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 **WARNING:** These products can potentially expose you to chemicals including Nickel, Chromium, Lead, Cobalt, Mercury and Beryllium, which are known to the state of California to cause cancer and/or birth defects or other reproductive harm. For more information, visit www.P65Warnings.ca.gov



Average Mechanical Properties

Various Steels Commonly Ordered to Chemical Specifications

A.I.S.I Number	Condition	*Tensile Strength	*Yield Point	Elongation %, 2"
C1018	Hot Rolled	58	32	25
C1018	Cold Drawn	64	54	15
C1020	Hot Rolled	55	30	25
C1020	Cold Drawn	64	54	24
C1040	Hot Rolled	90	56	24
C1040	Cold Drawn	85	71	17
C1040	Heat Treated	108	79	23
C1040	Heat Treated	100	70	26
C1040	Heat Treated	94	68	27
C1040	Heat Treated	96	68	27
C1040	Heat Treated	92	64	28
C1040	Heat Treated	85	60	30
C1042	Hot Rolled	92	58	24
C1042	Cold Drawn	101	86	19
C1045	Hot Rolled	82	45	16
C1045	Cold Drawn	91	77	12
C1117	Hot Rolled	62	34	27
C1117	Cold Drawn	69	58	21
C1137	Hot Rolled	87	54	20
C1137	Cold Drawn	98	82	16
C1137	Heat Treated	122	98	17
C1137	Heat Treated	110	71	21
C1137	Heat Treated	108	69	20
C1137	Heat Treated	108	76	21
C1137	Heat Treated	101	69	24
C1137	Heat Treated	98	69	24
C1141	Hot Rolled	94	51	15
C1141	Cold Drawn	105	88	10
C1144	Cold Drawn	108	90	10
A311 Class B	Cold Drawn	115	100	8
C12L14	Cold Drawn	78	60	10
C1215	Cold Drawn	78	60	10

*Tensile Strength and Yield Point based on 1,000 lbs. PSI

Two page chart, continues on next page

The information shown above represents the average results of a number of tests made at steel mill laboratories. Tensile strength, yield point, elongation, reduction of area and hardness are all affected by the size of the section being heat treated and permissible variations in analysis. This information, therefore, is only a guide and cannot be used as a basis for the acceptance or rejection of material. Physical properties can be guaranteed only on steels ordered heat treated to acceptable commercial limits. All tests were made on 1" diameter round bars.

Average Mechanical Properties

Various Steels Commonly Ordered to Chemical Specifications

A.I.S.I Number	Reduction Area, %	Hardness, Brinell	Hardness, Rockwell	Machinability %
C1018	50	116	B79	52
C1018	40	126	B85	70
C1020	50	137	B76	50
C1020	54	126	B79	58
C1040	49	187	B91	63
C1040	42	170	B93	62
C1040	63	217	B96	---
C1040	65	207	B95	---
C1040	68	197	B93	---
C1040	61	197	B93	---
C1040	64	187	B91	---
C1040	67	170	B87	---
C1042	49	201	B94	63
C1042	40	207	B95	60
C1045	40	163	C16	56
C1045	35	179	C15	55
C1117	47	131	B78	84
C1117	52	137	B87	90
C1137	47	192	B92	70
C1137	35	199	C15	70
C1137	51	248	C24	---
C1137	56	229	C21	---
C1137	52	223	B97	---
C1137	56	223	B97	---
C1137	60	207	B95	---
C1137	61	187	B94	---
C1141	35	212	B95	65
C1141	30	223	C19	70
C1144	30	217	---	83
A311 Class B	25	---	---	83
C 12L14	35	163	B86	180
C 1215	35	163	B86	136

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The information shown above represents the average results of a number of tests made at steel mill laboratories. Tensile strength, yield point, elongation, reduction of area and hardness are all affected by the size of the section being heat treated and permissible variations in analysis. This information, therefore, is only a guide and cannot be used as a basis for the acceptance or rejection of material. Physical properties can be guaranteed only on steels ordered heat treated to acceptable commercial limits. All tests were made on 1" diameter round bars.

Average Mechanical Properties

Various Steels Commonly Ordered to Chemical Specifications

A.I.S.I Number	Condition	*Tensile Strength	*Yield Point	Elongation %, 2"	Reduction Area, %
4130	HR Annealed	84	53	29	54
4130	CD Annealed	97	87	21	51
4130	Heat Treated	161	138	15	54
4130	Heat Treated	145	130	19	62
4130	Heat Treated	128	113	21	68
4140	HR Annealed	89	62	26	57
4140	CD Annealed	102	90	18	50
4140	Heat Treated	153	131	16	45
4140	Heat Treated	140	135	20	62
4140	Heat Treated	133	123	21	65
4150	HR Heat Treat.	156	138	18	51
4340	HR Annealed	101	69	21	45
4340	CD Annealed	114	96	15	44
4340	Heat Treated	175	166	14	46
4340	Heat Treated	165	159	17	54
4340	Heat Treated	139	128	20	60
6150	HR Annealed	91	58	22	53
6150	Heat Treated	155	132	15	44
8620	Hot Rolled	92	64	25	58
8620	Cold Drawn	104	79	21	49

*Tensile Strength and Yield Point based on 1,000 lbs. PSI

Two page chart, continues on next page

The information shown above represents the average results of a number of tests made at steel mill laboratories. Tensile strength, yield point, elongation, reduction of area and hardness are all affected by the size of the section being heat treated and permissible variations in analysis. This information, therefore, is only a guide and cannot be used as a basis for the acceptance or rejection of material. Physical properties can be guaranteed only on steels ordered heat treated to acceptable commercial limits. All tests were made on 1" diameter round bars.



Average Mechanical Properties

Various Steels Commonly Ordered to Chemical Specifications

A.I.S.I Number	Hardness, Brinell	Hardness, Rockwell	Mach. %	Heat Treatment		
				Quenched From	Tempered At	Medium
4130	183	B90	65	---	---	---
4130	201	B96	70	---	---	---
4130	321	C34	---	1575°	900°	Water
4130	293	C31	---	1575°	1000°	Water
4130	262	C27	---	1575°	1100°	Water
4140	187	B91	57	---	---	---
4140	223	C19	66	---	---	---
4140	311	C33	---	1550°	1000°	Oil
4140	285	C30	---	1550°	1100°	Oil
4140	269	C28	---	1550°	1200°	Oil
4150	302	C32	---	1525°	1100°	Oil
4340	207	C15	45	---	---	---
4340	229	C21	55	---	---	---
4340	352	C38	---	1475°	1000°	Oil
4340	331	C36	---	1475°	1100°	Oil
4340	277	C29	---	1475°	1200°	Oil
6150	183	B90	50	---	---	---
6150	302	C32	---	1550°	1000°	Oil
8620	192	B92	58	---	---	---
8620	212	B96	66	---	---	---

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The information shown above represents the average results of a number of tests made at steel mill laboratories. Tensile strength, yield point, elongation, reduction of area and hardness are all affected by the size of the section being heat treated and permissible variations in analysis. This information, therefore, is only a guide and cannot be used as a basis for the acceptance or rejection of material. Physical properties can be guaranteed only on steels ordered heat treated to acceptable commercial limits. All tests were made on 1" diameter round bars.

Combined AISI & SAE Standard Steel List

Chemical Composition Limits (percent)

A.I.S.I #	Carbon	Manganese	Phosphorus	Sulfur	S.A.E. #
C 1005	0.06 (max)	0.35 (max)	0.040 (max)	0.050 (max)	---
C 1006	0.08 (max)	0.25 / 0.40	0.040 (max)	0.050 (max)	1006
C 1008	0.10 (max)	0.25 / 0.50	0.040 (max)	0.050 (max)	1008
C 1010	0.08 / 0.13	0.30 / 0.60	0.040 (max)	0.050 (max)	1010
C 1011	0.08 / 0.13	0.60 / 0.90	0.040 (max)	0.050 (max)	---
C 1012	0.10 / 0.15	0.30 / 0.60	0.040 (max)	0.050 (max)	---
C 1013	0.11 / 0.16	0.50 / 0.80	0.040 (max)	0.050 (max)	---
C 1015	0.13 / 0.18	0.30 / 0.60	0.040 (max)	0.050 (max)	1015
C 1016	0.13 / 0.18	0.60 / 0.90	0.040 (max)	0.050 (max)	1016
C 1017	0.15 / 0.20	0.30 / 0.60	0.040 (max)	0.050 (max)	1017
C 1018	0.15 / 0.20	0.60 / 0.90	0.040 (max)	0.050 (max)	1018
C 1019	0.15 / 0.20	0.70 / 1.00	0.040 (max)	0.050 (max)	1019
C 1020	0.18 / 0.23	0.30 / 0.60	0.040 (max)	0.050 (max)	1020
C 1021	0.18 / 0.23	0.60 / 0.90	0.040 (max)	0.050 (max)	1021
C 1022	0.18 / 0.23	0.70 / 1.00	0.040 (max)	0.050 (max)	1022
C 1023	0.20 / 0.25	0.30 / 0.60	0.040 (max)	0.050 (max)	---
C 1024	0.19 / 0.25	1.35 / 1.65	0.040 (max)	0.050 (max)	1024
C 1025	0.22 / 0.28	0.30 / 0.60	0.040 (max)	0.050 (max)	1025
C 1026	0.22 / 0.28	0.60 / 0.90	0.040 (max)	0.050 (max)	1026
C 1027	0.22 / 0.29	1.20 / 1.50	0.040 (max)	0.050 (max)	1027
C 1029	0.25 / 0.31	0.60 / 0.90	0.040 (max)	0.050 (max)	---
C 1030	0.28 / 0.34	0.60 / 0.90	0.040 (max)	0.050 (max)	1030
C 1031	0.28 / 0.34	0.30 / 0.60	0.040 (max)	0.050 (max)	---
C 1032	0.30 / 0.36	0.60 / 0.90	0.040 (max)	0.050 (max)	---
C 1033	0.30 / 0.36	0.70 / 1.00	0.040 (max)	0.050 (max)	1033
C 1034	0.32 / 0.38	0.50 / 0.80	0.040 (max)	0.050 (max)	---
C 1035	0.32 / 0.38	0.60 / 0.90	0.040 (max)	0.050 (max)	1035
C 1036	0.30 / 0.37	1.20 / 1.50	0.040 (max)	0.050 (max)	1036
C 1037	0.32 / 0.38	0.70 / 1.00	0.040 (max)	0.050 (max)	---
C 1038	0.35 / 0.42	0.60 / 0.90	0.040 (max)	0.050 (max)	1038
C 1039	0.37 / 0.44	0.70 / 1.00	0.040 (max)	0.050 (max)	1039
C 1040	0.37 / 0.44	0.60 / 0.90	0.040 (max)	0.050 (max)	1040
C 1041	0.36 / 0.44	1.35 / 1.65	0.040 (max)	0.050 (max)	1041
C 1042	0.40 / 0.47	0.60 / 0.90	0.040 (max)	0.050 (max)	1042
C 1043	0.40 / 0.47	0.70 / 1.00	0.040 (max)	0.050 (max)	1043
C 1045	0.43 / 0.50	0.60 / 0.90	0.040 (max)	0.050 (max)	1045
C 1046	0.43 / 0.50	0.70 / 1.00	0.040 (max)	0.050 (max)	1046
C 1049	0.46 / 0.53	0.60 / 0.90	0.040 (max)	0.050 (max)	1049
C 1050	0.48 / 0.55	0.60 / 0.90	0.040 (max)	0.050 (max)	1050
C 1051	0.45 / 0.56	0.85 / 1.15	0.040 (max)	0.050 (max)	---
C 1052	0.47 / 0.55	1.20 / 1.50	0.040 (max)	0.050 (max)	1052
C 1053	0.48 / 0.55	0.70 / 1.00	0.040 (max)	0.050 (max)	---
C 1054	0.50 / 0.60	0.50 / 0.80	0.040 (max)	0.050 (max)	---
C 1055	0.50 / 0.60	0.60 / 0.90	0.040 (max)	0.050 (max)	1055
C 1057	0.50 / 0.61	0.85 / 1.15	0.040 (max)	0.050 (max)	---
C 1059	0.55 / 0.65	0.50 / 0.80	0.040 (max)	0.050 (max)	---
C 1060	0.55 / 0.65	0.60 / 0.90	0.040 (max)	0.050 (max)	1060
C 1061	0.54 / 0.65	0.75 / 1.05	0.040 (max)	0.050 (max)	---
C 1062	0.54 / 0.65	0.85 / 1.15	0.040 (max)	0.050 (max)	1062
C 1064	0.60 / 0.70	0.50 / 0.80	0.040 (max)	0.050 (max)	1064
C 1065	0.60 / 0.70	0.60 / 0.90	0.040 (max)	0.050 (max)	1065
C 1066	0.60 / 0.71	0.85 / 1.15	0.040 (max)	0.050 (max)	1066
C 1069	0.65 / 0.75	0.40 / 0.70	0.040 (max)	0.050 (max)	---

