SEAMLESS MECHANICAL TUBING TOLERANCES

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)
4.500-5.599 (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. (2.41mm).
[c] Larger sizes are available; consult manufacturer for sizes and tolerances.

Outside and Inside Diameter Tolerances for Round Cold-Worked Tubing[a, b, c]

Outside Diameter Size Range, in.[d]	Wall Thickness As Percent of Outside Diameter	Thermal Treatment after Final Cold Work Producing Size											
		None, or not exceeding 1100 F Nominal Temperature				Heated Above 1100 F Nominal Temperature Without Accelerated Cooling				Quenched and Tempered			
		OD, in.[d]		ID, in.[d]		OD, in.[d]		ID, in.[d]		OD, in.[d]		ID, in.[d]	
		Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under
Up to 0.499	all	0.004	0.000	—	—	0.005	0.002	—	—	0.010	0.010	0.010	0.010
0.500-1.699	all	0.005	0.000	0.000	0.005	0.007	0.002	0.002	0.007	0.015	0.015	0.015	0.015
1.700-2.099	all	0.006	0.000	0.000	0.006	0.006	0.005	0.005	0.996	0.020	0.020	0.020	0.020
2.100-2.499	all	0.007	0.000	0.000	0.007	0.008	0.005	0.005	0.008	0.023	0.023	0.023	0.023
2.500-2.899	all	0.008	0.000	0.000	0.008	0.009	0.005	0.005	0.009	0.025	0.025	0.025	0.025
2.900-3.299	all	0.009	0.000	0.000	0.009	0.011	0.005	0.005	0.011	0.028	0.028	0.028	0.028
3.300-3.699	all	0.010	0.000	0.000	0.010	0.013	0.005	0.005	0.013	0.030	0.030	0.030	0.030
3.700-4.099	all	0.011	0.000	0.000	0.011	0.013	0.007	0.010	0.010	0.033	0.033	0.033	0.033
4.100-4.499	all	0.012	0.000	0.000	0.012	0.014	0.007	0.011	0.011	0.036	0.036	0.036	0.036
4.500-4.899	all	0.013	0.000	0.000	0.013	0.016	0.007	0.012	0.012	0.038	0.038	0.038	0.038
4.900-5.299	all	0.014	0.000	0.000	0.014	0.018	0.007	0.013	0.013	0.041	0.041	0.041	0.041
5.300-5.549	all	0.015	0.000	0.000	0.015	0.020	0.007	0.014	0.014	0.044	0.044	0.044	0.044
5.550-5.999	under 6	0.010	0.010	0.010	0.010	0.018	0.018	0.018	0.018				
	6 to 71/2	0.009	0.009	0.009	0.009	0.016	0.016	0.016	0.016				
	over 71/2	0.018	0.000	0.009	0.009	0.017	0.015	0.016	0.016				
6.000-6.499	under 6	0.013	0.013	0.013	0.013	0.023	0.023	0.023	0.023				
	6 to 71/2	0.010	0.010	0.010	0.010	0.018	0.018	0.018	0.018				
	over 71/2	0.020	0.000	0.010	0.010	0.020	0.015	0.018	0.018				
6.500-6.999	under 6	0.015	0.015	0.015	0.015	0.027	0.027	0.027	0.027				
	6 to 71/2	0.012	0.012	0.012	0.012	0.021	0.021	0.021	0.021				
	over 71/2	0.023	0.000	0.012	0.012	0.026	0.015	0.021	0.021				
7.000-7.4999	under 6	0.018	0.018	0.018	0.018	0.032	0.032	0.032	0.032				
	6 to 71/2	0.013	0.013	0.013	0.013	0.023	0.023	0.023	0.023				
	over 71/2	0.026	0.000	0.013	0.013	0.031	0.015	0.023	0.023				
7.500-7.999	under 6	0.020	0.020	0.020	0.020	0.035	0.035	0.035	0.035				
	6 to 71/2	0.015	0.015	0.015	0.015	0.026	0.026	0.026	0.026				
	over 71/2	0.029	0.000	0.015	0.015	0.036	0.015	0.026	0.026				
8.000-8.499	under 6	0.023	0.023	0.023	0.023	0.041	0.041	0.041	0.041				
	6 to 71/2	0.016	0.016	0.016	0.016	0.028	0.028	0.028	0.028				
	over 71/2	0.031	0.000	0.015	0.016	0.033	0.022	0.028	0.028				
8.500-8.999	under 6	0.025	0.025	0.025	0.025	0.044	0.044	0.044	0.044				
	6 to 71/2	0.017	0.017	0.017	0.017	0.030	0.030	0.030	0.030				
	over 71/2	0.034	0.000	0.015	0.019	0.038	0.022	0.030	0.030				
9.000-9.499	under 6	0.028	0.028	0.028	0.028	0.045	0.045	0.049	0.049				
	6 to 71/2	0.019	0.019	0.019	0.019	0.033	0.033	0.033	0.033				
	over 71/2	0.037	0.000	0.015	0.022	0.043	0.022	0.033	0.033				
9.500-9.999	under 6	0.030	0.030	0.030	0.030	0.045	0.045	0.053	0.053				
	6 to 71/2	0.020	0.020	0.020	0.020	0.035	0.035	0.035	0.035				
	over 71/2	0.040	0.000	0.015	0.025	0.048	0.022	0.035	0.035				
10.000-10.999	under 6	0.034	0.034	0.034	0.034	0.045	0.045	0.060	0.060				
	6 to 71/2	0.022	0.022	0.022	0.022	0.039	0.039	0.039	0.039				
	over 71/2	0.044	0.000	0.015	0.029	0.055	0.022	0.039	0.039				
11.000-12.000	under 6	0.035	0.035	0.035	0.035	0.050	0.050	0.065	0.065				
	6 to 71/2	0.025	0.025	0.025	0.025	0.045	0.045	0.045	0.045				
	over 71/2	0.045	0.000	0.015	0.035	0.060	0.022	0.045	0.045				

