ALUMINUM •STAINLESS STEEL • AEROSPACE ALLOYS

ASA ALLOYS

DIVISIONS OF CANADIAN SPECIALTY METALS, ULC

MAGNA STAINLESS

CANADIAN DISTRIBUTOR OF SPECIALTY METAL PRODUCTS

HEAT RESISTANT, CORROSION RESISTANT, WEAR RESISTANT

CERTIFIED ISO 9001:2008
&
AS9120A

www.asaalloys.com

INTRODUCTION

Thank you for taking the time to read about ASA Alloys. We hope this Reference Guide will help us better serve you. This guide outlines products, grades, shapes, weights and standard lengths.

ASA Alloys has enjoyed over 30 years of growth - growth which can only be obtained by offering Quality-

- ***Service***
- ***Product***
- ***Delivery***
- ***Sales Representatives***

MISSION STATEMENT

We the employees of ASA Alloys are committed to quality and excellence in everything we do.

Our first responsibility is to the people who purchase and use our products and services. We are dedicated to providing them with superior quality, service and value, striving to exceed our customers expectations in a manner which promotes their respect and loyalty.

Quality, as defined by our customers, is our primary objective. Continuous quality improvement principles will be employed to enhance this objective.

SOURCING

If you are currently purchasing hard to find alloys, sizes or shapes that are not listed in our Reference Guide let our experienced Customer Sales Force Group locate your requirements with our extensive sourcing knowledge.

SERVICES

- Stock items delivered the next day.
- Material cut to your tolerance and to meet your delivery requirements.
- Automatic saw cutting up to 23" bar.
- Polishing (180 grit or #4)
- Centreless grinding to your specifications.

STAINLESS STEEL BAR SIZES AND WEIGHT TABLES

STAINLESS STEEL ALLOY GENERAL INFORMATION

HEAT RESISTANT ALLOYS GENERAL INFORMATION

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STAINLESS ROUNDS

TYPES: 303, 304, 304L, 316, 316L, 17-4 PH, 416, 410, 431 420, 431

- Annealed & centreless ground, peeled or smooth turned.
- Available in a wide selection of lengths and grades.
- 316/316L Available in pump shaft quality.

Sizes in Stock

Size in Inches	Est. Wt. per Ft. in Lbs	Size in Inches	Est. Wt. per Ft. in Lbs
1/16	0.010	2 9/16	17.540
5/64	0.016	2 5/8	18.400
3/32	0.024	2 11/16	19.290
1/8	0.042	2 3/4	20.190
5/32	0.065	2 7/8	22.070
3/16	0.094	2 15/16	23.040
7/32	0.128	3	24.030
1/4	0.167	3 1/8	26.080
9/32	0.214	3 1/4	28.210
5/16	0.261	3 3/8	30.420
3/8	0.376	3 1/2	32.710
7/16	0.511	3 5/8	35.090
1/2	0.668	3 3/4	37.550
9/16	0.845	3 7/8	40.010
5/8	1.040	4	42.730
11/16	1.260	4 1/4	48.230
3/4	1.510	4 3/8	51.110
13/16	1.760	4 1/2	54.080
7/8	2.050	4 5/8	57.121
15/16	2.350	4 3/4	60.250
1	2.670	4 7/8	63.460
1 1/16	3.020	5	66.760
1 1/8	3.380	5 1/4	73.600
1 3/16	3.770	5 1/2	80.770
1 1/4	4.170	5 5/8	84.490
1 5/16	4.600	5 3/4	88.290
1 3/8	5.050	6	96.130
1 7/16	5,520	6 1/16	98.150
1 1/2	6.010	6 1/4	104.30
1 9/16	6.520	6 1/2	112.80
1 5/8	7.050	6 3/4	121.70
1 11/16	7.600	7	130.90
1 3/4	8.180	7 1/4	140.40
1 13/16	8.770	7 1/2	150.20
1 7/8	9.390	7 3/4	160.40
1 15/16	10.020	8	170.90
2	10.680	8 1/2	192.90
2 1/16	11.360	9	216.30
2 1/8	12.060	10	267.00
2 3/16	12.790	12	384.50
2 1/4	13.520	12 1/2	437.50
2 5/16	14.280	13	453.20
2 3/8	15.060	14	523.40
2 7/16	15.870	16	684.00
2 1/2	16.690	18	865.00
		20	1079.61

Threaded bars, threaded right or left hand to any desired length are available on order.

STAINLESS FLATS

TYPES: 304, 304L, 316, 316L

- Stock Lengths: 10’ to 20’
- Available in a wide selection of lengths and grades.

Sizes in Stock

Size in Inches	Est. Wt. per Ft. in Lbs	Size in Inches	Est. Wt. per Ft. in Lbs
1/8 x 1/2	0.213	1/2 x 1 1/2	2.55
3/4	0.319	2	3.40
1	0.425	2 1/2	4.25
1 1/4	0.531	3	5.10
1 1/2	0.638	4	6.80
1 3/4	0.744	6	10.20
2	0.850	5/8 x 3/4	1.59
2 1/2	1.060	1	2.13
3	1.280	1 1/4	2.66
4	1.700	1 1/2	3.19
3/16 x 1/2	0.319	1 3/4	3.72
5/8	0.398	2	4.25
3/4	0.478	2 1/2	5.31
1	0.638	3	6.38
1 1/4	0.797	3 1/2	7.44
1 1/2	0.956	4	8.50
1 3/4	1.120	5	10.63
2	1.280	6	12.75
2 1/2	1.590	3/4 x 1	2.55
3	1.910	1 1/4	3.19
4	2.550	1 1/2	3.83
1/4 x 1/2	0.425	1 3/4	4.46
3/4	0.638	2	5.10
1	0.850	2 1/2	6.38
1 1/4	1.060	3	7.65
1 1/2	1.280	3 1/2	8.93
1 3/4	1.490	1 x 2	6.80
2	1.700	2 1/4	7.65
2 1/2	2.130	2 1/2	8.50
3	2.150	3	10.20
3 1/2	2.970	3 1/2	11.90
4	3.400	4	13.60
5	4.250	5	17.00
6	5.100	6	20.40
5/16 x 1	1.060	8	27.20
3/8 x 3/4	0.956	1 1/4 x 2	8.50
1	1.280	2 1/2	10.63
1 1/4	1.590	3	12.75
1 1/2	1.910	4	17.00
2	2.550	1 1/2 x 2	10.20
2 1/2	3.190	2 1/2	12.75
3	3.830	3	15.30
4	5.100	4	20.40
5	6.380	1 3/4 x 2	11.90
6	7.650	2 x 2 1/2	17.00
1/2 x 3/4	1.280	3	20.40
1	1.700	4	27.20
1 1/4	2.130		

Other sizes not shown can be produced quickly.
Longer lengths on inquiry.

STAINLESS SQUARES

TYPES: 303, 304, 316L

- Annealed & Cold Drawn, Hot Rolled, Annealed & Pickled.
- Available in a wide selection of lengths and grades.

Sizes in Stock

Size in Inches	Est. Wt. per Ft. in Lbs	Size in Inches	Est. Wt. per Ft. in Lbs
1/8	0.530	1	3.40
3/16	0.120	1 1/8	3.73
1/4	0.213	1 1/4	5.31
5/16	0.332	1 1/2	7.65
3/8	0.478	1 3/4	10.41
7/16	0.651	2	13.60
1/2	0.850	2 1/4	21.25
9/16	0.932	2 1/2	25.71
5/8	1.330	3 1/2	41.65
3/4	1.910	4	54.40
7/8	2.600		

STAINLESS HEXAGONS

TYPES: 303, 304, 304L, 316L

- Available in a wide selection of lengths and grades.

Sizes in Stock

Size in Inches	Est. Wt. per Ft. in Lbs	Size in Inches	Est. Wt. per Ft. in Lbs
1/8	0.046	1 1/8	3.73
3/16	0.104	1 3/16	4.15
1/4	0.184	1 1/4	4.60
5/16	0.288	1 5/16	5.07
11/32	0.348	1 3/8	5.57
3/8	0.414	1 7/16	6.09
7/16	0.564	1 1/2	6.63
1/2	0.736	1 9/16	7.19
9/16	0.932	1 5/8	7.78
5/8	1.150	1 3/4	9.02
11/16	1.390	1 13/16	9.67
3/4	1.660	1 7/8	10.40
13/16	1.940	2	11.78
7/8	2.250	2 1/4	14.91
15/16	2.590	2 1/2	18.40
1	2.950	3	26.50
1 1/16	3.320		

STAINLESS ANGLES

TYPES: 304, 304L, 316, 316L

- Hot Rolled, Annealed & Pickled
- Stock Length 20'
- Available in a wide selection of lengths.

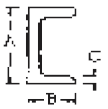
Sizes in Stock

Size in Inches					Est. Wt. per Ft. in Lbs
3/4	x	3/4	x	1/8	0.59
1	x	1		1/8	0.80
		1		3/16	1.16
		1		1/4	1.49
1 1/4	x	1 1/4		1/8	1.01
		1 1/4		3/16	1.48
		1 1/4		1/4	1.92
1 1/2	x	1 1/2		1/8	1.23
		1 1/2		3/16	1.80
		1 1/2		1/4	2.34
2	x	2	x	1/8	1.65
		2		3/16	2.44
		2		1/4	3.19
		2		3/8	4.70
2 1/2	x	2 1/2	x	3/16	3.07
		2 1/2		1/4	4.10
		2 1/2		3/8	5.90
3	x	2		3/16	3.07
		2		1/4	4.10
		3		1/4	4.90
		3		3/8	7.20
3 1/2	x	3 1/2	x	1/4	5.80
4		3	x	1/4	5.80
		3		3/8	8.50
		4		1/4	6.60
		4		3/8	9.80
		4		1/2	12.80
5	x	3		3/8	9.85

STAINLESS CHANNELS

TYPES: 304, 304L, 316, 316L

- Stock Lengths: 20 to 24 Ft. random

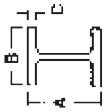


Sizes in Stock

Size in Inches				Est. Wt. per Ft. in Lbs	Size in Inches				Est. Wt. per Ft. in Lbs
A		B	C		A		B	C	
2	x	1	x 1/4	2.60	4	x	1 3/4	x 1/4	6.69
3	x	1 3/8	3/16	4.19	5	x	1 7/8	3/8	10.43
3	x	1 1/2	1/4	4.75	6	x	1.9	.343	8.32

STAINLESS BEAMS

TYPE: 304



• Stock Lengths: 20 to 24 Ft. random.

Sizes in Stock

A	B	C	Est. Wt. per Ft. in Lbs	A	B	C	Est. Wt. per Ft. in Lbs
3	$2^3/_8$	$^1/_4$	6.60	5	3	.326	11.49
4	$2^3/_4$	$^1/_4$	8.44	6	3.33	.326	14.90

ROUND TUBING STANDARD SIZE (WEIGHT/FT)

TYPES: 304, 316

• Available in Mechanical and Ornamental Specifications

GAUGE WALL THICKNESS	22 .030	20 .035	18 .049	16 .062	14 .083	12 .109	11 .120	9 .148	7 .180	5 .220	$^1/_4$WALL .250
OUTSIDE DIAMETER											
$^1/_8$	.029	.0336									
$^3/_{16}$	.0478	.0572									
$^1/_4$	.0664	.0804	.1052	.1284							
$^5/_{16}$	.0852	.1039	.1382	.1722							
$^3/_8$	.1038	.1271	.1706	.2152	.2588						
$^7/_{16}$		.1506	.2036	.2589							
$^1/_2$		.1738	.2360	.3020	.3696						
$^5/_8$		.2205	.3014	.3868	.4805						
$^3/_4$		.2673	.3668	.4755	.5913	.7462	.8074				
$^7/_8$		.3140	.4323	.5623	.7021	.8917	.9676				
1		.3607	.4977	.6491	.8129	1.0372	1.1278				
1.050		.3794	.5238	.6902	.8652	1.141	1.229				
$1^1/_8$		.4074	.5631	.7359	.9237	1.1827	1.2880				
$1^1/_4$		.4542	.6285	.8226	1.0345	1.3283	1.4482				
$1^5/_{16}$		.4777	.6615	.8759	1.090	1.417	1.529				
$1^3/_8$		.5009	.6939	.9094	1.1453	1.4738	1.6064				
$1^1/_2$		.5476	.7593	.9962	1.2561	1.6193	1.7686				
$1^5/_8$		.5943	.8248	1.083	1.3669	1.7648	1.9288				
1.660		.6074	.8141	1.117	1.3978	1.822	1.992	2.294			
$1^3/_4$		.6411	.8902	1.1697	1.4777	1.9103	2.069	2.5322			
$1^7/_8$		.6878	.9556	1.2565	1.5885	2.0558	2.2492	2.7296			
1.900		.6971	.9687	1.286	1.6107	2.104	2.255	2.743			
2		.7345	1.0210	1.3433	1.6993	2.2014	2.4094	2.9273			
$2^1/_4$			1.1518	1.5168	1.9209	2.4924	2.7298	3.3225			
$2^3/_8$			1.2175	1.5315	2.0313	2.6380	2.8401	3.5201	4.2197	5.0634	
$2^1/_2$			1.2827	1.6904	2.1425	2.7834	3.0502	3.7177	4.460	5.357	
$2^7/_8$				1.9507	2.498	3.220	3.564	4.3104	5.847	6.2382	
3				2.0375	2.5857	3.3655	3.6910	4.5080	5.4212	6.5319	
$3^1/_8$				2.1243	2.6966	3.511	3.8512				
4				2.7317	3.505	4.5296	5.019	6.0886	7.3436	8.8813	10.0125
$4^1/_2$				3.0788	3.952	5.1117	5.666	6.8789		10.0563	11.3475
5				3.4259	4.3586	5.6937	6.2542	7.6693	9.2660	11.2311	12.6834

Mill Finish or Polished to 180 Grit or 600 Grit.
Other grades available by special order, i.e.: 409, 309, 310, etc.

SQUARE AND RECTANGULAR TUBING STANDARD SIZE

TYPES: 304, 316

GAUGE	20	18	16	14	12	11	9	7	1/4 WALL	5/16	3/8
WALL THICKNESS	.035	.049	.062	.083	.109	.120	.148	.180	.250	.312	.375
OUTSIDE DIMENSION											
1/2 x 1/2	.2205	.3014	.3887	.4707							
5/8 x 5/8	.2808	.3868	.4950	.6117	.6851						
3/4 x 3/4	.3403	.4671	.6055	.7528	.9502	1.1278					
7/8 x 7/8	.3998	.5504	.7160	.8929	1.1355	1.2322					
1 x 1		.6337	.8264	1.0350	1.3206	1.4360					
1 1/8 x 1 1/8	.5186	.7170	.9369	1.1761	1.5061	1.6402					
1 1/4 x 1 1/4	.5783	.8003	1.0474	1.3172	1.6914	1.8442	2.2181				
1 1/2 x 1 1/2		.9668	1.2685	1.5995	2.104	2.2550	2.7213	3.3214			
1 3/4 x 1 3/4		1.1518	1.5168	1.9209	2.4924	2.7298	3.225	4.0166			
2 x 2		1.3001	1.7103	2.1637	2.8029	3.0678	3.7277	4.4555	6.0071		
2 1/4 x 2 1/4		1.4667	1.9315	2.4461	3.1738	3.4762	4.2309	5.0674			
2 1/2 x 2 1/2		1.6333	2.1525	2.7283	3.5444	3.8842	4.7341	5.6794			
3 x 3			2.5945	3.2927	4.2856	4.7002	5.7405	6.9034	8.9532		
3 1/2 x 3 1/2			3.059	3.857	5.027	5.516	6.747	8.127	11.3475		
4 x 4				4.360	5.490	6.260	7.6693	9.270	12.6843	14.620	17.040
5 x 5								11.550	15.070	20.234	23.995
6 x 6								13.560	18.199	24.491	29.094
7 x 7								16.253	23.129	28.747	34.193
8 x 8								19.235	26.529	33.004	39.293

GAUGE	20	18	16	14	12	11	9	7	1/4 WALL	5/16	3/8
WALL THICKNESS	.035	.049	.062	.083	.109	.120	.148	.180	.250	.312	.375
OUTSIDE DIMENSION											
1/8X1											
1/2X3/4	.2808	.3838	.4950								
1/2X1	.3403	.4671	.6055	.7529							
1/2X1 1/4	.3998	.5504	.7160	.8946							
1/2X1 1/2	.4593	.6337	.8264	1.0350							
1/2X2	.5783	.8003	1.0474	1.3172							
3/4X1	.3998	.5504	.7160	.8940							
3/4X1 1/4	.4593	.6337	.8264	1.0350							
3/4X1 1/2	.5188	.7170	.9369	1.1761							
3/4X2	.6378	.8836	1.1580	1.4584							
7/8X1 1/2	.5486	.7587	.9923	1.2468							
1X1 1/2		.8003	1.0474	1.3172	1.6914	1.8840					
1X2		.9668	1.2684	1.5993	2.0620	2.2522					
1X3		1.3000	1.7103	2.1637	2.8029	3.0682	3.7277	4.4554			
1 1/4X1 3/4		.9668	1.2685	1.5995	2.104	2.2550	2.7213	3.3214			
1 1/4X2 1/2		1.2167	1.5999	2.0226	2.6176	2.864	3.5201	4.2197			
1 1/2X2		1.335	1.4895	1.8817	2.4326	2.6602					
1 1/2X2 1/2			1.7105	2.1639	2.8032	3.0682	3.7277	4.4554			
1 1/2X3			1.9315	1.4461	3.1738	3.4762	4.6105	5.793			
1 1/2X4			2.3735	3.0105	3.9474	4.4018	5.2934	6.3824			
1 3/4X3		1.5500	2.0420	2.5872	3.3591	3.680	4.5080	5.4213			
1 3/4X4			2.3846	3.029	3.9711	4.4282	5.3252	6.4207			
2X3		1.6333	2.1525	2.7283	3.5444	3.8842	4.5351	5.6794	7.3425		
2X4			2.5945	3.2927	4.2865	4.7002	5.7405	6.9034	8.9325		
2X5				4.1390	5.397	5.924	7.250	8.739	11.3475		
2X6				4.40	5.6937	6.313	7.6693	9.20	12.6834		
3X4				3.857	5.027	5.516	6.747	8.127	11.3475		
3X6						6.390		9.020	12.6834		
3X7								11.550	15.070		
4X6								11.550	15.070	20.204	23.995
4X8								13.560	18.199	24.491	29.094
5X7								13.560	18.199	24.491	29.094
6X8								16.253	23.129	28.747	34.193
6X10								19.235	26.529	33.004	39.293

Mill Finish or Polished to 180 Grit or 600 Grit.

ROUND TUBING SIZE TOLERANCES

O.D. INCHES		WALL THICKNESS	O.D. +/-
1/2" to 1" INCL.		.025 to .065	.006
	OVER	.065 to .120	.010
1" to 1 1/2" INCL.		.025 to .065	.006
	OVER	.065 to .120	.010
1 1/2" to 2" INCL.		.025 to .049	.010
	OVER	.049 to .083	.011
	OVER	.083 to .148	.012
2" to 2 1/2" INCL.		.0351 to .065	.012
	OVER	.065 to .109	.013
	OVER	.109 to .165	.014
2 1/2" to 3 1/2" INCL.		.065 to .165	.020
	OVER	.165 to .220	.025
3 1/2" to 5" INCL.		.063 to .165	.020
	OVER	.165 to .220	.025

SQUARE & RECTANGULAR TUBING SIZE TOLERANCES

OUTSIDE DIAMETER	+/- INCH
1/2" to 1 1/4" INCL.	.015
1 1/4" to 2 1/2" INCL.	.020
2 1/2" to 5 1/2" INCL.	

TOLERANCE GUIDELINES

Manufacturing tolerances may be specified to conform to ASTM-A 500 specification. Unless otherwise specified, all manufacturing tolerances will be suitable for standard structural applications.

Chemical and Mechanical Properties
Chemical and mechanical properties of tubing shall conform to the properties of the starting material specification.

Corner Radius (R)
The outside corner radius of a rectangular or square section is generally 2 x's the material thickness (t) Maximum tolerance 3t.

Wall Thickness (t)
The wall thickness at any point shall not exceed +/-12 1/2% of the nominal wall.

Squareness of Sides (x°)
Adjacent sides may deviate from 90° by a tolerance of +/- 2° maximum.

Lengths

Cutting Tolerance	
Exact Cut	Cut to size +1/4, -0"
Min. R/L	Cut to min. size +6" (est.), -0"
Random Lengths	15' - 24', standard lengths 20'

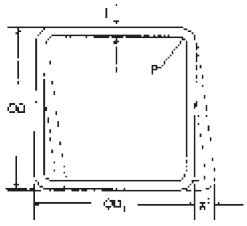
Twist (T)
Maximum twist.
Specified Dimensions of Longest Side, inch's.

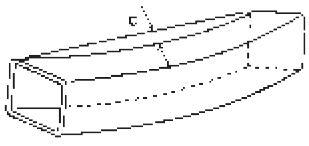
over 2 1/2" to 4" incl.	over 4" to 6" incl.	over 6" to 8" incl.	over 8
.075	.087	.100	.112

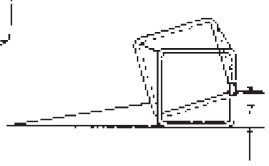
Straightness (C)
The commercial tolerance for straightness is 1/8" times the total number of feet of total length divided by 5.

$$.125 \times \frac{\text{total length}}{5}$$

Polishing
Polishing is an abrading operation employed for the removal of grinding lines, scratches, pits, tool marks and other surface defects that adversely affect the appearance of a tube.
On Square and rectangular tubing, polishing is done in a longitudinal direction. Tube corners are not polished. Polished grit finishes available are P180 &P240.







STAINLESS WELDED PIPE & SEAMLESS PIPE

TYPES: 304, 316, 309, 310, 330

Stock lengths 20 to 24 ft. randoms.

Sizes in Stock				
Nominal Pipe Size	Weight per Ft. in Lbs	O.D. in Inches	O.D. in Inches	Wall Thickness
Schedule 5				
1/2	.540	.840	.710	.065
3/4	.690	1.050	.920	.065
1	.880	1.315	1.185	.065
1 1/4	1.120	1.660	1.530	.065
1 1/2	1.290	1.900	1.770	.065
2	1.620	2.375	2.245	.065
3	3.060	3.500	3.334	.083
3 1/2	3.510	4.000	3.834	.083
Schedule 10				
1	1.42	1.315	1.097	.109
1 1/2	2.10	1.900	1.682	.109
2	2.66	2.375	2.157	.109
3	4.37	3.500	3.260	.120
3 1/2	5.02	4.000	3.760	.120
4	5.67	4.500	4.260	.120
5	7.84	5.563	5.295	.134
6	9.38	6.625	6.357	.134
8	13.40	8.625	8.329	.148
10	18.65	10.750	10.420	.165
12	24.16	12.750	12.390	.180
Schedule 40				
1/8	.250	.405	.269	068
1/4	.430	.540	.364	.088
3/8	.570	.675	.493	.091
1/2	.860			.109
3/4	1.140	1.050	.824	.113
1	1.700	1.315	1.049	.133
1 1/4	2.290	1.660	1.380	.140
1 1/2	2.740	1.900	1.610	.145
2	3.700	2.375	2.067	.154
2 1/2	5.850	2.875	2.469	.203
3	7.650	3.500	3.068	.216
3 1/2	9.190	4.000	3.548	.226
4	10.890	4.500	4.026	.237
5	14.750	5.563	5.047	.258
6	19.150	6.625	6.065	.280
8	28.820	8.625	7.981	.322
10	40.860	10.750	10.020	.365
12	50.030	12.750	12.000	.375

STAINLESS WELDED PIPE & SEAMLESS PIPE

TYPES: 304, 304L, 316, 316L

Sizes in Stock

Nominal Pipe Size	Weight per Ft. in Lbs	O.D. in Inches	O.D. in Inches	Wall Thickness
Schedule 80				
1/8	.320	.405	.215	.095
1/4	.540	.540	.302	.119
3/8	.750	.675	.423	.126
1/2	1.100	.840	.546	.147
3/4	1.490	1.050	.742	.154
1	2.190	1.315	.957	.179
1 1/4	3.030	1.660	1.278	.191
1 1/2	3.670	1.900	1.500	.200
2	5.070	2.375	1.939	.218
2 1/2	7.660	2.875	2.323	.276
3	10.250	3.500	2.900	.300
3 1/2	12.500	4.000	3.364	.318
4	14.980	4.500	3.826	.337
5	20.780	5.563	4.813	.375
6	28.570	6.625	5.761	.432
8	43.390	8.625	7.625	.500
10	64.330	10.750	9.564	.594
12	88.510	12.750	11.376	.688
14	106.100	14.000	12.500	.750
16	136.500	15.000	15.000	.843

ASA Alloys also stock a wide range of screwed and butt weld fittings.

- Unions
- Couplings
- Nipples
- Tees
- Elbows
- Flanges

STAINLESS STEEL SHEETS

TYPES: 304, 304L, 316, 316L, 309, 310

Other grades available upon request.
2B, #4 and XL blends finishes.

Sizes in Stock

Gauge and Sizes in Stock	Weight per Piece	Est. Wt. per Sq. Ft. in Lbs.	Est. Wt. per Sq. In. in Lbs.
10ga x 36 x 96	142	5.905	.04101
36 x 120	177		
48 x 96	189		
48 x 120	236		
48 x 144	283		
60 x 120	295		
60 x 144	354		
11ga x 36 x 96	126	5.25	.03645
36 x 120	158		
48 x 96	168		
48 x 120	210		
48 x 144	252		
60 x 120	263		
60 x 144	315		
12ga x 36 x 96	110	4.594	.03190
36 x 120	138		
48 x 96	147		
48 x 120	184		
48 x 144	220		
60 x 120	230		
60 x 144	275		
14ga x 36 x 96	79	3.281	.02278
36 x 120	98		
48 x 96	105		
48 x 120	131		
48 x 144	157		
60 x 120	164		
60 x 144	197		
16ga x 36 x 96	63	2.625	.01823
36 x 120	79		
48 x 96	84		
48 x 120	105		
48 x 144	126		
60 x 120	131		
60 x 144	158		
18ga x 36 x 96	50	2.100	.01460
36 x 120	63		
48 x 96	67		
48 x 120	84		
48 x 144	101		
60 x 120	105		
60 x 144	126		
20 ga x 36 x 96	38	1.580	.01095
36 x 120	47		
48 x 96	50		
48 x 120	63		
48 x 144	76		
22ga x 36 x 96	31	1.313	.00911
36 x 120	39		
48 x 96	42		
48 x 120	53		
48 x 144	63		
24ga x 36 x 96	26	1.050	.00731
36 x 120	32		
48 x 96	34		
48 x 120	42		
48 x 144	51		

STAINLESS STEEL COILS

TYPE: 304, 304L, 316, 316L

Finish: 304 - 2B and #4 Polish One Side.
316 - 2B

Sizes in Stock

Gauge	Thickness in inches	Width in inches	Est. Wt. per Sq. Ft. in Lbs.
10	.140	36, 48, 60	5.905
11	.125	36, 48, 60	5.250
12	.109	36, 48, 60	4.594
14	.078	36, 48, 60	3.281
16	.0625	36, 48, 60	2.625
18	.050	36, 48, 60	2.100
20	.0375	36, 48	1.580
22	.0312	36, 48	1.313
24	.025	36, 48	1.050

STAINLESS STEEL PLATES

TYPES: 304L, 304H, 316L, 317L, 2205, 321, 309, 310, 254, 904L

Other grades available upon request.
Hot Rolled, Annealed and Pickled.

Sizes in Stock

Thickness	Est. Wt. per Sq. Ft. in Lbs.	Est. Wt. per Sq. In. in Lbs.
3/16	8.579	.05958
1/4	11.162	.07751
5/16	13.746	.09546
3/8	16.496	.11456
7/16	19.080	.13250
1/2	21.663	.15044
9/16	24.246	.16838
5/8	26.831	.18633
3/4	32.123	.22308
7/8	37.291	.25897
15/16	39.875	.27690
1	42.665	.29628
1 1/8	47.903	.33266
1 1/4	53.226	.36963
1 1/2	63.871	.44355
1 3/4	74.516	.51747
2	85.161	.59140
2 1/4	95.807	.66533
2 1/2	106.452	.73925
2 3/4	117.097	.81317
3	127.742	.88710

STAINLESS DIAMOND FLOOR PLATES

TYPE: 304

Hot Rolled, Annealed and Pickled.

Sizes in Stock

Thickness and Sizes in inches		Est. Wt. per Sq. Ft. in Lbs.
1/8	36 x96, 120, 144	6.150
1/8	48 x96, 120, 144	6.150
3/16	48 x96, 120, 144	8.700
1/4	48 x96, 120, 144	11.250

STAINLESS STEEL PERFORATED METAL

Sizes in Stock

Hole Size	On Centre Dimension	Thickness	Width x Length
1/16	1/8	22 GA	36 x 96
3/32	3/16	22 GA	36 x 96
1/8	3/16	16 GA	36 x 96
3/16	1/4	16 GA	36 x 96
3/16	1/4	22 GA	36 x 96
1/4	5/16	20 GA	36 x 96
1/4	3/8	11 GA	36 x 96
1/4	3/8	16 GA	36 x 96
1/4	3/8	20 GA	36 x 96
3/8	9/16	16 GA	36 x 96
1/2	3/4	16 GA	36 x 96
1/8	3/16	18 GA	48 x 120

The pattern sizes shown are available for immediate delivery.

STANDARD STAINLESS STEEL EXPANDED METAL

Style	Lbs. per 100 S.F	Standard Sheet Size SWD	Standard Sheet Size LWD	Design Size (Inches) SWD	Design Size (Inches) LWD	Opening Size (Inches) SWO	Opening Size (Inches) LWO	Strand Size (Inches) Width	Strand Size (Inches) Thickness	Overall Thickness (Inches)	Open Area %	Normal Stock
1/2" - #20	50	8 4	4 8	0.5	1.2	0.437	0.937	0.08	0.037	0.164	70	4 x 8
1/2" - #18	67	8 4	4 8	0.5	1.2	0.437	0.937	0.08	0.05	0.164	70	4 x 8
1/2" - #16	84	8 4	4 8&10	0.5	1.2	0.437	0.937	0.08	0.062	0.164	70	4 x 8
1/2" - #13	187	8 4	4 8&10	0.5	1.2	0.325	0.875	0.119	0.093	0.225	65	4 x 8
3/4" - #16	60	8 4	4 8	0.923	2	0.812	1.75	0.106	0.062	0.202	83	4 x 8
3/4" - #13	91	8 4	4 8&10	0.923	2	0.75	1.687	1.07	0.093	0.202	80	4 x 8
3/4" - #9(10)	193	8 4	4 8&10	0.923	2	0.687	1.562	0.15	0.14	0.308	67	4 x 8
1'1/2" - #16	41	8 4	4 8	1.33	3	1.25	2.75	0.106	0.062	0.222	85	4 x 8
1'1/2" - #13	62	8 4	4 8	1.33	3	1.25	2.625	0.106	0.093	0.222	83	4 x 8
1'1/2"- - #9(10)	137	8 4	4 8&10	1.33	3	1.125	2.5	0.155	0.14	0.28	77	4 x 8

Above material conforms to military specification M1L-S-46044A (MR) Type 2

FLATTENED STAINLESS STEEL EXPANDED METAL

Style	Lbs. per 100 S.F	Standard Sheet Size SWD	Standard Sheet Size LWD	Design Size (Inches) SWD	Design Size (Inches) LWD	Opening Size (Inches) SWO	Opening Size (Inches) LWO	Strand Size (Inches) Width	Strand Size (Inches) Thickness	Overall Thickness (Inches)	Open Area %	Normal Stock
1/2" - #20F	48	8 4	4 8	0.5	1.26	0.312	1	0.91	0.033	0.033	60	4 x 8
1/2" - #18F	65	8 4	4 8	0.5	1.26	0.312	1	0.91	0.04	0.04	60	4 x 8
1/2" - #16F	81	8 4	4 8&10	0.5	1.26	0.312	1	0.91	0.05	0.05	60	4 x 8
1/2" - #13F	178	8 4	4 8&10	0.5	1.26	0.24	0.915	0.132	0.08	0.08	57	4 x 8
3/4" - #16F	57	8 4	4 8	0.923	2.1	0.75	1.812	0.118	0.05	0.05	75	4 x 8
3/4" - #13F	86	8 4	4 8&10	0.923	2.1	0.625	1.75	0.12	0.07	0.07	75	4 x 8
3/4" - #9(10)F	183	8 4	4 8&10	0.923	2.1	0.562	1.687	0.155	0.119	0.119	61	4 x 8
1'1/2" - #16F	39	8 4	4 8&10	1.33	3.15	1.062	2.75	0.119	0.05	0.05	80	4 x 8
1'1/2" - #13F	59	8 4	4 8	1.33	3.15	1	2.625	0.121	0.079	0.079	80	4 x 8
1'1/2"- - #9(10)F	131	8 4	4 8	1.33	3.15	0.937	2.625	0.165	0.119	0.119	75	4 x 8

Above material conforms to military specification M1L-S-46044A (MR) Type 2
Stainless Steel Styles also available in -3/16 -5/16 -5/8 -1
MESHES - Styles stocked in type 304 normally.

