



# Stainless Steel Instrumentation Fractional / Metric Tubing

TS-05-S  
July 2014

## Tubing Benefits

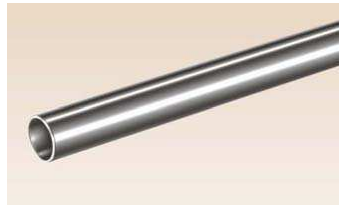
Tubing has many benefits when compared to piping.

- Pipe threading or welding is difficult to disassemble and re-assemble.
- Piping systems require skilled workers for welding & threading
- Tubing is assembled by a simple wrench make-up when using DK-Lok tube fittings reducing assembly time and the overall cost of installation.
- Tubing is annealed allowing it to be bent which supports lower pressure drop with fewer connections. This in turn reduces operating costs by improving flow.

For safe, reliable and leak-free tubing systems for use with DK-Lok fittings, tubing should be considered as one of the fitting components.

The following parameters should be considered when ordering instrumentation bright annealed seamless and welded tubing.

1. Tubing Selection
2. Tubing Handling
3. Tubing Installation
4. System Pressure
5. Compatibility



## DK-Tech Tubing Features

For the best performance with DK -LOK fittings, DK-Tech Tube offers ASTM A269/A213 bright annealed DK-Lok tubing 1/16 in. to 2 in. OD with the following features:

- Seamless or welded are suitable for bending and flaring.
- Chemically cleaned ID is free of dirt, oils and other contaminants.
- Special oxygen cleaning can be provided upon request
- Chemically cleaned and passivated surface.
- Cold drawn and bright annealed.
- Hardness is 80 HRB or less.

\* HRB 80 or less is a standard feature with DK-Tech Tube. RB80 or less is easier to cut and bend; reduces tube fitting torque; helps burnish out scratches to the OD that can be caused during the handling and installation process helping prevent possibly against leakage. RB 80 is more user friendly than RB90 for these reasons.

## DK-Tech Tubing Marking and Packaging

- Marking on the tubing includes OD, wall thickness (WT) material grade specification, heat code, and manufacturer name and part number.
- All Tubing ends are capped
- A controlled quantity is packaged in a protective cover at the factory and then packaged in a wooden crate for transportation protection.

## DK-Tech Tubing Standard Lengths

6 meter/ 20 foot tubing cut length variations as per the requirement of ASTM A450 standard.

## DK-Tech Tubing OD and WT Variations

ASTM A269 specifies permissible variation in tubing OD and WT, reads:

Tube O.D. In.	Permissible variation in OD, inch (mm)	Permissible variation in WT, %
Up to 1/2	+/- 0.005 (0.13)	+/- 15%
1/2 to 1 1/2, excl.	+/- 0.005 (0.13)	+/- 10%

- For tubing OD 1/8 in. and smaller +/- 0.003 inch variation for the leak-free performance with stainless steel 316 DK-Lok fittings.
- Tubing WT variations as specified in the ASTM A269 standard. See table 4 and 5.

## Heat Treatment

Solution annealed.

## Surface Finishes

Bright annealed with thermocouple clean level on the inside surface as per ASTM A632 S3: Ra 0.8 µm

## 1. Tubing Selection

### 1. Hardness

- Tubing must be softer than fitting material.
- SS Tubing must be fully annealed and suitable for bending and flaring.
- Tubing hardness must be selected according to the information in tables 4 and 5

### 2. Surface

Tubing surface must be free of scratches, draw marks, dirt, dust and flat spots.

### 3. Ovality / Concentricity

- Tubing that is oval or out-of-round may not fit into the fitting.
- Do not force the tubing into the fitting, it may damage the fitting sealing system on the nut, ferrules, and body.
- Tube OD and ID should be concentric or an even wall thickness throughout if uneven concentricity is visible the tubing should be rejected.

