

ASTM A-519**TABLE 1 Chemical Requirements of Low-Carbon Steels**

Grade Designation	Chemical Composition Limits, %				
	Carbon ^A	Manganese ^B	Phosphorus, ^B max	Sulfur, ^B max	
MT 1010	0.05-0.15	0.30-0.60	0.040	0.050	^A Limits apply to heat and product analysis ^B Limits apply to heat analysis; except as required by 6.1, product analysis are subject to the applicable additional tolerances given in Table 5
MT 1015	0.10-0.20	0.30-0.60	0.040	0.050	
MT X 1015	0.10-1.20	0.60-0.90	0.040	0.050	
MT 1020	0.15-0.25	0.30-0.60	0.040	0.050	
MT X 1020	0.15-0.25	0.70-1.00	0.040	0.050	

TABLE 2 Chemical Requirements of Other Low-Carbon Steels

Grade Designation	Chemical Composition Limits, % ^A				
	Carbon	Manganese	Phosphorus, max	Sulfur, max	
1008	0.10 max	0.30-0.50	0.040	0.050	^A The ranges and limits given in this table apply to heat analysis; except as required by 6.1, product analysis are subject to the applicable additional tolerances.
1010	0.08-0.13	0.30-0.60	0.040	0.050	
1012	0.10-0.15	0.30-0.60	0.040	0.050	
1015	0.13-0.18	0.30-0.60	0.040	0.050	
1016	0.13-0.18	0.60-0.90	0.040	0.050	
1017	0.15-0.20	0.30-0.60	0.040	0.050	
1018	0.15-0.20	0.60-0.90	0.040	0.050	
1019	0.15-0.20	0.70-1.00	0.040	0.050	
1020	0.18-0.23	0.30-0.60	0.040	0.050	
1021	0.18-0.23	0.60-0.90	0.040	0.050	
1022	0.18-0.23	0.70-1.00	0.040	0.050	
1025	0.22-0.28	0.30-0.60	0.040	0.050	
1026	0.22-0.28	0.60-0.90	0.040	0.050	
1030	0.28-0.34	0.60-0.90	0.040	0.050	
1035	0.32-0.38	0.60-0.90	0.040	0.050	
1040	0.37-0.44	0.60-0.90	0.040	0.050	
1045	0.43-0.50	0.60-0.90	0.040	0.050	
1050	0.48-0.55	0.60-0.90	0.040	0.050	
1518	0.15-0.21	1.10-1.40	0.040	0.050	
1524	0.19-0.25	1.35-1.65	0.040	0.050	
1541	0.36-0.44	1.35-1.65	0.040	0.050	

CHEMICAL REQUIREMENTS FOR ALLOY STEELS

Note 1 – The ranges and limits in this table apply to steel not exceeding 200 in.² (1290 cm²) in cross-sectional area.

Note 2 – Small quantities of certain elements are present in alloy steels which are not specified or required.

These elements are considered as incidental and may be present to the following maximum amounts:

copper, 0.35%; nickel, 0.25%; chromium, 0.20%; molybdenum, 0.10%.

Note 3 – The ranges and limits given in this table apply to heat analysis; except as required by 6.1, product analysis are subject to the applicable additional tolerances given in Table 5.