300 SERIES - SELECTION OF STAINLESS STEEL

Considering Physical and Mechanical Properties

ATLAS/AISI TYPE			303	304	304L
Analysis - %:	Carbon		0.15	0.08	0.030
	Manganese		2	2.0	2.0
Chemistry	Phosphorous		0.2	0.045	0.045
value is	Sulphur		15 Min	0.030	0.030
maximum	Silicon		1	1.0	1.0
except where	Chromium		17-19	18-20	18-20
range or	Nickel		8-10	8-10.5	8-12
minimum is	Other		-	-	-
shown					
		psi	35000	35000	33000
	(0.2% offset)	MPa	241	241	228
	Ultimate Strength	psi	90000	84000	81000
		MPa	621	579	558
	Elongation % in 2' ' (100 mm)		50	55	55
Mechanical		Brinell BHN	160	149	149
Properties	Hardness	Rockwell B	84	80	80
(Annealed):		ft.-lbs.	92	135	135
	Impact Charpy	J	146	182	182
	Creep Strength-1%	psi			
		at 1000°F	-	17300	17300
	flow in 10,000 hrs.				
	at 1000°F (540°C)				
		MPa at 540°C	-	119	119
	Modulus of Elasticity in tension	psi	$28.0x10^6$	$28.0x10^6$	$28.0x10^6$
		MPa	$1.9x10^5$	$1.9x10^5$	$1.9x10^5$
Electrical	Electrical Resistivity- Microhm - Cm at 68°F				
Properties	(20°C)		72	72	72
(Annealed):	Magnetic Permeability at 200H		1.02	1.02	1.02
	Maximum Operating Temperature	°F			
Heat			1400	1600	1600
Resistance:	Intermittent Service	°C	760	871	871
	Continuous Service	°F	1600	1700	1700
		°C	871	926	926
	Expansion-				
Thermal	(In./In./°F x 10^{-6})	32°-212°F	9.6	9.6	9.6
Expansion:	(cm/cm/°C x 10- 6)	0°-100°C	17.3	17.3	17.3
		32°-1200°F	10.4	10.4	10.4
		0°-650°C	18.7	18.7	18.7
	Conductivity-				
Thermal	(B.T.U./ft.²/hr./°F/ft.)	at 212° F	9.4	9.4	9.4
Conductivity:	(J/m/S/°C/m)	at 100°C	16.3	16.3	16.3
		at 932°F	12.4	12.4	12.4
		at 500° C	21.5	21.5	21.5

300 SERIES - SELECTION OF STAINLESS STEEL

Considering Physical and Mechanical Properties

309	309S	310	310S	316	316L	317	317L	321	330	347&348
0.20	0.08	0.25	0.08	0.08	0.03	0.08	0.03	0.08	0.08	0.08
2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.040	0.045
0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030
1.0	1.0	1.5	1.5	1.0	1.0	1.0	1.0	1.0	.075-1.0	1.0
22-24	22-24	24-26	24-26	16-18	16-18	18-20	18-20	17-19	17-19	17-19
12-15	12-15	19-22	19-22	10-14	10-14	11-15	11-15	9-12	34-37	9-13
-	-	-	-	Mo 2-3	Mo 2-3	Mo 3-4	Mo 3-4	Ti 5xC Min	-	*
45000	45000	45000	45000	42000	39000	40000	40000	35000	42000	40000
310	310	310	310	290	269	276	276	241	290	276
95000	95000	95000	95000	84000	81000	90000	90000	90000	85000	95000
655	655	655	655	579	558	621	621	621	586	655
45	45	45	45	50	50	45	45	45	45	45
170	170	170	170	149	149	163	163	160	150	160
85	85	85	85	80	80	85	85	84	80	85
135	135	110	110	135	135	135	135	135	240	135
182	182	165	165	182	182	182	182	182	325	182
15900	15900	17500	17500	24500	24500	24000	24000	18000	-	19300
110	110	121	121	169	169	165	165	124	-	133
$29.0x10^6$	$29.0x10^6$	$29.0x10^6$	$29.0x10^6$	$28.0x10^6$	$28.0x10^6$	$28.0x10^6$	$28.0x10^6$	$28.0x10^6$	$28.0x10^6$	$28.0x10^6$
$2.0x10^5$	$2.0x10^5$	$2.0x10^5$	$2.0x10^5$	$1.9x10^5$	$1.9x10^5$	$1.9x10^5$	$1.9x10^5$	$1.9x10^5$	$1.9x10^5$	$1.9x10^5$
78	78	78	78	74	74	74	74	72	102	73
1.02	1.02	1.01	1.01	1.02	1.02	1.02	1.02	1.02	1.01	1.02
1850	1850	1900	1900	1600	1600	1600	1600	1600	2100	1600
1008	1008	1036	1036	871	871	871	871	871	1149	871
1950	1950	2100	2100	1700	1700	1700	1700	1700	2100	1700
1061	1063	1149	1149	926	926	926	926	926	1149	926
8.3	8.3	8.0	8.0	8.9	8.9	8.9	8.9	9.3	9.3	9.3
14.9	14.9	14.4	14.4	16.0	16.0	16.0	16.0	16.7	16.7	16.7
10.0	10.0	9.7	9.7	10.1	10.1	10.3	10.3	10.7	10.1	10.6
18.0	18.0	17.5	17.5	18.2	18.2	18.5	18.5	19.3	18.2	19.1
8.0	8.0	8.0	8.0	9.4	9.4	9.4	9.4	9.3	7.5	9.3
13.8	13.8	13.8	13.8	16.3	16.3	16.3	16.3	16.1	12.9	16.1
10.8	10.8	10.8	10.8	12.4	12.4	12.4	12.4	12.8	11.6	12.8
18.7	18.7	18.7	18.7	21.5	21.5	21.5	21.5	22.2	20.1	22.2

400 Series - Selection of Stainless Steel

Considering Physical and Mechanical Properties

Atlas/Aisi Type			403	409	410	416*
Analysis - % Chemistry value is maximum except where range or minium is shown.	Carbon		0.15	0.08	0.15	0.15
	Manganese		1.0 max	1	1	1.25
	Phoshorous		0.040	0.040	0.040	0.060
	Sulphur		0.030	0.030	0.030	0.15 Max*
	Silicon		0.5	1.0	1.0	1.0
	Chromium		11.5-13	10.5-11.75	11.5-13.5	12-14
	Nickel		-	-	-	-
	Other		-	Ti 6 x C Min 0.75 max	-	Mo 0.6 (Optional)
Mechanical Properties (Annealed):	Yield Strength (0.2% offset)	psi	40000	35000	45000	83000††
		Mpa	276	241	310	572†
	Ultimate Strength	psi	75000	65000	70000	105000††
		MPa	517	448	483	724††
	Elongation% in 2" (100 min)		35	25	25	20
	Hardness Brinell BHN		153	150	150	225
	Hardness Rockwell B		82	75	80	97
	Impact Charpy	ft.-lbs.	110	16	110	21
		J	165	21	165	28
	Creep Strength-1% flow in 10,000 hrs at 1000°F (540°C)	psi at 1000°F	12000	10500	12000	9000
		MPa at 540°C	83	72	83	62
	Modlus of Elasticity in tension	psi	$29.0x10^6$	$29.0x10^6$	$29.0x10^6$	$29.0x10^6$
		MPa	$2.0x10^5$	$2.0x10^5$	$2.0x10^5$	$2.0x10^5$
Electrical Properties (Annealed):	Electrical Resistivity -Microhm-Cm at 68°F (20°C)		57	59	57	57
	Magnetic Permeability at 200H		-	-	-	-
Heat Resistance:	Maximum Operating Temperature- Intermittent Services	°F	1500	1475	1500	1400
		°C	815	774	815	760
	Continuous Sevice	°F	1300	1400	1300	1250
		°C	704	760	704	677
Thermal Expansion:	Expansion- (in./in./°Fx10-^{6})	32°-212°F	5.5	6.5	5.5	5.5
	(cm/cm/°Cx10-^{6})	0°-100°C	9.9	11.7	9.9	9.9
		32°-1200°F	6.5	7.2	6.5	6.5
		0°-650°C	11.7	13	11.7	11.7
Thermal Conductivity:	Conductivity (B.T.U./ft./hr/°F/ft)	at 212°F	14.4	14.4	14.4	14.4
	(J/m'/S/°C/m)	at 100°C	24.9	24.9	24.9	24.9
		at 932°F	16.6	16.6	16.6	16.6
		at 500°C	28.7	28.7	28.7	28.7

ATLAS/AISI TYPE	**416MX**	**416MF**	**416MN**	**4MX**
*typical sulphur analysis † or as required typical cold finished properties for optimum machinability	0.33	0.20	0.29	0.40†

400 Series - Selection of Stainless Steel

Considering Physical and Mechanical Properties

420	430 & 430F	431	440C	445	S15500		S17400	
0.15 Min	0.12	0.2	0.95-1.20	0.2	0.07		0.07	
1	1.25	1	1	1.5	1		1	
0.040	0.040	0.040	0.040	0.040	0.040		0.040	
0.030	0.15	0.030	0.030	0.030	0.030		0.030	
1.0	1.0	1.0	1.0	1.0	1.0		1.0	
12-14	16-18	15-17	16-18	23-27	14.0-15.5		15.5-17.5	
-	-	1.25-2.50	-	0.25	35-5.5		3.0-5.0	
-	*	-	Mo 0.75	-	Cu +2.5-4.5	Cb + Ta 0.15 - 0.45	Cu 3.0-5.0	Cb + Ta 0.15-0.45
50000	50000	95000	65000	50000	130000		130000	
345	345	655	448	345	896		896	
95000	75000	125000	110000	80000	160000		160000	
655	517	862	758	552	1103		1103	
25	25	20	14	20	15		15	
192	163	262	223	153	330		330	
92	85	103	97	82	35 Rc		35 Rc	
31	21	37	4	16	30		30	
42	28	50	6	22	34		34	
11400	8600	12000	-	6100	-		-	
79	59	83	-	42	-		-	
$29.0x10^6$	$29.0x10^6$	$29.0x10^6$	$29.0x10^6$	$29.0x10^6$	$29.0x10^6$		$29.0x10^6$	
$2.0x10^5$	$2.0x10^5$	$2.0x10^5$	$2.0x10^5$	$2.0x10^5$	$2.0x10^5$		$2.0x10^5$	
55	60	72	60	67	77		80	
-	-	-	-	-	-		-	
-	1600	1700	-	2150	-		-	
-	871	976	-	1176	-		-	
-	1500	1600	-	2000	-		-	
-	815	871	-	1093	-		-	
5.7	5.8	5.6	5.6	5.4	6.0		6.0	
10.3	10.4	10.1	10.1	9.7	10.8		10.8	
6.8	6.6	6.5	-	6.4	6.9		7	
12.2	11.9	117	-	11.5	12.4		12.6	
14.4	15.1	11.7	14	12.1	10.3		10.6	
24.9	26.1	20.2	24.2	21.6	17.8		13.1	
16.8	15.2	13.2	14.2	14.1	13.1		13.1	
29	26.3	22.8	24.6	24.4	22.6		22.6	

303 MX (UNS S30300)

This grade represents the optimum in machinability among the 300 Series stainless steels. It is primarily used when parts production involves extensive machining in automatic screw machines. The sulphur addition which is responsible for the improved machining and galling characteristics of Type 303 MX marginally lowers its corrosion resistance properties to slightly below that of Type 304.

Machinability Rating (B1212) 78%

Corrosion Resistance: Excellent resistance to mildly corrosive atmospheres… slightly less than Type 304 due to sulphur addition.

Heat Resistance: Good oxidation resistance in intermittent service to 1600°F.
Continuous use in 800-1575°F range not recommended but often performs well in temperatures fluctuating above and below this range.

Heat Treatment: Annealing - heat to 1850-2050°F. Cool rapidly. These grades cannot be hardened by thermal treatment.

Welding: Not generally recommended but, if unavoidable, use Type 308, 310 or 312 electrodes. Welds must be annealed for maximum corrosion resistance.

Typical applications:
Nuts and bolts.
Bushings.
Shafts.
Aircraft fittings.
Highway sign studs.
Electrical switchgear components.
Gears.
Fluid handling fittings.
Thermocouple fittings.

		C	Mn	P	S	Si	Cr	Ni	Se
A.I.S.I Analysis	303MX	15 max	2.0 max	.20 max	.15 Min	1.0 max	17.0 to 19.0	8.0 to 10.0	
	303Se	15 max	2.0 max	.20 max	.06 max	1.0 max	17.0 to 19.0	8.0 to 10.0	.15 Min

				Hardness				
Typical Mechanical Properties Annealed	Yeild Strength 2%Offset psi	Ultimate Strength psi	Elongation % in 2' '	Rb	BHN	Impact Charpy ft.-lbs.	Modulus of Elasticity in Tension - psi	
	350,000	90,000	50	84	160	92	28.0×10^6	

Other Properties	Creep Strength 1% Flow in 10,000 hrs. at 1000°F psi	Magnetic Permeability at 200 H-Annealed	Electrical Resistivity-Microhm-Cm at 68°F	Coefficient of Thermal Expansion (In/In/°F x 10^{6}) 32°-212°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft. at 212°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft. at 932°F
		1.02	72	9.6	9.4	12.4

304, 304L (UNS S30400, UNS S30403

This is the most versatile, and one of the most widely applied of the 300 Series stainless steels. It has excellent forming and welding characteristics. The carefully controlled analysis of Type 304 enables it to be deep drawn more severely than Types 301 and 302 without intermediate heat softening ... a characteristic that has made this grade dominant in the manufacture of drawn stainless parts such as sinks, and saucepans. It is readily brake or roll formed into a variety of other parts for application in the industrial, architectural, and transportation fields.

Type 304 also has outstanding welding characteristics. Post-weld annealing is not required to restore the excellent performance of this grade in a wide range of mildly corrosive conditions.

Type 304L does not require post-weld annealing and finds extensive use in heavy gauge components, where freedom from carbide weld precipitation is often required.

Corrosion Resistance: Excellent ... exceeding that of Type 302 in a wide variety of corrosive media including hot petroleum products, steam combustion gasses.

Heat Resistance: Good oxidation resistance in intermittent service to 1600°F and In continuous service to 1700°F. Continuous use of 304 in 800-1575°F range not recommended but often performs well in temperatures fluctuating above and below this range. Type 304L is more resistant to carbide precipitation and can be used in the above temperature range.

Heat Treatment: Annealing - heat to 1850-2050°F and cool rapidly. These grades cannot be hardened by thermal treatment.

Welding: Excellent. All standard methods. Use type 308 rods or electrodes. Heavy welded sections in Type 304 may require post-weld annealing for maximum corrosion resistance. This is not required if Type 304L is used.

Typical Applications:
The list of applications for this general purpose grade is very extensive and includes:
Beer barrels
Bulk milk coolers
Food processing equipment Fire extinguisher parts
Wine storage tanks
Tube skelp
Chemical containers
Heat exchangers
Winding wire

		C	Mn	P	S	si	Cr	Ni
A.I.S.I Analysis	304	.08 max	2.0 max	.045 max	.030 max	1.0 max	18.0 to 20.0	8.0 to 10.5
	304L	.030 max	2.0 max	.045 max	.030 max	1.0 max	18.0 to 20.0	8.0 to 12.0

Typical Mechanical Properties Annealed	Yeild Strength .2% offset psi	Ultimate Strength psi	Elongation % in 2' '	Hardness		Impact Charpy ft.-lbs.	Modulus Of Elasticity in Tension - psi
				Rb	BHN		
	35,000	84,000	55	80	149	135	28.0 x 10^6

Other Properties	Creep Strength 1% Flow in 10,000 hrs. at 1000°F psi	Magnetic Permeability at 200 H-Annealed	Electrical Resistivity - Microhm-Cm at 68°F	Coefficient Of Thermal Expansion (In/In°F x10^6) 32°-212°F	Thermal Conductivity BTU/Ft.²/Hr./°F/Ft.	
					at 212°F	at 932°F
	17,300	1.02	72	9.6	9.4	12.4

316, 316L (UNS S31600, UNS S31603)

Type 316 and Type 317 (described on the following page) are molybdenum bearing grades. This addition, slightly higher in Type 317, gives these grades better overall corrosion resistance properties than types 301 and 304 . . . and higher creep strength at elevated temperatures. Type 316 gives useful service at room temperature in sulphuric acid of concentration lower than 15% and higher than 85%. It also resists chloride attack and is often selected for use in marine atmospheres.

Type 316L with its .03 maximum carbon content is used in applications where it is not possible to anneal after welding and where maximum corrosion resistance is required

Corrosion Resistance: Good resistance to a wider range of chemicals than Type 304. Highly resistant to the complex sulphur compounds used in Pulp & Paper processing. Also resists attack of marine and corrosive industrial atmospheres.

Heat Resistance: Good oxidation resistance in intermittent service to 1600°F and in continuous service to 1700°F. Continuous use of 316 In 800° -1575° F range not recommended but often performs well in temperatures fluctuating above and below this range. Type 316L is more resistant to carbide precipitation and can be used in the above temperature range.

Heat Treatment: Annealing - heat to 1850-2050°F and cool rapidly. These grades cannot be hardened by thermal treatment.

Welding: Good characteristics suited to all standard methods. Use Type 316Cb, 316L or 309Cb tiller rods or electrodes depending on application. Welded sections in Type 316 require postweld annealing for maximum corrosion resistance. This is not required if Type 316L is used.

Typical applications:
Pulp & paper equipment.
Heat *exchangers.*
Dyeing equipment.
Photographic developing equipment.
Propeller shafts.
Fittings
Exterior architectural components in marine coastal *areas.*

		C	Mn	P	S	Si	Cr	Ni	Mo
A.I.S.I Analysis	316	.08 max	2.0 max	.045 max	.030 max	1.0 max	16.0 to 18.0	10.0 to 14.0	2.0 to 3.0
	316L	.03 max	2.0 max	.045 max	.030 max	1.0 max	16.0 to 18.0	10.0 to 14.0	2.0 to 3.0

	Yeild Strength .2% offset psi	Ultimate Strength psi	Elongation % in 2"	Hardness		Impact Charpy ft.-lbs.	Modulus Of Elasticity in Tension - psi
				Rb	BHN		
Typical Mechanical Properties Annealed	42,000	84,000	50	80	149	135	28.0 x 10^6

	Creep Strength 1% Flow in 10,000 hrs. at 1000°F psi	Magnetic Permeability at 200 H-Annealed	Electrical Resistivity - Microhm-Cm at 68°F	Coefficient Of Thermal Expansion (In/In°F x 10^6) 32°-212°F	Thermal Conductivity BTU/Ft.²/Hr./°F/Ft.	
					at 212°F	at 932°F
Other Properties	24,500	1.02	74	8.9	9.4	12.4

317, 317L (UNS S31700, UNS S31703)

This grade, with its molybdenum content slightly higher than Type 316 is the most corrosion resistant of the 300 series alloys and possesses the highest tensile and creep strength properties at elevated temperatures. It is designed for use in pharmaceutical, chemical and pulp and paper processing equipment to reduce product contamination to a minimum.
Type 317L with its .03 maximum carbon content is used in applications where it is not possible to anneal after welding and where maximum corrosion resistance is required

Corrosion Resistance: Improved resistance over Type 316. Often successfully applied where Type 316 has given only moderate performance.

Heat Resistance: Good oxidation resistance in intermittent service to 166°F and in continuous service to 1700°F. Continuous use of 317 in 800°-1575°F range is not recommended but often performs well in temperatures fluctuating above and below this range. Type 317L is more resistant to carbide precipitation and can be used in the above temperature range.

Heat Treatment: Annealing-heat to 1850-2050°F and cool rapidly for maximum corrosion resistance. These grades cannot be hardened by any form of thermal treatment.

Welding" Good welding characteristics suited to all standard methods. Use 317L or 309Cb filler rods or electrodes. Welded sections in Type 317 require post weld annealing for maximum corrosion resistance.

Typical Applications:
Sodium sulphate evaporators
Starch size containers
Insulation strapping
Acetic acid distillation columns and condensers
Pulp and paper machinery
Ink manufacturing and dyeing equipment

A.I.S.I Analysis		C	Mn	P	S	Si	Cr	Ni	Mo
	317	.08 max	2.0 max	.045 max	.030 max	1.0 max	18.0 to 20.0	11.0 to 15.0	3.0 to 4.0
	317L	.03 max	2.0 max	.045 max	.030 max	1.0 max	18.0 to 20.0	11.0 to 15.0	3.0 to 4.0

Typical Mechanical Properties Annealed	Yeild Strength 2%Offset psi	Ultimate Strength psi	Elongation % in 2"	Hardness		Impact Charpy ft.-lbs.	Modulus of Elasticity in Tension - psi
				Rb	BHN		
	40,000	90,000	45	85	163	135	28.0 x 10^6

Other Properties	Creep Strength 1% Flow in 10,000 hrs. at 1000°F psi	Magnetic Permeability at 200 H-Annealed	Electrical Resistivity-Microhm-Cm at 68°F	Coefficient of Thermal Expansion (In/In/°F x $10^{6)}$ 32°-212°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft.	
					at 212°F	at 932°F
	24,000	1.02	74	8.9	9.4	12.4

321 (UNS S32100)

Type 321 is basic 1818 steel stabilized by a titanium addition. It is not sensitive to intergranular corrosion when heated within the carbide precipitation range of 800-1600°F and can be used in this temperature range in corrosive environments.

Corrosive Resistance: Excellent. Equivalent to Types 302 or 304 in the annealed condition. . and superior if a weldment in these grades has not been post-weld annealed or if the application involves service in the 800-1600°F range.

Heat Resistance: Good oxidation resistance in intermittent service to 1600°F and in continuous service to 1700°F. Performs as well as any of the heat resisting stainless steels in the 800-1600°F range where serious corrosive conditions are present.

Heat Treatment: annealing – Heat to 1750-2050°F and cool rapidly for maximum corrosion resistance.
Stabilizing – Heat to 1550-1650°F for 1 hour per inch of thickness and air cool.
Stress Relief – Heat to 1300°F for 1 to 2 hours and air cool.
This grade cannot be hardened by thermal treatment

Welding: Good characteristics suited to all standard methods. Use Type 347 filler rod or electrodes.

Typical applications:
Aircraft exhaust manifolds.
Expansion joints
Bellows
Furnace parts
Heating element tubing

A.I.S.I Analysis		C	Mn	P	S	Si	Cr	Ni	Ti
	.08 max	2.0 max	.045 max	.030 max	1.0 max	1.0 max	17.0 to 19.0	9.0 to 12.0	5xC Min

Typical Mechanical Properties Annealed	Yeild Strength 2% Offset psi	Ultimate Strength psi	Elongation % in 2"	Hardness		Impact Charpy ft.-lbs.	Modulus of Elasticity in Tension - psi
				Rb	BHN		
	350000	90000	45	84	160	135	28.0 x 10^6

Other Properties	Creep Strength 1% Flow in 10,000 hrs. at 1000°F psi	Magnetic Permeability at 200 H-Annealed	Electrical Resistivity-Microhm-Cm at 68°F	Coefficient of Thermal Expansion (In/In/°F x $10^{6)}$ 32°-212°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft.	
					at 212°F	at 932°F
	18,000	1.02	72	9.3	9.3	12.8

347, 348 (UNS S34700, UNS S34800

These grades are chromium-nickel stainless steels containing columbium and tantalum. The columbium serves to produce a stabilized type of stainless steel which is immune to chromium carbide precipitation. The grades are thus recommended for parts fabricated by welding which cannot be subsequently annealed or for parts which must operate in service between 800-1600° F. Type 348 has the lower tantalum and cobalt contents of the two steels, making it suitable for use where the steel is subjected to nuclear irradiation.

Corrosion Resistance: Excellent. Equivalent to Type 304 and superior to Types 302 or 304 where unannealed weldments are involved or service temperatures in the 800 to 1600°F range. Where service is both corrosive and at elevated temperatures, these grades are superior to Type 321.

Heat Resistance: Good oxidation resistance in intermittent service to 1600°F and in continuous service to 1700°F. Best suited to service in the 800 to 1600°F range.

Heat Treatment: Annealing - Heat to 1850-2050°F and cool rapidly for maximum corrosion resistance.
Stabilizing - Heat to 1500 to 1650°F for 1 hour per inch of thickness, then air cool.
Stress Relief After fabrication, hold for 1 to 2 hours at 1300°F and air cool.

Welding: Good characteristics suited to all standard methods. Use Types 347 or 348 filler rod or electrodes. Post-weld annealing is not required.

Typical applications:
Radioactive systems.
Jet engine parts.
Furnace pans.
Welding rods.
Heat exchangers.

Typical Mechanical Properties Annealed	Yeild Strength .2% offset psi	Ultimate Strength psi	Elongation % in 2"	Hardness		Impact Charpy ft.-lbs.	Modulus Of Elasticity in Tension - psi
				Rb	BHN		
	40,000	95,000	45	85	160	135	28.0×10^6

Other Properties	Creep Strength 1% Flow in 10,000 hrs. at 1000°F psi	Magnetic Permeability at 200 H-Annealed	Electrical Resistivity - Microhm-Cm at 68°F	Coefficient Of Thermal Expansion (In/In°F $\times 10^6$) 32°-212°F	Thermal Conductivity BTU/Ft.²/Hr./°F/Ft.	
					at 212°F	at 932°F
	19,300	1.02	7473	9.3	9.3	12.8

403, 410 (UNS S40300, UNS S41000)

This is the basic grade in the group of 400 Series alloys that can be hardened by heat treatment. It, and its companion grade, Type 403, contain a minimum of 11.5 per cent chromium ... just sufficient to give them corrosion resistance properties. Both achieve maximum corrosion resistance when they have been hardened and then polished. While Type 403 is designed for a specific field of applications, Type 410 is a general purpose grade often supplied in the hardened, but still machinable condition for applications where high strength and moderate heat and corrosion resistance are required.

Corrosion Resistance: Resists dry atmosphere, fresh water, mild alkalies and acids, steam and hot gasses. Must be hardened for maximum heat and corrosion resistance, Less corrosion resistant than 300 Series grades and ferritic 400 Series alloys such as Type 430.

Heat Resistance: Good resistance to scaling in intermittent service to 1500°F and in continuous service to 1300°F.

Heat Treatment: Hardened by heating to 1700-1850°F, quenching in oil or air and tempering to obtain a wide variety of hardness values and mechanical properties as indicated in the accompanying table and graph.
NOTE: THE TEMPERING RANGE 750 to 1075°F SHOULD BE AVOIDED.

Welding: Readily welded by all standard methods ... but a pre-heat of 300-S00'F and post-weld annealing treatment is required to reduce the possibility of cracking. Use Type 410 welding rod if post hardening and tempering is involved. If parts are to be used in the "as welded" condition, a ductile joint can be achieved by using Type 308 or 309 filler rod.

Typical applications:
Bolts, nuts, screws.
Bushings.
Pump pans and shafts.
Petroleum fractioning towers.
Mine ladder *rungs.*
Valves.

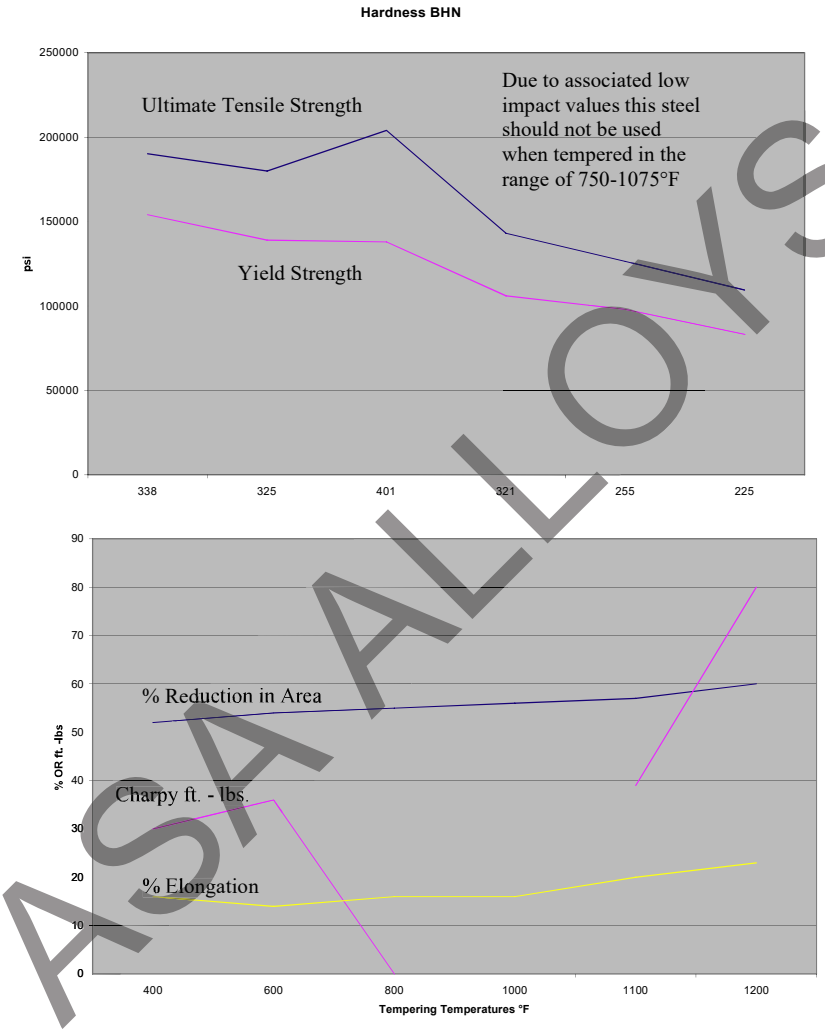
A.I.S.I Analysis	C	Mn	P	S	Si	Cr
	.15 max	1.0 max	.040 max	.030 max	1.0 max	11.5 to 13.5

Typical Mechanical Properties Annealed	Yeild Strength .2% Offset psi	Ultimate Strength psi	Elongation % in 2"	Hardness Rb	Hardness BHN	Impact Charpy ft.-lbs.	Modulus of Elasticity in Tension - psi
	45,000	70,000	25	80	150	110	29.0 x 10^6

Other Properties	Creep Strength 1% Flow in 10,000 hrs. at 1000°F psi	Coefficient of Thermal Expansion (In/In/°F x $10^{6)}$ 32°-212°F	Electrical Resistivity-Microhm-Cm at 68°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft. at 212°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft. at 932°F
	12,000	5.5	57	14.4	16.6

403, 410
(Continued)

TYPICAL MECHANICAL PROPERTIES OF 1" SECTION TYPE 410 OIL HARDENED FROM 1750°F AND TEMPERED AT VARIOUS TEMPERING TEMPERATURES FOR 1 HOUR.



	Tempering Temperature °F					
	400	600	800	1000	1100	1200
Ultimate Tensile Strength psi	190200	180000	204000	143000	126400	109500
.2% Yeild Strength	154000	139000	138000	106000	98000	83200
Elongation %	16	14	16	16	20	23
Reduction of Area %	52	54	55	56	57	60
Hardness BHN	338	325	401	321	255	225
Charpy impact Ft.-lbs.	30	36	Due to associated low impact values this steel should not be used when tempered in the range of 750-1075°F		39	80

416, 416MX, 416 MF, 416MH, 4MX (UNS S41600)

TYPE 416 SUPER FREE MACHINING GRADE FAMILY
TYPE 416MX – This grade with a typical sulphur content of .33, possess excellent machinability, provides a fine surface finish on the machined parts has uniform hardness in !he "as supplied" condition and can be hardened to 35Rc minimum ... characteristics that make this grade particularly suited for use in automatic screw machining operations. Machinability Rating (612.12) 90%

TYPE 416MH - A modification of Type 416MX, with a typical sulphur content of .29, combining the capacity of being heat treated to 40Rc minimum with excellent machinability. Machinability Rating (61212) 85%

TYPE 416MF - A second modification 01 Type 416MX having a typical sulphur content of .20 and combining formability and response to heat treatment with good machinability. Machinability Rating (BI212) 80%

TYPE 4MX - Developed to provide the ultimate in free machining, this grade is custom melted to meet specific application requirements. The Alias Metallurgical Department should be contacted for detailed information. Machinability Rating (61212) 95%

Corrosion Resistance: Good resistance to dry atmospheres, fresh water and mild alkalise and acids, but less resistant than the 300 Series grades. Maximum resistance in the hardened and tempered condition.

Heat Resistance: Fair resistance to scaling in intermittent service to 1400°F and to 1250°F in continuous service.

Heat Treatment: Annealing - Heal to 1500-1650°F hour per inch of thickness, Cool at 50°F per hour maximum to 1100°F and air cool.
Hardening – Hardened by heating to 1700-1850°F, quenching in oil, and tempering to suit the mechanical requirements. See accompanying table and chart.
NOTE: THE TEMPERING RANGE 750-1075°F SHOULD BE AVOIDED.

Welding: If welding is necessary ... use Type 410 low hydrogen electrodes. Pre-heat to 400-600°F. Follow immediately with annealing or re-hardening . . . or a stress relief at 1200-1250°F.

Typical applications:
Valve parts
Motor shafts
Bolt,s nuts, studs, gears.
Automatic screw machined parts
Washing machines

Typical Analysis and Properties for Atlas Type 416 Free Machining Grades

A.I.S.I Analysis	C	Mn	P	S	Si	Cr	Mo
416MX	0.15 max	1.25 max	0.06 max	0.33*	1.0 max	12.0 to 14.0	0.60 max ††
416MF	0.15 max	1.25 max	0.06 max	0.20*	1.0 max	12.0 to 14.0	0.60 max ††
416MH	0.15 max	1.25 max	0.06 max	0.29*	1.0 max	12.0 to 14.0	0.60 max ††
4MX	0.15 max	1.25 max	0.06 max	0.40†	1.0 max	12.0 to 14.0	0.60 max ††
A.I.S.I 416	0.15 max	1.25 max	0.06 max	0.15 min	1.0 max	12.0 to 14.0	0.60 max ††

Typical Mechanical Properties Annealed	Yeild Strength .2% Offset psi	Ultimate Strength psi	Elongation % in 2"	Hardness		Impact Charpy ft.-lbs.	Modulus of Elasticity in Tension - psi
				Rb	BHN		
	83,000	105,000	20	97	225	21	29.0 x 10^6

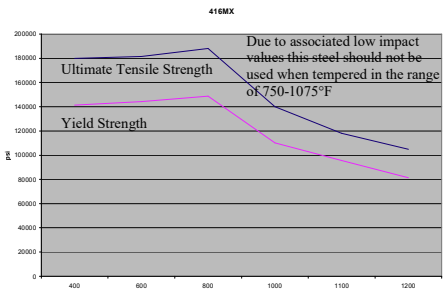
Other Properties	Creep Strength 1% Flow in 10,000 hrs. at 1000°F psi	Coefficient of Thermal Expansion (In/In/°F x $10^{6)}$ 32°-212°F	Electrical Resistivity-Microhm-Cm at 68°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft.	
				at 212°F	at 932°F
	9,000	5.5	57	14.4	16.6

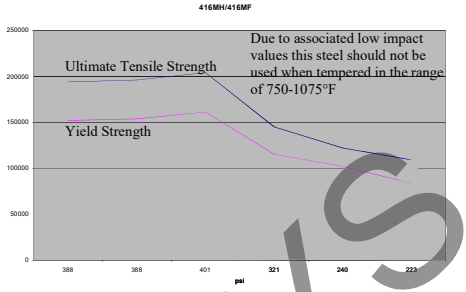
* Typical Sulfur Analysis † or as required ††optional

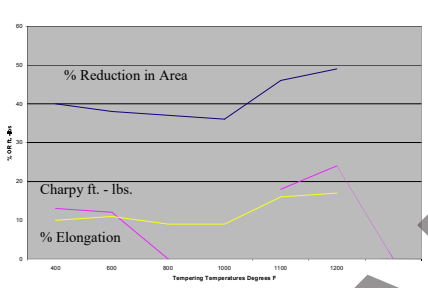
416, 416MX, 416MF, 416MH, 4MX

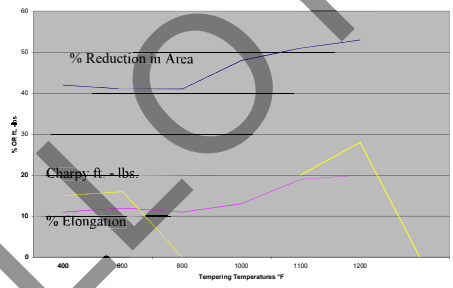
(Continued)

Typical mechanical properties of 1" section - Type 416MX / 416MH / 416MF oil hardened from 1750°F and tempered at various tempering temperatures for 1 hour.









Tempering Temp.°F	Ultimate Tensile Strength psi	.2% Yeild Strength psi	Elongation %	Reduction of Area %	Hardness BHN	Charpy Impact Ft.-Lbs
400	180000	141300	10	40	375	13
600	181400	144200	11	38	375	12
800	188000	148600	9	37	375	Due to the associated low impact values this steel should not be used when tempered in the range 750-1075°F
1000	140000	110200	9	36	-	
1100	118000	95600	16	46	241	18
1200	105000	81300	17	49	217	24

Tempering Temp.°F	Ultimate Tensile Strength psi	.2% Yeild Strength psi	Elongation %	Reduction of Area %	Hardness BHN	Charpy Impact Ft.-Lbs
400	194000	152000	11	42	388	15
600	196000	153700	12	41	388	16
800	204000	161300	11	41	401	Due to the associated low impact values this steel should not be used when tempered in the range 750-1075°F
1000	145000	115300	13	48	321	
1100	122000	102000	19	51	240	20
1200	109000	83600	20	53	223	28

420 (UNS S42000)

This grade has good ductility in the annealed condition but is capable of being hardened up to 50 Rc ... the highest hardness of the 12 per cent chromium grades. Best corrosion resistance for this grade III achieved when the metal is hardened, surface ground, or polished.

