

## Table 1

TUBING MATERIAL	GENERAL APPLICATION	RECOMMENDED TEMPERATURE RANGE
Stainless Steel	High Pressure, High Temperature, Generally Corrosive Media	-425°F to 1,200°F (-255°C to 605°C)
Carbon Steel	High Pressure, High Temperature Oil, Air, Some Specialty Chemicals	-20°F to 800°F (-29°C to 425°C)
Cooper	Low Temperature, Low Pressure Water, Oil, Air	-40°F to 400°F (-40°C to 205°C)
Aluminum	Low Temperature, Low Pressure Water, Oil, Air, Some Specialty Chemicals	-40°F to 400°F (-40°C to 205°C)
Monel 400™	Recommended for Sour Gas Applications Well Suited for Marine and General Chemical Processing Applications	-325°F to 800°F (-198°C to 425°C)
Alloy C276	Excellent Corrosion Resistance to Both Oxidizing and Reducing Media and Excellent Resistance to Localized Corrosion Attack	-325°F to 1000°F (-198°C to 535°C)
Carpenter 20™	Applications Requiring Resistance to Stress Corrosion Cracking in Extreme Conditions	-325°F to 800°F (-198°C to 425°C)
Alloy 600	Recommended for High Temperature Applications with Generally Corrosive Media	-205°F to 1200°F (-130°C to 650°C)
Titanium	Resistant to Many Natural Environments such as Sea Water, Body Fluids and Salt Solutions	-75°F to 600°F (-59°C to 315°C)

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- For operating temperatures above 800 °F (425 °C), consideration should be given to media. 300 Series Stainless Steels are susceptible to carbide precipitation which may lead to intergranular corrosion at elevated temperatures.
- Consideration should be given to maximum temperature ratings if fittings and/or tubing are

All temperature ratings based on temperatures per ASME/ANSI B31-3 Chemical Plant and Petroleum Refinery Piping Code, 1999 Edition.

The information listed in Table 1 is general in scope. For specific applications, please contact Parker's Instrumentation Products Division, Product Engineering Department (256) 881-2040.

## Gas Service

Special care must be taken when selecting tubing for gas service. In order to achieve a gas-tight seal, ferrules in instrument fittings must seal any surface imperfections. This is accomplished by the ferrules penetrating the surface of the tubing. Penetration can only be achieved if the tubing provides radial resistance and if the tubing material is softer than the ferrules.

Thick walled tubing helps to provide resistance. Tables 2-7 indicate the minimum acceptable wall thickness for various materials in gas service. The ratings in white indicate combinations of diameter and wall thickness which are suitable for gas service.

Acceptable tubing hardness for general application is listed in Table 9. These values are the maximum allowed by the ASTM. For gas service, better results can be obtained by using tubing well below this maximum hardness. For example, a desirable hardness of 80 Rb is suitable for stainless steel. The maximum allowed by ASTM is 90 Rb.

## System Pressure

The system operating pressure is another important factor in determining the type, and more importantly, the size of tubing to be used. In general, high pressure installations require strong materials such as steel or stainless steel. Heavy walled softer tubing such as copper may be used if chemical compatibility exists with the media. However, the higher strength of steel or stainless steel permits the use of thinner tubes without reducing the ultimate rating of the system. In any event, tube fitting assemblies should never be pressurized beyond the recommended working pressure.

The following tables (2-7) list by material the maximum suggested working pressure of various tubing sizes. Acceptable tubing diameters and wall thicknesses are those for which a rating is listed. Combinations which do not have a pressure rating are not recommended for use with instrument fittings.

## Maximum Allowable Working Pressure Tables

Table 2 316 or 304 STAINLESS STEEL (Seamless)																	
Tube O.D. Size	WALL THICKNESS																
	.010	.012	.014	.016	.020	.028	.035	.049	.065	.083	.095	.109	.120	.134	.156	.188	
1/16	5600	6900	8200	9500	12100	16800											
1/8						8600	10900										
3/16						5500	7000	10300									
1/4						4000	5100	7500	10300								
5/16							4100	5900	8100								
3/8							3300	4800	6600								
1/2							2600	3700	5100	6700							
5/8								3000	4000	5200	6100						
3/4								2400	3300	4300	5000	5800					
7/8								2100	2800	3600	4200	4900					
1									2400	3200	3700	4200	4700				
1-1/4										2500	3300	3700	4100	4900			
1-1/2											2400	2700	3000	3400	4000	4500	
2												2000	2200	2500	2900	3200	

