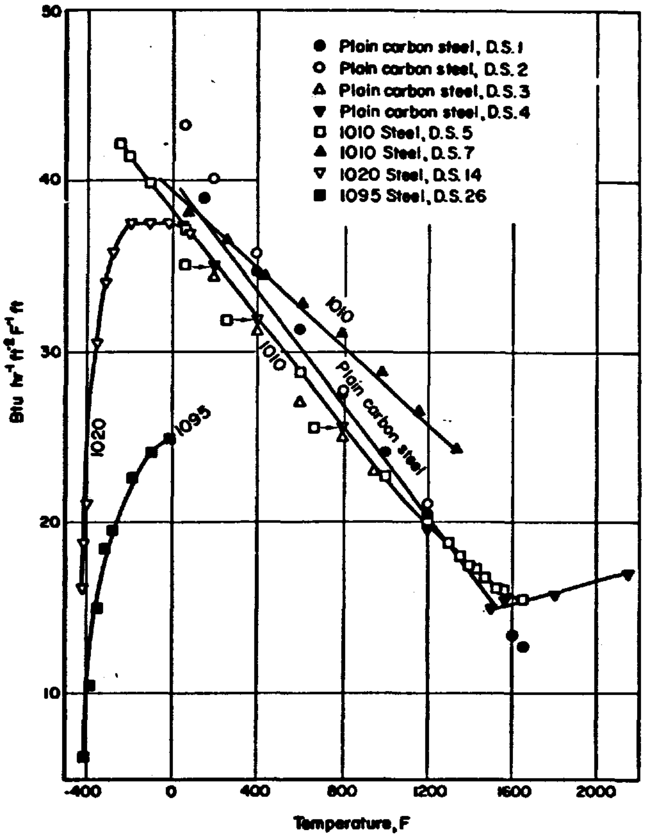
MATERIAL	Iron Alloy--Sparta						HEAT NUMBER		
CHEMICAL COMPOSITION PER CENT	Cr	Mo	C	Mn	V	Si	Fe		
	5.25	1.1	1.0	0.6	0.25	0.2	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Universal Cyclops Steel Corporation.								
REMARKS									

DENSITY

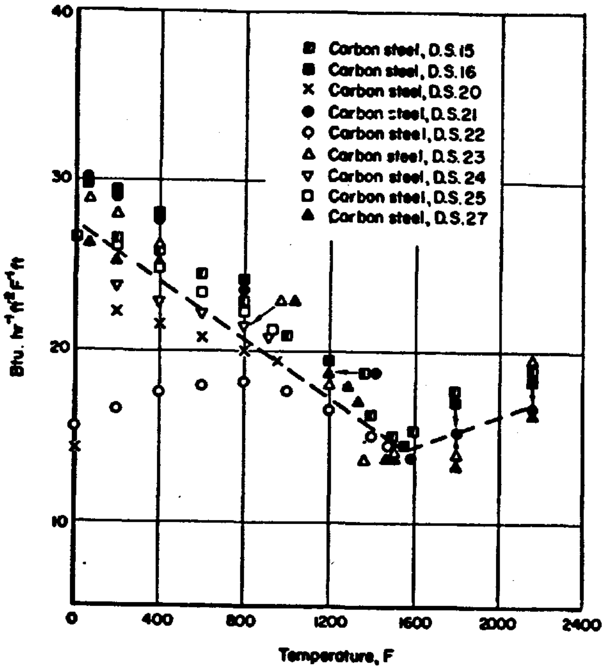
TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.283						
Data assumed to be at room temperature.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

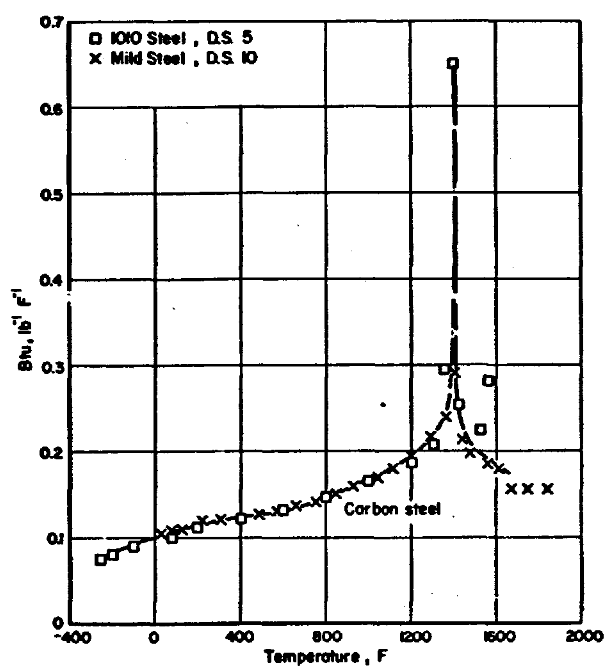
TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
200-500	5.91	200-800	7.19	200-1000	7.76	200-1200	7.91



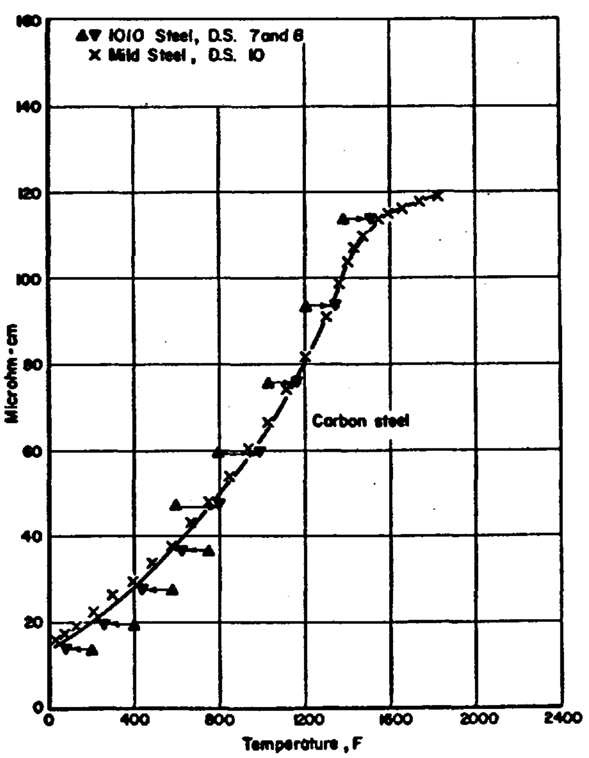
THERMAL CONDUCTIVITY OF CARBON STEELS



THERMAL CONDUCTIVITY OF CARBON STEELS



SPECIFIC HEAT OF CARBON STEELS



ELECTRICAL RESISTIVITY OF CARBON STEELS

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

(1)

MATERIAL	Plain Carbon Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Si	C	P	Mn	S	Fe			
	0.028	0.026	0.021	0.02	0.011	Bal			
FORM									
HEAT TREATMENT	Anneal 900 C.								
REFERENCE	Silverman, L., "Thermal Conductivity Data Presented for Various Metals and Alloys Up to 900 C", Journal of Metals, 5 (May, 1953) p. 631.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
150	39.1	600	31.2	1200	20.6	1600	13.3
200	37.1	800	27.6	1400	16.9	1650	12.7
400	34.7	1000	24.0				

Values interpolated from graph.

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

(2)

MATERIAL	Plain Carbon Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cu	S	Mn	C	Ni	Fe			
	0.067	0.039	0.035	0.028	0.024	Bal			
FORM									
HEAT TREATMENT	Hot rolled.								
REFERENCE	Armstrong, L. D. and Dauphine, T. M., "The Thermal Conductivity of Metals at High Temperatures. Part I. Description of Apparatus and Measurements on Iron", Canadian Journal of Research, 25 (November, 1947) p. 357.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
68	43.3	400	35.7	1200	21.1	1450	18.5
200	40.2	800	27.7				

Values interpolated from graph.

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

(3)

MATERIAL	Plain Carbon Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Si	P	Mn	C	S	Fe			
	0.265	0.136	0.046	0.04	0.025	Bal			
FORM									
HEAT TREATMENT	Hot rolled.								
REFERENCE	Shelton, S. M., "*Thermal Conductivity of Some Irons and Steels* Over the Temperature Range 100-500 C", N.B.S. Journal of Research, 12 (1934) p. 441.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	34.5	600	27.0	800	25.1	950	23.0
400	31.2						

Values interpolated from graph.

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

(4)

MATERIAL	Plain Carbon Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Mn	Cu	C	Ni	As	S	Mo	Cr	P
	0.381	0.08	0.06	0.055	0.039	0.035	0.03	0.022	0.017
	Si	Al	Fe						
	0.01	0.001	Bal						
FORM									
HEAT TREATMENT	Anneal 930 C.								
REFERENCE	Powell, R. W., "The Physical Properties of a Series of Steels. Section IIId, Notes on the Estimation of Thermal Conductivity of Steels", *Journal of the Iron and Steel Inst.*, 154 (1946) p. 116.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
68	37.3	800	25.6	1500	15.0	1800	15.9
200	35.1	1200	19.8	1562	15.6	2150	17.0
400	31.9						

Values interpolated from graph.

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

(5)

MATERIAL	Iron Alloy--SAE 1010					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Mn	S	C	P	Fe				
	0.42	0.028	0.10	0.008	Bal				
FORM									
HEAT TREATMENT									
REFERENCE	Lucks, C. F. and Deem, H. W., "Thermal Properties of Thirteen Metals", ASTM Special Technical Publication No. 227.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
-250	42.2 *	400	31.8	1300	18.7	1475	16.7
-200	41.4	600	28.8	1350	18.0	1525	16.2
-100	39.8	800	25.8	1400	17.4	1560	16.0
68	37.1	1000	22.8	1420	17.2	1650	15.5
200	35.0	1200	20.0				

* Extrapolated.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-(-250)	5.42	68-400	6.97	68-1300	8.29	68-1475	7.77
68-(-200)	5.54	68-600	7.36	68-1350	8.24	68-1525	7.42
68-(-100)	5.86	68-800	7.74	68-1400	8.15	68-1560	7.08
68	--	68-1000	8.06	68-1420	8.07	68-1650	6.90
68-200	6.55	68-1200	8.23				

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
-250	0.076	400	0.124	1200	0.190	1420	0.255
-200	0.081	600	0.132	1300	0.208	1475	0.203
-100	0.090	800	0.148	1350	0.296	1525	0.226
68	0.102	1000	0.166	1400	0.650	1560	0.283
200	0.112						

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
-250	0.2851	400	0.2818	1300	0.2752	1475	0.2748
-200	0.2850	600	0.2800	1350	0.2750	1525	0.2747
-100	0.2846	800	0.2788	1400	0.2749	1560	0.2747
68	0.2839	1000	0.2774	1420	0.2749	1650	0.2748
200	0.2831	1200	0.2759				

Density calculated from thermal-expansion data and measured density of 0.2840 lb in^{-3} at 32°F.

DIFFUSIVITY

TEMP., F	FT2 HR-1	TEMP., F	FT2 HR-1	TEMP., F	FT2 HR-1	TEMP., F	FT2 HR-1
-250	1.13	400	0.53	1300	0.19	1475	0.17
-200	1.04	600	0.45	1350	0.13	1525	0.15
-100	0.90	800	0.36	1400	0.06	1560	0.12
68	0.74	1000	0.29	1420	0.14	1650	--
200	0.64	1200	0.22				

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

6

MATERIAL	Low Carbon Steel--AISI C1010			HEAT NUMBER	
CHEMICAL COMPOSITION PER CENT	Mn	C	S	P	Fe
	0.30-0.50	0.08-0.13	max. 0.50	max. 0.40	Bal
FORM					
HEAT TREATMENT	Annealing temperature: 1650-1750 F; Hardening temperature: 1650-1700 F - water quenched; Tempering temperature: 300-1350 F.				
REFERENCE	"Materials in Design Engineering", Materials Selector, edited by H. R. Clauser, Vol 48, No. 5 (October, 1958) p. 38.				

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
212	27						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F-1 X 10^6	TEMP RANGE, F	F-1 X 10^6	TEMP RANGE, F	F-1 X 10^6	TEMP RANGE, F	F-1 X 10^6
70-1200	8.4						

SPECIFIC HEAT

TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1
Room	0.10-0.11						

Data assumed to be at room temperature.

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
68	14.3						

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.283						

Data assumed to be at room temperature.

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

7

MATERIAL	Iron Alloy--AISI 1010				HEAT NUMBER	
CHEMICAL COMPOSITION PER CENT	Mn	Si	C	S	P	Fe
	42	0.10	0.08	0.03	0.015	Bal
FORM						
HEAT TREATMENT	Annealed at 600 C in N_2 atm. Test run in N_2 atm. at 10 psig.					
REFERENCE	Raezer, Spencer D., "Thermal and Electrical Conductivities of AISI C-1010 Steel in the Ranges From 25 to 800 C", Institute Research, Lehigh University, Bethlehem, Pa., Technical Report 1, p. 48; As found in WADC Technical Report 58-476, "Thermophysical Properties of Solid Materials".					

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
80	38.2	440	34.6	800	31.0	1160	26.6
260	36.5	620	32.9	980	28.8	1340	24.2

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
80	14	620	37	980	60	1340	94
260	20	800	48	1160	76	1520	114
440	28						

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

8

MATERIAL	Iron Alloy--AISI 1010			HEAT NUMBER	
CHEMICAL COMPOSITION PER CENT	C	Mn	P	S	Fe
	0.08-0.13	0.30-0.60	max. 0.050	max. 0.040	Bal
FORM					
REFERENCE	Sawyer, Raymond B., "The Investigation of Thermal and Electrical Properties of Metals at High Temperatures", Institute of Research, Lehigh University, Bethlehem, Pa., p. 38; As found in WADC Technical Report 58-476, "Thermophysical Properties of Solid Materials".				
REMARKS	Nominal Composition taken from ASM Metals Handbook, 1948.				

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
80	14	620	37	980	60	1340	94
260	20	800	48	1160	76	1520	114
440	28						

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

(9)

MATERIAL	Iron Alloy--SAE 1010						HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Mn	Si	C	S	P	Fe	
	0.42	0.19	0.10	0.026	0.022	Bal	
FORM	Basic open hearth.						
HEAT TREATMENT	Annealed from 1600 F.						
REFERENCE	Bethlehem Steel Company.						
REMARKS	BHN-111.						

MAGNETIC PERMEABILITY

TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY
80	1810						

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

(10)

MATERIAL	Mild Steel						HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Mn	Si	C	Ni	Cr	Fe	
	0.61	0.20	0.13	0.12	0.01	Bal	
FORM							
HEAT TREATMENT							
REFERENCE	Pallister, P. R., "Specific Heat and Resistivity of Mild Steel", Journal of the Iron and Steel Institute, Vol 185, pp. 474.						
REMARKS							

SPECIFIC HEAT

TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1
32	0.104	572	0.133	1112	0.181	1472	0.200
68	0.106	662	0.138	1202	0.196	1544	0.188
122	0.111	752	0.143	1292	0.216	1594	0.183
212	0.118	842	0.151	1364	0.242	1663	0.158
302	0.122	932	0.159	1405	0.293	1742	0.157
392	0.126	1022	0.168	1436	0.214	1832	0.158
482	0.129						

Method: Guarded Specimen.

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
32	16.3	572	38.2	1112	74.2	1472	110
68	17.7	662	43.0	1202	82.2	1544	113.8
122	19.3	752	48.2	1292	91.0	1594	115.3
212	22.6	842	54.1	1364	99.4	1663	116.1
302	26.0	932	60.3	1405	104.3	1742	117.8
392	29.6	1022	67.1	1436	107.3	1832	119.4
482	33.7						

Method: Voltage Drop.

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

(11)

MATERIAL	Low Carbon Steel					HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Mn	C	S	P	Fe	
	0.30-0.60	0.13-0.18	max. 0.050	max. 0.040	Bal	
FORM						
HEAT TREATMENT	Annealing temperature: 1650-1750 F; Hardening temperature: 1650-1700 F - water quenched; Tempering temperature: 300-1350 F.					
REFERENCE	"Materials in Design Engineering", Materials Selector, edited by H. R. Clauser, Vol 48, No. 5 (October 1958) p. 38.					

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
212	27						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-1200	8.4						

SPECIFIC HEAT

TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1
Room	0.10-0.11						

Data assumed to be at room temperature.

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
68	14.3						

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.283						

Data assumed to be at room temperature.

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

(12)

MATERIAL	Low Carbon Steel					HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Mn	C	S	P	Fe	
	0.60-0.90	0.15-0.20	max. 0.050	max. 0.040	Bal	
FORM						
HEAT TREATMENT	Annealing temperature: 1650-1750 F; Hardening temperature: 1650-1700 F - water quenched; Tempering temperature: 300-1350 F.					
REFERENCE	"Materials in Design Engineering", Materials Selector, edited by H. R. Clauser, Vol 48, No. 5 (October, 1958) p. 38.					

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
212	27						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6
70-1200	8.4						

SPECIFIC HEAT

TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}
Room	0.10-0.11						
Data assumed to be at room temperature.							

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
68	14.3						

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.283						
Data assumed to be at room temperature.							

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

13

MATERIAL	Low Carbon Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Mn	C	S	P	Fe				
	0.30-0.60	0.18-0.23	max. 0.050	max. 0.040	Bal				
FORM									
HEAT TREATMENT	Annealing temperature: 1650-1750 F; Hardening temperature: 1600-1675 F - water quenched; Tempering temperature: 300-1350 F.								
REFERENCE	"Materials in Design Engineering", Materials Selector, edited by H. R. Clauser, Vol 48, No. 5 (October, 1958), p. 38.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6
70-1200	8.4						

SPECIFIC HEAT

TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}
Room	0.10-0.11						
Data assumed to be at room temperature.							

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
68	14.3						

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.283						
Data assumed to be at room temperature.							

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

14

MATERIAL	Iron Alloy--SAE 1020				- HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Mn	C	Si	Fe					
	0.33	0.18	0.014	Bal					
FORM									
HEAT TREATMENT									
REFERENCE	Powers, R. W., Ziegler, J. B. and Johnston, H. L., TR 264-6, Cyrogenic Laboratory, Ohio State University, 17 (1951); As found in "A Compendium of the Properties of Materials at Low Temperatures, Phase I", Part II, edited by Victor J. Johnson, N.B.S. Cryogenic Engineering Laboratory, Boulder, Colorado (December, 1959).								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
-413	16.2	-352	30.6	-190	37.6	-10	37.6
-406	18.8	-316	34.1	-100	37.6	80	37.0
-388	21.1	-280	35.8				

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

15

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Mn	C	Si	Cu	Cr	Ni	S	P	Co
	1.51	0.23	0.12	0.105	0.06	0.04	0.038	0.037	0.033
	Mo	Al	Fe						
	0.025	0.015	Bal						
FORM									
HEAT TREATMENT	Anneal 860 C.								
REFERENCE	Powell, R. W., "The Physical Properties of a Series of Steels, Section 111d, Notes on the Estimation of Thermal Conductivity of Steels", Journal of the Iron and Steel Inst., 154 (1946) p. 116.								
REMARKS									

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
0	26.6	600	24.4	1200	18.8	1600	15.2
200	26.6	800	22.8	1400	16.2	1800	15.8
400	25.8	1000	20.9	1500	15.1	2150	16.9
Values interpolated from graph.							

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

16

MATERIAL	Plain Carbon Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Mn	C	Cu	Si	Ni	As	P	S	Al
	0.635	0.23	0.13	0.11	0.074	0.036	0.034	0.034	0.01
	Cr	Fe							
	Trace	Bal							
FORM									
HEAT TREATMENT	Anneal 930 C.								
REFERENCE	Powell, R. W., "The Physical Properties of a Series of Steels, Section IIId, Notes on the Estimation of Thermal Conductivity of Steels", Journal of the Iron and Steel Inst., 154 (1946) p. 116.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
68	30.0	400	28.1	1200	19.5	1800	15.7
200	29.4	800	24.2	1580	14.5	2150	17.1
Values interpolated from graph.							

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

17

MATERIAL	Low Carbon Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Mn	C	S	P	Fe				
	0.30-0.60	0.22-0.28	max. 0.050	max. 0.040	Bal				
FORM									
HEAT TREATMENT	Annealing temperature: 1600-1700 F; Hardening temperature: 1600-1675 F - oil quenched; Tempering temperature: 300-1350 F.								
REFERENCE	"Materials in Design Engineering", Materials Selector, edited by H. R. Clauser, Vol 48, No. 5 (October, 1958) p. 38.								
REMARKS									

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
212	27						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6
70-1200	8.4						

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
Room	0.10-0.11						
Data assumed to be at room temperature.							

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
68	14.3						

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.283						
Data assumed to be at room temperature.							

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

18

MATERIAL	Medium Carbon Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Mn	C	S	P	Fe				
	0.60-0.90	0.28 0.34	max. 0.050	max. 0.040	Bal				
FORM									
HEAT TREATMENT	Annealing temperature: 1550-1700 F; Hardening temperature: 1575-1650 F - oil quenched; Tempering temperature: 300-1350 F.								
REFERENCE	"Materials in Design Engineering", Materials Selector, edited by H. R. Clauser, Vol 48, No. 5 (October, 1958) p. 39.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
212	27						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6
70-1200	8.4						

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
Room	0.10-0.11						
Data assumed to be at room temperature.							

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
68	19						

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.283						
Data assumed to be at room temperature.							