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Combined AISI & SAE Standard Steel List

Chemical Composition Limits (percent)

A.I.S.I #	Carbon	Manganese	Phosphorus	Sulfur	S.A.E. #
C 1070	0.65 / 0.75	0.60 / 0.90	0.040 (max)	0.050 (max)	1070
C 1071	0.65 / 0.76	0.75 / 1.05	0.040 (max)	0.050 (max)	---
C 1072	0.65 / 0.76	1.00 / 1.30	0.040 (max)	0.050 (max)	---
C 1074	0.70 / 0.80	0.50 / 0.80	0.040 (max)	0.050 (max)	1074
C 1075	0.70 / 0.80	0.40 / 0.70	0.040 (max)	0.050 (max)	---
C 1078	0.72 / 0.85	0.30 / 0.60	0.040 (max)	0.050 (max)	1078
C 1080	0.75 / 0.88	0.60 / 0.90	0.040 (max)	0.050 (max)	1080
C 1084	0.80 / 0.93	0.60 / 0.90	0.040 (max)	0.050 (max)	---
C 1085	0.80 / 0.93	0.70 / 1.00	0.040 (max)	0.050 (max)	1085
C 1086	0.82 / 0.95	0.30 / 0.50	0.040 (max)	0.050 (max)	1086
C 1090	0.85 / 0.98	0.60 / 0.90	0.040 (max)	0.050 (max)	1090
C 1095	0.90 / 1.03	0.30 / 0.50	0.040 (max)	0.050 (max)	1095
B 1006	0.08 (max)	0.45 (max)	0.07 / 0.12	0.060 (max)	---
B 1010	0.13 (max)	0.30 / 0.60	0.07 / 0.12	0.060 (max)	---
C 1106	0.08 (max)	0.30 / 0.60	0.040 (max)	0.08 / 0.13	---
C 1108	0.08 / 0.13	0.50 / 0.80	0.040 (max)	0.08 / 0.13	---
C 1109	0.08 / 0.13	0.60 / 0.90	0.040 (max)	0.08 / 0.13	1109
C 1110	0.08 / 0.13	0.30 / 0.60	0.040 (max)	0.08 / 0.13	---
C 1111	0.08 / 0.13	0.60 / 0.90	0.040 (max)	0.16 / 0.23	---
C 1113	0.10 / 0.16	1.00 / 1.30	0.040 (max)	0.24 / 0.33	---
C 1114	0.10 / 0.16	1.00 / 1.30	0.040 (max)	0.08 / 0.13	1114
C 1115	0.13 / 0.18	0.60 / 0.90	0.040 (max)	0.08 / 0.13	1115
C 1116	0.14 / 0.20	1.10 / 1.40	0.040 (max)	0.16 / 0.23	1116
C 1117	0.14 / 0.20	1.00 / 1.30	0.040 (max)	0.08 / 0.13	1117
C 1118	0.14 / 0.20	1.30 / 1.60	0.040 (max)	0.08 / 0.13	1118
C 1119	0.14 / 0.20	1.00 / 1.30	0.040 (max)	0.24 / 0.33	1119
C 1120	0.18 / 0.23	0.70 / 1.00	0.040 (max)	0.08 / 0.13	1120
C 1125	0.22 / 0.28	0.60 / 0.90	0.040 (max)	0.08 / 0.13	---
C 1126	0.23 / 0.29	0.70 / 1.00	0.040 (max)	0.08 / 0.13	1126
C 1132	0.27 / 0.34	1.35 / 1.65	0.040 (max)	0.08 / 0.13	1132
C 1137	0.32 / 0.39	1.35 / 1.65	0.040 (max)	0.08 / 0.13	1137
C 1138	0.34 / 0.40	0.70 / 1.00	0.040 (max)	0.08 / 0.13	1138
C 1140	0.37 / 0.44	0.70 / 1.00	0.040 (max)	0.08 / 0.13	1140
C 1141	0.37 / 0.45	1.35 / 1.65	0.040 (max)	0.08 / 0.13	1141
C 1144	0.40 / 0.48	1.35 / 1.65	0.040 (max)	0.24 / 0.33	1144
C 1145	0.42 / 0.49	0.70 / 1.00	0.040 (max)	0.04 / 0.07	1145
C 1146	0.42 / 0.49	0.70 / 1.00	0.07 / 0.12	0.08 / 0.13	1146
C 1148	0.45 / 0.52	0.70 / 1.00	0.040 (max)	0.04 / 0.07	---
C 1151	0.48 / 0.55	0.70 / 1.00	0.040 (max)	0.08 / 0.13	1151
C 1211	0.13 (max)	0.60 / 0.90	0.07 / 0.12	0.08 / 0.15	---
C 1212	0.13 (max)	0.70 / 1.00	0.07 / 0.12	0.16 / 0.23	---
C 1213	0.13 (max)	0.70 / 1.00	0.07 / 0.12	0.24 / 0.33	---
C 12L14	0.15 (max)	0.85 / 1.15	0.04 / 0.09	0.26 / 0.35	12L14
C 1215	0.09 (max)	0.75 / 1.05	0.04 / 0.09	0.26 / 0.35	---
B 1111	0.13 (max)	0.60 / 0.90	0.07 / 0.12	0.08 / 0.15	1111
B 1112	0.13 (max)	0.70 / 1.00	0.07 / 0.12	0.16 / 0.23	1112
B 1113	0.13 (max)	0.70 / 1.00	0.07 / 0.12	0.24 / 0.33	1113

Silicon: When a Silicon range is specified, standard limitations are as follows for Open Hearth Steels:

To C 1015 Exclusive: 0.10 (max)

C 1015 To C 1025 Inclusive: 0.10 (max), 0.10 / 0.20 or 0.15 / 0.30

Over C 1025: 0.10 / 0.20 or 0.15 / 0.30

To C 1113 Exclusive: 0.10 (max)

C 1113 and Over: 0.10 (max), .10/ .20 or .15/.30

C 12L14 - Pb: 0.15 / 0.35 Lead Added

Acid Bessemer Steel is not furnished with specified silicon content.



Combined AISI & SAE Standard Steel List

Open Hearth Alloy and Electric Furnace Alloy Steels

Chemical Composition Limits (percent)

A.I.S.I #	Carbon	Manganese	Phos. (max.)	Sulf. (max.)
1330	0.28 / 0.33	1.60 / 1.90	0.040	0.040
1335	0.33 / 0.38	1.60 / 1.90	0.040	0.040
1340	0.38 / 0.43	1.60 / 1.90	0.040	0.040
1345	0.43 / 0.48	1.60 / 1.90	0.040	0.040
2317	0.15 / 0.20	0.40 / 0.60	0.040	0.040
2515	0.12 / 0.17	0.40 / 0.60	0.040	0.040
E2517	0.15 / 0.20	0.45 / 0.60	0.025	0.025
3120	0.17 / 0.22	0.60 / 0.80	0.040	0.040
3130	0.28 / 0.33	0.60 / 0.80	0.040	0.040
3135	0.33 / 0.38	0.60 / 0.80	0.040	0.040
3140	0.38 / 0.43	0.70 / 0.90	0.040	0.040
E3310	0.08 / 0.13	0.45 / 0.60	0.025	0.025
E3316	0.14 / 0.19	0.45 / 0.60	0.025	0.025
4023	0.20 / 0.25	0.70 / 0.90	0.040	0.040
4024	0.20 / 0.25	0.70 / 0.90	0.040	0.035
4024	---	---	---	0.050
4027	0.25 / 0.30	0.70 / 0.90	0.040	0.040
4028	0.25 / 0.30	0.70 / 0.90	0.040	0.035
4028	---	---	---	0.050
4032	0.30 / 0.35	0.70 / 0.90	0.040	0.040
4037	0.35 / 0.40	0.70 / 0.90	0.040	0.040
4042	0.40 / 0.45	0.70 / 0.90	0.040	0.040
4047	0.45 / 0.50	0.70 / 0.90	0.040	0.040
4053	0.50 / 0.56	0.75 / 1.00	0.040	0.040
4063	0.60 / 0.67	0.75 / 1.00	0.040	0.040
4068	0.63 / 0.70	0.75 / 1.00	0.040	0.040
4118	0.18 / 0.23	0.70 / 0.90	0.040	0.040
4130	0.28 / 0.33	0.40 / 0.60	0.040	0.040
4135	0.33 / 0.38	0.70 / 0.90	0.040	0.040
4137	0.35 / 0.40	0.70 / 0.90	0.040	0.040
4140	0.38 / 0.43	0.75 / 1.00	0.040	0.040
4142	0.40 / 0.45	0.75 / 1.00	0.040	0.040
4145	0.43 / 0.48	0.75 / 1.00	0.040	0.040
4147	0.45 / 0.50	0.75 / 1.00	0.040	0.040
4150	0.48 / 0.53	0.75 / 1.00	0.040	0.040
4320	0.17 / 0.22	0.45 / 0.65	0.040	0.040
4337	0.35 / 0.40	0.60 / 0.80	0.040	0.040
E4337	0.35 / 0.40	0.65 / 0.85	0.025	0.025

Two page chart, continues on next page



Combined AISI & SAE Standard Steel List

Open Hearth Alloy and Electric Furnace Alloy Steels

Chemical Composition Limits (percent)

Silicon	Nickel	Chromium	Molybdenum	S.A.E. #
0.20 / 0.35	---	---	---	1330
0.20 / 0.35	---	---	---	1335
0.20 / 0.35	---	---	---	1340
0.20 / 0.35	---	---	---	1345
0.20 / 0.35	3.25 / 3.75	---	---	2317
0.20 / 0.35	4.75 / 5.25	---	---	2515
0.20 / 0.35	4.75 / 5.25	---	---	2517
0.20 / 0.35	1.10 / 1.40	0.55 / 0.75	---	3120
0.20 / 0.35	1.10 / 1.40	0.55 / 0.75	---	3130
0.20 / 0.35	1.10 / 1.40	0.55 / 0.75	---	3135
0.20 / 0.35	1.10 / 1.40	0.55 / 0.75	---	3140
0.20 / 0.35	3.25 / 3.75	1.40 / 1.75	---	3310
0.20 / 0.35	3.25 / 3.75	1.40 / 1.75	---	3316
0.20 / 0.35	---	---	0.20 / 0.30	4023
0.20 / 0.36	---	---	0.20 / 0.30	4024
---	---	---	---	4024
0.20 / 0.35	---	---	0.20 / 0.30	4027
0.20 / 0.35	---	---	0.20 / 0.30	4028
---	---	---	---	4028
0.20 / 0.35	---	---	0.20 / 0.30	4032
0.20 / 0.35	---	---	0.20 / 0.30	4037
0.20 / 0.35	---	---	0.20 / 0.30	4042
0.20 / 0.35	---	---	0.20 / 0.30	4047
0.20 / 0.35	---	---	0.20 / 0.30	4053
0.20 / 0.35	---	---	0.20 / 0.30	4063
0.20 / 0.35	---	---	0.20 / 0.30	4068
0.20 / 0.35	---	0.40 / 0.60	0.08 / 0.15	4118
0.20 / 0.35	---	0.80 / 1.10	0.15 / 0.25	4130
0.20 / 0.35	---	0.80 / 1.10	0.15 / 0.25	4135
0.20 / 0.35	---	0.80 / 1.10	0.15 / 0.25	4137
0.20 / 0.35	---	0.80 / 1.10	0.15 / 0.25	4140
0.20 / 0.35	---	0.80 / 1.10	0.15 / 0.25	4142
0.20 / 0.35	---	0.80 / 1.10	0.15 / 0.25	4145
0.20 / 0.35	---	0.80 / 1.10	0.15 / 0.25	4147
0.20 / 0.35	---	0.80 / 1.10	0.15 / 0.25	4150
0.20 / 0.35	1.65 / 2.00	0.40 / 0.60	0.20 / 0.30	4320
0.20 / 0.35	1.65 / 2.00	0.70 / 0.90	0.20 / 0.30	4337
0.20 / 0.35	1.65 / 2.00	0.70 / 0.90	0.20 / 0.30	---