[a] Many tubes with inside diameter less than 50% of outside diameter or with wall thickness more than 25% of outside diameter, or with wall thickness over 1 1/4 in., or weighing more than 90 lb/ft. are difficult to draw over a mandrel. Therefore, the inside diameter can vary over or under by an amount equal to 10% of the wall thickness. See also Footnote b.

[b] For those tubes with inside diameter less than 1/2 in. (or less than 5/8 in. when the wall thickness is more than 20% of the outside diameter), which are not commonly drawn over a mandrel, Footnote a is not applicable. Therefore, for those tubes, the inside diameter is governed by the outside diameter tolerance shown in this table and the wall thickness tolerances shown in Table 7b.

[c] Tubing having a wall thickness less than 3% of the outside diameter cannot be straightened properly without a certain amount of distortion. Consequently such tubes, while having an average outside diameter and inside diameter within the tolerances shown in this table, require an overality tolerance of 1/2% over and under nominal diameter, this being in addition to the tolerances indicated in this table.

[d] 1 in. = 25.4 mm.

SEAMLESS MECHANICAL TUBING TOLERANCES

TABLE 7b. Wall Thickness Tolerance for Round Cold-Worked Tubing

Wall Thickness Range as % of Outside Diameter	Wall Thickness Tolerance, Over and Under Nominal, %	
	Up to 1.499 in., ID	1.500 in. and Over
25 and under	10.0	7.5
Over 25	12.5	10.0

Wall Thickness Tolerance for Round Hot Finished Tubing

Wall Thickness Range as Percent Outside Diameter	Wall Thickness Tolerance,[a] percent Over and Under		
	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. (0.9 m) of length is measured with a 3-ft. straightedge 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
OD 5 in. (127.0 mm) and smaller. Wall thickness, over 3% of OD but not over 0.5 in. (12.7 mm)	0.030 (0.83)	0.030 x (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
OD over 5 to 8 in. (127.0 mm to 203.2 mm), incl. -Wall thickness, over 4% of OD but not over 0.75 in. (19.0 mm)	0.045 (1.25)	0.045 x (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
OD over 8 to 12 1/2 in. (203.2 to 323.8 mm), incl. -Wall thickness, over 4% of OD but not over 1 in. (25.4 mm)	0.045 (1.25)	0.045 x (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

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

NOTE 1 — The producer should be consulted for length tolerances for tubes produced by liquid- or air-quenching heat treatment.

