AEROSPACE RECOMMENDED PRACTICE

ARP4698™	REV. A

Issued 1995-07
Reaffirmed 2013-01
Stabilized 2023-09

Superseding ARP4698

Guide for Choosing a Minimum Wall Thickness of Tubing for Use with Weld Fittings Coded for a Range of Wall Sizes

RATIONALE

This technical report is being stabilized because it covers technology, products, or processes which are mature and not likely to change in the foreseeable future.

STABILIZED NOTICE

This document has been declared “STABILIZED” by SAE G-3, Aerospace Couplings, Fittings, Hose, Tubing Assemblies Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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FOREWORD

Weld fitting ends have a wall thickness that is slightly larger than the tubing wall thickness to which it will be welded. To minimize the number of part numbers, the fitting ends are designed to be welded to a range of tubing wall sizes. The ranges may vary from .002 to .012 in or more in tubing wall thickness. The fitting end callouts on the design standards have a “tube wall code” that designates the range of tubing wall thicknesses to which they may be welded. The individual weld fitting part number callouts include this “tube wall code”. For users of a weld fitting, it is desirable to have a guide for a minimum recommended wall thickness of tubing to be used with the fitting based on pressure, since the “tube wall code” may include tube walls that are thinner than desirable for a given pressure. This document is prepared as such a guide. The actual tubing wall thicknesses for use in a given pressure system should be chosen to meet all performance requirements of that system.

1. SCOPE:

This SAE Aerospace Recommended Practice (ARP) is intended as a guide for choosing a minimum wall thickness of tubing, based only on pressure, for use with welded tube fitting ends that have a “tube wall code” covering a range of tube wall thicknesses. These wall thicknesses are based on burst pressure with an arbitrary additional safety factor. If the weld fitting user has already established the required minimum wall thickness for given performance conditions, this guide does not apply.

2. REFERENCES:

2.1 Related Documents:

The following publications are provided for information purposes only and are not a required part of this document:

AMS 4944	Titanium Alloy Tubing, Seamless, Hydraulic 3.0Al - 2.5V Cold Worked, Stress Relieved
AMS 4945	Titanium Alloy Tubing, Seamless, Hydraulic 3Al - 2.5V, Texture Controlled 105 ksi (724 MPa) Yield Strength Cold Worked, Stress Relieved

2.1 (Continued):

AMS 5561 Steel Tubing, Welded and Drawn, Corrosion and Heat Resistant 9.0Mn - 20Cr - 6.5Ni - 0.28N High-Pressure Hydraulic

Formulas for Stress and Strain, Roark, Fourth Edition

3. TECHNICAL REQUIREMENTS:

3.1 Derivation of Minimum Wall Thicknesses:

Minimum wall thicknesses shown in Tables 1 and 2 have been calculated using the equations shown below to represent a theoretical minimum for the tube size and pressure shown. Users may choose to use a thicker of thinner wall for a given pressure at their own discretion. For wall thicknesses noted in Table 1, thicker walls should normally be used because of difficulty in bending thin walled tubing and because of potential mechanical loading damage. The burst pressure has been defined as four times the operating pressure. The 13% safety factor was derived from the specified wall thicknesses given in AS1579 for 3000 psi weld fittings that have been in use for many years. Equation 1 is for thin wall cylindrical vessels, page 298, Table XIII, case no. 1, "Formulas for stress and strain," Roark, Fourth edition with a 13% safety factor.

$$P = 2S\frac{B-A}{B+A} \qquad \text{(Eq. 1)}$$

where:

P = Internal burst pressure
S = Ultimate tensile strength of tubing
A = Nominal inner radius of tubing
B = Nominal outer radius of tubing

Equation 2 follows from Equation 1:

$$\text{Minimum Wall Thickness} = \frac{1.13\,P\,(\text{Nominal OD of Tube})}{2S+P} \qquad \text{(Eq. 2)}$$

3.2 Ultimate Tensile Strength of Tubing:

For the minimum ultimate tensile strength of tubing the following values have been used to calculate the minimum wall thicknesses in Tables 1 and 2:

a. Type 21-6-9 corrosion resistant steel tubing per AMS 5561, 140 000 psi
b. Type 3.0Al 2.5V titanium alloy tubing per AMS 4944 and AMS 4945, 125 000 psi

3.3 Calculated Minimum Wall Thicknesses:

The recommended minimum wall thicknesses have been calculated per Equation 2 and are presented in Tables 1 and 2.

TABLE 1 - Theoretical Minimum Size Nominal Tube Wall Thickness Based on Burst Pressure for Operating Pressure Shown for AMS 5561 Type 21-6-9 Corrosion Resistant Steel Tubing

Tube Size	1500 psi Operating Pressure	2000 psi Operating Pressure	3000 psi Operating Pressure	4000 psi Operating Pressure	5000 psi Operating Pressure
02	.003[1]	.004[1]	.006[1]	.008[1]	.010[1]
03	.005[1]	.006[1]	.009[1]	.012[1]	.014[1]
04	.006[1]	.008[1]	.012[1]	.016[1]	.019
05	.008[1]	.010[1]	.015[1]	.019	.024
06	.009[1]	.012[1]	.018	.023	.028
08	.012[1]	.016[1]	.023	.031	.038
10	.015[1]	.020	.029	.038	.047
12	.018	.024	.035	.046	.056
14	.021	.028	.041	.053	.066
16	.024	.031	.046	.061	.075
20	.030	.039	.058	.076	.093
24	.036	.047	.069	.091	.112
28	.041	.055	.081	.106	.131
32	.047	.062	.092	.121	.149

[1] Caution should be used for these wall thicknesses because of potential mechanical damage in use.

TABLE 2 - Theoretical Minimum Size Nominal Tube Wall Thickness Based on Burst Pressure for Operating Pressure Shown for AMS 4944 and AMS 4945 Titanium Alloy Tubing

Tube Size	1500 psi Operating Pressure	2000 psi Operating Pressure	3000 psi Operating Pressure	4000 psi Operating Pressure	5000 psi Operating Pressure
02	.004[1]	.005[1]	.007[1]	.009[1]	.011[1]
03	.005[1]	.007[1]	.010[1]	.013[1]	.016[1]
04	.007[1]	.009[1]	.013[1]	.017[1]	.021
05	.009[1]	.011[1]	.017[1]	.022	.027
06	.010[1]	.014[1]	.020	.026	.032
08	.014[1]	.018	.026	.034	.042
10	.017[1]	.022	.033	.043	.053
12	.020	.027	.039	.051	.063
14	.024	.031	.046	.060	.074
16	.027	.036	.052	.068	.084
20	.034	.044	.065	.085	.105
24	.040	.053	.078	.102	.126
28	.047	.062	.091	.119	.147
32	.053	.071	.104	.146	.168

[1] Caution should be used for these wall thicknesses because of potential mechanical damage in use.