Two page chart, continued from previous page

Combined AISI & SAE Standard Steel List

Open Hearth Alloy and Electric Furnace Alloy Steels

Chemical Composition Limits (percent)

A.I.S.I #	Carbon	Manganese	Phos. (max.)	Sulf. (max.)
4340	0.38 / 0.43	0.60 / 0.80	0.040	0.040
E4340	0.38 / 0.43	0.65 / 0.85	0.025	0.025
4608	0.06 / 0.11	0.25 / 0.45	0.040	0.040
4615	0.13 / 0.18	0.45 / 0.65	0.040	0.040
4617	0.15 / 0.20	0.45 / 0.65	0.040	0.040
4620	0.17 / 0.22	0.45 / 0.65	0.040	0.040
X4620	0.18 / 0.23	0.50 / 0.70	0.040	0.040
4621	0.18 / 0.23	0.70 / 0.90	0.040	0.040
4640	0.38 / 0.43	0.60 / 0.80	0.040	0.040
4720	0.17 / 0.22	0.50 / 0.70	0.040	0.040
4812	0.10 / 0.15	0.40 / 0.60	0.040	0.040
4815	0.13 / 0.18	0.40 / 0.60	0.040	0.040
4817	0.15 / 0.20	0.40 / 0.60	0.040	0.040
4820	0.18 / 0.23	0.50 / 0.70	0.040	0.040
5015	0.12 / 0.17	0.30 / 0.50	0.040	0.040
5046	0.43 / 0.50	0.75 / 1.00	0.040	0.040
5117	0.15 / 0.20	0.70 / 0.90	0.040	0.040
5120	0.17 / 0.22	0.70 / 0.90	0.040	0.040
5130	0.28 / 0.33	0.70 / 0.90	0.040	0.040
5132	0.30 / 0.35	0.60 / 0.80	0.040	0.040
5135	0.33 / 0.38	0.60 / 0.80	0.040	0.040
5140	0.38 / 0.43	0.70 / 0.90	0.040	0.040
5145	0.43 / 0.48	0.70 / 0.90	0.040	0.040
5147	0.45 / 0.52	0.70 / 0.95	0.040	0.040
5150	0.48 / 0.53	0.70 / 0.90	0.040	0.040
5152	0.48 / 0.55	0.70 / 0.90	0.040	0.040
5155	0.50 / 0.60	0.70 / 0.90	0.040	0.040
5160	0.55 / 0.65	0.75 / 1.00	0.040	0.040
E50100	0.95 / 1.10	0.25 / 0.45	0.025	0.025
E51100	0.95 / 1.10	0.25 / 0.45	0.025	0.025
E52100	0.95 / 1.10	0.25 / 0.45	0.025	0.025
6117*	0.15 / 0.20	0.70 / 0.90	0.040	0.040
6120*	0.17 / 0.22	0.70 / 0.90	0.040	0.040
6145**	0.43 / 0.48	0.70 / 0.90	0.040	0.040
6150**	0.48 / 0.53	0.70 / 0.90	0.040	0.040
8615	0.13 / 0.18	0.70 / 0.90	0.040	0.040
8617	0.15 / 0.20	0.70 / 0.90	0.040	0.040

* Vanadium 0.10 minimum

** Vanadium 0.15 minimum

Two page chart, continues on next page



Combined AISI & SAE Standard Steel List

Open Hearth Alloy and Electric Furnace Alloy Steels

Chemical Composition Limits (percent)

Silicon	Nickel	Chromium	Molybdenum	S.A.E. #
0.20 / 0.35	1.65 / 2.00	0.70 / 0.90	0.20 / 0.30	4340
0.20 / 0.35	1.65 / 2.00	0.70 / 0.90	0.20 / 0.30	E4340
0.25 (max)	1.40 / 1.75	---	0.15 / 0.25	4608
0.20 / 0.35	1.65 / 2.00	---	0.20 / 0.30	4615
0.20 / 0.35	1.65 / 2.00	---	0.20 / 0.30	4617
0.20 / 0.35	1.65 / 2.00	---	0.20 / 0.30	4620
0.20 / 0.35	1.65 / 2.00	---	0.20 / 0.30	X4620
0.20 / 0.35	1.65 / 2.00	---	0.20 / 0.30	4621
0.20 / 0.35	1.65 / 2.00	---	0.20 / 0.30	4640
0.20 / 0.35	0.90 / 1.20	0.35 / 0.55	0.15 / 0.25	4720
0.20 / 0.35	3.25 / 3.75	---	0.20 / 0.30	4812
0.20 / 0.35	3.25 / 3.75	---	0.20 / 0.30	4815
0.20 / 0.35	3.25 / 3.75	---	0.20 / 0.30	4817
0.20 / 0.35	3.25 / 3.75	---	0.20 / 0.30	4820
0.20 / 0.35	---	0.30 / 0.50	---	5015
0.20 / 0.35	---	0.20 / 0.35	---	5046
0.20 / 0.35	---	0.70 / 0.90	---	5117
0.20 / 0.35	---	0.70 / 0.90	---	5120
0.20 / 0.35	---	0.80 / 1.10	---	5130
0.20 / 0.35	---	0.75 / 1.00	---	5132
0.20 / 0.35	---	0.80 / 1.05	---	5135
0.20 / 0.35	---	0.70 / 0.90	---	5140
0.20 / 0.35	---	0.70 / 0.90	---	5145
0.20 / 0.35	---	0.85 / 1.15	---	5147
0.20 / 0.35	---	0.70 / 0.90	---	5150
0.20 / 0.35	---	0.90 / 1.20	---	5152
0.20 / 0.35	---	0.70 / 0.90	---	5155
0.20 / 0.35	---	0.70 / 0.90	---	5160
0.20 / 0.35	---	0.40 / 0.60	---	50100
0.20 / 0.35	---	0.90 / 1.15	---	51100
0.20 / 0.35	---	1.30 / 1.60	---	52100
0.20 / 0.35	---	0.70 / 0.90	---	6117
0.20 / 0.35	---	0.70 / 0.90	---	6120
0.20 / 0.35	---	0.80 / 1.10	---	6145
0.20 / 0.35	---	0.80 / 1.10	---	6150
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8615
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8617

Two page chart, continued from previous page

Combined AISI & SAE Standard Steel List

Open Hearth Alloy and Electric Furnace Alloy Steels

Chemical Composition Limits (percent)

A.I.S.I #	Carbon	Manganese	Phos. (max.)	Sulf. (max.)
8620	0.18 / 0.23	0.70 / 0.90	0.040	0.040
8622	0.20 / 0.25	0.70 / 0.90	0.040	0.040
8625	0.23 / 0.28	0.70 / 0.90	0.040	0.040
8627	0.25 / 0.30	0.70 / 0.90	0.040	0.040
8630	0.28 / 0.33	0.70 / 0.90	0.040	0.040
8635	0.33 / 0.38	0.75 / 1.00	0.040	0.040
8637	0.35 / 0.40	0.75 / 1.00	0.040	0.040
8640	0.38 / 0.43	0.75 / 1.00	0.040	0.040
8641	0.38 / 0.43	0.75 / 1.00	0.040	0.040
8642	0.40 / 0.45	0.75 / 1.00	0.040	0.040
8645	0.43 / 0.48	0.75 / 1.00	0.040	0.040
8650	0.48 / 0.53	0.75 / 1.00	0.040	0.040
8653	0.50 / 0.56	0.75 / 1.00	0.040	0.040
8655	0.50 / 0.60	0.75 / 1.00	0.040	0.040
8660	0.55 / 0.65	0.75 / 1.00	0.040	0.040
8715	0.13 / 0.18	0.70 / 0.90	0.040	0.040
8717	0.15 / 0.20	0.70 / 0.90	0.040	0.040
8720	0.18 / 0.23	0.70 / 0.90	0.040	0.040
8735	0.33 / 0.38	0.75 / 1.00	0.040	0.040
8740	0.38 / 0.43	0.75 / 1.00	0.040	0.040
8742	0.40 / 0.45	0.75 / 1.00	0.040	0.040
8750	0.48 / 0.53	0.75 / 1.00	0.040	0.040
9255	0.50 / 0.60	0.70 / 0.95	0.040	0.040
9260	0.55 / 0.65	0.70 / 1.00	0.040	0.040
9261	0.55 / 0.65	0.75 / 1.00	0.040	0.040
9262	0.55 / 0.65	0.75 / 1.00	0.040	0.040
E9310	0.08 / 0.13	0.45 / 0.65	0.025	0.025
E9314	0.11 / 0.17	0.40 / 0.70	0.025	0.025
9840	0.38 / 0.43	0.70 / 0.90	0.040	0.040
9845	0.43 / 0.48	0.70 / 0.90	0.040	0.040
9850	0.48 / 0.53	0.70 / 0.90	0.040	0.040

Note: Small quantities of certain elements may be found in alloy steel which are not specified or required. These elements are to be considered as incidental and acceptable to the following maximum amounts: copper, 0.35 per cent; nickel, 0.025 per cent; chromium, 0.20 per cent; molybdenum, 0.06 per cent.

Two page chart, continues on next page



Combined AISI & SAE Standard Steel List

Open Hearth Alloy and Electric Furnace Alloy Steels

Chemical Composition Limits (percent)

Silicon	Nickel	Chromium	Molybdenum	S.A.E. #
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8620
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8622
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8625
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8627
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8630
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8635
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8637
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8640
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8641
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8642
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8645
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8650
0.20 / 0.35	0.40 / 0.70	0.50 / 0.80	0.15 / 0.25	8653
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8655
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.15 / 0.25	8660
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.20 / 0.30	8715
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.20 / 0.30	8717
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.20 / 0.30	8720
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.20 / 0.30	8735
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.20 / 0.30	8740
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.20 / 0.30	8742
0.20 / 0.35	0.40 / 0.70	0.40 / 0.60	0.20 / 0.30	8750
1.80 / 2.20	---	---	---	9255
1.80 / 2.20	---	---	---	9260
1.80 / 2.20	---	0.10 / 0.25	---	9261
1.80 / 2.20	---	0.25 / 0.40	---	9262
0.20 / 0.35	3.00 / 3.50	1.00 / 1.40	0.08 / 0.15	9310
0.20 / 0.35	3.00 / 3.50	1.00 / 1.40	0.08 / 0.15	9314
0.20 / 0.35	0.85 / 1.15	0.70 / 0.90	0.20 / 0.30	9840
0.20 / 0.35	0.85 / 1.15	0.70 / 0.90	0.20 / 0.30	9845
0.20 / 0.35	0.85 / 1.15	0.70 / 0.90	0.20 / 0.30	9850

Note: Small quantities of certain elements may be found in alloy steel which are not specified or required. These elements are to be considered as incidental and acceptable to the following maximum amounts: copper, 0.35 per cent; nickel, 0.025 per cent; chromium, 0.20 per cent; molybdenum, 0.06 per cent.

