SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

SAE ARP1897

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Clamp Selection and Installation Guide

RATIONALE

ARP1897 has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

This document is prepared as an aid in the selection of clamping devices and their use in aerospace equipment for the installation and support of tubing and wiring.

2. APPLICABLE DOCUMENTS:

2.1 Military Specifications:

MIL-H-5440	Hydraulic Systems, Types I and II Design and Installation Requirements
MIL-W-5088	Wiring, Aerospace Vehicle
MIL-C-85052	Clamp, Loop, Cushioned, General Specification for
MIL-C-85499	Clamp, Assembly, Saddle Type, Cushioned, General Specification for
MS21919	Clamp Loop Type, Cushioned, Support
MIL-C-8603	Clamps, Loop Type, Support
AN735	Clamp, Loop type, Bonding
AN742	Clamp, Plain, Support, Loop Type, Aircraft
MIL-R-25988	Rubber, Fluorosilicone, Elastomer, Oil and Fuel Resistant
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-H-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft

2.2 SAE Documents:

ARP1974	Clamps, Support, Comparative Fatigue Strength, Test Method
AIR1388	Permissible Defects of Aircraft Hydraulic Tubing
ARP1527	Color Coding, Elastomers for Tube Clamp Cushions
AMS 3209	Chloroprene Rubber, Weather Resistant
AMS 3215	Nitrile Rubber, Aeromatic Fuel Resistant
AMS 3303	Silicone Rubber, General Purpose

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3. CLAMP SELECTION:

Clamp selection is primarily dictated by environment, materials and fluid compatibility, as well as the system or component being installed. Each style clamp listed in the following charted guide has specific areas of use and varieties of cushion materials to produce compatibility with the basic fluids used in aerospace vehicles.

3.1 Clamp Style Selection:

Style selection involves largely a consideration of the size of the item being clamped and the forces experienced at various areas of the system being considered. Also, the available mounting area for the clamping device will often affect the selection. For instance, if the clamping of a small cable or wire bundle is being considered and no surges or high vibrations are involved, a MS21919 loop style clamp may be applicable. On the other extreme, if the same installation was located in the windstream, such as on landing gear or in high vibration areas, the use of M85052 may be dictated. If the installation involves hydraulic tubing installations, the selection of a clamping device may involve M85052, M85499, or a type-support block. The use of M85052 for supporting hydraulic lines is limited to lines with diameters up to 1 1/2 in. For lines with a diameter greater than 1 1/2 in, M85449 should be utilized. Often, M85499 should be considered for tube diameters smaller than 1 1/2 in when line surges are apt to result in the loop-style clamp swiveling on its single-point mounting. If high vibration is also a consideration in these cases, a support block may be an even better selection, such as on helicopter installations.

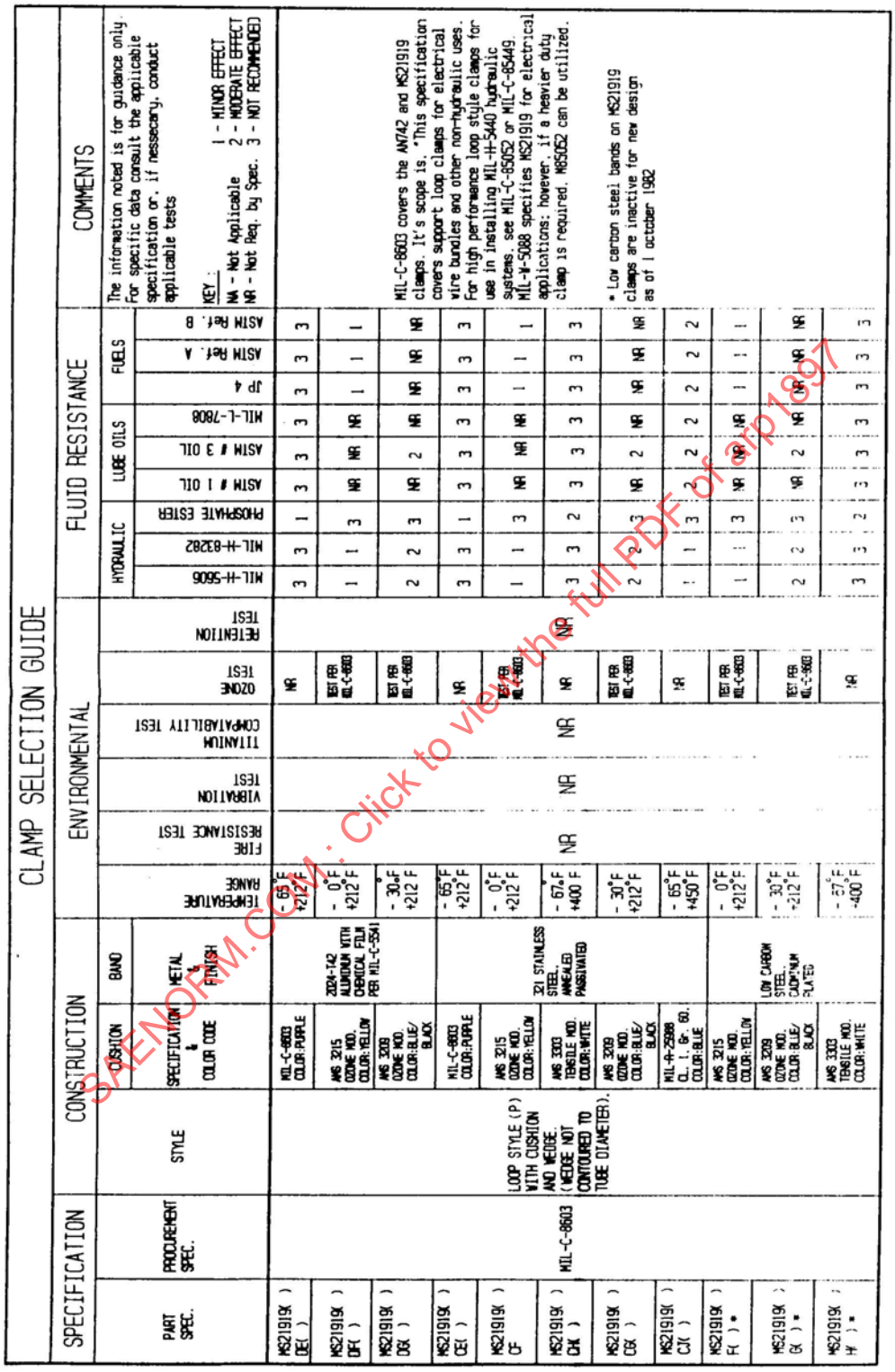
By considering the scopes of the listed clamp specifications and the comparison of the various clamping mediums and their applicable environmental test requirements, a reasonably accurate selection is possible for most applications. However, there are some applications where there are complex circumstances involved that can necessitate supplemental tests to substantiate the style selection. For instance, ARP1974 Clamp, Support, Comparative Fatigue Strength, Test Method may be considered.