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

(19)

MATERIAL	Carbon Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Mn	C	S	P	Fe				
	0.60-0.90	0.32-0.38	max. 0.050	max. 0.040	Bal				
FORM									
HEAT TREATMENT	Annealing temp.rature: 1550-1700 F; Hardening temperature: 1575-1650 F-oil quenched; Tempering temperature: 300-1350 F.								
REFERENCE	"Materials in Design Engineering", Materials Selector, edited by H. R. Clauser, Vol 48, No. 5 (October, 1958) p. 39.								
REMARKS									

THERMAL CONDUCTIVITY

TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$	TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$	TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$	TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$
212	27						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-1200	8.3						

DENSITY

TEMP, F	$LB\ CU\ IN^{-1}$	TEMP, F	$LB\ CU\ IN^{-1}$	TEMP, F	$LB\ CU\ IN^{-1}$	TEMP, F	$LB\ CU\ IN^{-1}$
Room	0.283						
Data assumed to be at room temperature.							

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

(20)

MATERIAL	Iron Alloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	W	Mn	Cr	C	P	Si	Ni	S	Fe
	1.04	0.75	0.61	0.35	0.35	0.22	0.17	0.028	Bal
FORM									
HEAT TREATMENT	Normalize 900 C.								
REFERENCE	Shelton, S. M., "Thermal Conductivity of Some Irons and Steels Over the Temperature Range 100-500 C", N.B.S. Journal of Research, 12 (1934) p. 441								
REMARKS									

THERMAL CONDUCTIVITY

TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$	TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$	TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$	TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$
0	14.0	400	21.5	800	20.0	950	19.5
200	22.3	600	20.8				
Values interpolated from graph.							

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

(21)

MATERIAL	Plain Carbon Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Mn	C	Cu	Si	Ni	As	P	S	Al
	0.643	0.415	0.12	0.11	0.063	0.033	0.031	0.029	0.006
	Cr	Fe							
	Trace	Bal							
FORM									
HEAT TREATMENT	Anneal 860 C.								
REFERENCE	Powell, R. W., "The Physical Properties of a Series of Steels, Section IIId, Notes on the Estimation of Thermal Conductivity of Steels", Journal of the Iron and Steel Inst., 154 (1946) p. 116.								
REMARKS									

THERMAL CONDUCTIVITY

TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$	TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$	TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$	TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$
68	30.0	400	27.7	1200	18.6	1800	15.2
200	29.2	800	23.6	1580	13.9	2150	16.9
Values interpolated from graph.							

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

(22)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Si	Mn	Cu	C	Ni	S	P	Cr	As
	1.98	0.90	0.637	0.485	0.16	0.047	0.044	0.04	0.029
	Al	Fe							
	0.007	Bal							
FORM									
HEAT TREATMENT	Anneal 930 C.								
REFERENCE	Powell, R. W., "The Physical Properties of a Series of Steels. Section IIId, Notes on the Estimation of Thermal Conductivity of Steels", Journal of the Iron and Steel Inst., 154 (1946) p. 116.								
REMARKS									

THERMAL CONDUCTIVITY

TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$	TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$	TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$	TEMP, F	$BTU\ HR^{-1}\ FT^{-2}\ F^{-1}\ FT$
0	15.6	600	18.0	1200	16.7	1600	14.8
200	16.5	800	18.1	1400	15.1	1800	15.2
400	17.4	1000	17.7	1472	14.5	2150	16.8
Values interpolated from graph.							

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

(23)

MATERIAL	Plain Carbon Steel								HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	C	Mn	Si	Ni	Cr	Cu	As	Mo	S
	0.80	0.32	0.13	0.13	0.11	0.07	0.021	0.01	0.009
	P	Al	Fe						
	0.008	0.004	Bal						
FORM									
HEAT TREATMENT	Anneal 800 C.								
REFERENCE	Powell, R. W. and Hickman, M. J., "Physical Properties of a Series of Steels, Section 111C, Thermal Conductivity of a 0.8% Carbon Steel", Journal of the Iron and Steel Inst., 154 (1946) p.112.								
REMARKS									

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
68	28.8	800	21.5	1364	13.7	1800	15.0
200	28.1	1200	18.1	1500	14.0	2150	16.9
400	26.1	1346	17.2				

Values interpolated from graph.

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

(24)

MATERIAL	Iron Alloy					HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	C	Mn	Si	P	S	Fe
	0.83	0.27	0.16	0.017	0.015	Bal
FORM						
HEAT TREATMENT	Quench, temper.					
REFERENCE	Shelton, S. M., "Thermal Conductivity of Some Irons and Steels Over the Temperature Range 100-500 C", N.B.S. Journal of Research, 12 (1934) p. 441.					
REMARKS						

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	23.8	600	22.3	800	21.5	932	20.9
400	23.0						

Values interpolated from graph.

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

(25)

MATERIAL	Iron Alloy					HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	C	Mn	Si	P	S	Fe
	0.83	0.27	0.16	0.017	0.015	Bal
FORM						
HEAT TREATMENT	Anneal 800 C.					
REFERENCE	Shelton, S. M., "Thermal Conductivity of Some Irons and Steels Over the Temperature Range 100-500 C", N.B.S. Journal of Research, 12 (1934) p. 441.					
REMARKS						

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	26.4	600	23.5	800	22.3	932	21.3
400	24.9						

Values interpolated from graph.

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

(26)

MATERIAL	Iron Alloy--SAE 1095					HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	C	Mn	Si	Ni	Mo	Fe
	0.93	0.34	0.26	0.1	0.05	Bal
FORM						
HEAT TREATMENT						
REFERENCE	Powers, R. W., Ziegler, J. B. and Johnston, H. L., TR 264-6, Cryogenic Laboratory, Ohio State University, 17 (1951); As found in "A Compendium of the Properties of Materials at Low Temperatures, Phase I" Part II, edited by Victor J. Johnson, N.B.S. Cryogenic Engineering Laboratory, Boulder, Colorado, (December, 1959).					

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
-417	6.25	-352	15.0	-280	19.6	-100	24.3
-388	10.4	-316	18.5	-190	22.5	- 10	24.8

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

(27)

MATERIAL	Plain Carbon Steel								HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	C	Mn	Si	Ni	Cr	Cu	As	S	Mo
	1.22	0.35	0.16	0.13	0.11	0.077	0.025	0.015	0.01
	P	Al	Fe						
	0.009	0.006	Bal						
FORM									
HEAT TREATMENT	Anneal 800 C.								
REFERENCE	Powell, R. W., "The Physical Properties of a Series of Steels, Section 111d, Notes on the Estimation of Thermal Conductivity of Steels", Journal of the Iron and Steel Inst., 154 (1946) p. 116.								
REMARKS									

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
68	26.3	800	21.8	1472	13.6	1800	14.8
200	25.9	1200	18.6	1500	13.8	2150	16.3
400	25.2	1292	17.9				

Values interpolated from graph.

CAST IRON

(NO CURVES ARE SHOWN FOR THESE DATA)

1

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

MATERIAL Nodular or Ductile Iron **HEAT NUMBER**

	T.C.	Si	Ni	Mo	Mn	P	Mg	Fe
CHEMICAL COMPOSITION PER CENT	3.4-3.8	2.0-2.75	2.5	1.0	0.3-0.6	max. 0.08	0.02-0.07	Bal

FORM

HEAT TREATMENT

REFERENCE Materials and Methods Manual No. 120, "Nodular or Ductile Iron" by John L. Everhart (October, 1955) p. 123.

REMARKS Melting range: 2050-2150 F.

THERMAL CONDUCTIVITY

TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT
Room	20						

Data assumed to be at room temperature.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^{6}$	TEMP RANGE, F	$F^{-1} \times 10^{6}$	TEMP RANGE, F	$F^{-1} \times 10^{6}$	TEMP RANGE, F	$F^{-1} \times 10^{6}$
70-400	6.6						

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
75	66 *						

* Iron containing 1% Si.

DENSITY

TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}
Room	0.257						

Data assumed to be at room temperature.

2

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

MATERIAL Nodular or Ductile Iron **HEAT NUMBER**

	T.C.	Si	Ni	Mn	P	Mg	Fe
CHEMICAL COMPOSITION PER CENT	3.3-3.8	2.0-3.0	1.0	0.2-0.5	0.06-0.08	0.02-0.07	Bal

FORM

HEAT TREATMENT

REFERENCE Materials and Methods Manual No. 120, "Nodular or Ductile Iron" by John L. Everhart (October, 1955) p. 123.

REMARKS Melting range: 2050-2150 F.

THERMAL CONDUCTIVITY

TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT
Room	18						

Data assumed to be at room temperature.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^{6}$	TEMP RANGE, F	$F^{-1} \times 10^{6}$	TEMP RANGE, F	$F^{-1} \times 10^{6}$	TEMP RANGE, F	$F^{-1} \times 10^{6}$
70-400	6.6						

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
75	68 *						

* Iron containing 1% Si.

DENSITY

TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}
Room	0.257						

Data assumed to be at room temperature.

3

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

MATERIAL Nodular or Ductile Iron **HEAT NUMBER**

	T.C.	Si	Ni	Mo	Mn	P	Mg	Fe
CHEMICAL COMPOSITION PER CENT	3.4-3.8	2.0-2.75	2.5	1.0	0.3-0.6	max. 0.08	0.02-0.07	Bal

FORM

HEAT TREATMENT

REFERENCE Materials and Methods Manual No. 120, "Nodular or Ductile Iron" by John L. Everhart (October, 1955) p. 123.

REMARKS Melting range: 2050-2150 F.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^{6}$	TEMP RANGE, F	$F^{-1} \times 10^{6}$	TEMP RANGE, F	$F^{-1} \times 10^{6}$	TEMP RANGE, F	$F^{-1} \times 10^{6}$
70-400	6.6						

DENSITY

TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}
Room	0.257						

Data assumed to be at room temperature.

4

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

MATERIAL Nodular or Ductile Iron **HEAT NUMBER**

	T.C.	Si	Ni	Mo	Mn	P	Mg	Fe
CHEMICAL COMPOSITION PER CENT	3.4-3.8	2.0-2.75	2.5	1.0	0.3-0.6	max. 0.08	0.02-0.07	Bal

FORM

HEAT TREATMENT

REFERENCE Materials and Methods Manual No. 120, "Nodular or Ductile Iron" by John L. Everhart (October, 1955) p. 123.

REMARKS Melting range: 2050-2150 F.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}
70-400	6.6						

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.257						
Data assumed to be at room temperature.							

5

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

MATERIAL Nodular or Ductile Iron HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Ni	T.C.	Si	Cr	Mn	P	Fe
	18-22	3.0	2.0-3.2	2.5	0.8-1.5	max. 0.2	Bal

FORM

HEAT TREATMENT

REFERENCE Materials and Methods Manual No. 120, "Nodular or Ductile Iron" by John L. Everhart (October, 1955) p. 123.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}
70-400	10.4						

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
75	102						

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.268						
Data assumed to be at room temperature.							

6

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

MATERIAL Nodular or Ductile Iron HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	T.C.	Si	Ni	Mn	P	Mg	Fe
	2.8-3.8	2.5-6.0	1.5	0.2-0.6	max. 0.08	0.02-0.07	Bal

FORM

HEAT TREATMENT

REFERENCE Materials and Methods Manual No. 120, "Nodular or Ductile Iron" by John L. Everhart (October, 1955) p. 123.

REMARKS Melting range: 2050-2150 F.

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.25 *						
* Approximately. Data assumed to be at room temperature.							

7

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

MATERIAL Gray Cast Iron HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	C	Si	Fe
	3.0	1.5	Bal

FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}
70-200	5.4	70-600	6.4	70-800	6.8	70-1000	7.2
70-400	5.9						

8

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

MATERIAL Cast Iron HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	C	Ni	Si	Fe
	3.0	2	1.5	Bal

FORM

HEAT TREATMENT

REFERENCE U. S. Steel

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}
70-200	5.4	70-600	6.4	70-800	6.8	70-1000	7.2
70-400	5.9						

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

9

MATERIAL	Cast Iron
HEAT NUMBER	
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	Polished Metallic Surface.
REFERENCE	Levy, A., "Metals for Short Time Service at High Temperatures", Materials and Methods Manual No. 115, (April, 1955).
REMARKS	

EMISSIVITY

TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL
392	0.21						
Assumed to be total emmissivity.							

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

10

MATERIAL	Cast Iron
HEAT NUMBER	
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	Newly turned; Metallic Surface.
REFERENCE	Levy, A., "Metals for Short Time Service at High Temperatures", Materials and Methods Manual No. 115, (April, 1955).
REMARKS	

EMISSIVITY

TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL
72	0.435						
Assumed to be total emmissivity.							

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

11

MATERIAL	Cast Iron
HEAT NUMBER	
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	Lathe turned; Metallic Surface.
REFERENCE	Levy, A., "Metals for Short Time Service at High Temperatures", Materials and Methods Manual No. 115, (April, 1955).
REMARKS	

EMISSIVITY

TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL
1620-1810	0.60-0.70						
Assumed to be total emmissivity.							

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

12

MATERIAL	Cast Iron
HEAT NUMBER	
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	Rough, Strongly Oxidized Surface.
REFERENCE	Levy, A., "Metals for Short Time Service at High Temperatures", Materials and Methods Manual No. 115, (April, 1955).
REMARKS	

EMISSIVITY

TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL
100-480	0.95						
Assumed to be total emissivity.							

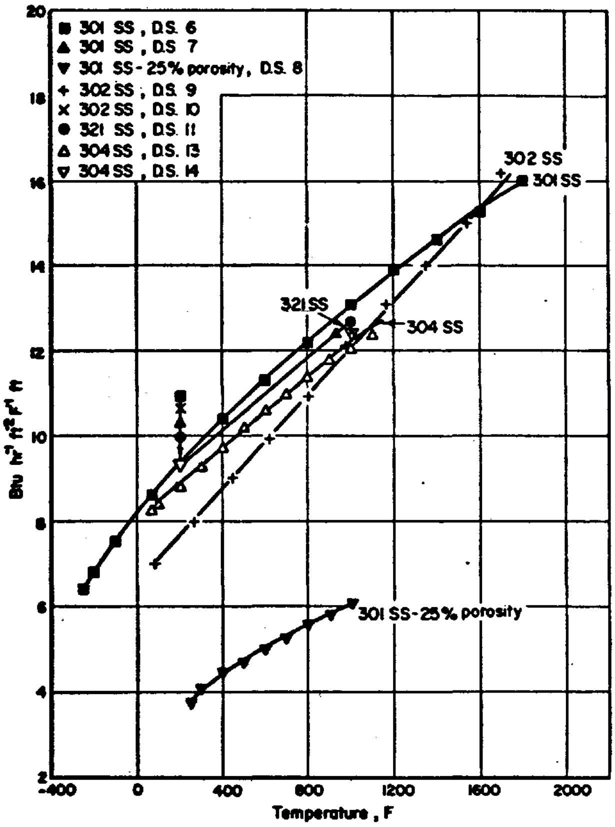
ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

13

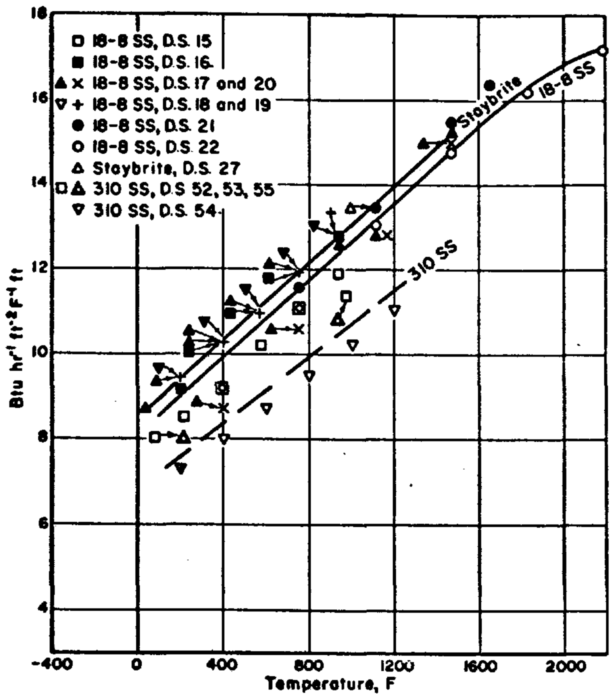
MATERIAL	Cast Iron
HEAT NUMBER	
CHEMICAL COMPOSITION PER CENT	
FORM	
HEAT TREATMENT	Surface Oxidized at 1100 F.
REFERENCE	Levy, A., "Metals for Short Time Service at High Temperatures", Materials and Methods Manual No. 115, (April, 1955).
REMARKS	

EMISSIVITY

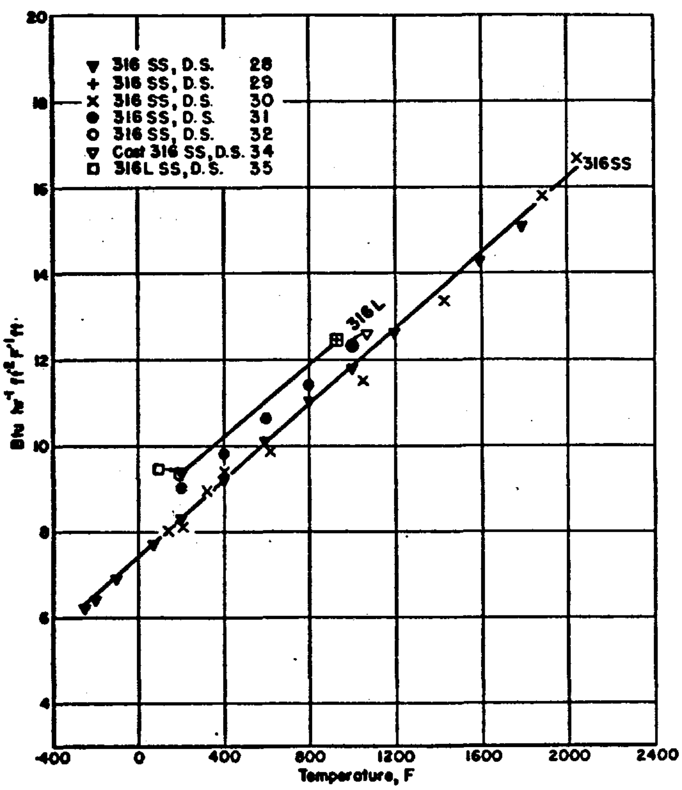
TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL	TEMP., F	TOTAL NORMAL
390-1110	0.64-0.78						
Assumed to be total emmissivity.							



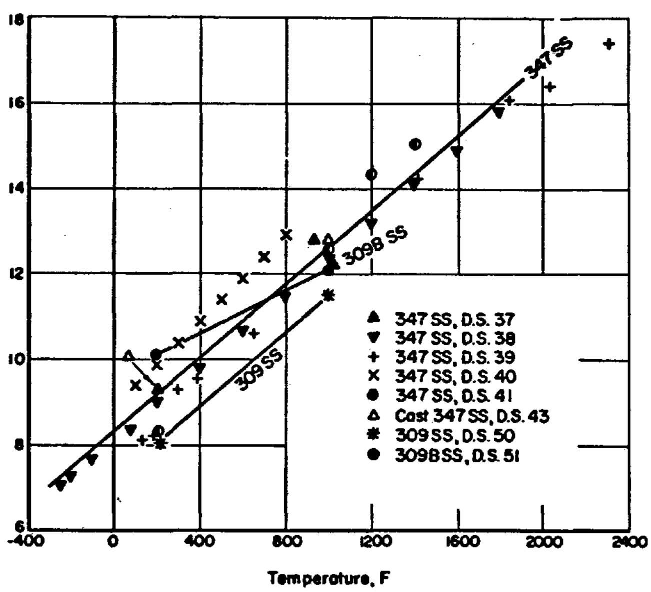
THERMAL CONDUCTIVITY OF CHROMIUM-NICKEL STAINLESS STEEL



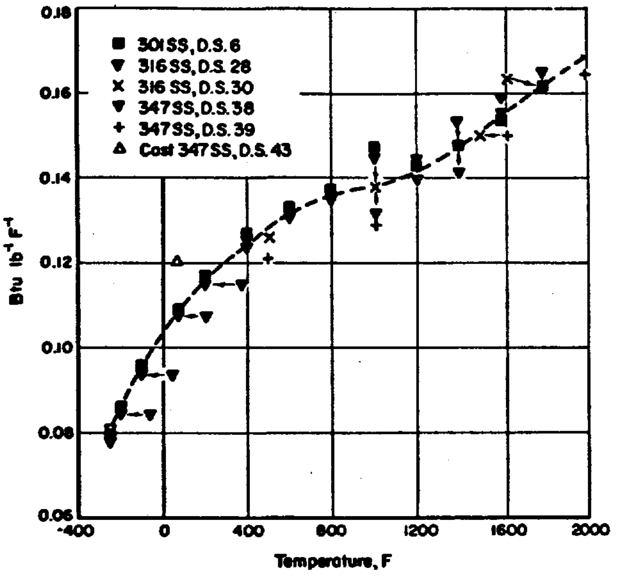
THERMAL CONDUCTIVITY OF CHROMIUM-NICKEL STAINLESS STEEL



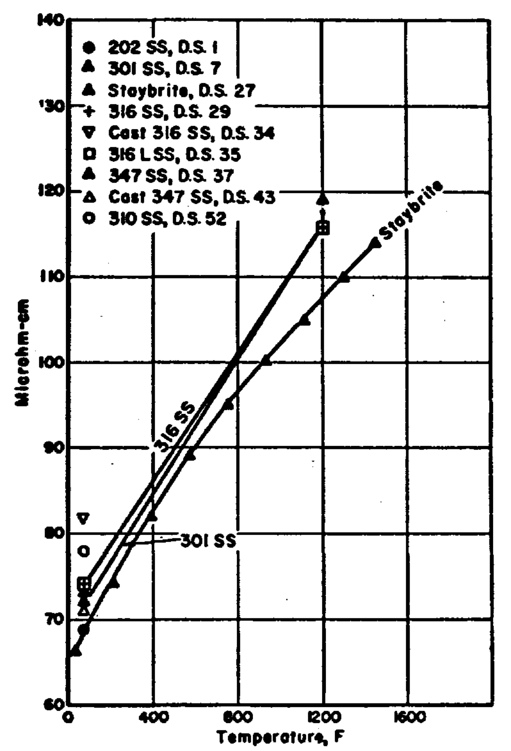
THERMAL CONDUCTIVITY OF CHROMIUM-NICKEL STAINLESS STEEL.



