PENNSYLVANIA STEEL COMPANY

PSC INCORPORATED

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All information provided is for general reference only and not be used for engineering or design purposes.

STRUCTURAL STEEL TUBE

Carbon Steel Squares & Rectangles A500

PSC INCORPORATED

DIMENSIONAL TOLERANCES

OUTSIDE DIAMETER:

LARGEST OUTSIDE DIMENSION	OUTSIDE TOLERANCE INCLUDING CONVEXITY AND CONCAVITY
up to 2½"	+.020"
over 2½" to 3½" inclusive	+.025"
over 3½" to 5½" inclusive	+.030"
over 5½"	+1%

Tolerances include allowance for convexity or concavity. For rectangular sections, the tolerance calculated for the larger flat dimension shall also apply to the smaller flat dimension. This tolerance may be increased 50 percent when applied to the smaller dimension, if the ratio of cross sectional dimensions is between 1.5 and 3, and 100 percent when the ratio exceeds 3.

WALL THICKNESS

Maximum Allowable Variation ..... +10%
(wall thickness is to be measured at the center of the flat, exclusive of the weld area, and not at corners)

CORNER RADII

The radius of any outside corner shall not exceed three times the specified wall thickness.

TWIST

LONGEST OUTSIDE DIMENSION	MAXIMUM TWIST PER 3 FEET OF LENGTH
2" to 2½%" inclusive	.062"
over 2½%" to 4" inclusive	.075"
over 4" to 6" inclusive	.087"
over 6" to 8" inclusive	.100"
over 8"	.112"

STRAIGHTNESS:

Permissible variation shall be 1/8" times the number of feet of total length divided by 5:

.125" x (total length) ÷ 5

SQUARENESS OF SIDES:

Adjacent sides may deviate from 90 degrees by a tolerance of plus or minus 2 degrees maximum.

FLASH:

Structural tubing usually is supplied flash-in. The height of the flash will vary with the wall thickness of the tube.

CHEMICAL COMPOSITION CHEMISTRY - LADLE ANALYSIS

GRADE DESIGNATION	CARBON	MANGANESE	PHOSPHOROUS	SULFUR
A501(A36)	0.26% max	-	0.04% max	0.05% max
A500A	0.26% max	-	0.04% max	0.05% max
A500B	0.26% max	-	0.04% max	0.05% max
A500C	0.23% max	1.35% max	0.04% max	0.05% max

Copper, when copper steel is specified, 0.20 minimum.

MECHANICAL PROPERTIES

GRADE DESIGNATION	GRADE CONDITION	TENSILE STRENGTH MINIMUM	YIELD STRENGTH MINIMUM	ELONGATION IN 2 INCHES MINIMUM
A501 (A36)	Hot Formed	58,000 psi	36,000 psi	23%
A500A	Cold Formed	45,000 psi	39,000 psi	25%
A500B	Cold Formed	58,000 psi	46,000 psi	23%
A500C	Cold Formed	62,000 psi	50,000 psi	21%

STRUCTURAL STEEL TUBE

Physical Properties

Round Structural Tubing	Grade A	Grade B	Grade C	Grade D
Tensile strength, min, psi (MPa)	45 000 (310)	58 000 (400)	62 000 (427)	58 000 (400)
Yield strength, min, psi (MPa)	33 000 (228)	42 000 (290)	46 000 (317)	36 000 (250)
Elongation in 2in. (50.8 mm), min, %D	25[A]	23[B]	21[C]	23[B]
Shaped Structural Tubing	**Grade A**	**Grade B**	**Grade C**	**Grade D**
Tensile strength, min, psi (MPa)	45 000 (310)	58 000 (400)	62 000 (427)	58 000 (400)
Yield strength, min, psi (MPa)	39 000 (269)	46 000 (317)	50 000 (345)	36 000 (250)
Elongation in 2in. (50.8 mm), min, %D	25[A]	23[B]	21[C]	23[B]

[A] Applies to specified wall thicknesses 0.120 in. (3.05 mm) and over. For wall thicknesses under 0.120 in., the minimum elongation shall be calculated by the formula: percent elongation in 2 in. = 56t + 17.5.

[B] Applies to specified wall thicknesses 0.180 in. (4.75 mm) and over. For wall thicknesses under 0.180 in., the minimum elongation shall be calculated by the formula: percent elongation in 2 in. = 61t + 12.

[C] Applies to specified wall thicknesses 0.120 in. (3.05 mm) and over. For lighter wall thicknesses, elongation shall be by agreement with the manufacturer.

[D] The minimum elongation values specified apply only to the tests performed prior to shipment of the tubing.

The following table gives calculated minimum values for longitudinal strip tests; where an ellipsis (...) appears in this table, there is no requirement

Wall thickness, in. (mm)	Elongation in 2 in. (50.8 mm), min, %	
	Grade A	Grade B
0.180 (4.57)	...	23
0.165 (4.19)	...	22
0.148 (3.76)	...	21
0.134 (3.40)	...	20
0.120 (3.05)	25	19.5
0.109 (2.77)	23.5	19
0.095 (2.41)	23	18
0.083 (2.11)	22	17
0.065 (1.65)	21	16
0.049 (1.24)	20	15
0.035 (0.89)	19.5	14

Permissible Variations in Dimensions

Outside Dimensions:

Round Structural Tubing - The outside diameter shall not vary more than +0.5% rounded to the nearest 0.005 in. (0.13 mm), of the nominal outside diameter size specified, for nominal outside diameters 1.900 in. (48.3 mm) and smaller, and +0.75% rounded to the nearest 0.005 in., of the nominal outside diameter for nominal outside diameters 2.00 in. (50.8 mm) and larger. The outside diameter measurements shall be made at positions at least 2 in. (50.8 mm) from the ends of the tubing.

WELDED MECHANICAL TUBING

Square, Rectangular, Shaped Tube A513

PSC INCORPORATED

Tolerances, Outside Dimensions* - Squares and Rectangles

Largest Nominal Outside Dimension, In.	Wall Thickness, In.	Outside Tolerance at All Sides at Corners = in.
3/16 to 3/8, incl.	0.020 to 0.083, incl.	0.004
Over 3/8 to 1 1¼, incl.	0.025 to 0.156, incl.	0.005
Over 1¼ to 1½, incl.	0.025 to 0.192, incl.	0.006
Over 1½ to 2, incl.	0.032 to 0.192, incl.	0.008
Over 2 to 3, incl.	0.035 to 0.259, incl.	0.010
Over 3 to 4, incl.	0.049 to 0.259, incl.	0.020
Over 4 to 6, incl.	0.065 to 0.259, incl.	0.020
Over 6 to 8, incl.	0.185 to 0.259, incl.	0.025

*Measured at corners at least 2 in. from the cut end of the tubing.

Convexity and concavity: Tubes having two parallel sides are also measured in the center of the flat sides for convexity and concavity. This tolerance applies to the specific size determined at the corners, and is measured on the following basis:

Largest Nominal Outside Dimension, In.	Tolerance Plus and Minus, In.
2½ and under	0.010
Over 2½ to 4	0.015
Over 4 to 8	0.025

Tolerances, Wall Thickness - Squares and Rectangles

Note - To determine the applicable wall tolerance for rectangular tubes, add the four sides and divide by four to obtain the equivalent square size shown below.