3.2 Materials Selection:

The selection of the clamp band and cushion materials, or in the case of support block, the block and channel materials is primarily a consideration of temperature range, fire resistance, fluid resistance, and in some applications, compatibility with titanium alloys. The maximum temperature ranges for the metal band materials are noted for the bare metal clamps AN735 and AN742. For cushion clamps and support block, the elastomer cushion materials are usually the governing factor.

CLAMP SELECTION GUIDE

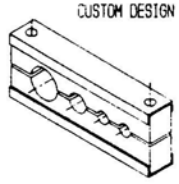
SPECIFICATION		CONSTRUCTION			ENVIRONMENTAL						FLUID RESISTANCE									COMMENTS
			CUSHION	BAND							HYDRAULIC			LUBE OILS			FUELS			
PART SPEC.	PROCUREMENT SPEC.	STYLE	SPECIFICATION & COLOR CODE	METAL & FINISH	TEMPERATURE RANGE	FIRE RESISTANCE TEST	VIBRATION TEST	TITANIUM COMPATABILITY TEST	OZONE TEST	RETENTION TEST	MIL-H-5606	MIL-H-83282	PHOSPHATE ESTER	ASTM # 1 OIL	ASTM # 3 OIL	MIL-L-7808	JP 4	ASTM Ref. A	ASTM Ref. B	The information noted is for guidance only. For specific data consult the applicable specification or, if nessecary, conduct applicable tests KEY : NA - Not Applicable 1 - MINOR EFFECT NR - Not Req. by Spec. 2 - MODERATE EFFECT 3 - NOT RECOMMENDED
AN735	NONE	CENTER MOUNT, NO CUSHION	NA	STEEL, CAD. OR ZINC PLATE	+400°F	NA	NR	NR	NA	NR	NA									This clamp is designed exclusively for electrical grounding or bonding applications
AN735D				ALUMINUM NO FINISH	+300°F	NA	NR	NR	NA	NR										
AN 742	MIL-C-8603	LOOP STYLE (P), NO CUSHION	NA	STEEL CAD. PLATE	+550°F	NA	NR	NR	NA	NR	NA									MIL-C-8603 covers the AN742 and MS21919 clamps. It's scope is, "This specification covers support loop clamps for electrical wire bundles and other non-hydraulic uses." For high performance loop style clamps for use in installing MIL-H-5440 hydraulic systems, see MIL-C-85052 or MIL-C-85449. MIL-H-5088 specifies MS21919 for electrical applications; however, if a heavier duty clamp is required, M85052 can be utilized.
AN742F				302 STAINLESS STEEL	+800°F	NA	NR	NR	NA	NR										
AN742D				2024-T42 ALUMINUM	+300°F	NA	NR	NR	NA	NR										
AN742H				321 STAINLESS STEEL	+1200°F	NA	NR	NR	NA	NR										