Table 3 316 or 304 STAINLESS STEEL (Welded)																
Tube O.D. Size	WALL THICKNESS															
	.010	.012	.014	.016	.020	.028	.035	.049	.065	.083	.095	.109	.120	.134	.156	.188
1/16	4800	5900	7000	8100	10300	14300										
1/8						7300	9300									
3/16						4700	6000	8700								
1/4						3400	4400	6400	8700							
5/16							3400	5000	6900							
3/8							2800	4100	5600							
1/2							2200	3200	4300	5700						
5/8								2500	3400	4500	5200					
3/4								2100	2800	3700	4200	4900				
7/8								1800	2400	3100	3600	4200				
1									2100	2700	3100	3600	4000			
1-1/4										2100	2400	2800	3100	3500	4200	
1-1/2											2000	2300	2600	2900	3400	4200
2												1700	1900	2100	2500	3000

## RATINGS IN GRAY NOT SUITABLE FOR GAS SERVICE

Table 4 CARBON STEEL (Seamless)												
Tube O.D. Size	WALL THICKNESS											
	.028	.035	.049	.065	.083	.095	.109	.120	.134	.148	.165	.180
1/8	8100	10300										
3/16	5200	6700	9700									
1/4	3800	4900	7100	9700								
5/16	3800	5500	7700									
3/8	3100	4500	6200									
1/2	2300	3300	4500	6000								
5/8	1800	2600	3500	4600	5400							
3/4	2200	2900	3800	4400	5100							
7/8	1800	2500	3200	3700	4300							
1	1600	2100	2800	3200	3700	4100						
1-1/4		1700	2200	2500	2900	3200	3700	4100	4600	5100		

Table 6 ALUMINUM (Seamless)					
Tube O.D. Size	WALL THICKNESS				
	.035	.049	.065	.083	.095
1/8	8700				
3/16	5600	8100			
1/4	4100	5900			
5/16	3200	4600			
3/8	2600	3800			
1/2	1900	2800	3800		
5/8	1500	2200	2900		
3/4		1800	2400	3200	
7/8		1500	2100	2700	
1		1300	1800	2300	2700

Table 5 COPPER (Seamless)										
Tube O.D. Size	WALL THICKNESS									
	.010	.020	.028	.035	.049	.065	.083	.095	.109	.120
1/16	1700	3800	5400	6000						
1/8		2800	3600							
3/16		1800	2300	3500						
1/4			1700	2600	3500					
5/16			1300	2000	2800					
3/8			1100	1600	2300					
1/2			800	1200	1600	2200				
5/8				900	1300	1700	2000			
3/4				800	1000	1400	1600	1900		
7/8				600	900	1100	1300	1600		
1				600	800	1000	1200	1400	1500	

Table 7 MONEL 400 (Seamless)											
Tube O.D. Size	WALL THICKNESS										
	.010	.020	.028	.035	.049	.065	.083	.095	.109	.120	
1/16	5900	12600	17000								
1/8		8600	11000								
3/16			5500	7100	10300						
1/4			4000	5100	7500	10300					
5/16				4000	5900	8100					
3/8				3300	4800	6600					
1/2				2300	3300	4500	5900				
5/8					2800	3700	4900	5700			
3/4						2300	3100	4000	4600	5400	
1							2300	2900	3400	3900	4400

Note:

- All working pressures have been calculated using the maximum allowable stress levels in accordance with ASME/ANSI B31.3, Chemical Plant and Petroleum Refinery Piping or ASME/ANSI B31.1 Power Piping.
- All calculations are based on maximum outside diameter and minimum wall thickness.
- All working pressures are at ambient (72° F) temperature.

# Systems Temperature

Operating temperature is another factor in determining the proper tubing material. Copper and aluminum tubing are suitable for low temperature media. Stainless steel and carbon steel tubing are suitable for higher temperature media. Special alloys such as Alloy 600 are recommended for extremely high temperature (see Table 1). Table 8 lists derating factors which should be applied to the working pressures listed in Table 2-7 for elevated temperature (see Table 1). Table 8 lists derating factors which should be applied to the working pressures listed in Tables 2-7 for elevated temperature conditions. Simply locate the correct factor in Table 8 and multiply this by the appropriate value in Tables 2-7 for the elevated temperature working pressure.

<b>Table 8 Temperature Derating Factors</b>							
Temperature °F (°C)		Copper	Aluminum	316 SS	304 SS	Steel	Monel 400
100	(38)	1.00	1.00	1.00	1.00	1.00	1.00
200	(93)	.80	1.00	1.00	1.00	.96	.88
300	(149)	.78	.81	1.00	1.00	.90	.82
400	(204)	.50	.40	.97	.94	.86	.79
500	(260)			.90	.88	.82	.79
600	(316)			.85	.82	.77	.79
700	(371)			.82	.80	.73	.79
800	(427)			.80	.76	.59	.76
900	(486)			.78	.73		
1000	(538)			.77	.69		
1100	(593)			.62	.49		
1200	(649)			.37	.30		

EXAMPLE: 1/2 inch x .049 wall seamless stainless steel tubing has a working pressure of 3700 psi @ room temperature. If the system were to operate @ 800°F (425°C), a factor of 80% (or .80) would apply (see Table 8 above) and the “at temperature” system pressure would be 3700 psi x .80 = 2960 psi

## Tubing Ordering Suggestions

Tubing for use with Parker instrument fittings must be carefully ordered to insure adequate quality for good performance. Each purchase order must specify the material nominal outside diameter, and wall thickness.

