AEROSPACE INFORMATION REPORT

AIR869	REV. B

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Revised 2008-09
Reaffirmed 2014-10

Superseding AIR869A

(R) V-Couplings, Including V-Band and V-Retainer Coupling Assemblies, Flange and Seal Design, Application of

RATIONALE

AIR869B has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE

This SAE Aerospace Information Report (AIR) is intended to inform users of the proper use, application, and installation of V-Couplings, which will perform satisfactorily only if they are properly installed. This document informs the user of the correct manner of applying and installing V-Couplings and also cautions against improper use.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS-W-6858 Welding, Resistance: Spot and Seam

ARP699 High Temperature Pneumatic Duct Systems for Aircraft

AS1701 Lubricant, Solid Film

AS1895 Coupling Assembly, V-Retainer, High Pressure, High Temperature, Pneumatic Tube

AS1960 Coupling Assembly, V-Band, Sheet Metal Flange, Pneumatic Tube

AS4108 T-Bolt and Eye Bolt, A-286 Cres, 1000 °F Fatigue Rated

AS4751 Coupling Assembly, V-Band, Sheet Metal Wide Flange, Pneumatic Tube

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SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AIR869B

AS5355 Couplings, Clamped, Grooved, V-Band

AS24563 Coupling Flanges, V-Band, Profile Dimensions for

2.1.2 AIA/NAS Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NASM7873 NUT, SELF-LOCKING, 1200 DEG F

NASM25027 NUT, SELF-LOCKING, 250 DEG F, 450 DEG F, AND 800 DEG F

2.2 Definitions

CLAMP: The general category of special fasteners which includes, V-Couplings, band clamps, and strap assemblies.

V-BAND COUPLING: A sheet metal band clamp with sheet metal or machined retainer sections welded or riveted to the band or band loops (i.e., AS1960, AS4751). Also called V-Band Clamps.

V-RETAINER COUPLINGS: Coupling with the V-retainer as an integral part of the coupling segment. V-Retainer Couplings have no band or straps. The latch components are attached to lugs on the retainer segments (i.e., AS1895).

V-COUPLING: The family of V-Band Couplings and V-Retainer Couplings.

V-COUPLING JOINT: The connection composed of a V-Coupling, mating flanges, and a seal when used.

2.3 Symbols

Ag = Seal load, in psi

B = Bolt nominal diameter, in inches

Df = Flange outside diameter, in inches

Dn = Coupling nominal diameter, in inches

Dpl = Pitch line diameter, in inches (flange to retainer contact point, see Figure 1)

Ds = Diameter at seal line or seal, in inches

H = Hoop or circumferential band load, in pounds

Kb = Number of bolts at each latch location

Ga = Radial apex gap, in inches

E = Axial load, in pounds

Hs = Seal height, in inches

Ls = Axial load to preload seal, in pounds

M = Bending moment, in pounds-inches

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Na = Axial tension load, in pounds per inch of circumference

Nb = Axial force as a result of bending moments, in pounds per inch of circumference

Np = Axial force due to internal pressure, in pounds per inch of circumference

N = Design load, in pounds per inch of circumference

Ns = Seal seating load, in pounds per inch of circumference

P = Internal pressure, psig

T = Approximate design nut torque, in pounds-inches

Φ = V-Retainer angle, in degrees (commonly 40 degrees)

2.3.1 Subscripts

c = coupling

f = flange

g = gasket

b = bending moment

pl = pitch line

n = nominal

p = pressure

s = seal line or seal

3. V-COUPLING DESIGN FEATURES AND FACTORS

V-Couplings are used to join two flanges together forming a V-Coupling Joint. The V-Coupling is tightened by applying torque to a nut which tightens a circumferential band or band loops or an integral retainer and lugs exerting an inward radial force onto V-shaped retainer segments. These retainer segments then exert an axial clamping force onto the flanges, joining or pressing them together. V-couplings consist of V-band couplings (Figures 2 and 3) and V-retainer couplings (Figure 4). V-Band Coupling design features are shown in Figures 2, 3, and 5. V-Retainer Coupling design features are shown in Figures 4 and 6.

