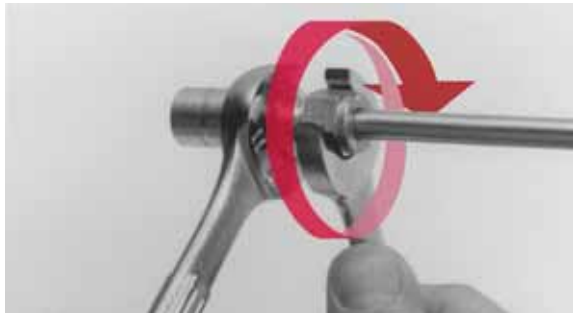




Gyrolok® Flareless Tube Fittings Tubing Data Charts



Design

HOKE Gyrolok Flareless Tube Fittings have been carefully designed and manufactured to provide a wide range of outstanding leak-tight application capabilities. HOKE Gyrolok® ratings and specifications are as follow:

Pressure Ratings

HOKE Gyrolok fittings are rated for working pressures higher than the tubing recommended for use with Gyrolok®. However, tubing should not be used above its maximum allowable working pressure.

Maximum allowable working pressures for tubing suitable for use with Gyrolok are identified herein. If no pressure is identified for a given size and a wall thickness, then that tube size/wall combination is not suitable for use with Gyrolok® fittings. See caution below.

Vacuum Rating

HOKE Gyrolok offers excellent vacuum capability. With good quality tubing, Gyrolok® fittings will be leak-tight at vacuum levels of 10^{-9} torr while tested with a leakage sensitivity of 10^{-9} sccs.

Materials

HOKE Gyrolok fittings are available in brass, 304 and 316 stainless steel, Monel®, Hastelloy®, Inconel®, titanium, 2205 Duplex, and 254 SMO. Contact your local HOKE distributor for further information.

Tubing

Fully annealed tubing to the specifications identified herein are suitable for use with HOKE Gyrolok® fittings.

The tubing selected, whether metallic or nonmetallic should be compatible with the process fluid, temperature and applications. The wall thickness selections should be based on pressure and temperature conditions.

Tubing should always be fully annealed. While welded tubing may be used with Gyrolok, inconsistencies in its manufacture and performance are sometimes encountered. As a result we recommend the use of seamless tubing.

For proper fitting performance, the tubing surface finish should be good, free from nicks or scratches. Do not use out of round tubing which does not easily go through fitting components.

Fitting performance is maximized when tube ends are squarely cut, using a tubing cutter, and deburred.

Proper fitting performance demands that the fitting be significantly harder than the tubing on which it is used. For example, stainless steel tubing should never exceed a maximum surface hardness of Rockwell B90, while Monel® tubing should never exceed a maximum surface hardness of Rockwell B75.

Accurate surface hardness measurements can be made using many different methods. The HOKE standard is to use the Vickers method, using a Leitz miniload tester with a load between 300 and 500 grams, dependent on wall thickness and surface conditions with a maximum reading of HV185 for stainless steel and HV138 for Monel®.

Gas Service

Gases (air, hydrogen, nitrogen, etc.) can escape through smaller leak paths than liquids. As such, the reduction of surface defects (scratches) on tubing becomes more important when the system media contains gases. As tubing wall thickness increases, the ability of the ferrules to coin out imperfections increases. The use of heavier wall tubing will help the ferrules to overcome minor surface defects that could contribute to gas leakage. Hoke recommends the following minimum wall thickness for tubing when system media contains gases.

TUBE OD (inches)	NOMINAL MINIMUM WALL THICKNESS (inches)	TUBE OD (inches)	NOMINAL MINIMUM WALL THICKNESS (inches)
1/8	0.028	3/4	0.065
3/16	0.028	7/8	0.083
1/4	0.028	1	0.083
5/16	0.035	1 1/4	0.109
3/8	0.035	1 1/2	0.134
1/2	0.049	2	0.180

Suggested Allowable Pressure Tables

Figures and tables are for reference only. HOKE makes no implication that these valves can be used for design work. Applicable codes and practices in industry should be reviewed and considered. ASME Codes are the successor to and replacement of ASA Piping Codes. For combinations not shown, consult factory .

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Gyrolok®

Calculating Yield, Burst, and Maximum Allowable Working Pressures

Maximum allowable stress values and calculation factors are used to determine yield, burst, and maximum allowable working pressures. HOKE has made these calculations for a variety of materials and included the results in charts beginning on page 6. The following information is presented to provide an understanding of how the numbers are derived.

Formulas

1. Maximum Allowable Working Pressure

Fractional: Factor \times Maximum Allowable Stress Value (psi)
Metric: Factor \times Maximum Allowable Stress Value (psi) \times 0.06895
Factor \times Maximum Allowable Stress Value (ksi) \times 68.95

2. Calculated Yield Pressure

Fractional: Factor \times Minimum Yield Strength (psi)
Metric: Factor \times Minimum Yield Strength (psi) \times 0.06895

3. Calculated Burst Pressure

Fractional: Factor \times Minimum Tensile Strength (psi)
Metric: Factor \times Minimum Tensile Strength (psi) \times 0.6895

See table of "Maximum Allowable Stress Values for Material at Various Temperatures" on pages 3 and 4, and the "Calculation Factor Tables" on page 5.

Maximum Allowable Working Pressure Calculation Examples

The values listed on the "CALCULATION FACTOR TABLE" are for stainless steel and may be used to determine the maximum allowable pressure, yield pressure, burst pressure or any other pressure for which a stress value is available. The Calculation Factor Tables on page 5 are based on stainless steel tubing having maximum allowable outside diameter and minimum allowable wall thickness. Stress values may be obtained from "MAXIMUM ALLOWABLE STRESS VALUES FOR MATERIALS AT VARIOUS TEMPERATURES" table or other sources. All of the charts contained herein are based on use of tubing having the "worst" tolerance conditions allowed for that particular material.

Example 1

Suppose that you want to know the maximum allowable working pressure of 304 S. ST. seamless, ASTM A-213, 1/4" O.D. by .035 wall tubing at a temperature of 100° F. This information can be directly obtained from the table "MAXIMUM ALLOWABLE WORKING PRESSURE – 304 STAINLESS STEEL" or calculated as follows:

First Find the factor (K) corresponding to 1/4" O.D. \times 0.035 wall on the "CALCULATION FACTOR TABLE".

$$K = 0.2753$$

Second Find the allowable stress (S_A) for seamless 304 stainless steel tubing at 100° F on the "MAXIMUM ALLOWABLE STRESS VALUES FOR MATERIALS AT VARIOUS TEMPERATURES".

$$S_A = 18,750 \text{ psi}$$

Third According to "CALCULATION FACTOR TABLE", Maximum Allowable Working Pressure (P_A) = Factor (K) \times Maximum Allowable Stress (S_A) Value in psi

$$\text{Therefore: } P_A = K \times S_A \\ P_A = 0.2753 \times 18,750 \text{ psi}$$

$P_A = 5161 \text{ psi}$ (Max. Allowable Working Pressure at 100° F)

Example 2

Suppose that you want to know the maximum allowable working pressure of 304 stainless steel seamless, ASTM A-213, 6mm O.D. by 1.2mm wall tubing at a temperature of 38° C. This information can be directly obtained from the table "MAXIMUM ALLOWABLE WORKING PRESSURE – 304 STAINLESS STEEL" or calculated as follows:

First Find the factor (K) corresponding to 6mm O.D. \times 1.2mm wall on the "CALCULATION FACTOR TABLE".

$$K = 0.4112$$

Second Find the allowable stress (S_A) for seamless 304 stainless steel tubing at 38° C on the "MAXIMUM ALLOWABLE STRESS VALUES FOR MATERIALS AT VARIOUS TEMPERATURES".

$$S_A = 18,750 \text{ psi}$$

Third According to "CALCULATION FACTOR TABLE", Maximum Allowable Working Pressure (P_A) = Factor (K) \times Maximum Allowable Stress (S_A) Value in psi \times 0.06895

$$\text{Therefore: } P_A = K \times S_A \times 0.06895 \\ P_A = .4112 \times 18,750 \text{ psi} \times 0.06895$$

$P_A = 532 \text{ bar}$ (Max. Allowable Working Pressure at 38° C)

CAUTION: Limited test data is available on certain materials, including Hastelloy®, Inconel®, 2205 Duplex, and 254 SMO. In such applications, further testing either by HOKE or by the user is recommended to assure fitting suitability for the application.