THERMAL CONDUCTIVITY OF CHROMIUM-NICKEL STAINLESS STEEL



SPECIFIC HEAT OF CHROMIUM-NICKEL STAINLESS STEEL



ELECTRICAL RESISTIVITY OF CHROMIUM-NICKEL STAINLESS STEEL

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

(1)

MATERIAL	202 Stainless Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Fe	Ni	Mn	Si	N_2	C			
	17.0-19.0	4.0-.0	7.5-10.0	max. 1.00	max. 1.00	max. 0.15			
FORM									
HEAT TREATMENT									
REFERENCE	Allegheny Ludlum Steel Corporation.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-212	9.4	68-1600	10.9				

SPECIFIC HEAT

TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}
32-212	0.12						

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
68	69.0						

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
room	0.28						

MAGNETIC PERMEABILITY

TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY
Room	1.02 max						
Permeability at 200 Oersteds, annealed.							

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

(2)

MATERIAL	202 Stainless Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Mn	Ni	Si	N	C	Fe		
	18.0	9.0	5.0	0.25	0.25	0.12	Bal		
FORM									
HEAT TREATMENT	Mill Annealed.								
REFERENCE	U. S. Naval Engineering Experiment Station, Annapolis, Maryland.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	9.6	100-1000	10.4	100-1600	11.0		
Method: absolute method. Leitz dilatometer; heating rate 5.0° or 5.6°F per minute.							

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

(3)

MATERIAL	202 Stainless Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Mn	Ni	N_2	C	Fe			
	17.61	9.98	4.04	0.14	0.10	Bal			
FORM	Annealed strip, tested after 0, 10, 20, 30% cold reduction.								
HEAT TREATMENT									
REFERENCE	U. S. Naval Engineering Experiment Station, Annapolis, Maryland.								
REMARKS									

MAGNETIC PERMEABILITY

COLD REDUCTION	(a) PERME-ABILITY		(b) PERME-ABILITY		(c) PERME-ABILITY		(d) PERME-ABILITY
0%	1.02		--		1.001		--
10%	1.02		1.01		1.004		1.005
20%	1.02		1.022		1.028		1.038
30%	1.21		1.11		1.13		1.17

(a) Permeability at 0.5 Oersted.
(b) Permeability at 20.0 Oersteds.
(c) Permeability at 100 Oersteds.
(c) Permeability at 200 Oersteds.

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

(4)

MATERIAL	202 Stainless Steel					HEAT NUMBER 25638			
CHEMICAL COMPOSITION PER CENT	Cr	Mn	Ni	C	N_2	Fe			
	17.43	10.12	3.91	0.097	0.17	Bal			
FORM	Annealed strip, tested after 0, 10, 20, 50% cold reduction.								
HEAT TREATMENT									
REFERENCE	U. S. Naval Engineering Experiment Station, Annapolis, Maryland.								
REMARKS									

MAGNETIC PERMEABILITY

COLD REDUCTION	(a) PERME-ABILITY		(b) PERME-ABILITY		(c) PERME-ABILITY		(d) PERME-ABILITY
0%	1.02		--		1.001		--
10%	1.02		1.01		1.003		1.002
20%	1.02		1.01		1.004		1.007
30%	1.02		1.025		1.026		1.031

(a) Permeability at 0.5 Oersted.
(b) Permeability at 20.0 Oersteds.
(c) Permeability at 100 Oersteds.
(d) Permeability at 200 Oersteds.

(5)

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

MATERIAL	202 Stainless Steel				HEAT NUMBER	97168			
CHEMICAL COMPOSITION PER CENT	Cr	Mn	Ni	C	N_2	Fe			
	17.68	9.63	4.69	0.094	0.16	Bal			
FORM	Annealed strip, tested after 0, 10, 20 and 30% cold reduction.								
HEAT TREATMENT									
REFERENCE	U. S. Naval Engineering Experiment Station, Annapolis, Maryland.								

MAGNETIC PERMEABILITY

COLD REDUCTION	(a) PERME-ABILITY		(b) PERME-ABILITY		(c) PERME-ABILITY		(d) PERME-ABILITY
0%	1.02		--		1.001		--
10%	1.02		1.01		1.002		1.004
20%	1.02		1.01		1.004		1.006
30%	1.02		1.035		1.036		1.044

(a) Permeability at 0.5 Oersted.
(b) Permeability at 20.0 Oersteds.
(c) Permeability at 100 Oersteds.
(d) Permeability at 200 Oersteds.

(6)

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

MATERIAL	301 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	C	Fe				
	16.0-18.0	6.0-8.0	max. 2.00	0.08-0.20	Bal				
FORM									
HEAT TREATMENT	Hot rolled and annealed - 1 hour at 1900 + water quenched.								
REFERENCE	Lucks, C. F. and Deem, H. W., "Thermal Properties of Thirteen Metals", ASTM Special Technical Publication No. 227.								

THERMAL CONDUCTIVITY

TEMP. F	BTU HR-1 FT-2 F-1 FT	TEMP. F	BTU HR-1 FT-2 F-1 FT	TEMP. F	BTU HR-1 FT-2 F-1 FT	TEMP. F	BTU HR-1 FT-2 F-1 FT
-250	6.4	200	9.4	800	12.2	1400	14.6
-200	6.8	400	10.4	1000	13.1	1600	15.3
-100	7.5	600	11.3	1200	13.9	1800	16.0*
68	8.6						

* extrapolated.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-(-250)	7.52	68-200	9.02	68-800	10.10	68-1400	10.81
68-(-200)	7.72	68-400	9.37	68-1000	10.40	68-1600	11.04
68-(-100	7.92	68-600	9.79	68-1200	10.60	68-1800	11.31*
68	--						

* Extrapolated.

SPECIFIC HEAT

TEMP. F	BTU LB-1 F-1	TEMP. F	BTU LB-1 F-1	TEMP. F	BTU LB-1 F-1	TEMP. F	BTU LB-1 F-1
-250	0.080	200	0.117	600	0.137	1400	0.148
-200	0.086	400	0.127	1000	0.140	1600	0.154
-100	0.096	600	0.133	1200	0.143	1800	0.162*
68	0.109						

* extrapolated.

DENSITY

TEMP. F	LB CU IN-1	TEMP. F	LB CU IN-1	TEMP. F	LB CU IN-1	TEMP. F	LB CU IN-1
-250	0.2885	200	0.2848	800	0.2797	1400	0.2741
-200	0.2882	400	0.2832	1000	0.2779	1600	0.2723
-100	0.2874	600	0.2814	1200	0.2760	1800	0.2705*
68	0.2859						

* extrapolated.
Density calculated from thermal expansion data and measured density of 0.2863 lb in^{-3} at 32 F.

DIFFUSIVITY

TEMP. F	FT2 HR-1	TEMP. F	FT2 HR-1	TEMP. F	FT2 HR-1	TEMP. F	FT2 HR-1
-250	0.159	200	0.162	800	0.185	1400	0.209
-200	0.158	400	0.167	1000	0.194	1600	0.212
-100	0.158	600	0.176	1200	0.203	1800	0.212*
68	0.160						

* extrapolated.

(7)

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

MATERIAL	301 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	C	Fe			
	16.0-18.0	6.0-8.0	max. 2.00	max. 1.00	max. 0.15	Bal			
FORM									
HEAT TREATMENT									
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Melting range: 2550-2590 F.								

THERMAL CONDUCTIVITY

TEMP. F	BTU HR-1 FT-2 F-1 FT	TEMP. F	BTU HR-1 FT-2 F-1 FT	TEMP. F	BTU HR-1 FT-2 F-1 FT	TEMP. F	BTU HR-1 FT-2 F-1 FT
212	9.4	932	12.4				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-212	9.2	68-1600	11.0				

SPECIFIC HEAT

TEMP. F	BTU LB-1 F-1	TEMP. F	BTU LB-1 F-1	TEMP. F	BTU LB-1 F-1	TEMP. F	BTU LB-1 F-1
32-212	0.12						

ELECTRICAL RESISTIVITY

TEMP. F	MICROHM-CM	TEMP. F	MICROHM-CM	TEMP. F	MICROHM-CM	TEMP. F	MICROHM-CM
68	72.0	1200	116.0				

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.29						

MAGNETIC PERMEABILITY

TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY
Room	1.02						

Permeability at 200 Oersteds, annealed.
Data assumed to be at room temperature.

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

(8)

MATERIAL	301 Stainless Steel				HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Cr	Ni	C	Fe	
	17.0	7.0	0.11	Bal	
FORM					
HEAT TREATMENT					
REFERENCE	"Thermal Conductivity of 14 Metals and Alloys Up to 1100 F", Jerry E. Evans, Jr., Lewis Flight Propulsion Lab., NACA Research Memorandum RM E50L, March, 1951.				
REMARKS	Porosity is 25 per cent.				

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
250	3.8	500	4.7	700	5.3	900	5.8
300	4.1	600	5.05	800	5.6	1000	6.1
400	4.5						

Interpolated data taken from a heat curve.

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

(9)

MATERIAL	302 Stainless Steel						HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Fe	Cr	Ni	Si	C	P	S
	71.60	18.40	9.60	0.130	0.116	0.021	0.013
FORM							
HEAT TREATMENT							
REFERENCE	Silverman, L., "Thermal Conductivity Data Presented for Various Metals and Alloys Up to 900 C", Journal of Metals, 5 pp. 631-2.						
REMARKS							

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
81	7.0	620	9.9	1160	13.1	1520	15.0
260	8.0	800	10.9	1340	14.0	1700	16.2
440	9.0	980	12.1				

Test method: comparative; rods.

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

(10)

MATERIAL	302 Stainless Steel					HEAT NUMBER	
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	C max.	N max.	Fe
	17	8	2	2	0.15	0.25	Bal
FORM							
HEAT TREATMENT							
REFERENCE	Crucible Steel Company of America.						
REMARKS	Nominal Composition taken from DMIC Memo 42.						

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	9.33	1000	12.50				

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

(11)

MATERIAL	321 Stainless Steel					HEAT NUMBER	
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	Ti	C max.	Fe
	17	9	2	1	0.4	0.08	Bal
FORM							
HEAT TREATMENT							
REFERENCE	Materials and Methods Manual No. 115, "Metals for Short Time Service at High Temperatures", by A. Levy (April, 1955).						
REMARKS	Nominal Composition taken from DMIC Memo 42.						

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	9.3	1000	12.7				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
32-212	9.3	32-1000	10.3	32-1200	10.7	32-1800	11.2
32-600	9.5						

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.290						

Data assumed to be at room temperature.

(12)

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

MATERIAL	321 Stainless Steel				HEAT NUMBER	91103			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	Ti	C	Fe		
	17	9	2	1	0.4	max. 0.08	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
212	9.2	932	10.5	1832	11.4		
Assumed to be instantaneous coefficients.							

(13)

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

MATERIAL	304 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	C	Fe			
	18.00	8.00	2.00	1.00	0.08	Bal			
FORM									
HEAT TREATMENT									
REFERENCE	Unpublished Battelle Memorial Institute measurements.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
70 *	8.2	300	9.3	600	10.6	900	11.8
100	8.4	400	9.7	700	11.0	1000	12.1
200	8.8	500	10.2	800	11.4	1100	12.4
* Extrapolated.							

(14)

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

MATERIAL	304 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	C	Fe			
	18	8	2	1	0.08	Bal			
FORM									
HEAT TREATMENT									
REFERENCE	Crucible Steel Company of America.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	9.33	1000	12.5				

(15)

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

MATERIAL	18-8 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	C	Fe				
	19.6	7.99	0.28	0.24	Bal				
FORM									
HEAT TREATMENT									
REFERENCE	Shelton, S. M., "Thermal Conductivity of Some Irons and Steels Over the Temperature Range 100-500 C", NBS Journal of Research, 12 (1934) p. 441.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
212	8.5	572	10.2	752	11.1	932	11.9
392	9.2						
Values interpolated from graph.							

(16)

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

MATERIAL	18-8 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	Ti	C	P	S	Fe
	18.08	9.12	0.59	0.47	0.34	0.07	0.013	0.003	Bal
FORM									
HEAT TREATMENT	Anneal.								
REFERENCE	Shelton, S. M., "Thermal Conductivity of Some Irons and Steels Over the Temperature Range 100-500 C", NBS Journal of Research, 12 (1934) p. 441.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
212	9.2	572	10.9	752	11.9	932	12.8
392	10.2						
Values interpolated from graph.							

(17)

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

MATERIAL	18-8 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	C	Fe				
	19.6	7.99	0.28	0.24	Bal				
FORM									
HEAT TREATMENT	Anneal 735 C.								
REFERENCE	Shelton, S. M., "Thermal Conductivity of Some Irons and Steels Over the Temperature Range 100-500 C", NBS Journal of Research, 12 (1934) p. 441.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
392	9.7	752	10.6	1112	12.8	1472	15.0

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (18)

MATERIAL	18-8 Stainless Steel								
HEAT NUMBER									
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	C	Fe				
	18.6	9.10	0.27	0.07	Bal				
FORM									
HEAT TREATMENT	Anneal 735 C.								
REFERENCE	Shelton, S. M., "Thermal Conductivity of Some Irons and Steels Over the Temperature Range 100-500 C", NBS Journal of Research, 12 (1934) p. 441.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
212	9.4	572	10.9	752	11.9	932	12.8
392	10.2						

Values interpolated from graph.

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (19)

MATERIAL	18-8 Stainless Steel								
HEAT NUMBER									
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	C	Fe				
	18.5	9.21	0.19	0.11	Bal				
FORM									
HEAT TREATMENT	Quench 1200 C.								
REFERENCE	Shelton, S. M., "Thermal Conductivity of Some Irons and Steels Over the Temperature Range 100-500 C", NBS Journal of Research, 12 (1934) p. 441.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
212	9.4	572	10.9	752	11.9	932	12.8
392	10.2						

Values interpolated from graph.

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (20)

MATERIAL	18-8 Stainless Steel								
HEAT NUMBER									
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	C	Fe			
	17.87	8.04	0.26	0.19	0.15	Bal			
FORM									
HEAT TREATMENT									
REFERENCE	Powell, R. W., "The Thermal and Electrical Conductivities of Metals and Alloys: Part 2, Some Heat Resistant Alloys From 0-800 C", Proc. Physical Society, 48 (1936) p. 381.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
392	8.7	752	10.6				

Values interpolated from graph.

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (21)

MATERIAL	18-8 Stainless Steel								
HEAT NUMBER									
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	C	Fe			
	18.42	8.97	0.61	0.51	0.17	Bal			
FORM									
HEAT TREATMENT									
REFERENCE	Hogan, C. L. and Sawer, R. B., "The Thermal Conductivity of Metals at High Temperatures", Journal of Applied Physics, 23 (February, 1952) p. 177.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
392	10.2	1112	13.5	1472	15.5	1652	16.4
752	11.6						

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (22)

MATERIAL	18-8 Stainless Steel								
HEAT NUMBER									
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Si	C	P	S	Fe		
	18.40	9.60	0.13	0.116	0.021	0.013	Bal		
FORM									
HEAT TREATMENT	Anneal 1100 C.								
REFERENCE	Silverman, L., "Thermal Conductivity Data Presented for Various Metals and Alloys Up to 900 C", Journal of Metals, 5 (May, 1953) p. 631.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
392	9.2	1112	13.1	1832	16.2	2192	17.2
752	11.1	1472	14.8				

Values interpolated from graph.

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (23)

MATERIAL	Iron Alloy--SAE No. 30905								
HEAT NUMBER									
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Fe						
	18	8	Bal						
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Steel.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	9.2	70-600	9.8	70-1000	10.3	70-1200	10.5
70-400	9.5	70-800	10.1				

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

(24)

MATERIAL	Iron Alloy					HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Si	Mo	Fe	
	18	8	1	3	Bal	
FORM						
HEAT TREATMENT						
REFERENCE	U. S. Steel.					

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	9.2	70-600	9.8	70-1000	10.3	70-1200	10.5
70-400	9.5	70-800	10.1				

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

(25)

MATERIAL	Iron Alloy				HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Si	Fe	
	18	8	3	Bal	
FORM					
HEAT TREATMENT					
REFERENCE	U. S. Steel.				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	9.2	70-600	9.8	70-1000	10.3	70-1200	10.5
70-400	9.5	70-800	10.1				

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

(26)

MATERIAL	Iron Alloy					HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Ti	Cb	Fe	
	18	8	stabilized		Bal	
FORM						
HEAT TREATMENT						
REFERENCE	U. S. Steel.					

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	9.2	70-600	9.8	70-1000	10.3	70-1200	10.5
70-400	9.5	70-800	10.1				

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

(27)

MATERIAL	Staybrite Steel								HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	C	S	P	Fe	
	17.87	8.04	0.26	0.19	0.15	?	?	Bal	
FORM									
HEAT TREATMENT	Softened 1150-1200 C.								
REFERENCE	Powell, R. W., "The Thermal and Electrical Conductivities of Metals and Alloys: Part 2, Some Heat-Resistant Alloys From 0-800 C" Proc. of the Physical Society, 48 (1936) p. 381.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
32	(8.7)	212	9.4	392	10.2	572	10.9
752	11.9	932	12.6	1112	13.5	1292	14.3
1472	(15.2)						
Method: comparative.							

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
32	(66.3)	572	89.1	932	100.1	1292	109.8
212	74.3	752	95.0	1112	104.8	1472	114.0
392	81.9						
Method: Voltage drop.							

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

(28)

MATERIAL	316 Stainless steel									HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	S	P	Fe	
	16.82	11.66	2.18	1.59	0.26	0.108	0.023	0.018	Bal	
FORM										
HEAT TREATMENT	Hot rolled and annealed - 2,000F - 1 hour - water quenched.									
REFERENCE	Lucks, C. F. and Deem, H. W., "Thermal Properties of Thirteen Metals", ASTM Special Technical Publication No. 227.									

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
-250	6.2(d)	200	8.3	800	11.0	1400	13.4
-200	6.4	400	9.2	1000	11.8	1600	14.3
-100	6.9	600	10.1	1200	12.6	1800	15.1(a)
(a) extrapolated.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-(-250)	8.22	70-200	8.60	70-800	9.81	70-1400	10.42
70-(-200)	8.26	70-400	8.99	70-1000	10.08	70-1600	10.51
70-(-100)	8.42	70-600	9.37	70-1200	10.28	70-1800	10.67
68	--						

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
-250	0.079	200	0.116	800	0.135	1400	0.147
-200	0.085	400	0.126	1000	0.137	1600	0.155
-100	0.094	600	0.131	1200	0.140	1800	0.165(a)
68	0.108						
(a) extrapolated.							

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
-250	0.2897	200	0.2861	800	0.2813	1400	0.2760
-200	0.2894	400	0.2846	1000	0.2796	1600	0.2741
-100	0.2886	600	0.2829	1200	0.2779	1800	0.2723
68	0.2873						

Density calculated from thermal-expansion data and measured density of 0.2877 lb in^{-3} at 32°F.

DIFFUSIVITY

TEMP, F	FT2 HR-1	TEMP, F	FT2 HR-1	TEMP, F	FT2 HR-1	TEMP, F	FT2 HR-1
-250	0.156	200	0.144	800	0.167	1400	0.191
-200	0.151	400	0.148	1000	0.173	1600	0.194
-100	0.147	600	0.158	1200	0.188	1800	0.195[a]
68	0.143						

(a) extrapolated.

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

MATERIAL 316 Stainless Steel HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	Fe
	16.0-18.0	10.0-14.0	2.0-3.0	max. 2.0	max. 1.0	max. 0.08	Bal

FORM

HEAT TREATMENT

REFERENCE Allegheny Ludlum Steel Corporation.

REMARKS Melting range: 2500-2550 F.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
212	9.4	932	12.4				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F-1 X 10^6	TEMP RANGE, F	F-1 X 10^6	TEMP RANGE, F	F-1 X 10^6	TEMP RANGE, F	F-1 X 10^6
68-212	9.2	68-1600	10.7				

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
32-212	0.12						

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
68	74.0	1200	116.0				

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.29						

MAGNETIC PERMEABILITY

TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY
Room	1.02						

Permeability at 200 Oersteds, annealed.

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

MATERIAL 316 Stainless Steel HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	Fe
	16	10	2	2	1	0.08	Bal

FORM

HEAT TREATMENT

REFERENCE Armour Research Foundation, WADC Technical Report No. 58-274.

REMARKS Nominal Composition taken from DMIC Memo 42.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
140	8.00	401	9.43	1047	11.51	1888	15.80
210	8.14	621	9.85	1435	13.37	2054	16.65
320	8.95						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F-1 X 10^6	TEMP RANGE, F	F-1 X 10^6	TEMP RANGE, F	F-1 X 10^6	TEMP RANGE, F	F-1 X 10^6
200-400	10.0	200-1000	10.9	20-1600	11.5	20-2200	12.0
200-600	10.8	200-1200	11.1	20-1800	11.6	20-2400	12.2
200-800	10.8	200-1400	11.3	20-2000	11.8		

Values interpolated from graph.