COLD ROLLED

Wall Thickness		Square Size Inches				
BWG*	In.	1/3 to 3/8 Incl.	3/4 to 1¾ Incl.	Over 1½ to 3 Incl.	Over 3 to 4 Incl.	Over 4 to 5 Incl.
22	(.028)	+.003 -.003	+.003 -.003	....	....	....
20	(.035)	+.003 -.004	+.003 -.004	+.003 -.004	....	....
18	(.049)	+.005 -.004	+.005 -.005	+.005 -.005	....	....
16	(.065)	+.006 -.004	+.006 -.005	+.006 -.005	+.006 -.005	+.006 -.007
14	(.083)	+.008 -.004	+.008 -.005	+.008 -.006	+.008 -.007	+.008 -.007
13	(.095)	+.009 -.004	+.009 -.005	+.009 -.005	+.009 -.007	+.009 -.007
12	(.109)	....	+.011 -.006	+.011 -.006	+.011 -.007	+.011 -.009
11	(.120)	....	+.012 -.006	+.012 -.006	+.012 -.007	+.012 -.009
10	(.134)	....	+.013 -.006	+.013 -.006	+.013 -.007	+.013 -.007
9	(.148)	....	+.015 -.006	+.015 -.006	+.015 -.007	+.015 -.009
8	(.155)	....	+.016 -.007	+.016 -.007	+.016 -.008	+.016 -.010

HOT ROLLED

Wall Thickness		Square Size Inches				
BWG*	In.	1/3 to 3/8 Incl.	3/4 to 1¾ Incl.	Over 1½ to 3 Incl.	Over 3 to 4 Incl.	Over 4 to 5 Incl.
16	(.065)	+.006 -.006	+.006 -.008	+.006 -.008	+.006 -.010	+.006 -.010
14	(.083)	+.008 -.006	+.008 -.008	+.008 -.008	+.008 -.010	+.008 -.012
13	(.095)	+.010 -.006	+.010 -.008	+.010 -.008	+.010 -.010	+.010 -.012
12	(.109)	+.011 -.006	+.011 -.006	+.011 -.006	+.011 -.010	+.011 -.012
11	(.120)	+.008 -.008	+.008 -.008	+.008 -.008	+.010 -.010	+.012 -.012
10	(.134)	....	+.013 -.008	+.013 -.008	+.013 -.010	+.013 -.012
9	(.148)	....	+.015 -.008	+.015 -.008	+.015 -.011	+.015 -.012
8	(.165)	....	+.017 -.008	+.017 -.008	+.017 -.011	+.017 -.012
7	(.180)	....	+.018 -.008	+.018 -.008	+.018 -.011	+.018 -.012
6	(.203)	....	+.020 -.010	+.020 -.010	+.020 -.012	+.020 -.013
5	(.220)	....	+.022 -.012	+.022 -.010	+.022 -.012	+.022 -.013
4	(.238)	....	....	+.024 -.018	+.024 -.018	+.024 -.018
3	(.259)	....	....	+.026 -.020	+.026 -.020	+.026 -.020

*Birmingham Wire Gauge

Note - Wall thickness to be measured at the center of the flat.

WELDED MECHANICAL STEEL TUBE

As-Welded Round Hot Rolled Electric Weld (HREW)

PSC INCORPORATED

DIAMETER TOLERANCES

OUTSIDE DIAMETER SIZE RANGE INCHES	WALL THICKNESS		OUTSIDE DIAMETER TOLERANCES, INCHES	
	BWG	INCHES	PLUS	MINUS
3/4 to 1-1/6, incl.	16 to 10	.065 to .134	.0035	.0035
Over 1-1/8 to 2, incl.	16 to 7	.065 to .180	.005	.005
Over 1-1/8 to 2, incl.	6 to 3	.203 to .259	.005	.005
Over 2 to 2-1/2, incl.	16 to 3	.065 to .259	.006	.006
Over 2-1/2 to 3, incl.	16 to 3	.065 to .259	.008	.008
Over 2-1/2 to 3, incl.	2 to .320	.284 to .320	.010	.010
Over 3 to 3-1/2, incl.	16 to 3	.065 to .259	.009	.009
Over 3 to 3-1/2, incl.	2 to .360	.284 to .360	.012	.012
Over 3-1/2 to 3, incl.	16 to 3	.065 to .259	.010	.010
Over 3-1/2 to 4, incl.	2 to .500	.284 to .500	.015	.015
Over 4 to 5, incl.	16 to 3	.065 to .259	.020	.020
Over 4 to 5, incl.	2 to .500	.284 to .500	.020	.020
Over 5 to 6, incl.	16 to 3	.065 to .259	.020	.020
Over 5 to 6, incl.	2 to 500	.284 to .500	.020	.020
Over 6 to 8, incl.	11 to 3	.120 to .259	.025	.025
Over 6 to 8, incl.	2 to 500	.284 to .500	.025	.025

NOTE 1 - Measurements for diameter are to be taken at least 2 inches from the ends of the tubes.
NOTE 2 - OVALITY shall be within the above tolerances except when the wall thickness is less than 3% of the outside diameter, In such cases the ovality may be 50% greater than the outside tolerances but the mean outside diameter shall be within the specified tolerances.

WALL TOLERANCES

WALL THICKNESS		OUTSIDE DIAMETER, INCHES									
		3/4 to 1,incl.		Over 1 to 1-1/16, Incl.		Over 1-15/16 to 3-3/4, Incl.		Over 3-3/4 to 4-1/2, Incl.		Over 4-1/2 to, Incl.	
		WALL THICKNESS TOLERANCES, INCHES									
Inches	BWG	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
.065	16	.005	.009	.004	.010	.003	.011	.002	.012	.002	.012
.072	15	.005	.009	.004	.010	.003	.011	.002	.012	.002	.012
.083	14	.006	.010	.005	.011	.004	.012	.003	.013	.003	.013
.095	13	.006	.010	.005	.011	.004	.012	.003	.013	.003	.013
.109	12	.006	.010	.005	.011	.004	.012	.003	.013	.003	.013
.120	11	.006	.010	.005	.011	.004	.012	.003	.013	.003	.013
.134	10	.006	.010	.005	.011	.004	.012	.003	.013	.003	.013
.148	9	—	—	.006	.012	.005	.013	.004	.014	.004	.014
.165	8	—	—	.006	.012	.005	.013	.004	.014	.004	.014
.180	7	—	—	.006	.012	.005	.013	.004	.014	.004	.014
.203	6	—	—	—	—	.007	.015	.006	.016	.005	.017
.220	5	—	—	—	—	.007	.015	.006	.016	.005	.017
.238	4	—	—	—	—	.012	.020	.011	.021	.010	.022
.259	3	—	—	—	—	.013	.021	.012	.022	.011	.023
.284	2	—	—	—	—	.014	.022	.013	.023	.012	.024
.300	1	—	—	—	—	.015	.023	.014	.024	.013	.025
.320	—	—	—	—	—	.016	.024	.015	.025	.014	.026
.344	—	—	—	—	—	.017	.025	.016	.026	.015	.027
.360	—	—	—	—	—	.017	.025	.016	.026	.015	.027
.375	—	—	—	—	—	—	—	.016	.026	.015	.027
.406	—	—	—	—	—	—	—	.017	.027	.016	.028
.438	—	—	—	—	—	—	—	.017	.027	.016	.028
.469	—	—	—	—	—	—	—	—	—	.016	.028
.500	—	—	—	—	—	—	—	—	—	.016	.028

INSIDE WELD FLASH

HREW tubing is usually produced to OD x Wall dimensions only and in three catergories determined by height of inside diameter welding flash:
Flash-In-Tubing - ID flash does not exceed wall thickness or 3/32" whatever is less.
Flash Controlled .010" - ID flash is .010" maximun height.
Flash Controlled .005" - ID flash is .005" maximun height.

WELDED MECHANICAL STEEL TUBE

As-Welded Round Cold Rolled Electric Weld (Crew)

PSC INCORPORATED

DIAMETER TOLERANCES

OUTSIDE DIAMETER SIZE RANGE INCHES	WALL THICKNESS		OUTSIDE DIAMETER TOLERANCES, INCHES	
	BWG	INCHES	PLUS	MINUS
1/4 to 3/8, incl.	22 to 14	.028 to .083	.0025	.0025
Over 3/8 to 5/8, incl.	22 to 16	.028 to .065	.003	.003
Over 3/8 to 5/8, incl.	14 to 12	.083 to .109	.003	.003
Over 5/8 to 1-1/8, incl.	22 to 14	.028 to .083	.0035	.0035
Over 5/8 to 1-1/8, incl.	13 to 11	.095 to .120	.0035	.0035
Over 1-1/8 to 2, incl.	22 to 14	.028 to .083	.005	.005
Over 1-1/8 to 2, incl.	13 to 9	.095 to .148	.005	.005
Over 2 to 2-1/2, incl.	20 to 14	.035 to .083	.006	.006
Over 2 to 2-1/2, incl.	13 to 9	.095 to .148	.006	.006
Over 2-1/2 to 3, incl.	20 to 18	.035 to .049	.008	.008
Over 2-1/2 to 3, incl.	16 to 9	.065 to .148	.008	.008
Over 3 to 3-1/2, incl.	20 to 9	.035 to .148	.009	.009
Over 3-1/2 to 4, incl.	20 to 8	.035 to .165	.010	.010
Over 4 to 5, incl.	16 to 14	.065 to .083	.020	.020
Over 4 to 5, incl.	11 to 3	.095 to .165	.015	.015
Over 5 to 6, incl.	16 to 8	.065 to .165	.020	.020

NOTE 1 - Measurements for diameter are to be taken at least 2 inches from the ends of the tubes.
NOTE 2 - OVALITY shall be within the above tolerances except when the wall thickness is less than 3% of the outside diameter, In such cases the ovality may be 50% greater than the outside tolerances but the mean outside diameter shall be within the specified tolerances.