Length, ft (mm)	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.	over 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 traction over 24 ft (7.3 m)	0

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 ± 7.5% of .250/.263" or .231/.283"

Tubing specified to O.D. and Wall Dimensions 4 1/2" O.D. x 1/4" wall.
O.D. 4.500/4.513" I.D. 3.962/4.051"
Wall ± 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 of Buttweld Steel Tubing with sufficient allowance for machining, based on chucking true to O.D.

A = Machined O.D. (Maximum)

B = Machined O.D. (Maximum) or I.D.

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

C = Camber in length of part. ration per foot

Under 5" O.D.	.020"
5" to 8" Excel.	.030"
8" to 10 1/4" Excel.	.040"

D = Machined I.D. (Minimum)

E = Outside Diameter Tolerance

F = Percent of Wall Thickness Tolerance

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.

Calculated I.D. = D – (B + C)

Calculated Wall Thickness =

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

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 off-set by the savings in material cost.

AVERAGE PHYSICAL PROPERTIES OF C.D.S.M

C-1018	
Minimum Yield Point	**65,000 PSI**
Minimum Tensile Strength	**75,000 PSI**
Minimum Elongation in 2"	**5%**
Rockwell "B"	**80**
C-1020	
Minimum Yield Point	**60,000 PSI**
Minimum Tensile Strength	**70,000 PSI**
Minimum Elongation in 2"	**5%**
Rockwell "B"	**75**
C-1026	
Minimum Yield Point	**70,000 PSI**
Minimum Tensile Strength	**80,000 PSI**
Minimum Elongation in 2"	**5%**
Rockwell "B"	**83**

STEEL TUBING TOLERANCES

TOLERANCES

Diameter Tolerances for Type 1 (A.W.H.R.) Round Tubing

NOTE — Measurements for diameter are to be taken at least 2 in.[a] from the ends of the tubes.

Outside Diameter Flange, in.[a]	Wall Thickness		Flash-in-Tubing[b,c]	Flash Controlled to 0.010 in max Tubing[c,e]	Flash Controlled to 0.005 in. max Tubing[d,e]	
	Bw[f]	in.[a]	Outside Diameter Plus and Minus	Outside Diameter Plus and Minus	Outside Diameter Plus and Minus	Inside Diameter Plus and Minus
			Tolerances, in.[a,g]			
3/4 to 1 1/8 incl	16 to 10	0.065 to 0.134	0.0035		0.0035	0.020
Over 1 1/8 to 2, incl	16 to 14	0.065 to 0.083	0.005	0.005	0.005	0.021
Over 1 1/8 to 2, incl	13 to 7	0.095 to 0.180	0.005	0.005	0.005	0.025
Over 1 1/8 to 2, incl	6 to 5	0.203 to 0.220	0.005	0.005	0.005	0.029
Over 1 1/8 to 2, incl	4 to 3	0.238 to 0.259	0.005	0.005	0.005	0.039
Over 2 to 2 1/2, incl	16 to 14	0.065 to 0.083	0.006	0.006	0.006	0.022
Over 2 to 2 1/2, incl	13 to 5	0.095 to 0.220	0.006	0.006	0.006	0.024
Over 2 to 2 1/2, incl	4 to 3	0.238 to 0.259	0.006	0.006	0.006	0.040
Over 2 to 3, incl	16 to 14	0.065 to 0.083	0.008	0.008	0.008	0.024
Over 2 to 3, incl	13 to 5	0.095 to 0.220	0.008	0.008	0.008	0.026
Over 2 to 3, incl	4 to 3	0.238 to 0.259	0.008	0.008	0.008	0.040
Over 2 to 3, incl	2 to 0.320	0.284 to 0.320	0.010	0.010	0.010	0.048
Over 3 to 3 1/2, incl	16 to 14	0.065 to 0.083	0.009	0.009	0.009	0.025
Over 3 to 3 1/2, incl	13 to 5	0.095 to 0.220	0.009	0.009	0.009	0.027
Over 3 to 3 1/2, incl	4 to 3	0.238 to 0.259	0.009	0.009	0.009	0.043
Over 3 to 3 1/2, incl	2 to 0.360	0.284 to 0.360	0.012	0.012	0.012	0.050
Over 3 1/2 to 4, incl	16 to 14	0.065 to 0.083	0.010	0.010	0.010	0.026
Over 3 1/2 to 4, incl	13 to 5	0.095 to 0.220	0.010	0.010	0.010	0.028
Over 3 1/2 to 4, incl	4 to 3	0.238 to 0.259	0.010	0.010	0.010	0.044
Over 3 1/2 to 4, incl	2 to 0.500	0.284 to 0.500	0.015	0.015	0.015	0.053
Over 4 to 5, incl	16 to 14	0.065 to 0.083	0.020	0.020	0.020	0.036
Over 4 to 5, incl	13 to 5	0.095 to 0.220	0.020	0.020	0.020	0.045
Over 4 to 5, incl	4 to 3	0.238 to 0.259	0.020	0.020	0.020	0.054
Over 4 to 5, incl	2 to 0.500	0.284 to 0.500	0.020	0.020	0.020	0.058
Over 5 to 6, incl	16 to 10	0.065 to 0.134	0.020	0.020	0.020	0.036
Over 5 to 6, incl	9 to 5	0.148 to 0.220	0.020	0.020	0.020	0.040
Over 5 to 6, incl	4 to 3	0.238 to 0.259	0.020	0.020	0.020	0.054
Over 5 to 6, incl	2 to 0.500	0.284 to 0.500	0.020	0.020	0.020	0.058
Over 6 to 8, incl	11 to 10	0.120 to 0.134	0.025	0.025	0.025	0.043
Over 6 to 8, incl	9 to 5	0.148 to 0.220	0.025	0.025	0.025	0.045
Over 6 to 8, incl	4 to 3	0.238 to 0.259	0.025	0.025	0.025	0.059
Over 6 to 8, incl	2 to 0.500	0.284 to 0.500	0.025	0.025	0.025	0.063