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
500	0.126	1000	0.138	1500	0.150	2000	0.162

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

(31)

MATERIAL	316 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	Fe		
	16	10	2	2	1	0.08	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Materials Data Book No. 1, General Electric Company.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
200	9.0	600	10.6	800	11.4	1000	12.3
400	9.8						
Values interpolated from graph.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
200	8.40	600	8.99	1000	9.70	1200	10.90
400	8.67	800	9.33				
Values interpolated from graph. Assumed to be instantaneous coefficients.							

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

(32)

MATERIAL	316 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	Fe		
	16	10	2	2	1	0.08	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Crucible Steel Company of America.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
200	9.3	1000	12.4				

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

(33)

MATERIAL	316 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	Fe		
	17.2	12.75	2.25	1.88	0.42	0.11	Bal		
FORM	1-3/4" dia. bar.								
HEAT TREATMENT									
REFERENCE	U. S. Naval Engineering Experiment Station, Annapolis, Maryland.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	9.8	100-1000	10.2	100-1600	10.2		
Method: absolute method Leitz dilatometer; heating rate 5.0° or 5.6°F per min.							

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

(34)

MATERIAL	Cast 316 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Si	Mn	C	P	Fe	
				max.	max.	max.	max.		
	18	9	2	2.0	1.5	0.12	0.04	Bal	
FORM									
HEAT TREATMENT	1950-2100 F - water quenched or oil quenched - hold to temperature long enough to heat all sections.								
REFERENCE	Alloy Casting Institute.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
212	9.4	1000	12.3				
Values interpolated from graph.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-212	8.9	70-1000	9.7				

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
70	82.0						

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.280						

MAGNETIC PERMEABILITY

TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY
Room	1.50-2.50						

(35)

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

MATERIAL	316 L Stainless Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	Fe		
	16.0-18.0	10.0-14.0	2.0-3.0	max. 2.0	max. 1.0	max. 0.03	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Melting range: 2500-2650 F.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
212	9.4	932	12.4				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-212	9.2	68-1600	10.7				

SPECIFIC HEAT

TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1
32-212	0.12						

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
68	74.0	1200	116.0				

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.29						

MAGNETIC PERMEABILITY

TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY
Room	1.02						

Permeability at 200 Oersteads annealed.
Data assumed to be at room temperature.

(36)

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

MATERIAL	316L Stainless Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	Fe		
	18.49	12.59	2.61	0.73	0.28	0.021	Bal		
FORM	1/2" dia. bar.								
HEAT TREATMENT									
REFERENCE	U. S. Naval Engineering Experiment Station, Annapolis, Maryland.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	9.3	100-1000	9.85	100-1600	10.5		

Method: absolute, Leitz dilatometer; heating rate 5.0 or 5.6 F per minute.

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

MATERIAL	347 Stainless Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	Cb	C	Fe		
	17.0-19.0	9.0-12.0	max. 2.0	max 1.0	0.8	max. 0.08	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Melting range: 2500-2600 F.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
212	9.3	932	12.8				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-212	9.2	68-1600	10.7				

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
68	73.0						

SPECIFIC HEAT

TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1
32-212	0.12						

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.29						

MAGNETIC PERMEABILITY

TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY
Room	1.02						
Permeability at 200 Oersteds, annealed.							
Data assumed to be at room temperature.							

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

MATERIAL	347 Stainless Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Cb	Si	Cu	C	Mo	S
	17.65	10.94	1.64	0.73	0.58	0.09	0.06	0.02	0.017
	P	Fe							
	0.013	Bal							
FORM									
HEAT TREATMENT									
REFERENCE	Lucks, C. F. and Deem, H. W., "Thermal Properties of Thirteen Metals", ASTM Special Technical Publication No. 227.								
REMARKS	Hot rolled and annealed at 2000f, 1 hour--water quenched.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
-250	7.1	200	9.0	800	11.5	1400	14.1
-200	7.3	400	9.8	1000	12.4	1600	14.9
-100	7.7	600	10.7	1200	13.2	1800	15.8*
68	8.4						
* extrapolated.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-(-250)	8.14	68-200	9.24	68-800	10.03	68-1400	10.64
68-(-200)	8.36	68-400	9.43	68-1000	10.23	68-1600	10.86
68-(-100)	8.75	68-600	9.83	68-1200	10.44	68-1800	11.05*
68	--						
* extrapolated.							

SPECIFIC HEAT

TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1
-250	0.080	68	0.108	600	0.131	1200	0.144
-200	0.085	200	0.116	800	0.135	1400	0.149
-100	0.094	400	0.124	1000	0.139	1600	0.159

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
-250	0.2879	200	0.2846	800	0.2795	1400	0.2740
-200	0.2875	400	0.2830	1000	0.2777	1600	0.2721
-100	0.2869	600	0.2813	1200	0.2759	1800	0.2702*
68	0.2856						
* extrapolated.							
Density was calculated from thermal expansion data and measured density of 0.2859 lb in^{-3} at 32 F.							

DIFFUSIVITY

TEMP., F	FT2 HR-1	TEMP., F	FT2 HR-1	TEMP., F	FT2 HR-1	TEMP., F	FT2 HR-1
-250	0.179	200	0.157	800	0.176	1400	0.199
-200	0.173	400	0.161	1000	0.185	1600	0.200
-100	0.165	600	0.168	1200	0.192	1800	0.194*
* extrapolated.							

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

MATERIAL	347 Stainless Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	Cb	C	Fe		
	17	9	2	1	0.8	0.08	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Armour Research Foundation, WADC Technical Report No. 58-274.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
134	8.11	396	9.54	1419	14.15	2040	16.37
195	8.21	649	10.6	1852	16.06	2318	17.35
299	9.30	1027	12.2				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
200-400	10.9	200-1000	11.8	200-1600	12.3	200-2200	12.7
200-600	11.2	200-1200	12.0	200-1800	12.4	200-2300	12.8
200-800	11.5	200-1400	12.1	200-2000	12.5		
Values interpolated from graph.							

SPECIFIC HEAT

TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1
500	0.121	1000	0.136	1500	0.150	2000	0.164

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

MATERIAL	347 Stainless Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	Cb	C	Fe		
	17	9	2	1	0.8	0.08	Bal		
FORM									
HEAT TREATMENT	Annealed.								
REFERENCE	Materials Data Book No. 1, General Electric Company.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
100	9.42	300	10.4	500	11.4	700	12.4
200	9.92	400	10.9	600	11.9	800	12.9
Values interpolated from graph.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
200	9.305	600	9.500	1000	10.200	1400	11.090
400	9.360	800	9.790	1200	10.710		
Values interpolated from graph. Assumed to be instantaneous coefficients.							

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

(41)

MATERIAL	347 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	Cb	C	Fe		
	17	9	2	1	0.8	0.08	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Levy, A., "Performance of Materials at Elevated Temperatures for Aircraft and Missiles", Marquardt Aircraft Co. MP-595.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	8.33	1000	12.5	1200	14.3	1400	15.0

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

(42)

MATERIAL	347 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Cb	Si	C	Fe		
	18.13	12.34	1.69	0.80	0.39	0.08	Bal		
FORM									
HEAT TREATMENT									
REFERENCE.	U. S. Naval Engineering Experiment Station, Annapolis, Maryland.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	9.9	100-1000	10.2	100-1600	10.6		
Method: absolute method, Leitz dilatometer; heating rate 5.0° or 5.6° per minute.							

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

(43)

MATERIAL	Cast 347 Stainless Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Si	Mn	Cb	C	P	S	Fe
			max.	max.	max.	max.	max.		
	18-20	9-12	2.00	1.50	1.0	0.08	0.04	0.04	Bal
FORM									
HEAT TREATMENT									
REFERENCE	Alloy Casting Institute, June, 1954.								
REMARKS	Melting point--approximate 2600 F.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
212	9.3	1000	12.8				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-212	9.3	70-1000	10.3				

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
70	0.12						

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
70	71.0						

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.280						

MAGNETIC PERMEABILITY

TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY
Room	1.20-1.80						
Data assumed to be at room temperature.							

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

(44)

MATERIAL Cast 347 Stainless Steel — HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Si	Cb	Mn	C	Fe		
	19.04	10.55	1.22	0.86	0.66	0.08	Bal		

FORM

HEAT TREATMENT

REFERENCE U. S. Naval Engineering Experiment Station, Annapolis, Maryland.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	9.3	100-1000	10.0	100-1600	10.8		

Method: absolute method. Leitz dilatometer. Heating rate: 5.0° or 5.6°F /min.

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

(45)

MATERIAL 347L Stainless Steel — HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Cb	Si	C	Fe		
	17.09	10.85	1.21	0.35	0.34	0.029	Bal		

FORM

HEAT TREATMENT

REFERENCE U. S Naval Engineering Experiment Station, Annapolis, Maryland.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	9.8	100-1000	10.2	100-1600	10.8		

Method: absolute method. Leitz dilatometer; heating rate 5.0° or 5.6°F per min.

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

(46)

MATERIAL Iron Alloy--SAE 30347 — HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Cb	Fe					
	18	11	1.1	Bal					

FORM Bar

HEAT TREATMENT 1200 F (2 hr) and air cooled.

REFERENCE "Report on Materials for Use at Liquid Hydrogen Temperature", Prepared for the 63rd Annual Meeting of the American Society for Testing Materials.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
78-(-104)	8.6	78-(-320)	7.6	78-(-410)	6.7		

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

(47)

MATERIAL Iron Alloy — HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Fe						
	18	12	Bal						

FORM

HEAT TREATMENT

REFERENCE U. S. Steel

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	9.2	70-600	9.8	70-1000	10.2	70-1200	10.4
70-400	9.5	70-800	10.0				

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

(48)

MATERIAL Iron Alloy — HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Si	Fe					
	20	10	3	Bal					

FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

THERMAL CONDUCTIVITY

TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT
70-200	8.9	70-600	9.5	70-1000	10.0	70-1200	10.2
70-400	9.3	70-800	9.8				

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

(49)

MATERIAL Iron Alloy — HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Si	Fe				
	20	10	2	1	Bal				

FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	8.9	70-600	9.5	70-1000	10.0	70-1200	10.2
70-400	9.3	70-800	9.8				

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

(50)

MATERIAL 309 Stainless Steel **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Cr	Ni	Mn	Si	C	Fe
22	12	2	1	max. 0.20	Bal

FORM

HEAT TREATMENT

REFERENCE Levy, A., "Performance of Materials at Elevated Temperatures for Aircraft and Missiles", Marquardt Aircraft Co. MP-595.

REMARKS Nominal Composition taken from DMIC Memo 42.

THERMAL CONDUCTIVITY

TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT
200	8.0	1000	11.5				

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

(51)

MATERIAL 309B Stainless Steel **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Cr	Ni	Mn	Si	C	Fe
22	12	2	1	max. 0.20	Bal

FORM

HEAT TREATMENT

REFERENCE Levy, A., "Performance of Materials at Elevated Temperatures for Aircraft and Missiles", Marquardt Aircraft Co. MP-595.

REMARKS Nominal Composition taken from DMIC Memo 42.

THERMAL CONDUCTIVITY

TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT
200	10.1	1000	12.1				

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

(52)

MATERIAL 310 Stainless Steel **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Cr	Ni	Mn	Si	C	Fe
24.0-26.0	19.0-22.0	max. 2.0	max. 1.50	max. 0.25	Bal

FORM

HEAT TREATMENT

REFERENCE Allegheny Ludlum Steel Corporation.

REMARKS Melting range: 2550-2650.

THERMAL CONDUCTIVITY

TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT
212	8.0	932	10.8				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}
68-212	8.0	68-2100	10.9				

SPECIFIC HEAT

TEMP., F	BTU LB^{-1} F^{-1}	TEMP., F	BTU LB^{-1} F^{-1}	TEMP., F	BTU LB^{-1} F^{-1}	TEMP., F	BTU LB^{-1} F^{-1}
32-212	0.12						

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
68	78.0						

DENSITY

TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}
Room	0.29						

MAGNETIC PERMEABILITY

TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY
Room	1.01						

Permeability at 200 Oersteads annealed.

Data assumed to be at room temperature.

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

(53)

MATERIAL 316 Stainless Steel **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Cr	Ni	Mn	Si	C	Fe
24	19	2	1.5	0.25	Bal

FORM

HEAT TREATMENT

REFERENCE Materials and Methods Manual No. 115, "Metals for Short Time Service at High Temperatures", by A. Levy (April, 1955).

REMARKS Melting Point: 2600 F.

THERMAL CONDUCTIVITY

TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT
200	8.0	1000	10.8				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}	TEMP RANGE, F	F^{-1} x 10^{6}
32-212	8.0	32-1000	9.4	32-1200	9.7	32-1800	10.6
32-600	9.0						

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.290						
Data assumed to be at room temperature.							

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

(54)

MATERIAL 310 Stainless Steel HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	C	Fe			
	24	19	2	1.5	0.25	Bal			

FORM

HEAT TREATMENT

REFERENCE General Electric Company.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	7.25	600	8.750	1000	10.25	1200	11.04
400	8.00	800	9.500				
Values interpolated from graph.							

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
200	7.95	600	8.98	1000	9.39	1200	9.70
400	8.59	800	9.22				
Values interpolated from graph.							

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

(55)

MATERIAL 310 Stainless Steel HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	C	Fe			
	24	19	2	1.5	0.25	Bal			

FORM

HEAT TREATMENT

REFERENCE Crucible Steel Company of America.

REMARKS Nominal Composition taken from DMIC Memo 42.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	8.00	1000	10.83				

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

(56)

MATERIAL 310 Stainless Steel HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	C	Fe			
	24.44	19.2	1.46	1.07	0.06	Bal			

FORM

HEAT TREATMENT

REFERENCE U. S. Naval Engineering Experiment Station, Annapolis, Maryland.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	9.1	100-1000	9.6	100-1600	10.3		
Method: absolute method, Leitz dilatometer; heating rate 5.0° or 5.6°F per min.							

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

(57)

MATERIAL 310 Stainless Steel HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	C	Fe			
	24.79	19.47	1.38	1.63	0.19	Bal			

FORM

HEAT TREATMENT

REFERENCE Allegheny Ludlum Steel Corporation.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	8.7	100-1000	9.1	100-1600	10.0		
Method: absolute method, Leitz dilatometer; heating rate 5.0° or 5.6°F per min.							

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

(58)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Fe						
	25	12	Bal						

FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	8.4	70-600	9.3	70-1000	9.7	70-1200	9.9
70-400	8.9	70-800	9.5				

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

(59)

MATERIAL Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Fe					
	25	12	2	Bal					

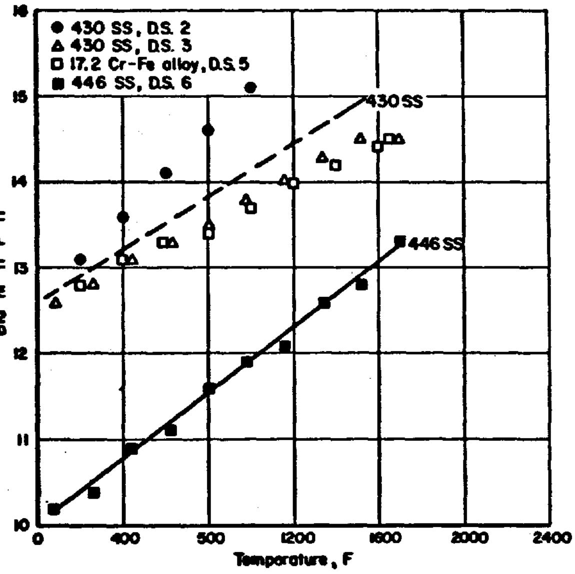
FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	8.4	70-600	9.3	70-1000	9.7	70-1200	9.9
70-400	8.9	70-800	9.5				



THERMAL CONDUCTIVITY OF FERRITIC - CHROMIUM STAINLESS STEELS

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

(1)

MATERIAL	Iron Alloy		HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Cr	Al	Fe
	12-14	0.20	Bal
FORM			
HEAT TREATMENT			
REFERENCE	U. S. Steel.		

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	5.6	70-600	6.2	70-1000	6.6	70-1200	6.8
70-400	5.9	70-800	6.4				

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

(2)

MATERIAL	430 Stainless Steel				HEAT NUMBER	
CHEMICAL COMPOSITION PER CENT	Cr	Mn	Si	C	Fe	
	14	1	1	max. 0.12	Bal	
FORM						
HEAT TREATMENT						
REFERENCE	Materials Data Book No. 1, General Electric Company.					
REMARKS	Nominal Composition taken from DMIC Memo 42.					

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	13.1	600	14.1	800	14.6	1000	15.1
400	13.6						

Values interpolated from graph.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
200	5.25	600	5.80	1000	6.20	1400	6.83
400	5.54	800	6.00	1200	6.44		

Values interpolated from graph and assumed to be instantaneous coefficients.

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

(3)

MATERIAL	430 Stainless Steel				HEAT NUMBER	
CHEMICAL COMPOSITION PER CENT	Fe	Cr	Mn	C	S	
	82.4	17.2	0.254	0.102	0.035	
FORM						
HEAT TREATMENT						
REFERENCE	Silverman, L., "Thermal Conductivity Data Presented for Various Metals and Alloys Up to 900 C", Journal of Metals, Vol 5, pp. 631-2; As found in WADC Technical Report 58-476, "Thermophysical Properties of Solid Materials".					

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
81	12.6	620	13.3	1160	14.0	1520	14.5
260	12.8	800	13.5	1340	14.3	1700	14.5
440	13.1	- 980	13.8				

Test method: comparative; rods.

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

(4)

MATERIAL	430 Stainless Steel					HEAT NUMBER	
CHEMICAL COMPOSITION PER CENT	Cr	Mn	Si	Ni	C	Fe	
	14.0-18.0	max. 1.0	max. 1.0	max. 0.50	max. 0.12	Bal	
FORM							
HEAT TREATMENT							
REFERENCE	Allegheny Ludlum Steel Corporation.						
REMARKS	Melting range: 2600-2750 F.						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-212	5.6	68-1500	6.6				

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
32-212	0.11						

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
68	60.0						

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.28						

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (5)

MATERIAL	Iron Alloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Mn	C	S	Fe				
	17.2	0.254	0.102	0.035	Bal				
FORM									
HEAT TREATMENT	Annealed at 1050 C.								
REFERENCE	Silverman, L., "Thermal Conductivity Data Presented for Various Metals and Alloys Up to 900 C", Journal of Metals, 5 (May, 1953) p. 631.								
REMARKS									

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	12.8	800	13.4	1200	14.0	1600	14.4
400	13.1	1000	13.7	1400	14.2	1650	14.5
600	13.3						
Values interpolated from graph.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (6)

MATERIAL	446 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Fe	Cr	C	Mn	S				
	76.44	23.58	0.152	0.043	0.021				
FORM									
HEAT TREATMENT									
REFERENCE	Silverman, L., "Thermal Conductivity Data Presented for Various Metals and Alloys up to 900 C", Journal Of Metals Vol 5, pp. 631-2; As found in WADC Technical Report 58-476, "Thermophysical Properties of Solid Materials".								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
81	10.2	620	11.1	1160	12.1	1520	12.8
260	10.4	800	11.6	1340	12.6	1700	13.3
440	10.9	980	11.9				
Test method: comparative; rod.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (7)

MATERIAL	Iron Alloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Fe							
	27	Bal							
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Steel.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	5.5	70-600	5.9	70-1000	6.3	70-1200	6.4
70-400	5.7	70-800	6.1				

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (8)

MATERIAL	Iron Alloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Si	Fe						
	27	1.5	Bal						
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Steel.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

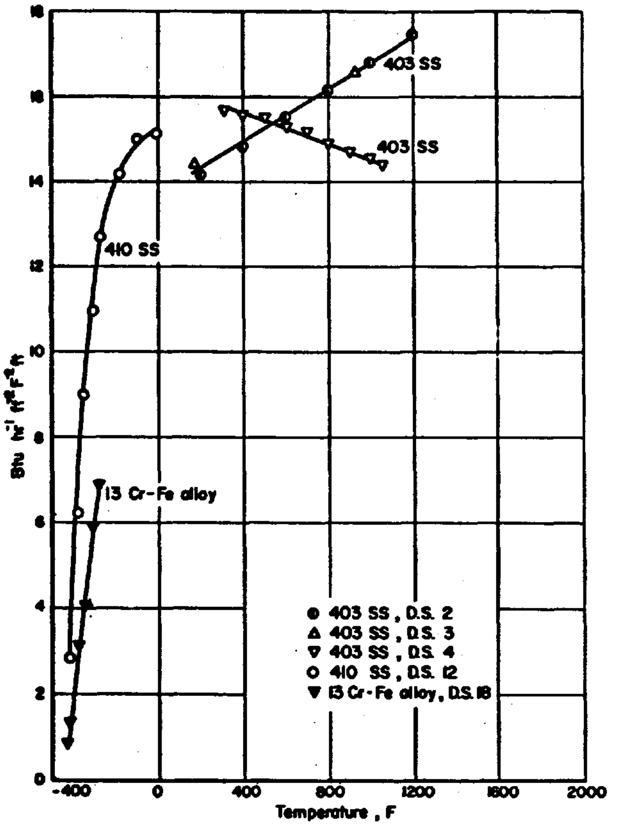
TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	5.5	70-600	5.9	70-1000	6.3	70-1200	6.4
70-400	5.7	70-800	6.1				

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (9)