Two page chart, continued from previous page

Metric System of Measurements

The principal units are the meter for length, the liter for capacity, and the gram for weight. The following prefixes are used for sub-divisions and multiples:

milli = 1/1000; centi = 1/100; deci = 1/10; deca = 10; hecto = 100; kilo = 1000.

Measures of Length

10 millimeters (mm.)	=	1 centimeter (cm.)
10 centimeters	=	1 decimeter (dm.)
10 decimeters	=	1 meter (m.)
1000 meters	=	1 kilometer (km.)

Square Measure

100 sq. millimeters (mm. ²)	=	1 sq. centimeter (cm. ²)
100 sq. centimeters	=	1 sq. decimeter (dm. ²)
100 sq. decimeters	=	1 sq. meter (m. ²)

Cubic Measure

1000 cu. millimeters (mm. ³)	=	1 cu. centimeter (cm. ³)
1000 cu. centimeters	=	1 cu. decimeter (dm. ³)
1000 cu. decimeters	=	1 cu. meter (m. ³)

Measure of Weight

10 milligrams (mg.)	=	1 centigram (cg.)	10 decigrams	=	1 hectogram (Hg.)
10 centigrams	=	1 decigram (dg.)	10 hectograms	=	1 Kilogram (Kg.)
10 decigrams	=	1 gram (g.)	1000 kilograms	=	1 (metric) ton (T.)s
10 grams	=	1 decagram (Dg.)			

Dry and Liquid Measure

10 milliliters (ml.)	=	1 centiliter (cl.)
10 centiliters	=	1 deciliter (dl.)
10 deciliters	=	1 liter (l.)
100 liters	=	1 hectoliter (Hl.)
1 liter	=	1 cubic decimeter = the volume of 1 kilogram water at a temperature of 39.2 degrees F.

Length Conversion Constants for Metric and U.S. Units

Millimeters	x	.03937	=	inches	Inches	x	25.4001	=	millimeters
Meters	x	39.370	=	inches	Inches	x	.0254	=	meters
Meters	x	3.2808	=	feet	Feet	x	.30480	=	meters
Meters	x	1.09361	=	yards	Yards	x	.91440	=	meters
Kilometers	x	3,280.8	=	feet	Feet	x	.0003048	=	kilometers
Kilometers	x	.62137	=	Statute Miles	Statute Miles	x	1.60935	=	kilometers
Kilometers	x	.53959	=	Nautical Miles	Nautical Miles	x	1.85325	=	kilometers

Continued on next page

Metric System of Measurements

The principal units are the meter for length, the liter for capacity, and the gram for weight. The following prefixes are used for sub-divisions and multiples:

milli = 1/100; centi = 1/100; deci = 1/10; deca = 10; hecto = 100; kilo = 1000.

Weight Conversion Constants for Metric and U.S. Units

Grams	x	981	= dynes	Dynes	x	0.0010193	= grams
Grams	x	15.432	= grams	Grams	x	0.0648	= grams
Grams	x	.03527	= ounces (Avd.)	Ounces (Avd.)	x	28.35	= grams
Grams	x	.033818	= fluid ounces (water)	Fluid Oz. (Water)	x	29.57	= grams
Kilograms	x	35.27	= ounces (Avd.)	Ounces (Avd.)	x	0.02835	= kilograms
Kilograms	x	2.20462	= pounds (Avd.)	Pounds (Avd.)	x	0.45359	= kilograms
Metric Tons (1000 Kg)	x	1.10231	= Net Ton (2000 lbs.)	Net Ton (2000 lbs)	x	0.90719	= Metric Tons (1000 Kg)
Metric Tons (1000 Kg)	x	0.98421	= Gross Ton (2240 lbs.)	Gross Ton (2240 lbs)	x	1.01605	= Metric Tons (1000 Kg)

Area Conversion Constants for Metric and U.S. Units

Square Millimeters	x	.00155	= square inches	Square Inches	x	645.163	= square millimeters
Square Centimeters	x	.155	= square inches	Square Inches	x	6.45163	= square centimeters
Square Meters	x	10.76387	= square feet	Square Feet	x	0.0929	= square meters
Square Meters	x	1.19599	= square yards	Square Yards	x	0.83613	= square meters
Hectares	x	2.47104	= acres	Acres	x	0.40469	= hectares
Square Kilometers	x	247.104	= acres	Acres	x	0.0040469	= square kilometers
Square Kilometers	x	.3861	= square miles	Square Miles	x	2.5899	= square kilometers

Volume Conversion Constants for Metric and U.S. Units

Cubic Centimeters	x	.033818	= fluid ounces	Fluid Ounces	x	29.57	= cubic centimeters
Cubic Centimeters	x	.061023	= cubic inches	Cubic Inches	x	16.387	= cubic centimeters
Cubic Centimeters	x	.271	= fluid drams	Fluid Drams	x	3.69	= cubic centimeters
Liters	x	61.023	= cubic inches	Cubic Inches	x	.016387	= liters
Liters	x	1.05668	= quarts	Quarts	x	.04636	= liters
Liters	x	.26417	= gallons	Gallons	x	3.78543	= liters
Liters	x	.035317	= cubic feet	Cubic Feet	x	28.316	= liters
Hectoliters	x	26.417	= gallons	Gallons	x	.0378543	= hectoliters
Hectoliters	x	3.5317	= cubic feet	Cubic Feet	x	.28316	= hectoliters
Hectoliters	x	2.83794	= bushel (2150.42 cu.in.)	Bushels (2150.42 cu. in.)	x	.352379	= hectoliters
Hectoliters	x	.1308	= cubic yards	Cubic Yards	x	7.645	= hectoliters
Cubic Meters	x	264.17	= gallons	Gallons	x	.00378543	= cubic meters
Cubic Meters	x	35.317	= cubic feet	Cubic Feet	x	.028316	= cubic meters
Cubic Meters	x	1.308	= cubic yards	Cubic Yards	x	.7645	= cubic meters

Geometric Formulas

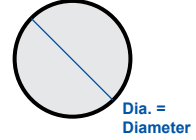
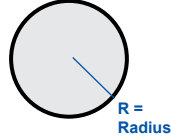
Circle

Area = π (3.1416) \times r^2 (Radius squared) = Area

Circumference = Diameter \times 3.1416

Diameter = Circumference \times .3183

Doubling diameter increases area four times;
tripling diameter increases area nine times, etc.

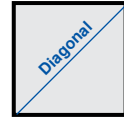


Square

Area = Length of one side² (squared)

Diagonal = Length of side \times 1.4142

Side Length = Diagonal \times 0.7071

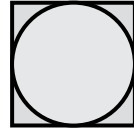


Square inscribed inside Circle

Side of Square = Diameter of Circle \times 0.7071 or Circumference of Circle \times 0.22251

Diameter of Circle = Length of one side of the Square \times 1.4142

Circumference of Circle = Length of one side of the Square \times 4.4429



Square and Circle with equal area

Side of Square = Diameter of Circle \times 0.8862

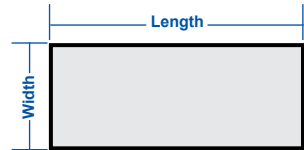
Diameter of Circle = Length of one side of the Square \times 1.128

Circumference of Circle = Length of one side of the Square \times 3.545

Rectangle

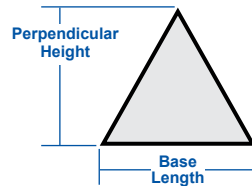
Area = Length \times Width

Diagonal = Square root of the sum of
Width² (squared) + Length² (squared).



Triangle

Area = Base Length \times 1/2 of the perpendicular height.



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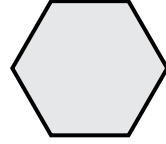
Geometric Formulas

Hexagon (Equal sides and angles)

Area = Distance across flats² (squared) x 0.886 or Side Length² (squared) x 2.598

Side = Half of diagonal or Distance across flats x 0.577

Diagonal = Distance across flats x 1.155 or Length of Side x 2



Octagon (Equal sides and angles)

Area = Distance across flats² (squared) x 0.828 or Side Length² (squared) x 4.828

Side = Diagonal x 0.383 or Distance across Flats x 0.414

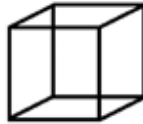
Diagonal = Distance across flats x 1.082 or Length of Side x 2.613

Cube

Area of Surface = Side² (squared) x 6

Volume = Side length³ (cubed)

Diagonal = Side length x 1.732



Sphere

Area of Surface = Dia.² (squared) x π (3.1416)

Volume = Diameter³ (cubed) x 0.5236



Cylinder

Area of Curved Surface = Diameter x Length x π (3.1416)

Volume = Diameter² (squared) x Length x 0.7854



Cone

Area of Curved Surface = Diameter of Base x Slant Height x 1.5708

Volume = Diameter of Base² (squared) x Perpendicular Height x 0.2618
or Area of Base x 1/3 Perpendicular Height



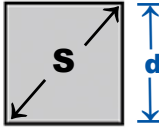
Pyramid

Lateral Surface Area (not including base) = Perimeter of Base x Half of Slant Height

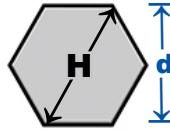
Volume = Area of Base x 1/3 Perpendicular Height

Distance Across Corners

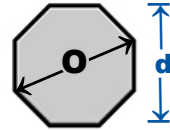
Squares (S), Hexagons (H), and Octagons (O)



$$S = 1.414d$$



$$H = 1.155d$$



$$O = 1.082d$$

"d" Size (inches)	Distance across corners (inches)		
	S Square	H Hexagon	O Octagon
1/8	.177	.144	.135
3/16	.265	.217	.203
1/4	.354	.289	.271
5/16	.442	.361	.338
3/8	.530	.433	.406
7/16	.619	.505	.474
1/2	.707	.577	.541
9/16	.795	.650	.609
5/8	.884	.722	.677
11/16	.972	.794	.744
3/4	1.061	.866	.812
13/16	1.149	.938	.879
7/8	1.237	1.010	.947
15/16	1.326	1.083	1.015
1	1.414	1.155	1.082
1-1/16	1.503	1.227	1.150
1-1/8	1.591	1.299	1.218
1-3/16	1.679	1.371	1.285
1-1/4	1.768	1.443	1.353
1-5/16	1.856	1.516	1.421
1-3/8	1.945	1.588	1.488
1-7/16	2.033	1.660	1.556
1-1/2	2.121	1.732	1.624
1-9/16	2.210	1.804	1.691
1-5/8	2.298	1.876	1.759
1-11/16	2.386	1.949	1.827
1-3/4	2.475	2.021	1.894
1-13/16	2.563	2.093	1.962
1-7/8	2.652	2.165	2.030
1-15/16	2.740	2.237	2.097
2	2.828	2.309	2.165
2-1/16	2.917	2.382	2.232

"d" Size (inches)	Distance across corners (inches)		
	S Square	H Hexagon	O Octagon
2-1/8	3.005	2.454	2.300
2-3/16	3.094	2.526	2.368
2-1/4	3.182	2.598	2.435
2-5/16	3.270	2.670	2.503
2-3/8	3.359	2.742	2.571
2-7/16	3.447	2.815	2.638
2-1/2	3.536	2.887	2.706
2-9/16	3.624	2.959	2.774
2-5/8	3.712	3.031	2.841
2-11/16	3.801	3.103	2.909
2-3/4	3.889	3.175	2.977
2-13/16	3.977	3.248	3.044
2-7/8	4.066	3.320	3.112
2-15/16	4.154	3.392	3.180
3	4.243	3.464	3.247
3-1/8	4.419	3.608	3.383
3-1/4	4.596	3.753	3.518
3-3/8	4.773	3.897	3.653
3-1/2	4.950	4.041	3.788
3-5/8	5.126	4.186	3.924
3-3/4	5.303	4.330	4.059
3-7/8	5.480	4.474	4.194
4	5.657	4.619	4.330
4-1/4	6.010	4.907	4.600
4-1/2	6.364	5.196	4.871
4-3/4	6.717	5.485	5.141
5	7.071	5.774	5.412
5-1/4	7.425	6.062	5.683
5-1/2	7.778	6.351	5.953
5-3/4	8.132	6.640	6.224
6	8.485	6.928	6.494



Weight Formulas

Steel bar weights are based on .2836 lb. per cubic inch. Aluminum weights are based on .098 lb. per cubic inch, which applies to 1100 alloy.

