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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE INFORMATION REPORT

SAE J1065

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Submitted for recognition as an American National Standard

PRESSURE RATINGS FOR HYDRAULIC TUBING AND FITTINGS

1. ***Scope—***This SAE Information Report is intended to provide design guidance in the selection of steel tubing and related tube fittings for general hydraulic system applications. The information presented herein is based on tubing products which conform to SAE J524, SAE J525, and SAE J356, and is subject to due consideration being given to the following limitations:

1.1 Since many factors influence the pressure at which a hydraulic system will or will not perform satisfactorily, this report should not be used as a "standard" not "specification," and the values shown herein should not be construed as "guaranteed" minimum.

1.1.1 Within the fluid power industry, many criteria are used for determining the pressure capability of tubing. Consideration is given to specified minimum yield or fiber stress factors, to calculated yield or burst pressures, and to yield or burst pressures determined by actual test. Also, varying design factors are applied, commensurate with the total system conditions. Thus, it is impractical to set down specific allowable working pressures that will satisfy all design criteria. It is considered desirable, however, to provide guidelines on the subject such as are published in this report.

1.1.2 Factors such as the thinning of tube walls due to forming operations, shock loads, and vibration characteristics of the system must also be considered.

2. ***References***

2.1 **Applicable Publications—**The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J356—Welded Flash Controlled Low Carbon Steel Tubing Normalized for Bending, Double Flaring, and Beading
SAE J514—Hydraulic Tube Fittings
SAE J524—Seamless Low Carbon Steel Tubing Annealed for Bending and Flaring
SAE J525—Welded and Cold Drawn Low Carbon Steel Tubing Annealed for Bending and Flaring
SAE J533—Flares for Tubing

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3. ***Hydraulic Tubing—***Three normally acceptable reference working pressures (psi) for each combination of diameter and wall thickness of commonly used tubing calculated using three generally accepted formulas and reflecting two popular design stress factors are presented in Figures 1 and 2. The designer, therefore may select the desired tubing on the basis of the value which best suits the intended application and satisfies any preference he may have regarding formulation.

3.1 **Formulae—**The formulae from which the three values tabulated vertically opposite each tube size were derived are, respectively:

3.1.1 THE BARLOW FORMULA

$$P = \frac{2ST}{D} \qquad \text{(Eq. 1)}$$

3.1.2 THE BOARDMAN FORMULA

$$P = \frac{2ST}{D - 0.8T} \qquad \text{(Eq. 2)}$$

3.1.3 THE LAME FORMULA

$$P = S\left(\frac{D^2 - d^2}{D^2 + d^2}\right) \qquad \text{(Eq. 3)}$$

where:

D = nominal outside diameter of tubing, mm
d = nominal inside diameter of tubing, mm
P = hydrostatic working pressure, MPa
S = allowable fiber stress of material, MPa
T = nominal wall thickness of tubing, mm

3.2 The values shown in Figure 1, reflecting a design factor of approximately 4:1, are based on an allowable fiber stress of 86 MPa (12 500 psi) which is equivalent to 50% of the minimum yield point and approximately 28% of the minimum ultimate strength of the tubing.

3.3 The values shown in Figure 2, reflecting a design factor of approximately 3:1, are based on an allowable fiber stress of 117 MPa (17 000 psi) which is equivalent to 68% of the minimum yield point and approximately 38% of the minimum ultimate strength of the tubing.

4. ***Hydraulic Tube Fittings—***When properly assembled in conjunction with appropriate tubing selected from respective tables (flared where applicable, in accordance with SAE J533), the hydraulic tube fittings specified in SAE J514 are capable of providing leak-proof full-flow connections in hydraulic systems operating at working pressures designated in the following:

4.1 At a design factor of approximately 4:1, these fittings should be suitable for use with tubings selected from Figure 1 which have a reference working pressure of 20.5 MPa (3000 psi) or less.

4.2 At a design factor of approximately 3:1, these fittings should be suitable for use with tubings selected from Figure 2 which have a reference working pressure of 34.5 MPa (5000 psi) or less.

4.3 These fittings area also capable of higher working pressures in hydraulic systems wherein conditions will permit the use of smaller tube sizes, increased wall thickness (37 degrees flared tube fittings are limited in this regard) and/or reduction of the design factor. Prior to such use, however, it is recommended that sufficient testing be conducted and reviewed by both the user and fittings manufacturers to assure performance levels will be satisfactory.