CLAMP SELECTION GUIDE

SPECIFICATION		CONSTRUCTION			ENVIRONMENTAL					FLUID RESISTANCE								COMMENTS
PART SPEC.	PROCUREMENT SPEC.	STYLE	CUSHION SPECIFICATION & COLOR CODE	BAND METAL & FINISH	TEMPERATURE RANGE	FIRE RESISTANCE TEST	VIBRATION TEST	TITANIUM COMPATABILITY TEST	OZONE TEST	RETENTION TEST	HYDRAULIC MIL-H-5606	HYDRAULIC MIL-H-83282	PHOSPHATE ESTER	LUBE OILS ASTM # 1 OIL	LUBE OILS ASTM # 3 OIL	LUBE OILS MIL-L-7808	FUELS JP 4	FUELS ASTM Ref. A	FUELS ASTM Ref. B	The information noted is for guidance only. For specific data consult the applicable specification or, if nessecary, conduct applicable tests KEY: NA - Not Applicable 1 - MINOR EFFECT NR - Not Req. by Spec. 2 - MODERATE EFFECT 3 - NOT RECOMMENDED
MS21919K ( ) DE( )	MIL-C-8603	LOOP STYLE (P) WITH CUSHION AND WEDGE (WEDGE NOT CONTOURED TO TUBE DIAMETER).	MIL-C-8603 COLOR: PURPLE	2024-T42 ALUMINUM WITH CHEMICAL FILM PER MIL-C-5541	- 65°F +212°F	NR	NR	NR	NR	NR	3	3	3	3	3	3	3	3	3	
MS21919K ( ) DF( )			AMS 3215 OZONE MOD. COLOR: YELLOW		- 0°F +212°F				TEST PER MIL-C-8603		1	1	3	NR	NR	1	1	1	1	
MS21919K ( ) DG( )			AMS 3209 OZONE MOD. COLOR: BLUE/ BLACK		- 30°F +212 F				TEST PER MIL-C-8603		2	2	3	NR	2	NR	1	NR	NR	MIL-C-8603 covers the AN742 and MS21919 clamps. It's scope is, "This specification covers support loop clamps for electrical wire bundles and other non-hydraulic uses. For high performance loop style clamps for use in installing MIL-H-5440 hydraulic systems, see MIL-C-85052 or MIL-C-85449. MIL-W-5088 specifies MS21919 for electrical applications; however, if a heavier duty clamp is required, M85052 can be utilized.
MS21919K ( ) CE( )			MIL-C-8603 COLOR: PURPLE	321 STAINLESS STEEL ANNEALED PASSIVATED	- 65°F +212°F						3	3	1	3	3	3	3	3	3	
MS21919K ( ) CF			AMS 3215 OZONE MOD. COLOR: YELLOW		- 0°F +212°F				TEST PER MIL-C-8603		1	1	3	NR	NR	NR	1	1	1	
MS21919K ( ) CH( )			AMS 3303 TENSILE MOD. COLOR: WHITE		- 67°F +400 F	NR	NR	NR	NR	NR	3	3	2	3	3	3	3	3	3	
MS21919K ( ) CG( )			AMS 3209 OZONE MOD. COLOR: BLUE/ BLACK		- 30°F +212°F				TEST PER MIL-C-8603		2	2	3	NR	2	NR	NR	NR	NR	* Low carbon steel bands on MS21919 clamps are inactive for new design as of 1 october 1982
MS21919K ( ) CJ( )			MIL-H-25988 CL. 1; Gr. 60. COLOR: BLUE		- 65°F +450°F				NR		1	1	3	2	2	2	2	2	2	
MS21919K ( ) F( )*			AMS 3215 OZONE MOD. COLOR: YELLOW	LOW CARBON STEEL CADMIUM PLATED	- 0°F +212°F				TEST PER MIL-C-8603		1	1	3	NR	NR	NR	1	1	1	
MS21919K ( ) G( )*			AMS 3209 OZONE MOD. COLOR: BLUE/ BLACK		- 30°F -212°F				TEST PER MIL-C-8603		2	2	3	NR	2	NR	NR	NR	NR	
MS21919K ( ) H( )*			AMS 3303 TENSILE MOD. COLOR: WHITE		- 67°F -400°F				NR		3	3	2	3	3	3	3	3	3	