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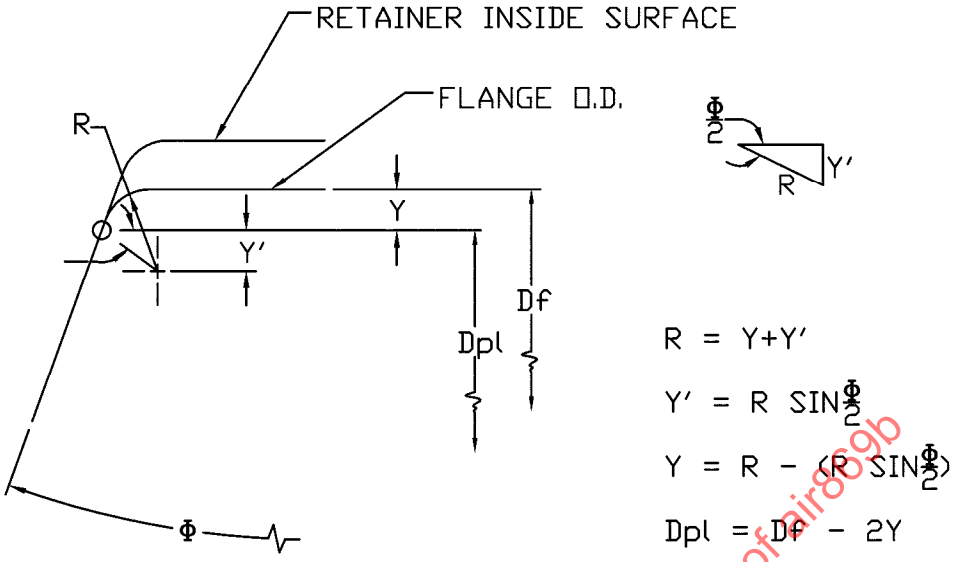

FIGURE 1 - LOCATION OF FLANGE TO REATINER CONTACT POINT (Dpl)