Rounds

Steel:

$$\text{Lb. per lineal foot} = 2.6729 \times D^2$$

$$\text{Lb. per lineal inch} = .22274 \times D^2$$

Aluminum:

$$\text{Lb. per lineal foot} = .924 \times D^2$$

D = Diameter in inches



Squares

Steel:

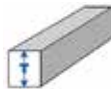
$$\text{Lb. per lineal foot} = 3.4032 \times T^2$$

$$\text{Lb. per lineal inch} = .2836 \times T^2$$

Aluminum:

$$\text{Lb. per lineal foot} = 1.18 \times T^2$$

T = Thickness in inches



Hexagons

Steel:

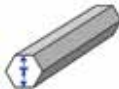
$$\text{Lb. per lineal foot} = 2.9473 \times T^2$$

$$\text{Lb. per lineal inch} = .2456 \times T^2$$

Aluminum:

$$\text{Lb. per lineal foot} = 1.02 \times T^2$$

T = Size in inches



Octagons

Steel:

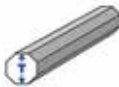
$$\text{Lb. per lineal foot} = 2.8193 \times T^2$$

$$\text{Lb. per lineal inch} = .23494 \times T^2$$

Aluminum:

$$\text{Lb. per lineal foot} = .974 \times T^2$$

T = Size in inches



Flats

Steel:

$$\text{Lb. per lineal foot} = 3.4032 \times T \times W$$

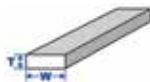
$$\text{Lb. per lineal inch} = .2836 \times T \times W$$

Aluminum:

$$\text{Lb. per lineal foot} = 1.18 \times T \times W$$

T = Thickness in inches

W = Width in inches



Tubing

Steel: (round)

$$\text{Lb. per lineal foot} = 10.68 \times (OD - W) \times W$$

$$\text{Lb. per lineal inch} = .89 \times (OD - W) \times W$$

Aluminum:

$$\text{Lb. per lineal foot} = 3.70 \times (OD - W) \times W$$

OD = Outside Diameter to 3 decimal places

W = Wall Thickness to 3 decimal places

Steel (square and rectangular):

$$\text{Lb per lineal foot} =$$

$$13.6 \times \left(\frac{\text{sum of 4 sides}}{4} - W \right) \times W$$



Circles

Steel:

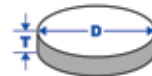
$$\text{Wt. of Circle in Lbs.} = .22274 \times T \times D^2$$

Aluminum:

$$\text{Wt. of Circle in Lbs.} = .077 \times T \times D^2$$

D = Diameter in inches

T = Thickness in inches



Rings

Steel:

$$\text{Wt. of Ring in Lbs.} =$$

$$.22274 \times T \times (OD^2 - ID^2)$$

Aluminum:

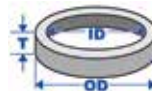
$$\text{Wt. of Ring in Lbs.} =$$

$$.077 \times T \times (OD^2 - ID^2)$$

OD = Outside Diameter in inches

ID = Inside Diameter in inches

T = Thickness in inches



Cut to Length

Approximate Stock Required to Produce 1000 Pieces

Finished Piece Length plus Cut-Off (inches)	Number of Feet per 1000 Cut Pieces
3/32	7.8
7/64	9.1
1/8	10.4
9/64	11.7
5/32	13.0
11/64	14.3
3/16	15.6
13/64	16.9
7/32	18.2
15/64	19.5
1/4	20.8
17/64	22.1
9/32	23.4
19/64	24.7
5/16	26.0
21/64	27.3
11/32	28.6
23/64	29.9
3/8	31.3
25/64	32.6
13/32	33.9
27/64	35.2
7/16	36.5
29/64	37.8
15/32	39.1
31/64	40.4
1/2	41.7
33/64	43.0
17/32	44.3
35/64	45.6
9/16	46.9
37/64	48.2
19/32	49.5
39/64	50.8
5/8	52.1
41/64	53.4
21/32	54.7
43/64	56.0
11/16	57.3
45/64	58.6

Finished Piece Length plus Cut-Off (inches)	Number of Feet per 1000 Cut Pieces
23/32	59.9
47/64	61.2
3/4	62.5
49/64	63.8
25/32	65.1
51/64	66.4
13/16	67.7
53/64	69.0
27/32	70.3
55/64	71.6
7/8	72.9
57/64	74.2
29/32	75.5
59/64	76.8
15/16	78.1
61/64	79.4
31/32	80.7
63/64	82.0
1	83.3
1-1/64	84.6
1-1/32	85.9
1-3/64	87.2
1-1/16	88.5
1-5/64	89.8
1-3/32	91.1
1-7/64	92.4
1-1/8	93.8
1-9/64	95.1
1-5/32	96.4
1-11/64	97.7
1-3/16	99.0
1-13/64	100.3
1-7/32	101.6
1-15/64	102.9
1-1/4	104.2
1-17/64	105.5
1-9/32	106.8
1-19/64	108.1
1-5/16	109.4
1-21/64	110.7

Finished Piece Length plus Cut-Off (inches)	Number of Feet per 1000 Cut Pieces
1-11/32	112.0
1-23/64	113.3
1-3/8	114.6
1-25/64	115.9
1-13/32	117.2
1-27/64	118.5
1-7/16	119.8
1-29/64	121.1
1-15/32	122.4
1-31/64	123.7
1-1/2	125.0
1-33/64	126.3
1-17/32	127.6
1-35/64	128.9
1-9/16	130.2
1-37/64	131.5
1-19/32	132.8
1-39/64	134.1
1-5/8	135.4
1-41/64	136.7
1-21/32	138.0
1-43/64	139.3
1-11/16	140.6
1-45/64	141.9
1-23/32	143.2
1-47/64	144.5
1-3/4	145.8
1-49/64	147.1
1-25/32	148.4
1-51/64	149.7
1-13/16	151.0
1-53/64	152.3
1-27/32	153.6
1-55/64	154.9
1-7/8	156.3
1-57/64	157.6
1-29/32	158.9
1-59/64	160.2
1-15/16	161.5
1-61/64	162.8

Based on 12 foot bars, the losses in bar ends are:

- 1" bar end - 0.70%
- 2" bar end - 1.38%
- 3" bar end - 2.08%
- 4" bar end - 2.80%



Cut to Length

Approximate Stock Required to Produce 1000 Pieces

Finished Piece Length plus Cut-Off (inches)	Number of Feet per 1000 Cut Pieces
1-31/32	164.1
1-63/64	165.4
2	166.7
2-1/64	168.0
2-1/32	169.3
2-3/64	170.6
2-1/16	171.9
2-5/64	173.2
2-3/32	174.5
2-7/64	175.8
2-1/8	177.1
2-9/64	178.4
2-5/32	179.7
2-11/64	181.0
2-3/16	182.3
2-13/64	183.6
2-7/32	184.9
2-15/64	186.2
2-1/4	187.5
2-17/64	188.8
2-9/32	190.1
2-19/64	191.4
2-5/16	192.7
2-21/64	194.0
2-11/32	195.3
2-23/64	196.6
2-3/8	197.9
2-25/64	199.2
2-13/32	200.5
2-27/64	201.8
2-7/16	203.1
2-29/64	204.4
2-15/32	205.7
2-31/64	207.0
2-1/2	208.3
2-33/64	209.6
2-17/32	210.9
2-35/64	212.2
2-9/16	213.5
2-37/64	214.8

Finished Piece Length plus Cut-Off (inches)	Number of Feet per 1000 Cut Pieces
2-19/32	216.1
2-39/64	217.4
2-5/8	218.8
2-41/64	220.1
2-21/32	221.4
2-43/64	222.7
2-11/16	224.0
2-45/64	225.3
2-23/32	226.6
2-47/64	227.9
2-3/4	229.2
2-49/64	230.5
2-25/32	231.8
2-51/64	233.1
2-13/16	234.4
2-53/64	235.7
2-27/32	237.0
2-55/64	238.3
2-7/8	239.6
2-57/64	240.9
2-29/32	242.2
2-59/64	243.5
2-15/16	244.8
2-61/64	246.1
2-31/32	247.4
2-63/64	248.7
3	250.0
3-1/64	251.3
3-1/32	252.6
3-3/64	253.9
3-1/16	255.2
3-5/64	256.5
3-3/32	257.8
3-7/64	259.1
3-1/8	260.4
3-9/64	261.7
3-5/32	263.0
3-11/64	264.3
3-3/16	265.6
3-13/64	266.9

Finished Piece Length plus Cut-Off (inches)	Number of Feet per 1000 Cut Pieces
3-7/32	268.2
3-15/64	269.5
3-1/4	270.8
3-17/64	272.1
3-9/32	273.4
3-19/64	274.7
3-5/16	276.0
3-21/64	277.3
3-11/32	278.6
3-23/64	279.9
3-3/8	281.3
3-25/64	282.6
3-13/32	283.9
3-27/64	285.2
3-7/16	286.5
3-29/64	287.8
3-15/32	289.1
3-31/64	290.4
3-1/2	291.7
3-33/64	293.0
3-17/32	294.3
3-35/64	295.6
3-9/16	296.9
3-37/64	298.2
3-19/32	299.5
3-39/64	300.8
3-5/8	302.1
3-41/64	303.4
3-21/32	304.7
3-43/64	306.0
3-11/16	307.3
3-45/64	308.6
3-23/32	309.9
3-47/64	311.2
3-3/4	312.5
3-25/32	314.1
3-13/16	316.7
3-7/8	322.9
3-15/16	328.1
4	333.3

Based on 12 foot bars, the losses in bar ends are:

- 1" bar end - 0.70%
- 2" bar end - 1.38%
- 3" bar end - 2.08%
- 4" bar end - 2.80%

U.S. Gallons In Round Tanks

For One Foot In Depth

Diameter of Tank	# of U.S. Gallons	Cubic Ft. & Area in Sqft.
1 ft.	5.87	.785
1 ft. 1 in.	6.89	.922
1 ft. 2 in.	8.00	1.069
1 ft. 3 in.	9.18	1.227
1 ft. 4 in.	10.44	1.396
1 ft. 5 in.	11.79	1.576
1 ft. 6 in.	13.22	1.767
1 ft. 7 in.	14.73	1.969
1 ft. 8 in.	16.32	2.182
1 ft. 9 in.	17.99	2.405
1 ft. 10 in.	19.75	2.640
1 ft. 11 in.	21.58	2.885
2 ft.	23.50	3.142
2 ft. 1 in.	25.50	3.409
2 ft. 2 in.	27.58	3.687
2 ft. 3 in.	29.74	3.976
2 ft. 4 in.	31.99	4.276
2 ft. 5 in.	34.31	4.587
2 ft. 6 in.	36.72	4.909
2 ft. 7 in.	39.21	5.241
2 ft. 8 in.	41.78	5.585
2 ft. 9 in.	44.43	5.940
2 ft. 10 in.	47.16	6.305
2 ft. 11 in.	49.98	6.681
3 ft.	52.88	7.069
3 ft. 1 in.	55.86	7.467
3 ft. 2 in.	58.92	7.867
3 ft. 3 in.	62.06	8.296
3 ft. 4 in.	65.28	8.727
3 ft. 5 in.	68.58	9.168
3 ft. 6 in.	71.97	9.621
3 ft. 7 in.	75.44	10.085
3 ft. 8 in.	78.99	10.559
3 ft. 9 in.	82.62	11.045
3 ft. 10 in.	86.33	11.541
3 ft. 11 in.	90.13	12.048
4 ft.	94.00	12.566
4 ft. 1 in.	97.96	13.095
4 ft. 2 in.	102.00	13.635
4 ft. 3 in.	106.12	14.186
4 ft. 4 in.	110.32	14.748
4 ft. 5 in.	114.61	15.321
4 ft. 6 in.	118.97	15.900
4 ft. 7 in.	123.42	16.500
4 ft. 8 in.	127.95	17.10
4 ft. 9 in.	132.56	17.72
4 ft. 10 in.	137.25	18.35
4 ft. 11 in.	142.02	18.99

