

SEAMLESS MECHANICAL TUBING

Outside Diameter Tolerances for Round Hot-Finished Tubing ^{a, b, c}

Outside Diameter Size Range, in. (mm)	Outside Diameter Tolerance, in. (mm)	
	Over	Under
Up to 2.999 (76.17)	0.020 (0.51)	0.020 (0.51)
3.000-4.499 (76.20-114.27)	0.025 (0.64)	0.025 (0.64)
4.500-5.999 (114.30-152.37)	0.031 (0.79)	0.031 (0.79)
6.000-7.499 (152.40-190.47)	0.037 (0.94)	0.037 (0.94)
7.500-8.999 (190.50-228.57)	0.045 (1.14)	0.045 (1.14)
9.000-10.750 (228.60-273.05)	0.050 (1.27)	0.050 (1.27)

- a Diameter tolerances are not applicable to normalized and tempered or quenched and tempered conditions.
- b The common range of sizes of hot finished tubes is 1-1/2 in. (38.1 mm) to 10-3/4 in. (273.0 mm) outside diameter, with wall thickness at least 3% or more of outside diameter, but not less than 0.095 in. (2.41 mm).
- c Larger sizes are available; consult manufacturer for sizes and tolerances.

Wall Thickness Tolerances for Round Hot-Finished Tubing

Wall Thickness Range as Percent of Outside Diameter	Wall Thickness Tolerance, ^a percent Over and Under Nominal		
	Outside Diameter 2.999 in. (76.19 mm) and smaller	Outside Diameter 3.000 in. (76.20 mm) to 5.999 in. (152.37 mm)	Outside Diameter 6.000 in. (152.40 mm) to 10.750 in. (273.05 mm)
Under 15	12.5	10.0	10.0
15 and over	10.0	7.5	10.0

^a Wall thickness tolerances may not be applicable to walls 0.199 in. (5.05 mm) and less; consult manufacturer for wall tolerances on such tube sizes.

Straightness Tolerances for Seamless Round Mechanical Tubing

NOTE 1 – The straightness variation for any 3 ft. (0.09 m) of length is measured with a 3-ft. straight-edge and the use of a feeler gage. The total variation, that is the maximum curvature at any point in the total length of the tube, is determined by rolling the tube on a surface plate and measuring the concavity with a feeler gage.

NOTE 2– The tolerances apply generally to unannealed, finish-annealed, and medium-annealed cold-finished or hot-finished tubes. When straightening stresses would interfere with the use of the end product, the straightness tolerances shown do not apply when tubing is specified "not to be straightened after furnace treatment." These straightness tolerances do not apply to soft-annealed or quenched and tempered tubes.

Size Limits	Maximum Curvature in any 3 ft. in. (mm)	Maximum Curvature in Total Lengths in. (mm)	Maximum Curvature for Lengths Under 3 ft. or 1 m
O.D. 5 in. (127.0 mm) and smaller. Wall thickness, over 3% of O.D.	0.030 (0.83)	$0.030 \times (\text{no. of ft. of length}/3)$ (0.83 x no. of m of length)	ratio of 0.010 in./ft. or 0.83 mm/m
O.D. over 5 to 8 in. (127.0 to 203.2 mm), incl. Wall thickness, over 4% of O.D.	0.045 (1.25)	$0.045 \times (\text{no. of ft. of length}/3)$ (1.25 x no. of m of length)	ratio of 0.015 in./ft. or 1.25 mm/m
O.D. over 8 to 12-3/4 in. (203.2 to 323.8 mm), incl. Wall thickness, over 4% of O.D.	0.060 (1.67)	$0.060 \times (\text{no. of ft. of length}/3)$ (1.67 x no. of m of length)	ratio of 0.020 in./ft. or 16.7 mm/m

Length Tolerances for Round Hot-Finished or Cold-Finished Tubing

NOTE – The producer should be consulted for length tolerances for tubes produced by liquid- or air-quenching heat treatment.

Length, ft. (m)	Outside Diameter, in. (mm)	Tolerance, in. (mm)	
		Over	Under
4 (1.2) and under	up to 2 (50.8), incl.	1/16 (1.6)	0
4 (1.2) and under	over 2 to 4 (50.8 to 101.6), incl.	3/32 (2.4)	0
4 (1.2) and under	over 4 (101.6)	1/8 (3.2)	0
Over 4 to 10 (1.2 to 3.0), incl.	up to 2 (50.8), incl.	3/32 (2.4)	0
Over 4 to 10 (1.2 to 3.0), incl.	Over 2 (50.8)	1/8 (3.2)	0
Over 10 to 24 (3.0 to 7.3), incl.	all sizes	3/16 (4.8)	0
Over 24 (7.3)	all sizes	3/16 + 1/2 (4.8 + 12.7) for each 10 ft. (3.0 m) or fraction over 24 ft. (7.3 m)	0

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.