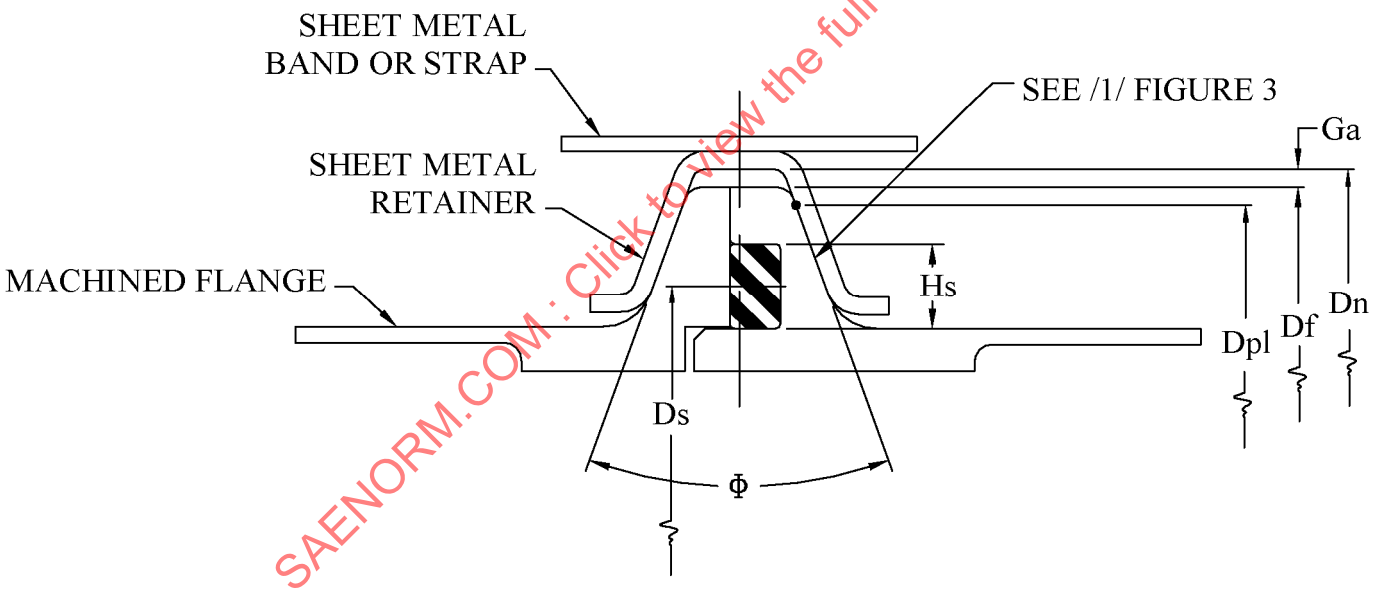

FIGURE 2 - V-BAND COUPLING JOINT AND MACHINED FLANGES

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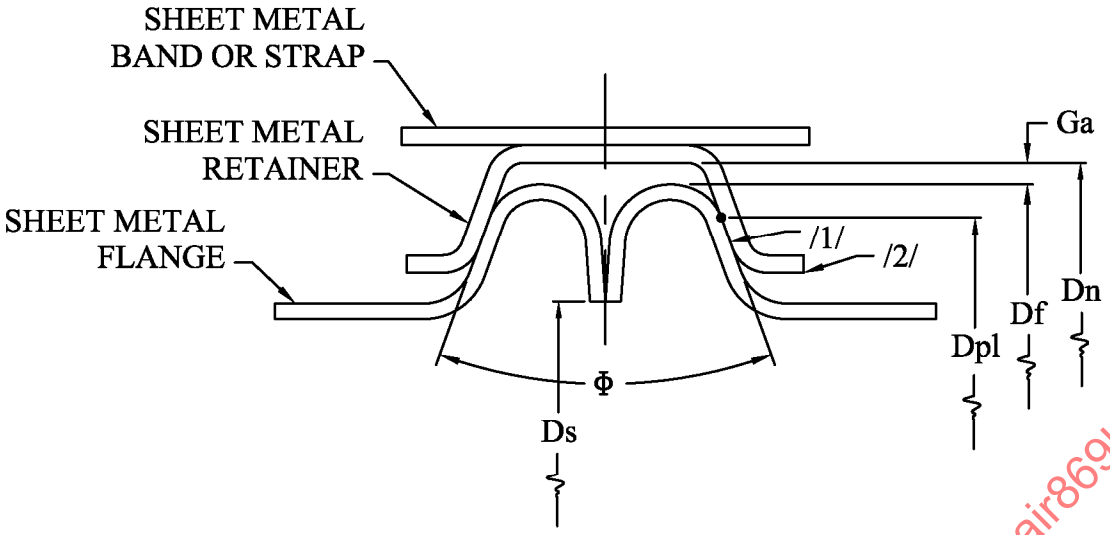

NOTES:

/1/ Retainers may spread in the installed condition causing a gap between the flange and retainer
/2/ Retainer foot at flange skirt usually has a gap equal to Ga