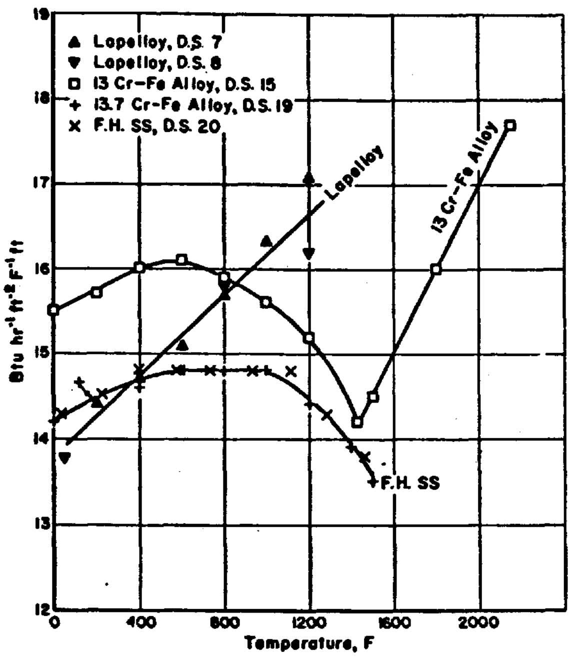
MATERIAL	Iron Alloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Fe					
	27	3.5	1.5	Bal					
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Steel.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

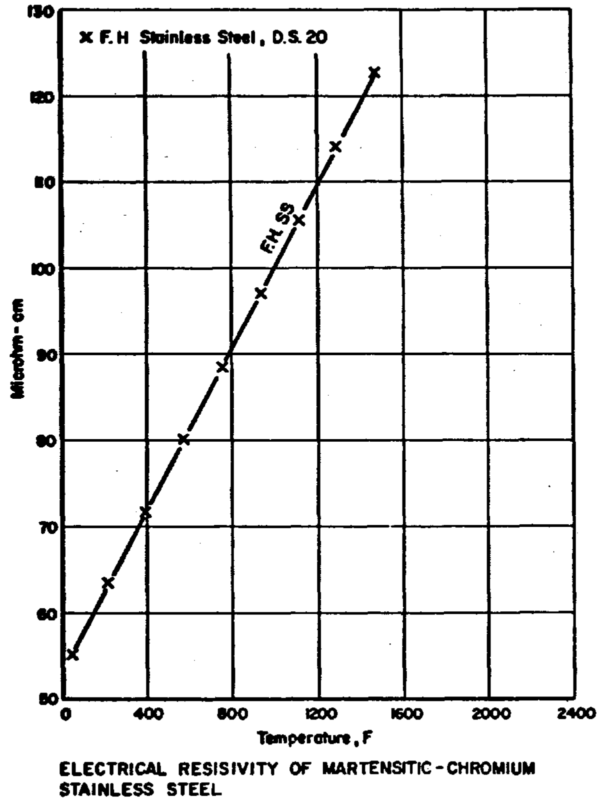
TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	5.5	70-600	5.9	70-1000	6.3	70-1200	6.4
70-400	5.7	70-800	6.1				



THERMAL CONDUCTIVITY OF MARTINSITIC-CHROMIUM STAINLESS STEELS



THERMAL CONDUCTIVITY OF MARTENSITIC-CHROMIUM STAINLESS STEELS



ELECTRICAL RESISIVITY OF MARTENSITIC-CHROMIUM STAINLESS STEEL

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

①

MATERIAL Iron Alloy **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT	Cr	Ni	C	Fe
	11	2	0.06	Bal

FORM

HEAT TREATMENT

REFERENCE U. S. Steel.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	5.7	70-600	6.2	70-1000	6.7	70-1200	6.8
70-400	6.0	70-800	6.5				

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

②

MATERIAL 403 Stainless Steel **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT	Cr	Mn	Si	C	Fe
	11.5	1	0.5	0.15	Bal

FORM

HEAT TREATMENT

REFERENCE Materials Data Book No. 1, General Electric Company.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	14.170	600	15.541	1000	16.833	1200	17.50
400	14.874	800	16.166				

Values interpolated from graph.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
200	5.57	600	5.72	1000	6.60	1400	6.75
400	5.61	800	6.20	1200	6.72		

Values interpolated from graph and assumed to be instantaneous coefficients.

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

③

MATERIAL 403 Stainless Steel **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT	Cr	Mn	Si	C	Fe
	11.5	1	0.5	max. 0.15	Bal

FORM

HEAT TREATMENT

REFERENCE Universal Cyclops Steel Corporation.

REMARKS Nominal Composition taken from DMIC Memo 42.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
212	14.4	932	16.6				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	5.5	70-600	5.6	70-1000	6.4	70-1200	6.5

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

④

MATERIAL 403 Stainless Steel **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT	Cr	C	Fe
	12.0	0.15	Bal

FORM

HEAT TREATMENT

REFERENCE Jerry E. Evans, Jr., "Thermal Conductivity of 14 Metals and Alloys Up to 1100 F", Lewis Flight Propulsion Laboratory, NACA Research Memorandum RM E 50L07, March, 1951

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
310	15.7	600	15.3	800	14.9	1000	14.6
400	15.6	700	15.2	900	14.75	1050	14.4
500	15.5						

Interpolated data taken from a best curve.

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

⑤

MATERIAL 403 Stainless Steel **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT	Cr	Mn	Si	C	Fe
	11.5	1	0.5	max. 0.15	Bal

FORM

HEAT TREATMENT

REFERENCE General Motors Corporation, Allison Division.

REMARKS Nominal Composition taken from DMIC Memo 42.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-400	5.9	70-800	6.1	70-1200	6.4	70-1400	6.4
70-600	6.0	70-1000	6.3				

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (6)

MATERIAL	403 Stainless Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Mn	Si	C	Fe				
	11.5	1	0.5	max. 0.15	Bal				
FORM									
HEAT TREATMENT									
REFERENCE	Haynes Stellite.								
REMARKS	Melting range: 2700-2790 F.								

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.28						
Data assumed to be at room temperature.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (7)

MATERIAL	Iron-Base Alloy--Lapelloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Mo	Mn	C	Ni	V	Si	Fe	
	12.0	2.75	1.0	0.30	0.30	0.25	0.25	Bal	
FORM									
HEAT TREATMENT									
REFERENCE	Thomson Lab. Data, General Electric Company.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
200	14.46	600	15.10	1000	16.33	1200	17.08
400	14.71	800	15.67				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6
70-200	147.5	70-600	164.0	70-1000	191.0	70-1400	226.5
70-400	154.5	70-800	176.5	70-1200	208.0		
Values interpolated from graph							

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
room	0.285						

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (8)

MATERIAL	Iron Base Alloy--Lapelloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Mo	Mn	Ni	C	Si	V	Fe	
	12.0	2.75	1.0	0.30	0.30	0.25	0.25	Bal	
FORM									
HEAT TREATMENT									
REFERENCE	Universal Cyclops Steel Corporation.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
70	13.8	800	15.8	1200	16.2		

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6
70-200	6.1	70-600	6.2	70-1000	6.5		

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (9)

MATERIAL	Iron Alloy--SAE 51335				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Fe							
	12-14	Bal							
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Steel.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6
70-200	5.6	70-600	6.2	70-1000	6.6	70-1200	6.8
70-400	5.9	70-800	6.4				

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (10)

MATERIAL	Iron Alloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Cb	Fe						
	12-14	0.68	Bal						
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Steel.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6
70-200	5.6	70-600	6.2	70-1000	6.6	70-1200	6.8
70-400	5.9	70-800	6.4				

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

(11)

MATERIAL	Iron Alloy--SAE 51410					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Fe							
	12.5	Bal							
FORM	Bar								
HEAT TREATMENT	Per specification.								
REFERENCE	"Report on Materials for Use at Liquid Hydrogen Temperature", Prepared for the 63rd Annual Meeting of the American Society for Testing Materials.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
78-(-104)	5.1	78-(-320)	4.8	78-(-410)	3.9		

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

(12)

MATERIAL	410 Stainless Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Si	Mn	Ni	C	Cu	N	P	Fe
	12.6	0.36	0.32	0.12	0.09	0.06	0.03	0.01	Bal
FORM									
HEAT TREATMENT									
REFERENCE	Powers, R. W., Ziegler, J. B. and Johnston, TR 264-6, Cryogenic Laboratory, Ohio State University, 17 (1951); As found in "A Compendium of the Properties of Materials at Low Temperatures, Phase I", Part II, edited by Victor J. Johnson, N.B.S. Cryogenic Engineering Laboratory, Boulder, Colorado (December, 1959).								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
-415	2.89	-352	9.07	-280	12.7	-100	15.0
-388	6.24	-316	10.98	-190	14.2	-10	15.1
Values interpolated from graph.							

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

(13)

MATERIAL	410 Stainless Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Mn	Si	C	Ni	Fe			
	12.2	0.43	0.35	0.14	0.2	Bal			
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Naval Engineering Experiment Station, Annapolis, Maryland.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	6.6	100-1000	6.7				
Method: absolute, Leitz dilatometer; heating rate 5.0 or 5.6 F per minute.							

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

(14)

MATERIAL	410 Stainless Steel					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Mn	Si	C	Ni	Fe			
	12.78	0.36	0.17	0.11	0.01	Bal			
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Naval Engineering Experiment Station, Annapolis, Maryland.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	6.3	100-1000	6.7				
Method: absolute, Leitz dilatometer; heating rate 5.0 or 5.6 F per minute.							

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

(15)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Mn	Si	Ni	C	Cu	Al	S	P
	12.95	0.25	0.17	0.14	0.13	0.06	0.034	0.024	0.018
	As	V	Fe						
	0.015	0.012	Bal						
FORM									
HEAT TREATMENT	Annealed at 750 C.								
REFERENCE	Powell, R. W., "The Physical Properties of a Series of Steels, Section 11ld. Notes on the Estimation of Thermal Conductivity of Steels" Journal of the Iron and Steel Institute, 154 (1946) p.116.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
0	15.5	600	16.1	1200	15.2	1800	16.0
200	15.7	800	15.9	1418	14.2	2150	17.7
400	16.0	1000	14.5				
Values interpolated from graph.							

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

(16)

MATERIAL	Iron Alloy--418					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	W	Ni	C	Fe				
	13.09	3.01	1.95	0.15	Bal				
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Naval Engineering Experiment Station, Annapolis, Maryland.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	6.1	100-1000	6.4				
Method: absolute, Leitz dilatometer; heating rate 5.0 or 5.6 F per minute.							

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

(17)

MATERIAL	Iron Alloy--Rezistal 418					HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Cr	W	Ni	C	Fe	
	13.23	3.09	0.27	0.10	Bal	
FORM						
HEAT TREATMENT						
REFERENCE	U. S. Naval Engineering Experiment Station, Annapolis, Maryland.					

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	6.2	100-1000	6.5				
Method: absolute, Leitz dilatometer; heating rate 5.0 to 5.6 F per minute.							

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

(18)

MATERIAL	Iron Alloy					HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Cr	C	Si	Mn	Fe	
	13.5	0.36	0.22	0.13	Bal	
FORM						
HEAT TREATMENT	Heated to 950 C, oil quenched, reheated to 450 C, air cooled.					
REFERENCE	deNobel, J., Physica, 17, (1951) pp. 551-562; As found in "A Compendium of the Properties of Materials at Low Temperatures, Phase I" Part II, edited by Victor J. Johnson, NBS Cryogenic Engineering Laboratory, Boulder, Colorado (December, 1959).					

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
-433	0.92	-388	3.18	-316	5.95	-280	6.93
-424	1.39	-352	4.10				
Values interpolated from graph.							

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

(19)

MATERIAL	Iron Alloy						HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	C	Fe	
	13.65	0.37	0.29	0.27	0.27	Bal	
FORM							
HEAT TREATMENT	Annealed at 725 C.						
REFERENCE	Powell, R. W., "The Thermal and Electrical Conductivities of Metals and Alloys, Part 2, Some Heat Resistant Alloys From 0-800 C", Proc. of Physical Society, 48 (1936) p. 381.						

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
0	14.2	600	14.8	1000	14.8	1400	13.9
200	14.4	800	14.8	1200	14.4	1500	13.5
400	14.6						
Values interpolated from graph.							

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

(20)

MATERIAL	F. H. Stainless Steel								HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	C	S	P	Fe	
	13.65	0.37	0.29	0.27	0.27	?	?	Bal	
FORM									
HEAT TREATMENT	Air hardened - 940 C. Tempered 725 C.								
REFERENCE	Powell, P. W., "The Thermal and Electrical Conductivities of Metals and Alloys: Part 2, Some Heat-Resistant Alloys From 0 to 800 C", Proc. of the Physical Society, Vol 48 (1936) p. 381.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
32	(14.3)	572	14.8	932	14.8	1292	14.3
212	14.5	752	14.8	1112	14.8	1472	(14.8)
392	14.8						
Method: comparative.							

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
32	(55.0)	572	80.2	932	97.0	1292	114.1
212	63.4	752	88.5	1112	105.6	1472	(122.7)
392	71.8						
Method: voltage drop.							

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

(21)

MATERIAL	Iron Alloy--SAE 51710		HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Cr	Fe	
	17	Bal	
FORM			
HEAT TREATMENT			
REFERENCE	U. S. Steel.		

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	5.6	70-600	6.1	70-1000	6.5	70-1200	6.6
70-400	5.8	70-800	6.3				

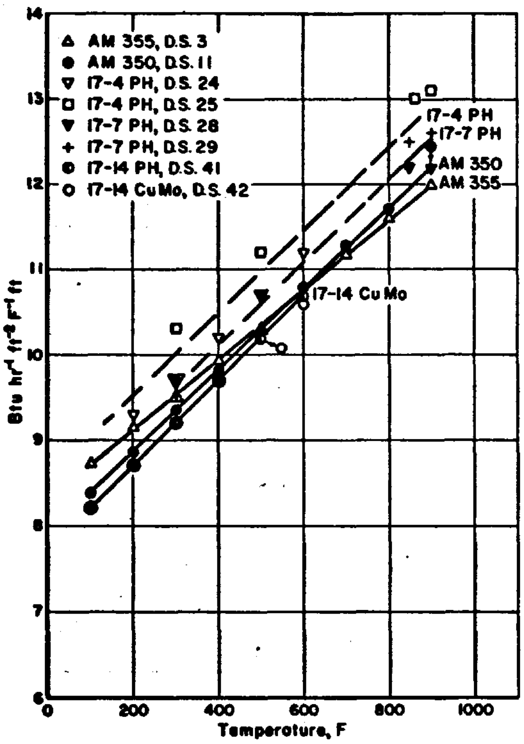
ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

(22)

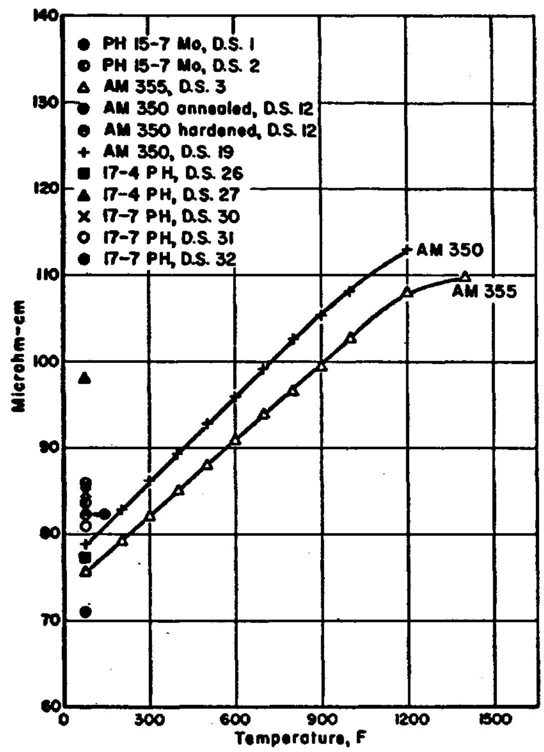
MATERIAL	Alloy Steel AMS 5630 SAE 51440C				HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Cr	C	Mo	Fe	
	17	1.1	0.5	Bal	
FORM	Bar				
HEAT TREATMENT	Per specification.				
REFERENCE	"Report on Materials for Use at Liquid Hydrogen Temperature", Prepared for the 63rd Annual Meeting of the American Society for Testing Materials.				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
78-(-104)	5.2	78-(-320)	4.5	78-(-110)	4.0		



THERMAL CONDUCTIVITY OF AGE HARDENING STAINLESS STEELS



ELECTRICAL RESISTIVITY OF AGE HARDENING STAINLESS STEELS

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

1

MATERIAL	Iron Alloy--PH 15-7 Mo				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Al	Mn	Si	C	Fe	
	15.0	7.0	2.5	1.0	max. 1.00	max. 1.00	0.09	Bal	
FORM									
HEAT TREATMENT	Annealed + 1400 F - 1-1/2 hrs. - cool to 60 F within 1 hour + 1050 F - 1-1/2 hrs. - air cooled.								
REFERENCE	Armco Steel Corporation.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.1	70-600	6.1	70-900	6.5	70-1000	6.6
70-400	6.1	70-800	6.3				

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
Room	82						
Data assumed to be at room temperature.							

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.277						
Data assumed to be at room temperature.							

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

2

MATERIAL	Iron Alloy--PH 15-7 Mo				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Al	Mn	Si	C	Fe	
	15.0	7.0	2.5	1.0	max. 1.00	max. 1.00	0.09	Bal	
FORM									
HEAT TREATMENT	Annealed + 1750 F - 10 minutes - cool to room temperature, refrigerate at -100 F - 8 hrs. + 950 F - 1-1/2 hrs. - air cooled.								
REFERENCE	Armco Steel Corporation.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	5.0	70-600	5.6	70-900	6.0	70-1000	6.1
70-400	5.4	70-800	5.9				

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
Room	83						
Data assumed to be at room temperature.							

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.277						
Data assumed to be at room temperature.							

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

3

MATERIAL	Iron Alloy--AM 355					HEAT NUMBER 83331			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	C	N	Si	P	S
	15.58	4.43	2.65	0.85	0.129	0.102	0.08	0.020	0.010
	Fe								
	Bal								
FORM									
HEAT TREATMENT	3 hrs. at 1375 F, air cooled and 1 hr. at 1710 F, water quenched and 3 hrs. at -100 F and 3 hrs. at 850 F, air cooled.								
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Testing performed at Armour Research Foundation using Powell stacked disk method. Temperature difference through specimens maintained at approximately 15 F during tests.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
100	8.72	400	9.92	600	10.7	800	11.6
200	9.18	500	10.3	700	11.2	900	12.0
300	9.52						

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
80	75.6	400	85.0	700	93.8	1000	102.7
200	79.2	500	88.0	800	96.7	1200	108.0
300	82.1	600	90.8	900	99.7	1400	109.8

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

4

MATERIAL	Iron Alloy--AM 355					HEAT NUMBER A-83331			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	C	N2	Si	P	S
	15.58	4.43	2.65	0.85	0.129	C.102	0.08	0.020	0.010
	Fe								
	Bal								
FORM	Hammer forged to billet, hot rolled to 2" dia. and 4" sq. bar.								
HEAT TREATMENT	3 hrs. at 1375 F, air colled + 1 hour at 1750 F, air cooled + 3 hrs. at -100 F + 3 hrs. at 1000 F.								
REFERENCE	Allegheny Ludlum Steel Corporation.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-(-320)	5.2	70-392	7.2	70-752	7.5	70-1112	7.6
70-212	7.0	70-572	7.5	70-932	7.6	70-1832	7.6

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

(5)

MATERIAL	Iron Alloy--AM 355					HEAT NUMBER B 83368			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	N2	P	S
	15.66	4.35	2.72	0.90	0.14	0.120	0.120	0.23	0.015
	Fe								
	Bal								
FORM	Hammer and forged to billet, hot rolled to 2" dia. and 4" sq. bar.								
HEAT TREATMENT	3 hrs at 1375 F, A.C. + 1 hr. at 1750 F, A.C. + 3 hrs at -100 F + 3 hrs at 1000 F.								
REFERENCE	Allegheny Steel Corporation.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-(-320)	5.7	70-392	7.0	70-752	7.7	70-1112	7.8
70-212	6.8	70-572	7.4	70-932	7.7	70-1832	8.4

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

(6)

MATERIAL	Iron Alloy--AM 355					HEAT NUMBER 92370		
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	N	Fe
	15.44	4.35	2.74	0.95	0.37	0.14	0.10	Bal
FORM								
HEAT TREATMENT	20 minutes at 1750 F, air cooled + 3 hrs. at -100 F + 850 F, 3 hrs. air cooled.							
REFERENCE	Allegheny Ludlum Steel Corporation.							
REMARKS	Tests were run in a quenching dilatometer during heating. Heating rate was 250 F/hr.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-212	6.4	70-572	6.8	70-932	7.2	70-1832	7.4
70-392	6.6	70-752	7.0	70-1112	7.2		

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

(7)

MATERIAL	Iron Alloy--AM 355					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	C	N	P	S	Fe
	15.50	4.39	2.67	0.65	0.12	0.05	0.025	0.012	Bal
FORM	Structure essentially tempered martensite.								
HEAT TREATMENT	Equalized and overtempered: 1375 F, 3 hrs. air cooled + 1050 F, 3 hrs. air cooled and 1 hr. water quenched and 3 hrs. at -100 F and 1000 F. 3 hrs. air cooled.								
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

DENSITY

TEMP. F	LB CU IN-1	TEMP. F	LB CU IN-1	TEMP. F	LB CU IN-1	TEMP. F	LB CU IN-1
Room	0.2814						
Data assumed to be at room temperature.							

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

(8)

MATERIAL	Iron Alloy--AM 355					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	C	N	P	S	Fe
	15.50	4.39	2.67	0.65	0.12	0.05	0.025	0.012	Bal
FORM	Structure essentially tempered martensite.								
HEAT TREATMENT	Equalized and overtempered: 1375 F, 3 hrs. air cooled + 1050 F, 3 hrs. air cooled + 1710 F, 1 hr. water quenched and 3 hrs. at -100 F and 850 F, 3 hrs. air cooled.								
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

DENSITY

TEMP. F	LB CU IN-1	TEMP. F	LB CU IN-1	TEMP. F	LB CU IN-1	TEMP. F	LB CU IN-1
Room	0.2811						
Data assumed to be at room temperature.							