[a] 1 in. = 25.4 mm

[b] Flash-In-Tubing is produced only to outside diameter tolerances and wall thickness tolerances and the inside diameter welding flash does not exceed the wall thickness or 3/32 in., whichever is less.

[c] Flash Controlled to 0.010 in. max tubing consists of tubing over 1 1/8 in. outside diameter which is commonly produced only to outside diameter tolerances and wall thickness tolerances, in which the height of the remaining welding flash is controlled not to exceed 0.010 in.

[d] Flash Controlled to 0.005 in. max tubing is produced to outside diameters and wall thickness tolerances, inside diameter and wall thickness tolerances, or outside diameters and inside diameter tolerances, in which the height of the remaining flash is controlled not to exceed 0.005 in. Any remaining flash is considered to be part of the applicable inside diameter tolerances.

[e] No Flash tubing is further processed for closer tolerances with mandrel tubing produced to outside diameter and wall, inside diameter and wall, or outside diameter and inside diameter to tolerances with no dimensional indication of inside diameter flash. This condition is available in Types 5 and 6.

[f] Birmingham Wire Gage

[g] The ovality shall be within the above tolerances except when the wall thickness is less than 3% of the outside diameter, in such cases see 11.6.1.

Wall Thickness Tolerance for Type 2 (A.W.C.R.) Round Tubing

Wall Thickness		Outside Diameter, in.[a]											
		3/8 to 7/8, incl		Over 7/8 to 1 15/16, incl		Over 1 7/8 to 3 3/4, incl		Over 3 3/4 to 5, incl		Over 5 to 6, incl		Over 6 to 8 incl	
in.[a]	Bwg[b]	Wall Thickness Tolerances, in.,[b] plus or minus											
		Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
0.028	22	0.001	0.005	0.001	0.005								
0.035	20	0.002	0.005	0.001	0.005	0.001	0.005						
0.040	18	0.003	0.005	0.002	0.006	0.002	0.006						
0.065	16	0.004	0.007	0.004	0.007	0.004	0.007	0.004	0.007	0.004	0.007		
0.083	14	0.005	0.007	0.005	0.007	0.004	0.007	0.004	0.007	0.004	0.008	0.004	0.008
0.095	13	0.006	0.007	0.005	0.007	0.004	0.007	0.004	0.007	0.004	0.008	0.004	0.008
0.109	12			0.006	0.008	0.005	0.008	0.005	0.008	0.005	0.009	0.005	0.009
0.120	11			0.007	0.008	0.006	0.008	0.005	0.008	0.005	0.009	0.005	0.009
0.134	10			0.007	0.008	0.006	0.008	0.005	0.008	0.005	0.009	0.005	0.009

[a] 1 in. = 25.4 mm

[b] Birmingham Wire Gage

Diameter Tolerances for Type 2 (A.W.C.R.) Round Tubing

NOTE — Measurements for diameter are to be taken at least 2 in.[a] from the ends of the tubes.