WALL TOLERANCES

WALL THICKNESS		OUTSIDE DIAMETER, INCHES									
		3/8 to 7/8, incl.		Over 7/8 to 1-7/8, Incl.		Over 1-7/8 to 3-3/4, Incl.		Over 3/4 to 5, Incl.		Over 5 to 6, Incl.	
		WALL THICKNESS TOLERANCES, INCHES									
Inches	BWG	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
.028	22	.001	.005	.001	.005	—	—	—	—	—	—
.035	20	.002	.005	.001	.001	.001	.005	—	—	—	—
.049	18	.003	.006	.002	.006	.002	.006	—	—	—	—
.065	16	.005	.007	.004	.007	.004	.007	.004	.007	.004	.007
.083	14	.006	.007	.005	.007	.004	.007	.004	.007	.004	.008
.095	13	.006	.007	.005	.007	.004	.007	.004	.007	.004	.008
.109	12	—	—	.006	.008	.005	.008	.005	.008	.005	.009
.120	11	—	—	.007	.008	.006	.008	.005	.008	.005	.009
.134	10	—	—	.007	.008	.006	.008	.005	.008	.005	.009

INSIDE WELD FLASH

CREW tubing is usually produced to OD x Wall dimensions only and in three catergories determined by height of inside diameter welding flash:

Flash-In-Tubing - ID flash does not exceed wall thickness or 3/32" whatever is less.

Flash Controlled .010" - ID flash is .010" maximun height.

Flash Controlled .005" - ID flash is .005" maximun height.

DOM MECHANICAL STEEL TUBE

Cold Drawn Round Welded & Drawn Over Mandrel - A513 Type 5

PSC INCORPORATED

DIAMETER TOLERANCES

OD SIZE RANGE	WALL % of OD	OD, INCHES		ID, INCHES	
		Plus	Minus	Plus	Minus
Up - .500	All	.004	.000		
0.500 - 1.699	All	.005	.000	.000	.005
1.700 - 2.099	All	.006	.000	.000	.006
2.100 - 2.499	All	.007	.000	.000	.007
2.500 - 2.899	All	.008	.000	.000	.008
2.900 - 3.299	All	.009	.000	.000	.009
3.300 - 3.699	All	.010	.000	.000	.010
3.700 - 4.099	All	.011	.000	.000	.011
4.100 - 4.499	All	.012	.000	.000	.012
4.500 - 4.899	All	.013	.000	.000	.013
4.900 - 5.299	All	.014	.000	.000	.014
5.300 - 5.549	All	.015	.000	.000	.015
5.550 - 5.999	Under 6	.010	.010	.010	.010
	6 to 7½	.009	.009	.009	.009
6.000 - 6.499	Under 6	.013	.013	.013	.013
	6 to 7½	.010	.010	.010	.010
6.500 - 6.999	Under 6	.015	.015	.015	.015
	6 to 7½	.012	.012	.012	.012
7.000 - 7.499	Under 6	.018	.018	.018	.018
	6 to 7½	.013	.013	.013	.013
7.500 - 7.999	Under 6	.020	.020	.020	.020
	6 to 7½	.015	.015	.015	.015
8.000 - 8.499	Under 6	.023	.023	.023	.023
	6 to 7½	.016	.016	.016	.016
8.500 - 8.999	Under 6	.025	.025	.025	.025
	6 to 7½	.017	.017	.017	.017
9.000 - 9.499	Under 6	.028	.028	.028	.028
	6 to 7½	.019	.019	.019	.019
9.500 - 9.999	Under 6	.030	.030	.030	.030
	6 to 7½	.020	.020	.020	.020
10.000 - 10.999	Under 6	.034	.034	.034	.034
	6 to 7½	.022	.022	.022	.022
11.000 - 11.999	Under 6	.035	.035	.035	.035
	6 to 7½	.025	.025	.025	.025
12.000 - 12.999	All	.037	.037	.037	.037
13.000 - 13.999	All	.037	.037	.037	.037
14.000 - 14.999	All	.038	.038	.038	.038

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

OD, INCHES	OVALITY	OD, INCHES	OVALITY
Up - 2 incl.	.010"	Over 7 to 8 incl	.040"
Over 2 to 3 incl.	.015"	Over 8 to 9 incl	.045"
Over 3 to 4 incl.	.020"	Over 9 to 10 incl	.050"
Over 4 to 5 incl.	.025"	Over 10 to 11 incl	.055"
Over 5 to 6 incl.	.030"	Over 11 to 12 incl	.060"
Over 6 to 7 incl.	.035"	Over 12 to 12.5 incl	.065"

WALL TOLERANCES

WALL THICKNESS, INCH	INCL. .375 to .875 OD	OVER .875 to 1.875 OD	OVER 1.875 to 3.75 OD	OVER 3.75 to 12.500 OD
.028	+.002 -.002	+.002 -.002	+.002 -.002	
.035	+.002 -.002	+.002 -.002	+.002 -.002	
.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	+.004 -.006	+.007 -.007
.238		+.005 -.006	+.005 -.006	+.007 -.007
.259		+.005 -.006	+.005 -.006	+.007 -.007
.284		+.005 -.006	+.005 -.006	+.007 -.007
.300		+.006 -.006	+.006 -.006	+.008 -.008
.320		+.007 -.007	+.007 -.007	+.008 -.008
.344		+.008 -.008	+.008 -.008	+.009 -.009
.375			+.009 -.009	+.009 -.009
.400			+.010 -.010	+.010 -.010
.438			+.011 -.011	+.011 -.011
.460			+.012 -.012	+.012 -.012
.531			+.013 -.013	+.013 -.013
.563			+.013 -.013	+.013 -.013
.580			+.014 -.014	+.014 -.014
.600			+.015 -.015	+.015 -.015
.625			+.016 -.016	+.016 -.016
.650			+.017 -.017	+.017 -.017

Tabulated tolerances can be applied simultaneously to only two of three cross-sectional dimensions, i.e., ODxWall, ODxID or IDxWall. ID Tolerances apply only to tube specified ODxID or IDxWall.

STRAIGHTNESS TOLERANCES

.030" in any 3 ft. of length up to 7.500" OD

.060 in any 3 ft. of length over 7.500" OD

TYPICAL CHEMISTRY BY GRADE

		Carbon	Manganese	Phosphorous, Max	Sulfur, Max	Silicon	Aluminum
1020	HF Seamless	0.18 - 0.23	0.30 - 0.60	0.040	0.050		
1020	CD Seamless	0.18 - 0.23	0.30 - 0.60	0.040	0.050		
1020	Welded SRA	0.17 - 0.23	0.30 - 0.60	0.035	0.035		
1026	HF Seamless	0.22 - 0.28	0.60 - 0.90	0.040	0.050		
1026	CD Seamless	0.22 - 0.28	0.60 - 0.90	0.040	0.050		
1026	Welded SRA	0.22 - 0.28	0.60 - 0.90	0.035	0.035		
ST52.3	Welded SRA	0.12 - 0.18	1.20 - 1.60	0.025	0.010	0.15 - 0.35	.02 min
4140/42	HF Seamless	0.38 - 0.45	0.75 - 1.00	0.040	0.040	0.15 - 0.35	