Maximum Allowable Stress Values for Materials at Various Temperatures

Values in ksi (psi=ksi × 1000)

TEMPERATURE		COPPER	TYPE 304			TYPE 316		MONEL® 400	INCONEL® 600
°F	°C	SEAMLESS ANNEALED TUBING SPEC ASTM B-75	SEAMLESS ANNEALED TUBING SPEC ASTM A-213	WELDED ANNEALED TUBING SPEC ASTM A-249	SEAMLESS ANNEALED TUBING SPEC ASTM A-213	WELDED ANNEALED TUBING SPEC ASTM A-249	SEAMLESS ANNEALED TUBING SPEC ASTM B-165	SEAMLESS ANNEALED TUBING SPEC ASTM B-167	
-20 to +100	-29 to +38	6.0	18.75	15.9	18.7	16	17.5	20.0	
150	66	5.1	18.27	15.5	18.7	16	16.95	20.0	
200	93	4.8	17.8	15.1	18.7	16	16.4	20.0	
250	121	4.8	17.2	14.6	18.	15.8	15.9	20.0	
300	149	4.7	16.6	14.1	18.4	15.6	15.4	20.0	
350	177	4.0	16.4	13.9	18.2	15.5	15.1	20.0	
400	204	3.0	16.2	13.8	18.0	15.3	14.8	20.0	
450	232		16.0	13.6	18.0	15.3	14.7	20.0	
500	260		15.9	13.5	18.0	15.3	14.7	20.0	
550	288		15.9	13.5	17.5	14.9	14.7	20.0	
600	316		15.9	13.5	17.0	14.5	14.7	20.0	
650	343		15.9	13.5	16.7	14.2	14.7	20.0	
700	371		15.9	13.5	16.3	13.9	14.7	20.0	
750	399		15.6	13.3	16.1	13.7	14.6	20.0	
800	427		15.2	12.9	15.8	13.4	14.2	20.0	
850	454		14.9	12.7	15.7	13.4	11.0	19.6	
900	482		14.7	12.5	15.6	13.3	8.0	16.0	
950	510		14.4	12.2	15.4	13.1		10.6	
1000	538		14.1	12.0	15.3	13.0		7.0	
1050	566		12.4	10.5	15.1	12.8		4.5	
1100	593		9.8	8.3	12.4	10.5		3.0	
1200	649		6.1	5.2	7.4	6.3		2.0	
1250	677		4.7	4.0	5.5	4.7			
1300	704		3.7	3.2	4.1	3.5			
1350	732		2.9	2.5	3.1	2.6			
1400	760		2.3	2.0	2.3	2.0			
1450	788		1.8	1.5	1.7	1.5			
1500	815		1.4	1.2	1.3	1.1			
Min. Tensile Strength (ksi) @ 100° F	Min Tensile Strength (ksi) @ 38° C	30	75	75	75	75	70	80	
Min. Yield Strength (ksi) @ 100° F	Min Yield Strength (ksi) @ 38° C	9	30	30	30	30	28	35	

Maximum Allowable Stress Values for Materials at Various Temperatures

Values in ksi (psi=ksi × 1000)

TEMPERATURE		HASTELLOY® C-276		254 SMO	2205 DUPLEX	2507 SUPER DUPLEX	TITANIUM GRADE 2	
°F	°C	SEAMLESS SOLUTION ANNEALED TUBING SPEC ASTM B-622	WELDED SOLUTION ANNEALED TUBING SPEC ASTM B-626	SEAMLESS SOLUTION TREATED TUBING SPEC. ASTM A-269	SEAMLESS SOLUTION TREATED TUBING SPEC. ASTM A-789	SEAMLESS SOLUTION TREATED TUBING SPEC. ASTM A-789	SEAMLESS ANNEALED TUBING SPEC. ASTM B-338	WELDED ANNEALED TUBING SPEC. ASTM B-338
-20 to +100	-29 to +38	25	21.25	23.5	22.5	29.0	12.5	10.6
150	66	25	21.25	23.5	22.5	29.0	12.0	10.2
200	93	25	21.25	23.5	22.5	28.9	10.9	9.3
250	121	25	21.25	22.95	22.1	28.1	9.9	8.4
300	149	25	21.25	22.4	21.7	27.3	9.0	7.7
350	177	24.65	20.95	21.85	21.3	26.9	8.4	7.1
400	204	24.3	20.7	21.3	20.9	26.4	7.7	6.5
450	232	24.1	20.5	20.9	20.65	26.2	7.2	6.1
500	260	23.9	20.3	20.5	20.4	25.9	6.6	5.6
550	288	23.7	20.15	20.3	20.3	25.8	6.2	5.3
600	316	23.5	20	20.1	20.2	25.8	5.7	4.8
650	343	23.3	19.8	19.9				
700	371	23.1	19.6	19.9				
750	399	22.9	19.5	19.8				
800	427	22.8	19.4					
850	454	22.6	19.2					
900	482	22.3	18.9					
950	510	22.1	18.8					
1000	538	21.8	18.5					
1050	566	18.5	15.7					
1100	593	15	12.7					
1200	649	9.8	8.3					
1250	677	7.8	6.6					
1300	704							
1350	732							
1400	760							
1450	788							
1500	815							
Min. Tensile Strength (ksi) @ 100° F	Min. Tensile Strength (ksi) @ 38° C	100	100	94	90		50	50
Min. Yield Strength (ksi) @ 100° F	Min. Yield Strength (ksi) @ 38° C	41	41	44	65		40	40

Allowable stress values extracted from ASME Boiler and Pressure Vessels Code Section II Part D and ASME B31.3 Process Piping with permission of the publisher ASME.

Tubing Data Charts

Stainless Steel Calculation Factor Tables

For gas service, select a wall thickness that is **not** shaded (see Gas Service, page 1).

TUBING O.D. (inch)	WALL THICKNESS (inch)																	
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188	
1/16	0.3035	0.3733	0.5238	0.6910														
1/8					0.4585	0.5851												
3/16					0.2942	0.3791	0.5492											
1/4					0.2155	0.2753	0.4033	0.5493										
3/8					0.1405	0.1781	0.2566	0.3533	0.4631									
1/2						0.1316	0.1882	0.2559	0.3363	0.3922								
5/8							0.1486	0.2010	0.2625	0.3050	0.3574							
3/4							0.1227	0.1654	0.2152	0.2494	0.2904	0.3235						
7/8							0.1045	0.1406	0.1824	0.2110	0.2451	0.2725						
1								0.1220	0.1579	0.1824	0.2115	0.2349						
1 1/4									0.1249	0.1440	0.1666	0.1847	0.2080	0.2318	0.2455	0.2876		
1 1/2										0.1189	0.1374	0.1522	0.1711	0.1904	0.2015	0.2354	0.2469	
2											0.0872	0.1006	0.1112	0.1248	0.1386	0.1465	0.1706	0.1787

For gas service, select a wall thickness that is **not** shaded (see Gas Service, page 1).

TUBING O.D. (mm)	WALL THICKNESS (mm)														
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0	
3	0.3285	0.4039	0.4790	0.5543	0.7009										
4	0.2406	0.2944	0.3504	0.4075	0.5213	0.6341									
6			0.2252	0.2607	0.3346	0.4112	0.5259	0.5642							
8			0.1659	0.1914	0.2439	0.2985	0.3846	0.4131							
10				0.1512	0.1919	0.2339	0.2993	0.3219	0.3686	0.4143					
12				0.1250	0.1582	0.1922	0.2450	0.2631	0.2999	0.3377					
14					0.1345	0.1632	0.2074	0.2224	0.2530	0.2844	0.3164	0.3665			
15					0.1252	0.1517	0.1926	0.2065	0.2347	0.2635	0.2930	0.3398			
16						0.1418	0.1798	0.1927	0.2189	0.2456	0.2728	0.3147	0.3873		
18						0.1253	0.1586	0.1699	0.1928	0.2161	0.2398	0.2761	0.3388		
20						0.1123	0.1420	0.1520	0.1723	0.1929	0.2139	0.2459	0.3010		
22						0.1017	0.1284	0.1375	0.1557	0.1742	0.1930	0.2217	0.2708		
25								0.1203	0.1361	0.1522	0.1684	0.1931	0.2354		
28										0.1348	0.1491	0.1708	0.2078	0.2849	
30										0.1254	0.1386	0.1587	0.1929	0.2640	
32										0.1172	0.1296	0.1483	0.1801	0.2460	
38												0.1238	0.1500	0.2041	
50													0.1125	0.1523	

Factors to left of heavy black line were calculated using the "Boardman Formula", those to the right were calculated using the "Lamé Formula".

Chart Factors have been established per "ASME Boiler and Pressure Vessel Code, Section VIII, UG-27 and Appendix 1, and ASME B31.3, Process Piping, Par. 304.1.2

For factor tables of other materials, contact HOKE Incorporated or your local distributor.