Grade A,B Designation	Chemical Composition Limits, %							
	Carbon	Manganese	Phosphorus, ^C max	Sulfur, ^{C,D} max	Silicon	Nickel	Chromium	Molybdenum
1330	0.28-0.33	1.60-1.90	0.040	0.040	0.15-0.35	—	—	—
1335	0.33-0.38	1.60-1.90	0.040	0.040	0.15-0.35	—	—	—
1340	0.38-0.43	1.60-1.90	0.040	0.040	0.15-0.35	—	—	—
1345	0.43-0.48	1.60-1.90	0.040	0.040	0.15-0.35	—	—	—
3140	0.38-0.43	0.70-0.90	0.040	0.040	0.15-0.35	1.10-1.40	0.55-0.75	—
E3310	0.08-0.13	0.45-0.60	0.025	0.025	0.15-0.35	3.25-3.75	1.40-1.75	—
4012	0.09-0.14	0.75-1.00	0.040	0.040	0.15-0.35	—	—	0.15-0.25
4023	0.20-0.25	0.70-0.90	0.040	0.040	0.15-0.35	—	—	0.20-0.30
4024	0.20-0.25	0.70-0.90	0.040	0.035-0.050	0.15-0.35	—	—	0.20-0.30
4027	0.25-0.30	0.70-0.90	0.040	0.040	0.15-0.35	—	—	0.20-0.30
4028	0.25-0.30	0.70-0.90	0.040	0.035-0.050	0.15-0.35	—	—	0.20-0.30
4037	0.35-0.40	0.70-0.90	0.040	0.040	0.15-0.35	—	—	0.20-0.30
4042	0.40-0.45	0.70-0.90	0.040	0.040	0.15-0.35	—	—	0.20-0.30
4047	0.45-0.50	0.70-0.90	0.040	0.040	0.15-0.35	—	—	0.20-0.30
4063	0.60-0.67	0.75-1.00	0.040	0.040	0.15-0.35	—	—	0.20-0.30
4118	0.18-0.23	0.70-0.90	0.040	0.040	0.15-0.35	—	0.40-0.60	0.08-0.15
4130	0.28-0.33	0.40-0.60	0.040	0.040	0.15-0.35	—	0.80-1.10	0.15-0.25
4135	0.33-0.38	0.70-0.90	0.040	0.040	0.15-0.35	—	0.80-1.10	0.15-0.25
4137	0.35-0.40	0.70-0.90	0.040	0.040	0.15-0.35	—	0.80-1.10	0.15-0.25
4140	0.38-0.43	0.75-1.00	0.040	0.040	0.15-0.35	—	0.80-1.10	0.15-0.25
4142	0.40-0.45	0.75-1.00	0.040	0.040	0.15-0.35	—	0.80-1.10	0.15-0.25
4145	0.43-0.48	0.75-1.00	0.040	0.040	0.15-0.35	—	0.80-1.10	0.15-0.25
4147	0.45-0.50	0.75-1.00	0.040	0.040	0.15-0.35	—	0.80-1.10	0.15-0.25
4150	0.48-0.53	0.75-1.00	0.040	0.040	0.15-0.35	—	0.80-1.10	0.15-0.25
4320	0.17-0.22	0.45-0.65	0.040	0.040	0.15-0.35	1.65-2.00	0.40-0.60	0.20-0.30

CHEMICAL REQUIREMENTS FOR ALLOY STEELS

Grade A,B Designation	Chemical Composition Limits, %							
	Carbon	Manganese	Phosphorus, ^C max	Sulfur, ^{C,D} max	Silicon	Nickel	Chromium	Molybdenum
4337	0.35-0.40	0.60-0.80	0.040	0.040	0.15-0.35	1.65-2.00	0.70-0.90	0.20-0.30
E4337	0.35-0.40	0.65-0.85	0.025	0.025	0.15-0.35	1.65-2.00	0.70-0.90	0.20-0.30
4340	0.38-0.43	0.60-0.80	0.040	0.040	0.15-0.35	1.65-2.00	0.70-0.90	0.20-0.30
E4340	0.38-0.43	0.65-0.85	0.025	0.025	0.15-0.35	1.65-2.00	0.70-0.90	0.20-0.30
4422	0.20-0.25	0.70-0.90	0.040	0.040	0.15-0.35	—	—	0.35-0.45
4427	0.24-0.29	0.70-0.90	0.040	0.040	0.15-0.35	—	—	0.35-0.45
5420	0.18-0.23	0.45-0.65	0.040	0.040	0.15-0.35	—	—	0.45-0.60
4615	0.13-0.18	0.45-0.65	0.040	0.040	0.15-0.35	1.65-2.00	—	0.20-0.30
4617	0.15-0.20	0.45-0.65	0.040	0.040	0.15-0.35	1.65-2.00	—	0.20-0.30
4620	0.17-0.22	0.45-0.65	0.040	0.040	0.15-0.35	1.65-2.00	—	0.20-0.30
4621	0.18-0.23	0.70-0.90	0.040	0.040	0.15-0.35	1.65-2.00	—	0.20-0.30
4718	0.16-0.21	0.70-0.90	0.040	0.040	0.15-0.35	0.90-1.20	0.35-0.55	0.30-0.40
4720	0.17-0.22	0.50-0.70	0.040	0.040	0.15-0.35	0.90-1.20	0.35-0.55	0.15-0.25
4815	0.13-0.18	0.40-0.60	0.040	0.040	0.15-0.35	3.25-3.75	—	0.20-0.30
4817	0.15-0.20	0.40-0.60	0.040	0.040	0.15-0.35	3.25-3.75	—	0.20-0.30
4820	0.18-0.23	0.50-0.70	0.040	0.040	0.15-0.35	3.25-3.75	—	0.20-0.30
5015	0.12-0.17	0.30-0.50	0.040	0.040	0.15-0.35	—	0.30-0.50	—
5046	0.43-0.50	0.75-1.00	0.040	0.040	0.15-0.35	—	0.20-0.35	—
5115	0.13-0.18	0.70-0.90	0.040	0.040	0.15-0.35	—	0.70-0.90	—
5120	0.17-0.22	0.70-0.90	0.040	0.040	0.15-0.35	—	0.70-0.90	—
5130	0.28-0.33	0.70-0.90	0.040	0.040	0.15-0.35	—	0.80-1.10	—
5132	0.30-0.35	0.60-0.80	0.040	0.040	0.15-0.35	—	0.75-1.00	—
5140	0.38-0.43	0.70-0.90	0.040	0.040	0.15-0.35	—	0.70-0.90	—
5145	0.43-0.48	0.70-0.90	0.040	0.040	0.15-0.35	—	0.70-0.90	—
5147	0.45-0.52	0.70-0.95	0.040	0.040	0.15-0.35	—	0.85-1.15	—
5150	0.48-0.53	0.70-0.90	0.040	0.040	0.15-0.35	—	0.70-0.90	—
5155	0.50-0.60	0.70-0.90	0.040	0.040	0.15-0.35	—	0.70-0.90	—
5160	0.55-0.65	0.75-1.00	0.040	0.040	0.15-0.35	—	0.70-0.90	—
E50100	0.95-1.10	0.25-0.45	0.025	0.025	0.15-0.35	—	0.40-0.60	—
E51100	0.95-1.10	0.25-0.45	0.025	0.025	0.15-0.35	—	0.90-1.15	—