TYPICAL PHYSICALS BY GRADE

		Yield	Tensile	Elongation (%)	Hardness Rb	Charpy Impact (ft-lbs @ 0- 20C)
1020	HF Seamless	28,000	48,000	30	50	
1020	CD Seamless	60,000	70,000	5	75	
1020	Welded SRA	55,000	65,000	10	75	
1026	HF Seamless	35,000	60,000	25	70	
1026	CD Seamless	75,000	90,000	10	90	
1026	Welded SRA	65,000	75,000	10	80	
ST52.3	Welded SRA	75,000	85,000	18	85	
4140/42	HF Seamless	60,000	80,000	25	85	20

SEAMLESS MECHANICAL STEEL TUBE

Hot Finished Round Carbon & Alloy Steel A106 A519

PSC INCORPORATED

OUTSIDE DIAMETER TOLERANCES FOR ROUND HOT-FINISHED TUBING [A,B,C]

OUTSIDE DIAMETER SIZE RANGE IN. (mm)	OUTSIDE DIAMETER TOLERANCES, IN. (mm)	
	OVER	UNDER
Up to 2.999 (76.17)	0.020 (0.51)	0.020 (0.51)
3.000 to 4.499 (76.20 - 114.27)	0.025 (0.64)	0.025 (0.64)
4.500 to 5.999 (114.30 - 152.37)	0.031 (0.79)	0.031 (0.79)
6.000 to 7.499 (152.40 - 190.47)	0.037 (0.94)	0.037 (0.94)
7.500 to 8.999 (190.50 - 228.57)	0.045 (1.14)	0.045 (1.14)
9.000 to 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 TOLERANCES - ASTM A106

WALL THICKNESS	MAXIMUM OVER & UNDER NOMINAL WALL			
	2″ to 11″ OD		Over 11″ OD	
	Plus	Minus	Plus	Minus
Walls under 10% of nominal Outside Diameter	10.0%	10.0%	12.5%	12.5%
Walls 10% to 25% of nominal O.D. inclusive	7.5%	7.5%	12.5%	12.5%
Walls over 25% of nominal Outside Diameter	7.5%	7.5%	12.5%	12.5%

STRAIGHTNESS TOLERANCES - ASTM A106

OUTSIDE DIAMETER SIZE RANGE INCHES	WALL % OF OUTSIDE DIAMETER	MAXIMUM DEVIATION FROM STRAIGHT		
		TOTAL INCHES IN ANY 3 FEET	LENGTH 3 to 22 FEET	TOTAL IN ENTIRE LENGTH: INCHES PER FOOT OF LENGTH
Up to 5.000″	3% OD & Over	.030″	.007″	.010″
5.001 / 8.000″	4% OD & Over	.045″	.010″	.015″
8.001 / 10.750″	4% OD & Over	.060″	.015″	.020″

Wall Thickness Tolerances - Round Hot-Finished Tube A519

WALL THICKNESS RANGE AS PERCENT OF OUTSIDE DIAMETER	WALL THICKNESS TOLERANCE, [A] PERCENT OVER AND UNDER NOMINAL		
	Outside Diameter 2.999 in. and smaller	Outside Diameter 3.000 in. to 5.999 in.	Outside Diameter 6.000 in. to 10.750 in.
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. and less; consult manufacturer for wall tolerances on such tube sizes.

Chemical Requirements A106

	Composition, %	
	Grade B	Grade C
Carbon, max[A]	0.30	0.35
Manganese	0.29 - 1.06	0.29 - 1.06
Phosphorous, max	0.035	0.035
Sulfur, max	0.035	0.035
Silicon, max	0.10	0.10
Chrome, max[B]	0.40	0.40
Copper, max[B]	0.40	0.40
Molybdenum, max[B]	0.15	0.15
Nickel, max[B]	0.40	0.40
Vanadium, max[B]	0.08	0.08

[A] For each reduction of 0.01% below the specified carbon maximum, an increase of 0.06% manganese above the specified maximum will be permitted up to a maximum of 1.35%.

[B] These five elements combined shall not exceed 1%.

SEAMLESS MECHANICAL TUBE
Cold Drawn Round Carbon Steel A519

PSC INCORPORATED

DIAMETER TOLERANCES

OD Size Range Inches	Wall: Percent Of OD	Unannealed or Stress Relief Annealed				Soft Annealed or Normalized				Oil Quenched & Tempered
		OD Inches		ID Inches		OD Inches		ID Inches		OD & ID
		Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus	Plus/Minus
Up - .499	All	.004	.000			.005	.002			.005
0.500 - 1.699	All	.005	.000	.000	.005	.007	.002	.002	.007	.007
1.700 - 2.099	All	.006	.000	.000	.006	.006	.005	.005	.006	.008
2.100 - 2.499	All	.007	.000	.000	.007	.008	.005	.005	.008	.009
2.500 - 2.899	All	.008	.000	.000	.008	.009	.005	.005	.009	.010
2.900 - 3.299	All	.009	.000	.000	.009	.011	.005	.005	.011	.012
3.300 - 3.699	All	.010	.000	.000	.010	.013	.005	.005	.013	.013
3.700 - 4.099	All	.011	.000	.000	.011	.013	.007	.010	.010	.014
4.100 - 4.499	All	.012	.000	.000	.012	.014	.007	.011	.011	.015
4.500 - 4.899	All	.013	.000	.000	.013	.016	.007	.012	.012	.017
4.900 - 5.299	All	.014	.000	.000	.014	.018	.007	.013	.013	.018
5.300 - 5.549	All	.015	.000	.000	.015	.020	.007	.014	.014	.019
	Under 6	.010	.010	.010	.010	.018	.018	.018	.018	.025
5.550 - 5.999	6 to 7½	.009	.009	.009	.009	.016	.016	.016	.016	.023
	Over 7½	.018	.000	.009	.009	.017	.015	.016	.016	.023
	Under 6	.013	.013	.013	.013	.023	.023	.023	.023	.033
6.000 - 6.499	6 to 7½	.010	.010	.010	.010	.018	.018	.018	.018	.025
	Over 7½	.020	.000	.010	.010	.020	.015	.018	.018	.025
	Under 6	.015	.015	.015	.015	.027	.027	.027	.027	.038
6.500 - 6.999	6 to 7½	.012	.012	.012	.012	.021	.021	.021	.021	.029
	Over 7½	.012	.012	.012	.012	.021	.021	.021	.021	.029
	Under 6	.018	.018	.018	.018	.032	.032	.032	.032	.045
7.000 - 7.499	6 to 7½	.013	.013	.013	.013	.023	.023	.023	.023	.033
	Over 7½	.026	.000	.013	.013	.031	.015	.023	.023	.033
	Under 6	.020	.020	.020	.020	.035	.035	.035	.035	.050
7.500 - 7.999	6 to 7½	.015	.015	.015	.015	.026	.026	.026	.026	.037
	Over 7½	.029	.000	.015	.015	.036	.015	.026	.026	.037
	Under 6	.023	.023	.023	.023	.041	.041	.041	.041	.058
8.000 - 8.499	6 to 7½	.016	.016	.016	.016	.028	.028	.028	.028	.040
	Over 7½	.031	.000	.015	.016	.033	.022	.028	.028	.040
	Under 6	.025	.025	.025	.025	.044	.044	.044	.044	.063
8.500 - 8.999	6 to 7½	.017	.017	.017	.017	.030	.030	.030	.030	.043
	Over 7½	.034	.000	.015	.019	.038	.022	.030	.030	.043
	Under 6	.028	.028	.028	.028	.045	.045	.049	.049	.070
9.000 - 9.499	6 to 7½	.019	.019	.019	.019	.033	.033	.033	.033	.047
	Over 7½	.037	.000	.015	.022	.043	.022	.033	.033	.047
	Under 6	.030	.030	.030	.030	.045	.045	.053	.053	.075
9.500 - 9.999	6 to 7½	.020	.020	.020	.020	.035	.035	.035	.035	.050
	Over 7½	.040	.000	.015	.025	.048	.022	.035	.035	.050
	Under 6	.034	.034	.034	.034	.045	.045	.060	.060	.080
10.000 - 10.999	6 to 7½	.022	.022	.022	.022	.039	.039	.039	.039	.055
	Over 7½	.044	.000	.015	.029	.055	.022	.039	.039	.055
	Under 6	.035	.035	.035	.035	.050	.050	.065	.065	
11.000 - 12.000	6 to 7½	.025	.025	.025	.025	.045	.045	.045	.045	
	Over 7½	.045	.000	.015	.035	.060	.022	.045	.045	

CARBON STEEL PIPE A53 A106

DIAMETER TOLERANCES - SEAMLESS & WELDED

NOMINAL PIPE SIZE INCHES	OUTSIDE DIAMETER TOLERANCES - INCHES OR PERCENT OF OD							
	A120		A53		A106		API-5L	
	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
1/8 - 1-1/2 IPS	.015"	.031"	.015"	.031"	.015"	.031"	.015"	.031*
2 - 4 IPS	1%	1%	1%	1%	.031"	.031"	1%	1%
5 - 8 IPS	1%	1%	1%	1%	.062"	.031"	.75%	.75%
108 IPS - 18 OD	1%	1%	1%	1%	.093"*	.031"*	.75%	.75%
2 0 OD - 26 OD	1%	1%	1%	1%	.125"	.031"	1%	1%

*Some mills may require ± 1% of nominal OD for sizes over 10" IPS in heavy walls of A106 pipe.