FIGURE 3 - V-BAND COUPLING JOINT AND SHEET METAL FLANGES

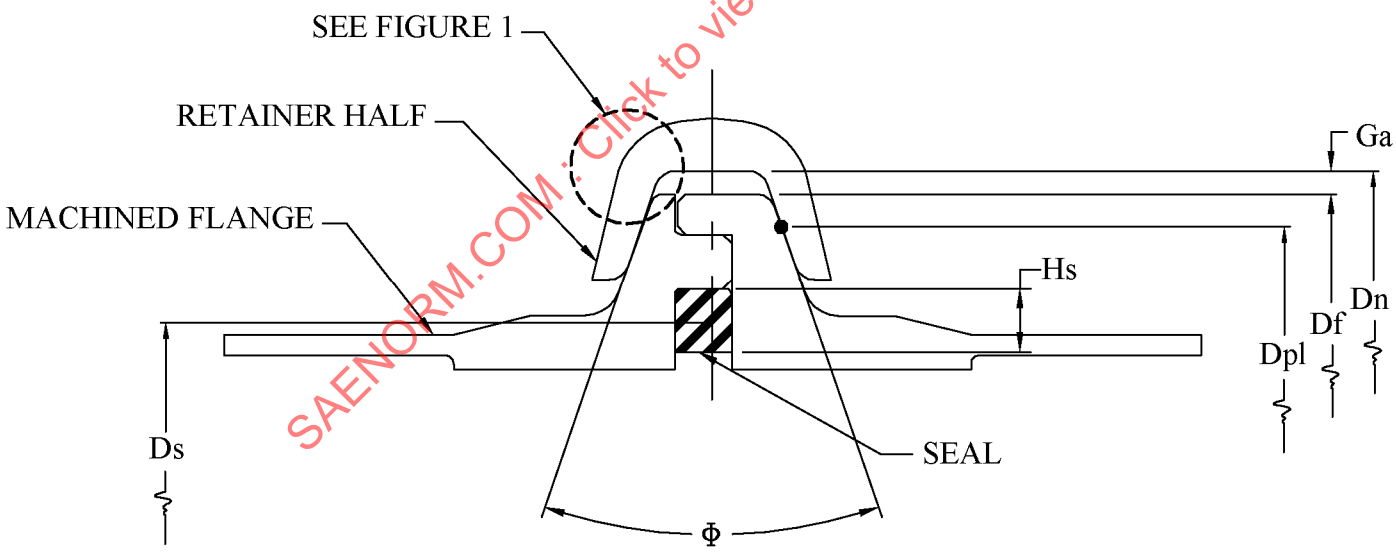

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FIGURE 4 - V-RETAINER COUPLING JOINT AND MACHINED FLANGES

3.1 Design Loads and Torque

The axial compressive clamping load that is generated by the application of nut torque must be sufficient to withstand design loads and the required seal load if used. These loads can be resolved into a load per unit of circumferential length at the flange to retainer contact point (Dpl Figures 2, 3, and 4) by the following formulas:

3.1.1 Seal Seating Load (Ns)

a. Load-per-unit circumferential length, Ns, at pitch diameter, Dpl, may be given by the seal manufacturer.

b. Or if total axial load, E, required to seal joint is given, then:

$$Ns = \frac{E}{\pi Dpl} \quad \text{(Eq. 1)}$$

c. Or with seal load per unit area Ag given:

$$Ns = Ag \ Hs \quad \text{(Eq. 2)}$$

(No consideration is given to the difference between actual diameter of seal and pitch diameter since it is relatively minor as diameters increase. The designer may account for it in the calculations if desired.)

3.1.2 Design Total Load (N)

a. As a result of internal pressure:

$$Np = \frac{P(Ds)^2}{4Dpl} \quad \text{(Eq. 3)}$$

b. As a result of bending moment:

$$Nb = \frac{4M}{\pi(Dpl)^2} \quad \text{(Eq. 4)}$$

c. As a result of axial tension load:

$$Na = \frac{E}{\pi Dpl} \quad \text{(Eq. 5)}$$

d. As a result of seal seating load, see 3.1.1.

NOTE: N is a result of any one or the sum of all the preceding loads.

$$N = Np + Na + Nb + Ns \quad \text{(Eq. 6)}$$

N aids in the use of published clamp manufacturers "pressure curves" which rate V-Couplings according to diameter and internal pressure loading only. If such curves are unavailable, consult the clamp manufacturer.

3.1.3 Design Nut Torque (T)

The approximate design nut torque in pound-inches is

$$T = \frac{.2 \ HB}{Kb} \quad \text{(Eq. 7)}$$

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Neglecting friction between the retainers and flanges, the circumferential hoop load (H) in the band is

$$H = NDpl \ TAN \frac{\Phi}{2} \quad \text{(Eq. 8)}$$

The recommended nut torque for the V-Coupling should be the approximate design nut torque given by the above calculation plus an allowance for the friction of the locknut. Since thread friction is often unpredictable, actual testing and reference to clamp manufacturers recommended torque values is suggested. Locknut designs and thread lubricants will affect the design torque. Locknuts generally increase torque requirements while lubricants tend to decrease torque requirements. The correct installation torque is the torque that tightens the V-Coupling to the design apex gap between the flanges outside diameter and the retainers inside diameter.

3.1.4 Critical Installation

Most pneumatic duct flange joints are critical in application because they contain high temperature gaseous fluid media. For such installations, the following are design recommendations.

a. Consider the operating temperature of the V-Coupling Joint when selecting materials. The more commonly used materials are:

   1. 300 Series cres: 800 °F max

   2. A-286 cres: 1200 °F max

   3. Nickel alloys: 1200 °F max

   All sheet metal V-Band Couplings, especially those operating at elevated temperature over 800 °F, should have tangential band loops or wraps (see Figure 5) to prevent excessive relaxation and further straightening of the band resulting in reduced tightness of the latch.