Diameter of Tank	# of U.S. Gallons	Cubic Ft. & Area in Sqft.
5 ft.	146.88	19.63
5 ft. 1 in.	151.82	20.29
5 ft. 2 in.	156.83	20.97
5 ft. 3 in.	161.93	21.65
5 ft. 4 in.	167.12	22.34
5 ft. 5 in.	172.38	23.04
5 ft. 6 in.	177.72	23.76
5 ft. 7 in.	183.15	24.48
5 ft. 8 in.	188.66	25.22
5 ft. 9 in.	194.25	25.97
5 ft. 10 in.	199.92	26.73
5 ft. 11 in.	205.67	27.49
6 ft.	211.51	28.27
6 ft. 3 in.	229.50	30.68
6 ft. 6 in.	248.23	33.18
6 ft. 9 in.	267.69	35.78
7 ft.	287.88	38.48
7 ft. 3 in.	308.81	41.28
7 ft. 6 in.	330.48	44.18
7 ft. 9 in.	352.88	47.17
8 ft.	376.01	50.27
8 ft. 3 in.	399.88	53.46
8 ft. 6 in.	424.48	56.75
8 ft. 9 in.	449.82	60.13
9 ft.	475.89	63.62
9 ft. 3 in.	502.70	67.20
9 ft. 6 in.	530.24	70.88
9 ft. 9 in.	558.51	74.66
10 ft.	587.52	78.54
10 ft. 3 in.	617.26	82.52
10 ft. 6 in.	647.74	86.59
10 ft. 9 in.	678.95	90.76
11 ft.	710.90	95.03
11 ft. 3 in.	743.58	99.40
11 ft. 6 in.	776.99	103.87
11 ft. 9 in.	811.14	108.43
12 ft.	846.03	113.10
12 ft. 3 in.	881.65	117.86
12 ft. 6 in.	918.00	122.72
12 ft. 9 in.	955.09	127.68
13 ft.	992.91	132.73
13 ft. 3 in.	1031.50	137.89
13 ft. 6 in.	1070.80	143.14
13 ft. 9 in.	1110.80	148.49
14 ft.	1151.50	153.94
14 ft. 3 in.	1193.00	159.48
14 ft. 6 in.	1235.30	165.13
14 ft. 9 in.	1278.20	170.87

31½ Gallons = 1 Barrel

To find the capacity of tanks greater than the largest given in the table, look in the table for a tank of one-half of the given size and multiply its capacity by 4, or one of one-third its size and multiply its capacity by 9, etc.



U.S. Gallons In Round Tanks

For One Foot In Depth

Diameter of Tank	# of U.S. Gallons	Cubic Ft. & Area in Sqft.
15 ft.	1321.90	176.71
15 ft. 3 in.	1366.40	182.65
15 ft. 6 in.	1411.50	188.69
15 ft. 9 in.	1457.40	194.83
16 ft.	1504.10	201.06
16 ft. 3 in.	1551.40	207.39
16 ft. 6 in.	1599.50	213.82
16 ft. 9 in.	1648.40	220.35
17 ft.	1697.90	226.98
17 ft. 3 in.	1748.20	233.71
17 ft. 6 in.	1799.30	240.53
17 ft. 9 in.	1851.10	247.45
18 ft.	1903.60	254.47
18 ft. 3 in.	1956.80	261.59
18 ft. 6 in.	2010.80	268.80
18 ft. 9 in.	2065.50	276.12
19 ft.	2120.90	283.53
19 ft. 3 in.	2177.10	291.04
19 ft. 6 in.	2234.00	298.65
19 ft. 9 in.	2291.70	306.35
20 ft.	2350.10	314.16
20 ft. 3 in.	2409.20	322.06
20 ft. 6 in.	2469.10	330.06
20 ft. 9 in.	2529.60	338.16
21 ft.	2591.00	346.36
21 ft. 3 in.	2653.00	354.66
21 ft. 6 in.	2715.80	363.05
21 ft. 9 in.	2779.30	371.54
22 ft.	2843.60	380.13
22 ft. 3 in.	2908.60	388.82
22 ft. 6 in.	2974.30	397.61
22 ft. 9 in.	3040.80	406.49
23 ft.	3108.00	415.48
23 ft. 3 in.	3175.90	424.56
23 ft. 6 in.	3244.60	433.74
23 ft. 9 in.	3314.00	443.01

Diameter of Tank	# of U.S. Gallons	Cubic Ft. & Area in Sqft.
24 ft.	3384.10	452.39
24 ft. 3 in.	3455.00	461.86
24 ft. 6 in.	3526.60	471.44
24 ft. 9 in.	3598.90	481.11
25 ft.	3672.00	490.87
25 ft. 3 in.	3745.80	500.74
25 ft. 6 in.	3820.30	510.71
25 ft. 9 in.	3895.60	520.77
26 ft.	3971.60	530.93
26 ft. 3 in.	4048.40	541.19
26 ft. 6 in.	4125.90	551.55
26 ft. 9 in.	4204.10	562.00
27 ft.	4283.00	572.56
27 ft. 3 in.	4362.70	583.21
27 ft. 6 in.	4443.10	593.96
27 ft. 9 in.	4524.30	604.81
28 ft.	4606.20	615.75
28 ft. 3 in.	4688.80	626.80
28 ft. 6 in.	4772.10	637.94
28 ft. 9 in.	4856.20	649.18
29 ft.	4941.00	660.52
29 ft. 3 in.	5026.60	671.96
29 ft. 6 in.	5112.90	683.49
29 ft. 9 in.	5199.90	695.13
30 ft.	5287.70	706.86
30 ft. 3 in.	5376.20	718.69
30 ft. 6 in.	5465.40	730.62
30 ft. 9 in.	5555.40	742.64
31 ft.	5646.10	754.77
31 ft. 3 in.	5737.50	766.99
31 ft. 6 in.	5829.70	779.31
31 ft. 9 in.	5922.60	791.73
32 ft.	6016.20	804.25
32 ft. 3 in.	6110.60	816.86
32 ft. 6 in.	6205.70	829.58
32 ft. 9 in.	6301.50	842.39

31½ Gallons = 1 Barrel

To find the capacity of tanks greater than the largest given in the table, look in the table for a tank of one-half of the given size and multiply its capacity by 4, or one of one-third its size and multiply its capacity by 9, etc.

U.S. Gallons In Rectangular Tanks

For One Foot In Depth

Width of Tank	Length of Tank									
	2 feet	2-1/2 feet	3 feet	3-1/2 feet	4 feet	4-1/2 feet	5 feet	5-1/2 feet	6 feet	6-1/2 feet
2 ft.	29.92	37.40	44.88	52.36	59.84	67.32	74.81	82.29	89.77	97.25
2-1/2 ft.	---	46.75	56.10	65.45	74.80	84.16	93.51	102.86	112.21	121.56
3 ft.	---	---	67.32	78.54	89.77	100.99	112.21	123.43	134.65	145.87
3-1/2 ft.	---	---	---	91.64	104.73	117.82	130.91	144.00	157.09	170.18
4 ft.	---	---	---	---	119.69	134.65	149.61	164.57	179.53	194.49
4-1/2 ft.	---	---	---	---	---	151.48	168.31	185.14	201.97	218.80
5 ft.	---	---	---	---	---	---	187.01	205.71	224.41	243.11
5-1/2 ft.	---	---	---	---	---	---	---	226.28	246.86	267.43
6 ft.	---	---	---	---	---	---	---	---	269.30	291.74
6-1/2 ft.	---	---	---	---	---	---	---	---	---	361.05
7 ft.	---	---	---	---	---	---	---	---	---	---
7-1/2 ft.	---	---	---	---	---	---	---	---	---	---
8 ft.	---	---	---	---	---	---	---	---	---	---
8-1/2 ft.	---	---	---	---	---	---	---	---	---	---
9 ft.	---	---	---	---	---	---	---	---	---	---
9-1/2 ft.	---	---	---	---	---	---	---	---	---	---
10 ft.	---	---	---	---	---	---	---	---	---	---
10-1/2 ft.	---	---	---	---	---	---	---	---	---	---
11 ft.	---	---	---	---	---	---	---	---	---	---
11-1/2 ft.	---	---	---	---	---	---	---	---	---	---
12 ft.	---	---	---	---	---	---	---	---	---	---

Two page chart, continues on next page



U.S. Gallons In Rectangular Tanks

For One Foot In Depth

Length of Tank										
7 feet	7-1/2 feet	8 feet	8-1/2 feet	9 feet	9-1/2 feet	10 feet	10-1/2 feet	11 feet	11-1/2 feet	12 feet
104.73	112.21	119.69	127.17	134.65	142.13	149.61	157.09	164.57	172.05	179.53
130.91	140.26	149.61	158.96	168.31	177.66	187.01	196.36	205.71	215.06	224.41
157.09	168.31	179.53	190.75	202.97	213.19	224.41	235.63	246.86	258.07	269.30
183.27	196.36	209.45	222.54	235.63	248.73	261.82	274.90	288.00	301.09	314.18
209.45	224.41	239.37	254.34	269.30	284.26	299.22	314.18	329.14	344.10	359.06
235.63	252.47	269.30	286.13	302.96	319.79	336.62	353.45	370.28	387.11	403.94
261.82	280.52	299.22	317.92	336.62	355.32	374.03	392.72	411.43	430.13	448.83
288.00	308.57	329.14	349.71	370.28	390.85	411.43	432.00	452.57	473.14	493.71
314.18	336.62	359.06	381.50	403.94	426.39	448.83	471.27	493.71	516.15	538.59
340.36	364.67	388.98	413.30	437.60	461.92	486.23	510.54	534.85	559.16	583.47
366.54	392.72	418.91	445.09	471.27	497.45	523.64	549.81	575.99	602.18	628.36
---	420.78	448.83	476.88	504.93	532.98	561.04	589.08	617.14	645.19	673.24
---	---	478.75	508.67	538.59	568.51	598.44	628.36	658.28	688.20	718.12
---	---	---	540.46	572.25	604.05	635.84	667.63	699.42	731.21	763.00
---	---	---	---	605.92	639.58	673.25	706.90	740.56	774.23	807.89
---	---	---	---	---	675.11	710.65	746.17	781.71	817.24	852.77
---	---	---	---	---	---	748.05	785.45	822.86	860.26	897.66
---	---	---	---	---	---	---	824.73	864.00	903.26	942.56
---	---	---	---	---	---	---	---	905.14	946.27	987.43
---	---	---	---	---	---	---	---	---	989.29	1032.3
---	---	---	---	---	---	---	---	---	---	1077.2