WALL TOLERANCES - SEAMLESS

NOMINAL PIPE SIZE INCHES	WALL TOLERANCE - PERCENT OF NOMINAL WALL THICKNESS							
	A120		A53		A106		API-5L	
	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
1/8 - 2-1/2 IPS	By Wt.	12.5	By Wt.	12.5	By Wt.	12.5	20.0	12.5
3 IPS	By Wt.	12.5	By Wt.	12.5	By Wt.	12.5	18.0	12.5
3-1/2 IPS - 26 OD	By Wt.	12.5	By Wt.	12.5	By Wt.	12.5	15.0	12.5

*Some mills may require ± 12.5% of nominal wall sizes over 10" IPS in heavy walls of A53 & A106 pipe.

WALL TOLERANCES - WELDED

NOMINAL PIPE SIZE INCHES	WALL TOLERANCE - PERCENT OF NOMINAL WALL THICKNESS							
	A120		A53		A106		API-5L	
	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
1/8 - 2-1/2 IPS	By Wt.	12.5	By Wt.	12.5	Available		20.0	12.5
3 IPS	By Wt.	12.5	By Wt.	12.5	Only As		18.0	12.5
3-1/2 IPS - 18 OD	By Wt.	12.5	By Wt.	12.5	Seamless		15.0	12.5
20 OD - 26 OD	By Wt.	12.5	By Wt.	12.5	Pipe		17.5	10.0

WALL TOLERANCES - SEAMLESS & WELDED

PIPE WEIGHT SCHEDULE	WEIGHT VARIATION - PERCENT OF NOMINAL WEIGHT							
	A120		A53		A106		API-5L	
	Plus	Minus	Plus	Minus	Plus	Minus	Plus	Minus
Standard	10	10	10	10	10	3.5	10	3.5
Extra Strong	10	10	10	10	10	3.5	10	3.5
Double Extra Strong	10	10	10	10	10	3.5	10	3.5

*Pipe 4" & under is weighted in conventional lifts, over 4" in individual lengths.

TYPICAL PROPERTIES

GRADE DESIGNATION	CHEMISTRY - PERCENT					TENSILE KSI	YIELD KSI	ELONG. % IN 2"
	C	Mn	P	S	Si			
A106B Smls.	.30 max	.29-1.06	.048 max	.058 max	.10 min	60 min	35 min	30 min
A53B Smls.	.30 max	1.20 max	.050 max	.060 max	—	60 min	35 min	30 min
5lb Smls.	.27 max	1.15 max	.040 max	.050 max	—	60 min	35 min	30 min

LOW CARBON STEEL HYDRAULIC TUBE

PSC INCORPORATED

HEAT EXCHANGER TUBE TOLERANCES

SPECIFICATIONS	SIZE OD RANGE INCHES	TOLERANCES			
		OD		WALL	
		Plus	Minus	Plus	Minus
ASTM - A179 ASME - SA179 Cold Drawn Seamless Heat Exchanger Tube Minimum Wall	Under 1.000 1.000 to 1.500 1.501 to 1.999 2.000 to 2.499 2.501 to 2.999 3.000 to 4.000	.004″ .006″ .008″ .010″ .012″ .015″	.004″ .006″ .008″ .010″ .012″ .015″	20% 20% 22% 22% 22% 22%	0% 0% 0% 0% 0% 0%
ASTM - A214 ASME - SA214 ERW Welded Heat Exchanger Tube Minimum Wall	Under 1.000 1.000 to 1.500 1.501 to 1.999 2.000 to 2.499 2.501 to 2.999 3.000 to 4.000	.004″ .006″ .008″ .010″ .012″ .015″	.004″ .006″ .008″ .010″ .012″ .015″	18% 18% 18% 18% 18% 18%	0% 0% 0% 0% 0% 0%

HYDRAULIC LINE TUBE TOLERANCES

SPECIFICATIONS	SIZE OD RANGE INCHES	TOLERANCES			
		OD		WALL	
		Plus	Minus	Plus	Minus
ANSI - B93. 11 - 1969 SAE - J524 AMS - 5050 Cold Drawn Seamless JIC Hydraulic Line	Up to 0.375 0.376 to 0.500 0.501 to 1.500 1.501 to 2.000 2.501 to 3.000 3.001 to 3.500	.003″ .003″ .005″ .010″ .010″ .010″	.003″ .003″ .005″ .010″ .010″ .010″	15% 10% 10% 10% 10% 10%	15% 10% 10% 10% 10% 10%
ANSI - B93. 11 - 1969 SAE - J524 Welded & Drawn JIC Hydraulic Line	Up to 0.375 0.376 to 0.625 0.626 to 2.000 2.000 to 2.499 2.501 to 3.500 3.001 to 4.000	.002″ .0025″ .003″ .004″ .005″ .006″	.002″ .0025″ .003″ .004″ .005″ .006″	15% 10% 10% 10% 10% 10%	15% 10% 10% 10% 10% 10%

TYPICAL PROPERTIES

GRADE DESIGNATION	CHEMISTRY - PERCENT				TENSILE KSI	YIELD KSI	ELONG. % IN 2″	HARDNESS ROCKWELL
	C	Mn	P	S				
A179 CDS	.06 - .18	.27 - .63	.048 max	.058 max	—	—	—	RB72 max
A214 ERW	.18 max	.27 - .63	.050 max	.060 max	—	—	—	RB72 max
J524 CDS	.18 max	.30 - .60	.040 max	.050 max	55 max	25 min	35 min	RB65 max
J525 W&D	.18 max	.30 - .60	.040 max	.050 max	55 max	25 min	35 min	RB65 max

CARBON STEEL BOILER TUBE A178

CHEMICAL REQUIREMENTS

ELEMENT	COMPOSITION, %		
	GRADE A, LOW-CARBON STEEL	GRADE C, MEDIUM-CARBON STEEL	GRADE D, CARBON-MANGANESE STEEL
Carbon	0.06 - 0.18	0.35 max	0.27 max
Manganese	0.27 - 0.63	0.80 max	1.00 - 1.50 max
Phosphorus, max	0.035	0.035	0.030
Sulfur, max	0.035	0.035	0.015
Silicon	—	—	0.10 min

TENSILE REQUIREMENTS

	GRADE C	GRADE D
Tensile strength, min, ksi (MPa)	60 (415)	70 (485)
Yield strength, min, ksi (MPa)	37 (255)	40 (275)
Elongation in 2 in. or 50 mm, min %	30	30
For longitudinal strip tests a deduction for each 1/32 - in. (0.8 mm) decrease in wall thickness below 5/16 in. (8 mm) from the basic minimum elongation of the following percentage points shall be made	1.50	1.50

MINIMUM ELONGATION VALUES

WALL THICKNESS		ELONGATION IN 2 IN. OR 50 MM, MIN%
Inch	Millimeter	
5/16 (0.312)	8	30
9/32 (0.281)	7.2	29
1/4 (0.250)	6.4	27
7/32 (0.219)	5.6	26
3/16 (0.188)	4.8	24
5/32 (0.156)	4	22
1/8 (0.125)	3.2	21
3/32 (0.094)	2.4	20
1/16 (0.062)	1.6	18