Tubing Data Charts

Copper Annealed Seamless Tubing

ASTM B-75 or Equivalent, Maximum Hardness HRf 55

Maximum Working Pressure (psi) for Fractional Sizes

Allowable Stress = 6,000 psi between -20° F and 100° F

For gas service, select a wall thickness that is not shaded. (See Gas Service, page 1)

TUBING O.D. (inch)	WALL THICKNESS (inch)																		
	0.010	0.012	0.016	0.020	0.028	0.032	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188	
1/16	1650	2120	3150	4000															
1/8					2770	3260	3630												
3/16					1800	2130	2340	3480											
1/4					1320	1540	1690	2560	3500										
3/8						1000	1090	1620	2250	2970									
1/2							800	1180	1620	2160									
5/8								630	930	1270	1680	1970							
3/4								510	760	1040	1350	1580	1860						
7/8								440	640	880	1140	1340	1570						
1								380	560	760	990	1160	1350	1500					
1 1/4										600	780	910	1060	1170	1330	1490	1580	1830	
1 1/2											640	750	870	960	1090	1220	1300	1500	1570
2												550	650	710	800	900	950	1090	1150

Factor of Safety = 5, considering tensile strength to be 30,000 psi at room temperature

Calculated Burst Pressure (psi) for Fractional Sizes

Minimum Tensile Strength = 30,000 psi

For gas service, select a wall thickness that is not shaded. (See Gas Service, page 1)

TUBING O.D. (inch)	WALL THICKNESS (inch)																		
	0.010	0.012	0.016	0.020	0.028	0.032	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188	
1/16	8250	10600	15750	20000															
1/8					13850	16300	18150												
3/16					9000	10650	11700	17400											
1/4					6600	7700	8450	12800	17500										
3/8						5000	5450	8100	11250	14850									
1/2							4000	5900	8100	10800									
5/8							3150	4650	6350	8400	9850								
3/4							2550	3800	5200	6750	7900	9300							
7/8							2200	3200	4400	5700	6700	7850							
1							1900	2800	3800	4950	5800	6750	7500						
1 1/4										3000	3900	4550	5300	5850	6650	7450	7900	9150	
1 1/2											3200	3750	4350	4800	5450	6100	6500	7500	7850
2												2750	3250	3550	4000	4500	4750	5450	5750

Tubing Data Charts

Copper Annealed Seamless Tubing

ASTM B-75 or Equivalent, Maximum Hardness HRf 55

Maximum Working Pressure (bar) for Metric Sizes

Allowable Stress = 41 MPa between -29° C and 38° C

For gas service, select a wall thickness that is not shaded. (See Gas Service, page 1)

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3			205	240										
4			150	176	223	276								
6			95	112	143	179	232	248						
8				82	103	129	169	181						
10				64	81	101	132	141	163	183				
12				53	67	83	108	115	132	150				
14					57	70	90	97	111	126	140	163		
15					53	65	84	90	103	117	131	151		
16					50	61	79	84	96	108	121	140	174	
18					43	53	68	73	84	94	105	121	151	
20					39	48	62	66	76	86	95	41	136	
22					35	43	55	59	68	77	84	97	120	
25					30	38	48	52	59	66	73	85	104	
28					27	33	43	46	52	59	65	75	92	126
30										54	60	70	86	116
32										51	57	65	80	108
38												54	66	90
50													50	68

Factor of safety = 5, considering tensile strength to be 205 MPa at room temperature

Calculated Burst Pressure (bar) for Metric Sizes

Minimum Tensile Strength = 205 MPa

For gas service, select a wall thickness that is not shaded. (See Gas Service, page 1)

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3			1024	1200										
4			748	879	1117	1379								
6			476	559	714	893	1159	1238						
8				410	517	645	845	907						
10				321	407	503	659	703	814	917				
12				266	334	414	538	576	662	748				
14					283	352	452	486	555	631	700	817		
15					266	324	421	452	517	586	655	755		
16					248	303	393	421	479	541	603	700	869	
18					217	266	341	366	421	472	524	607	755	
20					197	241	310	331	379	428	476	203	679	
22					176	214	276	297	338	383	421	486	600	
25					152	190	241	259	297	331	366	424	521	
28					134	166	214	231	262	293	324	376	462	628
30										272	300	348	428	579
32										255	283	324	400	541
38												269	331	448
50													248	341

Tubing Data Charts

304 & 316 Stainless Steel Annealed Seamless Tubing

ASTM A-213 or Equivalent, Maximum Hardness HRB 90

Maximum Working Pressure (psi) for Fractional Sizes

Allowable Stress = 18,750 psi between -20° F and 100° F

For gas service, select a wall thickness that is not shaded. (See Gas Service, page 1)

TUBING O.D. (inch)	WALL THICKNESS (inch)																	
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188	
1/16	5690	6990	9820	12950														
1/8					8590	10970												
3/16					5510	7100	10290											
1/4					4040	5160	7560	10290										
3/8					2630	3330	4810	6620	8680									
1/2						2460	3520	4790	6300	7350								
5/8								2780	3760	4920	5710	6700						
3/4								2300	3100	4030	4670	5440	6060					
7/8								1960	2630	3410	3950	4590	5100					
1									2280	2960	3410	3960	4400					
1 1/4										2340	2690	3120	3460	3900	4340	4600	5390	
1 1/2											2230	2570	2850	3200	3560	3770	4410	4620
2											1630	1880	2080	2340	2590	2740	3190	3350

Factor of safety = 4, considering tensile strength to be 75,000 psi at room temperature

Calculated Burst Pressure (psi) for Fractional Sizes

Minimum Tensile Strength = 75,000 psi

For gas service, select a wall thickness that is not shaded. (See Gas Service, page 1)

TUBING O.D. (inch)	WALL THICKNESS (inch)																
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188
1/16	22760	27960	39280	51800													
1/8					34360	43880											
3/16					22040	28400	41160										
1/4					16160	20640	30240	41160									
3/8					10520	13320	19240	26480	34720								
1/2					7800	9840	14080	19160	25200	29400							
5/8							11120	15040	19680	22840	26800						
3/4							9200	12400	16120	18680	21760	24240					
7/8							7840	10520	13640	15800	18360	20400					
1								9120	11840	13640	15840	17600					
1 1/4									9360	10760	12480	13840	15600	17360	18400	21560	
1 1/2										8920	10280	11400	12800	14240	15080	17640	18480
2										6520	7520	8320	9360	10360	10960	12760	13400

Tubing Data Charts

304 & 316 Stainless Steel Annealed Seamless Tubing

ASTM A-213 or Equivalent, Maximum Hardness HRB 90

Maximum Working Pressure (bar) for Metric Sizes

Allowable stress = 129.3 MPa between -29° C and 38° C

For gas service, select a wall thickness that is not shaded. (See Gas Service, page 1)

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	424	522	619	717	906									
4	311	381	452	527	674	819								
6			291	337	432	532	680	729						
8			214	247	315	386	497	534						
10				195	248	302	387	416	477	535				
12				161	204	248	317	340	388	437				
14					174	210	268	288	327	368	409	474		
15					161	196	249	267	303	341	379	439		
16						183	232	249	283	317	352	407	501	
18						161	205	219	249	279	310	357	438	
20						145	183	196	223	249	277	318	389	
22						131	166	177	201	225	249	286	350	
25								155	176	197	217	250	304	
28										174	192	221	268	368
30										162	179	205	249	341
32										151	167	192	232	318
38												160	194	263
50													145	197

Factor of safety = 4, considering tensile strength to be 517.1 MPa at room temperature

Calculated Burst Pressure (bar) for Metric Sizes

Minimum Tensile Strength = 517.1 MPa

For gas service, select a wall thickness that is not shaded. (See Gas Service, page 1)

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	1697	2088	2477	2866	3625									
4	1244	1523	1810	2108	2695	3277								
6			1164	1346	1730	2127	2720	2916						
8			858	988	1261	1542	1989	2135						
10				781	990	1208	1548	1663	1906	2141				
12				646	817	993	1266	1360	1550	1746				
14					695	841	1070	1150	1308	1470	1636	1895		
15					646	783	996	1068	1214	1363	1514	1757		
16						731	930	996	1131	1269	1410	1628	2003	
18						646	819	877	996	1117	1239	1426	1752	
20						579	734	783	891	996	1106	1272	1556	
22						524	662	709	806	899	996	1145	1399	
25								621	703	786	869	999	1217	
28										695	770	883	1073	1473
30										648	714	819	996	1366
32										604	668	767	930	1272
38												640	775	1054
50													579	786