CHEMICAL REQUIREMENTS FOR ALLOY STEELS

Grade A,B Designation	Chemical Composition Limits, %							
	Carbon	Manganese	Phosphorus, ^C max	Sulfur, ^{C,D} max	Silicon	Nickel	Chromium	Molybdenum
E52100	0.95-1.10	0.25-0.45	0.025	0.025	0.15-0.35	—	1.30-1.60	—
								<u>Vanadium</u>
6118	0.16-0.21	0.50-0.70	0.040	0.040	0.15-0.35	—	0.50-0.70	0.10-0.15
6120	0.17-0.22	0.70-0.90	0.040	0.040	0.15-0.35	—	0.70-0.90	0.10 min.
6150	0.48-0.53	0.70-0.90	0.040	0.040	0.15-0.35	—	0.80-1.10	0.15 min.
						<u>Aluminum</u>		<u>Molybdenum</u>
E7140	0.38-0.43	0.50-0.70	0.025	0.025	0.15-0.40	0.95-1.30	1.40-1.80	0.30-0.40
						<u>Nickel</u>		
8115	0.13-0.18	0.70-0.90	0.040	0.040	0.15-0.35	0.20-0.40	0.30-0.50	0.08-0.15
8615	0.13-0.18	0.70-0.90	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.15-0.25
8617	0.15-0.20	0.70-0.90	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.15-0.25
8620	0.18-0.23	0.70-0.90	0.040	0.040	0.15-0.35	0.50-0.70	0.40-0.60	0.15-0.25
8622	0.20-0.25	0.70-0.90	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.15-0.25
8625	0.23-0.28	0.70-0.90	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.15-0.25
8627	0.25-0.30	0.70-0.90	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.15-0.25
8630	0.28-0.33	0.70-0.90	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.15-0.25
8637	0.35-0.40	0.75-1.00	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.15-0.25
8640	0.38-0.43	0.75-1.00	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.15-0.25
8642	0.40-0.45	0.75-1.00	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.15-0.25
8645	0.43-0.48	0.75-1.00	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.15-0.25
8650	0.48-0.53	0.75-1.00	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.15-0.25
8655	0.50-0.60	0.75-1.00	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.15-0.25
8660	0.55-0.65	0.75-1.00	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.15-0.25
8720	0.18-0.23	0.70-0.90	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.20-0.30
8735	0.33-0.38	0.75-1.00	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.20-0.30
8740	0.38-0.43	0.75-1.00	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.20-0.30
8742	0.40-0.50	0.75-1.00	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.20-0.30
8822	0.20-0.25	0.75-1.00	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.30-0.40