4130 ALLOY STEEL TUBE MIL-T 6736B

CHEMICAL COMPOSITION

ELEMENT	ANALYSIS PERCENT	CHECK ANALYSIS TOLERANCE[1] PERCENT
Carbon	0.27 - 0.33	±0.02
Manganese	0.40 - 0.60	±0.03
Phosphorous	0.25 max	+.005
Sulfur	0.25 max	+.005
Silicon	0.20 - 0.35	±0.02
Chromium	0.80 - 1.10	+0.05 - 0.03
Molybdenum	0.15 - 0.25	±0.02

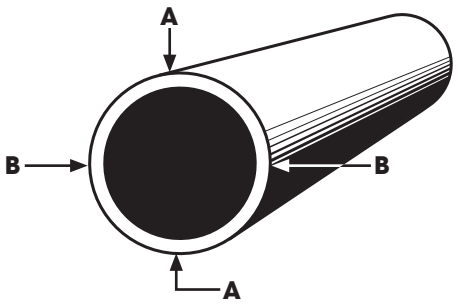
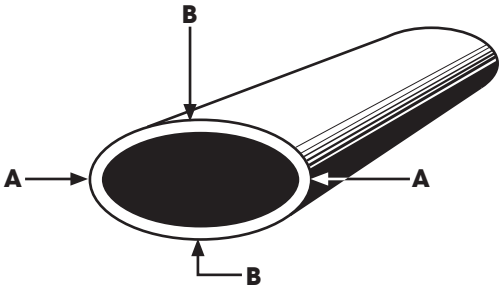
[1] Individual determinations may vary from the specified range to the extent shown in the check analysis column, except that elements in any heat shall not vary both above and below the specified range.

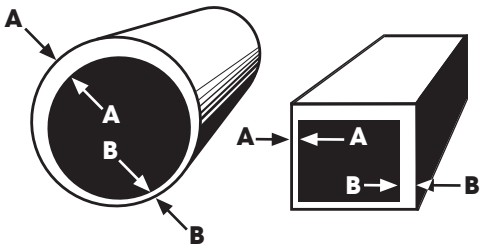
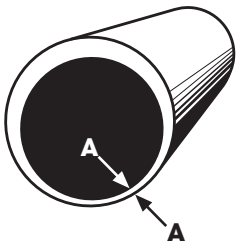
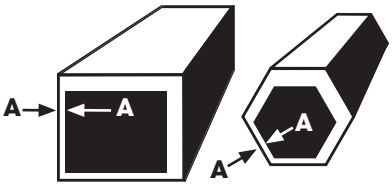
MECHANICAL PROPERTIES

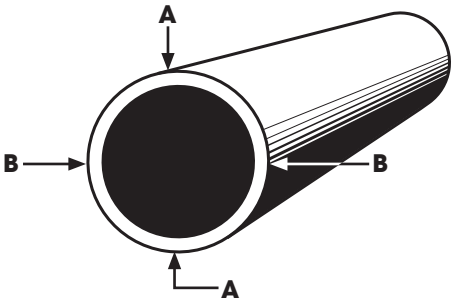
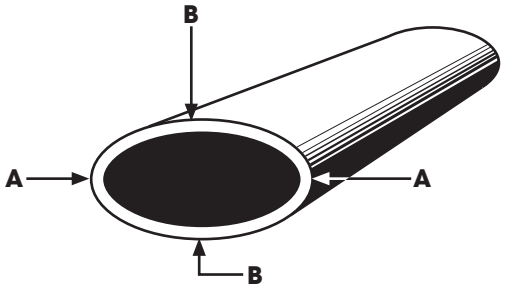
CONDITION & WALL THICKNESS	TENSILE STRENGTH (MIN.)	YIELD STRENGTH AT 0.2 PERCENT SET OR AT EXTENSION INDICATED		ELONGATION IN 2 INCHES	
		(Min.)	EXTENSION UNDER LOAD	FULL TUBE (MIN.)	STRIP (MIN.)
INCH	PSI	PSI	INCHES IN 2 INCHES	%	%
(A) (N)	[1] 95,000				
Up to 0.035 incl.	95,000	75,000	0.0090	10	5
Over 0.035 to 0.187 incl.	95,000	75,000	0.0090	12	7
Over 0.187	90,000	70,000	0.0087	15	10
(HT-125) All Walls	125,000	100,000	0.0107	12	7
(HT-150) All Walls	150,000	135,000	0.0130	10	6
(HT-180) All Walls	150,000	165,000	0.0154	8	5

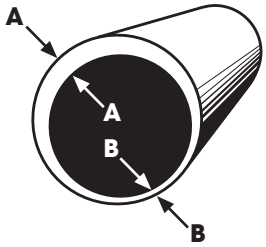
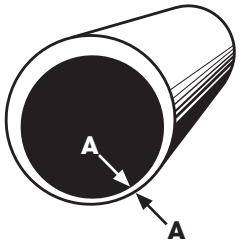
[1] Maximum

ALUMINUM DRAWN TUBE

DIAMETER	TOLERANCE (in. plus and minus)		
Specified Diameter (in.)	Allowable Deviation of Mean Diameter from Specified Diameter (Size)  Difference between 1/2 (AA + BB) and specified diameter	Allowable Deviation of Diameter at Any Point from Specified Diameter  Difference between AA or BB and specified diameter	
		Non-Heat-Treated Tube	Heat-Treated Tube
Col. 1	Col. 2	Col. 3	Col. 4
Under 0.500	.003	.003	.006
0.501 - 1.000	.004	.004	.008
1.001 - 2.000	.005	.005	.010
2.001 - 3.000	.006	.006	.012
3.001 - 5.000	.008	.008	.016
5.001 - 6.000	.010	.010	.020
6.001 - 8.000	.015	.015	.030
8.001 - 10.000	.020	.020	.040
10.001 - 12.000	.025	.025	.050

WALL THICKNESS	TOLERANCE (in. plus and minus)		
Specified Wall Thickness (in.)	Allowable Deviation of Mean Wall Thickness from Specified Wall Thickness	Allowable Deviation of Wall Thickness at Any Point from Specified Wall Thickness (Eccentricity)	
	 Difference between 1/2 (AA + BB) and specified wall thickness	Round, Non-Heat-Treated Alloys  Difference between AA and specified wall thickness	Round, Heat-Treated Alloys and other than round Alloys  Difference between AA and specified wall thickness
Col. 1	Col. 2	Col. 3	Col. 4
0.010 - 0.035	.002	.002	Plus and minus 10% of specified wall thickness, min. ± 0.003
0.038 - 0.049	.003	.003	
0.050 - 0.083	.004	.004	
0.084 - 0.120	.005	.006	
0.121 - 0.203	.006	.008	
0.204 - 0.300	.008	.012	
0.301 - 0.375	.015	.020	
0.376 - 0.500	.020	.030	

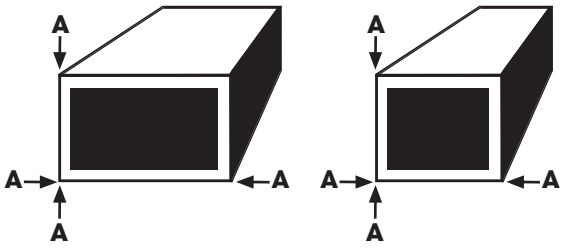
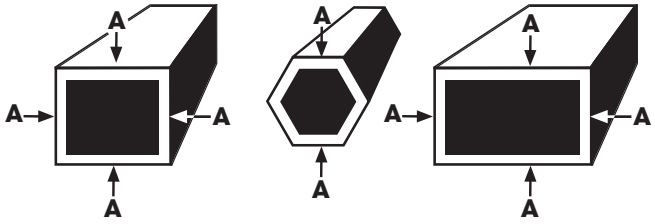
DIAMETER ROUND TUBE	TOLERANCE (in. plus and minus)			
Specified Diameter (in.)	Allowable Deviation of Mean Diameter from Specified Diameter (Size)  Difference between 1/2 (AA + BB) and specified diameter		Allowable Deviation of Diameter at Any Point from Specified Diameter  Difference between AA or BB and specified diameter	
	Col. 1		Col. 2	
	5xxx ≥ 4.0 Nominal Mg	Other Alloys	5xxx ≥ 4.0 Nominal Mg	Other Alloys
0.500 - 0.999		.010		.020
1.000 - 1.999		.012		.025
2.000 - 3.999		.015		.030
4.000 - 5.999		.025		.050
6.000 - 7.999		.035		.075
8.000 - 9.999		.045		.100
10.001 - 11.999		.055		.125
12.000 - 13.999		.065		.150
14.000 - 15.999		.075		.175
16.000 - 17.999		.085		.200
18.000 - 19.999		.095		.225
20.000 - 21.999		.105		.250
22.000 - 23.999		.115		.275