Outside Diameter Flange, in.[a]	Wall Thickness		Flash-in-Tubing[b]	Flash Controlled to 0.010 in max Tubing[c]	Flash Controlled[d] to 0.005 in. max Tubing	
	Bw[e]	in.[a]	Outside Diameter Plus and Minus	Outside Diameter Plus and Minus	Outside Diameter Plus and Minus	Inside Diameter Plus and Minus
			Tolerances, in.[f]			
3/8 to 5/8 incl	22 to 16	0.028 to 0.065	0.003			
Over 5/8 to 1 1/8, incl	22 to 20	0.028 to 0.035	0.0035	0.0035	0.0035	0.013
Over 5/8 to 1 1/8, incl	18	0.049	0.0035	0.0035	0.0035	0.015
Over 5/8 to 1 1/8, incl	16 to 14	0.065 to 0.083	0.0035	0.0035	0.0035	0.019
Over 3/4 to 1 1/8, incl	13	0.095	0.0035	0.0035	0.0035	0.019
Over 7/8 to 1 1/8, incl	12 to 11	0.091 to 0.120	0.0035	0.0035	0.0035	0.021
Over 1 1/8 to 2, incl	22 to 18	0.028 to 0.049	0.005	0.005	0.005	0.015
Over 1 1/8 to 2, incl,	16 to 13	0.065 to 0.095	0.005	0.005	0.005	0.019
Over 1 1/8 to 2, incl	12 to 10	0.109 to 0.134	0.005	0.005	0.005	0.022
Over 2 to 2 1/2, incl	20 to 18	0.035 to 0.049	0.006	0.006	0.006	0.016
Over 2 to 2 1/2, incl	16 to 13	0.065 to 0.095	0.006	0.006	0.006	0.020
Over 2 to 2 1/2, incl	12 to 10	0.109 to 0.134	0.006	0.006	0.006	0.023
Over 2 1/2 to 3, incl	20 to 18	0.035 to 0.049	0.008	0.008	0.008	0.018
Over 2 1/2 to 3, incl	16 to 13	0.065 to 0.095	0.008	0.008	0.008	0.022
Over 2 1/2 to 3, incl	12 to 10	0.109 to 0.134	0.008	0.008	0.008	0.025
Over 3 to 3 1/2, incl	20 to 18	0.035 to 0.049	0.009	0.009	0.009	0.019
Over 3 to 3 1/2, incl	16 to 13	0.065 to 0.095	0.009	0.009	0.009	0.023
Over 3 to 3 1/2, incl	12 to 10	0.109 to 0.134	0.009	0.009	0.009	0.026
Over 3 1/2 to 4, incl	20 to 18	0.035 to 0.049	0.010	0.010	0.010	0.020
Over 3 1/2 to 4, incl	16 to 13	0.065 to 0.095	0.010	0.010	0.010	0.024
Over 3 1/2 to 4, incl	12 to 10	0.109 to 0.134	0.010	0.010	0.010	0.027
Over 4 to 6, incl	16 to 13	0.065 to 0.095	0.020	0.020	0.020	0.037
Over 4 to 6, incl	12 to 10	0.109 to 0.134	0.020	0.020	0.020	0.034
Over 6 to 8, incl	14 to 13	0.083 to 0.095	0.025	0.025	0.025	0.039
Over 6 to 8, incl	12 to 10	0.109 to 0.134	0.025	0.025	0.025	0.042

[a] 1 in. = 25.4 mm

[b] Flash-In-Tubing is produced to outside diameter tolerances and wall thickness tolerances only, and the height of inside welding flash does not exceed the wall thickness or 3/32 in., whichever is less.