CLAMP SELECTION GUIDE

SPECIFICATION		CONSTRUCTION			ENVIRONMENTAL						FLUID RESISTANCE									COMMENTS
			CUSHION	BAND							HYDRAULIC			LUBE OILS			FUELS			
PART SPEC.	PROCUREMENT SPEC.	STYLE	SPECIFICATION & COLOR CODE	METAL & FINISH	TEMPERATURE RANGE	FIRE RESISTANCE TEST	VIBRATION TEST	TITANIUM COMPATABILITY TEST	OZONE TEST	RETENTION TEST	MIL-H-5606	MIL-H-83282	PHOSPHATE ESTER	ASTM # 1 OIL	ASTM # 3 OIL	MIL-L-7808	JP 4	ASTM Ref. A	ASTM Ref. B	The information noted is for guidance only. For specific data consult the applicable specification or, if nessecary, conduct applicable tests KEY : NA - Not Applicable NR - Not Req. by Spec. 1 - MINOR EFFECT 2 - MODERATE EFFECT 3 - NOT RECOMMENDED
M85052/1	MIL-C-85052	LOOP STYLE (P) WITH CUSHION AND FULL CONTOUR WEDGE	MIL-C-85052 COLOR: YELLOW	17-7PH STAINLESS STEEL, ANNEALED, HEAT TREATED TO CONDITION TH1100 AND PASSIVATED	- 65°F +275°F	YES	YES	YES	YES	YES	1	1	3	1	1	1	1	1	1	MIL-C-85052 has been designed for MIL-H-5440 hydrualic systems where a loop style clamp is desired. Where the application dictates a two hole mounting, see MIL-C-85449. This is a heavy-duty loop style clamp utilizing a 17-7ph band and three elastomer cushions with full contour wedge to provide maximal tube retention. This is a QPL part
M85052/2			MIL-C-85052 COLOR: PURPLE		- 65°F +275°F	YES	YES	YES	NA	YES	3	3	1	3	3	3	3	3	3	
M85052/3			MIL-C-85052 COLOR: BLUE		- 65°F +500°F	YES	YES	YES	NA	YES	2	2	2	2	2	2	3	3	3	
M85052/4			NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
M85449/1	MIL-C-85449	SADDLE STYLE, CUSHIONED, FOR TUBE SIZES -10 (5/8") THROUGH -48 (3")	MIL-C-85449 COLOR: YELLOW	321 STAINLESS STEEL, ANNEALED, PASSIVATED	- 65°F +275°F	YES	YES	YES	YES	NR	1	1	3	1	1	1	1	1	1	MIL-C-85449 covers saddle style clamps which are commonly used for tubing applications especially on larger sizes of tubes and ducts. Also, they are specially adaptable for those applications where a two hole mounting is required to prevent swiveling under loads and surges. The M85449/4 variation is designed with a teflon cushion to allow a sliding fit for permissible movement of the tube. This is a QPL part.
M85449/2			MIL-C-85449 COLOR: PURPLE		- 65°F +275°F	YES	YES	YES	NA	NR	3	3	1	3	3	3	3	3	3	
M85449/3			MIL-C-85449 COLOR: BLUE		- 65°F +500°F	YES	YES	YES	NA	NR	2	2	2	2	2	2	3	3	3	
M85449/4			MIL-C-85449 COLOR: WHITE		-320°F +450°F	YES	YES	YES	NA	NR	1	1	1	1	1	1	1	1	1	
ELASTOMERIC TUBE SUPPORT BLOCK	 CUSTOM DESIGN		M85052/1 COLOR: YELLOW	6061-T6 OR 7075-T6511 ALUMINUM 321 OR 302 STAINLESS STEEL	- 65°F +275°F	YES	NR	YES	YES	NR	1	1	3	1	1	1	1	1	1	Tube support blocks are a necessary system installation medium primarily used in high vibration environments such as experienced in helicopters. Due to their complexity, often dictated by the available space and tube location, a standard has not been feasible, except in elastomer selection. MIL-C-85052 elastomers have proven to be excellent for this type of clamping device in conjonation with the appropriate support channels.
			M85052/2 COLOR: PURPLE		- 65°F +275°F	YES	NR	YES	YES	NR	3	3	1	3	3	3	3	3	3	
			M85052/3 COLOR: BLUE		- 65°F +500°F	YES	NR	YES	YES	NR	2	2	2	2	2	2	3	3	3	

3.2.1 Cushioning Materials: The cushion materials have been color coded per ARP1527 for their environmental fluid resistance, making it possible to determine if the correct cushion material is being utilized in the intended area. Basically, there are eight different cushioning materials to consider:

a. Chloroprene per AMS-3209 and MIL-C-8603 (color coded black with blue identifier)

b. Nitrile butadiene per AMS-3215 and MIL-C-8603 (color coded yellow)

c. Ethylene propylene per MIL-C-8603, MIL-C-85052 and MIL-C-85449 (color coded purple)

d. Fluorosilicone per MIL-R-25988, Type 2, Class 1, Grade 60 (color coded blue)

e. Silicone per AMS-3303 and MIL-C-8603 (color coded white)

f. Nitrile butadiene per MIL-C-85052/1 and MIL-C-85449/1 (color coded yellow)

g. Fabric supported silicone per MIL-C-85052/3 and MIL-C-85449/3 (color coded light blue)

h. Polytetrafluoroethylene per MIL-C-85449/4

The Clamp Selection Guide Chart does show the many environmental considerations as well as some guidance for fluid resistance. Basically, the following are general comments for the use of the above material:

a. Chloroprene is used for the lower temperature range applications where nonvolatile fuels and low aniline oils could be a factor such as experienced in ground support or automotive type equipment. This material is not compatible with titanium and some vinyl wire insulation materials.

b. Nitrile butadiene is used for maximum hydrocarbon fluid resistance in the lower temperature ranges. This elastomer in the past has had ozone cracking problems; however, the materials specified by MIL-C-8603, MIL-C-85052/1 and MIL-C-85449/1 are now improved and are subject to ozone testing. The compound specified by MIL-C-8603 (AMS-3215) differs from the one specified in MIL-C-85052 and MIL-C-85449 in temperature range, tensile strength and fire resistance. The new materials required by MIL-C-85052/1 and MIL-C-85449/1 have been designed especially for the MIL-H-5440 hydraulic systems in current use in military and commercial aircraft.

c. Ethylene propylene elastomers specified by MIL-C-8603, MIL-C-85052/2 and MIL-C-85449/2 are almost identical and are used almost entirely for phosphate ester fluid resistance in hydraulic systems of commercial aircraft. It has excellent ozone resistance making this test unnecessary. It is also used in many applications (such as electrical equipment) where fluid resistance is not a factor but ozone resistance is critical.

3.2.1 (Continued):

d. Fluorosilicone elastomer is manufactured per MIL-R-25988, Class I, Type 2, Grade 60 and is designed for hydrocarbon resistance at elevated temperature. It is specified only for the lighter duty clamps manufactured per MIL-C-8603 and MS21919 since its mechanical properties are too low for the more stringent requirements of hydraulic systems.

e. Silicone elastomer, fabric supported, which is specified in MIL-C-85052/3 and MIL-C-85449/3, is designed for use at elevated temperatures with splash resistance to hydrocarbon and engine wash-down fluids. The fabric support provides the strengths necessary to withstand the rigors of hydraulic applications experienced in pylon and power plant applications

f. Polytetrafluorethylene is an excellent fluid resistant plastic with a wide temperature range of approximately -300 to +450°F (-184 to +273°C). Also, surface characteristics and hardness provide a surface that enables movement rather than retention experienced with the elastomer materials. On the other hand, the hard surface results in the use of thinner cushion pads (approximately 0.020 to 0.030 in) and amplification of vibratory input whereas the elastomeric materials have the tendency to dampen, or result in amplification of a much lesser degree. Used extensively for liquid oxygen systems and where structure flexing or heat growth requires line movement.