WALL THICKNESS	TOLERANCE (in. plus and minus)								
Specified Wall Thickness (in.)	Allowable Deviation of Mean Wall Thickness from Specified Wall Thickness  Difference between 1/2 (AA + BB) and specified wall thickness								Allowable Deviation of Wall Thickness at Any Point from Mean Wall Thickness (Eccentricity)  Difference between AA and mean wall thickness
	Under 1.250		1.250 - 2.999		3.000 - 4.999		5.000 & Over		
Col.1	Col.2		Col.3		Col.4		Col.5		Col.6
	5xxx ≥ 4.0 Nominal Mg	Other Alloys	5xxx ≥ 4.0 Nominal Mg	Other Alloys	5xxx ≥ 4.0 Nominal Mg	Other Alloys	5xxx ≥ 4.0 Nominal Mg	Other Alloys	
Under 0.047		.006		—		—		—	Plus and minus 10% of mean wall thickness max. ± 0.060 min. ± 0.010
0.047 - 0.061		.007		.008		.008		.010	
0.062 - 0.077		.008		.008		.009		.012	
0.078 - 0.124		.009		.009		.010		.015	
0.125 - 0.249		.009		.009		.013		.020	
0.250 - 0.374		.011		.011		.016		.025	
0.375 - 0.499		—		.015		.021		.035	
0.500 - 0.749		—		.020		.028		.045	
0.750 - 0.999		—		—		.035		.055	
1.000 - 1.499		—		—		.045		.065	
1.500 - 2.000		—		—		—		.075	
2.001 - 2.499		—		—		—		.085	± 0.120
2.500 - 2.999		—		—		—		.095	
3.000 - 3.499		—		—		—		.105	
3.500 - 4.000		—		—		—		.115	

ALUMINUM EXTRUDED TUBE & PIPE

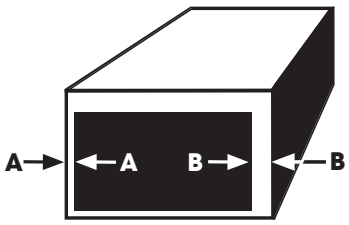
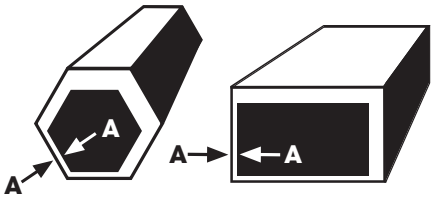
Square & Rectangular

PSC INCORPORATED

	TOLERANCE (in. plus and minus)				
Specified Width or Depth (in.)	Allowable Deviation of Width or Depth at Corners from Specified Width or Depth  Difference between AA and specified width or depth		Allowable Deviation of Width or Depth NOT at corners from Specified Width or Depth  Difference between AA and specified width, depth or distance across flats		
	Square, Rectangular		Square, Hexagonal, Octagonal		Rectangular
Col. 1	Col. 2		Col. 3		Col. 4
	5xxx ≥ 4.0 Nominal Mg	Other Alloys	5xxx ≥ 4.0 Nominal Mg	Other Alloys	All Alloys
0.500 - 0.749		.012		.020	The tolerance for the width is the value in the previous column for a dimension equal to the depth, and conversely, but in no case is the tolerance less than at the corners Example: The width tolerance of a 1 x 3 inch alloy 6061 rectangular tube is ±0.025 inch and the depth tolerance ±0.035 inch.
0.750 - 0.999		.014		.020	
1.000 - 1.999		.018		.025	
2.000 - 3.999		.025		.035	
4.000 - 4.999		.035		.045	
5.000 - 5.999		.045		.055	
6.000 - 6.999		.055		.065	
7.000 - 7.999		.065		.075	
8.000 - 8.999		.075		.085	
9.000 - 9.999		.085		.095	
10.000 - 10.999		.095		.105	
11.000 - 12.999		.105		.115	

ALUMINUM EXTRUDED TUBE & PIPE

Square & Rectangular

WALL THICKNESS	TOLERANCE (in. plus and minus)					
Specified Wall Thickness (in.)	Allowable Deviation of Mean Wall Thickness from Specified Wall Thickness				Allowable Deviation of Wall Thickness at Any Point fromMean Wall Thickness	
	 Difference between 1/2 (AA + BB) and specified wall thickness				 Difference between AA and mean wall thickness	
	Circumscribing Circle Diameter in.					
	Under 5.000		5.000 & Over		Under 5.000	5.000 & Over
Col.1	Col.2		Col.3		Col.4	Col.5
	5xxx ≥ 4.0 Nominal Mg	Other Alloys	5xxx ≥ 4.0 Nominal Mg	Other Alloys	All Alloys	All Alloys
Under 0.047		.005		.008	.005	Plus and minus 10% of mean wall thickness max. ± 0.060 min. ± 0.010
0.047 - 0.061		.006		.009	.007	
0.062 - 0.124		.007		.010	.010	
0.125 - 0.249		.008		.015	.015	
0.250 - 0.374		.011		.020	.025	
0.375 - 0.499		.014		.030	.030	
0.500 - 0.749		.025		.040	.040	
0.750 - 0.999		.035		.050	.050	
1.000 - 1.499		.045		.060	.060	
1.500 - 2.000		—		.070	—	

STAINLESS STEEL TUBE & PIPE

GENERAL SERVICE TUBE

SPECIFICATIONS	SIZE OD RANGE INCHES	TOLERANCES			
		OD		WALL	
		Plus	Minus	Plus	Minus
ASTM - A632	Under 0.094	.002″	.000″	10%	10%
Welded & Seamless	0.094 to 0.187	.003″	.000″	10%	10%
Cold Finished	0.188 to 0.500	.004″	.000″	10%	10%
ASTM - A269	Under 0.500	.005″	.005″	15%	15%
Welded & Seamless	0.500 to 1.499	.005″	.005″	10%	10%
General Service	1.500 to 3.499	.010″	.010″	10%	10%
Cold Finished	3.500 to 5.499	.015″	.015″	10%	10%
or Hot Finished	5.500 to 8.000	.030″	.030″	10%	10%

HEAT EXCHANGER TUBE

SPECIFICATIONS	SIZE OD RANGE INCHES	TOLERANCES			
		OD		WALL	
		Plus	Minus	Plus	Minus
ASTM - A249	Under 1.000	.004″	.004″	10%	10%
ASME - SA249	1.000 to 1.500	.006″	.006″	10%	10%
Welded & Colded Worked	1.501 to 1.999	.008″	.008″	10%	10%
Heat Exchanger Tube	2.000 to 2.499	.010″	.010″	15%	15%
Average Wall	2.500 to 2.999	.012″	.012″	10%	10%
(see Note 1)	3.000 to 4.000	.015″	.015″	10%	10%
	4.001 to 5.000	.015″	.025″	10%	10%
ASTM - A213	Under 1.000	.004″	.004″	20%	0%
ASTM - SA213	1.000 to 1.500	.006″	.006″	20%	0%
Cold Finished Seamless	1.501 to 1.999	.008″	.008″	22%	0%
Heat Exchanger Tube	2.000 to 2.499	.010″	.010″	22%	0%
Minimum Wall	2.500 to 2.999	.012″	.012″	22%	0%
(see Note 2 & 3)	3.000 to 4.000	.015″	.015″	22%	0%
	4.001 to 5.000	.015″	.025″	22%	0%

Notes (1) Also available in minimum wall + 18/-0% (2) Also available in average wall ± 10% (3) Also available hot finished, see specification for tolerances.