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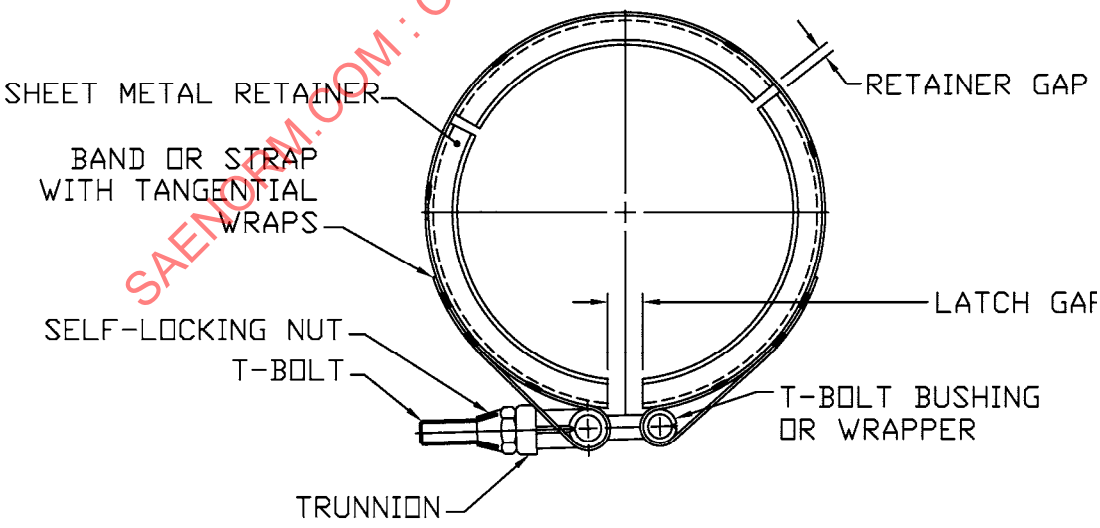

FIGURE 5 - V-BAND COUPLING

b. Recommended exclusively is the use of A-286 cres bolts per AS4108. This iron-based superalloy has been the preferred material for aerospace bolts and has been specified on the V-Couplings in AS1895, AS1960, AS4751, and AS5355.

c. The maximum load capacity of a V-Coupling is limited by the bending yield strength of the retainer segment at its apex corners. The combined forces of axial load, internal pressure, and bending loads apply this bending load on the retainer apex corners, see Figures 2, 3, and 4. The "burst pressure curves" published by manufacturers relates to the yield point of the retainer at the maximum internal gas pressure only rated load as a function of seal diameter. The formulas which combine axial, bending, and pressure loads into an equivalent pressure only load to facilitate the use of the published pressure curves are in 3.1.2. Published maximum load rating curves apply only at room temperature. V-Couplings to be used at elevated temperatures must have their design load capability reduced by a correction factor (see applicable V-Coupling standard or supplier published data).

d. Most V-Couplings have latches consisting of a T-bolt or eye bolt, trunnion, and locknut. Some of these bolts are defined in AS4108. Some V-Band Couplings have a quick-release latch which adds a hinged and slotted yoke that engages the bushing wrapped head of the T-bolt. Select the quick-release latch only when the V-Coupling is expected to be installed and removed frequently, or when quick installation and removal is necessary. T-bolts can only be replaced on quick-release latches and cannot be replaced on the basic T-bolt latch. Eyebolts can only be replaced by the manufacturer.

Safety latches (secondary backup latch) are commonly used on V-Retainer Couplings (see Figure 6) and occasionally on V-Band Couplings. This is a redundant latch system that maintains joint integrity with reduced sealing in the event of the primary latch failure, which requires immediate replacement of the V-Coupling.

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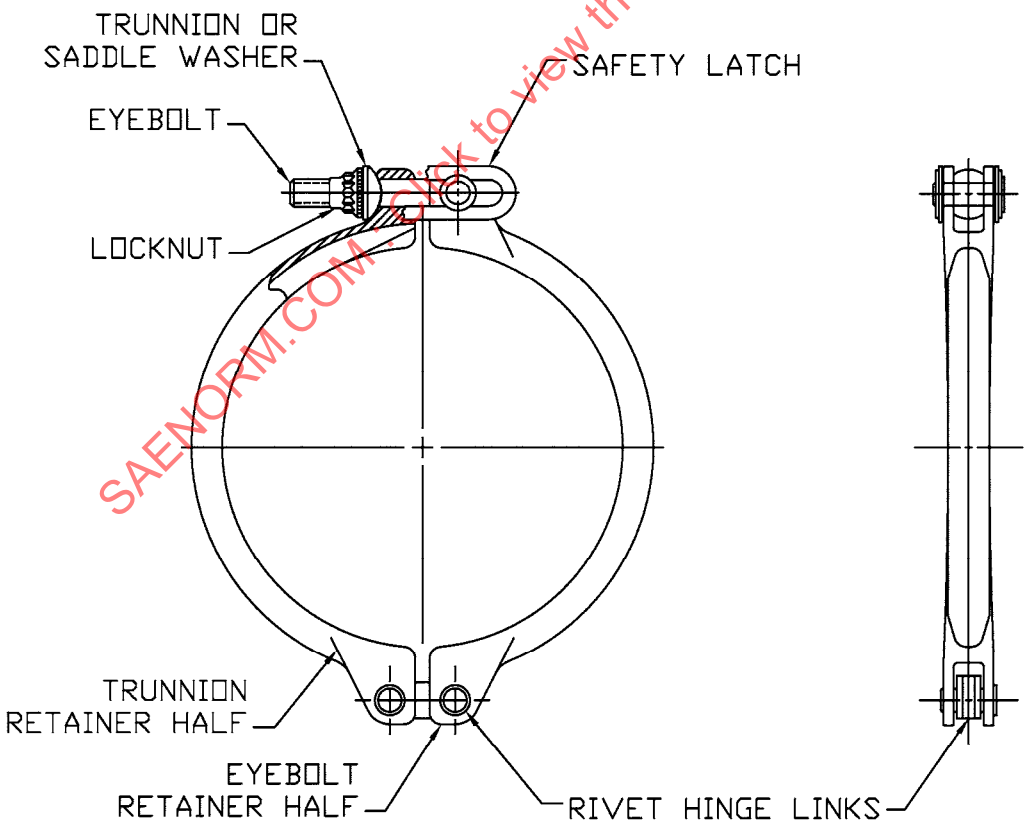