Tubing Data Charts

304 & 316 Stainless Steel Annealed Welded Tubing

ASTM A-249 or Equivalent, Maximum Hardness, HRB 90

Maximum Working Pressure (psi) for Fractional Sizes

Allowable Stress = 15,940 psi between -20° F and 100° F

For gas service, select a wall thickness that is not shaded. (See Gas Service, page 1)

TUBING O.D. (inch)	WALL THICKNESS (inch)																		
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188		
1/16	4850	5970	8380	11050															
1/8					7330	9360													
3/16					4700	6060	8780												
1/4					3440	4400	6450	8780											
3/8					2240	2840	4100	5650	7400										
1/2						2100	3010	4090	5380	6270									
5/8							2370	3210	4190	4880	5710								
3/4								1960	2640	3440	3990	4640	5170						
7/8								1670	2240	2910	3370	3920	4360						
1									1950	2520	2910	3380	3750						
1 1/4										1990	2300	2660	2950	3320	3700	3920	4600		
1 1/2											1900	2190	2430	2730	3040	3220	3760	3950	
2												1390	1600	1770	1990	2210	2340	2720	2850

Factor of safety = 4, considering tensile strength to be 75,000 psi at room temperature and a weld joint efficiency factor of approximately 0.85

Calculated Burst Pressure (psi) for Fractional Sizes

Minimum Tensile Strength = 75,000 psi

For gas service, select a wall thickness that is not shaded. (See Gas Service, page 1)

TUBING O.D. (inch)	WALL THICKNESS (inch)																		
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188		
1/16	19400	23880	33520	44200															
1/8					29320	37440													
3/16					18800	24240	35120												
1/4					13760	17600	25800	35120											
3/8					8960	11360	16400	22600	29600										
1/2						8400	12040	16360	21520	25080									
5/8							9480	12840	16760	19520	22840								
3/4								7840	10560	13760	15960	18560	20680						
7/8								6680	8960	11640	13480	15680	17440						
1									7800	10080	11640	13520	15000						
1 1/4										7960	9200	10640	11800	13280	14800	15680	18400		
1 1/2											7600	8760	9720	10920	12160	12880	15040	15800	
2												5560	6400	7080	7960	8840	9360	10880	11400

Tubing Data Charts

304 & 316 Stainless Steel Annealed Welded Tubing

ASTM A-249 or Equivalent, Maximum Hardness HRB 90

Maximum Working Pressure (bar) for Metric Sizes

Allowable Stress = 109.9 MPa between -29° C and 38° C

For gas service, select a wall thickness that is not shaded. (See Gas Service, page 1)

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	362	446	528	611	773									
4	266	325	386	450	575	699								
6			248	288	369	453	580	622						
8			183	211	269	329	424	455						
10				166	212	258	330	354	406	457				
12				137	174	212	270	290	330	372				
14					148	180	228	245	279	313	349	404		
15					138	167	212	228	259	290	323	374		
16						156	198	212	241	270	301	347	427	
18						138	174	187	212	238	264	304	374	
20						123	157	168	190	212	236	271	332	
22						112	141	151	172	192	212	244	299	
25								132	150	168	186	213	259	
28										148	164	188	229	314
30										138	152	174	212	291
32										129	143	163	199	271
38												137	166	225
50													124	168

Factor of safety = 4, considering tensile strength to be 517.1 MPa at room temperature and weld joint efficiency factor of approximately 0.85

Calculated Burst Pressure (bar) for Metric Sizes

Minimum Tensile Strength = 517.1 MPa

For gas service, select a wall thickness that is not shaded. (See Gas Service, page 1)

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	1448	1782	2113	2444	3092									
4	1062	1299	1545	1799	2301	2797								
6			993	1150	1476	1812	2320	2488						
8			731	844	1076	1316	1697	1821						
10				665	847	1032	1319	1418	1625	1826				
12				549	698	847	1081	1159	1321	1490				
14					593	720	913	979	1114	1252	1396	1617		
15					552	668	850	910	1034	1161	1291	1498		
16						623	792	850	966	1081	1203	1388	1708	
18						552	698	748	850	952	1057	1217	1495	
20						494	626	670	759	850	943	1084	1327	
22						447	566	604	687	767	850	977	1194	
25								530	599	670	742	852	1037	
28										593	657	753	916	1255
30										552	610	698	850	1164
32										516	571	654	794	1084
38												546	662	899
50													497	670

Tubing Data Charts

Monel® 400 (Nickel-Copper) Annealed Seamless Tubing

ASTM B-165 or Equivalent, Maximum Hardness HRB 75

Maximum Working Pressure (psi) for Fractional Sizes

Allowable Stress = 17,500 psi between -20° F and 100° F

TUBING O.D. (inch)	WALL THICKNESS (inch)																
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188
1/16	4900	6010	8400	11030													
1/8				5110	7460	9540											
3/16				3320	4800	6190	8970										
1/4					3530	4500	6570	8990									
3/8						2920	4200	5780									
1/2						2160	3090	4190	5500								
5/8						1810	2580	3490	4560	5300							
3/4						1500	2130	2880	3740	4340	5050	5630					
7/8						1280	1820	2450	3170	3670	4270	4740					
1						1120	1580	2130	2750	3180	3690	4100					
1 1/4								1690	2180	2510	2910	3220	3630	4050	4290	5020	
1 1/2									1800	2070	2400	2650	2990	3320	3520	4110	4310
2										1540	1770	1960	2200	2440	2580	3010	3150

Factor of safety = 4, considering tensile strength to be 70,000 psi at room temperature

Calculated Burst Pressure (psi) for Fractional Sizes

Minimum Tensile Strength = 70,000 psi

TUBING O.D. (inch)	WALL THICKNESS (inch)																
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188
1/16	19600	24040	33600	44120													
1/8				20440	29840	38160											
3/16				13280	19200	24760	35880										
1/4					14120	18000	26280	35960									
3/8						11680	16800	23120									
1/2						8640	12360	16760	22000								
5/8						7240	10320	13960	18240	21200							
3/4						6000	8520	11520	14960	17360	20200	22520					
7/8						5120	7280	9800	12680	14680	17080	18960					
1						4480	6320	8520	11000	12720	14760	16400					
1 1/4								6760	8720	10040	11640	12880	14520	16200	17160	20080	
1 1/2									7200	8280	9600	10600	11960	13280	14080	16440	17240
2										6160	7080	7840	8800	9760	10320	12040	12600

Tubing Data Charts

Monel[®] 400 (Nickel-Copper) Annealed Seamless Tubing

ASTM B-165 or Equivalent, Maximum Hardness HRB 75

Maximum Working Pressure (bar) for Metric Sizes

Allowable Stress = 120.6 MPa between -29° C and 38° C

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	368	452	537	621	790									
4	270	330	392	458	586	714								
6			254	294	376	463	592	636						
8			188	216	275	337	434	466						
10				171	217	264	337	363						
12				141	179	217	277	297	339	381				
14					152	185	234	251	286	321	357	414		
15					141	172	218	233	266	298	331	384		
16					140	170	215	231	262	294	327	377	460	
18					124	150	190	203	231	259	288	331	406	
20					111	134	170	182	207	232	257	295	361	
22					101	122	154	165	187	209	232	266	325	
25					88	107	134	144	163	183	202	232	283	
28					79	95	120	128	145	162	179	206	250	343
30										151	167	191	232	318
32										141	156	179	217	296
38												149	181	246
50													135	183

Factor of safety = 4, considering tensile strength to be 482.6 MPa at room temperature

Calculated Burst Pressure (bar) for Metric Sizes

Minimum Tensile Strength = 482.6 MPa

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	1470	1810	2146	2486	3159									
4	1081	1321	1570	1832	2342	2858								
6			1015	1175	1503	1851	2370	2543						
8			750	863	1101	1346	1735	1862						
10				684	866	1057	1349	1451						
12				566	714	869	1106	1189	1354	1523				
14					610	739	938	1004	1142	1283	1429	1655		
15					566	687	872	932	1062	1192	1324	1537		
16					560	679	861	924	1048	1178	1308	1509	1840	
18					497	601	761	814	924	1037	1150	1324	1625	
20					444	538	681	728	828	927	1026	1181	1446	
22					403	488	615	659	748	836	927	1065	1299	
25					353	428	538	577	654	731	808	927	1131	
28					314	381	480	513	579	648	717	822	1001	1371
30										604	668	764	930	1272
32										563	623	714	866	1183
38												596	723	982
50													541	731