Two page chart, continued from previous page



Hardness Conversion Table

Brinell		Rockwell		Vickers	Approximate Tensile Strength	
Dia. Ball Impression (mm)	Hardness Number (Std. Ball)	C	B	VHN	KSI	MPA
-	-	68	-	940	-	-
-	-	67	-	900	-	-
-	-	66	-	865	-	-
-	-	65	-	832	-	-
-	-	64	-	800	-	-
-	-	63	-	772	-	-
-	-	62	-	746	-	-
-	-	61	-	720	-	-
-	-	60	-	697	-	-
-	-	59	-	674	326	2237.8
-	-	58	-	653	315	2171.9
-	-	56	-	613	295	2034.0
-	-	55	-	595	287	1978.9
-	-	54	-	577	278	1916.8
2.70	514	52.4	-	533	265	1827.2
2.75	495	51.0	-	528	253	1744.4
2.80	477	49.4	-	504	241	1661.7
2.85	461	48.1	-	485	232	1599.6
2.90	444	46.3	-	462	221	1523.8
2.95	429	45.7	-	454	216	1489.3
3.00	415	44.5	-	440	209	1441.1
3.05	401	43.1	-	424	201	1385.9
3.10	388	41.7	-	409	194	1337.6
3.15	375	40.4	-	396	188	1296.3
3.20	363	39.0	-	382	181	1248.0
3.25	352	37.8	-	370	175	1206.6
3.30	341	36.6	-	359	170	1172.2
3.35	331	35.4	-	349	165	1137.7
3.40	321	34.3	-	339	160	1103.2
3.45	311	33.0	-	327	154	1061.8
3.50	302	32.1	(107)	319	150	1034.3
3.55	293	30.9	(106)	309	146	1006.7
3.60	285	30.0	(105.5)	301	142	979.1
3.65	277	28.8	(104.5)	293	138	951.5
3.70	269	27.7	(103.5)	283	132	910.1
3.75	262	26.7	(103)	277	129	889.5
3.80	255	25.5	(102)	269	126	868.7
3.85	248	24.2	(101)	261	121	834.3
3.90	241	22.7	100.2	254	117	806.7
3.95	235	21.7	99.2	247	114	786.0
4.00	229	20.6	98.2	241	112	772.2
4.05	223	19.4	97.2	(236)	109	751.6
4.10	217	(18)	96.2	(231)	106	730.8
4.15	212	(16)	95.3	(225)	102	703.3
4.20	207	(15)	94.4	(219)	100	689.5
4.25	201	(14)	93.2	(213)	98	675.7
4.30	197	(13)	92.4	(207)	96	661.9
4.35	192	(12)	91.4	(201)	94	648.1
4.40	187	(10)	90.4	(195)	90	620.6
4.45	183	(9)	89.6	(189)	88	606.8
4.50	179	(8)	88.8	(183)	87	599.9
4.55	174	(7)	87.5	(177)	85	586.1
4.60	170	(6)	86.3	(171)	84	579.2
4.65	167	(5)	85.5	(167)	82	565.4
4.70	163	(4)	84.3	(163)	80	551.6
4.75	159	(3)	83.0	(159)	78	537.8
4.80	156	(2)	82.0	(156)	77	530.9



Material Safety Data Sheet - Steel

Product Description and Hazardous Ingredients/Identity Information

I. MANUFACTURER/DISTRIBUTOR and PRODUCT IDENTIFICATION

DISTRIBUTOR: Alro Steel Corporation
3100 East High Street
Jackson, MI 49204

REVIEWED AND REVISED: 12/21/95 by Alro Steel Corporation

MANUFACTURER: Various manufacturers

CHEMICAL FAMILY: Metals

CHEMICAL NAME AND SYNONYMS: Steel

EMERGENCY PHONE NUMBER: (517) 787-5500

II. CHEMICAL COMPONENTS

See section II-A, "Product Description & Hazardous Ingredients/Identity Information" and II-B "Percentile of Weight by Grade and Type of Material."

III. PHYSICAL DATA

Melting point F : Greater than 2400 **Specific Gravity(H₂O=1)**: Greater than 7.0

Vapor pressure: n/a **% Volatile by Volume**: n/a

Vapor Density (Air=1): n/a **Evaporation Rate**: n/a

Solubility in Water: Negligible

Appearance and Odor: Grayish to silvery odorless product in various shapes.

IV. FIRE AND EXPLOSION DATA

NONFLAMMABLE. Use fire-fighting methods appropriate for the surrounding area.

V. HEALTH HAZARD INFORMATION

See Section V-A, General Health Hazard Information.

VI. REACTIVITY DATA

STABILITY: Stable

INCOMPATIBILITY: Not incompatible. HAZARDOUS POLYMERIZATION: n/a

HAZARDOUS DECOMPOSITION PRODUCTS: n/a

CONDITIONS TO AVOID: May liberate metal fumes & metal oxides if burned or welded.

VII. SPILL AND LEAK PROCEDURES/ENVIRONMENTAL

Residue from cutting or grinding should be swept or vacuumed and placed in suitable containers for disposal in accordance with federal, state, or local waste disposal regulations. This material may be reclaimed for reuse. See section II-A for information concerning materials subject to SARA Title III reporting requirements.

VIII. SPECIAL PROTECTION

RESPIRATORY PROTECTION: When exposure limits are exceeded, use proper approved respirator. (Consult OSHA and/or state or local codes)

VENTILATION: Use local exhaust when cutting, grinding or welding.

EYE PROTECTION AND PROTECTIVE CLOTHING: Proper protective clothing and appropriate face and eye protection should be used when cutting, grinding, or welding. (Consult OSHA and/or state or local rules and regulations)

IX. SPECIAL PRECAUTIONS

PEL/TLV exposures should be controlled to remain below OSHA and ACGIH specifications to ensure proper health protection of workers.

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Continued on next page

Material Safety Data Sheet - Steel

Product Description and Hazardous Ingredients/Identity Information

Material Safety Data Sheet - Steel Product Description and Hazardous Ingredients/Identity Information

BASE METAL	CAS #	% COMP. BY WEIGHT	ACGIH TLV (mg/m ³)	OSHA 1910.1000 (mg/m ³)	LD ₅₀ Species Route
Iron, Fe	7439-89-6	Usually >95.0	5.0 as oxide fume	10.0 as oxide dust and fume	NE
ALLOYING ELEMENTS	CAS NUMBER	% COMPOSITION BY WEIGHT	ACGIH TWA (mg/m³)	OSHA 1910.1000 TWA (mg/m³)	LD₅₀ Species Route
Aluminum, Al	7429-90-5	.01 - 1.50	10.0 as metal dust & oxide 5.0 as welding fume	15.0 as total dust 5.0 as respirable fraction	NE
Carbon, C	1333-86-4	.01 - 2.5	3.5 as carbon black	3.5 as carbon black	NE
Chromium, Cr	7440-47-3	.01 - 20.0	0.5 as metal	1.0 as metal	NE
Cobalt, Co	7440-84-4	.01 - 8.0	0.05 as dust and fume	0.10 as dust and fume	NE
Copper, Cu	7440-50-8	.01 - 2.0	0.2 as fume; 1.0 as dust	0.1 as fume; 1.0 as dust	NE
Lead, Pb	7439-92-1	.01 - 1.0	0.15 as dust and fume	0.05	NE
Manganese, Mn	7439-96-5	.01 - 10.0	1.0 as fume/5.0 as dust 3.0 STEL as fume	5.0 Ceiling	9gm/kg Rat, oral
Molybdenum, Mo	7439-98-7	.01 - 7.0	5.0 soluble/15.0 total dust	5.0 soluble/10.0 insoluble	NE
Nickel, Ni	7440-02-0	.01 - 20.0	1.0 as metal	1.0 as metal	50 mg/kg mouse-intravenous
Silicon, Si	7440-21-3	.01 - 3.0	10.0 as total dust	15.0 as total dust	NE
Sulphur, S	7404-34-9	< 0.1	5.2 as SO ₂ /13.0 STEL as SO ₂	5.0 as respirable fraction	NE
Tungsten, W	7440-33-7	.00 - 19.0	5.0 as dust	13.0 as SO ₂	NE
Vanadium, V	7440-62-2	.01 - 5.0	0.5 (C) - dust as V ₂ O ₅ fume as V ₂ O ₅	5.0 as dust	NE
Zinc, Zn	7440-66-6	.00 - 99.0 as coating only	5.0 as oxide fume 10.0 STEL as oxide fume 10.0 dust as ZnO	0.05 - respirable dust and 5.0 as oxide fume 15.0 as oxide total dust 5.0 as respirable fraction	59.0 mg/kg Mouse-subcutaneous
ABBREVIATIONS: (C) - Ceiling Level PEL - Permissible Exposure Limit NE - Not Established CAS No. - Chemical Abstract Service Number LD50 - Lethal dose for 50% of tested animals STEL - Short Term Exposure Limit ACGIH-TLV American Conference of Governmental Industrial Hygienist - Threshold Limit Value Revised 1/21/95					

Continued on next page



Material Safety Data Sheet - Steel

Product Description and Hazardous Ingredients/Identity Information

Material Safety Data Sheet - Steel Product Description and Hazardous Ingredients/Identity Information

PERCENTILE OF WEIGHT BY GRADE AND TYPE OF MATERIAL									
Grade Symbol	Iron Fe	Manganese Mn	Carbon C	Aluminum Al	Chromium Cr	Copper Cu	Molybdenum Mo	Nickel Ni	
Mild Steel	Balance	0.25-2.0	0.18-0.31	n/a	n/a	n/a	n/a	n/a	n/a
Low Alloy	Balance	0.25-2.0	0.01-1.20	n/a	0.01-1.00	0.10-1.00	n/a	0.01-1.0	
Alloy Steel	Balance	0.25-2.0	0.01-1.20	n/a	0.10-2.50	0.10-1.00	0.01-1.10	0.01-1.0	
Leaded Steel	Balance	0.25-2.0	0.01-1.20	n/a	0.10-2.50	0.10-1.00	0.01-1.10	0.01-4.0	
Galvanized	Balance	0.25-2.0	0.01-1.80	n/a	0.10-2.00	0.01-2.00	n/a	0.01-1.0	
Tool Steel	Balance	0.25-2.5	0.05-2.50	0.01-1.50	0.10-13.0	0.01-1.00	0.01-10.00	0.01-4.0	
Stainless	Balance	0.10-10.0	0.03-2.00	n/a	4.00-20.00	n/a	0.01-5.00	3.0-20.0	
Powder Metal	Balance	0.20-2.0	0.01-2.00	n/a	1.00-5.00	n/a	1.00-7.00	0.01-0.8	
PERCENTILE OF WEIGHT BY GRADE AND TYPE OF MATERIAL (Continued)									
Grade Symbol	Lead Pb	Vanadium V	Cobalt Co	Sulfur S	Tungsten W	Silicon Si	Zinc Zn		
Mild Steel	n/a	n/a	n/a	<0.50	n/a	....	....
Low Alloy	n/a	n/a	n/a	<0.30	n/a	....	....
Alloy Steel	n/a	n/a	n/a	<0.10	n/a	....	....
Leaded Steel	.01-1.0	n/a	n/a	<0.40	n/a	0.15-2.20	....	
Galvanized	n/a	n/a	n/a	<0.50	n/a	....	99.0 coat		
Tool Steel	n/a	0.01-5.00	0.01-8.0	<0.10	0 - 0.75	0.01-2.50	....	
Stainless	n/a	n/a	0.01-1.0	<0.20	n/a	0.01-3.00	....	
Powder Metal	n/a	1.00-5.00	0.01-6.0	<0.10	1.0-19.0	0.10-0.50	....	

Material Safety Data Sheet - Aluminum

Product Description and Hazardous Ingredients/Identity Information

I. MANUFACTURER/DISTRIBUTOR and PRODUCT IDENTIFICATION

DISTRIBUTOR: Alro Steel Corporation
3100 East High Street
Jackson, MI 49204

REVIEWED AND REVISED: 12/21/95 by Alro Steel Corporation

EMERGENCY PHONE NUMBER:(517) 787-5500

MANUFACTURER: Various Sources

CHEMICAL NAME: Aluminum and Alloys

CHEMICAL FAMILY: Metals

II. CHEMICAL COMPONENTS

See section II-C, Product Description & Hazardous Ingredients/Identity Information.