Corrosion Resistance: Good resistance in the hardened condition to the atmosphere, foods, fresh water, and mild alkalies or acids. Corrosion resistance is very low in the annealed condition.

Heat Resistance: Not recommended for use in temperatures above 700°F.

Heat Treatment: Annealing - Heat to 1550-1650°F, slow furnace cool to 1100°F and then air cool. Sub-Critical Anneal - Heat to1350·1450°F and air cool.

Hardening - Heat to 1800-1900°F and air or oil cool. Oil quenching is necessary for heavy sections. Temper to obtain a wide variety of hardness values and mechanical properties as indicated in the accompanying table and graph. NOTE: THE TEMPERING RANGE 800 TO 1100˚F SHOULD BE AVOIDED.

Welding: Pre-Heat at 300-600°F and post-heat at 1125-1400°F. Type 420 coaled welding rods recommended for high strength joints. Types 309 and 310 can be used if ductile weld required.

Typical Applications:
Cutlery
Knife blades
Surgical instruments
Needle valves
Shear blades

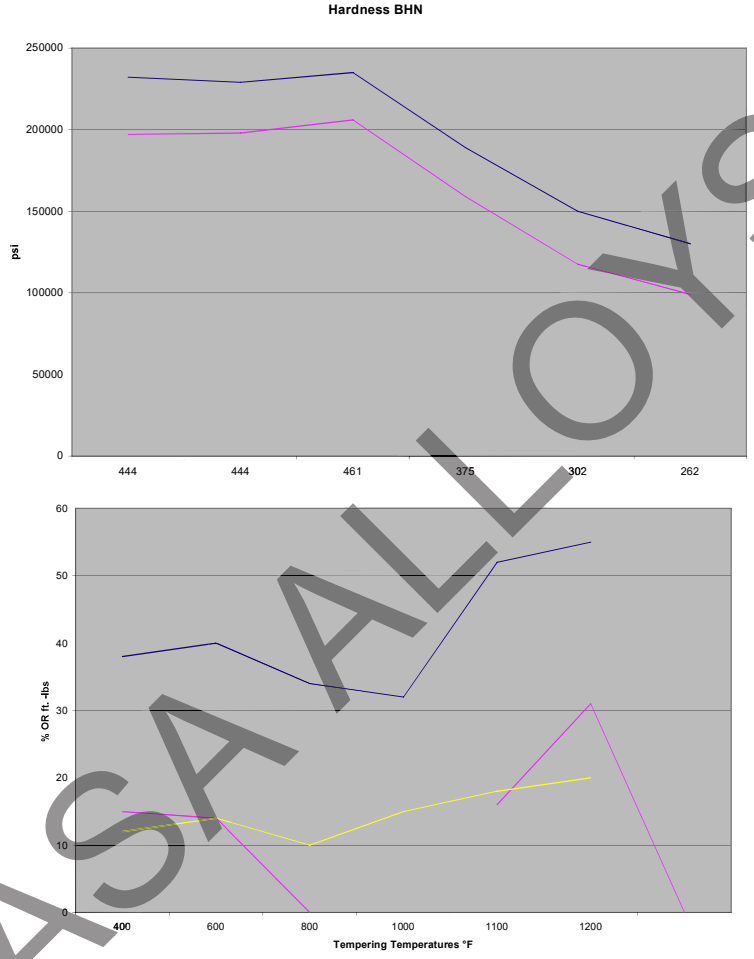
A.I.S.I Analysis	C	Mn	P	S	Si	Cr
	.15 max	1.0 max	.040 max	.030 max	1.0 max	12.0 to 14.0

Typical Mechanical Properties Annealed	Yeild Strength .2% Offset psi	Ultimate Strength psi	Elongation % in 2"	Hardness Rb	Hardness BHN	Impact Charpy ft.-lbs.	Modulus of Elasticity in Tension - psi
	50,000	95,000	25	92	192	31	29.0×10^6

Other Properties	Creep Strength 1% Flow in 10,000 hrs. at 1000°F psi	Coefficient of Thermal Expansion (In/In/°F x $10^{6)}$ 32°-212°F	Electrical Resistivity-Microhm-Cm at 68°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft. at 212°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft. at 932°F
	11,400	5.7	55	14.4	16.8

420
(Continued)

Typical mechanical properties of 1" section Type 420 oil hardened from 1750°F and tempered at various tempering temperatures for 1 hour.



	Tempering Temperature °F					
	400	600	800	1000	1100	1200
Ultimate Tensile Strength psi	232200	229000	235000	189000	150000	130000
.2% Yield Strength psi	197000	198000	206000	159000	117500	99000
Elongation %	12	14	10	15	18	20
Reduction of Area %	38	40	34	32	52	55
Hardness BHN	444	444	461	375	302	262
Charpy Impact Ft.-Lbs.	15	14	Due to associated low impact values this steel should not be used when tempered in the range of 800-1000°F		16	31

430, 430F (UNS S43020)

Type 430 is a straight chromium, non-hardenable grade combining good corrosion resistance and formability characteristics with useful mechanical properties. Its ability to resist nitric acid attack permits its use in specific chemical applications but automotive trim represents its largest field' of applications.

Type 430F is the free-machining version 01 this grade designed for use in parts produced in automatic screw machines.

AISI Type 434 is the molybdenum bearing version of Type 430 and has the same useful combination of properties. Its molybdenum addition improves corrosion resistance particularly to road salt attack in automotive trim applications.

AISI Type 436 is another version of 430. It contains columbrium, as well as the molybdenum addition, to improve the surface appearance of stretched and drawn parts.

Corrosion Resistance: Good resistance to a wide variety of corrosive media including nitric acid and some organic acids. It attains its maximum corrosion resistance when in the highly polished or buffed condition.

Heat Resistance: Resists oxidation in intermittent service up to 1600°F and to 1500°F in continuous service. This grade may become brittle at room temperature after prolonged heating in the 750-100°F range. This can be eliminated by annealing.

Heat Treatment: Annealing – Heat to 1500 to 1550°F, hold for ½ hour per inch of thickness, slow furnace cool to 1100°F and then quickly air cool.

Sub-critical Anneal – Heat to 1400-1500°F and then air cool.
This grade is not hardenable by thermal treatment.

Welding: If welding is necessary . . . preheat at 300-400°F. Embrittlement in the weld metal and heat affected zone can be relieved by a post-anneal but grain refinement will not occur. Use type 430,308 or 310 filler rod.

Typical applications:
Automotive trim
Lashing wire
Element supports
Stove trim rings
Chimney liners

A.I.S.I Analysis		C	Mn	P	S	Si	Cr	Mo
	430	.12 max	1.0 max	.040 max	.030 max	1.0 max	16.0 to 18.0	
	430F	.12 max	1.25 max	.040 max	.15 Min	1.0 max	16.0 to 18.0	.60 max Optional

Typical Mechanical Properties Annealed	Yeild Strength .2% Offset psi	Ultimate Strength psi	Elongation % in 2"	Hardness		Impact Charpy ft.-lbs.	Modulus of Elasticity in Tension - psi
				Rb	BHN		
	50,000	75,000	25	85	163	21	29.0×10^6

Other Properties	Creep Strength 1% Flow in 10,000 hrs. at 1000°F psi	Coefficient of Thermal Expansion (In/In/°F x $10^{6)}$ 32°-212°F	Electrical Resistivity-Microhm-Cm at 68°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft.	
				at 212°F	at 932°F
	8,600	5.8	60	15.1	15.2

431 (UNS S43100)

This heat treatable, nickel bearing grade has the best corrosion resistance properties of all the straight chromium types. It has excellent tensile and torque strength, and good toughness . . . making it ideally suited to shafting and bolt applications. Because of its high yield strength, this grade is not recommended for use in operations such as cold heading, bending, deep drawing or spinning.

Corrosion Resistance: Excellent resistance to a wide variety of corrosive media. Good resistance to salt water in northern waters but less resistant than Type 316 in tropical waters.

Heat Resistance: Resists scaling in intermittent service to 1700°F and continuous service to 1600°F

Heat Treatment: Annealing – Heat to 150-1225°Ffor 12 to 24 hours and air cool. Hardening – hardened by heating to 1800-1900°F, quenching in oil and tempering to suit mechanical requirements. See accompanying table and chart. NOTE: THE TEMPERING RANGE 800 TO 1100°F SHOULD BE AVOIDED.

Welding: A pre-heat of 500°F is recommended prior to welding. Type 410 filler rod can be used, but Types 308,309 or 310 will provide more ductile welds. Post-weld anneal at 1150-1225°F.

Typical applications:
Nut and bolts
Propeller shafting
Beater bars
Marine hardware

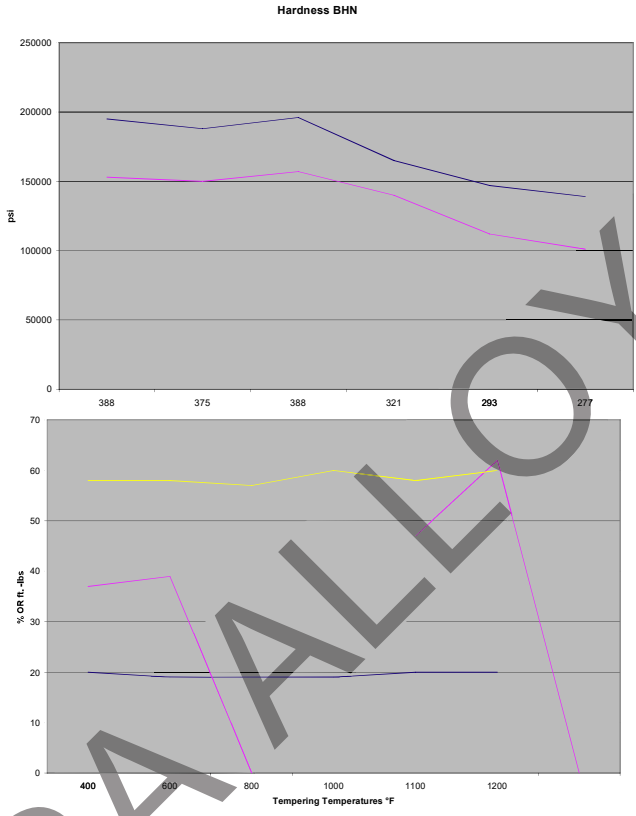
A.I.S.I Analysis	C	Mn	P	S	Si	Cr	Ni
	.20 max	1.0 max	.040 max	.15 max	0.03 max	15.0 to 17.0	1.25 to 2.50

Typical Mechanical Properties Annealed	Yeild Strength .2% Offset psi	Ultimate Strength psi	Elongation % in 2 ''	Hardness		Impact Charpy ft.-lbs.	Modulus of Elasticity in Tension - psi
				Rb	BHN		
	95,000	125,000	20	103	262	37	29.0 x 10^6

Other Properties	Creep Strength 1% Flow in 10,000 hrs. at 1000°F psi	Coefficient of Thermal Expansion (In/In/°F x $10^{6)}$ 32°-212°F	Electrical Resistivity-Microhm-Cm at 68°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft.	
				at 212°F	at 932°F
	12,000	5.6	72	11.7	13.2

431
(Continued)

Typical mechanical properties of 1" section Type 431 oil hardened from 1800°F and tempered at various tempering temperatures for 1 hour.



	Tempering Temperature °F					
	400	600	800	1000	1100	1200
Ultimate Tensile Strength psi	195000	188000	196000	165000	147000	139000
.2% Yeild Strength	153000	150000	157000	140000	112000	101000
Elongation %	20	19	19	19	20	20
Reduction of Area %	58	58	57	60	58	60
Hardness BHN	388	375	388	321	293	277
Charpy impact Ft.-lbs.	37	39	Due to associated low impact values this steel should not be used when tempered in the range of 750-1075°F		47	62

440C (UNS S44004)

This grade is capable of attaining, after heat treatment, the highest strength and wear resistant properties of all the stainless alloys. Its relatively high carbon content is responsible for these strength wear characteristics which make Type 440C particularly suited to such applications as ball bearings and valve parts

Corrosion Resistance: Good resistance to the atmosphere, fresh water, foods, alkalies and mild acids when in the hardened, tempered and passivated condition.

Heat Resistance: Not recommended for use above 700°F.

Heat Treatment: Hardened by heating to 1850-1950°F, cooling in oil and tempering to suit mechanical conditions as indicated in the accompanying table and graph.
Annealing: Heat to 1550-1650°F and slow cool.
Sub Critical Anneal: heat to 1350-1450°F and air cool. NOTE: TEMPERING ABOVE 700°F IS TO BE AVOIDED.

Welding: If welding is necessary preheat at 500°F and follow with a full anneal. Types 420, 309 and 310 filler rods can be used following this pre-heat and post-annealing procedure.

Typical Applications:
High grade cutlery.
Surgical tools.
Bearings and races.

A.I.S.I Analysis	C	Mn	P	S	Si	Cr	Ni
	.95 to 1.20	1.0 max	.040 max	.030 max	1.0 max	16.0 to 18.0	.75 max

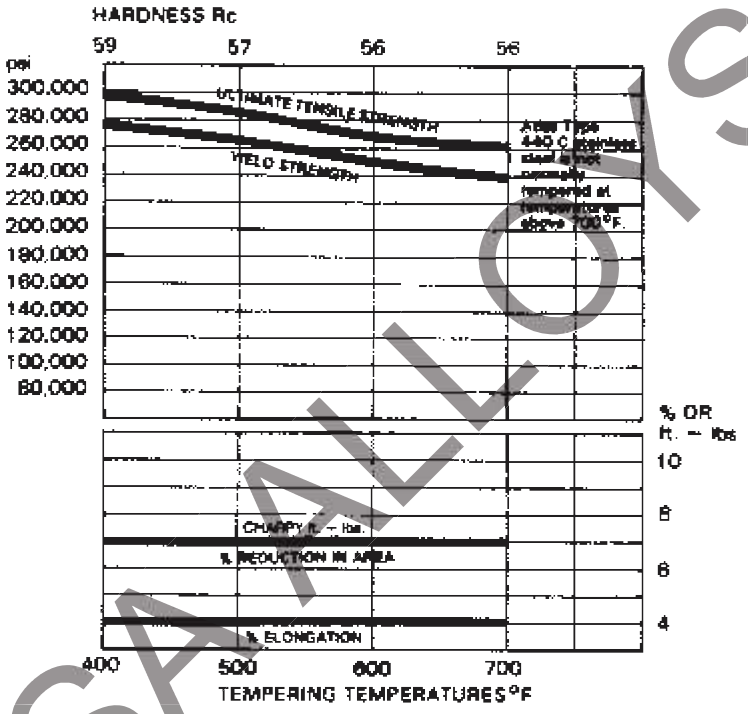
Typical Mechanical Properties Annealed	Yeild Strength .2% Offset psi	Ultimate Strength psi	Elongation % in 2"	Hardness		Impact Charpy ft.-lbs.	Modulus of Elasticity in Tension - psi
				Rb	BHN		
	65,000	110,000	14	97	223	4	29.0 x 10^6

Other Properties	Creep Strength 1% Flow in 10,000 hrs. at 1000°F psi	Coefficient of Thermal Expansion (In/In/°F x $10^{6)}$ 32°-212°F	Electrical Resistivity-Microhm-Cm at 68°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft.	
				at 212°F	at 932°F
		5.6	60	14.0	14.2

440C

(Continued)

TYPICAL MECHANICAL PROPERTIES OF 1" SECTION TYPE 440C OIL HARDENED FROM 1800°F AND TEMPERED AT VARIOUS TEMPERATURES FOR 1 HOUR.



NITRONIC 50 (S20910)

Nitronic 50 is a nitrogen strengthened austenitic stainless that provides a combination of corrosion resistance and strength. Corrosion resistance greater than that of 316 and 316L plus approximately twice the yield strength. Nitronic 50 has very good mechanical properties at both elevated and subzero temperatures. Nitronic 50 is non-hardenable by heat treatment and is non-magnetic.

Chemical Composition (nominal analysis)	
Carbon, max.	0.06%
Manganese, max.	4.0-6.0
Phosphorus, max.	0.04
Sulfur, max.	0.08
Silicon, max.	1.00
Chromium, max.	20.5-23.5
Nickel, max.	11.5-13.5
Molybdenum, max.	1.5-3.0
Others	N .20/.40, Cb .10/.30, V .10/.30

NITRONIC 60 (S21800)

Nitronic 60 has excellent galling resistance and corrosion resistance comparable to 304 plus approximately twice the yield-strength. Metal to metal abrasive wear is also good. Nitronic 60 is non-hardenable by heat treatment and is non-magnetic.

Chemical Composition (nominal analysis)	
Carbon, max.	0.10%
Manganese, max.	7.0-9.0
Silicon, max.	3.5-4.5
Chromium, max.	16.0-18.0
Nickel, max.	8.0-9.0
Others	N .20/.40, Cb .10/.30, V .10/.30

254 SMO (UNS S31254)

254 SMO is an austenitic stainless steel designed for maximum resistance to pitting and crevice corrosion. 254 SMO has excellent impact toughness, workablilty and weldability in addition to being highly resistant to chloride stress corrosion cracking. this alloy is 50% stronger than 300 series austenitic stainless steels.

Applications: Seawater handling systems, pulp mill bleach systems, tall oil distillation columns and equipment, chemical processing equipment, food processing equipment, desalination equipment, flue gas desulphurization scrubbers, oil and gas production equipment.

Chemical Composition, wt. pct.		
Element	Wrought Products	Castings
Carbon	0.020 max	0.025
Chromium	19.5 - 20.5	19.5 - 20.5
Nickel	17.5 - 18.5	17.5 - 19.5
Molybdenum	6.0 -6.5	6.0 -7.0
Nitrogen	0.18 - 0.22	0.180 - 0.240
Copper	0.50 - 1.00	0.50 - 1.00
Sulphur	0.010 max	0.010 max
Phosphorus	0.030 max	0.045 max
Silicon	0.80 max	1.oo max
Manganese	1.00 max	1.20 max
Iron	balance	balance

RA 2205 (UNS S31803, UNS S32205)

Duplex Stainless

RA2205 is an austenitic-ferritic stainless steel containing about 40-50% ferrite in the annealed condition. The high chromium, molybdenum and nitrogen contents provide corrosion resistance superior to 316L or 317L stainless in most environments. The design strength of RA2205 is significantly higher, often permitting lighter wall construction. RA b2205 has good notch impact toughness down to -40°F, and is fabricated by established duplex welding procedures.

Applications: Chemical process vessels, piping and heat exchangers. Pulp mill digesters, bleach washers, chip pre-streaming vessels. Food processing equipment. Oil feild piping and heat exchangers.

Machining: Because of its high strength, RA 2205 is generally more difficult to machine than conventional austenitic stainless. It is relatively easier to machine duplex stainless with high speed steel, rather than cemented carbide tooling.

Welding: When welding RA2205 the aim is to obtain fusion and heat affected zones having the same high corrosion resistance and impact strength asthe base metal. This is achieved by control of heat input and interpass temperature and by limiting total time for the HAZ to be in the 1300-1800°F range.

Chemical Composition, wt. pct.	
Chromium	22.0 - 23.0
Nickel	4.50 - 6.50
Molybdenum	2.50 - 3.50
Carbon	0.030 max
Nitrogen	0.14 - 0.20
Manganese	2.0 max
Silicon	1.0 max
Phosphorus	0.030 max
Sulphur	0.020 max
Iron	balance

AL-6XN® Alloy (UNS NO8367

The AL-6XN alloy (UNS N08367) Is the most corrosion resistant austenlllc stainless alloy produced by Allegheny Ludlum Corporation at this tme. The alloy is resistant to a broad range of very corrosive environments and is readily available from stock in a wide range of product forms, including thick plate that is suitable for multi-pass welding during field fabrication. The high strength and corrosion resistance of the AL-6XN alloy make it a better choice than the conventional duple~ stainless steels and a cost effective alternate to more expensive nickel base alloys in applications where excellent formability, weldability, strength and corrosion resistance are essential. It Is also a viable alternative to less expensive alloys, such as Type 316, that do not have the strength required for certain applications.

The AL-6XN alloy is a low carbon, high purity, nitrogen bearing "super·austenitic" stainless alloy. The alloy represents the highest levels of chromium, nickel and molybdenum available in the austenitic class of stainless alloys.

The high nickel and molybdenum contents provide excellent resistance to chloride stress corrosion cracking. Copper (Cu) has been intentionally kept to a residual level for improved performance in seawater and to minimize the precipitation of deleterious secondary phases. The high alloy composition of the AL-6XN alloy resists crevice corrosion and pitting in oxidizing chloride solutions to a degree previously achieved only by nickel-base alloys and titanium.

AL·6XN alloy is well suited for such applications as:

- Chemical process tanks and pipelines
- Process systems for offshore oil and gas platforms
- Condensers. heat exchangers and piping containing seawater or crude oil
- Filter washers, vats and press rolls in pulp bleaching plants
- Power plant flue gas scrubbe, environments
- Tall oil distillation columns and pecking
- Reverse osmosis desalination equipment and pumps
- Service water piping systems for nuclear power plants

AL-6XN alloy offers the following distinct advantages:

- **Corrosion Resistance -** The intrinsic corrosion resistance of the AL-6XN alloy in both acidic and alkaline environments provides protection against metallic contamination of process streams and rapid degradation of components made of the alloy.
- **Cost Effectiveness -** The AL-6XN alloy is a viable alternative to non-metallic materials that provide high levels of corrosion resistance but are costly to install and maintain. AL·6XN alloy is significantly less costly than most nickel-base alloys.
- **Workability -** The toughness and ductility of the AL-6XN alloy provide for relative ease of fabrication. The formability and weldability of the AL-6XN alloy are much better than that of high alloy ferritc stainless steels that demonstrable comparable resistance to corrosion
- **As-Welded Properties** - The low carbon and high nitrogen contents minimize the precipitation of carbides and secondary phases that can occur during welding so that aswelded assemblies can be placed in service, provided that a suitable over-matched filler metal is used and the assembly is properly cleaned.
- **Wide Range of Product Forms -** AL·6XN alloy is readily available in a wide range of product forms, such as lube, pipe, sheet, plate, bar, billet and forgings. Components such as pumps, valves, fittings, fasteners and castings are also available.

Chemical Composition

The typical and specified chemical compositions of AL-6XN alloy are presented in Table 1. The chromium, nickel and molybdenum contents are significantly higher in the AL-6XN alloy than in the standard Type :104L, 316L and 317L grades. The alloy has been registered with the Society of Automotive Engineers (SAE) with the designation UNS N08367 and is included in nine different standards in the American Society for Testing and Materials (ASTM) annual book 01 standards. ASTM has classified AL·6XN alloy with the nonferrous alloys in the "B" specification because the alloy contains slightly less than 50% iron. The alloy is listed with an "N" in the Unified Number System (UNS) for the same reason. The low carbon content of AL-6XN alloy distinguishes it as an "L" grade, providing high resistance to intergranular corrosion in the as welded condition.

Chemical Element	Composition, Wt.%	
	Typial Al-6XN Alloy	UNS N08367
C	0.02	0.03 max
Mn	0.04	2.00 max
P	0.025	0.040 max
S	0.002	0.030 max
Si	0.4	1.00 max
Cr	20.5	2.00/22.00
Ni	24	23.50/25.50
Mo	6.3	6.00/7.00
Ni	0.22	0.18/0.25
Cu	0.1	0.75 max
Fe	Balance	Balance

Table 1-Chemical Composition

ALLOY 20 (UNS N08020)

Features

- Excellent resistance to hot sulfuric acid
- Resistant to intergranular corrosion in the as-welded condition
- Chloride stress corrosion cracking resistance

Applications

- Flue gas scrubbing systems
- Sulfuric acid pickling tanks, racks, and heating coils
- Phosphate coating drums and racks
- Heat exchangers
- Bubble caps
- Process piping
- Mixing tanks
- Chemical and petroleum process equipment

Chemical Composition %

	Min.	Max
Nickel	32.50	35.00
Chromium	19.00	21.00
Carbon	-	0.06
Molydbenum	2.00	3.00
Copper	3.00	4.00
Manganese	-	2.00
Phosphorus	-	0.035
Sulfur	-	0.035
Silicon	-	1.00
Cb + Ta	8 x C	1.00
Iron	Remainder	

General

Alloy 20 stainless is the alloy designed specifically to withstand sulfuric acid. Its nickel, chromium, molybdenum and copper levels all provide excellent corrosion resistance. At 33% nickel, Alloy 20 has practical immunity to chloride stress corrosion cracking. This alloy is often chosen to solve SCC problems which may occur with 316 stainless. Restricted carbon plus columbium stabilization permits welded fabrications to be used in corrosive environments, normally without post-weld heat treatment. Alloy 20 stainless finds extensive use processing pharmaceuticals, food, plastics, explosives and synthetic fibers.

Mechanical Properties

Minimum Room Temperature Properties:

Tensile Strength, psi	0.2% Yeild Strength, psi	Elong. In 2" or 4D, %	Hardness Rockwell B
80,000	35,000	30	84

Typical Room Temperature Properties:

Tensile Strength, psi	0.2% Yeild Strength, psi	Elong. %	Reduction Of Area, %	Hardness Brinell
91,000	48,000	45	67	174

17-4 PH Precipitation Hardening Stainless (UNS S17400)

This 17Cr/4Ni precipitation hardening stainless steel has a combination of high hardness and strength after suitable heat treatment. It also has similar corrosion and heat resistance to Type 304.

Corrosion Resistance: Excellent resistance to the same range of corrosive environments as Atlas Type 304 stainless steel.

Heat Resistance: Good oxidation resistance. To preserve mechanical properties and hardness do use above 900°F.

Heat Treatment: Solution anneal-heat at 1900°F for 1/2 hour and cool to 90°F maximum in air. Oil quenching may be used for small non - intricate sections.

Hardening: A single low temperature process is employed. Heat to 900°-1150°F 1 to 4 hours and air cool. Typical hardness values after hardening are:

Hardening Temperature (°F)	Typical Hardness Rockwell C
900	44
925	42
1025	38
1075	36
1100	35
1150	33

A decrease in size (shrinkage) takes place during the hardening process, and this change must be allowed for in prior manufacturing operations. The magnitude of the size change is temperature dependent-
900°F - .0005" approx.
1150°F -. 001" approx.

Welding: Can be successfully welded by all standard methods. Preheating is not necessary. Properties comparable to those of the parent metal may be achieved in the weld metal by appropriate post-weld heat treatment. Somewhat low weld metal ductility may give rise to notch sensitivity. Precaution should be taken in design and welding procedures to avoid concentration of weld melt stresses.

Typical applications:
Gears
Valves
Power Plant
Plastic molding dies
High Strength shafts
Engine parts

A.I.S.I Analysis	C	Mn	P	S	Si	Cr	Ni	Cu	Cb + Ta
	.07 max	1.0 max	.040 max	.030 max	1.0 max	14.0 to 15.5	3.5 to 5.5	2.5 to 4.5	0.15 to 0.45

Typical Mechanical Properties Annealed	Yeild Strength .2% Offset psi	Ultimate Strength psi	Elongation % in 2 ' '	Hardness		Impact Charpy ft.-lbs.	Modulus of Elasticity in Tension - psi
				Rb	BHN		
	130,000	160,000	15	35	330	30	28.5 x 106

Other Properties	Creep Strength 1% Flow in 10,000 hrs. at 1000°F psi	Coefficient of Thermal Expansion (In/In/°F x 106) 32°-212°F	Electrical Resistivity-Microhm-Cm at 68°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft.	
				at 212°F	at 932°F
	23	6	77	10.3	13.1

15-5 PH Percipitation Hardening Stainless (UNS S15500)

This 15Cr/5Ni precipitation hardening stainless steel is similar to S17400 (17Cr/4Ni) offering the same excellent combination of high hardness and strength in addition to the corrosion and heat resistance of Type 304. The chemical balance of 15Cr/5Ni PH reduces the delta ferrite content enhancing the traverse ductility and impact properties. 15Cr/5Ni PH is produced by vacuum arc remelting and meets the most stringent cleanliness requirements (e.g. for aerospace applications).

Corrosion Resistance: Excellent - Similar to Type 304.

Heat Resistance: Good oxidation resistance. To preserve mechanical properties and hardness do use above 900°F.

Heat Treatment: Solution anneal-heat at 1900°F for 1/2. hour and cool to 90°F maximum in air. Oil quenching may be used for small non-intricate sections.

Hardening: A single low temperature process is employed. Heat to 900°-1150°F 1 to 4 hours and air cool. Typical hardness values after hardening are:

A decrease in size (shrinkage) takes place during the hardening process, and this change must be allowed for in prior manufacturing operations. The magnitude of the size change is temperature dependent-

900"F -. 0005" approx.
1150"F - .001" approx.

Welding: Can be successfully welded by all standard methods. Preheating is, not necessary. Properties comparable to those of the parent metal may be achieved in the weld metal by appropriate post weld heat treatment. Somewhat low weld metal ductility may give rise to notch sensitivity. Precaution should be taken in design and welding procedures to avoid concentration of weldmelt stresses.

Typical applications:
Aircraft and aerospace components.
Nuclear applications.
Chemical and paper processing equipment.
Valves, shafts, gears.
Engine parts.

	C	Mn	P	S	Si	Cr	Ni	Cu	Cb + Ta
A.I.S.I Analysis	.070 max	1.0 max	.040 max	.030 max	1.0 max	14.0 to 15.5	1.25 to 2.50	2.5 to 4.5	0.45

Typical Mechanical Properties Annealed	Yeild Strength .2% Offset psi	Ultimate Strength psi	Elongation % in 2 ' '	Hardness Rb	Hardness BHN	Impact Charpy ft.-lbs.	Modulus of Elasticity in Tension - psi
	95,000	125,000	20	103	262	37	29.0 x 10^6

Other Properties	Creep Strength .1% Flow in 1,000 hrs. at 900°F psi	Coefficient of Thermal Expansion (In/In/°F x $10^{6)}$ 32°-212°F	Electrical Resistivity-Microhm-Cm at 68°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft. at 212°F	Thermal Conductivity BTU-Ft.²/Hr./°F/Ft. at 932°F
	23	6.0	77	10.3	13.1

E-BRITE®* Alloy

Features

- Freedom from chloride stress corrosion cracking
- Highly resistant to organic acids, oxidizing acids, caustics and many chlorine and ammonia compounds
- Resistant to pitting and crevice corrosion
- low thermal expansion and high thermal conductivity

Applications

- Heat exchanger tubing
- Petroleum refining
  overhead condensers
  reboilers
  feed heaters
- Pulp and paper liquor heaters
- Organic acid heaters and condensers
- Nitric acid cooler condensers
- Urea stripper tubing

Chemical Composition, %

	Min.	Max
Nickel	-	.50
Chromium	25.0	27.5
Carbon	-	.010
Molydbenum	.75	1.50
Copper	-	.20
Manganese	-	.40
Phosphorus	-	.02
Sulfur	-	.02
Silicon	-	.40
Columbium	.05	.20
Nitrogen	-	0.015
Ni + Cu	-	.20
Iron	-	.50
	Remainder	

*Registered trademark of Allegheny Ludlum Steel Corporation.
UNS S44627

General

E·BRITE is a high chromium specialty alloy which has proven itself over the past decade as an excellent material at construction where stress corrosion cracking, pitting, and crevice corrosion are at ajar concern.

E-BRITE has very good general corrosion resistance in most oxidizing acids, organic acids, and caustics. It has been specified for heat exchanger tubing in a variety at industrial applications, including pulp liquor heaters, bleach equipment, urea strippers, most petroleum refinery oberhead condensers, MEA and DEA reboilers, after-coolers, and feed heaters.

In general, E-BRITE serves best in all at the above where brackish or high chloride water must be used for either heating or cooling the process stream. Being a ferritic alloy, E-BRITE has both a high thermal conductivity and a low coefficient of thermal expansion relative to the 300 series stainless steels.

Tensile Strength, psi	0.2% Yeild Strength, psi	Elong. %	Hardness Brinell
70,000	50,000	30	84

Stress Corrosion Cracking Resistance:
(42% Boiling $MgCl_2$)

Ally	Results Hours to failure
E-BRITE	No Failure in 200 Hours
Type 304	3
Type316	24

ASA ALLOY 309

Features

- Oxidation resistance to 2000°F
- Moderate strength at high temperature
- East of fabrication
- Availability
- Low cost

Applications

- Burner parts
- Heat exchanges & combustion chambers
- Kilns
- Annealing covers & boxes
- Incinerators
- Muffles, retorts
- Radiant tubes
- Power boiler tube hangers
- Anchor bolts
- Brazing fixtures
- Glass forming equipment
- Chemical plant equipment
- Furnace fans, shafts & housings
- Thermowells
- Paper mill equipment
- Neutral salt pots

Composition
UNS S30908

Chromium	22.00 - 24.00
Nickel	12.00 - 15.00
Carbon	0.08 max
Silicon	1.00 max
Manganese	2.00 max
Phosphorus	0.045 max
Sulfur	0.030 max
Iron	balance

General

309 is an austenitic heat resistant alloy with useful oxidation resistance to 2000°F under constant temperature conditions. When frequent heating and cooling is involved the alloy is resistant to about 1850°F.

309 is particularly suited for oxidizing environments involving constant temperature or mild cycling with slow rates of heating or cooling. Because of its relatively high rates of thermal expansion the alloy is not suggested for applications involving severe thermal cycling, such as liquid quenching.

The high chromium and relatively low nickel contents of 309 make it the preferred choice among the austenitic grades for high temperature sulfur bearing atmospheres. Under the most severe conditions, however, alloys completely free of nickel may be required.

309 is one of the most commonly used heat resisting alloys in the range of 1500-2000°F under oxidizing conditions.

Carburization

309 has a degree of resistance to carbon absorption in some environments. Low cost, good sulfidation and moderate carburization resistance combine to make 309 the most widely used alloy for carbon saggers.

ASA ALLOY 310

Features

- Oxidation resistance to 2100°F
- Moderate strength at high temperature
- Resistance to hot corrosion
- Low magnetic permeability
- Strength and toughness at cryogenic temperatures
- Availability

Applications

- Kilns
- Heat exchangers
- Radiant tubes
- Muffles, retorts, annealing covers
- Saggers
- Tube hangers for petroleum refining and steam boilers
- Coal gasifier internal components
- Burners, combustion chambers
- Refractory anchor bolts
- Lead pots
- Fluidized bed coal combustor internals

Composition
UNS S31008

Nickel	24.00 - 26.00	
Carbon	19.00 - 22.00	
Silicon	0.08	max
Manganese	0.75	max
Phosphorus	2.00	max
Sulfur	0.040	max
Molybdenum	0.75	max
Copper	0.50	
Iron	balance	

General

310 is an austenitic heat resisting alloy with excellent resistance to oxidation under mildly cyclic conditions to 2100°F. Rapid thermal cycling increases the rate of metal wastage somewhat by spalling of the protective oxide scale. The oxidation resistance of 310 is significantly better than that of 309.

Because of its high chromium and medium nickel contents 310 has good resistance to hot corrosion in a variety of environments. 310 has useful resistance to high temperature environments containing moderate amounts of sulfur. However, sufficiently high concentrations of sulfur may dictate the use of materials free of nickel.