4. CLAMP SELECTION:

4.1 Available space, mounting area, fluid contamination temperature and vibration, as well as other criteria, all have a definite bearing on the device and materials selected. The two clamp specifications designed especially for tubing installations are MIL-C-85052 (loop clamp) and MIL-C-85449 (saddle clamp). Tube support blocks are also commonly used for tubing installations especially in areas and on aircraft where vibration is a concern. While no specifications exist on the tube support blocks, the elastomeric materials specifications incorporated in specification MIL-C-85052 are utilized for the block portions of the assemblies.

4.1.1 MIL-C-85052, Loop Clamp: This clamp specification is required for the installation of Type I and Type II aircraft hydraulic systems by Specification MIL-H-5440. Specification MIL-C-85052 is accompanied by four slash sheets which cover three different cushion materials and a reinforcing washer. (See the Clamp Selection Guide for color coding, fluid compatibility, temperature range, and other recommended usage). Also, it involves a full contoured wedge for maximum retention. Size Range: 1/8 in diameter through 1 1/2 in diameter in increments of 1/16 in.

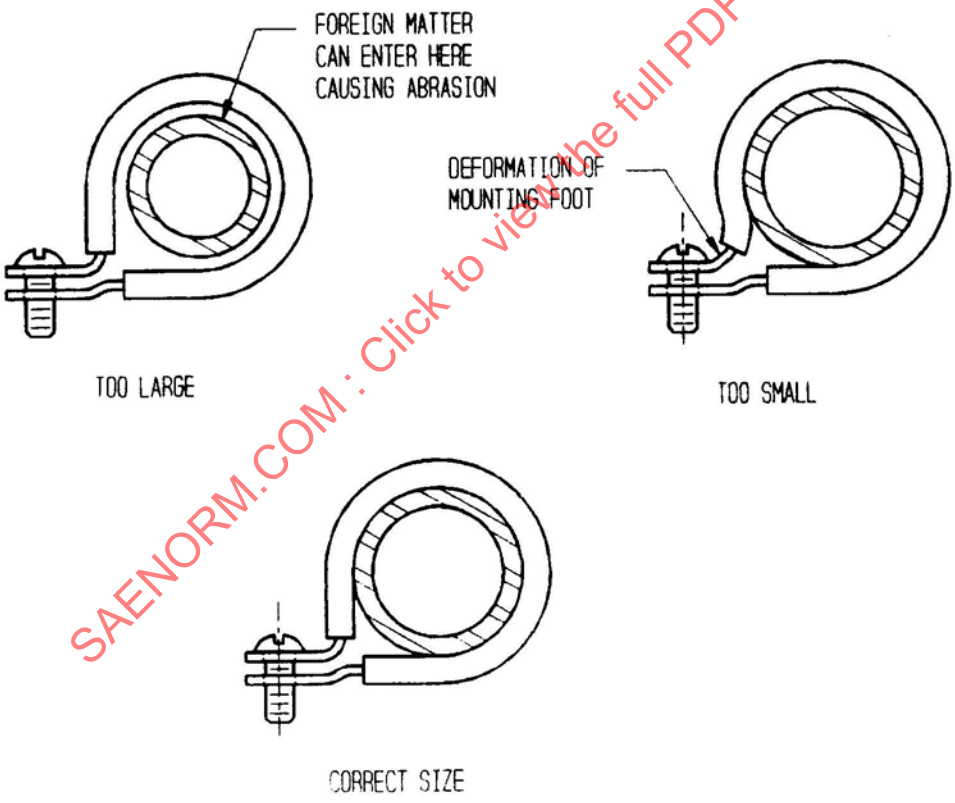
4.1.2 MIL-C-85449, Saddle Clamp: This clamp specification is also designed for Type I and Type II aircraft hydraulic systems; however, provides a two-point mounting. It consists of four slash sheets covering four cushion materials. (See the Clamp Selection Guide for Fluid Compatibility and Temperature Range). Size Range: 5/8- through 3-in diameter.

4.1.3 Line Support Blocks: As noted in 4.1, the cushion material specifications incorporated in Specification MIL-C-85052 are also utilized for line support blocks together with either extruded aluminum or formed stainless steel support channel. Other materials are employed, the types being dictated by special environmental conditions.