Tubing Data Charts

Inconel 600 (Nickel-Chromium-Iron) Annealed Seamless Tubing

ASTM B-167 or Equivalent, Maximum Hardness HRB 88

Maximum Working Pressure (psi) for Fractional Sizes

Allowable Stress = 20,000 psi between -20° F and 800° F

TUBING O.D. (inch)	WALL THICKNESS (inch)																
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188
1/16	5600	6870	9600	12610													
1/8				5840	8530	10900											
3/16				3800	5480	7070	10260										
1/4					4030	5140	7510	10270									
3/8						3340	4800	6610	8660								
1/2						2470	3530	4790	6290								
5/8						2070	2950	3990	5210	6060							
3/4						1720	2440	3290	4280	4960	5770	6430					
7/8						1460	2080	2800	3630	4200	4880	5420					
1						1280	1810	2430	3150	3640	4220	4690					
1 1/4								1930	2490	2870	3320	3680	4150	4620	4900	5740	
1 1/2									2060	2370	2740	3030	3410	3800	4020	4700	4930
2										1760	2030	2240	2520	2790	2950	3440	3610

Factor of safety = 4, considering tensile strength to be 80,000 psi at room temperature

Calculated Burst Pressure (psi) for Fractional Sizes

Minimum Tensile Strength = 80,000 psi

TUBING O.D. (inch)	WALL THICKNESS (inch)																
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188
1/16	22400	27480	38400	50440													
1/8				23360	34120	43600											
3/16				15200	21920	28280	41040										
1/4					16120	20560	30040	41080									
3/8						13360	19200	26440	34640								
1/2						9880	14120	19160	25160								
5/8						8280	11800	15960	20840	24240							
3/4						6880	9760	13160	17120	19840	23080	25720					
7/8						5840	8320	11200	14520	16800	19520	21680					
1						5120	7240	9720	12600	14560	16880	18760					
1 1/4								7720	9960	11480	13280	14720	16600	18480	19600	22960	
1 1/2									8240	9480	10960	12120	13640	15200	16080	18800	19720
2										7040	8120	8960	10080	11160	11800	13760	14440

Tubing Data Charts

Inconel 600 (Nickel-Chromium-Iron) Annealed Seamless Tubing

ASTM B-167 or Equivalent, Maximum Hardness HRB 88

Maximum Working Pressure (bar) for Metric Sizes

Allowable Stress = 137.9 MPa between -29° C and 38° C

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	420	517	613	710	903									
4	309	378	449	523	670	817								
6			290	335	430	529	677	727						
8			214	247	314	384	496	532						
10				195	248	302	386	414						
12				161	204	248	317	339	387	435				
14					174	211	268	288	327	367	408	473		
15					162	197	249	267	303	340	378	439		
16					160	194	246	264	300	337	374	431	526	
18					142	172	217	233	264	296	328	379	464	
20					127	154	194	208	236	265	293	337	413	
22					115	139	176	188	214	239	265	304	372	
25					101	122	154	165	187	209	231	265	323	
28					90	109	137	147	166	186	205	235	286	392
30										172	190	219	266	363
32										161	178	204	248	339
38												170	206	281
50													154	209

Factor of safety = 4, considering tensile strength to be 551.6 MPa at room temperature

Calculated Burst Pressure (bar) for Metric Sizes

Minimum Tensile Strength = 551.6 MPa

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	1680	2069	2452	2841	3611									
4	1236	1512	1796	2091	2679	3266								
6			1159	1341	1719	2116	2709	2908						
8			855	988	1258	1537	1983	2130						
10				781	990	1208	1542	1658						
12				646	817	993	1266	1357	1548	1741				
14					695	844	1073	1150	1308	1468	1633	1892		
15					648	786	996	1068	1214	1360	1512	1754		
16					640	775	985	1057	1200	1346	1495	1724	2105	
18					568	687	869	932	1057	1183	1313	1514	1857	
20					508	615	778	833	943	1059	1172	1349	1652	
22					461	557	703	753	855	954	1059	1217	1487	
25					406	488	615	659	748	836	924	1059	1291	
28					361	436	549	588	662	742	819	941	1142	1567
30										690	761	874	1062	1454
32										646	712	817	990	1354
38												681	825	1123
50													618	836

Tubing Data Charts

Hastelloy® C-276 (Nickel-Molybdenum-Chromium) Solution Annealed Seamless Tubing ASTM B-622 or Equivalent, Maximum Hardness HRB 98

Maximum Working Pressure (psi) for Fractional Sizes

Allowable Stress = 25,000 psi between -20° F and 300° F

TUBING O.D. (inch)	WALL THICKNESS (inch)																	
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188	
1/16	7230	8880	12430	16350														
1/8				7540	11010	14070												
3/16				4900	7080	9130	13240											
1/4					5200	6640	9710	13260										
3/8						4300	6200	8530										
1/2						3180	4550	6180	8120									
5/8						2520	3590	4860	6340	7370								
3/4						2150	3050	4110	5350	6200	7220	8040						
7/8						1830	2600	3500	4530	5250	6100	6780						
1						1600	2260	3040	3940	4550	5270	5860						
1 1/4								2410	3110	3590	4160	4610	5190	5780	6130	7180		
1 1/2									2570	2970	3430	3790	4270	4750	5030	5870	6160	
2										2200	2530	2800	3150	3490	3690	4300	4510	

Factor of safety = 4, considering tensile strength to be 100,000 psi at room temperature.

Calculated Burst Pressure (psi) for Fractional Sizes

Minimum Tensile Strength = 100,000 psi

TUBING O.D. (inch)	WALL THICKNESS (inch)																	
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188	
1/16	28920	35520	49720	65400														
1/8				30160	44040	56280												
3/16				19600	28320	36520	52960											
1/4					20800	26560	38840	53040										
3/8						17200	24800	34120										
1/2						12720	18200	24720	32480									
5/8						10080	14360	19440	25360	29480								
3/4						8600	12200	16440	21400	24800	28880	32160						
7/8						7320	10400	14000	18120	21000	24400	27120						
1						6400	9040	12160	15760	18200	21080	23440						
1 1/4								9640	12440	14360	16640	18440	20760	23120	24520	28720		
1 1/2									10280	11880	13720	15160	17080	19000	20120	23480	24640	
2										8800	10120	11200	12600	13960	14760	17200	18040	

Tubing Data Charts

Hastelloy® C-276 (Nickel-Molybdenum-Chromium) Solution Annealed Seamless Tubing ASTM B-622 or Equivalent, Maximum Hardness HRB 98

Maximum Working Pressure (bar) for Metric Sizes

Allowable Stress = 172.4 MPa between -29° C and 38° C

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	542	668	792	917	1163									
4	399	488	580	675	864	1053								
6			374	433	555	683	874	938						
8			276	319	406	497	640	687						
10				252	319	390	498	535						
12				208	263	321	408	438	499	562				
14					224	272	346	371	421	474	527	611		
15					209	253	321	344	391	439	488	566		
16					200	243	308	330	374	421	467	539	658	
18					177	214	272	291	330	370	411	473	581	
20					159	192	243	261	295	331	367	421	516	
22					144	174	220	236	267	299	331	380	464	
25					126	152	192	206	233	261	289	331	404	
28					112	136	171	183	208	232	257	294	357	490
30										216	239	273	332	454
32										201	223	255	310	423
38												213	258	351
50													193	261

Factor of safety = 4, considering tensile strength to be 689.6 MPa at room temperature

Calculated Burst Pressure (bar) for Metric Sizes

Minimum Tensile Strength = 689.6 MPa

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	2168	2670	3167	3666	4651									
4	1594	1950	2320	2701	3457	1053								
6			1495	1732	2221	683	3498	3752						
8			1103	1274	1622	497	2560	2748						
10				1007	1277	390	1992	2141						
12				833	1054	321	1633	1752	1997	2248				
14					897	1090	1382	1484	1686	1895	2108	2444		
15					836	1012	1286	1377	1564	1757	1953	2265		
16					800	971	1230	1319	1498	1683	1868	2154	2632	
18					709	858	1087	1164	1321	1481	1644	1892	2323	
20					637	770	974	1043	1181	1324	1468	1686	2063	
22					577	698	880	943	1068	1194	1324	1520	1857	
25					505	610	770	825	932	1043	1156	1324	1617	
28					450	543	684	734	830	927	1026	1175	1429	1961
30										863	954	1092	1327	1818
32										806	891	1021	1239	1694
38												852	1032	1404
50													772	1046

Tubing Data Charts

Hastelloy® C-276 (Nickel-Molybdenum-Chromium) Solution Annealed Welded Tubing ASTM B-626 or Equivalent, Maximum Hardness HRB 98