Nominal Tube OD mm	Nominal Tube OD (in)	See Note (a)	Nominal Tube Wall Thickness, mm (in) 0.71 (0.028)	0.89 (0.035)	1.24 (0.049)	1.65 (0.065)	2.11 (0.083)	2.41 (0.095)	2.77 (0.109)	3.05 (0.120)	3.40 (0.134)	3.76 (0.148)	3.96 (0.156)	4.78 (0.188)
		1	38.5	48.5										
3.18	(0.125)	2	47.0	62.0										
		3	46.0	58.5										
		1	26.0	32.0										
4.77	(0.188)	2	29.5	38.0										
		3	29.5	37.5										
		1	19.4	24.0	34.0	45.0								
6.35	(0.250)	2	21.5	27.0	40.0	56.5								
		3	21.5	27.0	39.5	54.0								
		1	15.5	19.4	27.0	36.0								
7.92	(0.312)	2	16.6	21.5	31.0	43.0								
		3	16.8	21.5	31.0	42.5								
		1	12.8	16.2	22.5	30.0	38.5	44.0						
9.53	(0.375)	2	13.8	17.2	25.0	35.0	46.0	55.0						
		3	13.8	17.6	25.0	34.5	45.0	52.5						
		1		12.0	17.0	22.5	28.5	33.0	37.5	41.5				
12.70	(0.500)	2		12.8	18.2	25.0	33.0	38.5	45.5	51.5				
		3		12.8	18.6	25.0	33.0	38.5	44.5	49.5				
		1		9.7	13.5	18.0	23.0	26.0	30.0	33.0				
15.88	(0.625)	2		10.0	14.5	19.6	25.5	30.0	35.0	39.0				
		3		10.4	14.5	19.6	26.0	30.0	35.0	38.5				
		1		7.9	11.4	14.8	19.0	21.5	25.0	27.5				
19.05	(0.750)	2		8.3	11.8	16.2	21.0	24.0	28.5	31.5				
		3		8.3	12.0	16.2	21.0	24.5	28.5	31.5				
		1		6.9	9.7	12.8	16.2	18.6	21.5	23.5				
22.23	(0.875)	2		7.2	10.0	13.5	17.6	20.5	24.0	26.5				
		3		7.2	10.4	13.8	18.0	20.5	24.0	27.0				
		1		6.0	8.3	11.0	14.0	16.2	18.6	20.5	23.0	25.5		
25.40	(1.000)	2		6.2	8.6	11.8	15.2	17.6	20.5	23.0	26.0	29.0		
		3		6.2	9.0	12.0	15.5	18.0	20.5	23.0	26.0	29.0		
		·			7.6	10.0	12.8	14.5	16.6	18.2	20.5	23.0		
28.58	(1.125)	2			7.9	10.4	13.5	15.5	18.2	20.0	23.0	25.5		
		3			7.9	10.6	13.8	15.8	18.2	20.5	23.0	25.5		
		·			6.9	9.0	11.4	13.0	15.2	16.6	18.6	20.5	21.5	26.0
31.75	(1.250)	2			6.9	9.3	12.0	13.8	16.2	18.0	20.5	22.5	24.0	29.5
		3			6.9	9.3	12.0	14.2	16.2	18.2	20.5	23.0	24.0	29.5
		1				7.6	9.7	11.0	12.4	13.8	15.5	16.8	18.0	21.5
38.10	(1.500)	2				7.6	10.0	11.4	13.5	14.8	16.6	18.6	19.6	24.0
		3				7.9	10.0	11.8	13.5	14.8	16.8	18.6	19.6	24.0
		1				6.4	8.3	9.3	10.6	11.8	13.2	14.5	15.5	18.6
44.45	(1.750)	2				6.6	8.6	9.7	11.4	12.4	14.2	15.5	16.6	20.5
		3				6.6	8.6	10.0	11.4	12.8	14.2	15.8	16.6	20.5
		1				5.5	7.2	8.3	9.3	10.4	11.4	12.8	13.5	16.2
50.80	(2.000)	2				5.9	7.2	8.6	9.7	11.0	12.0	13.5	14.5	17.6
		3				5.9	7.6	8.6	10.0	11.0	12.4	13.8	14.5	17.6
		1				4.8	6.2	7.2	8.3	9.3	10.4	11.4	12.0	14.5
57.15	(2.250)	2				5.2	6.6	7.6	8.6	9.7	10.6	12.0	12.8	15.5
		3				5.2	6.6	7.6	8.6	9.7	11.0	12.0	12.8	15.5

Notes:
Wall Thickness Having Values Shown to Right of Bold Line are not Normally Considered Suitable For 37 Degrees Single Flaring to SAE J533.