FIGURE 6 - V-RETAINER COUPLING

e. The majority of aerospace V-Couplings are tightened with an all metal self-locking nut. Such locknuts conform to either NASM7873 or NASM25027. These locknuts have a limited number of installations and removal cycles on a bolt before excessive wear causes thread galling and seizure. The following recommended guidelines will promote successful use of all-metal locknuts on V-Couplings.

1. Both the locknut and bolt threads should be clean and free of dirt, burrs, and damaged threads. All stainless steel nuts should be silver plated or dry film lubricated, to prevent thread galling and seizure.

2. Installation of the locknut should not exceed 2 rps or 120 rpm. Installation with a hand torque wrench is recommended. Excessive nut rotation speed causes frictional heat which promotes thread galling.

3. Lubricants greatly reduce the free running frictional resistance between locknuts and bolts. Dry film lubricants per AS1701 when applied to bolt threads have significantly increased thread life and reduced galling. Antiseize thread lubricants have also been used with success.

CAUTION: Use of lubricants on bolt threads can significantly affect torque/tension relationships. When a lubricant is used, the installation torque must be reduced accordingly to prevent excessive tightening that can damage the clamp.

f. Beware of excessive chlorine exposure to V-Couplings. The 300 series (austenitic) cres materials are very prone to stress corrosion cracking when exposed to excess chlorides. Nickel alloys such as 625, 718, K-400 and K-500 are recommended for excess chloride exposure.

3.1.5 Flange Configuration and Seal Selection

V-Couplings are used on two different kinds of flanges, solid machined flanges and flexible sheet metal flanges. Solid machined flanges are usually used on high strength applications such as bleed air connections on engines and on mechanical accessory connections. Sheet metal flanges are lighter weight flanges and are usually used on pneumatic ducting. All solid machined flanges in pneumatic systems require a separate seal that is either elastomeric or metallic to affect a seal between the flanges. Flexible sheet metal flanges do not use a separate seal. These flanges are made so that they effectively seal themselves on finely machined face surfaces. A joint relationship exists between the seal, flange configuration, and the V-Coupling. The choice of flange and V-Coupling configuration is a result of joint analysis, testing, or both. Design and environmental conditions, as a rule, will dictate seal selection. The criteria for component selection are based upon specific system requirements. Design standards for some specific systems are referenced in Section 2.

The following items are very important considerations in any system:

a. Recommended machined flange profile configuration and tolerances should be per AS24563, since most available V-Couplings are designed to mate with these profiles.

b. Machined flanges must have their outside diameter flange corner machined to a radius no less than the maximum inside corner radius of the V-Coupling retainer to prevent interference.

4. INSTALLATION PROCEDURE

Prior to installation, all of the V-Coupling components should be examined for defects. Prior to final assembly, a check of the installation should be conducted.

4.1 V-Coupling Examination

Some V-Couplings may appear to be of the same size but designed for different applications and could be physically interchanged. It is possible that a lighter duty V-Coupling could mistakeably be installed in an application requiring a higher-strength V-Coupling, or one made from materials intended only for noncritical temperature applications may be improperly used in an elevated temperature installation. Beware of installation of the wrong V-Coupling. Even though the fit may seem to go together, the operating conditions require the correct as designed V-Coupling installation. Verify that the specified part number V-Coupling is used.

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