310 is widely used in moderately carburizing atmosphere such as encountered in petrochemical environments. 310 does not possess sufficient resistance to carbon and nitrogen absorption for service in the highly carburizing atmospheres of industrial heat treating furnaces. 330 or 333 are better suited to this latter environment.

The chromium content of 310 provides resistance to aqueous corrosion under oxidizing conditions. 310 is susceptible to chloride ion stress corrosion cracking but is superior in this respect to the lower alloy stainless 304 and 316. 310 has fair resistance to polythionic acid attack. Resistance to intergranular attack of material intended for service in the 850-1000°F range may be improved by thermal stabilization at 1500-1550°F for four hours.

330

Features

- Oxidation resistance to 2200°F
- Resistant to carburization and nitriding
- Resistant to thermal shock
- Good strength at elevated temperature
- Metallurgical stability
- Chloride ion stress corrosion cracking resistance

Applications

- Furnace containers-carburizing, carbonitriding, annealing, malleablizing
- Muffles, retorts
- Quenching fixtures
- Bar frame heat treating baskets
- Heat exchangers
- Radiant tubes
- Salt pots, both neutral and cyanide
- Gas turbine parts
- Petrochemical furnace components
- Furnace fans and shafts
- Conveyors
- Hot pressing platens

Composition

Chromium	18.00 - 20.00	
Nickel	34.00 - 37.00	
Carbon	0.08	max
Silicon	1.00 - 1.50[a]	
Manganese	2.00	max
Phosphorus	0.030	max
Sulfur	0.030	max
Copper	1.00	max
Iron	balance	

Specifications
UNS N08330
ASTM B 511, B 512, B 535, B 536, B 546, B 710, B 739
ASME SB-511, SB-535, SB-536
SB-710
AMS 5592, 5716

[a] All product forms except welded pipe and tube, silicon 0.75 - 1.50

General

330 is an authentic heat and corrosion resistant alloy offering an exceptional combination of strength and resistance to carburization, oxidation and thermal shock. Carburization and oxidation resistance to 2200°F are enhanced by a nominal 1.25% silicon addition. 330 finds wide application in high temperature industrial environments where good resistance to the combined effects of carburization and thermal cycling is a prime requisite. 330 remains fully austenitic at all temperatures and is not subject to embrittlement from sigma formation.

Sizes and Availability

330 is available from stock in a greater variety of items and product forms than any other heat resisting alloy composition. Refer to current stock list for details. Special shapes, sizes or quantities may be mill produced promptly.

Welding

330 is readily welded using 330-04 weld fillers of matching composition. 330-04DO lime type electrodes are available from stock in popular sizes. 330-04 bare welding wire is available in straight lengths for GTA welding or spooled for GMA welding. For best results do not preheat, keep interpass temperature low and use reinforced bead contours.

ALLOY 333

Features

- High temperature SO_X, hot salt corrosion resistance
- Practical immunity to chloride ion and to polythionic acid stress corrosion cracking
- Good resistance to sulfuric acid
- Excellent oxidation and carburization resistance at elevated temperatures

Applications

- Chemical and petrochemical process equipment
- Sulfuric acid plant dampers
- Tube hangers in crude oil distillation
- Flare tips
- Gas turbine combustion cans
- Sour water stripper reboiler lining
- Molten glass
- Heat treating muffles, retorts and fixtures

Chemical Composition, %

	Min.	Max.
Nickel	44.00	47.00
Chromium	24.00	27.00
Molybdenum	2.50	4.00
Cobalt	2.50	4.00
Tungsten	2.50	4.00
Carbon	—	0.08
Silicon	0.75	1.50
Manganese	—	2.00
Phosphorus	—	0.030
Sulfur	—	0.030
Iron	Remainder	

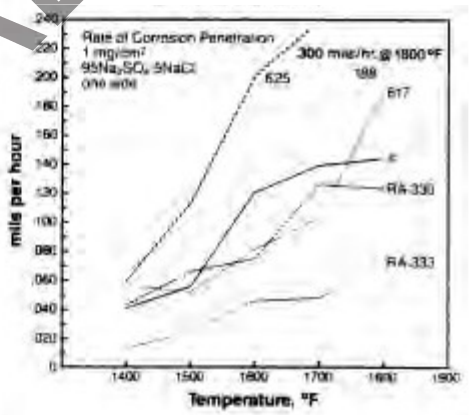
UNS N06333

General

333 is a high chromium nickel based superalloy with extreme temperature corrosion resistance and strength. In addition to high temperature properties, 333 has useful resistance to hot sulfuric acid and to hydrochloric acid solutions.

333 is one of the few materials that can withstand corrosive conditions ranging from aqueous to white heat. The alloy has been used for dampers and refractory anchors in 13% SO_2/SO_3 at 1800°F, and for refinery flare tips. Upon shutdown, 333 resists acid attack by sulphuric acid formed below the dew point. It also resists polythionic acid stress corrosion cracking. 333 has exceptional resistance to molten glass and has replaced platinum spinnerets in the manufacture of fiberglass.

Hot Salt Corrosion



Mechanical Properties

Minimum Room Temperature Properties:

Tensile Strength, psi	0.2% Yield Strength, psi	Elong. in 2" or 4D, %	Hardness Rockwell B
80,000	35,000	30	95 max.

Features

- Outstanding resistance to carburization
- Resistance to combined carburization and sulfidation (better than T310, T330 and a cobalt-base alloy)
- Good oxidation resistance
- Good fabric ability
- Weldable with matching combination filler metal
- Better hot strength than T309, T310 and 600

Applications

- Heat treating fixtures and bar frame baskets
- Molten salt hangers for austempering
- Sleeves and saggers fro baking carbon products
- Radiat tubes
- Waste incineration
- Fluidized beds
- Combustion nozzles

Composition, %	
Nickel	14.5
Chromium	18.5
Silicon	3.5
Aluminum	1.0
Carbon	0.20
Manganese	0.5
Iron	Remainder

*Registered trademark of Rolled Alloys, Inc.

General

RA85H is a fully austenitic heat resistant alloy modified with high silicon and aluminum. RA85H is annealed to provide good high temperature strength combined with excellent resistance to thermal fatigue. The addition of silicon for RA85H provides exceptional resistance to carburization. This property is critical in a variety of applications including heat treating and waste incineration.

HR-120™ Alloy

Features

- Outstanding strength up to 2000°F
- Good resistance to carburizing and sulfidizing atmospheres
- Oxidation resistance
- Good fabricability
- Weldable with 556' alloy filler wire and MUL TIMET'" covered electrodes

Applications

- Heat treating fixtures and bar frame baskets
- Wire mesh furnace belts and basket liners
- Cast link belt pins
- Waste incinerators
- Recuperators
- Fluidized bed components

Chemical Composition (Weight %)

Nickel	37
Chromium	25
Cobalt	3 max
Molybdenum	2.5 max
Tungsten	2.5 max
Columium	0.7
Manganese	0.7
Silicon	0.6
Nitrogen	0.2
Aluminum	0.1
Carbon	0.05
Boron	0.004
Iron	balance

General

HR-120 alloy, produced by Haynes International and supplied by roiled Alloys, is a solid-solution strengthened heat-resistant alloy that provides excellent strength of elevated temperatures combined with very good resistance to carburizing and sulfidizing environments. Its oxidation resistance is comparable to other widely used Fe-Ni-Cr materials, such as 800 HT. The strength of HR-120 alloy is what sets it apart from the others. This improved strength allows for thinner cross-sectional construction in certain applications which can lead to greater thermal efficiency. For example, a heat treat basket constructed from 3/8" diameter HR-120 alloy bar can provide equivalent or superior performance to one constructed from 1/2 diameter 330 alloy, with a 43% reduction in weight. Having a maximum service temperature of 2000°F, HR·120 alloy is quickly becoming accepted as a standard material of construction in many high temperature applications.

HR -120™ ALLOY

(Continued)

Physical Properties

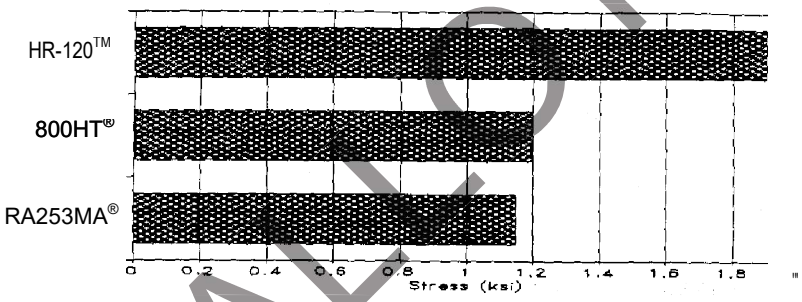
Density	0.291 lb/in^3 (8.07 gm/cm^3)	Thermal Expansion (iin/in °F)	
		9.7 x 10^{-6}	(70-1600°F)
Melting Range	2375-2600°F (1300-1425°C)		

Dynamic Modulus at Elasticity (Room Temperature): 28.6 x 10^6 psi

Average Room Temperature Tensile Properties

Ultimate Tensile Strength (ksi)	0.2% Yield Strength (ksi)	Elongation (in 2 In.)
106	45	50%

Stress to Produce Rupture in 10,000 Hours (1600°F)



Fabrication

Welding: HR·120 alloy is readily wieldable by Gas Tungsten Arc (TIG), Gas Metal Arc (MIG), and Shielded Metal Arc (SMAW) welding processes using 556[1] alloy filler wire or MULTIMET® electrodes. Many of the alloy's welding characteristics are similar to those for nickel alloys and the same precautions apply. Any start/stop cracking should be removed by grinding prior to further welding. Do not attempt remelt or "wash out" welding cracks.

Machining: HR·120 alloy can be readily machined using conventional techniques. Generally, the same practices are employed as those used with the 300 series austenitic stainless steels. Some minor adjustments may be required to obtain optimum results.

HR-120 & 556 are trademarks and MULTIMFT is a reregistered trademark of Havnes International Inc.

Alloy 446

Features

- Oxidation resistance to 2200°F
- Sulfidation resistance
- Availability
- Resists attack by molton copper alloys

Applications

- Recuperators
- Combustion chambers
- Soot blowers
- Neutral salt pot electrodes
- Oil burner components
- Spouts for conveying molten copper alloys
- Kiln linings
- Thermocouple protection tubes
- Stack dampers
- Boiler baffles
- Gas-injection nozzles for various molten compounds
- Flame rods

Composition

Chromium	23.00	27.00
Carbon	0.15	max
Nitrogen	0.25	max
Manganese	1.50	max
Silicon	1.00	max
Phosphorus	0.040	max
Sulfur	0.030	max
Iron	balance	

UNS S44600

General

446 is a high chromium ferritic heat resisting alloy with excellent resistance to oxidation and to various forms of hot corrosion. The alloy is most commonly used for service between 1500 and 2200°F (815 and 1200°C) although its elevated temperature strength is quite low.

446, in common with other high chromium ferritics, embrittles severely when held in, or cooled slowly through the 700-1000°F (370-540°C) temperature range. This phenomenon is referred to as 885°F (475°C) embrittlement. 446 should not be used in this temperature range unless near complete loss of room temperature ductility may be tolerated. 446 is also subject to room temperature embrittlement from sigma phase formation after long time service in the 1000-1300°F (540-700°C) temperature range. Both 885°F and sigma phase embrittlements are reversible and ductility may be restored by annealing.

Molten Metal Corrosion

Unlike austenitic stainless or nickel alloys, 446 resists intergranular penetration by molten copper or silver alloys. 446, like other metals, is not particularly resistant to molten aluminum.

TYPE 4340V

AMS 6414, AMS6415, MIL S 8844 CL1, MIL-S-5000
AMS 2300, DMS 1555, BMS 7-28

4340 is a heat treatable, low alloy steel containing nickel, chromium and molybdenum. It is known for it toughness and capability of developing high stength in the heat treated condition while retaining good fatigue strength.
Typical applications are for structural use, such as aircraft landing gears and shafts and other structural parts.

Machining is best done with this alloy in the annealed or normalized and tempered condition. It can be machined by all conventional methods. However in the high strength conditions of 200 ksi or greater the machinability is only from 25% to 10% that of the alloy in the annealed condition.
4340 has good ductility in the annealed condition and most forming operations are carried out in that condition. It can be bent or formed by spinning or pressing in the annealed state.

Chemical Composition (Wt. %)	
C	0.37-0.43
Cr	0.7-0.9
Fe	96
Mn	0.7
Mo	0.2-0.3
Ni	1.83
P	Max 0.035
S	Max 0.04
Si	0.23

TYPE 300M/4340 Mod

AMS 6257, MIL S 8844 CL3, AMS 6419
BMS 7-26, DMS 1935

300 M is a low alloy, vacuum melted steel of very high strength. Essentially it is a modified AISI 4340 steel with silicon, vanadium and slightly greater carbon and molybdenum content than 4340. 300M has a very good combination of strength (280 to 305 ksi), toughness, fatigue strength and good ductility. It is a through hardening alloy.

Applications for 300M steel are those that require strength in the 290 - 300 ksi range, such as aircraft landing gear, high strength bolts and airframe parts.

Machining is best accomplished with the alloy in the normalized and tempered condition. Final machining to finish tolerances is done by grinding with care due the hardness of the heat treated alloy (Rockwell C 55). It is important to do a stress relief anneal at 550 °F after finish grinding.

Formability by conventional methods is good in the annealed condition. The alloy behaves much like AISI 4340 steel.

Chemical Composition (Wt. %)	
C	0.4-0.46
Cr	0.7-0.95
Fe	93.4-94.8
Mn	0.65-0.9
Mo	0.3-0.45
Ni	1.65-2.0
P	Max 0.035
S	Max 0.04
Si	1.45-1.80
V	Min 0.05

TYPE 13-8MO

AMS 5629, DMS 2100, ASTM A 564 GR XM13
AMS 2300, AMS 5864

13-8MO is commonly used for manufactuing air frame structural components, missle components, valve parts, fasteners and chemical process equipment.

Chemical Composition (Wt. %)	
Al	1.05
C	0.03
Cr	12.80
Mn	0.10
Mo	2.30
N	0.005
Ni	8.0
P	0.005
S	0.004
Si	0.05

TYPE 15-5

AMS 5659, A 705/705 M, ASTM A564 GR 630
AMS 2300, AMS 5862

Type 15-5 is commonly used for manufactuing aircraft and missle fittings, fasteners, gears, turbine and pump blades, shafts.

Chemical Composition (Wt. %)	
C	0.035
Cb	0.30
Cr	14.50
Cu	3.50
Mn	0.50
Ni	4.75
P	0.02
S	0.015
Si	0.5

BERYLLIUM COPPER C-172

ALLOY C-172 TO ASTM B-196 & AMS 4533 + QQ-C-530

Typically used for oil patch energy exploration components, Aircraft bushings, drilloing and machine tools

Chemical Composition (% max., unless shown as range or min.)	
Cu (1)	98.1
Al	0.20
Be	1.80-2.00
Co (2)	0.20 min
Si	0.20

(1) Cu value includes Ag.

(2) Ni + Co, .20 min: Ni + Fe + Co, .6% max. Ni +

Note: Cu + Sum of named elements, 99.5% min.

C63000 NICKLE ALUMINUM BRONZE

AMS 4640, AMS 4880, ASTM B150
GRADE 630, CA 18 (U.K.)
TEMPER HR 50 OR TQ50

C63000 alloy is an excellent choice for applications involving heavy loads, adhesive wear, friction, abrasive wear and corrosion. The addition of nickle increases the alloys strength without diminishing its excellent ductility, toughness and corrosion resistance. Typical applications for C63000 nickle aluminum bronze include aircraft landing gear components, strut bearings, main pistons, trunnion bearings and similar vital components.

Chemical Composition (Wt. % max)	
Copper	Remainder
Iron	4.0
Tin	0.20
Zinc	0.30
Aluminum	11.0
Manganese	1.50
Silicon	0.25
Nickel (incl. Co)	5.50

NICKEL 200 (UNS N02200)

Nickel 200 is commercially pure metal used structurally in corrosive environments. A tough and ductile metal at both high and low temperatures nickel is widely used in the food, electrical and chemical fields.
Typical uses include: cable sheathing, terminals, lead wire, fuel cells, heat exchangers, deep drawn electronic cans, shells, caustic shipping containers, piping and other uses where product purity is important.

Nickel 200 may be joined by conventional brazing, soldering and welding techniques. Nickel 141 electrodes and nickel 61 filler wires are used to weld nickel to itself and other metals. Shapes and sizes other than those shown as stock are available on special order from mill service centres..

Chemical Composition (nominal analysis)	
Carbon, max.	0.08%
Manganese, max.	0.048
Sulfur, max.	0.005
Silicon, max.	0.18
Iron, max	0.02
Copper, max	0.13
Nickel, max.	99.5

NICKEL 200

(Continued)

TYPICAL MECHANICAL & PHYSICAL PROPERTIES	
Tensile Strength, psi (C.D. Annealed Bar)	65,000
Yield Strength, psi (C.D. Annealed Bar)	22,500
Elongation, % (C.D. Annealed Bar)	48
Density Lb/cu.in.	0.321
Specific Heat (BTU/Lb•°F)	0.109
Thermal Expansion (In/In/°F x 10^{-6}) 70°F	.58
Thermal Conductivity (BTU•in/ft2•h•°F) 70°F	520
Electrical Resistivity (ohm•Circ.Mil./ft)	57
Modulus of Elasticity. psi	29,600,000
Melting Point	2635
Curie Point (°F)	680
Poisson's Ratio	0.26
Colour Identification Code	RED

Alloy 276 (UNS N10276)

Alloy 276 is a nickel-chrome alloy with high moly and tungsten but low iron and silicon contents, which provides superior corrosion resistance to a wide variety of environments. The composition is specially formulated to maintain corrosion resistance, even in the weld heataffected zone, thus making Alloy 276 suitable even in the as welded condition. The alloy has excellent resistance to general pitting and stress corrosion cracking and resists oxidation up to approximately 1900°F. Alloy 276 has found wide acceptance in the chemical and petro-chemical process industry, flue gas desulfurization systems and the pulp and paper industries. It shows exceptional resistance to ferric and cupric chlorides, hot contaminated mineral acids, solvents, chlorine and chlorine-contaminated media, dry chlorine, formic acid, acetic acid acetic anhydride, sea water and brine. Alloy 276 is one of the few materials that resists wet chlorine gas, hypochlorite and chlorine dioxide solutions. The alloy has shown remarkable corrosion resistance in the especially corrosive areas of flue gas desulfurization systems, such as outlet ducting leading to the stack. It has also been used to solve corrosive problem areas in municipal sewage treatment plants.

Chemical Composition (nominal analysis)	
Carbon, max.	0.020%
Manganese, max.	1.00
Sulfur, max.	0.015
Chromium	14.5-16.5
Iron	4.0-7.0
Molybdenum	15.0-17.0
Tungsten	3.0-4.5
Silicon, max.	0.08
Cobalt, max.	2.5
Vanadium, max.	0.35
Nickel	Balance

Alloy 276
(Continued)

Room Temperature Mechanical Properties (minimum)	
Tensile Strength, psi	100,000
Yield Strength (0.2% offset), psi	41,000
Elongation in 2 in., %	40

Short - Time Elevated-Temperature Tensile Properties of Plate, 0.75 in.
(Heat Treated at 2100°F, water quenched)

Test Temperature °F	Tensile Strength psi	Yield Strength (0.2% Ofset) psi	Elongation (2 in.) %
Room	114000	52000	70
400	102000	44000	71
800	94000	34000	75
1200	87000	33000	73
1600	64000	30000	92
1800	39000	27000	127

Physical Properties	
Density, lb/cu. In.	0.321
Gm./cu. Cm	8.89
Melting range, °F	2415-2500
Thermal coef. Expansion/°F	
75 to 200°F	6.2 x 10-6
75 to 1000°F	7.4 x 10-6
75 to 1700°F	8.8 x 10-6
Thermal conductivity, Btu/sq. ft.hr. °F/in.	
-270°F	50
0°F	65
100°F	71
1000°F	132
1400°F	159
2000°F	195
Electrical resistivity, ohms/cir. Mil. Ft.	779
Specific heat, Btu/lb./°F	0.102
Modulus of elasticity, psi (dynamic)	
Room temperature	29.8 x 10-6
1000°F	25.5 x 10-6

Avaliability	
Plate	3/16 inches and thicker Dimensions of 72x320 inches max.
Plate Shapes	Variety of plate shapes available, including Abrasive cut bar

Alloy 400

Features

- Resistant to hydrofluoric acid
- Freedom from chloride stress corrosion cracking
- Useful resistance to dry chlorine, fluorine, hydrogen chloride and hydrogen fluoride gases
- Good strength and toughness over a wide temperature range

Applications

- Caustic evaporators
- Hydrofluoric acid production
- Chemical processing equipment
- Salt protection equipment
- Crude oil distillation towers
- Marine components
- Valve and pump components

Chemical Composition, %

	Max.	Min.
Nickel	63.0	70.0
Copper	28.0	34.0
Iron	-	2.5
Carbon	-	0.3
Manganese	-	2.0
Sulfur	-	0.024
Silicon	-	0.5

UNS N04400

General

Alloy 400 is a ductile nickel-copper alloy with resistance to a wide range of corrosive environments. This grade is often chosen to handle sulfuric acid under reducing conditions. Alloy 400 possesses useful resistance to hydrochloric acid up to about 10% concentration at room temperature. The alloy has excellent resistance to sea or brackish water under high velocity conditions. Alloy 400 is one of the few materials with good resistance to hydrofluoric acid.

The Curie point of Alloy 400 is near room temperature, and is affected by small variations in chemical composition. For this reason, some heats of Alloy 400 are magnetic at room temperature while others are not.

Mechaical Properties

Minimum Room Temperature Properties:

Tensile Strength, psi	0.2% Yield Strength, psi	Elongation in 2" or 4D, %
70,000	28,000	35

Typical Room Temperature Property Range:

Tensile Strength, psi	0.2% Yield Strength, psi	Elongation %	Hardness Brinell
70,000-85,000	28000-50,000	35-50	110-140

Effect of Oxygen on Corrosion of RA 400 in Hydrofluoric Acid

Vol. % Oxygen in Hydrogen Purge Gas	Corrosion Rate, mils per year	
	Liquid	Vapor
0	11	1
0.1	21	2
1	75	12
Air Blanket (No Hydrogen)	22	1000

Laboratory Test: 1000 hours (41.5 days)

40% Hydrofluoric Acid Boiling - 266°F(130°C).

Alloy 600 (UNS N06600)

Features

- Resistant to hot, dry, chlorine gas
- More resistant to sulfur attack than RA 200 and RA 201
- Good oxidation resistance to 2000°F

Applications

- Jacketed heat exchangers
- Chlorination equipment up to 1000°F
- Paper mill alkaline digesters
- Vegetable and fatty acid vessels
- Chemical and food processing equipment
- Heat treating muffles and retorts

Chemical Composition, %

	Min.	Max.
Nickel	72.0	-
Chromium	14.0	17.0
Iron	6.0	10.0
Carbon	-	-
Copper	-	0.5
Manganese	-	1.0
Sulfur	-	0.015
Silicon	-	0.5

UNS N06600

Alloy 600 is a nickel-chromium-iron alloy for use in environments requiring resistance to heat and corrosion. The high nickel content of this alloy makes it resistant to corrosion by a number of organic and inorganic compounds, and gives it excellent corrosion resistance to chloride-ion stress-corrosion cracking. Its chromium content gives the alloy resistance to sulfur compounds and various oxidizing environments.
In addition Alloy 600 has excellent mechanical properties and a combination of high strength and good workability. The alloy performs well in applications with temperatures from cryogenic to more than 2000°F.

Various corrosive and high temperature applications for Alloy 600 include chemical and food processing, heat treating and aircraft/aerospace.

Mechanical Properties
Minimum Room Temperature Properties

Tensile Strength, psi	0.2% Yeild Strength, psi	Elongation in 2" or 4D, %
80,000	35,000	30

Typical Room Temperature Property Range

Tensile Strength, psi	0.2% Yeild Strength, psi	Elong. %	Hardness Brinell
80,000-105,000	35,000-50,000	30-55	130-180

Corrosion in Dry Chlorine

Alley	Approx. Temperature at which Given Corrosion Rate is Exceeded in Short Time Test, °F			Suggested upper Temperature Limit for Continuous Service ° F
	0.03 in. Per Year	0.12 in. Per Year	1.2 in. Per Year	
RA 400	750	900	1000	800
RA 200	950	1100	1250	1000
RA 600	950	1050	1250	1000
Copper	350	500	550*	400
Platinum	900	1000	1050	500

ALLOY 601 (UNS N06601)

Alloy 601 is a nickel-chromium alloy with an addition of aluminum for outstanding resistance to oxidation and other forms of high temperature corrosion. It also has high mechanical properties at elevated temperatures.

Alloy 601 is commonly used for industrial furnaces; heat treating equipment such as baskets, muffles and retorts; petro chemical and other process equipment; and gas turbine components. Standard product forms are round, flats, forging stock, pipe, tube, plate, sheet, strip and wire.

Limiting Chemical Composition, %	
Carbon, max.	0.10%
Manganese, max.	1.0
Sulfur, max.	0.015
Silicon, max.	0.50
Copper, max	1.0
Nickel (plus Co.)	58.0-63.0
Chromium	21.0-25.0
Aluminum	1.0-1.7
Iron	remainder

ALLOY 601

(Continued)

PHYSICAL CONSTANTS & THERMAL PROPERTIES	
Density, Lb/cu.in (Mg/m^3)	0.293 (8.11)
Melting Range, °F (°C)	2480-2571 (1360-1411)
Specific Heat, BTU/Lb•°F (J/kg•°C)	0.107 (448)
Thermal Conductivity, BTU•in/SqFt•Hr•°F	78
W/m•°C	11.2
Electrical Resistivity (ohm°•circ.Mil./ft)	717
Curie Temperature, °F (°C)	< 320 (<196)
Permeability at 200 oersted (15.9 kA/m)	1.003
Coefficient of Expansion, 70-200°F. 10^{-6} in/in•°F	7.60
21-93C, m/m•°C	13.75

RUPTURE STRENGTH (1000h)	psi	MPa
1200°F / 650°C	28000	195
1400°F / 706°C	9100	63
1600°F / 870°C	4300	30
1800°F / 980°C	2100	14
2000°F / 1095°C	1000	7

ALLOY 625 (UNS N06625)

625 is a nickel-molybdenum-columbium alloy well suited for applications where strength and corrosion resistance are required. The alloy exhibits exceptional fatigue strength and superior strength and toughness at temperatures ranging from cryogenic to 2000°F. It is resistant to oxidation, general corrosion, pitting and crevice corrosion and is virtually immune to chloride-ion stress-corrosion cracking. These properties are derived from additions of molybdenum and columbium to the alloy's basic nickel-chromium composition. In addition, 625 is readily fabricated by standard industry practices.

The combination of strength, corrosion resistance and fabricabilty make 625 suitable for a variety of applications. These include components such as heat exchangers, bubble caps, reaction vessels, distillation columns and valves for chemical processing plants, sea water applications, aerospace applications, nuclear reactor components and flue gas desulfurization systems.

Chemical Composition (nominal analysis)	
Carbon , max.	.10%
Manganese, max.	.50
Phosphorus, max.	0.015
Sulfur, max.	0.015
Silicon, max.	.50
Chromium	20.0-23.0
Nickel, min.	58.0
Molybdenum	8.0-10.0
Iron, max.	5.0
Cobalt, max. (if determined)	1.0
Columbium + Tantalum	3.15-4.15
Aluminum, max.	0.40
Titanium, max.	0.40

ALLOY 625
(Continued)

Room Temperature Mechanical Properties (minimum)		
		Code Case 1409
Tensile Strength, psi	120,000	100,000
Yield Strength (0.2% offset), psi	60,000	40,000
Elongation, %	30	30
Reduction of Area, %	25	40

Physical Properties	
Density, grams per cu.cm.	8.44
lb.per cu.in.	0.305
Melting Range, °F	2350-2460
Specific Heat at 70°F	
Btu per lb.per °F	0.098
Magnetic Permeability (75°F, 200 oersted)	1.0006
Curie Temperature, °F	<-320
Modulus of Elasticity at 70°F, 10^6 psi	
Tension	30.1
Torsion	11.8
Mean Coefficient Of Thermal Expansion	
10^6 inches per inch per °F	
70° to 200°F	7.1
70° to 400°F	7.3
70° to 600°F	7.4
70 ° to 800°F	7.6
70° to 1000°F	7.8
70° to 1200°F	8.2
70° to 1400°F	8.5
70° to 1600°F	8.8
70° to 1700°F	9
Electrical Resistivity,	
Ohm per Circ.mil.per ft.	
70°F	776
100°F	780
200°F	794
400°F	806
600°F	812
800°F	818
1000°F	830
1200°F	830
1400°F	824
1600°F	818
1700°F	-
1800°F	812
2000°F	806

Availability	
Plate	3/16 inches and thicker Dimensions of 72 X 320 inches max.
Plate Shapes	Variety of plate shapes available, including Abrasive Cut Bar

ALLOY 800 (UNS N08800)

Alloy 800 is a nickel-iron-chromium alloy with good strength and excellent resistance to oxidation and carburization in high temperature atmospheres. It also resists corrosion by many aqueous environments. The alloy maintains a stable, austenitic structure during prolonged exposure to high temperatures.

Alloy 800 is commonly used for process piping, heat exchangers, carburizing equipment, heating element sheathing and nuclear steam generator tubing. Standard product forms are round, flats, forging stock, pipe, tube, plate, sheet, strip and wire.

Limiting Chemical Composition, %	
Carbon, max.	0.10%
Manganese, max.	1.50
Sulfur, max.	0.015
Silicon, max.	1.0
Copper, max	0.75
Nickel	30.0-35.0
Chromium	19.0-23.0
Aluminum	0.15-0.60
Titanium	0.15-0.60
Iron, min	39.5

PHYSICAL CONSTANTS & THERMAL PROPERTIES	
Density, Lb/cu.in (Mg/m^3)	0.287 (7.94)
Melting Range, °F (°C)	2475-2525 (1357-1385)
Specific Heat, BTU/Lb•°F (J/kg•°C)	0.11 (460)
Thermal Conductivity, BTU•in/SqFt•Hr•°F	80
W/m•°C	11.5
Electrical Resistivity (ohm°•circ.Mil./ft)	595
Curie Temperature, °F (°C)	175 (115)
Permeability at 200 oersted (15.9 kA/m)	1.014
Coefficient of Expansion, 70-200°F. 10^{-6} in/in•°F	7.90
21-93C, m/m•°C	14.40

RUPTURE STRENGTH (1000h)	psi	MPa
1000°F / 540°C	48000	330
1100°F / 595°C	32000	220
1200°F / 650°C	21000	145
1300°F / 705°C	11000	75

ALLOY 800HT (UNS N08811)

Alloy 800HT is a nickel-iron-chromium alloy having the same basic composition as Alloy 800 but with significantly higher creep rupture strength. The higher strength results from close control of the carbon, aluminum and titanium contents in conjunction with a high temperature anneal.

Alloy 800HT is commonly used in chemical and petrochemical processing, in power plants for super-heating and reheater tubing, in industrial furnaces and heat treating equipment. Standard product forms are round, flats, forging stock, pipe, tube, plate, sheet, strip and wire.

Limiting Chemical Composition, %	
Carbon	0.60-0.10
Manganese, max.	1.50
Sulfur, max.	0.015
Silicon, max.	1.0
Copper, max.	0.75
Nickel	30.0-35.0
Chromium	19.0-23.0
Aluminum	0.15-0.60
Titanium	0.15-0.60
Aluminum + Titanium	0.85-1.20
Iron, min.	39.5

PHYSICAL CONSTANTS & THERMAL PROPERTIES	
Density, Lb/cu.in (Mg/m^3)	0.287 (7.94)
Melting Range, °F (°C)	2475-2525 (1357-1385)
Specific Heat, BTU/Lb•°F (J/kg•°C)	0.11 (460)
Thermal Conductivity, BTU•in/SqFt•Hr•°F	80
W/m•°C	11.5
Electrical Resistivity (ohm°•circ.Mil./ft)	595
Curie Temperature, °F (°C)	175 (115)
Permeability at 200 oersted (15.9 kA/m)	1.014
Coefficient of Expansion, 70-200°F. 10^{-6} in/in•°F	7.90
21-93C, m/m•°C	14.40

RUPTURE STRENGTH (1000h)	psi	MPa
1200°F / 650°C	24000	165
1300°F / 705°C	15000	105
1400°F / 760°C	10000	70
1600°F / 870°C	4700	32
1800°F / 980°C	2000	14

ALLOY 825 (UNS N08825)

825 is a nickel-iron-chromium- molybdenumcopper alloy for use in extremely corrosive environments. The nickel content of this alloy makes it resistant to chloride-ion stress-corrosion cracking. Additions of molybdenum and copper give 825 resistance to pitting and to corrosion in reducing acid environments such as sulfuric or phosphoric acid solutions. The alloy's chromium content gives it resistance to various oxidizing environments, such as nitrates, nitric acid solutions and oxidizing salts.

In addition, 825 offers excellent resistance to corrosion by sea water and resists intergranular corrosion after being heated in the sensitizing temperature range (1200-1400°F).

The many corrosion resistant properties of 825 make the alloy a suitable choice for a variety of difficult applications. Possible uses include fabricated equipment found in chemical and petro-chemical processing, pulp and paper manufacturing, flue gas desulfurization systems and metal pickling operations.

Chemical Composition (nominal analysis)	
Carbon, max.	0.05%
Manganese, max.	1.0
Sulfur, max.	0.03
Silicon, max.	0.5
Chromium	19.5-23.5
Nickel (plus Cobalt)	38.0-46.0
Iron, min.	22.0
Molybdenum	2.5-3.5
Copper	1.5-3.0
Aluminum, max.	2.0
Titanium	0.6-1.2

ALLOY 825

(Continued)

Room Temperature Mechanical Properties (minimum)	
Tensile Strength, psi	85,000
Yield Strength (0.2% offset), psi	35,000
Elongation in 2in., %	30

Physical Properties	
Density, grams per cu.cm.	8.14
lb.per cu.in.	0.294
Magnetic Permeability (70°F, 200 oersted)	1.005
Curie Temperature, °F	<-320
Modulus of Elasticity in Tension (Dynamic), psi	
80°F	28,300,000.00
500°F	26,400,000.00
1000°F	23,800,000.00
1200vF	22,700,000
1350°F	21,700,000
1500°F	20,300,000
1600°F	19,400,000
1700°F	18,300,000
1800°F	17,300,000
Melting Range, °F	2500-2550
Mean Coefficient of Thermal Expansion	
10^6 inches per inch per °F	
80° to 200°F	7.8
80° to 400°F	8.3
80° to 600°F	8.5
80° to 800°F	8.7
80° to 1000°F	8.8
80° to 1200°F	9.1
80° to 1400°F	9.5
80° to 1600°F	9.7
Electrical Resistivity,	
Ohm per circ.mil. Per ft.	
78°F	678
100°F	680
200°F	687
400°F	710
600°F	728
800°F	751
1000°F	761
1200°F	762
1400°F	765
1600°F	775
1800°F	782
2000°F	793

Availability	
Plate	3/16 inches and thicker Dimensions of 84 X 320 inches max.
Plate Shapes	Variety of plate shapes available, including Abrasive Cut Bar

AQUATECH 17

Aquatech 17 is a chromium-nickel-copper alloy product that is precipitation hardened during the manufacturing process to give it uniform tensile, yield strengths and superior hardness. These three qualities combine to create a strong, very corrosion resistant boat shaft regardless of size that is also very cost effective. The superior strength of Aquatech 17 allows boat builders to to reduce the size of of underwater components resulting in reduced weight and drag and therefore superior performance.