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

(9)

MATERIAL	Iron Alloy--AM 355					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	C	N	P	S	Fe
	15.50	4.39	2.67	0.65	0.12	0.05	0.025	0.012	Bal
FORM	Structure essentially tempered martensite.								
HEAT TREATMENT	Equalized and overtempered: 1375 F, 3 hours, air cooled + 1050 F, 3 hours, air cooled.								
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

DENSITY

TEMP. F	LB CU IN-1	TEMP. F	LB CU IN-1	TEMP. F	LB CU IN-1	TEMP. F	LB CU IN-1
Room	0.2824						
Data assumed to be at room temperature.							

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

(10)

MATERIAL	Iron Alloy--AM 355					HEAT NUMBER 21683			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	C	Si	N	P	S
	15.50	4.39	2.67	0.65	0.12	0.07	0.05	0.025	0.012
	Fe								
	Bal								
FORM									
HEAT TREATMENT	3 hrs at 1375 F, air cooled and 1 hour at 1710 F, air cooled and 3 hrs at -100 F and 3 hrs. at 1000 F, air cooled.								
REFERENCE	Allegheny Ludlum Steel Corporation.								

MAGNETIC PERMEABILITY

TEMP. F	PERMEABILITY	TEMP. F	PERMEABILITY	TEMP. F	PERMEABILITY	TEMP. F	PERMEABILITY
70	11,508	200	11,408	300	11,208	500	10,608
Induction at 200 Oersted. Values not at saturation.							

MAGNETIC PERMEABILITY

TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY
Room	150	200	156	300	155	500	151
Saturation - Gausses at 200 Oersteds.							

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

(11)

MATERIAL	Iron Alloy--AM 350					HEAT NUMBER	1282		
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	N	C	Si	P	S
	16.71	4.57	2.76	1.01	0.116	0.108	0.06	0.026	0.019
	Fe								
	Bal								
FORM									
HEAT TREATMENT	1 hour at 1750 F, water quenched and 3 hrs. at -100 F and 3 hrs. at 850 F, air cooled.								
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Testing performed at Armour Research Foundation using Powell stacked disk method. Temperature difference through specimens maintained at approximately 15 F during tests.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
100	8.38	400	9.81	600	10.8	800	11.7
200	8.87	500	10.3	700	11.3	900	12.2
300	9.36						

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

(12)

MATERIAL	Iron Alloy--AM 350				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	Fe		
	17.0	4.2	2.75	0.60	0.40	0.08	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Allegheny Ludlum Steel Corporation.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$			TEMP RANGE, F	$F^{-1} \times 10^6$		
70-1000	9.00			70-1000	7.10		
70-1400	9.38			70-1400	6.72		
70-1750	9.91			70-1750	7.63		
Annealed				Hardened			

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM			TEMP, F	MICROHM-CM		
Room	70.97			Room	82.11		
Annealed				Hardened			
Data assumed to be at room temperature.							

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.286						

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

(13)

MATERIAL	Iron Alloy--AM 350				HEAT NUMBER	18240		
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	N	Fe
	16.50	4.30	2.75	0.80	0.25	0.10	0.10	Bal
FORM								
HEAT TREATMENT								
REFERENCE	Allegheny Ludlum Steel Corporation.							
REMARKS	Nominal Composition taken from DMIC Memo 42.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
212	6.0	932	6.6	1819	7.4		
Assumed to be instantaneous coefficient.							

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

(14)

MATERIAL	Iron Alloy--AM 350				HEAT NUMBER	21744		
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	N	Si	C	Fe
	16.28	4.23	3.08	1.13	0.100	0.32	0.11	Bal
FORM	Hammer forged to billets, hot rolled to 1-1/2 in. dia. bars.							
HEAT TREATMENT	3 hrs. at 1375 F, air cooled and 3 hrs. at 1050 F, air cooled; Anneal 1 hr. at 1710 F, air cooled and 3 hrs at -100 F and 3 hrs. at 850 F, air cooled.							
REFERENCE	Allegheny Ludlum Steel Corporation.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-(-320)	5.2	70-572	7.1	70-1112	7.6	70-1500	7.5
70-212	6.6	70-752	7.4	70-1150	7.6	70-1700	8.0
70-392	7.0	70-932	7.5	70-1350	7.2	70-1832	8.4

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

(15)

MATERIAL	Iron Alloy--AM 350				HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	C	N	Si	Fe
	15.84	4.25	2.76	0.68	0.113	0.098	0.07	Bal
FORM	Hammer forged to billets, hot rolled to 1-1/2 inch dia. bars.							
HEAT TREATMENT	3 hrs. at 1375 F, air cooled, and 3 hrs. at 1050 F, air cooled. Anneal 1 hr. at 1710 F, air cooled, and 3 hrs. at -100 F, and 3 hours at 850 F, air cooled.							
REFERENCE	Allegheny Ludlum Steel Corporation.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-(-320)	4.7	70-572	6.4	70-1112	6.8	70-1500	6.5
70-212	5.9	70-752	6.6	70-1150	6.8	70-1700	7.2
70-392	6.2	70-932	6.8	70-1350	6.2	70-1832	7.5

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

(16)

MATERIAL	Iron Alloy--AM 350					HEAT NUMBER 69443			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	N	Fe	
	16.50	4.30	2.75	0.80	0.25	0.10	0.10	Bal	
FORM									
HEAT TREATMENT	20 minutes at 1700-1800 F, air cooled and 3 hrs. at -100 F and 3 hrs. at 850 F, air cooled.								
REFERENCE	Allegheny Ludlum Steel Corporation.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-212	6.6	70-752	6.9	70-1150	7.2	70-1500	7.0
70-572	6.7	70-932	7.1	70-1350	6.7	70-1700	7.5

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

(17)

MATERIAL	Iron Alloy--AM 350					HEAT NUMBER 69588			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	N	Fe	
	16.50	4.30	2.75	0.80	0.25	0.10	0.10	Bal	
FORM									
HEAT TREATMENT	20 minutes at 1700-1800 F, air cooled and 3 hrs. at -100 F and 3 hrs. at 850 F, air cooled.								
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-212	6.0	70-752	6.9	70-1150	7.2	70-1500	7.0
70-572	6.7	70-932	7.1	70-1350	6.7	70-1700	7.5

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

(18)

MATERIAL	Iron Alloy--AM 350					HEAT NUMBER 82964			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	C	N	Si	Fe	
	16.61	4.41	2.90	0.79	0.123	0.104	0.09	Bal	
FORM	Hammer forged to billets, hot rolled to 1-1/2 in. dia. bars.								
HEAT TREATMENT	3 hrs. at 1375 F, air cooled, and 3 hrs. at 1050 F, air cooled, Anneal 1 hr. at 1710 F, air cooled and 3 hrs. at -100 F, and 3 hrs. at 850 F, air cooled.								
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-(-320)	5.1	70-572	7.2	70-1112	7.7	70-1500	7.8
70-212	6.6	70-752	7.4	70-1150	7.7	70-1700	8.2
70-392	6.8	70-932	7.6	70-1350	7.4	70-1832	8.7

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

(19)

MATERIAL	Iron Alloy--AM 350					HEAT NUMBER 82964			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	C	N	Si	Fe	
	16.61	4.41	2.90	0.79	0.123	0.104	0.09	Bal	
FORM									
HEAT TREATMENT	3 hrs. at 1375 F, air cooled and 1 hour at 1710 F, water quenched and 3 hrs. at -100 F and 3 hrs. at 850 F, air cooled.								
REFERENCE	Allegheny Ludlum Steel Corporation.								

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
80	78.8	400	89.4	700	99.2	1000	108.3
200	82.8	500	92.7	800	102.4	1200	113.2
300	86.1	600	96.0	900	105.3		

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

(20)

MATERIAL	Iron Alloy--AM 350					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	N	Fe	
	16.50	4.30	2.75	0.80	0.25	0.10	0.10	Bal	
FORM									
HEAT TREATMENT									
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

SPECIFIC HEAT

TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}
32-212	0.12						
Assumed to be mean specific heat.							

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

(21)

MATERIAL	Iron Alloy--AM 350					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	N	Fe	
	16.50	4.30	2.75	0.80	0.25	0.10	0.10	Bal	
FORM									
HEAT TREATMENT	High temperature annealed, 1950 F, rapid cool.								
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.286						
Data assumed to be at room temperature.							

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

22

MATERIAL	Iron Alloy--AM 350					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	N	Fe	
	16.50	4.30	2.75	0.80	0.25	0.10	0.10	Bal	
FORM									
HEAT TREATMENT	High temperature annealed, 1950 F, rapid cool + 3 hrs. at 1375 F, air cooled and 3 hrs. at 850 F, air cooled.								
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.282						
Data assumed to be at room temperature.							

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

23

MATERIAL	Iron Alloy--AM 350					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Mn	Si	C	N	Fe	
	16.50	4.30	2.75	0.80	0.25	0.10	0.10	Bal	
FORM									
HEAT TREATMENT	High temperature annealed, 1950 F, rapid cool + 1710 F, rapid cool and 3 hrs. at -100 F and 3 hrs. at 850 F, air cooled.								
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.282						
Data assumed to be at room temperature.							

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

24

MATERIAL	Armco Iron--17-4PH					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Cu	Ni	Mn	Si	Cb	C	Fe	
	16.5	4.0	4	1	1	0.35	0.07	Bal	
FORM									
HEAT TREATMENT									
REFERENCE	Levy, A., "Performance of Materials at Elevated Temperature for Aircraft and Missles"; Marquardt Aircraft Company MP - 595; As found in Armco Technical Data Manual, "Precipitation Hardness Stainless Steel."								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
200	9.3	400	10.2	600	11.2	1000	12.2
300	9.7						

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

25

MATERIAL	Armco Iron--17-4PH					HEAT NUMBER	10397		
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Cu	Mn	Si	Cb	C	P	S
	16.42	4.44	3.85	0.53	0.47	0.34	0.044	0.025	0.013
	Fe								
	Bal								
FORM	Hot rolled and annealed bar stock.								
HEAT TREATMENT	Condition H 900-1900 F - 1/2 hour - water quenched + 900 F - 1 hour - air cooled.								
REFERENCE	Armco Steel Corporation.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
300	10.3	500	11.2	860	13.0	900	13.1

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.0	70-400	6.1	70-600	6.3	70-800	6.5

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.282						
Data assumed to be at room temperature.							

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

26

MATERIAL	Armco Iron--17-4PH					HEAT NUMBER	28147		
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Cu	Mn	Cb	Si	C	P	S
	16.62	4.40	3.85	0.58	0.43	0.36	0.054	0.023	0.010
	Fe								
	Bal								
FORM	Hot rolled and annealed bar stock.								
HEAT TREATMENT	Condition H 900-1800 F - 1/2 hour - water cooled + 900 F - 1 hour - air cooled.								
REFERENCE	Armco Steel Corporation.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.0	70-400	6.1	70-600	6.3	70-800	6.5

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
Room	77						

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.282						

MAGNETIC PERMEABILITY

TEMP, F	(a) PERME-ABILITY	TEMP, F	(b) PERME-ABILITY	TEMP, F	(c) PERME-ABILITY	TEMP, F	PERME-ABILITY
Room	100	Room	60	Room	151		

(a) Permeability at field strength of 100 Oersteds.
(b) Permeability at field strength of 200 Oersteds.
(c) Maximum Permeability.

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

27

MATERIAL Armco Iron--17-4PH **HEAT NUMBER** 28147

CHEMICAL COMPOSITION PER CENT

Cr	Ni	Cu	Mn	Cb	Si	C	P	S	Fe
16.62	4.40	3.85	0.58	0.43	0.36	0.054	0.023	0.010	Bal

FORM Hot rolled and annealed bar stock.

HEAT TREATMENT Annealed - 1800 F - 1/2 hour - water quenched.

REFERENCE Armco Steel Corporation.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.0	70-400	6.0	70-600	6.2	70-800	6.3

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
Room	98						

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.280						

MAGNETIC PERMEABILITY

TEMP, F	(a) PERME-ABILITY	TEMP, F	(b) PERME-ABILITY	TEMP, F	(c) PERME-ABILITY	TEMP, F	PERME-ABILITY
Room	74	Room	48	Room	95		

(a) Permeability at field strength of 100 Oersteds.
(b) Permeability at field strength of 200 Oersteds.
(c) Maximum Permeability.

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

28

MATERIAL Armco Iron--17-7PH **HEAT NUMBER** 28959

CHEMICAL COMPOSITION PER CENT

Cr	Ni	Al	Mn	Si	C	P	S	Fe
17.01	7.23	0.98m	0.58	0.54	0.078	0.025	0.016	Bal

FORM Hot rolled and annealed bar stock.

HEAT TREATMENT Condition TH 950-1900 F - 1/2 hour - air cooled + 1400 F - 1-1/2 hour - air cooled.

REFERENCE Armco Steel Corporation.

REMARKS

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
300	9.7	500	10.7	850	12.2	900	12.2

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

29

MATERIAL Armco Iron--17-7PH **HEAT NUMBER** 30804

CHEMICAL COMPOSITION PER CENT

Cr	Ni	Al	Mn	Si	C	P	S	Fe
17.17	7.63	1.04	0.65	0.32	0.072	0.026	0.020	Bal

FORM Cold drawn bar stock.

HEAT TREATMENT Condition CH 900 - Cold drawn + 900 F - 1 hour - air cooled.

REFERENCE Armco Steel Corporation.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
300	9.5	500	10.6	850	12.5	900	12.6

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

30

MATERIAL Armco Iron--17-7PH **HEAT NUMBER** 19113

CHEMICAL COMPOSITION PER CENT

Cr	Ni	Al	Mn	Si	C	P	S	Fe
16.48	7.01	1.02	0.61	0.43	0.060	0.020	0.015	Bal

FORM Cold drawn bar stock.

HEAT TREATMENT Condition CH 900 - cold drawn + 900 F - 1 hour - air cooled.

REFERENCE Armco Steel Corporation.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.1	70-600	6.4	70-800	6.6	70-900	--
70-400	6.2						

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
Room	83.8						

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.277						

MAGNETIC PERMEABILITY

TEMP, F	(a) PERME-ABILITY	TEMP, F	(b) PERME-ABILITY	TEMP, F	(c) PERME-ABILITY	TEMP, F	PERME-ABILITY
Room	70	Room	43.5	Room	125		

(a) Permeability at field strength of 100 Oersteds.
(b) Permeability at field strength of 200 Oersteds.
(c) Maximum Permeability.

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

(31)

MATERIAL	Armco Iron--17-7PH					HEAT NUMBER	19113		
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Al	Mn	Si	C	P	S	Fe
	16.48	7.01	1.02	0.61	0.43	0.060	0.020	0.015	Bal
FORM	Hot rolled and annealed bar stock.								
HEAT TREATMENT	Annealed - 1900 F - 1/2 hour - water quenched.								
REFERENCE	Armco Steel Corporation.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	8.5	70-600	9.5	70-800	9.6	70-900	--
70-400	9.0						

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
Room	81.0						

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.282						

MAGNETIC PERMEABILITY

TEMP, F	(a) PERME-ABILITY	TEMP, F	(b) PERME-ABILITY	TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY
Room	3.2	Room	3.3				

(a) Permeability at field strength of 100 Oersteds.
(b) Permeability at field strength of 200 Oersteds.

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

(32)

MATERIAL	Armco Iron--17-7PH					HEAT NUMBER	32465		
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Al	Mn	Si	C	P	S	Fe
	17.18	6.75	1.0	0.64	0.36	0.069	0.022	0.012	Bal
FORM	Hot rolled and annealed bar stock.								
HEAT TREATMENT	Condition TH 1050-1900 F - 1/2 hour - air cooled + 1400 F - 1-1/2 hour - air cooled to 60 F + 1050 F - 1-1/2 hour - air cooled.								
REFERENCE	Armco Steel Corporation.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	5.6	70-400	6.1	70-600	6.3	70-800	6.6

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
Room	85.0						

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.276						

MAGNETIC PERMEABILITY

TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY	TEMP, F	PERME-ABILITY
Room	90-110	Room	53-63	Room	175-260		

(a) Permeability at field strength of 100 Oersteds.
(b) Permeability at field strength of 200 Oersteds.
(c) Maximum Permeability.

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

(33)

MATERIAL	Armco Iron--17-7PH					HEAT NUMBER	32383		
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Al	Mn	Si	C	P	S	Fe
	17.28	7.21	1.17	0.77	0.38	0.085	0.022	0.010	Bal
FORM	Hot rolled and annealed bar stock.								
HEAT TREATMENT	Condition TH 1050-1900 F - 1/2 hour - air cooled + 1400 F - 1-1/2 hour - air cooled - (to 60 F) + 1050 F - 1-1/2 hour - air cooled.								
REFERENCE	Armco Steel Corporation.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	5.6	70-400	6.1	70-600	6.3	70-800	6.6

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
Room	85.0						

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.276						

MAGNETIC PERMEABILITY

TEMP, F	(a) PERME-ABILITY	TEMP, F	(b) PERME-ABILITY	TEMP, F	(c) PERME-ABILITY	TEMP, F	PERME-ABILITY
Room	90-110	Room	53-63	Room	175-260		

(a) Permeability at field strength of 100 Oersteds.
(b) Permeability at field strength of 200 Oersteds.
(c) Maximum Permeability.

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

(34)

MATERIAL	Armco Iron--17-7PH					HEAT NUMBER	38489		
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Al	Mn	Si	C	P	S	Fe
	16.93	7.04	1.09	0.65	0.47	0.069	0.021	0.009	Bal
FORM	Cold drawn bar stock.								
HEAT TREATMENT	Cold drawn + 900 F - 1 hour - air cooled.								
REFERENCE	Armco Steel Corporation.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.1	70-400	6.2	70-600	6.4	70-800	6.6

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
Room	83.8						

DENSITY

TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}
Room	0.277						

MAGNETIC PERMEABILITY

TEMP., F	(a) PERME-ABILITY	TEMP., F	(b) PERME-ABILITY	TEMP., F	(c) PERME-ABILITY	TEMP., F	PERME-ABILITY
Room	70	Room	43.5	Room	125		

(a) Permeability at field strength of 100 Oersteds.
(b) Permeability at field strength of 200 Oersteds.
(c) Maximum Permeability.

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

(35)

MATERIAL Armco Iron--17-7PH **HEAT NUMBER** 38489

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Al	Mn	Si	C	P	S	Fe
	16.93	7.04	1.09	0.65	0.47	0.069	0.021	0.009	Bal

FORM Hot rolled and annealed.

HEAT TREATMENT Annealed - 1900 F - 1/2 hour - water quenched.

REFERENCE Armco Steel Corporation.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	8.5	70-400	9.0	70-600	9.5	70-800	9.6

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
Room	81.0						

DENSITY

TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}
Room	0.282						

MAGNETIC PERMEABILITY

TEMP., F	(a) PERME-ABILITY	TEMP., F	(b) PERME-ABILITY	TEMP., F	PERME-ABILITY	TEMP., F	PERME-ABILITY
Room	3.2	Room	3.3				

(a) Permeability at field strength of 100 Oersteds.
(b) Permeability at field strength of 200 Oersteds.

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

(36)

MATERIAL Armco Iron--17-7PH **HEAT NUMBER** 45328

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Al	Mn	Si	C	P	S	Fe
	17.01	7.25	1.30	0.74	0.28	0.071	0.019	0.006	Bal

FORM Annealed sheet stock.

HEAT TREATMENT Condition RH 950-1900 F - 1/2 hour - water quenched + 1750 F - 10 minutes - air cooled + 110 F - 8 hours + 950 F - 1 hour - air cooled.

REFERENCE Armco Steel Corporation.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.2	70-600	6.8	70-800	6.9	70-900	7.0
70-400	6.6						

MAGNETIC PERMEABILITY

TEMP., F	(a) PERME-ABILITY	TEMP., F	(b) PERME-ABILITY	TEMP., F	(c) PERME-ABILITY	TEMP., F	PERME-ABILITY
Room	75-87	Room	44-52	Room	120-134		

(a) Permeability at field strength of 100 Oersteds.
(b) Permeability at field strength of 200 Oersteds.
(c) Maximum Permeability.

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

(37)

MATERIAL Armco Iron--17-7PH **HEAT NUMBER** 53836

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Al	Mn	Si	C	P	S	Fe
	17.45	7.18	1.10	0.71	0.39	0.069	0.021	0.008	Bal

FORM Hot rolled and annealed sheet stock.

HEAT TREATMENT RH 950-1900 F - 1/2 hour - water quenched + 1750 F - 10 min. - air cooled + 110 F - 8 hour - air cooled + 950 F - 1 hour - air cooled.

REFERENCE Armco Steel Corporation.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.2	70-600	6.8	70-500	6.9	70-900	7.0
70-400	6.6						

MAGNETIC PERMEABILITY

TEMP., F	(a) PERME-ABILITY	TEMP., F	(b) PERME-ABILITY	TEMP., F	(c) PERME-ABILITY	TEMP., F	PERME-ABILITY
Room	75-87	Room	44-52	Room	120-134		

(a) Permeability at field strength of 100 Oersteds.
(b) Permeability at field strength of 200 Oersteds.
(c) Maximum Permeability.