[c] Flash Controlled to 0.010 in. max tubing consists of tubing over 5/8 in. outside diameter which is commonly produced to outside diameter tolerances and wall thickness tolerances only, in which the height of the remaining welding flash is controlled not to exceed 0.010 in.

[d] Flash Controlled to 0.005 in. max tubing is produced to outside diameters tolerances and wall thickness tolerances, inside diameter tolerances and wall thickness tolerances, or outside diameters tolerances and inside diameter tolerances, in which the height of the remaining flash is controlled not to exceed 0.005 in. Any remaining flash is considered to be part of the applicable inside diameter tolerances.

[e] Birmingham Wire Gage

[f] The ovality shall be within the above tolerances except when the wall thickness is less than 3% of the outside diameter, in such cases see 11.6.1.

Wall Thickness Tolerance for Type 1 (A.W.H.R.) Round Tubing

Wall Thickness		Outside Diameter, in.[a]											
		3/4 to 1, incl		Over 1 to 1 15/16, incl		Over 1 15/16 to 3 3/4, incl		Over 3 3/4 to 4 1/2, incl		Over 4 1/2 to 6, incl		Over 6 to 8 incl	
in.[a]	Bwg[b]	Wall Thickness Tolerances, in., plus or minus											
		Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
0.065	16	0.005	0.009	0.004	0.010	0.003	0.011	0.002	0.012	0.002	0.012		
0.072	15	0.005	0.009	0.004	0.010	0.003	0.011	0.002	0.012	0.002	0.012		
0.083	14	0.006	0.010	0.005	0.011	0.004	0.012	0.003	0.013	0.003	0.013		
0.095	13	0.006	0.010	0.005	0.011	0.004	0.012	0.003	0.013	0.003	0.013		
0.109	12	0.006	0.010	0.005	0.011	0.004	0.012	0.003	0.013	0.003	0.013	0.003	0.013
0.120	11	0.006	0.010	0.005	0.011	0.004	0.012	0.003	0.013	0.003	0.013	0.003	0.013
0.134	10	0.006	0.010	0.005	0.011	0.004	0.012	0.003	0.013	0.003	0.013	0.003	0.013
0.148	9			0.006	0.012	0.005	0.013	0.004	0.014	0.004	0.014	0.004	0.014
0.165	8			0.006	0.012	0.005	0.013	0.004	0.014	0.004	0.014	0.004	0.014
0.180	7			0.006	0.012	0.005	0.013	0.004	0.014	0.004	0.014	0.004	0.014
0.203	6					0.007	0.015	0.006	0.016	0.005	0.017	0.005	0.017
0.220	5					0.007	0.015	0.006	0.016	0.005	0.017	0.005	0.017
0.238	4					0.012	0.020	0.011	0.021	0.010	0.022	0.010	0.022
0.259	3					0.013	0.021	0.012	0.022	0.011	0.023	0.011	0.023
0.284	2					0.014	0.022	0.013	0.023	0.012	0.024	0.012	0.024
0.300	1					0.015	0.023	0.014	0.024	0.013	0.025	0.013	0.025
0.320						0.016	0.024	0.015	0.025	0.014	0.026	0.014	0.026
0.344						0.017	0.025	0.016	0.026	0.015	0.027	0.015	0.027
0.360						0.017	0.025	0.016	0.026	0.015	0.027	0.015	0.027
0.375								0.016	0.026	0.015	0.027	0.015	0.027
0.406								0.017	0.027	0.016	0.028	0.016	0.028
0.438								0.017	0.027	0.016	0.028	0.016	0.028
0.469										0.016	0.028	0.016	0.028
0.500										0.016	0.028	0.016	0.028