Aquatech 17 is used in military patrol craft, offshore crew and supply vessels, commercial fishing boats, ferry boats, excursion boats and pleasure craft. Aquatech 17 boat shafting is ground and polished to a 64 RMS finish, precision straightened and protected during shipping and storage by fibre tubing. Aquatech 17 may be weld-repaired in worn bearing areas provided that a post-weld heat treat at 1150º for four hours be performed. Aquatech 17 exhibits good corrosion resistance in both salt and brackish water. To avoid galvanic corrosion, cathodic protection is recommended. Navy grade zinc anodes properly installed, should provide satisfactory protection against galvanic corrosion.

Typical Chemical Composition Aquatech 17

Elements	%
Carbon, max.	070
Manganese, max.	1.00
Phosphorus, max.	0.04
Sulfur, max.	0.03
Silicon, max.	1.00
Chromium.	15.00-17.00
Nickel.	3.50-5.00
Copper.	3.00-5.00
Columbium & Tantalum.	0.15-0.45

AQUATECH 19

Aquatech 19 boat shafting is an 18-8 stainless alloy with nitrogen added to increase both strength and corrosion resistance, while maintaining ductility and, like austenitic stainless steels, it is non-magnetic.
Aquatech 19 is more resistant to corrosion than Aquatech 17. Under certain conditions it may exhibit crevice attack, but can be protected by use of navy grade, properly installed, zinc anodes.
Aquatech 19 is used in commercial fishing boats and pleasure boats and occasionally in work boats where higher speeds and more frequent starting and stopping occurs. Aquatech 19 boat shafting is ground and polished to close tolerances and surface finish, precision straightened and protected during shipping and handling by fibre tubing. Aquatech 19 exhibits equal strength to Aquatech 17 up to 2" in diameter.

Typical Chemical Composition Aquatech 19

Elements	%
Carbon, max.	0.08
Manganese, max.	2.00
Phosphorus, max.	0.04
Sulfur, max.	0.03
Silicon, max.	1.00
Chromium.	18.00-20.00
Nickel.	8.00-10.50
Nitrogen	20.0-0.30

AQUATECH 22 & 22HS

Aquatech 22 boat shafting is a non magnetic, alloy of chromium, nickel and manganese with molybdenum, nitrogen, columbium and vanadium added to create the highest degree of strength and corrosion resistance while maintaining ductility and machinability. Aquatech 22 is used in yachts and other vessels that require more corrosion resistant shafting due to conditions such as running time versus docking time, extreme water temperatures or pollution.

Aquatech 22 boat shafting is produced with careful control of raw materials, chemistry, melting, rolling and heat treating. Aquatech 22 is ground and polished to specified tolerances, precision straightened and protected by fibre tubing for shipping and handling. Aquatech 22 provides the highest degree of resistance to pitting and crevice corrosion in all marine environments. Never the less, catholic protection is recommended using zinc anodes to prevent galvanic corrosion.

Auatech 22HS (High Strength) boat shifting is manufactured similarly to Aquatech 22 with additional steps taken to achieve increased tensile and yield strengths. Aquatech 22HS is used in high horsepower luxury yachts and special purpose military vessels. Aquatech 22 HS combines strength similar to Aquatech 17 with greater corrosion resistance. It is available in diameters ranging between 2-1/2" and 6".

Typical Chemical Composition Aquatech 22

Elements	%
Carbon, max.	0.06
Manganese, max.	4.00-6.00
Phosphorus, max.	0.04
Sulfur, max.	0.03
Silicon, max.	1.00
Chromium.	20.50-23.50
Nickel.	11.00-13.50
Nitrogen	20.0-0.40
Molybdemun	1.50-3.00
Columbium & Tantalum	0.10-0.30
Vanadium.	0.10-0.30

STAINLESS STEEL PIPE & TUBE SPECIFICATIONS TO ASTM

A-213 Seamless stainless steel boiler, superheater and heat exchanger tubes. Covers 17 grades of austenitic stainless including most 300 series and 12 grades of ferritic stainless (such as T5, T9, T11, T21 etc.).
Usual size range: 1/8" I.D. to 5"O.D.
.015" to 1/2" wall
minimum wall or average wall

A-249 Welded austenitic steel boiler, superheater, heat exchanger and condenser tubes. Covers 24 grades of austenitic stainless tubing
Usual size range: 1/8" I.D. to 5"O.D.
.015" to .320" wall
Generally nominal wall, but also minimum wall if so specified.

A-269 Seamless and welded austenitic stainless steel tubing for general service: general corrosive resistance and low or high temperature service. Covers 18 grades of austenitic stainless.
Usual size range: 1/4" I.D. and larger
.020 wall and heavier
nominal wall

A-312 Seamless and welded austenitic stainless steel pipe for high temperature and general corrosive service. Covers 24 grades of stainless pipe, including most 300 series, with no addition of filler material.
Usual size range: 1/8" to 30" nominal pipe size. Schedule 5S to 80S. Dimensions per ANSI B36-19. Nominal pipe size or outside diameter and schedule number of average wall thickness.

A-511 Seamless stainless steel mechanical tubing for mechanical applications requiring corrosive resistance or high temperature strength. Covers 14 grades of austenitic steel, including most 300 series, 6 grades of martensitic steel such as 410, 440A etc., 7 grades of ferritic steel such as 430, 443, etc.
Usual size range: up to 12-3/4" outside diameter. Wall thickness as required. Cold finished or hot finished.

A-450 Specification covering general requirements for ferritic and austenitic steel tubes, including A-249, A-268, A-269, A-270, A-272, A-669, A-688 and others.

A-530 Specification covering general requirements for stainless steel pipe, including A-312, A-358, A-376, A-409 and others.

In addition to the above specifications, tubing and pipe to other ASTM specifications can be obtained through ASA including:

A-268 Seamless and welded ferritic stainless steel tubing for general corrosive resistance and high temperature service. Covers 10 grades of ferritic stainless tubing, generally 400 series. They are commonly called"straight chromium" type and are ferromagnetic.
Usual size range: Up to approximately 8" outside diameter. Nominal wall.

A-270 Seamless and welded austenitic stainless steel sanitary tubing for use in the dairy and food industries, and having special surface finishes such as Finish #80, #120, etc.
Size range: Up to 4" outside diameter
Chemistry: Type 304.

A-271 Seamless austenitic chromium-nickel steel still tubes for refinery service for use in carrying fluids at elevated temperatures in various heaters and furnaces. Covers 8 grades of austenitic stainless (300 Series).
Size range: 2" to 9" outside diameter.
Wall over .220".
Minimum wall.
Hot finished or cold drawn.

A-358 Electric fusion welded austenitic chromium-nickel stainless steel pipe for corrosive or high temperature service. Covers 13 grades of austenitic pipe.
Size Range: No restrictions but commercial practice generally limits sizes to 8" nominal diameter and over.
Class 1- Double welded; use of filler metal; complete radiography.
Class 2- Double welded; use of filler metal; no radiography.
Class 3- Single welded; use of filler metal; complete radiography
Class 4- Same as Class 3 except that weld pass exposed to the inside pipe surface may be made without filler metal.
Class 5- Double welded; use of filler metal; spot radiography.

A-376 Seamless austenitic stainless steel pipe for high temperature central station service. Covers 14 grades of austenitic pipe, including 5 H grades and 2 nitrogen grades specifically intended for high temperature service.
Produced to nominal pipe size or outside diameter and schedule number or average wall thickness.

A-409 Electric fusion welded (straight or spiral seam), light wall, austenitic stainless steel pipe for corrosive or high temperature service. Covers 10 grades of austenitic pipe (300 series)
Size range: 14" to 30" nominal outside diameter. Extra light (Schedule 5's) and light (Schedule 10's) wall thickness. Steel used in manufacture is hot or cold rolled sheet, or hot finished plate which conforms to the requirements of A-240.

A-554 Welded stainless steel mechanical tubing in which appearance, mechanical properties, or corrosive resistance is required. Covers 16 grades of austenitic steel and 3 grades of ferritic steel.
Size range: As-welded or cold-reduced mechanical tubing to 16" outside diameter. .020 wall and over. Tubing can be produced in round, square, rectangular or special shapes.

A-688 Welded austenitic stainless steel feedwater heater tubes, including U-tubes for tubular feed water heaters. Covers 9 grades of austenitic steel tubes.
Size range: 5/8" to 1" outside diameter
.028 average or minimum wall or heavier.

MILITARY SPECIFICATIONS

MIL-T-5695D 304 cold drawn seamless or welded corrosion resistant steel tubing, 1/4 and 1/2 hard

MIL-T-6737B Welded stainless steel tubing (347 and 321) stabilized, corrosion resistant, heat resistant.

STAINLESS STEEL SHEET & PLATE

MATERIAL SPECIFICATIONS

ASTM A167	Specification for stainless and Heat Resisting Chromium Nickel steel plate, sheet and strip.
ASTM A240	Specification for stainless and Heat Resisting Chromium Nickel steel plate , sheet and strip for pressure vessels.
ASTM A262	Practices for detecting susceptibility to intergranular attack in austenitic stainless steels.
ASTM A370	Methods and definitions for mechanical testing of steel products.
ASTM A480 A480M	Specification for general requirements for flat rolled stainless and heat resisting steel plate, sheet and strip.
ASTM A751	Methods, practices and definitions for chemical analysis of steel products.
ASTM E140	Hardness equivalents. QQ-S766-Federal specification for steel plate, sheet and strip corrosion resisting.
MIL-S-4043	Specification for steel: corrosion resisting for plate, sheet and strip (grain size for plate shall be aim 5 max.)
MIL-S-5059	Amendment 4 (except product analysis), military specification for steel corrosion resistance (18-8) plate, sheet and strip.
AMS-5511E	Specification for steel plate, sheet and strip corrosion resistance.
AMS-5513D	Specification for steel plate, sheet and strip corrosion resistance.
AMS-5524	Specification for steel plate and sheet corrosion resistance.
ASME-SA240	Specification for heat resisting chromium and chromium nickel steel plate, sheet and strip for pressure vessels.
ASTM-A666	Specification for austenitic stainless steel strip, plate and flat bar for structural applications.
QQ-S-766	Specification for steel plate, sheet and strip corrosion resistance.

DESCRIPTIONS OF PRODUCTS SPECIFIC TO THIS STANDARD

Plate and sheet as used in this specification are described as follows:

Plate: material 3/16 inch in thickness and over in.

Sheet: material under 3/16 in and 24 inch and over in width.

Strip: material under 3/16 inch and less than 24 inch wide.

CHEMISTRY AND MECHANICAL PROPERTIES

The product purchased to this specification shall meet the chemistry and mechanical properties of all the specifications referenced and as written on the purchase order.

DIMENSIONS AND PERMISSIBLE VARIATIONS

Unless otherwise specified in the purchase order, material shall conform to the permissible tolerances shown in Specification ASTM A480/A480M. Should A480/A480M not cover the product being produced, agreement shall be mutually resolved prior to production, by the purchaser and ASA Alloys Inc..

STAINLESS STEEL BAR

MATERIAL SPECIFICATIONS

Grade	ASTM	ASME	QQS	AMS	MIL S CODE	COLOUR
303	A582		764B	5640P	7720	DK BLUE
416	A582		764B	5610L		DK BROWN
304/304L	A276 A193B8CL1 A182 A479	SA182 SA479 SA193B8CL1	763E	5639F (304L- 5647F)		GREY
316/316L	A276 A193B8MCL1 A182 A479	SA182 SA479 SA193B8MCL1	763E	5648G (316L- 5653C)	7720	RED
410	A276 A193B6	SA182 SA479 SA193B6	763E	5613N		WHITE
420	A276	SA182	763E	5621D		RED/YELLOW
630(17-4)CONDA	A-564	SA564		5643N		BLACK
630(17-4)DT H 1150	A564	SA564				PURPLE
310	A276 A182	SA182 SA479	763E	5651G		YELLOW/BLK
309	A276 A182	SA182 SA479	763E	5650D		YELLOW
347	A276 A182 A479 A193B8CCL1	SA182 SA479 SA479B8CCL1 SA193B8CCL1	763	5646K		PINK
321	A276 A193B8TCL1	SA479 SA193B8TCL1	763	5645M		GOLD/BLACK

Most grades are available to NACE MR 0175

HARDNESS CONVERSION TABLE

(Approximate)

Brinell Hardness	Rockwell B Scale	Rockwell C Scale	Approximate Tensile Lbs., p.s.i.	Brinell Hardness	Rockwell B Scale	Approximate Tensile Lbs., p.s.i.
653	—	62	*324,000*	**217**	96	*103,000*
627	—	60	*311,000*	**212**	96	*103,000*
601	—	59	*306,000*	**207**	95	*101,000*
578	—	57	*290,000*	**202**	94	*98,000*
555	—	56	*284,000*	**197**	93	*96,000*
534	—	54	*270,000*	**192**	92	*93,000*
514	—	53	*263,000*	**187**	91	*91,000*
495	—	51	*250,000*	**183**	90	*89,000*
477	—	50	*243,000*	**179**	89	*87,000*
461	—	49	*236,000*	**174**	88	*85,000*
444	—	47	*223,000*	**170**	87	*83,000*
429	—	47	*217,000*	**166**	86	*81,000*
415	—	45	*211,000*	**163**	85	*80,000*
401	—	42	*194,000*	**159**	84	*78,000*
388	—	41	*188,000*	**156**	83	*77,000*
375	—	40	*182,000*	**153**	82	*76,000*
363	—	38	*171,000*	**149**	81	*75,000*
352	—	37	*166,000*	**146**	80	*74,000*
331	—	36	*162,000*	**143**	79	*73,000*
321	—	34	*153,000*	**140**	78	*71,000*
311	—	33	*148,000*	**137**	77	*70,000*
302	—	32	*144,000*	**134**	76	*69,000*
293	—	31	*140,000*	**131**	74	*67,000*
285	—	30	*136,000*	**128**	73	*66,000*
277	—	29	*132,000*	**126**	72	*65,000*
269	—	28	*129,000*	**124**	71	*63,000*
262	—	27	*126,000*	**121**	70	*62,000*
255	—	25	*120,000*	**118**	69	*61,000*
248	—	24	*117,000*	**116**	68	*60,000*
241	100	23	*115,000*	**114**	67	*59,000*
235	99	22	*112,000*	**112**	66	*58,000*
229	98	21	*110,000*	**109**	65	*57,000*
223	97	20	*108,000*	**107**	64	*55,000*

Fractional Inches Converted to Decimal Inches and Millimeters

Fraction	Decimal(in.)	mm		Fraction	Decimal(in.)	mm
1/64	0.0156	0.3969		**33/64**	0.5156	13.0969
1/32	0.0313	0.7938		**17/32**	0.5313	13.4938
3/64	0.0469	1.1906		**35/64**	0.5469	13.8906
1/16	0.0625	1.5875		**9/16**	0.5625	14.2875
5/64	0.0781	1.9844		**37/64**	0.5781	14.6844
3/32	0.0938	2.3813		**19/32**	0.5938	15.0813
7/64	0.1094	2.7781		**39/64**	0.6094	15.4781
1/8	0.1250	3.1750		**5/8**	0.6250	15.8750
9/64	0.1406	3.5719		**41/64**	0.6406	16.2719
5/32	0.1563	3.9688		**21/32**	0.6563	16.6688
11/64	0.1719	4.3656		**43/64**	0.6719	17.0656
3/16	0.1875	4.7625		**11/16**	0.6875	17.4625
13/64	0.2031	5.1594		**45/64**	0.7031	17.8594
7/32	0.2188	5.5563		**23/32**	0.7188	18.2563
15/64	0.2344	5.9531		**47/64**	0.7344	18.6531
1/4	0.2500	6.3500		**3/4**	0.7500	19.0500
17/64	0.2656	6.7469		**49/64**	0.7656	19.4469
9/32	0.2813	7.1438		**25/32**	0.7813	19.8438
19/64	0.2969	7.5406		**51/64**	0.7969	20.2406
5/16	0.3125	7.9375		**13/16**	0.8125	20.6375
21/64	0.3281	8.3344		**53/64**	0.8281	21.0344
11/32	0.3438	8.7313		**27/32**	0.8438	21.4313
23/64	0.3594	9.1281		**55/64**	0.8594	21.8281
3/8	0.3750	9.5250		**7/8**	0.8750	22.2250
25/64	0.3906	9.9219		**57/64**	0.8906	22.6219
13/32	0.4063	10.3188		**29/32**	0.9063	23.0188
27/64	0.4219	10.7156		**59/64**	0.9219	23.4156
7/16	0.4375	11.1125		**15/16**	0.9375	23.8125
29/64	0.4531	11.5094		**61/64**	0.9531	24.2094
15/32	0.4688	11.9063		**31/32**	0.9688	24.6063
31/64	0.4844	12.3031		**63/64**	0.9844	25.0031
1/2	0.5000	12.7000		**1"**	1.0000	25.4000

WORKABILITY CHARACTERISTICS

OPERATION	ATLAS/AISI TYPES—300 SERIES									
	303	304	304L	309	309S	310	310S	316	316L	317
Blanking	-	B	B	B	B	B	B	B	B	B
Brake Forming	-	A	A	A	A	A	A	A	A	A
Brazing	D	B	B	B	B	B	B	B	B	B
Buffing	D	A-B	B	B	B	B	B	B	B	B
Coining	D	B	B	B	B	B	B	B	B	B
Deep Drawing	-	A	A	B	B	B	B	B	B	B
Drilling	A	C	C-	C	C	C	C	C	C	C
Embossing	C	B	B-	B	B	B	B	B	B	B
Forging-Cold	D	B	B	B-C	B-C	B-C	B-C	B	D	D
Forging-Hot	B	B	B	B	B	B	B	B	B	B-C
Hardening by Cold Work - Relative Ultimate Tensile Strengths. (Typical Values for Strip Products)										
a. Annealed 1000 psi	-	84	81	95	95	95	95	84	-	90
b. 25% Reduction 1000 psi	-	138	140	130	130	126	126	136	-	134
c. 50% Reduction 1000 psi	-	178	182	169	169	165	165	167	-	165
Hardening by Heat Treatment	No	No	No	No	No	No	No	No	No	No
Heading-Cold	D	B	B	-	-	A-B	A-B	B	B	-
Heading-Hot	B	A	A	-	-	A	A	A	A	-
Machining	A	C	C	C	C	C	C	C	C	C
Machinability Rating % B1212	78	49	49	-	-	-	-	48	48	-
Magnetic	Not	Not	Not	Not	Not	Not††	Not††	Not††	Not	Not††
Punching	-	B	B	B	B	B	B	B	B	B
Polishing D	A	A	B	B	B	B	B	B	B	
Roll-Forming	-	A	A	B	B	A	A	A	A	B
Sawing	A	C	C	C	C	C	C	C	C	C
Shearing	C	B	B	B	B	B	B	B	B	B
Spinning	-	B-C	B-C	B	B	B	B	B	B	B

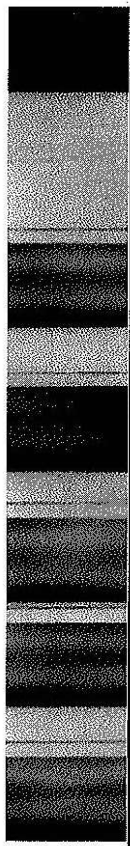
A-Excellent B-Good C-Fair D-Not generally recommended
*-Severe sharp corner bends should be avoided *Sections

WORKABILITY CHARACTERISTICS

			ATLAS/AISI TYPES—400 SERIES											
317L	321	347	403	409	410	416MX	416MN	420	430	430F	431	436	440C	446
B	B	B	A	A	A	-	-	B	A	-	-	A	-	A
A	A	A	A*	A*	A*	-	-	C*	A*	-	-	A*	-	A*
B	B	B	B	B	B	D	D	C	B	D	C	B	C	D
B	C	C	B	B	B	D	D	B	A	D	B	A	B	C-D
B	C	C	A	A	A	D	D	C-D	A	D	C-D	A-B	D	B
B	B	B	A	A	A	-	-	D	A-B	-	D	A-B	-	B-C
C	C	C	A-B	A-B	A-B	A	A	C	A-B	A	C	A-B	C	B
B	B	B	A	A	A	C	C	D	A	C	D	A	D	B
D	B	B	B	B	B	D	D	D	B	D	D	B	D	-
B-C	B	B	B	B	B	B	B	B	B	B	B	B	B	-
-	90	95	-	-	-	-	-	-	75	-	-	77	-	80
-	136	136	-	-	-	-	-	-	76	-	-	100	-	-
-	167	167	-	-	-	-	-	-	120	-	-	125	-	-
No	No	No	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	No
-	B	B	A	-	A	D	D	C	A	D	C	A	D	-
-	A	A	A	-	A	B	B	A	A	B	A	A	B	-
C	C	C	B	B	B	A	A	C	B	A	B	B	C	B
-	-	-	-	-	59	90	85	53	60	87	49	-	40	-
No†	No†	No†	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
B	B	B	A-B	A-B	A-B	-	-	C	A-B	-	C	A-B	-	B
B	C	CC	B	B	B	D	D	B	B	D	B	B	B	C
B	B	B	-	A	A	-	-	-	A	-	-	A	-	B
C	C	C	B	B	B	A	A	C	B	A	C	B	C	B
B	B	B	B	B	B	C	C	C	B	C	C	B	C	B
B	C-D	C-D	A	A	A	-	-	D	A	-	B	A	-	B

† - Develops magnetism after cold reduction †† - Develops less magnetism after cold reduction.

STAINLESS STEEL FINISHES



Description	Size Range: Rounds	Tolerances: Plus	Tolerances: Minus	Straightness	Typical Surface Finish	Applications	Standard Packaging** (Special Packaging Refer to Mill)
Hot Rolled Annealed and Pickled After hot working, product is mechanically or chemically descaled and passivated.	Rounds* .718 - .875 .876 - 1.000 1.001 - 1.125 1.126 - 1.250 1.251 - 1.375 1.376 - 1.500 1.501 - 2.000 2.001 - 2.500 2.501 - 3.500 3.501 - 4.500 4.501 - 5.500 5.501 - 6.500 6.501 - 8.250	Plus .008 .009 .010 .011 .012 .014 .016 .031 .046 .062 .078 .125 .156	Minus .008 .009 .010 .011 .012 .014 .016 .000 .000 .000 .000 .000 .000	.125" in 5 ft.	Matte gray appearance; scale pattern and surface roughness increases with bar size. Hot rolled defects not removed. Scale free.	Commonly used for corrosion resistant, heat resistant and industrial applications where aesthetic appearance and smoothness of finish are not particularly important.	Bundled and strapped.
Machined Bar peeled up to 7" to remove scale and surface imperfections; larger sizes are lathe turned.	Rounds .750 - 3.499 3.500 - 5.000 5.001 - 6.750 6.751 - 18.000	Plus .010 .015 .032 .063	Minus .000 .000 .000 .000	.0625" in 5 ft.	Clean, bright finish with HR defects removed. Tooling marks from bar turning apparent even after straightening operation. Typical RMS Finish: 150-250.	Ideally suited for applications involving further hot working (forging, rerolling or extrusion), or where subsequent cold finishing operations are to be performed. Main criteria is to be free from hot working surface imperfections.	Bundled and strapped.
Cold Drawn Product is descaled, pickled and cold drawn to size.	Rounds* .125 - .3125 .313 - .500 .501 - .999 1.000 - 1.499 1.500 - 4.000	Plus .001 .0015 .002 .0025 .003	Minus .001 .0015 .002 .0025 .003	.0625" in 5 ft.	Dull matte gray appearance; drawing lubricant on surface. Typical RMS Finish: 150-250. Optional - bright drawn finish also available.	A general purpose finish used in similar applications as HRAP product: has improved size tolerance and surface finish over HRAP product. Bright drawn is applicable where finish supplied is that of the end product.	Bundled and strapped.
Smooth Turned Bar turned and rough centreless ground.	Rounds .250 - .999 1.000 - 1.499 1.500 - 3.499 3.500 - 5.000	Plus .002 .0025 .003 .004	Minus .002 .0025 .003 .004	.0625" in 5 ft.	Clean, bright smooth finish; defect free. Typical RMS Finish: 50.	General purpose bar finish suitable for most applications.	Bundled, strapped and plastic wrapped.
Centreless Ground Cold finished by cold drawing and/or bar turning and centreless ground.	Rounds .125 - .317 .318 - .500 .501 - .999 1.000 - 1.499 1.500 - 3.499 3.500 - 6.750	Plus .000 .000 .000 .000 .000 .001	Minus .001 .0015 .002 .0025 .003 .003	.0625" in 5 ft. Pump shaft quality straightness also available.	Clean, bright smooth finish; defect free. Smoother finish than Smooth Turned. RMS Finish: 30 max. guaranteed.	Improved bar finish and tolerance over Smooth Turned. Used where the finish supplied is that of the end product; aesthetic appearance is important.	Bundled, strapped and plastic wrapped.
Centreless Ground and Polished Cold finished by cold drawing and/or bar turning, followed by centreless grinding and polishing.	Rounds .125 - .317 .318 - .500 .501 - .999 1.000 - 1.499 1.500 - 3.499 3.500 - 6.750	Plus .000 .000 .000 .000 .000 .001	Minus .001 .0015 .002 .0025 .003 .003	.0625" in 5 ft. Pump shaft quality straightness also available.	Clean, bright reflective smooth surface; defect free. RMS Finish: 20 max. guaranteed.	This superior finish is employed where the final surface appearance is critical.	Ringed, bundled, strapped and plastic wrapped.

CORROSION DATA GUIDE

Substance	Condition			Type			
	Strength	°F	°C	316	302/304	430	410
Acetaldehyde	100%	142	61	A	A	—	—
Acetic Acid	5-10%	70	20	A	A	A	B
" "	5-10%	Boiling		A	A	C	—
" "	20%	70	20	A	A	A	C
" "	20%	Boiling		A	A	—	—
" "	33-1/3%	70	20	A	A	A	C
" "	33-1/3%	Boiling		A	B	C	—
" "	50%	70	20	A	A	A	C
" "	50%	Boiling		A	B	—	—
" "	80%	70	20	A	A	A	—
" "	80%	180	85	A	A	C	—
" "	80%	Boiling		B	B	C	—
" "	100%	70	20	A	A	A	C
" "	100%	180	85	A	A	C	—
" "	100%	Boiling		C	C	C	—
" "	100% 150# pressure	200	95	C	C	—	—
" "	100% 150# pressure	400	205	C	C	—	—
Acetic Anhydride	90%	70	20	A	A	B	—
" "	90%	Boiling		A	B	C	—
" "	90% Aerated	180	85	B	C	—	—
" "	60%	180	85	A	A	—	—
Acetic Vapours	30%	70	20	A	B	—	C
" "	30%	Hot		B	B	—	—
" "	100%	70	20	A	B	—	C
" "	100%	Hot		B	C	—	—
Acetone		70	20	A	A	B	B
"		Boiling		A	A	—	C
Acetophenone	66%	302	150	A	A	—	—
Acetyl Chloride		70	20	B	B	—	—
" "		Boiling		B	B	—	—
Acetylene		70	20	A	A	A	B
Acrylic Acid	96%	77	25	A	A	—	—
Activine	Aqueous Solution	70	20	A	A	—	—
Alcohol Ethyl		70	20	A	A	A	B
" "		Boiling		A	A	A	—
Alcohol Methyl		70	20	A	A	A	A
" "		150	65	B	B	B	—
Alkaform Anesthesia		70	20	A	A	C	C
Alkaline Liquor	20%	Boiling		A	A	—	—
Aluminum	Molten	1380	750	C	C	C	C
Aluminum Acetate	Saturated	70	20	A	A	—	—
" "	Saturated	Boiling		A	A	—	—
Aluminum Chloride	5%	70	20	C	C	C	C
" "	10-25%	70	20	C	C	C	—
" "	Saturated	70	20	C	C	C	C
Aluminum Fluoride	5%	70	20	B	C	C	C
" "	Saturated	70	20	B	C	C	C
Aluminum Hydroxide	Saturated	70	20	A	A	A	—
Aluminum Potassium Sulphate (Alum)	2%	70	20	A	A	A	B
" " "	10%	70	20	A	A	B	—
" " "	10%	Boiling		A	A	B	—
" " "	Saturated	70	20	A	B	C	—
" " "	Saturated	Boiling		B	B	C	—
Aluminum Sulphate	5%	150	65	A	A	—	—
" "	10%	70	20	A	A	C	C
" "	10%	Boiling		A	B	C	—
" "	Saturated	70	20	A	A	C	C
" "	Saturated	Boiling		A	B	C	—
" " (+1%H_2SO_4)	Saturated	70	20	A	B	—	C
" " (+1%Na_2CO_3)	Saturated	70	20	A	A	—	B
Ammonia (Anhydrous)		70	20	A	A	A	—
Ammonia Gas		Cold		A	A	A	—
" "		Hot		C	C	C	—
Ammonia Liquor	All Strengths	70	20	A	A	—	—
" "	All Strengths	Boiling		A	A	—	—
Ammonium Alum	Saturated	70	20	A	A	A	—
" " (Slightly Ammoniacal)	Saturated	200	95	A	A	—	C

Legend: A—Fully Resistant
B—Fairly Resistant
C—Not Resistant
M—Complete details of service should be submitted for a recommendation on the proper grade for these substances.
— No data available.

CORROSION DATA GUIDE

(Continued)

Substance	Condition			Type			
	Strength	°F	°C	316	302/304	430	410
Ammonium Bicarbonate	Saturated	70	20	A	A	—	—
" "	Saturated	Hot		A	A	—	—
Ammonium Bromide	5%	70	20	B	C	—	—
" "	Saturated	70	20	A	B	—	—
Ammonium Carbonate	1 and 5%	70	20	A	A	A	B
" "	Saturated	70	20	A	A	A	B
Ammonium Chloride	1%	70	20	A	B	—	—
" "	5%	70	20	A	B	—	—
" "	10%	Boiling		A	B	—	—
" "	20%	Boiling		A	B	—	—
" "	28%	Boiling		A	C	—	—
" "	50%	Boiling		A	C	—	—
" "	Saturated	70	20	A	B	—	—
Ammonium Hydroxide	All Strengths	70	20	A	A	A	B
Ammonium Monophosphate	Saturated	70	20	A	A	A	B
Ammonium Nitrate (Agitated and Aerated)	All Strengths	70	20	A	A	A	B
Ammonium Nitrate	Saturated	Boiling		A	A	A	B
Ammonium Nitrate (Dissolved in Conc. H_2SO_4)		140	60	A	A	—	—
" "		250	120	A	A	—	—
Ammonium Oxalate	5%	70	20	A	A	A	B
" "	Saturated	70	20	A	A	—	B
Ammonium Perchlorate	10%	Boiling		A	A	—	—
Ammonium Persulphate	5%	70	20	A	A	B	B
Ammonium Phosphate	5%	70	20	A	A	A	B
" "	Saturated	70	20	A	A	A	—
Ammonium Potassium Sulphate (Slightly Ammoniacal)	Saturated	200	95	A	A	—	C
Ammonium Sulphate (Agitated)	1 and 5%	70	20	A	A	A	B
Ammonium Sulphate (Aerated)	1 and 5%	70	20	A	A	A	B
Ammonium Sulphate	10%	70	20	A	A	—	—
" "	10%	Boiling		A	B	—	—
" "	Saturated	70	20	A	A	—	—
" "	Saturated	Boiling		A	B	—	—
Ammonium Sulphate (+.5%H_2SO_4)	Saturated	70	20	A	B	—	C
Ammonium Sulphate (+5%H_2SO_4)	Saturated	70	20	—	C	—	C
Ammonium Sulphite	Saturated	70	20	A	A	—	—
" "	Saturated	Boiling		A	A	—	—
Amyl Acetate	Concentrated	70	20	A	A	A	A
Amyl Chloride				A	A	B	B
Amyl Phenol		390	200	A	A	—	—
Aniline	3%	70	20	A	A	A	B
Aniline Crude	Concentrated	70	20	A	A	A	—
Aniline Hydrochloride	5%	70	20	C	C	C	C
Antibiotics		70	20	A	A	—	—
Antimony	Molten	1110	600	C	C	—	—
Antimony Trichloride	Saturated	70	20	C	C	C	—
Arsenic Acid		150	65	A	A	—	—
"		225	110	—	B	—	—
Arsenious Acid		70	20	A	A	A	B
Baking Oven Gases				A	A	A	B
Baking Soda	Solution	70	20	A	A	—	—
Barium Carbonate	Solution	70	20	A	A	A	B
Barium Chloride	5%	70	20	A	B	—	—
" "	Saturated	70	20	A	A	—	—
" "	Saturated	Hot		A	B	—	—
Barium Hydrate	Saturated	70	20	A	A	A	A
Barium Nitrate	Saturated	Hot		A	A	—	—
Barium Sulphate	Saturated	70	20	A	A	A	—
Beer (Barley, Malt and Hops)		70	20	A	A	—	—
Beet Juice		70	20	A	A	—	—
Benzene (from coal tar or crude oil)		70	20	A	A	—	—
Benzene (from coal tar or crude oil)		Boiling		A	A	—	—
Benzoic Acid		70	20	A	A	A	B
Benzol		70	20	A	A	A	B
"		Hot		A	A	A	B
Bleaching Powder (Dry)				A	C	C	C
Bleaching Solution (Containing Chlorine)		70	20	A	B	—	—

Legend A—Fully Resistant
B—Fairly Resistant
C—Not Resistant

M—Complete details of service should be submitted for a recommendation on the proper grade for these substances.
— No data available.