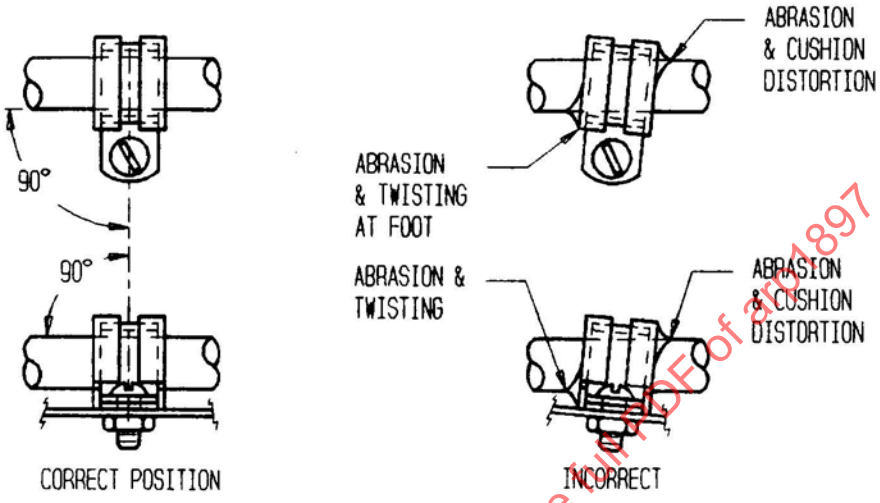
5. TUBING INSTALLATION:

5.1 Fit:

Selecting the correct size clamp for the installation is vital for a dependable installation. A loose clamp will permit abrasion and often cause clamp breakage or even result in tube and/or fitting failure. The use of too small a clamp will almost always result in a broken clamp and subsequent tubing or fitting failure. Clamp standards are commonly graduated in standard tubing O.D. dimensions making it possible to obtain the required fit.

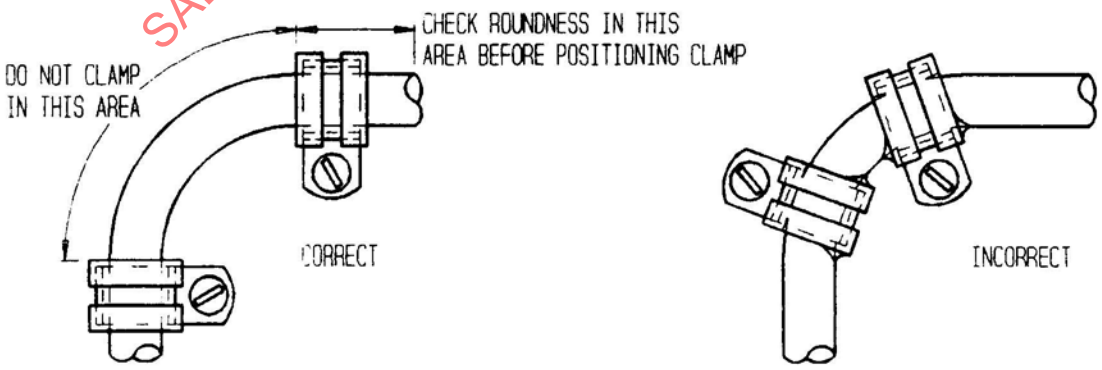


5.2 The position of the clamp relative to the tube must be at 90° at installation to prevent built-in preload and subsequent clamp distortion and failure. Also, clamp misalignment may cause abrasion or tearing of the cushion material resulting in a metal-to-metal condition, and a far greater abrasion problem.



In some instances, due to flexure or line surge, clamp swivel is experienced causing the above condition. It may then become necessary to substitute a clamp with two-hole mounting to eliminate this condition.

Tubing should be supported to rigid structure as close to the tube bends as possible as this is an area of pressure build-up and surge, especially in hydraulic and fuel systems. As tubing is no longer perfectly round after bending, the mechanical should check the tube for roundness, before positioning the clamp and securing it to the structure. Do not clamp on the tube bend or out of round areas in any case as this will distort the clamp causing abrasion and subsequent clamp or tube failure. Also, where possible, the clamp mounting should be located to the inside of the bend for the best structural advantage.



5.3 Spacing:

Spacing of clamps must be determined for each and every tube installation taking into consideration load, flexure, vibrature, surges, and other operational factors. Specification MIL-H-5440 notes maximum spacing and other criteria for aircraft hydraulic installations. However, it too must be only used as a guide in view of the other variables that can be involved. A suggested formula and example of computing spacing follows:

The relation between the fundamental natural frequency of fluid lines supported by cushioned tubing clamps, loop or saddle, and the distance between supports may be closely approximated by the equation for uniform beams vibrating in flexure with simply supported ends.

For straight runs of tubing:

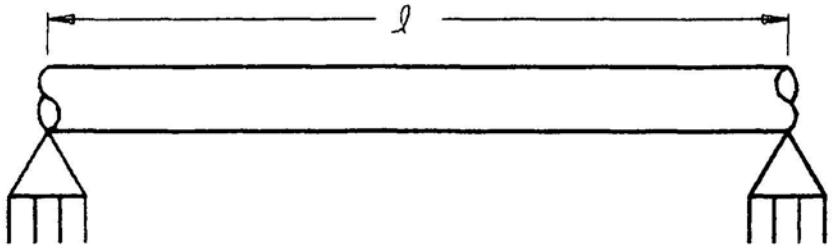
$$f_n \text{ (cycles per sec.)} = c_n \frac{\sqrt{EIG}}{w\ell^4} \qquad \text{(Eq. 1)}$$

Where:

EI = Flexural stiffness (lb. - in^2)
w = Weight per unit length (lb./in including applicable fluid weight)
ℓ = Distance between supports (in)
g = 386 in/s
c_n = 1.56
f_n = Natural frequency (H_z)
D = Tube, outside diameter
d = Tube, inside diameter
E = Modulus of elasticity, psi*
I = Moment of inertia $= \frac{\pi}{64}(D^4 - d^4)$, in^4*