Maximum Working Pressure (psi) for Fractional Sizes

Allowable Stress = 21,250 psi between -20° F and 300° F

TUBING O.D. (inch)	WALL THICKNESS (inch)																	
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188	
1/16	6130	7530	10540	13860														
1/8				6390	9340	11930												
3/16				4150	6000	7740	11220											
1/4					4410	5630	8230	11240										
3/8					2880	3650	5250	7230	9480									
1/2						2700	3860	5240	6890	8040								
5/8						2140	3050	4120	5380	6250	7330							
3/4						1820	2580	3490	4530	5260	6120	6820						
7/8						1550	2200	2960	3840	4450	5170	5750						
1						1350	1920	2580	3340	3860	4470	4970						
1 1/4								2040	2640	3040	3520	3910	4400	4900	5190	6080		
1 1/2									2180	2510	2910	3220	3620	4030	4260	4980	5220	
2										1860	2150	2380	2670	2960	3130	3650	3820	

Factor of safety = 4, considering tensile strength to be 100,000 psi at room temperature and a weld joint efficiency factor of approximately 0.85

Calculated Burst Pressure (psi) for Fractional Sizes

Minimum Tensile Strength = 100,000 psi

TUBING O.D. (inch)	WALL THICKNESS (inch)																	
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188	
1/16	24520	30120	42160	55440														
1/8				25560	37360	47720												
3/16				16600	24000	30960	44880											
1/4					17640	22520	32920	44960										
3/8					11520	14600	21000	28920	37920									
1/2						10800	15440	20960	27560	32160								
5/8						8560	12200	16480	21520	25000	29320							
3/4						7280	10320	13960	18120	21040	24480	27280						
7/8						6200	8800	11840	15360	17800	20680	23000						
1						5400	7680	10320	13360	15440	17880	19880						
1 1/4								8160	10560	12160	14080	15640	17600	19600	20760	24320		
1 1/2									8720	10040	11640	12880	14480	16120	17040	19920	20880	
2										7440	8600	9520	10680	11840	12520	14600	15280	

Tubing Data Charts

Hastelloy® C-276 (Nickel-Molybdenum-Chromium) Solution Annealed Welded Tubing ASTM B-626 or Equivalent, Maximum Hardness HRB 98

Maximum Working Pressure (bar) for Metric Sizes

Allowable Stress = 146.5 MPa between -29° C and 149° C

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	460	566	671	777	986									
4	338	414	492	572	732	892								
6			317	367	471	579	741	795						
8			234	270	344	421	543	583						
10				214	271	330	422	454						
12				177	223	272	346	372	423	477				
14					190	230	293	314	357	401	447	518		
15					177	214	272	292	332	372	414	480		
16					170	206	261	280	318	357	396	457	558	
18					150	182	230	247	280	314	348	401	492	
20					134	163	206	221	250	281	311	357	437	
22					122	148	187	200	226	253	281	322	394	
25					107	130	163	174	198	221	245	281	343	
28					95	115	146	155	176	197	217	249	303	416
30										183	202	232	281	385
32										171	189	216	263	359
38												181	219	298
50													164	222

Factor of safety = 4, considering tensile strength to be 689.6 MPa at room temperature and weld joint efficiency factor of approximately 0.85

Calculated Burst Pressure (bar) for Metric Sizes

Minimum Tensile Strength = 689.6 MPa

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	1840	2265	2684	3109	3942									
4	1352	1655	1967	2290	2930	892								
6			1269	1468	1884	2317	2966	3181						
8			935	1081	1377	1683	2171	2331						
10				855	1084	1321	1688	1815						
12				706	894	1087	1385	1487	1694	1906				
14					761	921	1172	1258	1429	1606	1788	2072		
15					709	858	1090	1167	1327	1490	1655	1920		
16					679	822	1043	1120	1272	1426	1583	1826	2232	
18					601	728	921	988	1120	1255	1393	1606	1970	
20					538	651	825	883	1001	1123	1244	1429	1749	
22					488	590	748	800	905	1012	1123	1288	1575	
25					428	519	654	698	792	886	979	1123	1371	
28					381	461	582	621	703	786	869	996	1211	1663
30										731	808	927	1126	1539
32										684	756	863	1051	1434
38												723	874	1192
50													657	888

Tubing Data Charts

254 SMO (UNS S31254) Stainless Steel Solution Treated Seamless Tubing

ASTM A-269 (Mechanical Properties per ASTM A-249), Maximum Hardness HRB 90

Maximum Working Pressure (psi) for Fractional Sizes

Allowable Stress = 23,500 psi between -20° F and 200° F

TUBING O.D. (inch)	WALL THICKNESS (inch)																
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188
1/16	7130	8770	12300	16230													
1/8				7380	10770	13740											
3/16				4770	6910	8900	12900										
1/4				3530	5060	6470	9470	12900									
3/8					3300	4180	6030	8300									
1/2					2440	3090	4420	6010	7900								
5/8						2450	3490	4720	6160								
3/4						2030	2880	3880	5050								
7/8						1730	2450	3300	4280								
1						1500	2130	2860	3710								
1 1/4																	
1 1/2																	
2																	

Factor of safety = 4, considering tensile strength to be 94,000 psi at room temperature

Calculated Burst Pressure (psi) for Fractional Sizes

Minimum Tensile Strength = 94,000 psi

TUBING O.D. (inch)	WALL THICKNESS (inch)																
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188
1/16	28520	35080	49200	64920													
1/8				29520	43080	54960											
3/16				19080	27640	35600	51600										
1/4				14120	20240	25880	37880	51600									
3/8					13200	16720	24120	33200									
1/2					9760	12360	17680	24040	31600								
5/8						9800	13960	18880	24640								
3/4						8120	11520	15520	20200								
7/8						6920	9800	13200	17120								
1						6000	8520	11440	14840								
1 1/4																	
1 1/2																	
2																	

*Applicable for use with 254 SMO or 316 Stainless Steel Gyrolok® Fittings.

Tubing Data Charts

254 SMO (UNS S31254) Stainless Steel Solution Treated Seamless Tubing

ASTM A-269 (Mechanical Properties per ASTM A-249m), Maximum Hardness HRB 90

Maximum Working Pressure (bar) for Metric Sizes

Allowable Stress = 162.0 MPa between -29° C and 93° C

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	532	654	776	898	1136									
4	390	477	568	660	844	1028								
6			365	422	542	666	852	914						
8			268	310	395	483	623	669						
10				245	310	379	485	521						
12				202	256	311	397	426	486	547				
14					218	264	336	360	410	461				
15					203	246	312	334	380	427				
16					190	230	291	312	354	398				
18					168	203	257	275	312	350				
20					150	181	230	246	279	312				
22					136	165	208	223	252	282				
25					119	144	182	194	220	246				
28														
30														
32														
38														
50														

Factor of safety = 4, considering tensile strength to be 648.0 MPa at room temperature

Calculated Burst Pressure (bar) for Metric Sizes

Minimum Tensile Strength = 648.0 MPa

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	2127	2618	3103	3592	4543									
4	1559	1906	2270	2640	3377	4110								
6			1459	1688	2168	2665	3407	3655						
8			1073	1239	1581	1934	2491	2676						
10				979	1241	1514	1939	2086						
12				808	1023	1244	1586	1705	1942	2188				
14					872	1057	1343	1440	1639	1843				
15					811	982	1247	1338	1520	1708				
16					759	919	1164	1247	1418	1592				
18					670	811	1026	1101	1250	1399				
20					601	726	919	985	1114	1250				
22					543	659	830	891	1007	1128				
25					477	577	728	778	880	985				
28														
30														
32														
38														
50														

*Applicable for use with 254 SMO or 316 Stainless Steel Gyrolok® Fittings.