Pressures for Tube Sizes Not Shown May be Calculated Using the Formulae Given in 3.1

(a) Pressure values listed opposite numbers 1, 2, and 3 for each tube OD were derived from the Barlow, Boardman, and Lamé formulas, respectively, with 86 MPa allowable stress factor.
(b) 1 MPa = 145 psi

FIGURE 1—REFERENCE WORKING PRESSURES AT APPROXIMATELY 4:1 DESIGN FACTOR, MPa (SEE NOTE B)

Nominal Tube OD mm	(in)	See Note (a)	Nominal Tube Wall Thickness, mm (in) 0.71 (0.028)	0.89 (0.035)	1.24 (0.049)	1.65 (0.065)	2.11 (0.083)	2.41 (0.095)	2.77 (0.109)	3.05 (0.120)	3.40 (0.134)	3.76 (0.148)	3.96 (0.156)	4.78 (0.188)
		1	52.5	65.5										
3.18	(0.125)	2	64.0	84.5										
		3	62.5	79.5										
		1	35.0	44.0										
4.77	(0.188)	2	39.5	51.5										
		3	40.0	51.0										
		1	26.0	33.0	46.0	61.0								
6.35	(0.250)	2	29.0	37.0	54.5	77.0								
		3	29.0	37.0	54.0	73.5								
		1	21.0	26.0	37.0	48.5								
7.92	(0.312)	2	23.0	29.0	42.0	58.5								
		3	23.0	29.0	42.0	57.5								
		1	17.6	21.5	30.5	40.5	52.0	59.5						
9.53	(0.375)	2	18.6	24.0	34.0	47.0	63.0	74.5						
		3	19.0	24.0	34.5	47.0	61.5	71.5						
		1		16.6	23.0	30.5	39.0	44.5	51.0	56.0				
12.70	(0.500)	2		17.2	25.0	34.0	45.0	52.5	62.0	69.5				
		3		17.6	25.0	34.0	45.0	52.0	60.5	67.0				
		1		13.2	18.2	24.5	31.0	35.5	41.0	45.0				
15.88	(0.625)	2		13.8	19.6	26.5	35.0	40.5	47.5	53.0				
		3		13.8	20.0	27.0	35.0	40.5	47.5	53.0				
		1		11.0	15.2	20.5	26.0	29.5	34.0	37.5				
19.05	(0.750)	2		11.4	16.2	21.5	28.5	33.0	38.5	43.0				
		3		11.4	16.2	22.0	28.5	33.5	38.5	43.0				
		1		9.3	13.2	17.6	22.5	25.5	29.5	32.0				
22.23	(0.875)	2		9.7	13.8	18.6	24.0	28.0	32.5	36.0				
		3		9.7	13.8	18.6	24.0	28.5	33.0	36.0				
		1		8.3	11.4	15.2	19.4	22.5	25.5	28.5	31.5	35.0		
25.40	(1.000)	2		8.3	12.0	16.2	20.5	24.0	28.0	31.0	35.0	39.5		
		3		8.6	12.0	16.2	21.0	24.5	28.5	31.5	35.5	39.5		
		1			10.4	13.5	17.2	19.6	23.0	25.0	28.0	30.5		
28.58	(1.125)	2			10.6	14.2	18.2	21.5	24.5	27.0	31.0	34.5		
		3			10.6	14.5	18.6	21.5	25.0	27.5	31.0	35.0		
		1			9.3	12.0	15.5	18.0	20.5	22.5	25.0	28.0	29.5	35.0
31.75	(1.250)	2			9.7	12.8	16.6	19.0	22.0	24.5	27.5	30.5	32.5	40.0
		3			9.7	12.8	16.6	19.4	22.0	24.5	27.5	31.0	33.0	40.5
		1				10.0	13.2	14.8	16.8	18.6	21.0	23.0	24.5	29.5
38.10	(1.500)	2				10.6	13.5	15.5	18.0	20.0	22.5	25.0	26.6	33.0
		3				10.6	13.8	15.8	18.2	20.5	23.0	25.5	27.0	33.0
		1				8.6	11.0	12.8	14.5	16.2	18.0	20.0	21.0	25.0
44.45	(1.750)	2				9.0	11.8	13.5	15.5	16.8	19.0	21.5	22.5	27.5
		3				9.0	11.8	13.5	15.5	17.2	19.4	21.5	23.0	28.0
						7.6	9.7	11.0	12.8	14.2	15.8	17.2	18.2	22.0
50.80	(2.000)	2				7.9	10.0	11.8	13.5	14.8	16.6	18.2	19.6	24.0
		3				7.9	10.0	11.8	13.5	14.8	16.8	18.6	19.6	24.0
		1				6.7	8.6	10.0	11.4	12.4	13.8	15.5	16.2	19.6
57.15	(2.250)	2				6.9	9.0	10.4	11.8	13.2	14.8	16.2	17.2	21.0
		3				6.9	9.0	10.4	12.0	13.2	14.8	16.6	17.2	21.0

Notes:
Wall Thickness Having Values Shown to Right of Bold Line are not Normally Considered Suitable For 37 Degrees Single Flaring to SAE J533.

Pressures for Tube Sizes Not Shown May be Calculated Using the Formulae Given in 3.1

(a) Pressure values listed opposite numbers 1, 2, and 3 for each tube OD were derived from the Barlow, Boardman, and Lamé formulas, respectively, with 117 MPa allowable stress factor.
(b) 1 MPa = 145 psi

FIGURE 2—REFERENCE WORKING PRESSURES AT APPROXIMATELY 3:1 DESIGN FACTOR, MPa (SEE NOTE B)