MECHANICAL HOLLOW BAR

SPECIFICATIONS	SIZE OD RANGE INCHES	TOLERANCES		
		OD	WALL	
			.125 to .250	.250 & Over
ASTM - A511	1.125 to 1.499	±.005″	±12.5%	±10.0%
AMS 5639 AMS 5648	1.000 to 1.500	±.010″	±12.5%	±10.0%
Seamless Hollow Bar	3.500 to 5.499	±.015″	±12.5%	±10.0%
Cold Finished	5.500 to 8.000	±.031″	±12.5%	±10.0%
ASTM A511	1.125 to 2.999	±.023″	±15.0%	±12.5%
Seamless Hollow Bar	3.000 to 5.499	±.031″	±15.0%	±12.5%
Hot Finished	5.500 to 8.000	±.047″	±15.0%	±12.5%

Some Hot Finished Sizes may require outside diameter tolerance of ± 1.5% of OD

SEAMLESS AND WELDED STANDARD PIPE TOLERANCES

NOMINAL PIPE SIZE INCHES	OUTSIDE DIAMETER TOLERANCES					
	A312 SEAMLESS		A312 WELDED		A376 SEAMLESS	
	Plus	Minus	Plus	Minus	Plus	Minus
1/8 IPS to 1½ IPS incl.	0.15″	.031″	.015″	.031″	.015″	.031″
2 IPS to 4 IPS incl.	0.31″	.031″	.031″	.031″	.031″	.031″
5 IPS to 8 IPS incl.	0.62″	.031″	.062″	.031″	.062″	.031″
10 IPS to 12 IPS incl.	0.93″	.031″	.093″	.031″	.093″	.031″
Wall Tolerances	By Wt.	12.5%	By Wt.	12.5%	By Wt.	12.5%
Weight Tolerances	10.0%	3.5%	10.0%	3.5%	10.0%	3.5%

WELDED A409 LIGHT WALL PIPE TOLERANCES

NOMINAL PIPE SIZE INCHES		OD TOLERANCE		WALL TOLERANCE		OVALITY TOLERANCE	
OD	Wall	Plus	Minus	Plus	Minus	Plus	Minus
14 to 30	Under .188	.20%	.20%	*	.018″	1.5%	1.5%
14 to 30	.188 & Over	.40%	.40%	*	.018″	1.5%	1.5%

* Wall plus tolerance determined by A480 sheet plate thickness tolerances

WELDED A358 HEAVY PLATE PIPE TOLERANCES

NOMINAL PIPE SIZE INCHES	OD TOLERANCE		WALL TOLERANCE		OVALITY TOLERANCE	
	Plus	Minus	Plus	Minus	Plus	Minus
8 IPS & Larger	0.5%	0.5%	*	.010″	1.0%	1.0%

* Wall plus tolerance determined by A240 sheet plate thickness tolerances

PIPE DESCRIPTION

SPECIFICATION	SUMMARY
ASTM-A312	Seamless or Welded Without Filler Metal
ASTM-A358	Fusion Welded from Plate With Filler Metal
ASTM-A376	Seamless for high Temperature Service
ASTM-A409	Welded Light Wall Pipe, Filler Metal Optional

CHEMICAL COMPOSITION (TYPICAL)

AISI TYPE	CHEMISTRY - PERCENT								
	C	Mn	P	S	Si	CR	Ni	Other	TYPICAL CHARACTERISTICS
304	0.08 max	2.00 max	0.040 max	0.030 max	0.75 max	18.00-20.00	8.00-11.00	— —	General purpose "300" series grade for tubing applications.
304L	0.035 max	2.00 max	0.040 max	0.030 max	0.75 max	18.00 20.00	0.035 max	— —	Low carbon type 304 where greater resistance to carbide precipitation is desired.
304H	0.04-0.10	2.00 max	0.040 max	0.030 max	0.75 max	18.00 20.00	0.04-0.10	— —	Carbon modified for improved high temperature strength.
310	0.15 max	2.00 max	0.040 max	0.030 max	0.75 max	24.00 26.00	0.15 max	— —	High resistance to scaling and oxidation up to 2000°F.
316	0.08 max	2.00 max	0.040 max	0.030 max	0.75 max	16.00 18.00	16.00 18.00	Mo 2.00 - 3.00	Better corrosion resistance than type 304 in reducing media. Good hi-temp strength
316L	0.035 max	2.00 max	0.040 max	0.030 max	0.75 max	16.00 18.00	16.00 18.00	Mo 2.00 - 3.00	Low carbon type 316 where greater resistance to carbide precipitation is desired.
316H	0.04-0.10	2.00 max	0.040 max	0.030 max	0.75 max	16.00 18.00	16.00 18.00	Mo 2.00 - 3.00	Carbon modified for improved temperature strength.
317	0.08 max	2.00 max	0.040 max	0.030 max	0.75 max	18.00 20.00	0.08 max	Mo 3.00 - 4.00	Similar to type 316 but with better corrosion resistance and creep strength
321	0.08 max	2.00 max	0.040 max	0.030 max	0.75 max	17.00 20.00	0.08 max	Ti 5xC - 0.70	Titanium stabilized against carbide precipitation. Similar properties to type 304.
347	0.08 max	2.00 max	0.040 max	0.030 max	0.75 max	17.00 20.00	0.08 max	Cb + To 5xC - 0.70	Columbium and tantalum stabilized against carbide precipitation.
21-6-9	0.04 max	8.00 10.00	0.060 max	0.030 max	1.00 max	19.00 21.50	0.04 max	N 0.15 - 0.40	High strength-to-weight ratio. Good corrosion resistance.
416	0.15 max	1.25 max	0.060 max	0.30 max	1.00 max	12.00 14.00	— —	— —	Hardenable by heat treatment. Free machining. Moderate corrosion resistance.

MECHANICAL PROPERTIES

Type	Temper	NOMINAL MECHANICAL PROPERTIES			
		Tensile PSI	Yield PSI	Elong. % In 2"	Rockwell Hardness
304	Annealed 1/8 Hard	85,000 105,000	35,000 75,000	55 20	RB80 RB95
304L	Annealed 1/8 Hard	80,000 105,000	30,000 75,000	55 20	RB75 RB95
304H	Annealed	85,000	35,000	55	RB80
310	Annealed	95,000	45,000	45	RB85
316	Annealed	85,000	35,000	50	RB80
316L	Annealed	80,000	30,000	50	RB75
316H	Annealed	85,000	35,000	50	RB80
317	Annealed	90,000	40,000	45	RB85
321	Annealed 1/8 Hard	90,000 105,000	35,000 75,000	55 20	RB80 RB95
347	Annealed	95,000	40,000	50	RB85
21-6-9	Annealed 1/8 Hard	100,000 142,000	60,000 120,000	45 20	RB90 RC30
416	Annealed	75,000	35,000	20	RB95

STAINLESS STEEL ORNAMENTAL TUBE ASTM A554

FINISHES (ROUNDS): 180, 240, 320, 400 Polish & Buff (Mirror)

TOLERANCES			
NORMAL ROUND	WALL THICKNESS	OD TOLERANCE	WALL TOLERANCE
5/8″ to 1″ incl.	.035 to .062	+ or - .005″	+ or - 10%
5/8″ to 1″ incl.	Over .062	+ or - .010″	+ or - 10%
Over 1″ to 1½″ incl.	.035 to .062	+ or - .008″	+ or - 10%
Over 1″ to 1½″ incl.	Over .062	+ or - .010″	+ or - 10%
Over 1½″ to 2½″ incl.	Over .035	+ or - .012″	+ or - 10%
Over 2½″ to 3½″ incl.	Over .049	+ or - .020″	+ or - 10%
Over 3½″ to 5″ incl.	Over .049	+ or - .025″	+ or - 10%
Over 5″	Over .083	+ or - .030″	+ or - 10%

FINISHES (SQUARES & RECTANGLES): 180, 240, 320, 400 Grit

TOLERANCES		
LARGEST NOMINAL OUTSIDE DIAMETER	OD TOLERANCE CONCAVITY OR CONVEXITY	WALL TOLERANCE
To 1¼″ incl.	+ or - .015″	+ or - 10%
Over 1¼‟ to 2½″ incl.	+ or - .020″	+ or - 10%
Over 2½″ to 5½″ incl.	+ or - .030″	+ or - 10%
Over 5½″	+ or - .060″	+ or - 10%

All information provided is for general reference only and not be used for engineering or design purposes.