Tubing Data Charts

2205 Duplex (UNS S31803) Stainless Steel Solution Treated Seamless Tubing

ASTM A-789 or Equivalent, Maximum Hardness HRC 30.5

Maximum Working Pressure (psi) for Fractional Sizes

Allowable Stress = 22,500 psi between -20° F and 200° F

TUBING O.D. (inch)	WALL THICKNESS (inch)																
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188
1/16	6300	7730	10800	14190													
1/8				6570	9600	12270											
3/16				4270	6170	7950	11540										
1/4				3160	4530	5790	8450	11560									
3/8					2960	3750	5400	7440									
1/2					2330	2950	4220	5740	7540								
5/8						2340	3330	4510	5890								
3/4						1940	2750	3710	4830								
7/8						1650	2340	3150									
1						1440	2040	2740									
1 1/4																	
1 1/2																	
2																	

Factor of safety = 4, considering tensile strength to be 90,000 psi at room temperature

Calculated Burst Pressure (psi) for Fractional Sizes

Minimum Tensile Strength = 90,000 psi

TUBING O.D. (inch)	WALL THICKNESS (inch)																
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188
1/16	25200	30920	43200	56760													
1/8				26280	38400	49080											
3/16				17080	24680	31800	46160										
1/4				12640	18120	23160	33800	46240									
3/8					11840	15000	21600	29760									
1/2					9320	11800	16880	22960	30160								
5/8						9360	13320	18040	23560								
3/4						7760	11000	14840	19320								
7/8						6600	9360	12600									
1						5760	8160	10960									
1 1/4																	
1 1/2																	
2																	

Tubing Data Charts

2205 Duplex (UNS S31803) Stainless Steel Solution Treated Seamless Tubing ASTM A-789 or Equivalent, Maximum Hardness HRC 30.5

Maximum Working Pressure (bar) for Metric Sizes

Allowable Stress = 155.1 MPa between -29° C and 93° C

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	472	581	690	799	1015									
4	348	425	505	588	753	919								
6			326	377	483	595	762	818						
8			241	278	354	432	557	599						
10				220	279	339	434	466						
12				182	230	279	356	382	435	490				
14					208	252	321	344	392	440				
15					194	234	298	319	363	408				
16					181	219	278	298	339	380				
18					160	194	246	263	299	334				
20					143	174	219							
22					130	157	199							
25					114	138	174							
28														
30														
32														
38														
50														

Factor of safety = 4, considering tensile strength to be 620.5 MPa at room temperature

Calculated Burst Pressure (bar) for Metric Sizes

Minimum Tensile Strength = 620.5 MPa

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	1890	2326	2761	3197	4061									
4	1390	1699	2019	2353	3012	3674								
6			1305	1509	1934	2381	3048	3272						
8			963	1112	1415	1730	2229	2394						
10				880	1114	1357	1735	1865						
12				728	921	1117	1423	1528	1741	1959				
14					833	1010	1283	1377	1567	1760				
15					775	938	1192	1277	1451	1630				
16					723	877	1112	1192	1354	1520				
18					640	775	982	1051	1194	1338				
20					574	695	877							
22					521	629	794							
25					455	552	695							
28														
30														
32														
38														
50														

Tubing Data Charts

2507 Super Duplex (UNS 32750) Stainless Steel Solution Treated Seamless Tubing

ASTM A789, Maximum Hardness HRC 32

Maximum Working Pressure (psi) for Fractional Sizes

Allowable Stress = 29,000 psi between 20° F and 100° F

TUBING O.D. (inch)	WALL THICKNESS (inch)		
	0.035	0.049	0.065
¼	10,000	15,000	
⅜		10,100	12,700
½		7,200	10,100
¾			6,300

Factor of safety = 4, considering tensile strength to be 116,000 psi at room temperature

Calculated Burst Pressure (psi) for Fractional Sizes

Minimum Tensile Strength = 116,000 psi

TUBING O.D. (inch)	WALL THICKNESS (inch)		
	0.035	0.049	0.065
¼	40,000	60,000	
⅜		40,400	50,800
½		28,800	40,400
¾			25,200

Tubing Data Charts

Grade 2 Titanium Annealed Seamless Tubing

ASTM B-338 or Equivalent, Maximum Hardness HRB 80

Maximum Working Pressure (psi) for Fractional Sizes

Allowable Stress = 12,500 psi between -20° F and 100° F

TUBING O.D. (inch)	WALL THICKNESS (inch)																	
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188	
1/16	3790	4660	6540	8630														
1/8				3920	5730	7310												
3/16				2540	3670	4790	6860											
1/4					2690	3440	5040	6860										
3/8					1750	2220	3200	4410										
1/2					1300	1640	2350	3190	4200									
5/8						1300	1850	2510	3280	3810								
3/4						1080	1530	2060	2680	3110	3630	4040						
7/8						920	1300	1750	2270	2630	3060	3400						
1						800	1130	1520	1970	2280	2640	2930						
1 1/4								1210	1560	1800	2080	2310	2600	2890	3070	3590		
1 1/2									1290	1480	1710	1900	2130	2370	2510	2940	3080	
2										1100	1270	1400	1570	1750	1850	2150	2260	

Factor of safety = 4, considering tensile strength to be 50,000 psi at room temperature,

Calculated Burst Pressure (psi) for Fractional Sizes

Minimum Tensile Strength = 50,000 psi

TUBING O.D. (inch)	WALL THICKNESS (inch)																	
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188	
1/16	15160	18640	26160	34520														
1/8				15680	22920	29240												
3/16				10160	14680	19160	27440											
1/4					10760	13760	20160	27440										
3/8					7000	8880	12800	17640										
1/2					5200	6560	9400	12760	16800									
5/8						5200	7400	10040	13120	15240								
3/4						4320	6120	8240	10720	12440	14520	16160						
7/8						3680	5200	7000	9080	10520	12240	13600						
1						3200	4520	6080	7880	9120	10560	11720						
1 1/4								4840	6240	7200	8320	9240	10400	11560	12280	14360		
1 1/2									5160	5920	6840	7600	8520	9480	10040	11760	12320	
2										4400	5080	5600	6280	7000	7400	8600	9040	

Tubing Data Charts

Grade 2 Titanium Annealed Seamless Tubing

ASTM B-338 or Equivalent, Maximum Hardness HRB 80

Maximum Working Pressure (bar) for Metric Sizes

Allowable Stress = 86.2 MPa between -29° C and 38° C

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	283	348	412	477	603									
4	207	253	301	351	449	546								
6			194	224	288	354	453	486						
8			143	165	210	257	331	356						
10				130	165	201	258	277						
12				108	136	166	211	226	258	291				
14					116	140	179	191	218	245	272	316		
15					108	130	166	178	202	227	252	292		
16					101	122	155	166	189	212	235	272	334	
18					89	108	137	146	166	186	207	238	292	
20					80	97	122	130	148	166	184	212	259	
22					72	88	110	119	134	150	166	191	234	
25					63	77	97	103	117	131	145	166	203	
28					57	68	86	92	103	116	128	147	179	246
30										108	119	137	166	228
32										101	112	128	155	212
38												106	129	176
50													97	131

Factor of safety = 4, considering tensile strength to be 344.7 MPa at room temperature

Calculated Burst Pressure (bar) for Metric Sizes

Minimum Tensile Strength = 344.7 MPa

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	1131	1390	1650	1909	2414									
4	828	1012	1206	1404	1796	2185								
6			775	897	1153	1415	1812	1942						
8			571	659	839	1029	1324	1423						
10				519	659	806	1032	1109						
12				430	543	662	844	905	1032	1164				
14					463	560	714	764	872	979	1090	1263		
15					430	521	662	712	808	908	1010	1170		
16					403	488	621	665	756	847	941	1087	1335	
18					356	430	546	585	665	745	828	952	1170	
20					320	386	488	521	593	665	737	847	1037	
22					290	350	441	474	538	601	665	764	935	
25					254	306	386	414	469	524	579	665	811	
28					226	273	342	367	414	463	513	588	714	982
30										430	477	546	665	910
32										403	447	510	621	847
38												425	516	703
50													386	524

Tubing Data Charts

Grade 2 Titanium Annealed Welded Tubing

ASTM B-338 or Equivalent, Maximum Hardness HRB 80

Maximum Working Pressure (psi) for Fractional Sizes

Allowable Stress = 10,625 psi between -20° F and 100° F

TUBING O.D. (inch)	WALL THICKNESS (inch)																	
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188	
1/16	3210	3950	5550	7320														
1/8			2590	3320	4860	6200												
3/16			1690	2150	3110	4060	5820											
1/4			1250	1590	2280	2910	4270	5820										
3/8					1480	1880	2720	3740	4900									
1/2					1100	1390	1990	2710	3560	4150								
5/8						1100	1570	2130	2780	3230	3780							
3/4						910	1300	1750	2280	2640	3070	3420						
7/8						780	1100	1490	1930	2230	2590	2880						
1						680	960	1290	1670	1930	2240	2490						
1 1/4								1020	1320	1520	1760	1950	2200	2450	2600	3050		
1 1/2									1090	1260	1450	1610	1810	2010	2130	2490	2610	
2										930	1070	1190	1330	1480	1570	1820	1910	

Factor of safety = 4, considering tensile strength to be 50,000 psi at room temperature and weld joint efficiency factor of approximately 0.85