CHEMICAL REQUIREMENTS FOR ALLOY STEELS

Grade A,B Designation	Chemical Composition Limits, %							
	Carbon	Manganese	Phosphorus, ^C max	Sulfur, ^{C,D} max	Silicon	Nickel	Chromium	Molybdenum
9255	0.50-0.60	0.70-0.95	0.040	0.040	1.80-2.20	—	—	—
9260	0.55-0.65	0.70-1.00	0.040	0.040	1.80-2.20	—	—	—
9262	0.55-0.65	0.75-1.00	0.040	0.040	1.80-2.20	—	0.25-0.40	—
E9310	0.08-0.13	0.45-0.65	0.025	0.025	0.15-0.35	3.00-3.50	1.00-1.40	0.08-0.15
9840	0.38-0.43	0.70-0.90	0.040	0.040	0.15-0.35	0.85-1.15	0.70-0.90	0.20-0.30
9850	0.48-0.53	0.70-0.90	0.040	0.040	0.15-0.35	0.85-1.15	0.70-0.90	0.20-0.30
50B40	0.38-0.42	0.75-1.00	0.040	0.040	0.15-0.35	—	0.40-0.60	—
50B44	0.43-0.48	0.75-1.00	0.040	0.040	0.15-0.35	—	0.40-0.60	—
50B46	0.43-0.50	0.75-1.00	0.040	0.040	0.15-0.35	—	0.20-0.35	—
50B50	0.48-0.53	0.74-1.00	0.040	0.040	0.15-0.35	—	0.40-0.60	—
50B60	0.55-0.65	0.75-1.00	0.040	0.040	0.15-0.35	—	0.40-0.60	—
51B60	0.55-0.65	0.75-1.00	0.040	0.040	0.15-0.35	—	0.70-0.90	—
81B45	0.43-0.48	0.75-1.00	0.040	0.040	0.15-0.35	0.20-0.40	0.35-0.55	0.08-0.15
86B45	0.43-0.48	0.75-1.00	0.040	0.040	0.15-0.35	0.40-0.70	0.40-0.60	0.15-0.25
94B15	0.13-0.18	0.75-1.00	0.040	0.040	0.15-0.35	0.30-0.60	0.30-0.50	0.08-0.15
94B17	0.15-0.20	0.75-1.00	0.040	0.040	0.15-0.35	0.30-0.60	0.30-0.50	0.08-0.15
94B30	0.28-0.33	0.75-1.00	0.040	0.040	0.15-0.35	0.30-0.60	0.30-0.50	0.08-0.15
94B40	0.38-0.43	0.75-1.00	0.040	0.040	0.15-0.35	0.30-0.60	0.30-0.50	0.08-0.15

^A Grades shown in this table with prefix letter E generally are manufactured by the basic-electric-furnace process. All others are normally manufactured by the basic-open-hearth process but may be manufactured by the basic-electric-furnace process with adjustments in phosphorus and sulfur.

^B Grades shown in this table with the letter B, such as 50B40, can be expected to have 0.0005% minimum boron content.

^C The phosphorus-sulfur limitations for each process are as follows:

Basic electric furnace	0.025 max %	Acid electric furnace	0.050 max %
Basic open hearth	0.040 max %	Acid open hearth	0.050 max %

^D Minimum and maximum sulfur content indicates resulfurized steels.

**TUBING SPECIFIED TO O.D. AND I.D. DIMENSIONS IS
RECOMMENDED FOR MACHINING AND OTHER
APPLICATIONS REQUIRING AN ACCURATE
INSIDE DIAMETER**

Example: Tubing specified to O.D. and I.D. dimensions 4-1/2" O.D. x 4" I.D.
O.D. 4.500"/4.513" I.D. 3.987"/4.000"
Wall $\pm$ 7.5% of .250"/.263" or .231"/.283"

Tubing specified to O.D. and Wall Dimensions 4-1/2" O.D. 1/4" wall.
O.D. 4.500"/4.513" I.D. 3.962"/4.051"
Wall $\pm$ 7.5% of .250" or .231"/.269"

MACHINING ALLOWANCES FOR TUBING FROM WAREHOUSE STOCK

The following procedure may be used to determine the proper warehouse stock size (O.D. and wall thickness) of Cold Drawn Seamless or Butt Weld Steel Tubing with sufficient allowance for machining, based on chucking true to O.D.

A = Machined O.D. (Maximum)

D = Machined I.D. (Minimum)

B = Machining allowance, O.D. or I.D.

E = Outside Diameter Tolerances

F = Percent of Wall Thickness Tolerance

Under 1-1/2" O.D.	.020"
1-1/2" to 3" Excl.	.040"
3" to 5-1/2" Excl.	.060"
5-1/2" to 8" Excl.	.080"

C = Camber in length of part, ratio per foot.

Under 5" O.D.	.020"
5" to 8" Excl.	.030"
8" to 10-3/4"	.040"

$$\text{Calculated O.D.} = A + B + C$$

Stock Size O.D. – When the calculated O.D. is not shown as available in the stock list, use the stock size O.D. listed which is next larger than the calculated O.D.

$$\text{Calculated I.D.} = D - (B + C)$$

$$\text{Calculated Wall Thickness} = \frac{(\text{Stock Size O.D.} + E - \text{Calculated I.D.}) (1.00 + F)}{2}$$

Stock Size Wall Thickness – When the calculated wall thickness is not shown as available in the stock size O.D. above, use the stock size wall thickness listed, which is next heavier.

Notes:

If the machined part is less than 4" long, or the maximum machined O.D. and minimum machined I.D. is within 4" of the chuck, camber may be ignored. Also, the formula assumes that tolerances, surface defects, eccentricity, and camber are all at the permissible maximum at the same time. Since this condition is extremely unlikely, a stock size slightly under either the calculated O.D. or wall may sometimes be used to advantage with the risk offset by the savings in material cost.