NOTE: Reduce distance between supports for lines bent over 20°

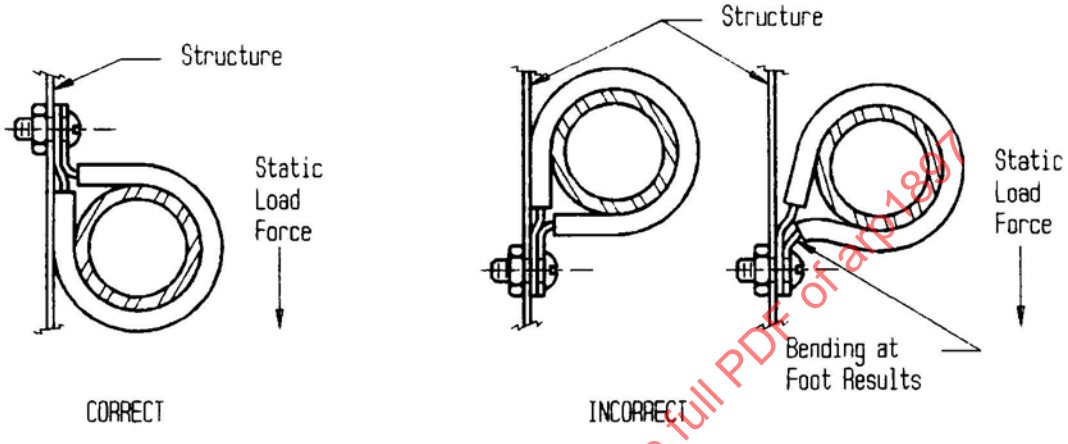
* From Marks Mechanical Engineering Handbook, Sixth Edition, Section 5, Vibration:



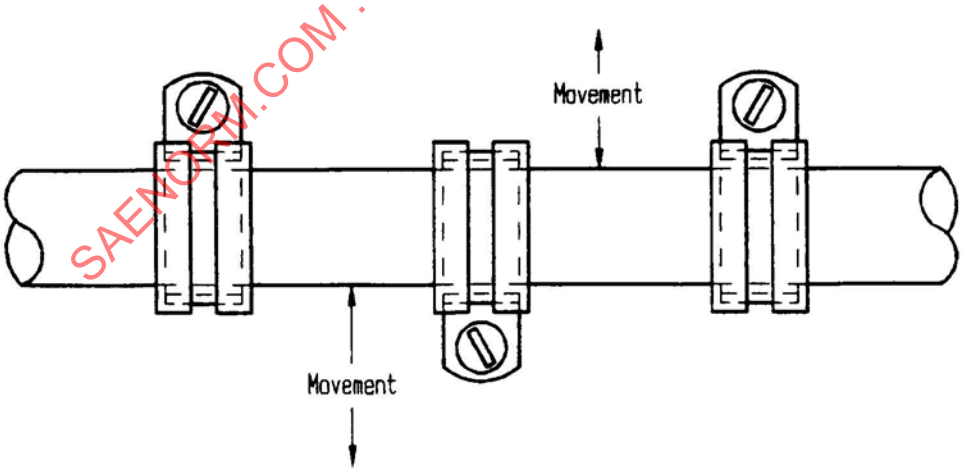
NOTE : Reduce distance between supports for lines bent over 20°

5.4 Mounting:

When mounting tubes to vertical structure the static load force should oppose the mounting foot and bolt when using a single mounting point clamp. If the tube is mounted with the bolt below the tube, bending or distortion can, and probably will, result from either static load or personnel using the tubing as a handhold.

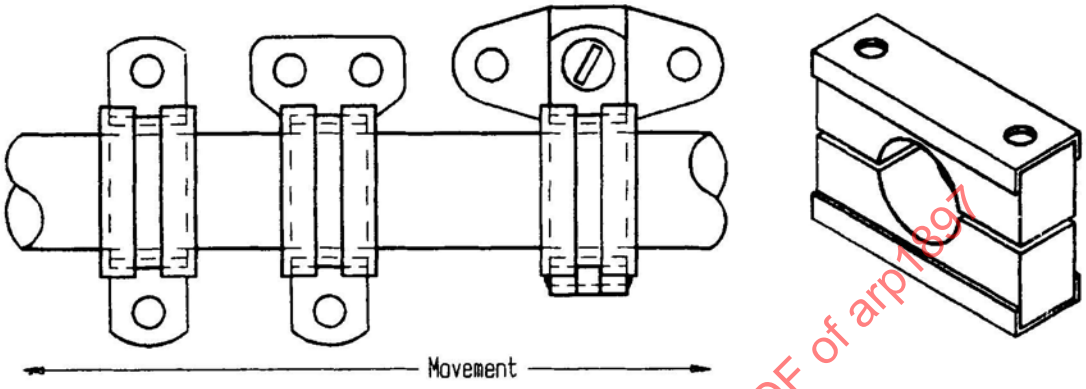


When surges, loads, or flexure occur on installations to vertical or horizontal structure, it is good practice to alternate the mounting points to provide maximum support in both directions. If conditions are severe, a saddle style clamp may be necessary. If surge or flexure is in only one direction, the mounting should oppose the force.