CORROSION DATA GUIDE

(Continued)

Substance	Condition			Type			
	Strength	°F	°C	316	302/304	430	410
Blood—Meat Juices		70	20	A	A	—	—
Blue Vitriol	Saturated	Boiling		A	A	—	—
Boracic Acid (Boric Acid)	5%	70	20	A	A	A	B
" "	5%	Hot		A	A	A	B
" " (Boric Acid)	70%	Hot		C	C	C	C
Borax	5%	Hot		A	A	A	B
Bordeaux Mixture				A	A	—	—
Bromine Gas		70	20	C	C	C	C
Bromine Water		70	20	C	C	C	C
Butane		70	20	A	A	—	—
Buttermilk		70	20	A	A	A	B
Butyl Acetate				A	A	A	B
Butyric Acid	5%	70	20	A	A	A	B
" "	5%	150	65	A	A	A	B
" "	Saturated	70	20	A	A	A	—
Butyric Acid	Saturated	Boiling		A	B	—	—
Cadmium	Molten	610	320	C	C	—	—
Calcium Bisulphite	Aqueous Solution	Boiling		A	A	—	—
" "	Aqueous Solution						
	300# pressure	390	200	B	C	—	—
Calcium Brine (+NaCl)		70	20	A	B	—	—
Calcium Carbonate		70	20	A	A	A	B
Calcium Chlorate	Dilute Solution	70	20	A	A	—	—
" "	Dilute Solution	Hot		A	A	—	—
" "	Saturated	70	20	A	A	—	—
Calcium Chloride	5%	70	20	A	B	—	—
" "	Saturated	70	20	A	B	—	—
" "	All Concentrations	Boiling		A	C	—	—
Calcium Hydroxide	5%	70	20	A	A	A	B
" "	10%	Boiling		A	A	—	—
" "	20%	70	20	A	A	—	—
" "	20%	Boiling		A	A	—	—
" "	50%	70	20	A	B	—	—
" "	50%	Boiling		B	C	—	—
" "	Saturated	70	20	A	A	A	B
Calcium Hypochlorite	2%	70	20	A	B	B	C
" "	Saturated	70	20	A	C	C	C
" " with 10/11 PH (Bleach Solution)	Saturated	70/80	20/30	M	C	C	C
Calcium Sulphate	Saturated	70	20	A	A	A	—
Camphor		70	20	A	A	A	B
Carbolic Acid	C.P.	70	20	A	A	B	B
" "	C.P.	Boiling		A	A	B	B
" "	Crude	Boiling		A	A	B	—
" "	5%	Boiling		A	A	—	—
Carbonated Water				A	A	A	B
Carbonate of Soda	5%	Boiling		A	A	—	—
" "	50%	Boiling		A	A	—	—
" "	Molten	1650	900	C	C	—	—
Carbon Bisulphide		70	20	A	A	A	B
Carbon Black		70	20	A	A	—	—
Carbon Monoxide Gas		1400	760	A	A	A	B
" " "		1600	870	A	A	A	—
Carbon Tetrachloride	5-10%	70	20	B	B	B	C
" " "	Pure	70	20	A	A	B	C
" " "	Pure	Boiling		A	A	—	—
" "	Vap. Refluxed	Boiling		C	C	—	—
Carnallite	Saturated	Boiling		B	B	—	—
Casein		70	20	A	A	—	—
Caustic Potash	30%	Boiling		A	A	—	—
Caustic Soda	30%	Boiling		A	A	—	—
Cellulose				A	A	—	—
Charged Water				A	A	—	—
Chinosol (Antiseptic)	1:500	70	20	A	A	—	—
Chloracetic Acid		70	20	B	C	C	C
Chlorate of Lime	Solution	Hot		A	A	—	—
Chlorobenzol (pure)	Concentrated	70	20	A	A	A	—
Chloric Acid		70	20	C	C	C	—
Chloride of Lime	Saturated	212	100	A	A	—	—
Chlorinated Water	Saturated	70	20	M	B	C	C

Legend: A—Fully Resistant
B—Fairly Resistant
C—Not Resistant

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CORROSION DATA GUIDE

(Continued)

Substance	Condition			Type			
	Strength	°F	°C	316	302/304	430	410
Chlorine Gas	Dry	70	20	B	B	C	C
" "	Moist	70	20	B	C	C	C
" "		212	100	C	C	C	C
Chlorobenzene		Boiling		A	A	—	—
Chloroform	Dry	70	20	A	A	A	B
Chlorosulfonic Acid	10%	70	20	M	B	C	C
" "	Concentrated	70	20	A	A	C	C
Chromic Acid	5%	70	20	A	A	B	C
" "	10%	70	20	A	A	B	C
" "	10%	Boiling		B	B	C	C
" "	50% c.p.	70	20	B	B	C	C
" "	50%	Boiling		B	C	C	C
Chromic Acid (Cont. SO_3)	50% (Comm.)	70	20	B	B	C	C
" " " "	50% (Comm.)	Boiling		C	C	C	C
Chromic Acid	Saturated	70	20	C	C	C	C
Chromium Plating Bath		70	20	A	A	—	—
Cider		70	20	A	A	A	B
Citric Acid	5% (Still)	70	20	A	A	A	B
" "	5% (Still)	150	65	A	A	A	B
" "	5%	Boiling		A	A	A	—
" "	5% (45# pressure)	285	140	A	B	—	—
" "	10%	70	20	A	A	—	—
" "	10%	Boiling		A	A	—	—
" "	15%	70	20	A	A	A	B
" "	15%	Boiling		A	A	B	B
" "	25%	70	20	A	A	—	B
" "	25%	Boiling		A	B	—	—
" "	50%	70	20	A	A	B	B
" "	50%	Boiling		A	B	—	—
" "	Concentrated	70	20	A	A	—	—
	Concentrated	Boiling		A	B	—	—
Citrus Juices	All Concentrations	Hot		A	A	—	—
Cobalt Acetate		70	20	A	A	—	—
Coca-Cola Syrup	Pure	70	20	A	A	—	—
Coffee		Boiling		A	A	A	B
Copal Varnish		70	20	A	A	A	B
Copperas	Dilute	Hot		A	A	—	—
Copper Acetate	Saturated	70	20	A	A	A	—
Copper Carbonate	Saturated	70	20	A	A	A	B
Copper Carbonate (+50%NH_4OH)	Saturated	70	20	A	A	A	—
Copper Chloride	1%	70	20	C	C	C	C
Copper Chloride (Agitated)	1%	70	20	A	B	B	B
Copper Chloride (Aerated)	1%	70	20	A	B	B	B
Copper Chloride (Agitated)	5%	70	20	B	B	B	B
Copper Chloride (Aerated)	5%	70	20	C	C	C	C
Copper Chloride	10%	Boiling		C	C	C	C
" "	Saturated	70	20	C	C	C	C
Copper Cyanide	Saturated	70	20	A	A	A	B
" "	Saturated	Boiling		A	A	A	B
Copper Nitrate	1 and 5%	70	20	A	A	A	B
" "	50%	Hot		A	A	—	—
" "	Saturated	70	20	A	A	A	B
Copper Sulphate	5% (Still)	70	20	A	A	A	B
" "	5% (Aerated)			A	A	A	B
" "	10%	70	20	A	A	A	B
" "	Saturated	Boiling		A	A	A	B
Copper Sulphate (+2%H_2SO_4)	Saturated	70	20	A	A	B	B
Creosote (Coal Tar)		Hot		A	A	—	—
Creosote (Oil)		Hot		A	A	—	—
Creosote (+3% Salt)				C	C	C	C
Cresylic Acid		Up to Boiling		A	A	A	—
Cyanogen Gas		70	20	A	A	—	—
Detergents				A	A	A	A
Developing Solutions		70	20	A	B	—	—
Dichloro-Ethane		Boiling		A	A	—	—
Digestor Acid (Pulp Paper Ind.)		70	20	M	M	C	—
Dinitrochlorbenzol (melted and solidified)		70	20	A	A	A	—
Distillery Wort		70	20	A	A	—	—
Dutch Liquor		70	20	A	A	—	—

Legend A—Fully Resistant
B—Fairly Resistant
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CORROSION DATA GUIDE

(Continued)

Substance	Condition			Type			
	Strength	°F	°C	316	302/304	430	410
Dyes		70	20	A	B	—	—
Dyewood Liquor		70	20	A	A	—	—
Epsom Salt Solution		Hot or Cold		A	A	A	—
Ether		70	20	A	A	A	B
Ethyl Acetate	All Concentrations	70	20	A	A	A	—
Ethyl Chloride		70	20	A	A	A	B
Ethylene Chloride		70	20	A	A	—	—
Ethylene Glycol	Concentrated	70	20	A	A	A	B
Fatty Acid	All	350	175	A	B	—	—
Fatty Acid (Olein)		350	175	A	A	—	—
Ferric Chloride	1%	70	20	B	C	—	—
" "	1%	Boiling		B	C	C	C
" "	5%	70	20	B	C	C	C
Ferric Chloride (Agitated)	5%	70	20	B	C	C	C
Ferric Chloride (Aerated)	5%	70	20	B	C	C	C
Ferric Chloride	10%	70	20	B	C	C	C
Ferric Hydroxide (Hydrated Iron Oxide)		70	20	A	A	A	B
Ferric Nitrate	1 and 5%	70	20	A	A	A	B
" "	Saturated	70	20	A	A	A	B
Ferric Sulphate	1 and 5%	70	20	A	A	A	B
" "	1%	Boiling		A	A	A	B
" "	Saturated	70	20	A	A	A	—
" "	5%	Boiling		A	A	—	—
Ferrous Sulphate	10%	70	20	A	A	A	B
" "	5%	70	20	A	A	A	B
" "	10%	Boiling		A	A	—	—
" "	Saturated	70	20	A	A	A	B
Fertilizers		70	20	A	B	—	—
Fluorine Gas		70	20	C	C	C	C
Fluosilicic Acid	90%	70	20	B	C	—	—
Food Pastes		70	20	A	A	A	B
Formalin (40% solution Formaldehyde)	40%	70	20	A	A	A	B
Formaldehyde (Formalin, Methanol)		70	20	A	A	A	B
" "		Boiling		A	A	A	B
Formic Acid	1%	70	20	A	A	A	—
" "	1%	100	40	A	A	C	—
" "	1%	Boiling		A	A	C	—
" "	5%	70	20	A	A	—	—
" "	5%	150	65	A	B	—	—
" "	10%	70	20	A	A	—	—
" "	10%	100	40	A	A	—	—
" "	10%	180	85	A	C	—	—
" "	10%	Boiling		C	C	—	—
" "	50%	70	20	A	B	—	—
" "	50%	100	40	A	C	—	—
" "	50%	180	85	A	C	—	—
" "	50%	Boiling		C	C	—	—
Fruit Juices	Saturated	70	20	A	C	—	C
" "		70	20	A	A	A	B
" "		Hot		A	A	A	B
Fuel Oil		70	20	A	A	A	B
" "		Hot		A	A	—	—
" " (Containing Sulphuric Acid)		70	20	A	B	—	—
Gallic Acid	5%	70	20	A	A	A	B
" "	5%	150	65	A	A	A	B
" "	Saturated	70	20	A	A	A	—
" "	Saturated	Boiling		A	A	B	—
Gasoline		70	20	A	A	A	B
Gelatine				A	A	A	B
Glauber's Salt		70	20	A	A	—	—
Glue (Dry)		70	20	A	A	A	—
Glue		Hot		A	A	—	—
Glue (Solution Acid)		70	20	A	B	—	—
" " "		140	60	A	B	—	—
Glycerine		70	20	A	A	A	B

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CORROSION DATA GUIDE

(Continued)

Substance	Condition			Type			
	Strength	°F	°C	316	302/304	430	410
Gold Cyanide Electroplating Solution		70	20	A	A	—	—
Gun Cotton Brine (Waste Acids)		70	20	A	A	—	—
Gypsum				A	A	—	—
Hops		70	20	A	A	—	—
Hydrobromic Acid	Saturated	70	20	C	C	C	C
Hydrochloric Acid	1% or less	70	20	B	C	C	C
" "	1% or less	140	60	C	C	C	C
" "	1% or less	Boiling		C	C	C	C
" "	10%	70	20	C	C	C	C
" "	10%	Boiling		C	C	C	C
" "	Higher Concentrations	All Temperatures		C	C	C	C
Hydrochloric Acid Vapours		70	20	B	C	C	C
" " "		212	100	C	C	C	C
" " "		930	498	C	C	C	C
Hydrocyanic Acid (Prussic)		70	20	A	A	C	C
Hydrofluoric Acid	All Concentrations	70	20	C	C	C	C
Hydrofluoric Acid Vapours		212	100	C	C	C	C
Hydrofluosilicic Acid		70	20	C	C	C	C
Hydrofluosilicic Acid Vapours		212	100	C	C	C	C
Hydrogen Peroxide (Acid Free)		70	20	A	A	B	B
Hydrogen Peroxide		Boiling		A	B	B	—
Hydrogen Sulphide	Dry	70	20	A	A	A	—
" "	Wet	70	20	A	B	B	—
" "		to 400	to 205	A	B	—	—
Hyposulphate of Soda	Dilute	Hot		A	A	—	—
Hyposulphate Soda (Hypo.)		70	20	A	A	B	—
Ink		70	20	A	A	B	B
Iodine	Dry	70	20	A	C	C	C
"	Moist	70	20	B	C	C	C
Iodoform		70	20	A	B	—	—
Iron Gall Ink		70	20	A	A	—	—
Jam (Marmalade, Etc.)		70	20	A	A	A	—
Kerosene		70	20	A	A	A	—
Ketchup		70	20	A	A	A	B
Lactic Acid	5%	70	20	A	A	B	C
" "	5%	150	65	A	B	B	C
" "	5%	180	85	A	B	C	—
" "	5%	Boiling		A	B	C	—
" "	10%	150	65	B	C	—	—
" "	10%	Boiling		B	C	—	—
" "	20%	70	20	A	—	—	—
" "	20%	Boiling		B	—	—	—
" "	50%	70	20	A	A	B	—
" "	50%	100	40	A	B	C	—
" "	50%	140	60	A	C	—	—
" "	50%	Boiling		B	C	—	—
" "	100%	70	20	A	A	B	B
" "	100%	100	40	A	B	C	—
" "	100%	180	85	B	C	—	—
Lactic Acid (+Salt)	100%	70	20	A	B	—	—
Lard		70	20	A	A	A	—
"		Hot		A	A	A	—
Lead	Molten	1110	600	B	B	B	C
Lead Acetate	Saturated	70	20	A	A	A	—
" "	Saturated	Hot		A	A	A	B
Lemon Juice		70	20	A	A	A	—
Linseed Oil		70 and Hot		A	A	A	B
Linseed Oil (+3% H_2SO_4)		390	200	A	A	—	—
Lysol		70	20	A	B	C	C
Lye	30%	Boiling		A	A	—	—
Magnesium Carbonate	Saturated	70	20	A	B	A	A
Magnesium Chloride	1 and 5%	70	20	A	A	B	B
" "	1 and 5%	Hot		B	B	—	—
" "	Saturated	70	20	A	B	B	B

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CORROSION DATA GUIDE

(Continued)

Substance	Condition			Type			
	Strength	°F	°C	316	302/304	430	410
Magnesium Hydroxide	Thick	70	20	A	A	A	B
Magnesium Nitrate	Saturated	70	20	A	A	A	—
Magnesium Oxychloride		70	20	B	B	—	—
Magnesium Sulphate	5%	Hot		A	A	A	C
" "	Saturated	70	20	A	A	A	C
" "	Saturated	Hot		A	A	A	C
Malic Acid	5%	70	20	A	A	A	B
" "	Saturated	70	20	A	A	B	C
Manganese Chloride	10%	Boiling		B	B	—	—
" "	50%	Boiling		B	B	—	—
Manganese Sulphate		70	20	A	A	A	—
Mayonnaise		70	20	A	A	B	B
Marsh Gas		70	20	A	A	—	—
Mash		Hot		A	A	—	—
Meats		70	20	A	A	A	B
Mercuric Chloride	0.1%	70	20	A	A	—	—
" "	0.1%	Boiling		A	A	—	—
" "	0.7%	70	20	B	B	—	—
" "	0.7%	Boiling		C	C	—	—
" "	2.0%	70	20	B	C	—	—
Mercuric Cyanide				A	A	—	—
Mercurous Nitrate	Saturated	70	20	A	A	A	B
Mercury		70	20	A	A	A	B
Methanol (Methyl Alcohol)		70	20	A	A	A	B
Methyl Aldehyde	40%	70	20	A	A	—	—
Methyl Chloride		70	20	A	A	—	—
Methylene Chloride		Boiling		A	A	—	—
Milk (Fresh or Sour)		70	20	A	A	A	B
" " "		Hot		A	A	A	B
Mine Water (Acid)		70	20	A	A	A	B
MIXED ACIDS—(% BY WEIGHT):							
50% Conc. H_2SO_4 + 50% Conc. HNO_3		120-140	50-60	A	A	—	—
" " " "		190-200	90-95	B	B	—	—
50% Conc. H_2SO_4 + 50% Conc. HNO_3		Boiling 480	250	B	B	—	—
75% Conc. H_2SO_4 + 25% Conc. HNO_3		120-140	50-60	A	A	—	—
" " " "		190-200	90-95	B	B	—	—
" " " "		Boiling 310	154	C	C	—	—
70% Conc. H_2SO_4 + 20% Water		120-140	50-60	A	A	—	—
" " " "		190-200	90-95	B	B	—	—
" " " "		Boiling 300	150	C	C	—	—
15% Conc. H_2SO_4 + 5% Conc. HNO_3 + 80% Water		120-140	50-60	A	A	—	—
" " " "		190-200	90-95	A	A	—	—
15% Conc. H_2SO_4 + 5% Conc. HNO_3 + 80% Water		Boiling 220	104	A	A	—	—
30% H_2SO_4 + 5% HNO_3		203	95	A	A	—	—
" " " "		230	110	A	A	—	—
58% H_2SO_4 + 40% HNO_3		140	60	A	A	—	—
" " " "		203	95	A	A	—	—
" " " "		230	110	C	C	—	—
70% H_2SO_4 + 10% HNO_3		140	60	A	A	—	—
" " " "		203	95	A	A	—	—
1% H_2SO_4 + 99% HNO_3		Boiling		A	A	—	—
10% H_2SO_4 + 90% HNO_3		Boiling		A	A	—	—
Molasses		70	20	A	A	A	B
Molybdic Acid		70	20	A	A	—	—
Monoethanolamine		Up to 212	Up to 100	A	A	—	—
Muriatic Acid		70	20	C	C	C	C
Mustard		70	20	A	B	B	C
Naphtha		70	20	A	A	A	B
Naphtha Crude		70	20	A	A	—	—
Naphthalene Sulphonic Acid		70	20	A	A	—	—

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CORROSION DATA GUIDE

(Continued)

Substance	Condition			Type			
	Strength	°F	°C	316	302/304	430	410
Nickel Chloride	Saturated	70	20	A	B	—	—
Nickel Nitrate	Saturated	70	20	A	A	A	B
" "	All Concentrations	Boiling		A	A	—	—
Nickel Sulphate	Saturated	70	20	A	A	—	—
" "	Saturated	Hot		A	A	—	—
Nickel Sulphate (Electroplating Solution)		70	20	A	A	—	—
Niter Cake	Fused	70	20	A	B	B	—
Nitrating Acids		70	20	A	A	A	—
Nitric Acid	5%	70	20	A	A	A	A
" "	5%	Boiling		A	A	A	—
" "	20%	70	20	A	A	A	A
" "	20%	Boiling		A	A	A	—
" "	50%	70	20	A	A	A	A
" "	50%	Boiling		A	A	B	—
" "	65%	Boiling		B	B	B	C
" "	Concentrated	70	20	A	A	A	A
" "	Concentrated	Boiling		B	B	C	C
Nitric Acid (10% + Barium Nitrate - 17%)		Boiling		A	A	—	—
Nitric Acid (+ 10% Pot. Nitrate)	Fuming	Boiling		B	B	—	—
Nitric Acid (+ 10% Al Nitrate)	Fuming	Boiling		B	B	—	—
Nitric Acid (+ 2% HCL)	Concentrated	70	20	—	A	C	C
Nitric Acid	Concentrated-Fuming	70	20	A	A	—	—
" "	Concentrated-Fuming	Boiling		C	C	—	—
Nitrous Acid	5%	70	20	A	A	A	—
" "	Concentrated	70	20	A	A	A	A
Oils—Crude (Asphalt and Paraffin Base)		70	20	A	A	A	—
" " " "		Hot		A	A	A	—
Oils—Lubricating		70	20	A	A	A	A
" "		Hot		A	A	A	A
Oils—Vegetable and Mineral		70	20	A	A	A	A
" " " "		Hot		A	A	A	A
Oleic Acid	Concentrated	70	20	A	A	A	B
" "	Concentrated	200	95	A	A	A	B
Oxalic Acid	2½%	70	20	A	A	B	—
" "	2½%	180	85	A	C	C	—
" "	2½%	Boiling		C	C	C	—
" "	5%	70	20	A	A	B	B
" "	5%	Hot		A	A	B	B
" "	10%	70	20	A	A	—	—
" "	10%	Boiling		B	C	—	—
" "	25%	Boiling		B	C	—	—
" "	50%	Boiling		B	B	—	—
" "	Saturated	70	20	A	B	C	C
" "	Saturated	140	60	B	C	C	—
" "	Saturated	Boiling		C	—	—	—
Palmitic Acid		212	100	A	A	A	—
" "		300	150	A	A	B	—
Paraffin		70	20	A	A	A	A
"		Hot		A	A	A	A
Paregoric Compound				A	A	—	B
Perchloric Acid		70	20	C	C	C	C
Peroxide of Hydrogen		70	20	A	A	—	—
Petroleum				A	A	—	—
Petroleum Ether				A	A	A	A
Phenol	CP +10% Water	Boiling		A	A	A	A
Phenol	CP	70 and Boiling	20	A	A	—	—
"	Crude	212	100	A	A	A	A
"	Crude	Boiling		A	A	A	A
"	Commercial	70	20	A	A	A	B
Phosphoric Acid	1%	70	20	A	A	—	—
" "	1%	Boiling		A	A	—	—
Phosphoric Acid (45#Pressure)	1%	280	140	A	A	B	B
Phosphoric Acid	5%	70	20	A	A	B	B
" "	10%	70	20	A	A	C	C

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CORROSION DATA GUIDE

(Continued)

Substance	Condition			Type			
	Strength	°F	°C	316	302/304	430	410
Phosphoric Acid (Agitated)	10%	70	20	A	B	C	C
Phosphoric Acid (Aerated)	10%	70	20	A	B	—	—
Phosphoric Acid	10%	Boiling		A	A	—	—
" "	80%	140	60	A	A	—	—
" "	80%	230	110	B	C	—	—
" "	Saturated	70	20	A	A	C	—
Phosphoric Anhydride	Dry	70	20	A	A	—	—
"	Moist	70	20	A	A	—	—
Phosphorus Trichloride	Saturated	70	20	A	A	—	—
Photographic Developers		70	20	A	B	—	—
Picric Acid	Concentrated	70	20	A	A	A	A
Pineapple Juice		70	20	A	A	—	—
Pine Tar Oil		70	20	A	A	—	—
Plaster of Paris				A	A	—	—
Potable Water		70	20	A	A	A	B
Potash	Solution	Hot		A	A	—	—
Potassium Bichromate	5%	Boiling		A	A	A	B
" "	25%	Boiling		A	A	—	—
" "	Saturated	70	20	A	A	A	A
Potassium Bitartrate	Saturated	Boiling		B	B	—	—
Potassium Bromide	5%	70	20	A	B	B	—
"	Saturated	70	20	A	B	—	—
Potassium Carbonate	All Concentrations	70	20	A	A	A	B
"	All Concentrations	Hot		A	A	—	—
Potassium Chlorate	Saturated	70	20	A	A	A	B
" "	Saturated	Hot		A	A	—	—
Potassium Chloride	1 and 5%	70	20	A	A	A	B
" "	1 and 5%	Boiling		A	A	—	—
Potassium Chloride	Saturated	70	20	A	A	B	B
Potassium Cyanide	Saturated	70	20	A	A	A	B
Potassium Dichromate	25%	Boiling		A	A	A	A
" "	5%	Boiling		A	A	A	A
Potassium Ferrocyanide	5%	70	20	A	A	A	—
" "	25%	70	20	A	A	—	—
" "	25%	Boiling		A	A	—	B
" "	Saturated	70	20	A	A	A	A
" "	Saturated	Boiling		A	A	A	A
Potassium Hydrate	Saturated	70	20	A	A	A	A
Potassium Hydroxide	All strengths up to 25%	70	20	A	A	A	A
" "	"	Boiling		A	A	A	—
" "	27%	Boiling		A	A	—	—
" "	50%	Boiling		A	B	—	—
" "	Melting	680	360	A	A	—	—
Potassium Hypochlorite	Saturated	70	20	A	B	—	—
" "	Saturated PH 10-11	70-80	20-30	M	C	—	—
Potassium Iodide	Saturated	70	20	A	A	—	B
Potassium Nitrate	1 and 5%	70	20	A	A	A	B
" "	1 and 5%	Hot		A	A	—	—
" "	Saturated	70	20	A	A	A	B
" "	Melting	1020	550	A	A	—	—
Potassium Oxalate	Saturated	70	20	A	A	A	—
Potassium Permanganate	5%	70	20	A	A	A	—
" "	5%	Boiling		A	A	—	—
" "	Saturated	70	20	A	A	A	A
" "	Saturated	Boiling		A	A	—	—
Potassium Sulphate	1 and 5%	70	20	A	A	A	B
" "	1 and 5%	Hot		A	A	—	—
" "	Saturated	70	20	A	A	A	B
Potassium Sulphide	Salt	70	20	A	A	—	—
" "	Solution	Hot		A	A	—	—
Prussic Acid				A	A	C	C
Pyrogallic Acid	Concentrated	70	20	A	A	A	B
Pyroligeous Acid	Concentrated	70	20	A	A	—	—
Quinine Bisulphate	Dry	70	20	A	B	B	C
Quinine Sulphate	Dry	70	20	A	A	B	B
Quinosol	1:500	70	20	A	A	—	—
Rosin	Molten			A	A	A	B
Sal Ammoniac	10%	Boiling		A	A	A	—
" "	50%	Boiling		A	B	—	—

Legend: A—Fully Resistant
B—Fairly Resistant
C—Not Resistant
M—Complete details of service should be submitted for a recommendation on the proper grade for these substances.
— No data available.

CORROSION DATA GUIDE

(Continued)

Substance	Condition			Type			
	Strength	°F	°C	316	302/304	430	410
Salicylic Acid	90%	Up to 212	Up to 100	A	A	A	B
Salt Brine		70	20	A	C	—	—
Saltpetre	Solution	Hot		A	A	—	—
Sauerkraut Brine		70	20	A	C	—	—
Sea Water		70	20	M	M	C	C
Sewage		70	20	A	B	—	—
Silver Bromide		70	20	A	B	C	C
Silver Chloride		70	20	C	C	C	C
Silver Cyanide Electroplating Solution		70	20	A	A	A	C
Silver Nitrate	10%	70	20	A	A	A	B
" "	10%	Boiling		A	B	—	—
Slop Liquor				A	A	—	—
Soap		70	20	A	A	A	B
Soda Ash	10%	200	95	A	A	A	A
" "	50%	200	95	A	A	A	A
Soda Niter	Solution	Hot		A	A	—	—
Sodium Acetate Salt	Moist	70	20	A	A	A	—
Sodium Acetate	5%	70	20	A	A	A	B
" "	Saturated	70	20	A	A	—	B
Sodium Bicarbonate	All Concentrations	70	20	A	A	A	B
" "	5%	150	65	A	A	A	B
Sodium Bichromate	Saturated	70	20	A	A	A	B
Sodium Bisulphate	10%	70	20	A	A	—	—
" "	10%	Boiling		A	A	—	—
" "	Saturated	70	20	A	A	—	—
Sodium Bisulphite	S.G. 1.38	70	20	A	A	—	—
Sodium Borate	Saturated	70	20	A	A	A	B
Sodium Bromide	Saturated	70	20	A	A	—	B
" "	5%	70	20	B	B	B	B
Sodium Carbonate	All Concentrations	70	20	A	A	A	B
" "	All Concentrations	150	65	A	A	A	B
" "	Molten	1650	840	C	C	C	C
Sodium Chlorate	10%	70	20	A	A	A	B
" "	25%	70	20	A	A	A	B
Sodium Chloride (Aerated)	2%	70	20	A	A	B	C
" "	5%	70	20	A	A	B	C
" " (Aerated)	5%	70	20	A	B	C	C
" " (Aerated)	20%	70	20	A	B	C	C
Sodium Chloride	Saturated	70	20	A	B	C	C
" "	Saturated	Boiling		A	B	C	C
Sodium Citrate	Saturated	70	20	A	A	A	B
Sodium Fluoride	5%	70	20	A	B	—	—
" "	Saturated	70	20	B	B	—	—
Sodium Hydroxide	All Concentrations	70	20	A	A	A	A
" "	20%	230	110	A	A	—	—
" "	30%	Boiling		A	A	—	—
" "	50%	Boiling		A	B	—	—
" "	Melting	600	315	B	C	—	—
Sodium Hypochlorite	5%	70	20	A	B	C	C
Sodium Hypochlorite (Dakin's Solution)		70	20	A	B	C	C
Sodium Hypochlorite (PH 10/11)	Saturated	200	95	M	C	C	C
Sodium Lactate	Saturated	70	20	A	A	—	—
Sodium Nitrate	All Concentrations	70	20	A	A	A	A
" "	All Concentrations	Hot		A	A	B	C
" "	Fused			B	B	B	—
Sodium Nitrite	Saturated	70	20	A	A	—	—
Sodium Perchlorate	10%	70	20	A	A	—	—
" "	10%	Boiling		A	A	—	—
Sodium Peroxide	10%	70	20	A	A	—	—
" "	10%	200	95	A	A	—	—
" "	Saturated	212	100	A	A	A	—
Sodium Phosphate	5%	70	20	A	A	A	A
" "	Saturated	70	20	A	A	A	—
Sodium Salicylate	Saturated	70	20	A	A	A	A
Sodium Sulphate	All Concentrations	70	20	A	A	C	C
" "	5%	Hot		A	B	C	C
Sodium Sulphide	50%	Boiling		A	A	C	C
" "	5%	70	20	A	A	C	C
" "	Saturated	70	20	A	B	B	B

Legend: A—Fully Resistant
B—Fairly Resistant
C—Not Resistant
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— No data available.

CORROSION DATA GUIDE

(Continued)

Substance	Condition			Type			
	Strength	°F	°C	316	302/304	430	410
Sodium Sulphite	5%	70	20	A	A	C	C
" "	10%	150	65	A	B	C	C
" "	50%	Boiling		A	B	C	C
" "	Saturated	70	20	A	A	A	B
Sodium Thiosulphate	25%	70	20	A	A	A	—
" "	25%	Boiling		A	A	A	—
Sodium Thiosulphate (+4% Pot. Meta Bisulphate)	Saturated	70	20	A	A	A	B
Soy Bean Oil	5%			A	A	—	—
Stannic Chloride		70	20	B	C	C	C
" "	5%	Boiling		C	C	C	C
" "	Saturated	70	20	C	C	C	C
" "	Saturated	Boiling		C	C	C	C
Stannous Chloride	5%	70	20	B	B	C	C
" "	5%	140	60	B	B	C	C
" "	Saturated	70	20	A	B	C	C
Stannous Fluoride	15%	70	20	A	B	—	—
Starch		70	20	A	A	A	A
Steam				A	A	A	B
Steam and air refluxed				A	A	—	B
Steam—CO_2 and air				A	A	B	B
Steam—SO_2, CO_2 and air				A	A	B	B
Stearic Acid	Concentrated	70	20	A	A	A	A
" "	Concentrated	200	95	A	A	A	—
Strontium Hydroxide		70	20	A	A	—	—
Strontium Nitrate		Hot		A	A	—	—
Sublamin	1:500	70	20	A	A	—	—
Sugar Juice		70	20	A	A	A	—
"		Hot		A	A	A	—
Sulphur	Dry	70	20	A	A	A	B
"	Wet	70	20	A	B	B	C
Sulphur Dioxide Gas	Moist	70	20	B	B	B	B
" " "		575	300	A	A	A	—
Sulphur Chloride		70	20	B	—	—	—
Sulphuretted Hydrogen		70	20	A	A	—	—
Sulphuric Acid	5%	70	20	A	B	C	C
" "	5%	100	40	A	C	C	C
" "	5%	140	60	A	C	C	C
" "	5%	Boiling		M	C	C	C
" "	10%	70	20	A	B	C	C
" "	10%	100	40	A	C	C	C
" "	10%	140	60	A	C	C	C
" "	10%	Boiling		M	C	C	C
Sulphuric Acid (+Copper Sulphate 10%)	10%	Boiling		A	A	—	—
Sulphuric Acid (+Ferric Sulphate 2%)	10%	Boiling		A	A	—	—
Sulphuric Acid	15%	70	20	A	C	C	C
" "	15%	100	40	M	C	C	C
" "	15%	140	60	M	C	C	C
Sulphuric Acid (+ Potassium Dichromate 2%)	15%	70	20	A	A	—	—
Sulphuric Acid (+Copper Sulphate 6%)	40%	140	60	A	A	A	A
" " "	40%	Boiling		M	C	C	C
Sulphuric Acid	50%	70	20	B	C	C	C
" "	50%	Boiling		C	C	C	C
" "	85%	70	20	A	B	C	C
" "	85%	100	40	B	B	C	C
" "	Concentrated	70	20	A	A	C	C
" "	Concentrated	100	40	A	B	C	C
" "	Concentrated	140	60	B	B	C	C
" "	Concentrated	212	100	C	C	C	C
" "	Concentrated	300	150	C	C	C	C
" "	Concentrated	Boiling		C	C	C	C
Sulphuric Acid (11% Free SO_3)	Fuming	70	20	B	C	—	—
" " (60% Free SO_3)	Fuming	212	100	B	B	—	—
" " "	Fuming	70	20	A	A	—	—
	Fuming	160	70	A	A	—	—
Sulphuric Acid Plus Nitrates	Many Proportions			A	A	A	A

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B—Fairly Resistant
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— No data available.

CORROSION DATA GUIDE

(Continued)

Substance	Condition			Type			
	Strength	°F	°C	316	302/304	430	410
Sulphurous Acid	Saturated	70	20	A	A	B	B
" " (60# pressure)	Saturated	250	120	A	B	C	—
" " (70-125# pressure)	Saturated	320	160	A	B	C	—
" " (150# pressure)	Saturated	375	190	A	B	C	—
" " (200# pressure)	Saturated	390	200	B	B	—	—
" " (300# pressure)	Saturated	390	200	B	B	—	—
" " Spray		70	20	C	C	—	—
Sweet Water		Hot		A	A	—	—
Syrup		Hot		A	A	—	—
Tannic Acid	All Concentrations	70	20	A	A	A	B
" "	All Concentrations	Boiling		A	A	A	B
Tanning Liquor				A	A	—	—
" " with salt added				M	M	C	C
Tar				A	A	—	—
Tar plus Ammonia in Water				A	A	—	—
Tartaric Acid	1%	70	20	A	A	A	—
" "	1%	100	40	A	A	A	—
" "	10%	70	20	A	A	C	C
" "	10%	Boiling		A	A	C	C
" "	Concentrated	70	20	A	A	A	B
" "	Concentrated	150	65	A	B	C	C
Tetrachloride of Tin	Saturated	Boiling		C	C	C	C
Tin	Molten	1110	600	B	B	B	—
Titanium Tetrachloride	Saturated	70	20	A	A	A	A
Tomato Juice		70	20	A	A	A	B
Trichloracetic Acid		70	20	C	C	C	—
Trichlorethylene		70	20	A	A	—	C
"		Boiling		A	A	—	—
Tung Oil		70	20	A	A	—	—
Turpentine Oil		95	35	A	A	—	—
Uric Acid	Concentrated	70	20	A	A	A	A
Varnish		70	20	A	A	A	A
"		Hot		A	A	B	B
Vegetable Juices		70	20	A	A	B	B
" "		Hot		A	A	B	B
Vinegar		70	20	A	A	B	B
"		Hot		A	A	—	—
Vinegar (Agitated)		70	20	A	A	A	B
Vinegar (Aerated)		70	20	A	A	A	A
Vinegar Fumes				A	B	B	—
Vinegar—Sauces and Pickles				A	A	A	—
Vinegar—(+5% Salt)		Up to 200		A	A	B	B
Vitriol—Blue	Saturated	Boiling		A	A	A	A
" Green	Saturated	70	20	A	A	A	A
" White	Saturated	70	20	A	A	A	A
Water		70	20	A	A	A	B
"		Hot		A	A	A	B
Water Oily		70	20	A	A	A	A
" "		Hot		A	A	A	A
Wet Coal or Cinders				A	A	A	B
Whiskey				A	A	—	—
Wine				A	A	—	—
Wood Pulp				A	B	—	—
Wort				A	A	—	—
X-Ray Developing Solution				A	B	—	—
Yeast				A	A	—	—
Zinc	Molten	1110	600	C	C	C	C
Zinc Chloride	5%	70	20	A	A	B	A
" "	5%	Boiling		B	B	B	C
" "	10%	Boiling		C	C	C	C
" "	50%	105	40	B	B	C	C
" "	Saturated	70	20	B	C	C	C
Zinc Cyanide	Moist	70	20	A	A	—	—
Zinc Nitrate		Hot		A	A	—	—
Zinc Sulphate	5%	70	20	A	A	B	C
" "	25%	70	20	A	A	B	C
" "	25%	Boiling		A	B	C	C
" "	Saturated	70	20	A	B	B	—

Legend: A—Fully Resistant
B—Fairly Resistant
C—Not Resistant

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— No data available.