Calculated Burst Pressure (psi) for Fractional Sizes

Minimum Tensile Strength = 50,000 psi

TUBING O.D. (inch)	WALL THICKNESS (inch)																	
	0.010	0.012	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.148	0.156	0.180	0.188	
1/16	12840	15800	22200	29280														
1/8			10360	13280	19440	24800												
3/16			6760	8600	12440	16240	23280											
1/4			5000	6360	9120	11640	17080	23280										
3/8					5920	7520	10880	14960	19600									
1/2					4400	5560	7960	10840	14240	16600								
5/8						4400	6280	8520	11120	12920	15120							
3/4						3640	5200	7000	9120	10560	12280	13680						
7/8						3120	4400	5960	7720	8920	10360	11520						
1						2720	3840	5160	6680	7720	8960	9960						
1 1/4								4080	5280	6080	7040	7800	8800	9800	10400	12200		
1 1/2									4360	5040	5800	6440	7240	8040	8520	9960	10440	
2										3720	4280	4760	5320	5920	6280	7280	7640	

Tubing Data Charts

Grade 2 Titanium Annealed Welded Tubing

ASTM B-338 or Equivalent, Maximum Hardness HRB 80

Maximum Working Pressure (bar) for Metric Sizes

Allowable Stress = 73.3 MPa between -29° C and 38° C

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	239	294	350	405	512									
4	175	214	256	297	381	463								
6			164	190	244	300	384	412						
8			121	139	178	218	281	301						
10				110	140	170	219	235						
12				91	115	140	179	192	219	246				
14					98	119	151	162	185	208	231	268		
15					91	110	141	150	171	192	214	248		
16					86	103	132	141	160	179	199	230	283	
18					76	92	116	124	141	158	175	202	248	
20					68	82	103	111	126	141	156	179	220	
22					61	74	94	100	114	128	141	162	198	
25					54	65	82	88	99	111	123	141	172	
28					48	57	72	78	88	98	109	125	152	208
30										92	101	116	141	193
32										86	94	108	132	179
38												90	110	149
50													82	111

Factor of safety = 4, considering tensile strength to be 344.7 MPa at room temperature and weld joint efficiency factor of approximately 0.85

Calculated Burst Pressure (bar) for Metric Sizes

Minimum Tensile Strength = 344.7 MPa

TUBING O.D. (mm)	WALL THICKNESS (mm)													
	0.5	0.6	0.7	0.8	1.0	1.2	1.5	1.6	1.8	2.0	2.2	2.5	3.0	4.0
3	957	1178	1399	1619	2047									
4	701	858	1023	1189	1523	1851								
6			657	761	977	1200	1537	1647						
8			483	557	712	872	1123	1206						
10				441	560	681	874	941						
12				364	461	560	714	767	874	985				
14					392	474	604	648	739	830	924	1070		
15					364	441	563	601	684	770	855	993		
16					342	414	527	563	640	717	797	921	1131	
18					303	367	463	497	563	632	701	808	990	
20					270	328	414	444	502	563	623	717	880	
22					246	298	375	400	455	510	563	648	792	
25					215	259	328	350	397	444	491	563	687	
28					190	229	290	312	353	392	436	499	607	833
30										367	406	463	563	772
32										342	378	433	527	717
38												361	439	596
50													328	444

Tubing Tolerances

Copper ASTM B-75 (B-251 & B-251m)

O.D.	Tolerance
Up to 1/8" inclusive	±0.002"
Over 1/8"–5/8" inclusive	±0.002"
Over 5/8"–1" inclusive	±0.0025"
Over 1"–2" inclusive	±0.003"
Up to 3mm	±0.05mm
Over 3–16mm inclusive	±0.05mm
Over 16–25mm inclusive	±0.06mm
Over 25–51mm inclusive	±0.08mm

Wall Thickness Tolerance (inch)

Wall Thickness	1/32–1/8" inclusive	Over 1/8–5/8" inclusive	Over 5/8–1" inclusive	Over 1–2" inclusive
Up to 0.017" inclusive	±0.002"	±0.001"	±0.0015"	±0.002"
Over 0.017–0.024" inclusive	±0.003"	±0.002"	±0.002"	±0.0025"
Over 0.024–0.034" inclusive	±0.003"	±0.0025"	±0.0025"	±0.003"
Over 0.034–0.057" inclusive	±0.003"	±0.003"	±0.0035"	±0.0035"
Over 0.057–0.082" inclusive	—	±0.0035"	±0.004"	±0.004"
Over 0.082–0.119" inclusive	—	±0.004"	±0.005"	±0.005"
Over 0.119–0.164" inclusive	—	±0.005"	±0.006"	±0.006"

Wall Thickness Tolerance (mm)

Wall Thickness	0.80–3.0mm inclusive	Over 3.0–16mm inclusive	Over 16–25mm inclusive	Over 25–51mm inclusive
Over 0.40–0.60mm inclusive	±0.08mm	±0.05mm	±0.04mm	±0.06mm
Over 0.60–0.90mm inclusive	±0.08mm	±0.06mm	±0.06mm	±0.08mm
Over 0.90–1.5mm inclusive	±0.08mm	±0.08mm	±0.09mm	±0.09mm
Over 1.5–2.0mm inclusive	—	±0.09mm	±0.10mm	±0.10mm

304 and 316 Stainless Steel ASTM A-213 & A-249/A-249m (A-450) 254 SMO Stainless Steel ASTM A-269

O.D.	O.D. Tolerance	Wall Thickness Tolerance
Under 1" (25.4mm)	±0.004" (0.1mm)	Seamless (sizes ≤ 1½") ±10%
1–1½" (25.4–38.1mm)	±0.006" (0.15mm)	Seamless (sizes > 1½") ±11%
Over 1½–2" (38.1–50.8mm)	±0.008" (0.2mm)	Welded (all sizes) ±9%

2205 Duplex Stainless Steel ASTM A-789/A-789m & 2507 Super Duplex

O.D.	O.D. Tolerance	Wall Thickness Tolerance
Up to ½" (12.7mm) exclusive	±0.005" (0.13mm)	±15%
½–1½" (12.7–38.1mm) exclusive	±0.005" (0.13mm)	±10%
1½–2" (38.1–50.8mm) inclusive	±0.010" (0.2mm)	±10%

Tubing Tolerances

Monel® 400 ASTM B-165 & Inconel® 600 ASTM B-167

O.D.	O.D. Tolerance	Wall Thickness Tolerance
Over 0.400– $\frac{5}{8}$ " (10–16mm) exclusive	± 0.005 " (0.13mm)	$\pm 15\%$
$\frac{5}{8}$ – $1\frac{1}{2}$ " (16–38.1mm) inclusive	± 0.0075 " (0.19mm)	$\pm 10\%$
Over $1\frac{1}{2}$ –2" (38.1–50.8mm) inclusive	± 0.010 " (0.25mm)	$\pm 10\%$

Hastelloy® C-276 ASTM B-622 (Seamless)

O.D.	O.D. Tolerance	Wall Thickness Tolerance
0.500– $\frac{5}{8}$ " (12.7–15.9mm) inclusive	± 0.005 " (0.13mm)	$\pm 12\frac{1}{2}\%$
Over $\frac{5}{8}$ – $1\frac{1}{2}$ " (15.9–38.1mm) inclusive	± 0.0075 " (0.19mm)	$\pm 10\%$
Over $1\frac{1}{2}$ –2" (38.1–50.8mm) inclusive	± 0.010 " (0.25mm)	$\pm 10\%$

Hastelloy® C-276 ASTM B-622 (Welded)

O.D.	O.D. Tolerance	Wall Thickness Tolerance
Over $\frac{1}{8}$ – $\frac{5}{8}$ " (3.2–16mm) inclusive	± 0.005 " (0.13mm)	$\pm 15\%$
Over $\frac{5}{8}$ – $1\frac{1}{2}$ " (16–38.1mm) inclusive	± 0.0075 " (0.19mm)	$\pm 12\frac{1}{2}\%$
Over $1\frac{1}{2}$ –2" (38.1–50.8mm) inclusive	± 0.010 " (0.25mm)	$\pm 12\frac{1}{2}\%$

Titanium ASTM B-338

O.D.	O.D. Tolerance	Wall Thickness Tolerance
Up to 1" (25.4mm) exclusive	± 0.004 " (0.102mm)	$\pm 10\%$
$1\frac{1}{2}$ " (25.4–38.1mm) exclusive	± 0.005 " (0.127mm)	$\pm 10\%$
$1\frac{1}{2}$ –2" (38.1–50.8mm) exclusive	± 0.006 " (0.152mm)	$\pm 10\%$
2" (50.8mm) inclusive	± 0.007 " (0.178mm)	$\pm 10\%$

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