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

(38)

MATERIAL	Armco Iron--17-7PH						HEAT NUMBER		
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mn	Si	Al	C	Fe		
	16	6.5	1	1	0.75	0.09	Bal		

FORM	
HEAT TREATMENT	TH-1050 condition.
REFERENCE	General Motors Corporation, Allison Division, G. R. Sippel.
REMARKS	Nominal Composition taken from DMIC Memo 42.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
80-400	6.1	80-600	6.3	80-800	6.6		

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

(39)

MATERIAL	Armco Iron--17-7PH						HEAT NUMBER 34141		
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Al	Mn	Si	C	P	S	Fe
	17.08	7.22	1.25	0.79	0.35	0.068	0.019	0.007	Bal

FORM	Hot rolled and annealed stock.
HEAT TREATMENT	Condition RH 950-1900 F - 1/2 hour - water quenched + 1750 F - 10 minutes - air cooled + 110 F - 8 hours + 950 F - 1 hour - air cooled.
REFERENCE	Armco Steel Corporation.

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
Room	82.6						

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

(40)

MATERIAL	Armco Iron--17-7PH				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Al	Ni	C	Fe				
	7.0	11.25	7.00	0.07	Bal				

FORM	
HEAT TREATMENT	
REFERENCE	Haynes Stellite.
REMARKS	Nominal Composition taken from DMIC Memo 42.

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.276						
Data assumed to be at room temperature.							

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

(41)

MATERIAL	Armco Iron--17-14 Cu-Mo					HEAT NUMBER 046012			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Cu	Mo	Mn	Si	Cb	Ti	C
	16.79	14.19	3.01	2.75	1.26	0.66	0.42	0.28	0.088
	P	S	Fe						
	0.013	0.009	Bal						

FORM	Hot rolled bar stock.
HEAT TREATMENT	2250 F - 1/2 hour - water quenched + 1350 F - 5 hours - water quenched.
REFERENCE	Armco Steel Corporation.
REMARKS	

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
100	8.2	300	9.2	500	10.2	600	10.7
200	8.7	400	9.7				

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.287						

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

(42)

MATERIAL	Iron Alloy--17-14 Cu-Mo					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Cu	Mo	Mn	Si	Cb	Ti	C
	15.9	14.1	3	2.5	0.75	0.50	0.45	0.25	0.12
	Fe								
	Bal								

FORM	
HEAT TREATMENT	
REFERENCE	Armco Steel Corporation.
REMARKS	Nominal Composition taken from DMIC Memo 42.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
100	8.2	300	9.2	500	10.2	600	10.6
200	8.7	400	9.7				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-300	8.23	70-700	9.17	70-1300	9.91	70-1500	10.07
70-500	8.75	70-1000	9.69				

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.287						
Data assumed to be at room temperature.							

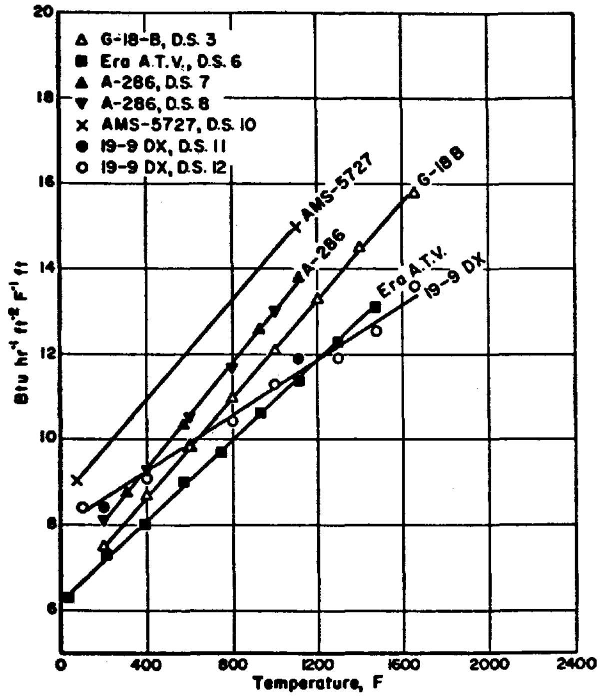
ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

43

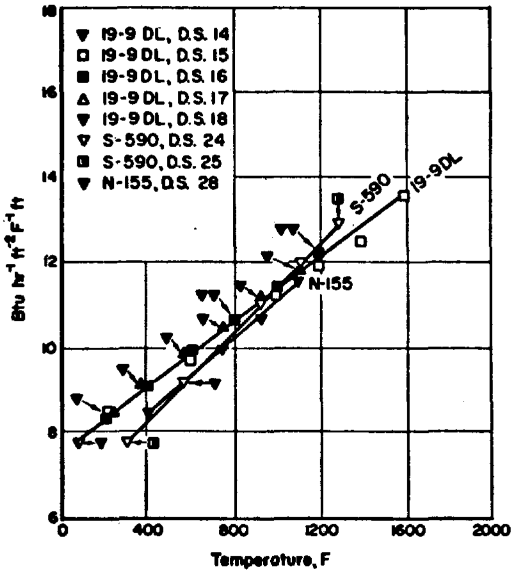
MATERIAL	Armco Iron--17-14PH					HEAT NUMBER 47584			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Cu	Mo	Mn	Cb	Si	Ti	C
	16.22	13.40	3.13	2.33	0.88	0.37	0.32	0.18	0.124
	P	S	Fe						
	0.023	0.007	Bal						
FORM	Hot rolled and bar stock.								
HEAT TREATMENT	2250 F - 1/2 hour - water quenched + 1350 F - 5 hours - water quenched.								
REFERENCE	Armco Steel Corporation.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

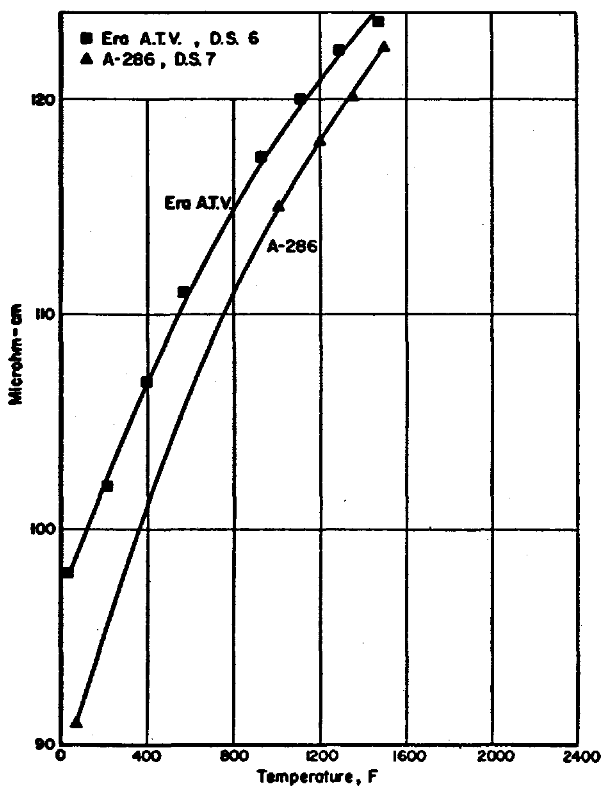
TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-300	8.23	70-700	9.17	70-1100	9.69	70-1500	10.07
70-500	8.75	70-900	9.44	70-1300	9.91		



THERMAL CONDUCTIVITY OF SUPERALLOYS



THERMAL CONDUCTIVITY OF SUPERALLOYS



ELECTRICAL RESISTIVITY OF SUPERALLOYS

(1)

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

MATERIAL Iron Alloy--AF-71 **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT									
	Mn	Cr	Mo	Ni	V	Si	C	N	B
	18	12.5	3	1.0	0.9	max. 0.6	0.25	0.2	0.2
	S	P	Al	Fe					
	max. 0.04	max. 0.04	low	Bal					

FORM

HEAT TREATMENT 2050 F - 1 hr., water quenched + 1300 F - 16 hrs. - air cooled.

REFERENCE All:gheny Ludlum Steel Corporation.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-212	8.46	70-752	9.90	70-1112	10.61	70-1472	11.33
70-392	8.78	70-932	10.40	70-1292	11.00	70-1562	11.40
70-572	9.38						

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
room	0.280						

MAGNETIC PERMEABILITY

HEAT	(a) PERMEABILITY			HEAT	(b) PERMEABILITY		
9X-495	1.002			9X-495	1.001		

(a) Condition 2050 F - 1 hr. - water quenched.
(b) Condition 2050 F - 1 hr. - water quenched + 1400 F - 4 hrs. - air cooled + 1300 F - 16 hr. - air cooled.

(2)

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

MATERIAL Iron Alloy--AF 183 **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT									
	Mn	Cr	Mo	Ni	Si	C	N	S	P
	18	12.5	3	max. 1.0	max. 0.6	0.25	0.2	max. 0.04	max. 0.04
	Al	Fe							
	low	Bal							

FORM

HEAT TREATMENT 19C0 F - 1 hr. water quenched + 1300 F - 16 hr. air cooled.

REFERENCE Allegheny Ludlum Steel Corporation.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-212	8.55	70-752	9.85	70-1112	10.64	70-1472	11.21
70-392	8.83	70-932	10.38	70-1292	11.00	70-1562	11.33
70-572	9.37						

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.281						

Data assumed to be at room temperature.

(3)

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

MATERIAL Iron Alloy **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT									
	Ni	Cr	Co	Cb	W	Mo	Si	Mn	C
	13.4	13.3	10.3	3.38	2.72	1.80	1.13	0.76	0.41
	Fe								
	Bal								

FORM

HEAT TREATMENT

REFERENCE Oliver and Harris, Metallurgia 34 (1946)

REMARKS

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
200	7.5	400	8.7	600	9.8	800	11.0
1000	12.1	1200	13.3	1400	14.5	1650	15.8

Values interpolated from graph.

(4)

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

MATERIAL Iron Alloy--S-497 **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT									
	Fe	Co	Ni	Cr	Cb	Mo	W	Si	C
	33.93	20.61	19.46	13.70	4.15	3.36	3.17	0.38	0.36
	Mn								
	0.3								

FORM

HEAT TREATMENT

REFERENCE U. S. Naval Engineering Experiment Station, Annapolis, Maryland.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	8.2	100-1000	8.5	100-1600	9.2		

(5)

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

MATERIAL Iron Alloy--S-495 **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT									
	Ni	Cr	Mo	Cb	W	Mn	C	Si	Fe
	19.71	13.92	4.28	4.2	3.87	0.68	0.41	0.34	Bal

FORM

HEAT TREATMENT

REFERENCE U. S. Naval Engineering Experiment Station, Annapolis, Maryland.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	8.6	100-1000	8.9	100-1600	9.4		

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

6

MATERIAL	Iron Alloy--Era A.T.V. Steel				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Ni	Cr	W	Si	Mn	C	P	S	Fe
	26.86	15.20	2.77	1.30	1.18	0.46	0.018	0.014	Bal
FORM									
HEAT TREATMENT	Forged steel.								
REFERENCE	Powell, R. W., "The Thermal and Electrical Conductivities of Metals and Alloys: Part 2, Some Heat-Resistant Alloys From 0 - 800 C", Proc. of the Physical Society, Vol 48 (1936) pp. 381.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
32	6.3	212	7.3	392	8.0	572	9.0
752	9.7	932	10.6	1112	11.4	1292	12.3
1472	13.1						
Method: comparative.							

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
32	(98.0)	212	102.7	392	106.9	572	111.0
752	114.2	932	117.3	1112	120.1	1292	122.2
1472	(123.6)						
Method: Voltage drop.							

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

7

MATERIAL	Iron Alloy--A 286				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Ni	Cr	Ti	Mn	Mo	Si	V	Al	C
	26.06	15.52	1.95	1.35	1.25	0.95	0.32	0.20	0.045
	P	S	Fe						
	0.021	0.018	Bal						
FORM	Rolled or forged from 200 F to 2150 F.								
HEAT TREATMENT	Solution: 1800 F - p hour - oil quench; Aged: 1325 F - 16 hours-air.								
REFERENCE	Allegheny Ludlum Steel Corporation.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
302	8.7	572	10.3	932	12.6	1112	13.8

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	9.17	70-800	9.64	70-1100	9.84	70-1300	9.94
70-400	9.35	70-1000	9.78	70-1200	9.88	70-1400	10.32
70-600	9.45						

SPECIFIC HEAT

TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1
79-304	0.10	82-577	0.11	86-1004	0.11	104-1299	0.11

ELECTRICAL RESISTIVITY

TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM	TEMP., F	MICROHM-CM
77	91.0	1004	115.6	1202	118.8	1348	120.1
1499	122.4						

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.286						
Data assumed to be at room temperature.							

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

8

MATERIAL	Iron Alloy--A 286				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Ni	Cr	Ti	Mn	Mo	Si	Va	Al	C
	24.0-28.0	13.50-16.00	1.75-2.25	1.0-2.0	1.0-1.5	0.40-1.00	0.10-0.50	max. 0.35	max. 0.08
	S	P	Fe						
	max. 0.04	max. 0.04	Bal						
FORM									
HEAT TREATMENT	.								
REFERENCE	Materials Data Book No. 1, General Electric Company.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
200	8.1	600	10.5	800	11.7	1000	13.0
400	9.3						
Values interpolated from graph.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
200	8.25	600	8.95	1000	9.62	1400	10.27
400	8.60	800	9.27	1200	9.95	1600	10.60
Values interpolated from graph and assumed to be instantaneous coefficients.							

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

9

MATERIAL	Iron Alloy--A 286				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Ni	Cr	Ti	Mn	Mo	Si	V	B	Fe
	26.0	15.0	2.1	1.5	1.3	0.7	0.3	0.005	Bal
FORM									
HEAT TREATMENT									
REFERENCE	"Report on Materials for Use at Liquid Hydrogen Temperature", Prepared for the 63rd Annual Meeting of the American Society for Testing Materials.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
78-(-104)	7.9	78-(-320)	7.3	78-(-410)	6.6		

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

(10)

MATERIAL Iron Alloy--AMS 5727 **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT	Ni	Cr	Mo	Mn	Si	N	C	P	S
	24.00-27.00	15.00-17.00	5.50-7.00	max. 2.0	max. 1.00	0.10-0.20	max. 0.08	max. 0.030	max. 0.030
	Fe								
	Bal								

FORM

HEAT TREATMENT Final working at 1200-1300 F, cooling 1200 F.

REFERENCE Timken Roller Bearing Company.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
Room	9	1100	15				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-600	9.0	70-1200	10.2	70-1600	11.7	70-2000	12.4
70-800	9.4	70-1400	10.8	70-1800	12.0	70-2200	13.0
70-1000	9.6						

SPECIFIC HEAT

TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}
room	0.105						

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
room	0.291						

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

(11)

MATERIAL Iron Alloy--Uniloy 19-9 DX **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	W	Mn	Ti	Si	C	Fe
	18.50	9.00	1.60	1.35	1.15	0.55	0.55	0.32	Bal

FORM

HEAT TREATMENT

REFERENCE Universal Cyclops Steel Corporation.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
212	8.4	1112	11.9				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-500	9.20	70-1000	9.78	70-1200	9.97	70-1500	10.01
70-800	9.59						

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

(12)

MATERIAL Iron Alloy--19-9 DX **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	W	Mn	Ti	Si	C	Fe
	19.25	9	1.50	1.25	1.15	0.60	0.55	0.30	Bal

FORM

HEAT TREATMENT

REFERENCE Levy, A., "Performance of Materials at Elevated Temperatures for Aircraft and Missiles", Marquardt Aircraft Co., MP-595.

REMARKS Nominal Composition taken from DMIC 42.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
100	8.4	600	9.8	1000	11.3	1472	12.5
400	9.1	800	10.4	1292	11.9	1650	13.6

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

(13)

MATERIAL Iron Alloy--19-9 W-Mo **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT	Cr	Ni	W	Si	Mn	Cb	Mo	Ti	C
	18.94	8.35	1.31	0.75	0.65	0.44	0.38	0.22	0.13
	Fe								
	Bal								

FORM

HEAT TREATMENT

REFERENCE U. S. Naval Engineering Experiment Station, Annapolis Maryland.

REMARKS Nominal Composition taken from DMIC Memo 42.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	9.2	100-1000	9.7	100-1600	10.7		

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

(14)

MATERIAL Iron Alloy--19-9 DL **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	W	Mn	Si	Cb+Ta	C	Ti
	18.50	9.00	1.40	1.35	1.15	0.55	0.40	0.32	0.25
	Fe								
	Bal								

FORM

HEAT TREATMENT

REFERENCE Universal Cyclops Steel Corporation.

REMARKS Melting range: approximately 2590-2615.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
70	7.8	800	10.7	1200	12.2		

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	8.5	70-600	9.3	70-1000	9.8	70-1500	10.0

SPECIFIC HEAT

TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}
32-212	0.10						

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
68	78						

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.287						

Data assumed to be at room temperature.

MAGNETIC PERMEABILITY

CONDITION	PERME-ABILITY
Hot rolled + 1800 F - air cooled	1.0046
Hot rolled + 1800 F - air cooled + 1500 F, 4 hours	1.018
Hot rolled + 1800 F - air cooled + 1500 F, 8 hours	1.014
Hot rolled + 1800 F - water quenched	1.030
Hot rolled + 1800 F - water quenched + 1500 F, 4 hours	1.014
Hot rolled + 1200 F - air cooled	1.090

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (15)

MATERIAL Iron Alloy--19-9 DL **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	W	Mn	Si	Ti	C	Fe
	19.25	9	1.25	1.25	1.15	0.55	0.30	0.30	Bal

FORM

HEAT TREATMENT

REFERENCE Materials and Methods Manual No. 115, "Metals for Short Time Service at High Temperatures", by A. Levy (April, 1955).

REMARKS Melting Point: 2600 F.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
200	8.4	1000	11.2	1400	12.5	1600	13.6
600	9.7	1200	11.9				

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-212	8.2	70-1000	9.5	70-1600	10.2	70-2000	11.0 *
70-600	8.7	70-1200	9.7	70-1800	10.5 *		

* Extrapolated values.

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.287						

Data assumed to be at room temperature.

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (16)

MATERIAL Iron Alloy--19-9 DL **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	W	Mn	Si	Ti	C	Fe
	19.25	9	1.25	1.25	1.15	0.55	0.30	0.30	Bal

FORM

HEAT TREATMENT

REFERENCE Materials Data Book No. 1, General Electric Company.

REMARKS Nominal Composition taken from DMIC Memo 42.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
200	8.3	600	9.9	1000	11.4	1200	12.2
400	9.1	800	10.7				

Values interpolated from graph.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
200	8.4	600	9.2	1000	9.8	1400	10.2
400	8.8	800	9.5	1200	9.9		

Values interpolated from graph and assumed to be instantaneous coefficients.

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (17)

MATERIAL Iron Alloy--19-9 DL **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	W	Mn	Si	Ti	C	Fe
	19.25	9	1.25	1.25	1.15	0.55	0.30	0.30	Bal

FORM

HEAT TREATMENT

REFERENCE Levy, A., "Performance of Materials at Elevated Temperatures for Aircraft and Missiles", Marquardt Aircraft Co., MP-595.

REMARKS Nominal Composition taken from DMIC Memo 42.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
212	8.4	572	9.8	932	11.2	1112	11.9
392	9.1	752	10.5				

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

(18)

MATERIAL	Iron Alloy--19-9 DL				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	W	Mn	Si	Ti	C	Fe
	19.25	9	1.25	1.25	1.15	0.55	0.30	0.30	Bal
FORM									
HEAT TREATMENT									
REFERENCE	Universal Cyclops Steel Corporation.								
REMARKS	Melting point: 2590-2615 F.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
70	7.8	572	9.8	800	10.7	1112	11.9
212	8.4	752	10.5	932	11.2	1200	12.2

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

(19)

MATERIAL	Iron Alloy--19-9 DL				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	W	Mn	Si	Ti	C	Fe
	19.25	9	1.25	1.25	1.15	0.55	0.30	0.30	Bal
FORM									
HEAT TREATMENT									
REFERENCE	General Motors Corporation, Allison Division.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
80-200	8.52	80-600	9.31	80-1000	9.78	80-1500	10.01
80-400	9.11	80-800	9.57	80-1200	9.97		

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

(20)

MATERIAL	Iron Alloy--19-9 DL				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	W	Mo	Mn	Si	Cb	C	Ti
	18.72	9.12	1.33	1.18	0.90	0.70	0.35	0.3	0.25
	Co	Fe							
	0.10	Bal							
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Naval Engineering Experiment Station.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	9.3	100-1000	10.0	100-1600	10.6		

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

(21)

MATERIAL	Iron Alloy--19-9 DL				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	W	Mn	Si	Cb	C	Ti
	19.32	9.29	1.30	1.21	0.95	0.77	0.71	0.36	0.05
	Fe								
	Bal								
FORM	Cast								
HEAT TREATMENT									
REFERENCE	U. S. Naval Engineering Experiment Station.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	9.4	100-1000	9.9	100-1600	10.2		

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

(22)

MATERIAL	Iron Alloy--19-9 DL				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	W	Mn	Si	Cb	C	Ti
	19.86	9.53	1.38	1.24	1.21	0.96	0.71	0.35	0.09
	Fe								
	Bal								
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Naval Engineering Experiment Station.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	9.3	100-1000	9.9	100-1600	10.3		

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

(23)

MATERIAL	Iron Alloy--19-9 DL				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	W	Mn	Si	Ti	C	Fe
	19.25	9	1.25	1.25	1.15	0.55	0.30	0.30	Bal
FORM									
HEAT TREATMENT									
REFERENCE	Haynes Stellite.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.287						
Data assumed to be at room temperature.							