[a] 1 in. = 25.4 mm

[b] Birmingham Wire Gage

DRAWN OVER MANDREL TOLERANCES

WALL THICKNESS TOLERANCES

Wall Thickness, Inch	.375 to .875	Over .875 to 1.875	Over 1.875 to 3.750	Over 3.750 to 2.500
.028	+.002 –.002	+.002 –.002	+.002 –.002	
.035	+.002 –.002	+.002 –.003	+.002 –.003	
.049	+.002 –.002	+.002 –.003	+.002 –.003	
.065	+.002 –.002	+.002 –.003	+.002 –.003	+.004 –.004
.083	+.002 –.002	+.002 –.003	+.003 –.003	+.004 –.005
.095	+.002 –.002	+.002 –.003	+.003 –.003	+.004 –.005
.109	+.002 –.003	+.002 –.004	+.003 –.003	+.005 –.005
.120	+.003 –.003	+.002 –.004	+.003 –.003	+.005 –.005
.134		+.002 –.004	+.003 –.003	+.005 –.005
.148		+.002 –.004	+.003 –.003	+.005 –.005
.165		+.003 –.004	+.003 –.004	+.005 –.006
.180		+.004 –.004	+.003 –.005	+.006 –.006
.203		+.004 –.005	+.004 –.005	+.006 –.007
.220			+.004 –.006	+.007 –.007
.238			+.005 –.006	+.007 –.007
.259			+.005 –.006	+.007 –.007
.284			+.005 –.006	+.007 –.007
.300			+.006 –.006	+.008 –.008
.320			+.007 –.007	+.008 –.008
.344			+.008 –.008	+.009 –.009
.375				+.009 –.009
.400				+.010 –.010
.438				+.011 –.011
.480				+.012 –.012
.531				+.013 –.013
.563				+.013 –.013
.580				+.014 –.014

For intermediate wall:
Use the tolerance for the nearest listed wall. If the intermediate wall falls equally between two listed walls, use the greater tolerance.

OD & ID TOLERANCES

OD Size Range	OD, Inches Over	OD, Inches Under	ID, Inches Over	ID, Inches Under
Up to 0.500	.004	.000		
0.500 – 1.699	.005	.000	.000	.005
1.700 – 2.099	.006	.000	.000	.006
2.100 – 2.499	.007	.000	.000	.007
2.500 – 2.899	.008	.000	.000	.008
2.900 – 3.299	.009	.000	.000	.009
3.300 – 3.699	.010	.000	.000	.010
3.700 – 4.099	.011	.000	.000	.011
4.100 – 4.499	.012	.000	.000	.012
4.500 – 4.899	.013	.000	.000	.013
4.900 – 5.299	.014	.000	.000	.014
5.300 – 5.499	.015	.000	.000	.015
5.500 – 5.999	.010	.010	.010	.010
6.000 – 6.499	.013	.013	.013	.013
6.500 – 6.999	.015	.015	.015	.015
7.000 – 7.499	.018	.018	.018	.018
7.500 – 7.999	.020	.020	.020	.020
8.000 – 8.499	.023	.023	.023	.023
8.500 – 8.999	.025	.025	.025	.025
9.000 – 9.499	.028	.028	.028	.028
9.500 – 9.999	.030	.030	.030	.030
10.000 – 10.999	.034	.034	.034	.034
11.000 – 11.999	.035	.035	.035	.035
12.000 – 12.999	.037	.037	.037	.037

The ovality shall be within the above tolerance except when the wall thickness is less than 3% of the OD. In such cass the additional ovality shall be as follows, but the mean diameter shall be within the specified tolerance.

	Over OD, Inches		Additional Ovality Tolerance, Inch
Up to 2.000			.010
Over	2.000 – 3.000	Incl.	.015
Over	3.000 – 4.000	Incl.	.020
Over	4.000 – 5.000	Incl.	.025
Over	5.000 – 6.000	Incl.	.030
Over	6.000 – 7.000	Incl.	.035
Over	7.000 – 8.000	Incl.	.040
Over	8.000 – 9.000	Incl.	.045
Over	9.000 – 10.000	Incl.	.050
Over	10.000 – 11.000	Incl.	.055
Over	11.000 – 12.000	Incl.	.060
Over	12.000 – 12.500	Incl.	.060

REFERENCE FORMULAS:

TO FIND WALL: OD – ID ÷ 2 = WALL **TO FIND OD:** ID +(2 x WALL)= OD **TO FIND ID:** OD – (2 x WALL)= ID
TO FIND WEIGHT PER FOOT/ROUND/STEEL TUBING: OD – WALL x WALL x 10.68 = WPF
TO FIND WEIGHT PER FOOT OF ROUND STEEL BAR: DIA x DIA x 2.69 = WPF