## 5. Material

Using the same tubing and fitting material is essential for the thermal compatibility and corrosion resistance. Different materials have different hardness levels that may adversely affect the fitting seal on the tubing. Proven exceptions are Copper Tubing/Brass Fittings and Stainless Tubing/Carbon Steel fittings with SS front and back ferrule.

## 6. Wall Thickness

Tables 4 and 5 show tubing working pressure ratings in a wide range of wall thickness. Too thin of a wall does not cause enough resistance, too thick of a wall causes too much resistance to support an effective swaging process. DK-Lok fittings are **not** recommended for tube wall thickness not listed in the table 4 and 5 and void all DK-Lok Tube fitting warranties.

## 7. Wall Thickness for Gas Applications

Gases such as nitrogen, air, hydrogen and helium, can escape even the most minute leak path due to their small molecular structure. Heavy wall tubing helps resist ferrule action by coining out minor defects of the tubing surface. For gas service, avoiding the shaded area in tables 4 and 5 is recommended.

## 8. Welded Tubing

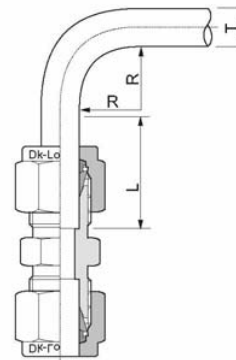
The weld should not be noticeable, visually or by feel per ASTM A213 on the outside (OD) of the tube.

## 2. Tubing Handling

Careful handling and storage practices will protect tubing from unnecessary scratched, nicks and or degrading good tubing surface finish.

- Tubing ends should be capped to help prevent foreign materials from falling inside during transportation and storage.
- Do not drag across tubing racks, cement, gravel or any other abrasive surface.
- Use the correct tube cutter for the appropriate tube material. The wrong cutter wheel may result in excessive deformation of the tube end.
- Do not cut deep with each turn of the tube cutter, Tube cutters and hacksaws should be sharp.
- Hacksaw blades should have at least 32 teeth per inch.
- Debur and clean tube ends before installation, to help prevent against system containments and reduced flow.

## 3. Tubing Installation



T: Tube OD

R: Radius

L: Straight tube length

When the tube bend is too close to the fitting, the bend section may prevent the tube from being bottomed out into the fitting, and may result in leakage or a blowout.

Keep the proper straight length of tube as shown in table 1 below.

Do not bend a tube in the fitting. Pre-bend using proper tube bending techniques.

**Table 1.**

Fractional tube, in.		Metric tube, mm	
T	L	T	L
1/16	1/2	3	19
1/8	23/32	6	21
3/16	3/4	8	23
1/4	13/16	10	25
5/16	7/8	12	31
3/8	15/16	14	32
1/2	1- 3/16	15	32
5/8	1- 1/4	16	32
3/4	1- 1/4	18	32
7/8	1- 5/16	20	34
1	1- 1/2	22	34
1- 1/4	2	25	40
1- 1/2	2- 13/32	28	46
2	3- 1/4	30	50
		32	54
		38	63
		50	80



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## 4. System Pressure

DK-Lok fitting pressure ratings are governed by the applicable tubing pressure rating. To determine allowable working pressure at elevated temperatures, multiply the working pressure at the ambient temperature shown in table 4 and 5 by the factor shown in table 2.

Example:

SS316 seamless tubing 1/2 in. O.D. x 0.065 in. WT at 700 F.  $4700 \text{ psig} \times 0.82 = 3854 \text{ psig}$ .  
Therefore 3854 psig is the maximum allowable working pressure at 700 °F for SS316 seamless 1/2 in. O.D. x 0.065 in. wall thickness tubing.