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

(24)

MATERIAL	Iron Alloy--S-590					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Co	Ni	Cb	W	Mo	Mn	C	Si
	20.32	20.20	19.65	4.43	4.06	3.68	1.31	0.44	0.4
	Fe								
	Bal								
FORM									
HEAT TREATMENT	Solution 2150-2250 F - 1 hour - water quenched - age - 1400 F - 16 hours - air.								
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Melting Range: 2400-2500 F.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
302	7.8	932	11.1	1112	12.0	1292	12.9
572	9.2						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-212	8.03	70-752	8.22	70-1292	8.86	70-1652	9.29
70-392	7.92	70-932	8.44	70-1472	9.10	70-1832	9.59
70-572	8.07	70-1112	8.58				

SPECIFIC HEAT

TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}
77-572	0.10	77-932	0.10	77-1292	0.11		

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
room	0.301						

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

(25)

MATERIAL	Iron Alloy--S-590	AMS 5533			HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Fe	Cr	Ni	Co	Mo	W	Cb	Mn	C
	24	20.5	20	20	4	4	4	1.25	0.43
	Si								
	0.5								
FORM									
HEAT TREATMENT									
REFERENCE	Alloy Digest.								
REMARKS	Nominal Composition taken from DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
300	7.8	1292	12.9				

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

(26)

MATERIAL	Iron Alloy--S-590					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Ni	Cr	Co	W	Cb	Mo	Mn	C	Si
	19.78	19.5	19.35	4.15	4.04	3.95	0.6	0.49	0.21
	Fe								
	Bal								
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Naval Engineering Experiment Station, Annapolis, Maryland.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	8.1	100-1000	8.4	100-1600	9.1		

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

(27)

MATERIAL	Iron Alloy--N 155					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Co	Mo	W	Mn	Cb+Ta	Si	N_2
	20.75	19.85	19.50	2.95	2.35	1.50	1.15	0.70	0.13
	C	Fe							
	0.010	Bal							
FORM									
HEAT TREATMENT									
REFERENCE	Universal Cyclops Steel Corporation.								
REMARKS	Melting point: 2325-2475 F.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-600	8.7	70-1000	9.1	70-1200	9.4	70-1500	9.8

SPECIFIC HEAT

TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}
70-212	0.103						

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
Room	94.5						

Data assumed to be at room temperature.

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.300						

Data assumed to be at room temperature.

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

(28)

MATERIAL: Iron Alloy--Multimet N-155 — HEAT NUMBER:

CHEMICAL COMPOSITION PER CENT

Cr	Ni	Co	Mo	W	Mn	Cb+Ta	C	N
21.5	20.0	20.0	3.0	2.5	1.5	1.0	max. 0.20	0.15
Fe								
Bal								

FORM: Cast

HEAT TREATMENT:

REFERENCE: Haynes Stellite Company.

REMARKS:

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
392	8.4	752	10.0	932	10.7	1112	11.6
572	9.2						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6
70-600	8.70	70-1000	9.10	70-1200	9.40	70-1500	9.77

SPECIFIC HEAT

TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}
Room	0.1040*						

* Calculated

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
Room	93.0						

Data assumed to be at room temperature.

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.296						

Data assumed to be at room temperature.

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

(29)

MATERIAL: Iron Alloy--N 155 — HEAT NUMBER:

CHEMICAL COMPOSITION PER CENT

Cr	Ni	Co	Mo	V	Cb	C	Fe	
20.0	20.0	20.0	3.25	2.5	1.1	0.2	Bal	

FORM:

HEAT TREATMENT:

REFERENCE:

REMARKS: Jerry E. Evans, Jr., "Thermal Conductivity of 14 Metals and Alloys Up to 1100 F", Lewis Flight Propulsion Laboratory, NASA Research Memorandum RM E 50L07, March, 1951.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
260	9.75	500	11.25	800	12.9	1000	13.8
300	10.05	600	11.8	900	13.35	1075	14.2
400	10.6	700	12.3				

Interpolated data taken from a best curve.

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

(30)

MATERIAL: Iron Alloy--N 155 — HEAT NUMBER:

CHEMICAL COMPOSITION PER CENT

Cr	Co	Ni	W	Mo	Mn	Cb	C	Fe
20.68	20.18	18.9	2.15	2.08	1.43	0.90	0.14	Bal

FORM:

HEAT TREATMENT:

REFERENCE: U. S. Naval Engineering Experiment Station.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6
100-500	8.4	100-1000	9.0	100-1600	9.7		

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

(31)

MATERIAL: Iron Alloy--N 155 — HEAT NUMBER:

CHEMICAL COMPOSITION PER CENT

Cr	Co	Ni	W	Mn	Cb	Si	C	N
21.06	20.25	19.79	1.68	1.65	1.13	0.50	0.16	0.08
Fe								
Bal								

FORM:

HEAT TREATMENT:

REFERENCE: U. S. Naval Engineering Experiment Station.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6
100-500	8.2	100-1000	8.8	100-1600	9.5		

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

(32)

MATERIAL: Iron Alloy--N 155 — HEAT NUMBER:

CHEMICAL COMPOSITION PER CENT

Ni	Cr	Co	Mo	W	Mn	Cb	Si	C
21.23	20.84	20.63	4.05	2.68	1.26	1.05	0.54	0.22
Fe								
Bal								

FORM:

HEAT TREATMENT: 2200 F - water cooled, 1500 F - held 4 hours.

REFERENCE: U. S. Naval Engineering Experiment Station.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6	TEMP RANGE, F	F^{-1} x 10^6
100-500	8.6	100-1000	9.0	100-1600	9.7		

(33)

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

MATERIAL Iron Alloy--N 155 **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Cr	Co	Ni	Mo	W	Mn	Cb	Si	C
21.66	20.48	19.4	2.76	1.9	1.74	0.79	0.37	0.15
N	Fe							
0.14	Bal							

FORM

HEAT TREATMENT

REFERENCE U. S. Naval Engineering Experiment Station.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	8.8	100-1000	9.1	100-1600	9.8		

(34)

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

MATERIAL Iron Alloy--N 155 **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Cr	Ni	Co	Si	C	Mo	W	Mn	Cb
21.0	20.0	20.0	6.5	6.15	3.0	2.5	1.5	1.0
N	Fe							
0.15	Bal							

FORM

HEAT TREATMENT

REFERENCE Materials Data Book No. 1, General Electric Company.

REMARKS Nominal Composition taken from DMIC Memo 42.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
600	9.35	1000	10.25	1200	10.80	1400	11.18
800	9.80						

Values interpolated from graph and assumed to be instantaneous coefficients.

(35)

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

MATERIAL Iron Alloy--Miltimet N-155 **HEAT NUMBER**

CHEMICAL COMPOSITION PER CENT

Cr	Co	Ni	Mo	W	Mn	Cb	C	Fe
20	20	20	3.0	2.5	1.5	1.0	0.12	Bal

FORM

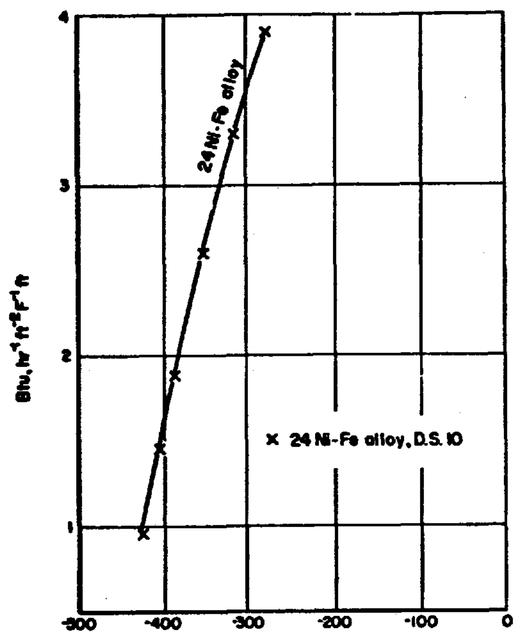
HEAT TREATMENT

REFERENCE "Report on Materials for Use at Liquid Hydrogen Temperature", Prepared for the 63rd Anneal Meeting of the American Society for Testing Materials.

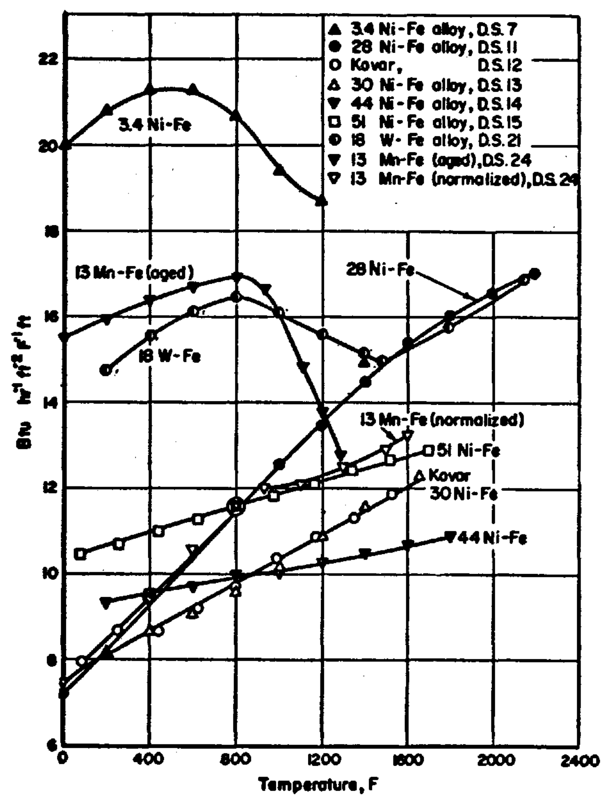
REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
78-(-104)	7.1	78-(-320)	6.5	78-(-410)	6.0		



THERMAL CONDUCTIVITY OF IRON ALLOYS



THERMAL CONDUCTIVITY OF IRON ALLOYS

1

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

MATERIAL: Iron Alloy — HEAT NUMBER:

CHEMICAL COMPOSITION PER CENT	Cr	Al	Mo	Fe
	1	1	0.20	Bal

FORM:
HEAT TREATMENT:
REFERENCE: U. S. Steel.
REMARKS:

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.5	70-600	7.4	70-1000	7.7	70-1200	
70-400	7.1	70-800	7.6				

2

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

MATERIAL: Iron Alloy — HEAT NUMBER:

CHEMICAL COMPOSITION PER CENT	Cr	Ni	C	Fe
	20	3	0.05	Bal

FORM:
HEAT TREATMENT:
REFERENCE: U. S. Steel.
REMARKS:

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	5.5	70-600	5.9	70-1000	6.3	70-1200	6.4
70-400	5.7	70-800	6.1				

3

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

MATERIAL: Iron Alloy — HEAT NUMBER:

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Fe
	22	2	Bal

FORM:
HEAT TREATMENT:
REFERENCE: U. S. Steel.
REMARKS:

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	5.5	70-600	5.9	70-1000	6.3	70-1200	6.4
70-400	5.7	70-800	6.1				

4

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

MATERIAL: Iron Alloy — HEAT NUMBER:

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Fe
	25	20	Bal

FORM:
HEAT TREATMENT:
REFERENCE: U. S. Steel.
REMARKS:

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	7.7	70-600	8.4	70-1000	8.9	70-1200	9.1
70-400	8.1	70-800	8.7				

5

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

MATERIAL: Iron Alloy — HEAT NUMBER:

CHEMICAL COMPOSITION PER CENT	Cr	Ni	Si	Fe
	30	10	1.5	Bal

FORM:
HEAT TREATMENT:
REFERENCE: U. S. Steel.
REMARKS:

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	8.0	70-600	8.7	70-1000	9.3	70-1200	9.6
70-400	8.4	70-800	9.0				

6

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

MATERIAL: Iron Alloy — HEAT NUMBER:

CHEMICAL COMPOSITION PER CENT	Ni	Fe
	2.25	Bal

FORM:
HEAT TREATMENT:
REFERENCE: U. S. Steel.
REMARKS:

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.4	70-600	7.1	70-1000	7.7	70-1200	8.0
70-400	6.7	70-800	7.4				

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

(7)

MATERIAL	Iron Alloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Ni	Cr	Mn	C	Si	Mo	Cu	S	P
	3.38	0.8	0.53	0.33	0.17	0.07	0.053	0.033	0.031
	As	V	Al	Fe					
	0.028	0.01	0.006	Bal					
FORM									
HEAT TREATMENT	Annealed at 860 C.								
REFERENCE	Powell, R. W., "The Physical Properties of a Series of Steels. Section IIId. Notes on the Estimation of Thermal Conductivity of Steels", Journal of the Iron and Steel Institute, 154 (1946) p. 116.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
0	20.0	400	21.3	800	20.7	1200	18.7
200	20.8	600	21.3	1000	19.4	1400	15.0
Values interpolated from graph.							

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

(8)

MATERIAL	Iron Alloy--Cyclops 17-A				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Ni	Cr	Si	Mn	C	Fe			
	20.00	8.00	1.10	0.65	0.40	Bal			
FORM									
HEAT TREATMENT									
REFERENCE	Universal Cyclops Steel Corporation.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
100	11.3						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-572	9.33	572-1112	10.00	1112-1652	11.11		

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

(9)

MATERIAL	Iron Alloy--Cyclops 17-B				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Ni	Cr	Si	Mn	C	Fe			
	20.00	8.00	1.10	0.65	0.40	Bal			
FORM									
HEAT TREATMENT									
REFERENCE	Universal Cyclops Steel Corporation.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
Room	13.2						
Data is assumed to be at room temperature.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-212	10.0	68-1472	10.5				

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

(10)

MATERIAL	Iron Alloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Ni	Mn	C	Fe					
	24.30	6.05	1.18	Bal					
FORM									
HEAT TREATMENT	Heated to 1050 C and water quenched.								
REFERENCE	deNobel, J., Physica, 17, (1959) pp. 551-562; As found in "A Compendium of the Properties of Materials at Low Temperatures, Phase I", Part II, edited by Victor J. Johnson, NBS Cryogenic Engineering Laboratory, Boulder, Colorado (December, 1959).								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
-424	0.95	-388	1.88	-316	3.3	-280	3.9
-406	1.44	-352	2.6				
Values interpolated from graph.							

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

(11)

MATERIAL	Iron Alloy				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Ni	Mn	C	Si	Cu	As	Al	P	S
	28.37	0.89	0.28	0.15	0.03	0.027	0.012	0.009	0.003
	Cr	Fe							
	Trace	Bal							
FORM									
HEAT TREATMENT	Quenched at 950 C.								
REFERENCE	Powell, R. W., "The Physical Properties of a Series of Steels. Section IIId. Notes on the Estimation of Thermal Conductivity of Steels", Journal of the Iron and Steel Institute, 154, (1946) p. 116.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
0	7.26	600	10.4	1200	13.5	1800	16.0
200	8.22	800	11.5	1400	14.5	2000	16.6
400	9.43	1000	12.6	1600	15.4	2192	17.0

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

(12)

MATERIAL	Iron Alloy--Kovar				HEAT NUMBER				
CHEMICAL COMPOSITION PER CENT	Fe	Ni	Co	Mn	C				
	55.8	28.75	17.15	0.47	0.017				
FORM									
HEAT TREATMENT									
REFERENCE	Silverman, L, "Thermal Conductivity Data Presented for Various Metals and Alloys up to 900 C", Journal of Metals, 5, pp. 631-2; As found in WADC Technical Report 58-476, "Thermophysical Properties of Solid Materials".								
REMARKS	Test method: Comparative; rods.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
81	8.0	621	9.2	981	10.4	1341	11.4
261	8.7	801	9.7	1161	10.9	1521	11.9
441	8.7						

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

(13)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Ni	Co	Mn	C	Fe				
	29.75	17.15	0.47	0.017	Bal				
FORM									
HEAT TREATMENT	Annealed at 900 C.								
REFERENCE	Silverman, L., "Thermal Conductivity Data Presented for Various Metals and Alloys Up to 900 C", Journal of Metals, 5 (May, 1953) p. 631.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	8.22	600	9.14	1000	10.2	1400	11.6
400	8.71	800	9.68	1200	10.9	1650	12.3
Values interpolated from graph.							

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

(14)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Ni	Mn	C	S	Fe				
	43.91	0.22	0.05	0.003	Bal				
FORM									
HEAT TREATMENT									
REFERENCE	Silverman, L., "Thermal Conductivity Data Presented for Various Metals and Alloys Up to 900 C", Journal of Metals, 5 (May 1953) p. 631.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	9.31	800	9.92	1200	10.3	1600	10.8
400	9.56	1000	10.1	1400	10.5	1800	10.9
600	9.68						
Values interpolated from graph.							

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

(15)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Ni	Fe	Mn	C	S				
	50.85	48.5	0.12	0.024	0.003				
FORM									
HEAT TREATMENT									
REFERENCE	WADC Technical Report 58-476, "Thermophysical Properties of Solid Materials.								
REMARKS									

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
81	10.5	621	11.3	1161	12.2	1521	12.7
261	10.7	801	11.6	1341	12.5	1701	12.9
441	11.0	981	11.9				

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

(16)

MATERIAL	Iron Alloy--Motung 652						HEAT NUMBER		
CHEMICAL COMPOSITION PER CENT	W	Mo	Cr	V	C	Mn	Si	Fe	
	6.0	5.0	4.0	1.9	0.83	0.3	0.3	Bal	
FORM									
HEAT TREATMENT									
REFERENCE	Universal Cyclops Steel Corporation.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	5.16	100-1000	6.59	100-1500	6.88		
100-800	6.16	100-1200	6.78				

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
room	0.294						
Data assumed to be at room temperature.							

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

(17)

MATERIAL	Iron Alloy--Super Motung						HEAT NUMBER		
CHEMICAL COMPOSITION PER CENT	Mo	Co	Cr	W	V	C	Mn	Si	Fe
	8.25	5.0	4.0	1.5	1.25	0.82	0.3	0.3	Bal
FORM									
HEAT TREATMENT									
REFERENCE	Universal Cyclops Steel Corporation.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	5.62	100-1000	6.46	100-1200	6.80	100-1500	6.87
100-800	6.22						

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
room	0.289						
Data assumed to be at room temperature.							

(18)

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

MATERIAL: Iron Alloy--[illegible] HEAT NUMBER

CHEMICAL COMPOSITION PER CENT

Mo	Cr	W	V	C	Mn	Si	Fe
8.5	4.0	1.5	1.15	0.8	0.3	0.3	Bal

FORM

HEAT TREATMENT

REFERENCE: Universal Cyclops Corporation.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	5.61	100-[illegible]	6.66	100-1200	6.86	100-1500	7.07
100-800	6.32						

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
room	0.289						

Data assumed to be at room temperature.

(19)

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

MATERIAL: Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT

W *	Fe
4	Bal

* W in solution.

FORM

HEAT TREATMENT

REFERENCE: U. S. Steel.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	5.6	70-[illegible]	6.6	70-1000	7.4	70-1200	7.7
70-400	6.0	70-[illegible]	7.0				

(20)

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

MATERIAL: Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT

W*	Fe
4	Bal

* W as Carbide.

FORM

HEAT TREATMENT

REFERENCE: U. S. Steel.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	5.3	70-[illegible]	7.0	70-1000	7.8	70-1200	8.2
70-400	6.5	70-[illegible]	7.4				

(21)

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

MATERIAL: Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT

W	Cr	V	C	Si	Mn	Ni	Cu	Al
18.45	4.26	1.075	0.715	0.30	0.25	0.07	0.064	0.04
As	S	P	Mo	Fe				
0.035	0.028	0.018	Trace	Bal				

FORM

HEAT TREATMENT: Annealed at 830 C.

REFERENCE: Powell, R. W., "The Physical Properties of a Series of Steels, Section 111d, Notes on the Estimation of Thermal Conductivity of Steel", Journal of the Iron and Steel Institute, 154 (1946) p. 116.

REMARKS

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
200	14.76	800	16.45	1400	15.19	1800	15.84
400	15.72	1000	16.09	1472	15.00	2150	16.91
600	16.21	1200	15.72				

Values interpolated from graph.

(22)

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

MATERIAL: Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT

Cu	Fe
1	Bal

FORM

HEAT TREATMENT

REFERENCE: U. S. Steel.

REMARKS

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.2	70-600	7.2	70-1000	7.9	70-1200	8.2
70-400	6.8	70-800	7.6				

(23)

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

MATERIAL: Iron Alloy HEAT NUMBER

CHEMICAL COMPOSITION PER CENT

Mn	Fe
1.25	Bal

FORM

HEAT TREATMENT

REFERENCE: U. S. Steel.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.3	70-600	7.3	70-1000	8.0	70-1200	8.3
70-400	6.9	70-800	7.7				

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (24)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Mn	C	Si	Ni	Cu	P	As	Cr	S
	13.0	1.22	0.22	0.07	0.07	0.038	0.038	0.03	0.01
	Al	Fe							
	0.004	Bal							
FORM									
HEAT TREATMENT									
REFERENCE	Powell, R. W., "The Physical Properties of a Series of Steels, Section 111b, Effect of Heat Treatment on Electrical Resistivity and Thermal Conductivity of 13% Mn. Steel", Journal of the Iron and Steel Institute 154 (1946) p. 105.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
0	7.50	600	10.6	1100	12.1	1500	12.9
200	8.35	800	11.5	1300	12.5	1598	13.3
400	9.43	932	12.0				
Values interpolated from graph. Normalized 1050 C.							

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
0	15.48	600	16.69	932	16.69	1202	13.79
200	15.97	800	16.93	1112	14.88	1292	12.82
400	16.40						
Values interpolated from graph. Aged at 450 C for 102 days.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (25)

MATERIAL	Iron Alloy					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Si	Fe							
	4.25	Bal							
FORM									
HEAT TREATMENT									
REFERENCE	U. S. Steel.								
REMARKS									

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-200	6.2	70-600	7.0	70-1000	7.6	70-1200	7.8
70-400	6.6	70-800	7.3				