III. PHYSICAL DATA

Melting point F°: 950 - 1215

Specific Gravity(H₂O=1): 2.5 - 2.9

Vapor pressure: n/a

% Volatile by Volume: n/a

Vapor Density (Air=1): n/a

Evaporation Rate: n/a

Solubility in Water(% by weight): nil

Appearance and Odor: Metallic appearance, no odor. Solid at normal conditions.

IV. FIRE AND EXPLOSION DATA

PRODUCT NONFLAMMABLE. Damp aluminum dust may spontaneously heat with liberation of hydrogen to form explosive air mixtures. Do not use water or halogen on dust fires, use dry powder or sand.

V. HEALTH HAZARD INFORMATION

See Section V-A, General Health Hazard Information and Section IX. Appropriate personal protective equipment is required when melting, casting, forging, machining, or otherwise processing. The nature of activity will determine the form of protection necessary (i.e., glasses, respirator, clothing, and ear protection).

VI. REACTIVITY DATA

STABILITY: Stable

INCOMPATIBILITY: Anhydrous bromine

HAZARDOUS POLYMERIZATION: n/a

HAZARDOUS DECOMPOSITION PRODUCTS and CONDITIONS TO AVOID: See Fire and Explosion Section. See Additional Information Section.

VII. SPILL AND LEAK PROCEDURES/ ENVIRONMENTAL

Used or unused product should be tested to determine hazard status and disposal requirements under federal, state, and local laws and regulations. This material may be reclaimed for reuse. See section II-A for information concerning materials subject to SARA Title III reporting requirements.

VIII. SPECIAL PROTECTION

RESPIRATORY PROTECTION: When limits are exceeded, use proper approved respirator. (Consult OSHA and/or state or local codes for all requirements)

VENTILATION: Use local exhaust when cutting, grinding or welding.

EYE PROTECTION AND PROTECTIVE CLOTHING: Proper protective clothing and appropriate face and eye protection should be used when processing.

Continued on next page



Material Safety Data Sheet - Aluminum

Product Description and Hazardous Ingredients/Identity Information

IX. Special Precautions & Additional Information

(1) PEL/TLV exposures should be controlled to remain below OSHA and ACGIH specifications to ensure proper health protection of workers. (2) Acids and bases in contact with aluminum may generate explosive mixtures with hydrogen. (3) Finely divided aluminum will form explosive mixtures in air. It will also form explosive mixtures in air in the presence of bromates, iodates, or ammonium nitrate. (4) When remelting aluminum scrap, entrapped moisture or the presence of strong oxidizers such as ammonium nitrate could cause an explosion. (5) Do not touch cast or heated aluminum without knowing the temperature. Aluminum experiences no color change during heating. (6) Aluminum powder must be packed and shipped as a flammable solid, UN1396. (7) Hard alloy ingots in the 2000 and 7000 series must be stress relieved to prevent explosion or violent cracking when sawed. (8) The welding of aluminum alloys may generate carbon dioxide, ozone, carbon monoxide, nitrogen oxides, infra-red radiation and ultra-violet radiation, in addition to metal fume. (9) Vapor degreaser must be properly maintained to limit the accumulation of aluminum fines. Such accumulation could result in a potential degreaser fire or explosion. (10) Some aluminum scrap may be contaminated with oil at levels greater than 1%. Melting of aluminum scrap may generate oil vapors which are irritating to the eyes and upper respiratory tract. Prolonged or repeated skin contact with oil may cause skin irritation. (11) Nickel, Chromium, Lead, Beryllium and Cadmium, listed on California's Proposition 65 list of "Chemicals Known to the State to cause Cancer or Reproductive Harm," may exist in aluminum alloys at the maximum concentrations by weight - Ni (1.20), Cr (0.35), Pb (0.70), Be (0.05), Ca (0.05).

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Material Safety Data Sheet - Aluminum

Product Description and Hazardous Ingredients/Identity Information

Material Safety Data Sheet - Aluminum Product Description and Hazardous Ingredients/Identity Information

BASE METAL	CAS #	% COMP. BY WEIGHT	ACGIH TLV (mg/m ³)	OSHA 1910,1000 TWA (mg/m ³)	WISHA PEL (mg/m ³)
Aluminum, Al	7429-90-5	80.0 - 99.7	10.0 as metal dust & oxide 5.0 as welding fume	15.0 as total dust 5.0 as respirable fraction	10.0 as metal dust & oxide 5.0 as welding fume
ALLOYING ELEMENTS	CAS NUMBER	% COMPOSITION BY WEIGHT	ACGIH TWA (mg/m ³)	OSHA 1910,1000 TWA (mg/m ³)	WISHA PEL (mg/m ³)
Chromium, Cr	7440-47-3	0.0 - 1.0	0.5 as metal	1.0 as metal	0.5 as metal
Cobalt, Co	7440-48-4	0.1 - 10.0	0.05 as dust and fume	0.10 as dust and fume	0.05 as fume and dust
Copper, Cu	7440-50-8	1.0 - 20.0	0.2 as fume; 1.0 as dust	0.1 as fume; 1.0 as dust	0.1 as fume; 1.0 as dust
Iron, Fe	7439-89-6	1.0 - 10.0	5.0 as oxide fume	10.0 as oxide dust and fume	5.0 as oxide dust and fume
Magnesium, Mg	1309-48-4	1.0 - 20.0	10.0 as oxide fume	15.0 as particulates	10.0 as total oxide dust fume
Manganese, Mn	7439-96-5	1.0 - 10.0	1.0 as fume	5.0 Ceiling 3.0 STEL as fume 5.0 as dust	5.0 Ceiling
Nickel, Ni	7440-02-0	1.0 - 10.0	1.0 as metal	1.0 as metal	1.0 as metal
Silicon, Si	7440-21-3	1.0 - 20.0	10.0 as total dust	15.0 as total dust 5.0 as respirable fraction	100 as total dust 5.0 as respirable fraction
Silver, Ag	7440-22-4	0.1 - 10.0	0.1 as metal	0.01 as metal dust and fume	0.01 as metal
Tin, Sn	7440-31-5	1.0 - 10.0	2.0 as oxide and metal	2.0 except oxide	2.0 as oxide fume and metal
Zinc, Zn	7440-66-6	1.0 - 10.0	5.0 as oxide fume 10.0 STEL as oxide fume 10.0 as oxide dust	5.0 as oxide fume 15.0 as oxide total dust 5.0 as respirable fraction	5.0 as oxide fume 10.0 STEL as oxide fume 10.0 as oxide total dust 5.0 as oxide respirable fraction

Key: STEL - Short Term Exposure Limit

PEL - Permissible Exposure Limit

CAS No. - Chemical Abstract Service Number

ACGIH-TLV American Conference of Governmental Industrial Hygienists - Threshold Limit Value

Aluminum alloys may be comprised of all or variations of the alloys shown here. In addition,

the welding of aluminum alloys may produce the hazards listed in V-B.

Revised 12/21/95

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Material Safety Data Sheet - Aluminum

Product Description and Hazardous Ingredients/Identity Information

V-A. GENERAL HEALTH AND HAZARD DATA (Product, Alloying Elements and Compounds)

NOTE: Steel and aluminum products in their usual physical form do not pose any health hazard and are not listed by IARC or NTP as carcinogens or suspected carcinogens. However, when subjected to welding, burning, sawing, brazing, grinding, etc., potentially hazardous fumes or dust may be generated. These operations should be performed in well-ventilated areas. The primary route of exposure is from inhalation of fumes or dust. The effects of overexposure to the various metal fumes and dusts which may be generated from this product and the associated health effects from overexposure are as follows:

ACUTE: Excessive inhalation of metallic fume or dust may be irritating to respiratory passages. Excessive inhalation of fume from metals can produce an acute reaction called "metal fume fever." Symptoms consist of chills and fever (easily confused with flu), a metallic taste in the mouth, dryness, and irritation of the throat. The symptoms arrive a few hours after exposure and may last 12-48 hours. Long-term effects have not been noted. High concentrations of metallic dusts can result in eye irritation.

CHRONIC: Chronic inhalation of high concentrations of metallic fume and dusts are associated with the following:

IRON OXIDE: Chronic inhalation of excessive iron dust or fumes may result in development of a benign pneumoconiosis (siderosis). No physical impairment of lung function has been associated with siderosis.

ALUMINUM: Chronic excessive exposure to certain aluminum compounds as fume or dusts may initiate fibrotic changes to lung tissue.

MANGANESE: Chronic exposure to excessive fumes and dusts may result in bronchitis, pneumonitis, or effect the central nervous system causing lack of coordination.

CHROMIUM: Health hazards associated with exposure to chromium are dependent on its oxidation state. The metal form, as it exists in this product, is of very low toxicity. The hexavalent form is very toxic. Adverse effects may include skin ulcerations, dermatitis, and skin allergies. Inhalation of hexavalent chromium compounds can result in ulceration of mucous membranes and perforation of the nasal septum, bronchitis, and bronchial carcinoma. IARC lists hexavalent chromium compounds as known human carcinogens. ACGIH has reviewed the toxicity data and concluded that chromium metal is not carcinogenic to humans.

NICKEL: Nickel fumes are respiratory irritants and may cause pneumonitis. Skin contact may cause allergic skin rash. Nickel sensitivity, once acquired, is apparently not lost. Certain airborne nickel contaminating dusts are regarded as carcinogens via inhalation. Listed by NTP and the IARC Monographs. Nickel is listed as a mutagen.

VANADIUM PENTOXIDE: Chronic exposure to vanadium pentoxide dust and fume may cause severe irritation of the eyes, skin and upper respiratory tract. Symptoms include conjunctivitis, nasopharyngitis, cough, dyspnea, palpitation, lung changes, chronic bronchitis, skin pallor, rash, greenish-black tongue.

COBALT: Mildly irritating to eyes, skin, and upper respiratory tract. Chronic inhalation of dust or fume may result in an asthma-like respiratory disorder.

LEAD: Chronic exposure to excessive concentrations of lead and lead compounds as dust or fume may lead to anemia, urinary dysfunction, weakness, constipation, nausea and disorders of the central and peripheral nervous systems. Prolonged exposure may cause kidney damage and reproductive disorders.

COPPER: Overexposure to copper fume can cause upper respiratory tract irritation. Skin sensitization has been reported.

MOLYBDENUM: Chronic excessive exposure to certain compounds have indicated morphological changes in the liver, kidneys, and spleen; anemia, diarrhea, bone deformity, and growth deformation.

SULPHUR (as Sulphur Dioxide): Excessive exposure may result in upper respiratory tract irritation and pulmonary edema.

ZINC: Exposure to zinc oxide fume may result in "zinc chills" (metal fume fever).

Continued on next page

MSDS - Steel and Aluminum

TIN: Toxicity is generally low. Exposure to excessive levels of dust or fume can result in a benign pneumoconiosis called stannosis.

TUNGSTEN: Metal and insoluble compounds are generally considered to have a low level of toxicity but have produced lung changes in laboratory animals.

MAGNESIUM: Oxide fume may cause irritation to eyes, nose and throat; overexposure may cause flu-like symptoms. Chronic exposure may cause metal fume fever.

EMERGENCY AND FIRST AID PROCEDURES: SKIN CONTACT; Remove particles by washing with water and soap. EYE CONTACT: Flush with water for at least 15 minutes. Get medical attention if irritation persists. INHALATION: In the event of acute exposure, remove the subject from exposure and obtain prompt medical attention. If unconscious, administer oxygen. If not breathing, resuscitate immediately.

DISCLAIMER

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As sold, the product described in this MSDS is considered by Alro to be an "article" within the meaning of Title 29 of the Code of Federal Regulations, section 1910, 1200 *et seq.* This MSDS is intended to be used solely for the purpose of satisfying informational requests made pursuant to that requirement. It is not intended to preempt, replace, or expand the terms contained in Alro's Conditions of Sale. Compliance with all applicable federal, state, and local laws and regulations remains the responsibility of the user. The user has the responsibility to provide a safe workplace, to examine all aspects of its operation, and to determine if or where precautions, in addition to those herein, are required. Revised 12/21/95