**Table 2. Temperature De-rating Factors**

Temperature		Stainless steel ASTM A269	
°F	°C	SS304	SS316
100	38	1	1
200	93	1	1
300	149	1	1
400	204	0.94	0.97
500	260	0.88	0.9
600	316	0.82	0.85
700	371	0.8	0.82
800	427	0.76	0.8
900	482	0.73	0.78
1000	538	0.69	0.77
1200	649	0.3	0.37

**Table 3. Elastomer seal working temperature**

Elastomer Seals	Working Temperature
NBR	-40 to 110 °C (-40 to 230 °F)
FKM	-20 to 200 °C (-4 to 392 °F)
FFKM (Kalrez®)	-30 to 275 °C (-22 to 527 °F)

When Elastomer seals are used in the system, care must be taken for allowable working temperature. See Table 3.

Kalrez®: TM Dupont



## Cryogenic Service

SS316 DK-Lok fittings provide highly reliable performance from cryogenic to high temperature.  
SS316 DK-Lok fitting and tubing temperature Rating: -425 to 1200 °F (-253 to 649 °C)  
Cryogenic temperatures are below -100°F (-73 °C)



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## Stainless Steel Tubing

Fully annealed austenitic Type 304 or 316 seamless and welded tubing ASTM A269 or A213, or equivalent. Tubing to be free from scratches, draw marks, dirt, dust and flat spots. Suitable for bending and flaring.

**Table 4. Seamless and Welded Stainless Steel Fractional Tubing**

Recommended hardness: 80 HRB (180 HV) or less. Hardness not to exceed 90 HRB or 200 HV.

Tube OD in.	Tube Wall Thickness, in.														
	0.012	0.014	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.156	0.188
1/16	6800	8100	9400	12000											
1/8					8500	10900									
3/16					5400	7000	10200								
1/4					4000	5100	7500	10200			Working Pressure in PSIG				
5/16						4000	5800	8000							
3/8						3300	4800	6500	8600						
1/2						2400	3500	4700	6200						
5/8							2900	4000	5200	6000					
3/4							2400	3300	4200	4900	5800	6400			
7/8							2000	2800	3600	4200	4800	5400	6100		
1								2400	3100	3600	4200	4700	5300	6200	
1 1/4									2400	2800	3300	3600	4100	4900	
1 1/2										2300	2700	3000	3400	4000	4900
2											2000	2200	2500	2900	3600

**Table 5. Seamless and Welded Stainless Steel Metric Tubing**

Recommended hardness: 180 HV (80 HRB) or less. Hardness not to exceed 90 HRB or 200 HV.

Tube OD mm	Tube Wall Thickness, mm												
	0.8	1	1.2	1.5	1.8	2	2.2	2.5	2.8	3	3.5	4	4.5
3	710												
6	330	420	520	670									
8		310	380	490						Working Pressure in Bar			
10		240	300	380									
12		200	240	310	380	430							
14		180	220	280	340	390	430						
15		170	200	260	320	360	400						
16			190	240	300	330	370						
18			170	210	260	290	320	370					
20			150	190	230	260	290	330	380				
22			130	170	210	230	260	300	340				
25					180	200	230	260	300	320			
28						180	200	230	260	280	330		
30						170	190	210	240	260	310		
32						160	170	200	230	240	290	330	
38							140	170	190	200	240	280	310

ASTM A269 tubing allowable working pressure is calculated at -20 to 100°F (-28 to 37°C) using allowable stress value of 20,000 psi according to ASME B31.3 Code.

Pressure calculations are based on **maximum O.D. and minimum wall thickness** and no allowance is made for corrosion and erosion. i.e., ASTM A269 1/2 in. OD x 0.035 in.: OD tolerance ± 0.005 in., WT tolerance ± 15%.

Calculations are based on 0.505 in.OD x 0.0298 in. WT.

Safety Factor is 3.75 to 1, considering ultimate tensile strength of 75,000 psi.

For working pressure according to ASME B31.1, multiply the ASME 31.3 rating by 0.94.



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## Tubing Ordering Information

DK-Tech A269 seamless bright annealed stainless steel grade TP316 tubing.