ALUMINUM SHEET & COIL
3003-H14

Sizes in Stock

Thickness	Width	Length	Est. Wt. lbs/sqft	Thickness	Width	Length	Est. Wt. lbs/sqft
.020	48	96	0.288	.100	36	coil	1.440
.025	36	coil	0.360	.100	36	96	1.440
.025	48	coil	0.360	.100	36	120	1.440
.025	48	96	0.360	.100	48	coil	1.440
.025	48	120	0.360	.100	48	96	1.440
.032	36	coil	0.460	.100	48	120	1.440
.032	36	96	0.460	.125	36	coil	1.800
.032	48	120	0.460	.125	36	96	1.800
.040	48	coil	0.576	.125	36	120	1.800
.040	48	96	0.576	.125	48	coil	1.800
.040	48	120	0.576	.125	48	96	1.800
.050	48	coil	0.720	.125	48	96	1.800
.050	48	96	0.720	.125	48	120	1.800
.050	48	120	0.720	.125	48	120	1.800
.050	60	coil	0.720	.125	48	144	1.800
.050	60	120	0.720	.125	48	144	1.800
.063	36	coil	0.907	.125	60	coil	1.800
.063	36	96	0.907	.125	60	96	1.800
.063	36	120	0.907	.125	60	96	1.800
.063	48	coil	0.907	.125	60	120	1.800
.063	48	96	0.907	.125	60	120	1.800
.063	48	120	0.907	.125	60	144	1.800
.063	48	144	0.907	.125	60	144	1.800
.063	60	120	0.907	.125	60	240	1.800
.080	48	coil	1.150	.188	48	coil	2.700
.080	48	96	1.150	.188	48	96	2.700
.080	48	120	1.150	.188	48	120	2.700
.080	60	coil	1.150	.188	60	96	2.700
.080	60	120	1.150	.188	60	120	2.700
.090	36	coil	1.300	.250	48	coil	3.600
.090	36	96	1.300	.250	48	96	3.600
.090	36	120	1.300	.250	48	120	3.600
.090	48	96	1.300	.250	60	120	3.600
.090	48	120	1.300				

ALUMINUM BRITE TREAD SHEET & COIL
3003-H22

Sizes in Stock

Thickness	Width	Length	Est. Wt. lbs/sqft	Thickness	Width	Length	Est. Wt. lbs/sqft
.063	48	96	0.983	.125	60	144	1.900
.063	48	120	0.983	.125	60	192	1.900
.063	60	coil	0.983	.187	48	96	2.800
.063	60	96	0.983	.187	48	192	2.800
.063	60	120	0.983	.187	48	120	2.800
.100	60	192	1.575	.187	60	120	2.800
.125	48	coil	1.900	.187	60	144	2.800
.125	48	96	1.900	.187	60	192	2.800
.125	48	120	1.900	.250	48	96	3.700
.125	48	192	1.900	.250	48	192	3.700
.125	60	coil	1.900	.250	60	192	3.700
.125	60	96	1.900				
.125	60	120	1.900				

ALUMINUM SHEET & COIL
5052-H32

Sizes in Stock

Thickness	Width	Length	Est. Wt. lbs/sqft	Thickness	Width	Length	Est. Wt. lbs/sqft
.032	48	96	0.460	.125	36	120	1.800
.032	48	120	0.460	.125	36	144	1.800
.040	48	coi	0.576	.125	48	coil	1.800
.040	48	96	0.576	.125	48	96	1.800
.040	48	120	0.576	.125	48	120	1.800
.050	36	coil	0.720	.125	48	144	1.800
.050	36	96	0.720	.125	60	coi	1.800
.050	36	120	0.720	.125	60	96	1.800
.050	48	96	0.720	.125	60	120	1.800
.050	48	120	0.720	.125	60	144	1.800
.050	60	coil	0.720	.125	72	coil	1.800
.050	60	120	0.720	.125	72	96	1.800
.050	60	144	0.720	.125	72	120	1.800
.063	48	coil	0.907	.125	72	240	1.800
.063	48	96	0.907	.125	72	288	1.800
.063	48	120	0.907	.188	48	coil	2.700
.063	60	coil	0.907	.188	48	96	2.700
.063	60	120	0.907	.188	48	120	2.700
.063	60	144	0.907	.188	60	coil	2.700
.080	48	coil	1.150	.188	60	120	2.700
.080	48	96	1.150	.188	60	144	2.700
.080	48	120	1.150	.188	60	240	2.700
.080	60	coil	1.150	.188	72	coil	2.700
.080	60	96	1.150	.188	72	240	2.700
.080	60	120	1.150	.188	72	288	2.700
.090	48	coil	1.300	.250	48	96	3.600
.090	48	96	1.300	.250	48	96	3.600
.090	48	120	1.300	.250	48	120	3.600
.100	36	120	1.440	.250	60	coil	3.600
.100	48	coil	1.440	.250	60	120	3.600
.100	48	96	1.440	.250	60	144	3.600
.100	48	120	1.440	.250	72	144	3.600
.100	60	coil	1.440	.250	72	240	3.600
.100	60	96	1.440	.375	72	288	3.600
.100	60	120	1.440	.375	48	96	5.400
.125	36	coil	1.800	.500	48	144	5.400
.125	36	96	1.800		48	96	7.200

ALUMINUM SHEET
6061 T6

Sizes in Stock							
Thickness	Width	Length	Est. Wt. lbs/sqft	Thickness	Width	Length	Est. Wt. lbs/sqft
.050	48	144	0.73	.125	48	96	1.80
.063	48	144	0.92	.125	48	120	1.80
.090	48	144	1.29	.187	48	96	2.70

ALUMINUM PLATE
6061 T6

Sizes in Stock							
Thickness	Width	Length	Est. Wt. lbs/sqft	Thickness	Width	Length	Est. Wt. lbs/sqft
.250	48.5	96.5	3.60	.750	48.5	96.5	10.80
.250	48.5	144.5	3.60	.750	48.5	144.5	10.80
.375	48.5	96.5	5.40	1.00	48.5	96.5	14.40
.375	48.5	144.5	5.40	1.00	48.5	144.5	14.40
.500	48.5	96.5	7.20	1.25	48.5	144.5	18.00
.500	48.5	144.5	7.20	1.5	48.5	144.5	21.60
.625	48.5	96.5	9.00	2.00	48.5	144.5	28.20
.625	48.5	144.5	9.00	2.50	48.5	144.5	35.80

Also availabla 5005 AQ & 1100-H14

ALUMINUM ROUND BAR
6061 T6

Sizes in Stock

Diameter	Length	Est. Wt. lbs/ft	Diameter	Length	Est. Wt. lbs/ft
1/8	12	0.015	2.0	20	3.700
3/16	12	0.032	2 1/4	20	4.680
1/4	20	0.058	2 1/2	20	5.780
3/8	20	0.131	2 3/4	12	7.000
1/2	20	0.231	3.0	12	8.320
5/8	20	0.361	3 1/4	12	9.790
3/4	20	0.520	3 1/2	12	11.300
7/8	20	0.708	3 3/4	12	13.100
1.0	20	0.925	4.0	12	14.800
1 1/8	20	1.170	4 1/4	12	16.700
1 1/4	20	1.450	4 1/2	12	18.700
1 3/8	20	1.750	5.0	12	23.100
1 1/2	20	2.080	5 1/2	12	28.000
1 3/4	20	2.830			
1 7/8	20	3.267			

ALUMINUM ROUND BAR
6061 T6
Oversize

Sizes in Stock

Diameter	Length	Est. Wt. lbs/sqft	Diameter	Length	Est. Wt. lbs/ft
6.0	12	33.300	11	6, 12	112.000
6 1/2	12	39.100	12	12	133.000
7.0	12	45.210	12 1/2		145.720
7 1/2	12	52.000	13		157.600
8.0	12	59.200	14		182.790
9.0	12	76.340	15		209.830
10	12	92.500	16		238.740

ALUMINUM SQUARE BAR
6061 T6

Sizes in Stock

Diameter	Length	Est. Wt. lbs/ft	Diameter	Length	Est. Wt. lbs/ft
3/8	12	0.166	2.0	12	4.710
7/16	12	0,250	2 1/2	12	7.360
1/2	12	0.292	2 3/4	12	8.900
5/8	12	0.458	3.0	12	10.600
3/4	12	0.662	3 1/4	12	11.500
1.0	12	1.180	3 1/2	12	14.400
1 1/8	12	1.490	4.0	12	19.000
1 1/4	12	1.840	4 1/2	12	23.750
1 3/8	12	2.230			
1 1/2	12	2.650			

ALUMINUM FLAT BARS

6061,T6

Sizes in Stock

Diameter	Length	Est. Wt. lbs/ft
1/8 x 1/2	12	0.074
3/4	12	0.110
1.0	12	0.151
1 1/4	12	0.185
1 1/2	12	0.221
2.0	12	0.295
3.0	12	0.441
4.0	12	0.588
5.0	12	0.735
5 1/2	12	0.808
3/16 x 3/4	20	0.165
1.0	20	0.221
1 1/4	20	0.275
1 1/2	20	0.331
2.0	20	0.442
3.0	20	0.663
4.0	20	0.883
1/4 x 1/2	20	0.150
3/4	20	0.221
1.0	20	0.295
1 1/4	20	0.368
1 1/2	20	0.442
2.0	20	0.589
2 1/4	20	0.662
2 1/2	20	0.736
2 3/4	20	0.812
3.0	20	0.883
3 1/2	20	1.030
4.0	20	1.180
5.0	20	1.470
6.0	20	1.800
3/8 x 1/2	20	0.220
3/4	20	0.331
1.0	20	0.442
1 1/4	20	0.552
1 1/2	20	0.661
2.0	20	0.882
2 1/4	20	1.000
2 1/2	20	1.100
3.0	20	1.350
4.0	20	1.750
5.0	20	2.200
6.0	20	2.730
8.0	20	3.513
1/2 x 3/4	20	0.440
1.0	20	0.587
1 1/2	20	0.865
2.0	20	1.200
2 1/2	20	1.500
2 3/4	20	1.620
3.0	20	1.760
3 1/2	20	2.050
4.0	20	2.350
5.0	20	2.950
6.0	20	3.550
3/4 x 1.0	20	0.882
1 1/2	20	1.300
1 5/8	20	1.432
2.0	20	1.750
2 1/2	20	2.200
3.0	20	2.650
3 1/2	20	3.100
4.0	20	3.520
5.0	20	4.438
6.0	12	5.300
1.0 x 1 1/4	12	1.500
1 1/2	12	1.780
2.0	12	2.350
2 1/2	12	2.950
3.0	12	3.530
4.0	12	4.700
5.0	12	5.918
6.0	12	7.060
16.0	12	18.820
1 1/2 x 2.0	12	3.600
3.0	12	5.300
4.0	12	7.051
2.0 x 3.0	12	7.060
4.0	12	9.580

ALUMINUM ANGLE
6061 T6

Sizes in Stock

Legs	Thickness	Length	Est. Wt. lbs/ft	Legs	Thickness	Length	Est. Wt. lbs/ft
3/4 x 3/4	1/8	20	0.207	2.0 x 2.0	1/4	20	1.110
1.0 x 1.0	1/8	20	0.280	2.0 x 3.0	1/4	20	1.400
1.0 x 2.0	1/8	20	0.421	2 1/2 x 2 1/2	1/4	20	1.400
1 1/4 x 1 1/4	1/8	20	0.340	2 1/2 x 3 1/2	1/4	20	1.716
1 1/2 x 1 1/2	1/8	20	0.420	3.0 x 3.0	1/4	20	1.680
2.0 x 2.0	1/8	20	0.566	3.0 x 4.0	1/4	20	2.012
				4.0 x 4.0	1/4	20	2.280
1.0 x 1.0	3/16	20	0.400				
1 1/4 x 1 1/4	3/16	20	0.510	3 1/2 x 6.0	5/16	20	3.417
1 1/2 x 1 1/2	3/16	20	0.620				
1 1/2 x 2.0	3/16	20	0.739	3.0 x 3.0	3/8	20	2.470
1 1/2 x 2 1/2	3/16	20	0.849	3.0 x 4.0	3/8	20	2.974
2.0 x 2.0	3/16	20	0.850	4.0 x 4.0	3/8	20	3.420
2.0 x 3.0	3/16	20	1.073	3 1/2 x 5.0	3/8	20	3.625
3.0 x 3.0	3/16	20	1.313	4.0 x 6.0	3/8	20	4.295
1.0 x 1.0	1/4	20	0.510	4.0 x 6.0	1/82	20	5.617
1 1/4 x 1 1/4	1/4	20	0.660				
1 1/2 x 1 1/2	1/4	20	0.810				
1 1/2 x 2.0	1/4	20	0.956				
1 1/2 x 2 1/2	1/4	20	1.108				
1 3/4 x 1 3/4	1/4	20	0.960				

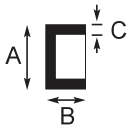
ALUMINUM ANGLE
6063 T5

Sizes in Stock

Legs	Thickness	Length	Est. Wt. lbs/ft
3/4 x 3/4	1/16	20	0.106
3/4 x 3/4	1/8	20	0.200
1.0 x 1/2	1/8	20	0.200
1.0 x 1.0	3/16	20	0.399
1.0 x 2.0	316	20	0.623

ALUMINUM STRUCTURAL CHANNEL

6061 T6

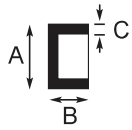


Sizes in Stock

A		B		C	Length	Est. Wt. lbs/ft
1 1/4	x	5/8	x	1/8	20	0.329
2.0	x	1.0	x	1/8	20	0.566
3.0	x	1.0	x	1/8	20	0.702
3.0	x	1 1/2	x	3/16	20	1.241
4.0	x	2.0	x	3/16	20	2.029
3.0	x	1 1/2	x	1/4	20	1.841
3.0	x	2.0	x	1/4	20	2.180
4.0	x	2.0	x	1/4	20	2.520
5.0	x	2 1/2	x	1/4	20	3.574
6.0	x	2 1/2	x	1/4	20	3.497
6.0	x	2 3/4	x	1/4	20	4.048
6.0	x	2.0	x	9/32	20	3.580
8.0	x	3.0	x	9/32	20	5.513
10.0	x	3.0	x	9/32	20	6.200
12.0	x	4.0	x	.290	20	8.160
10.0	x	3 1/2	x	5/16	20	7.802
12.0	x	4	x	3/8	20	10.500

ALUMINUM SAFETY GRIP CHANNEL

6061 T6

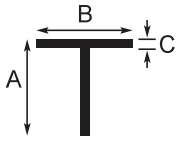


Sizes in Stock

A		B		C	Length
7.0	x	2.0	x	.125	12
10.0	x	2.0	x	.125	12
12.0	x	2.0	x	.125	12

ALUMINUM STRUCTURAL TEE

6061 T6

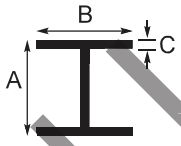


Sizes in Stock

A		B		C	Length	Est. Wt. lbs/ft
$1^1/_2$	x	$1^1/_2$	x	$^3/_{16}$	20	0.638
2.0	x	$1^1/_2$	x	$^3/_{16}$	20	0.752
2.0	x	2.0	x	$^1/_4$	20	1.146

ALUMINUM STRUCTURAL I BEAM

6061 T6



Sizes in Stock

A		B		C	Length	Est. Wt. lbs/ft
4.0	x	3.0	x	$^3/_{16}$	24	3.089
6.0	x	3.0	x	$^1/_4$	20	3.948
6.0	x	3.5	x	$^1/_4$	24	4.860

ALUMINUM ROUND TUBE
6061 T6

Sizes in Stock			
Diameter	Wall	Length	Est. Wt. lbs/ft
5/8	.049	20	0.104
3/4	.125	20	0.343
7/8	.120	20	0.343
1.0	.065	20	0.208
1.0	.120	20	0.403
1 1/8	.125	20	0.516
1 1/4	.120	20	0.504
1 1/2	.065	20	0.345
1 1/2	.125	20	0.639
1 1/2	.250	20	1.118
2.0	.065	20	0.467
2.0	.125	20	0.868
2 1/2	.120	20	1.051
3.0	.187	20	1.944
3.0	.250	20	2.535
3.0	.500	20	4.632
4.0	.125	20	1.800
6.0	.125	20	2.702
6.0	.187	20	4.000
6.0	.250	20	5.287

ALUMINUM ROUND TUBE
6063 T5

Sizes in Stock			
Diameter	Wall	Length	Est. Wt. lbs/ft
3/4	.065	20	0.167
1 1/8	.058	20	0.230
1 1/4	.058	20	0.256
1 1/2	.125	20	0.639

ALUMINUM SQUARE TUBE

6061 T6

Available with square or round corners

Sizes in Stock

Diameter	Wall	Length	Est. Wt. lbs/ft
3/4	.120	20	0.357
1.0	.095	20	0.406
1.0	.120	20	0.485
1 1/4	.095	20	0.406
1 1/4	.120	20	0.640
1 1/2	.095	20	0.631
1 1/2	.120	20	0.781
2.0	.060	20	0.550
2.0	.095	20	0.854
2.0	.120	20	1.064
2.0	.187	20	1.566
2.0	.250	20	1.990
2 1/2	.120	20	1.347
3.0	.120	20	1.560
3.0	.187	24	2.490
3.0	.250	20	3.254
3.0	.312	20	3.755
4.0	.187	24	3.239
4.0	.250	20	4.307

ALUMINUM SQUARE TUBE

6063 T5

Available with square or round corners

Sizes in Stock

Diameter	Wall	Length	Est. Wt. lbs/ft
1.0	.062	20	0.267
1.0	.120	20	0.513
1 1/4	.125	20	0.674
2.0	.120	20	1.057
2.0	.187	20	1.064

ALUMINUM RECTANGULAR TUBE

6061 T6

Available with square or round corners

Sizes in Stock				
Cross Section		Wall	Length	Est. Wt. lbs/ft
1 1/2	x 2.0	.120	20	1.064
1 1/2	x 3.0	.120	20	1.229
2.0	x 2 1/2	.120	20	1.202
2.0	x 3.0	.125	20	1.397
2.0	x 4.0	.120	20	1.630
2.0	x 4.0	.187	20	2.438

ALUMINUM RECTANGULAR TUBE

6063 T5

Available with square or round corners

Sizes in Stock				
Cross Section		Wall	Length	Est. Wt. lbs/ft
1.0	x 1 1/2	.095	20	0.625
1.0	x 2.0	.095	20	0.634
1.0	x 2.0	.120	20	0.809
1.0	x 3.0	.120	20	1.056
2.0	x 6.0	.120	20	2.203
4.0	x 6.0	.187	20	4.225

ALUMINUM PIPE
6061 T6

Sizes in Stock

Diameter	Schedule	Length	Est. Wt. lbs/ft
1/4	40	20	0.136
3/8	40	20	0.196
1/2	40	20	0.292
3/4	40	20	0.391
1.0	40	20	0.581
1.0	80	20	0.758
1 1/4	40	20	0.786
1 1/2	40	20	0.940
1 1/2	80	20	1.260
2.0	40	20	1.264
2.0	80	20	1.737
2 1/2	40	20	2.017
2 1/2	80	20	2.668
3.0	40	20	2.637
3.0	80	20	3.567
3 1/2	40	20	3.160
4.0	40	20	3.756
4.0	80	20	5.183
5.0	40	24	5.100
5.0	80	20	7.157
6.0	40	20	6.564
12.0	40	22, 25	18.520

ALUMINUM PIPE
6061 T4

Sizes in Stock

Diameter	Wall	Length	Est. Wt. lbs/ft
3/4	40	20	0.391
1.0	40	24	0.581
1 1/4	40	24	0.788
1 1/2	40	24	0.940
2.0	40	20	1.271
2 1/2	40	20	2.017
3.0	40	20	2.637
4.0	10	20	2.033
4.0	40	20	3.733

ALUMINUM PIPE
6063 T5

Sizes in Stock

Diameter	Wall	Length	Est. Wt. lbs/ft
3/4	40	24	0.391
1 1/4	40	24	0.786
1 1/2	40	24	0.940
2.0	40	24	1.264

MARINE/DUMP/TANKER/TRAILERS

5083-H321/116

An alloy with superior tensile strength and welding properties. Typical end uses are large marine craft, containers, railroad cars, structurals and elevator cars. This material is dual certified and has a tensile strength of 44 ksi(min) and 31 ksa(min) yield. In addition, 5083-321/H116 has excellent corrosion resistance.

Sizes in Stock

Thickness	Width	Length	Est. Wt. lbs/sqft	Thickness	Width	Length	Est. Wt. lbs/sqft
3/16	48	192 spv	2.7	1/4	48	240 spv	3.6
3/16	48	240 spv	2.7	1/4	48	192 spv	3.6
3/16	60	192 spv	2.7	1/4	48	240 spv	3.6
3/16	60	288	2.7	1/4	60	192 spv	3.6
3/16	60	360	2.7	1/4	60	288 spv	3.6
3/16	60	240	2.7	1/4	72	240 spv	3.6
3/16	72	240	2.7	1/4	84	288	3.6
3/16	72	288 spv	2.7				
3/16	72	360	2.7	5/16	72	240	4.5
3/16	84	288	2.7				
				3/8	60	192	5.4
				3/8	60	240	5.4
				3/8	96	240	5.4
				1/2	60	192	7.2
				1/2	96	240	7.2

5454-H32

A non heat treatable alloy of medium strength and with high corrosion resistance in marine applications. Typical uses are truck dump bodies, tanker trucks and chemical storage tanks on vessels.

Sizes in Stock

Thickness	Width	Length	Est. Wt. lbs/sqft	Thickness	Width	Length	Est. Wt. lbs/sqft
.188	60	144	2.7	.250.	60	144	3.6
.188	72	144	2.7	250	72	144	3.6

5086-H116

Sister alloy to 5083 with comparable characteristics but slightly less strength. Used in welded pressure vessels, marine applications, drilling rigs and transportation equipment.

Sizes in Stock

Thickness	Width	Length	Est. Wt. lbs/sqft	Thickness	Width	Length	Est. Wt. lbs/sqft
.188	72	240	2.7	.250.	72	240	3.6

TREAD PLATE

5086-H116 DIAMOND PATTERN

This material is excellent for locations requiring skid resistant floors or docks with added corrosion characteristics

Sizes in Stock

Thickness	Width	Length	Est. Wt. lbs/sqft	Thickness	Width	Length	Est. Wt. lbs/sqft
3/16	60	192	2.8	3/8	48	96	5.22
3/16	60	240	2.8	3/8	48	192	5.22

TREAD PLATE

5052-H32 5 BAR PATTERN

This material is excellent for locations requiring skid resistant floors or docks with added corrosion characteristics

Sizes in Stock

Thickness	Width	Length	Est. Wt. lbs/sqft
3/16	60	192	2.8
3/16	60	240	2.8

VAN TRAILER
3004-H291, HIGH GLOSS WHITE 1 SIDE

Sizes in Stock

Thickness	Width	Length	Est. Wt. lbs/sqft
.040	49 coil		.576
.040		96	.576
.050	49 coil		.720
.050		108	.720
.050		110	.720

VAN TRAILER
UTILITY, HIGH GLOSS BLACK 1 SIDE

Sizes in Stock

Thickness	Width	Length	Est. Wt. lbs/sqft
.040	49 coil		.576
.040		96	.576
.040		120	.576

ROOF COIL

Sizes in Stock

Thickness	Width	Length	Est. Wt. lbs/sqft
.032	96 coil		.461
.032	102 coil		.461
.040	102 coil		.576

SIGN MAUFACTURING

Utility Pre-painted White

Pre-painted white high gloss polyester 2 sides, wax free.
Has an excellent surface appearance and cleanliness.
Other colours and coating systems available upon request.
Custom lemgths available upon request.

Sizes in Stock

Thickness	Width	Length	Est. Wt. lbs/sqft
.025	48 x coil		.36
.025	48	120	.36
.025	48	96	.36
.040	48 x coil		.36
.040	48	96	.576
.040	48	120	.576
.050	48 x coil		.576
.050	48	96	.72
.050	48	120	.72
.063	48 x coil		.72
.063	48	96	.907
.063	48	120	.907
.080	48 x coil		.907
.080	48	96	1.15
.080	48	120	1.15

5052-H38 Alodined 2 sides

This material is full hard 39 ksi (min) tensile, 32 ksi (min) yield which has increased strength and corrosion resistance. The product has been pre-treated with a conversion coat for excellent adhesion and is ready for films and other coatings.

Sizes in Stock

Thickness	Width	Length	Est. Wt. lbs/sqft
.080	48 x coil		1.15
.080	48 x	96	1.15
.080	48 x	120	1.15
.080	48 x	144	1.15

TECHNICAL DATA / Alloy Designation System

A system for designating wrought aluminum and wrought aluminum alloys was established by the Aluminum Association. Specific limits for chemical compositions to which conformance is required are provided by applicable product standards

Wrought Aluminum and Aluminum Alloy Designation System.

A system of four-digit numerical designations is used to identify wrought aluminum and wrought aluminum alloys.

The first digit indicates the alloy group as follows:

Aluminum, 99.00 percent minimum and greater	1XXX
Aluminum Alloys grouped by major alloying elements.	
Copper (Cu)	2XXX
Manganese (Mn)	3XXX
Silicon (Si)	4XXX
Magnesium (Mg)	5XXX
Magnesium and Silicon (Mg and Si)	6XXX
Zinc (Zn)	7XXX
Other Element	8XXX
Unused series	9XXX

ALUMINUM

In the 1XXX group for minimum aluminum purities of 99.00 percent and greater, the last two fo the four digits in the designation indicate the minimum aluminum percentage. These digits are the same as the last two digits to the right of the decimal point in the minimum aluminum percentage when it is expressed to the nearest 0.01 percent. The second digit in the designation indicates modifications in impurity limits. If the second digit is zero, it indicates unalloyed aluminum having natural impurity limits; integers 1 through 9 , which are assigned consecutively as needeed, indicate special control of one or more individual impurities or alloying elements.

ALUMINUM ALLOYS

In the 2XXX through 8XXX alloy groups the last two of the four digits in the designation have no special significance but serve only to identify the different alloys in the group.. The second digit in the alloy designation indictes alloy modifications. If the second digit is zero, it indicates the original alloy; integers 1 through 9, which are asigned consecutively, indicte alloy modifications.

NATIONAL VARIATIONS

National variations of wrought aluminum and wrought aluminum alloys registered by another country in accordance with this system are indentified by a serial letter following the numerical designation. The serial letters are assigned internationally in alphabetic sequence starting with A but omitiing I, O and Q.

EXPERIMENTAL ALLOYS

Experimental alloys are also designated in accordance with this system but they are indicted by the prefix X. The prefix is dropped when the alloy is no longer experimental. During the development and before they are designated as experimental, new alloys are indentified by serial numbers assigned by their originators. Use of the serial number is discontinued when the X is assigned.

TECHNICAL DATA / Temper Designation System

The Aluminum Association's established temper designation system is used for all forms of wrought and cast aluminum and aluminum alloys except ingot. It is based on the sequence of basic treatments used to produce various tempers. The temper designation follows the alloy designation with the two seperated by a hyphen. Basic designations consist of a letter while the subdivisions of those basic tempers, where required, are indicated by one or more digits following those letters. The sytem is designed to set down specific sequences of fabrication processes, but only those operations that are recognized as significantly influencing the characteristics of the product are involved. Should some other variationof the same sequence of basic operations be applied to the same alloy, resulting in different characteristics, then additional digits will be added to the numerical designation.

BASIC TEMPER DESIGNATIONS

F AS FABRICATED Denotes metal that has been fabricated to ordered dimensions without any attempt on the part of the producer To control the results of either strain-hardening operations or thermal treatments. There are no mechanical property limits, and the strength levels may vary from lot to lot and from shipment to shipment.

O ANNEALED Applies to wrought products that have undergone a thermal treatment to reduce their mechanical property levels to their minimums. Often described as "dead soft" metal.

W SOLUTION HEAT-TREATED An unstable temper applying to certain of the heat-treatable alloys that, after heat treatment, spontaneously age harden at room temperature. Only when the period of natural aging is indicated (W 1 hr for example) is this a specific and complete designation.

H STRAIN-HARDENED Applies to those wrought products which have had an increase in strength by reduction through strain-hardening, or cold working, operations. The "H" is always followed by two or more digits.

T THERMAL TREATED TO PRODUCE TEMPERS OTHER THAN F, O OR H.
Applies to those products which have an increase in strength due to thermal treatments, with or without supplemental strain-hardening operations. The "T" is always followed by one or more digits.

SUBDIVISIONS OF BASIC TEMPERS

SUBDIVISION OF "H" TEMPER

NON-HEAT-TREATABLE ALLOYS

H1 STRAIN-HARDENED ONLY Applies to products which are strain-hardened or cold worked to obtain the desired strength level without supplemental thermal treatments. The number following this designation indictes the degree of strain-hardening.

H2 STRAIN-HARDENED AND PARTIALLY ANNEALED Applies to products strain hardened or cold worked more then the desired final amount and then reduced in strength to that desired level by partial annealing operation.

H3 STRAIN-HARDENED AND STABILIZED
Applies to products in the magnesium-aluminum class which will age-soften at room temerature after strain-hardening. These products are stain-hardened to the desired amount and then subjected to a low temperature thermal operation which results in a stable but slightly lower tensile strength and improved ductility. The number following this designation indicates the degree of strain-hardening remaining after the stabilization treatment

The digit following the designation H1, H2 or H3 indicates the degree of strain-hardening as follows:

H_1 1/8 hard
H_2 1/4 hard
H_3 3/8 hard
H_4 1/2 hard
H_5 5/8 hard
H-6 3/4 hard
H-7 7/8 hard
H_8 full hard (approximately 75% reduction after a full anneal)
H_9 extra hard (limited to certain alloys and/or product forms)

The third digit, when used, indicates a variation of the two-digit temper.
It is used when the degree of control of temper or the mechanical properties are different from but close to the two-digit designation to which it is added, or when some other characteristic is significantly affected.

The following three-digit H temper designations have been assigned for wrought products in all alloys:

H_11 Applies to products which incur sufficent strain-hardening after the final anneal that they fail to qualify as annealed but nit enough to qualfy as H-1

H112 Applies to products which may acquire some temper from working at an elevated temperature and for which there are mechanical property limits.

Temper Designation System (continued)

The following three-digit H temper designations have been assigned for patterned or embossed sheet. It is estimated that the amount of strain-hardening or cold working , imparted by the embossing action increses the mechanical property level be one-eigth. Based on this, the second digit is increased by one and a four is added as the third digit to denote that the metal has been embossed. Although seldom seen, note that the system changes when extra hard metal (H_9) is embossed.

Beginning Unembossed	Resulting Embossed (respectively)
0	H114
H11, H21, H31	H124, H224, H324
H12, H22, H32	H135, H234, H334
H13, H23, H33	H144, H244, H344
H14, H24, H34	H154, H254, H354
H15, H25, H35	H164, H264, H364
H16, H26, H36	H174, H274, H374
H17, H27, H37	H184, H284, H384
H18, H28, H38	H194, H294, H394
H19, H29, H39	H195, H295, H395

SUBDIVISION OF "T" TEMPER
HEAT-TREATABLE ALLOYS

T1 COOLED FROM AN ELEVATED TEMPERATURE SHAPING PROCESS AND NATURALLY AGED TO A SUBSTANTIALLY STABLE CONDITION
Usually associated with extruded products and limited to certain of the 6XXX series alloys.

T2 COOLED FROM AN ELEVATED TEMPERATURE SHAPING PROCESS, COLD WORKED AND NATURALLY AGED TO A SUBSTANTIALLY STABLE CONDITION
Usually associated with cast products.

T3 SOLUTION HEAT-TREATED, COLD WORKED AND NATURALLY AGED TO A SUBSTANTIALLY STABLE CONDITION
Usually associated with cast products.

T4 SOLUTION HEAT-TREATED, AND NATURALLY AGED TO A SUBSTANTIALLY STABLE CONDITION

T5 COOLED FROM AN ELEVATED TEMPERATURE SHAPING PROCESS AND ARTIFICIALLY AGED
Usually associated with extruded products in certain of the 6XXX series alloys. (T1+artificial age)

T6 SOLUTION HEAT-TREATED AND ARTIFICIALLY AGED
A srable temper. (T4+artificial age)

T7 SOLUTION HEAT-TREATED AND OVERAGED/STABILIZED
Applies to alloy products which are thermally overaged after solution heat-treatment to carry them beyond the point of maximum strength to provide control of some special characteristic. A stable temper.

T8 SOLUTION HEAT-TREATED, COLD WORKED, AND ARTIFICIALLY AGED
A stable temper. (T3+artificial age)

T9 SOLUTION HEAT-TREATED, ARTIFICIALLY AGED, AND COLD WORKED
A stable temper. (T6+cold work)

T10 COOLED FROM AN ELEVATED TEMPERATURE SHAPING PROCESS, COLD WORKED AND ARTIFICIALLY AGED
Usually associated with cast products. A stable temper. (T2+artificial age)

Additional digits, the first of which shall not be zero, maybe added to the basic designations to indicate a variation in treatment which significantly alters the characteristics of the product.

The following specific additional digits have been assigned for stress-relieved tempers of wrought products.

T_51 Applies to certain products when stress-relieved by stretching the indicated amount. Stretching is performed after solution heat treatment or after cooling from an elevated temperature shaping process. No straightening tales place after stretching.
Plate ..... 1.5 to 3% permanent set
Rolled or cold finished rod
or bar ..... 1 to 3% permanent set
Die or ring forgings .. 1 to 3% permanent set

T_510 Applies to extruded products and to drawn tube when stress-relieved by stretching the indicated amount. Stretching is performed after solution heat treatment or after cooling from an elevated temperature shaping process. No straightening tales place after stretching.
Rod, bar, shapes
and tube .....1 to 3% permanent set
Drawn tube .... 0.5 to 3% permanent set

T_511 Applies to extruded products and to drawn tube when stress-relieved by stretching the indicated amount. Stretching is performed after solution heat treatment or after cooling from an elevated temperature shaping process. These products may recieve minor straightening to comply with standard tolerances.
Bar, shapes and tube ....1 to 3% permanent set
Drawn tube .... 0.5 to 3% permanent set

T_52 Applies to products stress-relieved by compressing.

T_54 Applies to die forgings stress-relieved by restiking code.

The following temper designations have been assigned for wrought product test material heat-treated from annealed (0, 01, etc.) or F temper, or to wrought products heat-treated from any temper by the user. The former demonstrates a response to heat-treatment.