Ordering to ASTM specifications insures that the tubing will be dimensionally, physically, and chemically within strict limits. Also, more stringent requirements may be added by the user. All tubing should be ordered free of scratches and suitable for bending.

A purchase order meeting the above criteria would read as follows: 1/2" x .049316 stainless steel, seamless, or welded and redrawn per ASTM A-249. Fully annealed, 80 Rb or less. Must be suitable for bending; surface scratches, and imperfections (incomplete weld seams) are not permissible.

Table 9 lists specific ordering information for each material.

<b>Table 9</b>				
<b>Material</b>	<b>Type</b>	<b>ASTM Tubing Spec.</b>	<b>Condition</b>	<b>Max. Recommended Hardness</b>
Stainless Steel	304, 316, 316L	ASTM-A-269, A-249, A-213, A632	Fully Annealed	90 Rb
Copper	K or L	ASTM-B75 B68, B88* (K or L)	Soft Annealed Temper 0	60 Max. Rockwell 15T
Carbon Steel	1010	SAE-J524b, J525b ASTM-A-179	Fully Annealed	72 Rb
Aluminum	Alloy 6061	ASTM B-210	T6 Temper	56 Rb
Monel™	400	ASTM B-165	Fully Annealed	75 Rb
Alloy C-276	C-276	ASTM-B-622, B-626	Fully Annealed	90 Rb
Alloy 600	600	ASTM B-167	Fully Annealed	90 Rb
Carpenter 20™	20CB-3	ASTM B-468	Fully Annealed	90 Rb
Titanium	Commercially Pure Grade 2	ASTM B-338	Fully Annealed	99 Rb 200 Brinell Typical

Note: B88 Copper Tube to be ordered non-engraved



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## ASTM Tubing Specifications Outside Diameter/Wall Thickness

It is important to understand that both of the above can affect the ferrule(s) ability to seal on the tubing. We recommend ordering tubing manufactured to the plus (+) side of the outside diameter tolerance. Wall thickness variations can affect pressure ratings and flow characteristics.

The following tables should explain the allowable variations.

### ASTM Dimensional Specifications for Tubing

Table 1 Permissible Variations in Outside Diameter (1)

Table 2 Permissible Variations in Wall Thickness

Table 3 Permissible Variations in Wall Thickness for ASTM B68 and ASTM B75

### ASTM Dimensionable Specifications for Tubing

Table 1 Permissible Variations in Outside Diameter (1)

Tube O.D. Inches	A213 A249	A269	A632	A179	B68 B75	B165 B167	B338	B468	B622	B626				
1/16	±.004	±.005	+ .002	±.004	±.002	+ .002	±.004	±.004	N/A	+ .004 - .005				
1/8			+ .003			+ .003								
3/16			+ .004			±.005					±.0025	±.0075	±.005	±.006
1/4														
5/16														
3/8														
1/2														
5/8														
3/4														
7/8														
1														
1-1/4	±.006	±.010	N/A	±.006	±.003	±.005	±.006	±.0075	±.006					
1-1/2														
2	±.010			±.010		±.010	±.007	±.010	±.010	±.010				

(1) Cold Drawn Tubing

Table 2 Permissible Variations in Wall Thickness

Tube O.D. Inches	A213	A249	A269	A632	A179	B165 B167	B338	B468	B622	B626
1/16	+20%	±10%	±15%	±10%	+20%	±15%	±10%	±15%	N/A	±12.5%
1/8										
3/16										
1/4										
5/16										
3/8										
1/2										
5/8										
3/4										
7/8										
1										
1-1/4										
1-1/2	+22%				+20%	±10%		±10%		
2										

Permissible Variation in Wall Thickness for ASTM B68 and ASTM B75 Copper

Table 3 Wall Thickness (Inches)

Tube O.D. Inches	.010	.020	.028	.035 .049	.065	.083 .095 .109	.120
1/16	±.001	±.002	±.0025	±.003	±.0035	±.004	±.005
1/8							
3/16							
1/4							
5/16							
3/8							
1/2							
5/8							
3/4							
7/8							
1							
1-1/4							
1-1/2	±.002	±.0025	±.003	±.0035	±.004	±.005	±.006
2							