Tube OD in.	Nominal Wall Thickness in.	Ordering Number	Nominal Length ft.
1/8	0.028	TL2-028-S	20
	0.035	TL2-035-S	
1/4	0.028	TL4-028-S	
	0.035	TL4-035-S	
	0.049	TL4-049-S	
	0.065	TL4-065-S	
3/8	0.035	TL6-035-S	
	0.049	TL6-049-S	
	0.065	TL6-065-S	
	0.083	TL6-083-S	
1/2	0.035	TL8-035-S	
	0.049	TL8-049-S	
	0.065	TL8-065-S	
	0.083	TL8-083-S	
3/4	0.065	TL12-065-S	
	0.083	TL12-083-S	
	0.095	TL12-095-S	
	0.109	TL12-109-S	
1	0.120	TL12-120-S	
	0.134	TL16-134-S	
	0.156	TL16-156-S	
	0.083	TL16-083-S	
	0.095	TL16-095-S	
	0.109	TL16-109-S	
	0.120	TL16-120-S	

Tube OD mm	Nominal Wall Thickness mm	Ordering Number	Nominal Length meter
6	1.00	TL6M-1.0-S	6
	1.20	TL6M-1.2-S	
	1.50	TL6M-1.5-S	
8	1.00	TL8M-1.0-S	
	1.20	TL8M-1.2-S	
	1.50	TL8M-1.5-S	
10	1.00	TL10M-1.0-S	
	1.20	TL10M-1.2-S	
	1.50	TL10M-1.5-S	
12	1.20	TL12M-1.2-S	
	1.50	TL12M-1.5-S	
	1.80	TL12M-1.8-S	
	2.00	TL12M-2.0-S	
20	1.80	TL20M-1.8-S	
	2.00	TL20M-2.0-S	
	2.20	TL20M-2.2-S	
	2.50	TL20M-2.5-S	
25	2.80	TL20M-2.8-S	
	1.80	TL25M-1.8-S	
	2.00	TL25M-2.0-S	
	2.50	TL25M-2.5-S	
	2.80	TL25M-2.8-S	
	3.00	TL25M-3.0-S	

To order Welded stick use suffix -WT304 or -WT316 ie: TL6-035-WT316

To order Welded coil use suffix -WCT304 or -WCT316 ie TL8-035-WCT316. Standard coils are 500 ft, other lengths are available upon request by contracting your local DK-Lok Distributor.

### TP316 / TP316L Standard Instrumentation Tubing Material Grade and Chemical Requirements

Material Grade	ASTM	A269		A213 (a) / A249		
	UNS	S31600	S31603	S31600	S31603	
	Grade	TP316	TP316L	TP316	TP316L	
Chemical %	Chromium	16.0 to 18.0				
	Nickel	10.0 to 14.0		10.0 to 14.0	10.0 to 14.0	
	Molybdenum	2.00 to 3.00				
	Manganese	2.00		max		
	Silicon	1.00		0.75 max	0.75 max (b)	
	Carbon	0.08 max	0.035 max (c)		0.08 max	0.035 max (c)
	Phosphorus	0.045 max		0.040 max		
	Sulfur	0.030		max		

- (a) Nominal wall thickness, not minimum wall thickness.
- (b) For seamless TP316L tube, the silicon maximum shall be 1.00%.
- (c) For smaller diameter or thin walls, or both, where many drawing passes are required, a carbon maximum of 0.040 % is necessary in grade TP316L. This is applicable tubing size less than 1/2 in. OD and less than 0.049 in. (1.2 mm) in WT.

**Note:** Tubing of ornamental, structural or mechanical grade should not be used for fluid system.

#### Safe Product Selection

The selection of product for any applications or system design must be considered to ensure safe performance. Product function, material compatibility, rating, proper installation, operation and maintenance remain the sole responsibility for the system designer and the user. DK-Tech accepts no liability for any improper selection, installation, operation or maintenance.