T_42 Solution heat-treated and naturally aged to a substantially stable condition.

T_62 Solution heat-treated and artificially aged to a substantially stable condition.

CHEMICAL COMPOSITION LIMITS OF WROUGHT ALUMINUM ALLOYS[1][2]

Alloy	Silicon	Iron	Copper	Manganese	Magnesium	Chromium	Zinc	Titanium	Others		Aluminum Min.[5]
									Each[3]	Total[4]	
1100	0.95 Si + Fe		0.05–0.20	0.05	—	—	0.10	—	0.05[6]	0.15	99.00
1145[7]	0.55 Si + Fe		0.05	0.05	0.05	—	0.05	0.03	0.03[8]	—	99.45
1350[9]	0.10	0.40	0.05	0.01	—	0.01	0.05	—	0.03[10]	0.10	99.50
2011	0.40	0.7	5.0–6.0	—	—	—	0.30	—	0.05[11]	0.15	Remainder
2014	0.50–1.2	0.7	3.9–5.0	0.40–1.2	0.20–0.8	0.10	0.25	0.15	0.05	0.15	Remainder
2017	0.20–0.8	0.7	3.5–4.5	0.40–1.0	0.40–0.8	0.10	0.25	0.15	0.05	0.15	Remainder
2024	0.50	0.50	3.8–4.9	0.30–0.9	1.2–1.8	0.10	0.25	0.15	0.05	0.15	Remainder
2117	0.8	0.7	2.2–3.0	0.20	0.20–0.50	0.10	0.25	—	0.05	0.15	Remainder
2124	0.20	0.30	3.8–4.9	0.30–0.9	1.2–1.8	0.10	0.25	0.15	0.05	0.15	Remainder
2219	0.20	0.30	5.8–6.8	0.20–0.40	0.02	—	0.10	0.02–0.10	0.05[12]	0.15	Remainder
3003	0.6	0.7	0.05–0.20	1.0–1.5	—	—	0.10	—	0.05	0.15	Remainder
3004	0.30	0.7	0.25	1.0–1.5	0.8–1.3	—	0.25	—	0.05	0.15	Remainder
3005	0.6	0.7	0.30	1.0–1.5	0.20–0.6	0.10	0.25	0.10	0.05	0.15	Remainder
3105	0.6	0.7	0.30	0.30–0.8	0.20–0.8	0.20	0.40	0.10	0.05	0.15	Remainder
4043	4.5–6.0	0.8	0.30	0.05	0.05	—	0.10	0.20	0.05[6]	0.15	Remainder
5005	0.30	0.7	0.20	0.20	0.50–1.1	0.10	0.25	—	0.05	0.15	Remainder
5050	0.40	0.7	0.20	0.10	1.1–1.8	0.10	0.25	—	0.05	0.15	Remainder
5052	0.25	0.40	0.10	0.10	2.2–2.8	0.15–0.35	0.10	—	0.05	0.15	Remainder
5056	0.30	0.40	0.10	0.05–0.20	4.5–5.6	0.05–0.20	0.10	—	0.05	0.15	Remainder
5083	0.40	0.40	0.10	0.40–1.0	4.0–4.9	0.05–0.25	0.25	0.15	0.05	0.15	Remainder
5086	0.40	0.50	0.10	0.20–0.7	3.5–4.5	0.05–0.25	0.25	0.15	0.05	0.15	Remainder
5154	0.25	0.40	0.10	0.10	3.1–3.9	0.15–0.35	0.20	0.20	0.05	0.15	Remainder
5183	0.40	0.40	0.10	0.50–1.0	4.3–5.2	0.05–0.25	0.25	0.15	0.05[6]	0.15	Remainder
5252	0.08	0.10	0.10	0.10	2.2–2.8	—	0.05	—	0.03[8]	0.10	Remainder
5356	0.25	0.40	0.10	0.05–0.20	4.5–5.5	0.05–0.20	0.10	0.06–0.20	0.05[6]	0.15	Remainder
5454	0.25	0.40	0.10	0.50–1.0	2.4–3.0	0.05–0.20	0.25	0.20	0.05	0.15	Remainder
5456	0.25	0.40	0.10	0.50–1.0	4.7–5.5	0.05–0.20	0.25	0.20	0.05	0.15	Remainder
6061	0.40–0.8	0.7	0.15–0.40	0.15	0.8–1.2	0.04–0.35	0.25	0.15	0.05	0.15	Remainder
6063	0.20–0.6	0.35	0.10	0.10	0.45–0.9	0.10	0.10	0.10	0.05	0.15	Remainder
6101[13]	0.30–0.7	0.50	0.10	0.03	0.35–0.8	0.03	0.10	—	0.03[14]	0.10	Remainder
6105	0.6–1.0	0.35	0.10	0.10	0.45–0.8	0.10	0.10	0.10	0.05	0.15	Remainder
6262	0.40–0.8	0.7	0.15–0.40	0.15	0.8–1.2	0.04–0.14	0.25	0.15	0.05[15]	0.15	Remainder
6351	0.7–1.3	0.50	0.10	0.40–0.8	0.40–0.8	—	0.20	0.20	0.05	0.15	Remainder
7005	0.35	0.40	0.10	0.20–0.7	1.0–1.8	0.06–0.20	4.0–5.0	0.01–0.06	0.05[16]	0.15	Remainder
7049	0.25	0.35	1.2–1.9	0.20	2.0–2.9	0.10–0.22	7.2–8.2	0.10	0.05	0.15	Remainder
7050	0.12	0.15	2.0–2.6	0.10	1.9–2.6	0.04	5.7–6.7	0.06	0.05[17]	0.15	Remainder
7075	0.40	0.50	1.2–2.0	0.30	2.1–2.9	0.18–0.28	5.1–6.1	0.20	0.05	0.15	Remainder
7129	0.15	0.30	0.50–0.9	0.10	1.3–2.0	0.10	4.2–5.2	0.05	0.05[18]	0.15	Remainder
7178	0.40	0.50	1.6–2.4	0.30	2.4–3.1	0.18–0.28	6.3–7.3	0.20	0.05	0.15	Remainder

NOTE: This table does not include all active alloys registered with the Aluminum Association.

(1) Composition in percent by weight maximum unless shown as a range or a minimum.

(2) Except for "aluminum" and "others," analysis normally is made for elements for which specific limits are shown. For purposes of determining conformance to these limits, an observed value or a calculated value obtained from analysis is rounded off to the nearest unit in the last right-hand place of figures used in expressing the specified limit, in accordance with ASTM Recommended Practice E 29.

(3) In addition to those alloys referencing footnote (6), a 0.0008 weight percent maximum beryllium is applicable to any alloy to be used as welding electrode or welding rod.

(4) The sum of those "others" metallic elements 0.010 percent or more each, expressed to the second decimal before determining the sum.

(5) The aluminum content for unalloyed aluminum not made by a refining process is the difference between 100.00 percent and sum of all other metallic elements present in amounts of 0.010 percent or more each, expressed to the second decimal before determining the sum.

(6) Beryllium 0.0008 maximum for welding electrode and welding rod only.

(7) Foil.

(8) Vanadium 0.05 percent maximum.

(9) Electric conductor. Formerly designated EC.

(10) Vanadium plus titanium 0.02 percent maximum; boron 0.05 percent maximum; gallium 0.03 percent maximum.

(11) Also contains 0.20–0.6 percent each of lead and bismuth.

(12) Vanadium 0.05–0.15; zirconium 0.10–0.25.

(13) Bus conductor.

(14) Boron 0.06 percent maximum.

(15) Also contains 0.40–0.7 percent each of lead and bismuth.

(16) Zirconium 0.08–0.20.

(17) Zirconium 0.08–0.15.

(18) Vanadium 0.05 percent maximum; gallium 0.03 percent maximum.

Sheet, Plate & Coil/
Standard Tolerances

THICKNESS

Applicable to all alloys not included in the Aerospace Alloys table or specified for Aerospace applications. Also applicable to the alloys listed when supplied as Alclad.

Specified Thickness (1) In.		Specified Width-In.							
		Up thru 39.37	Over 39.37 thru 59.06	Over 59.06 thru 78.74	Over 78.74 thru 98.43	Over 98.43 thru 118.11	Over 118.11 thru 137.80	Over 137.80 thru 157.48	Over 157.48 thru 177.17
Over	Thru	Tolerances-In. plus and minus							
0.0059	0.010	0.0010	0.0015	—	—	—	—	—	—
0.010	0.016	0.0010	0.0015	—	—	—	—	—	—
0.016	0.025	0.0015	0.0020	0.0030	0.0035	—	—	—	—
0.025	0.032	0.0020	0.0025	0.0035	0.0040	—	—	—	—
0.032	0.039	0.0020	0.0030	0.0035	0.0045	0.006	—	—	—
0.039	0.047	0.0025	0.0035	0.0045	0.0055	0.007	0.008	—	—
0.047	0.063	0.0030	0.0035	0.0050	0.006	0.007	0.009	—	—
0.063	0.079	0.0035	0.0040	0.0055	0.007	0.008	0.010	—	—
0.079	0.098	0.0035	0.0045	0.006	0.007	0.009	0.011	—	—
0.098	0.126	0.0045	0.0055	0.007	0.009	0.011	0.013	—	—
0.126	0.158	0.0055	0.007	0.009	0.011	0.013	0.015	—	—
0.158	0.197	0.007	0.009	0.011	0.013	0.015	0.018	—	—
0.197	0.248	0.009	0.011	0.013	0.015	0.018	0.022	0.027	—
0.248	0.315	0.012	0.014	0.015	0.018	0.022	0.027	0.035	0.043
0.315	0.394	0.015	0.017	0.020	0.023	0.027	0.033	0.041	0.051
0.394	0.630	0.023	0.023	0.027	0.032	0.035	0.043	0.053	0.065
0.630	0.984	0.031	0.031	0.037	0.043	0.047	0.058	0.070	0.085
0.984	1.575	0.039	0.039	0.047	0.055	0.065	0.075	0.090	0.105
1.575	2.362	0.055	0.055	0.060	0.070	0.085	0.100	0.115	—
2.362	3.150	0.075	0.075	0.085	0.100	0.105	0.125	—	—
3.150	3.937	0.100	0.100	0.115	0.125	0.130	0.160	—	—
3.937	6.299	0.130	0.130	0.145	0.165	—	—	—	—

WIDTH AND LENGTH— Sawed Flat Sheet and Plate

Specified Thickness In.	Specified Width–In.							
	Up thru 30	Over 30 thru 60	Over 60 thru 120	Over 120 thru 240	Over 240 thru 360	Over 360 thru 480	Over 480 thru 600	Over 600 thru 720
	Tolerance(2)–In.							
0.080–0.249	± 1/8 + 1/4	± 1/8 + 5/16	± 3/16 + 3/8	± 1/4 + 1/2	± 1/4 + 9/16	± 5/16 + 5/8	± 3/8 + 3/4	± 7/16 + 7/8
0.250–6.000								

Notes:

The above standards are those published by the Aluminum Association, Aluminum Standards & Data 1990 and ANSI H35.2-90.

(1) When a dimension tolerance is specified other than as an equal bilateral tolerance, the value of the standard tolerance is that which applies to the mean of the maximum and minimum dimensions permissible under the tolerance for the dimension under consideration.

(2) Tolerances applicable at ambient mill temperatures. A change in dimension of 0.013 in. per 100 in. per 10° F must be recognized.

ESTIMATED SHEET AND PLATE WEIGHTS IN POUNDS, BASED ON DENSITY OF 0.100 lb./cu. in.[1][2]

Thickness Inches	Weight Sq. Ft.	Estimated Weights Of Various Sheet Sizes								
		24 x 72"	36 x 96"	36 x 120"	36 x 144"	48 x 96"	48 x 120"	48 x 144"	60 x 144"	60 x 180"
.012	.173	2.1	4.2	5.2	6.2	5.5	6.9	8.3	10.4	13.0
.016	.230	2.8	5.5	6.9	8.3	7.4	9.2	11.0	13.8	17.3
.020	.288	3.5	6.9	8.6	10.4	9.2	11.5	13.8	17.3	21.6
.025	.360	4.3	8.6	10.8	13.0	11.5	14.4	17.3	21.6	27.0
.032	.461	5.5	11.1	13.8	16.6	14.8	18.4	22.1	27.7	34.6
.040	.576	6.9	13.8	17.3	20.7	18.4	23.0	27.6	34.6	43.2
.050	.720	8.6	17.3	21.6	25.9	23.0	28.8	34.6	43.2	54.0
.063	.907	10.9	21.8	27.2	32.6	29.0	36.3	43.5	54.4	68.0
.071	1.022	12.3	24.5	30.7	36.8	32.7	40.9	49.1	61.3	76.7
.080	1.152	13.8	27.6	34.6	41.5	36.9	46.1	55.3	69.1	86.4
.090	1.296	15.6	31.1	38.9	46.7	41.5	51.8	62.2	77.8	97.2
.100	1.440	17.3	34.6	43.2	51.8	46.1	57.6	69.1	86.4	108.0
.125	1.800	21.6	43.2	54.0	64.8	57.6	72.0	86.4	108.0	135.0
.160	2.304	27.6	55.3	69.1	82.9	73.7	92.2	110.6	138.2	172.8
.190	2.736	32.8	65.7	82.1	98.5	87.6	109.4	131.3	164.2	205.2
.250	3.600	43.2	86.4	108.0	129.6	115.2	144.0	172.8	216.0	270.0
.313	4.507	54.1	108.2	135.2	162.3	144.2	180.3	216.3	270.4	338.0
.375	5.400	64.8	129.6	162.0	194.4	172.8	216.0	259.2	324.0	405.0
.500	7.200	86.4	172.8	216.0	259.2	230.4	288.0	345.6	432.0	540.0
.625	9.000	108.0	216.0	270.0	324.0	288.0	360.0	432.0	540.0	675.0
.750	10.800	129.6	259.2	324.0	388.8	345.6	432.0	518.4	648.0	810.0
.875	12.600	151.2	302.4	378.0	453.6	403.2	504.0	604.8	756.0	945.0
1.000	14.400	172.8	345.6	432.0	518.4	460.8	576.0	691.2	864.0	1080.0
1.250	18.000	216.0	432.0	540.0	648.0	576.0	720.0	864.0	1080.0	1350.0
1.500	21.600	259.2	518.4	648.0	777.6	691.2	864.0	1036.8	1296.0	1620.0
1.750	25.200	302.4	604.8	756.0	907.2	806.4	1008.0	1209.6	1512.0	1890.0
2.000	28.800	345.6	691.2	864.0	1036.8	921.6	1152.0	1382.4	1728.0	2160.0
2.250	32.400	388.8	777.6	972.0	1166.4	1036.8	1296.0	1555.2	1944.0	2430.0
2.500	36.000	432.0	864.0	1080.0	1296.0	1152.0	1440.0	1728.0	2160.0	2700.0
2.750	39.600	475.2	950.4	1188.0	1425.6	1267.2	1584.0	1900.8	2376.0	2970.0
3.000	43.200	518.4	1036.8	1296.0	1555.2	1382.4	1728.0	2073.6	2592.0	3240.0
4.000	57.600	691.2	1382.4	1728.0	2073.6	1843.2	2304.0	2764.8	3456.0	4320.0
5.000	72.000	864.0	1728.0	2160.0	2592.0	2304.0	2880.0	3456.0	4320.0	5400.0
6.000	86.400	1036.8	2073.6	2592.0	3110.4	2764.8	3456.0	4147.2	5184.0	6480.0

Notes:

(1) Table does not take into consideration thickness, length or width tolerances.

(2) For specific alloys, a more accurate weight may be obtained by multiplying the weights in this table by the appropriate density conversion factor shown below.

WEIGHT CONVERSION FACTORS FOR OTHER ALLOYS AND METALS

Multiply weights above by the appropriate conversion factor below.

Aluminum Alloy	Conversion Factor	Aluminum Alloy	Conversion Factor	Other Metals	Conversion Factor
1100	0.98	5052	0.97	Brass	3.0
1350	0.975	5083	0.96	Copper	3.2
2014	1.01	5086	0.96	Nickel	3.2
2024	1.01	5252	0.96	Monel	3.2
2219	1.03	5454	0.97	Steel	2.8
2124	1.00	5456	0.96	Zinc	2.5
3003	0.99	5457	0.97	Tin	2.6
3004	0.98	6061	0.98	Titanium	1.7
3005	0.98	7050	1.02	Magnesium	0.65
3105	0.98	7075	1.01	—	—
5005	0.98	7178	1.02	—	—
5050	0.97	—	—	—	—

THICKNESS FOR SHEET AND PLATE FOR AEROSPACE ALLOYS

Alloys 2014, 2024, 2124, 2219, 7049, 7050, 7075, 7150, 7178 and 7475 and other alloys when specified for aerospace applications. Also applicable to alloys when supplied as Alclad.

Specified Thickness(1) In.		Specified Width–In.											
		Up thru 39.37	Over 39.37 thru 47.24	Over 47.24 thru 55.12	Over 55.12 thru 59.06	Over 59.06 thru 70.87	Over 70.87 thru 78.84	Over 78.74 thru 86.61	Over 86.61 thru 98.43	Over 98.43 thru 118.11	Over 118.11 thru 137.80	Over 137.80 thru 157.48	Over 157.48 thru 177.17
Over	Thru	Tolerance–In. plus and minus											
0.0059	0.010	0.0010	0.0020	0.0020	0.0020	—	—	—	—	—	—	—	—
0.010	0.016	0.0015	0.0025	0.0025	0.0025	—	—	—	—	—	—	—	—
0.016	0.025	0.0015	0.0025	0.0025	0.0025	—	—	—	—	—	—	—	—
0.025	0.032	0.0015	0.0015	0.0020	0.0030	0.0030	—	—	—	—	—	—	—
0.032	0.039	0.0015	0.0015	0.0020	0.0030	0.0030	0.0035	0.0035	0.007	—	—	—	—
0.039	0.047	0.0020	0.0020	0.0020	0.0030	0.0030	0.0035	0.0035	0.008	0.010	0.011	—	—
0.047	0.063	0.0020	0.0020	0.0030	0.0030	0.0030	0.0035	0.0035	0.009	0.011	0.013	—	—
0.063	0.079	0.0020	0.0020	0.0030	0.0035	0.0035	0.0035	0.0035	0.010	0.013	0.015	—	—
0.079	0.098	0.0025	0.0025	0.0035	0.0040	0.0040	0.0045	0.0045	0.011	0.015	0.018	—	—
0.098	0.126	0.0035	0.0035	0.0035	0.0045	0.0045	0.0045	0.0045	0.013	0.016	0.020	—	—
0.126	0.158	0.0040	0.0040	0.0045	0.007	0.007	0.009	0.009	0.015	0.018	0.022	—	—
0.158	0.197	0.0055	0.007	0.007	0.009	0.009	0.011	0.011	0.018	0.022	0.026	—	—
0.197	0.248	0.009	0.012	0.012	0.012	0.017	0.017	0.021	0.021	0.025	0.029	—	—
0.248	0.315	0.012	0.015	0.015	0.015	0.019	0.019	0.024	0.024	0.029	0.033	0.041	0.051
0.315	0.394	0.017	0.018	0.018	0.018	0.022	0.022	0.028	0.028	0.033	0.039	0.047	0.059
0.394	0.630	0.023	0.023	0.023	0.023	0.028	0.028	0.033	0.033	0.039	0.047	0.059	0.070
0.630	0.984	0.031	0.031	0.031	0.031	0.037	0.037	0.043	0.043	0.051	0.060	0.070	0.085
0.984	1.575	0.039	0.039	0.039	0.039	0.047	0.047	0.055	0.055	0.065	0.075	0.090	0.105
1.575	2.362	0.055	0.055	0.055	0.055	0.060	0.060	0.070	0.070	0.090	0.100	0.115	—
2.362	3.150	0.075	0.075	0.075	0.075	0.085	0.085	0.100	0.100	0.110	0.125	—	—
3.150	3.937	0.100	0.100	0.100	0.100	0.115	0.115	0.130	0.130	0.150	0.160	—	—
3.937	6.299	0.130	0.130	0.130	0.130	0.145	0.145	0.165	0.165	—	—	—	—

Notes:

The above standards are those published by the Aluminum Association, Aluminum Standards & Data 1990 and ANSI H35.2-90.

(1) When a dimension tolerance is specified other than as an equal bilateral tolerance, the value of the standard tolerance is that which applies to the mean of the maximum and minimum dimensions permissible under the tolerance for the dimension under consideration.

RECOMMENDED MINIMUM INSIDE BEND RADII FOR 90 DEGREE COLD FORMING OF SHEET AND PLATE[1][2][3][4]

Alloy	Temper	Radii For Various Thicknesses Expressed In Terms Of Thickness "T"							
		1/64 In.	1/32 In.	1/16 In.	1/8 In.	3/16 In.	1/4 In.	3/8 In.	1/2 In
5052	O	0	0	0	½t	1t	1t	1½t	1½t
	H32	0	0	1t	1½t	1½t	1½t	1½t	2t
	H34	0	1t	1½t	2t	2t	2½t	2½t	3t
	H36	1t	1t	1½t	2½t	3t	3½t	4t	4½t
	H38	1t	1½t	2½t	3t	4t	5t	5½t	6½t
5083	O	—	—	½t	1t	1t	1t	1½t	1½t
	H321	—	—	1t	1½t	1½t	1½t	2t	2½t
5086	O	0	0	½t	1t	1t	1t	1½t	1½t
	H32	0	½t	1t	1½t	1½t	2t	2½t	3t
	H34	½t	1t	1½t	2t	2½t	3t	3½t	4t
	H36	1½t	2t	2½t	3t	3½t	4t	4½t	5t
5454	O	0	½t	1t	1t	1t	1½t	1½t	2t
	H32	½t	½t	1t	2t	2t	2½t	3t	4t
	H34	½t	1t	1½t	2t	2½t	3t	3½t	4t
6061	O	0	0	0	1t	1t	1t	1½t	2t
	T4	0	0	1t	1½t	2½t	3t	3½t	4t
	T6	1t	1t	1½t	2½t	3t	3½t	4½t	5t
7075	O	0	0	1t	1t	1½t	2½t	3½t	4t
	T6	3t	4t	5t	6t	6t	8t	9t	9½t

Notes:

(1) The radii listed are the minimum recommended for bending sheets and plates without fracturing in a standard press brake with air bend dies. Other types of bending operations may require larger radii or permit smaller radii. The minimum permissible radii will also vary with the design and condition of the tooling.

(2) Alclad sheet in the heat-treatable alloys can be bent over slightly smaller radii than the corresponding tempers of the bare alloy.

(3) Heat-treatable alloys can be formed over appreciably smaller radii immediately after solution heat treatment.

(4) The H112 temper (applicable to non-heat-treatable alloys) is supplied in the as-fabricated condition without special property control but usually can be formed over radii applicable to the H14 (or H34) temper or smaller.

(5) Tempers T361 and T861 formerly designated T36 and T86 respectively.

Sheet, Plate & Coil/Mechanical Properties

The following typical properties are not guaranteed since in most cases they are averages for various sizes, product forms and methods of manufacture and may not be exactly representative of any particular product or size. These data are intended only as a basis for comparing alloys and tempers and should not be specified as engineering requirements or used for design purposes.

TYPICAL MECHANICAL PROPERTIES[1]

Alloy And Temper	TENSION				HARDNESS	SHEAR	FATIGUE	MODULUS
	Strength ksi		Elongation percent in 2 in.		Brinell Number	Ultimate Shearing Strength	Endurance[2] Limit	Modulus[3] Of Elasticity
	Ultimate	Yield	1/16 in. Thick Specimen	1/2 in. Diameter Specimen	500 kg load 10 mm ball	ksi	ksi	ksi x 10^3
1100-O	13	5	35	45	23	9	5	10.0
1100-H12	16	15	12	25	28	10	6	10.0
1100-H14	18	17	9	20	32	11	7	10.0
1100-H16	21	20	6	17	38	12	9	10.0
1100-H18	24	22	5	15	44	13	9	10.0
1350-O	12	4	—	—	—	8	—	10.0
1350-H12	14	12	—	—	—	9	—	10.0
1350-H14	16	14	—	—	—	10	—	10.0
1350-H16	18	16	—	—	—	11	—	10.0
1350-H19	27	24	—	—	—	15	7	10.0
2014-O	27	14	—	18	45	18	13	10.6
2014-T4, T451	62	42	—	20	105	38	20	10.6
2014-T6, T651	70	60	—	13	135	42	18	10.6
Alclad 2014-O	25	10	21	—	—	18	—	10.5
Alclad 2014-T3	63	40	20	—	—	37	—	10.5
Alclad 2014-T4, T451	61	37	22	—	—	37	—	10.5
Alclad 2014-T6, T651	68	60	10	—	—	41	—	10.5
2024-O	27	11	20	22	47	18	13	10.6
2024-T3	70	50	18	—	120	41	20	10.6
2024-T4, T351	68	47	20	19	120	41	20	10.6
2024-T361[4]	72	57	13	—	130	42	18	10.6
Alclad 2024-O	26	11	20	—	—	18	—	10.6
Alclad 2024-T3	65	45	18	—	—	40	—	10.6
Alclad 2024-T4, T351	64	42	19	—	—	40	—	10.6
Alclad 2024-T361[4]	67	53	11	—	—	41	—	10.6
Alclad 2024-T81, T851	65	60	6	—	—	40	—	10.6
Alclad 2024-T861[4]	70	66	6	—	—	42	—	10.6
2036-T4	49	28	24	—	—	—	18[5]	10.3
2219-O	25	11	18	—	—	—	—	10.6
2219-T42	52	27	20	—	—	—	—	10.6
2219-T31, T351	52	36	17	—	—	—	—	10.6
2219-T37	57	46	11	—	—	—	—	10.6
2219-T62	60	42	10	—	—	—	15	10.6
2219-T81, T851	66	51	10	—	—	—	15	10.6
2219-T87	69	57	10	—	—	—	15	10.6
3003-O	16	6	30	40	28	11	7	10.0
3003-H12	19	18	10	20	35	12	8	10.0
3003-H14	22	21	8	16	40	14	9	10.0
3003-H16	26	25	5	14	47	15	10	10.0
3003-H18	29	27	4	10	55	16	10	10.0

TYPICAL MECHANICAL PROPERTIES[1]

Alloy And Temper	TENSION				HARDNESS	SHEAR	FATIGUE	MODULUS
	Strength ksi		Elongation percent in 2 in.		Brinell Number	Ultimate Shearing Strength	Endurance[2] Limit	Modulus[3] Of Elasticity
	Ultimate	Yield	1/16 in. Thick Specimen	1/2 in. Diameter Specimen	500 kg load 10 mm ball	ksi	ksi	ksi × 10^3
3004-O	26	10	20	25	45	16	14	10.0
3004-H32	31	25	10	17	52	17	15	10.0
3004-H34	35	29	9	12	63	18	15	10.0
3004-H36	38	33	5	9	70	20	16	10.0
3004-H38	41	36	5	6	77	21	16	10.0
Alclad 3004-O	26	10	20	25	—	16	—	10.0
Alclad 3004-H32	31	25	10	17	—	17	—	10.0
Alclad 3004-H34	35	29	9	12	—	18	—	10.0
Alclad 3004-H36	38	33	5	9	—	20	—	10.0
Alclad 3004-H38	41	36	5	6	—	21	—	10.0
3105-O	17	8	24	—	—	12	—	10.0
3105-H12	22	19	7	—	—	14	—	10.0
3105-H14	25	22	5	—	—	15	—	10.0
3105-H16	28	25	4	—	—	16	—	10.0
3105-H18	31	28	3	—	—	17	—	10.0
3105-H25	26	23	8	—	—	15	—	10.0
5005-O	18	6	25	—	28	11	—	10.0
5005-H12	20	19	10	—	—	14	—	10.0
5005-H14	23	22	6	—	—	14	—	10.0
5005-H16	26	25	5	—	—	15	—	10.0
5005-H18	29	28	4	—	—	16	—	10.0
5005-H32	20	17	11	—	36	14	—	10.0
5005-H34	23	20	8	—	41	14	—	10.0
5005-H36	26	24	6	—	46	15	—	10.0
5005-H38	29	27	5	—	51	16	—	10.0
5050-O	21	8	24	—	36	15	12	10.0
5050-H32	25	21	9	—	46	17	13	10.0
5050-H34	28	24	8	—	53	18	13	10.0
5050-H36	30	26	7	—	58	19	14	10.0
5050-H38	32	29	6	—	63	20	14	10.0
5052-O	28	13	25	30	47	18	16	10.2
5052-H32	33	28	12	18	60	20	17	10.2
5052-H34	38	31	10	14	68	21	18	10.2
5052-H36	40	35	8	10	73	23	19	10.2
5052-H38	42	37	7	8	77	24	20	10.2
5083-O	42	21	—	22	—	25	—	10.3
5083-H321, H116	46	33	—	16	—	—	23	10.3
5086-O	38	17	22	—	—	23	—	10.3
5086-H32, H116	42	30	12	—	—	—	—	10.3
5086-H34	47	37	10	—	—	27	—	10.3

TYPICAL MECHANICAL PROPERTIES[1]

Alloy And Temper	TENSION				HARDNESS	SHEAR	FATIGUE	MODULUS
	Strength ksi		Elongation percent in 2 in.		Brinell Number	Ultimate Shearing Strength	Endurance[2] Limit	Modulus[3] Of Elasticity
	Ultimate	Yield	1/16 in. Thick Specimen	1/2 in. Diameter Specimen	500 kg load 10 mm ball	ksi	ksi	ksi x 10^3
5154-O	35	17	27	—	58	22	17	10.2
5154-H32	39	30	15	—	67	22	18	10.2
5154-H34	42	33	13	—	73	24	19	10.2
5154-H36	45	36	12	—	78	26	20	10.2
5154-H38	48	39	10	—	80	28	21	10.2
5154-H112	35	17	25	—	63	—	17	10.2
5454-O	36	17	22	—	62	23	—	10.2
5454-H32	40	30	10	—	73	24	—	10.2
5454-H34	44	35	10	—	81	26	—	10.2
5454-H112	36	18	18	—	62	23	—	10.2
5456-O	45	23	—	24	—	—	—	10.3
5456-H112	45	24	—	22	—	—	—	10.3
5456-H321, H116	51	37	—	16	90	30	—	10.3
6009-T4	33	18	25	—	62	22	17	10.0
6010-T4	42	25	24	—	78	28	18	10.0
6061-O	18	8	25	30	30	12	9	10.0
6061-T4, T451	35	21	22	25	65	24	14	10.0
6061-T6, T651	45	40	12	17	95	30	14	10.0
7050-T7451[6]	76	68	—	11	—	44	—	10.4
7050-T7651	80	71	—	11	—	47	—	10.4
7075-O	33	15	17	16	60	22	—	10.4
7075-T6, T651	83	73	11	11	150	48	23	10.4
7075-T73, T7351	73	63	13	—	—	—	22	10.4
Alclad 7075-O	32	14	17	—	—	22	—	10.4
Alclad 7075-T6, T651	76	67	11	—	—	46	—	10.4

Notes:

(1) The indicated typical mechanical properties for all except O temper material are higher than the specified minimum properties. For O temper products typical ultimate and yield values are slightly lower than specified (maximum) values.

(2) Based on 500,000,000 cycles of completely reversed stress using the R.R. Moore type of machine and specimen.

(3) Average of tension and compression moduli. Compression modulus is about 2% greater than tension modulus.

(4) Tempers T361 and T861 were formerly designated T36 and T86, respectively.

(5) Based on 10^7 cycles using flexural type testing of sheet specimens.

(6) T7451 although not previously registered has appeared in literature and in some specifications as T73651.

GAUGES COMPARATIVE — SHEET AND PLATE

Gauge Number	Brown & Sharpe Non-Ferrous Sheet, Wire, And Rod (Size, Inches)	United States Standard (Old) Ferrous Sheet And Plate (Size, Inches)	Mfrs.' Std. For Sheet Steel Uncoated Ferrous Sheet (Size, Inches)
0	0.3249	0.312	—
1	0.2893	0.281	—
2	0.2576	0.266	—
3	0.2294	0.250	0.2391
4	0.2043	0.234	0.2242
5	0.1819	0.219	0.2092
6	0.1620	0.203	0.1943
7	0.1443	0.188	0.1793
8	0.1285	0.172	0.1644
9	0.1144	0.156	0.1495
10	0.1019	0.141	0.1345
11	0.0907	0.125	0.1196
12	0.0808	0.109	0.1046
13	0.0720	0.0938	0.0897
14	0.0641	0.0781	0.0747
15	0.0571	0.0703	0.0673
16	0.0508	0.0625	0.0598
17	0.0453	0.0562	0.0538
18	0.0403	0.0500	0.0478
19	0.0359	0.0438	0.0418
20	0.0320	0.0375	0.0359
21	0.0285	0.0344	0.0329
22	0.0253	0.0312	0.0299
23	0.0226	0.0281	0.0269
24	0.0201	0.0250	0.0239
25	0.0179	0.0219	0.0209
26	0.0159	0.0188	0.0179
27	0.0142	0.0172	0.0164
28	0.0126	0.0156	0.0149
29	0.0113	0.0141	0.0135
30	0.0100	0.0125	0.0120

DECIMAL EQUIVALENTS OF COMMON FRACTIONS

	1/32	2/64	=	0.03125
1/16	2/32	4/64	=	.0625
	3/32	6/64	=	.09375
1/8	4/32	8/64	=	.125
	5/32	10/64	=	.15625
3/16	6/32	12/64	=	.1875
	7/32	14/64	=	.21875
1/4	8/32	16/64	=	.25
	9/32	18/64	=	.28125
5/16	10/32	20/64	=	.3125
	11/32	22/64	=	.34375
3/8	12/32	24/64	=	.375
	13/32	26/64	=	.40625
7/16	14/32	28/64	=	.4375
	15/32	30/64	=	.46875
1/2	16/32	32/64	=	.50
	17/32	34/64	=	.53125
9/16	18/32	36/64	=	.5625
	19/32	38/64	=	.59375
5/8	20/32	40/64	=	.625
	21/32	42/64	=	.65625
11/16	22/32	44/64	=	.6875
	23/32	46/64	=	.71875
3/4	24/32	48/64	=	.75
	25/32	50/64	=	.78125
13/16	26/32	52/64	=	.8125
	27/32	54/64	=	.84375
7/8	28/32	56/64	=	.875
	29/32	58/64	=	.90625
15/16	30/32	60/64	=	.9375
	31/32	62/64	=	.96875

METRIC UNITS AND U.S. CUSTOMARY UNITS LENGTH

U.S. Customary To Metric				Metric To U.S. Customary			
1 inch	=	25.4 (exact)	mm.	1 mm.	=	0.03937	in.
	=	2.54	cm.		=	0.003281	ft.
	=	0.0254	m.	1 cm.	=	0.3937	in.
1 foot	=	304.8	mm.		=	0.03281	ft.
	=	30.480	cm.		=	0.01094	yd.
	=	0.3048	m.	1 meter	=	39.37	in.
1 yard	=	91.44	cm.		=	3.2808	ft.
	=	0.9144	m.		=	1.0936	yd.
	=	0.0_3914	km.		=	0.0_36214	mi.
1 mile	=	1609.344	m.	1 kilometer	=	3280.833	ft.
	=	1.6093	km.		=	1093.611	yd.
					=	0.6214	mi.

Note: $0.0_34 = 0.0004$ — subscript number is number of zeroes after decimal.