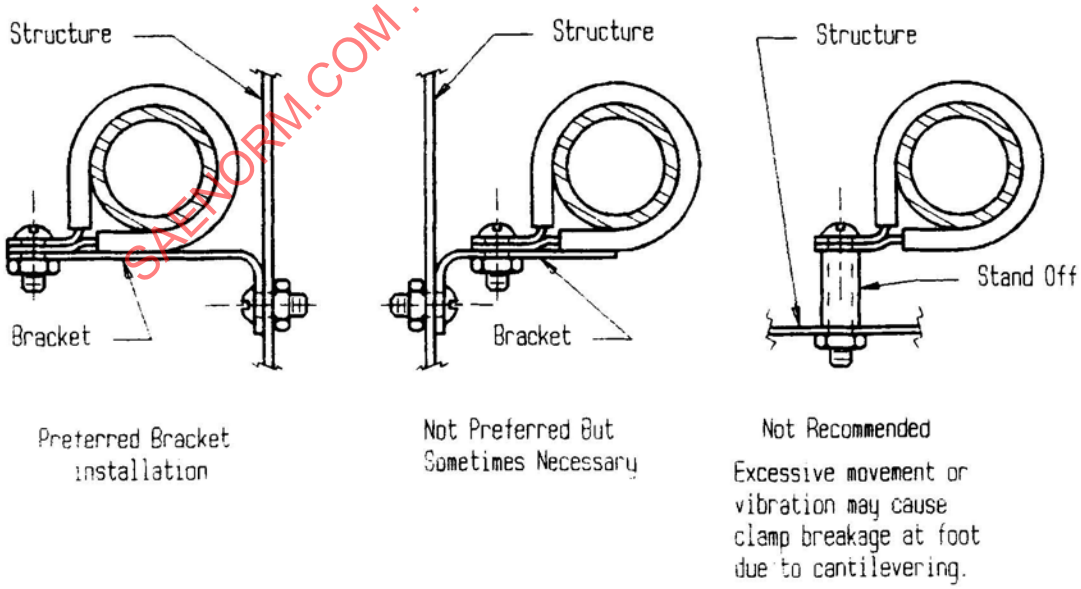


5.4 (Continued):

When surge or movement is parallel to the centerline of the tube, and the forces are sufficient to produce swiveling of single mounting point clamps, it becomes necessary to use two-hole mountings or line blocks.

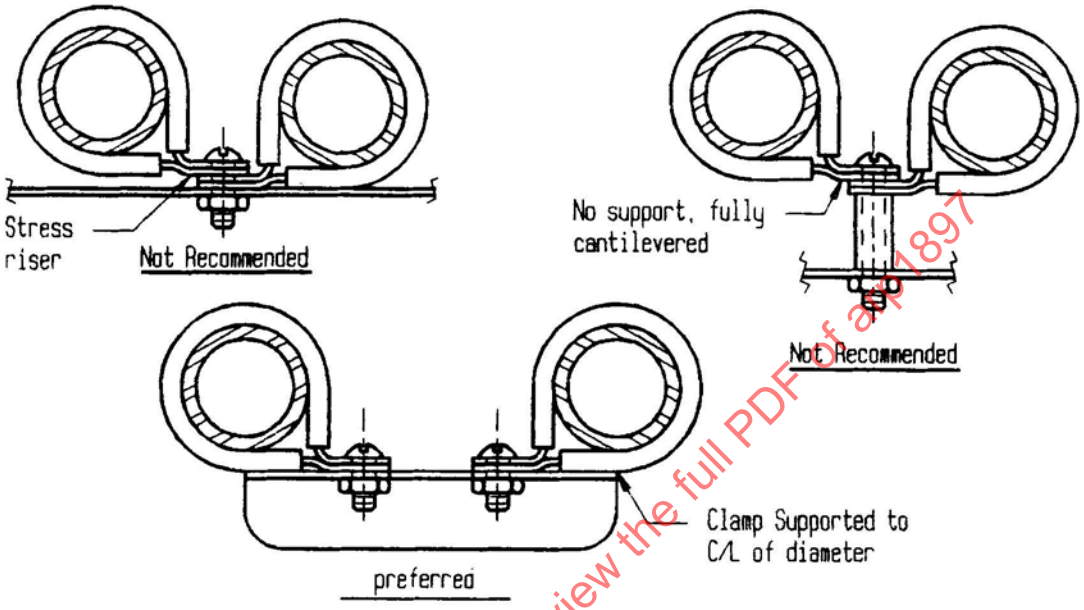


Standoffs and brackets are necessary for many tubing and wiring installations due to available structure and the line or cable separation required. Brackets are preferred over standoffs since they provide more support for the clamp and eliminate another piece of loose hardware, a principal cause of foreign object damage (FOD). Standoffs should not be used under high vibration and surge conditions as swiveling, cocking, and the high degree of clamp movement experienced with the cantilever type mounting will ultimately result in clamp breakage. This same problem can result from cantilever mounting from brackets; however to a lesser degree since the bracket will provide greater support under the clamp foot.



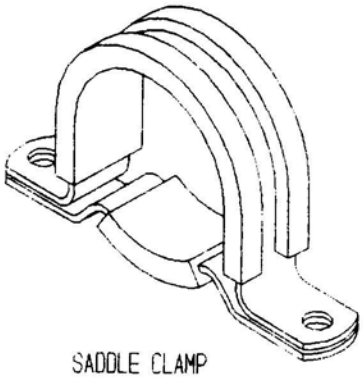
5.4 (Continued):

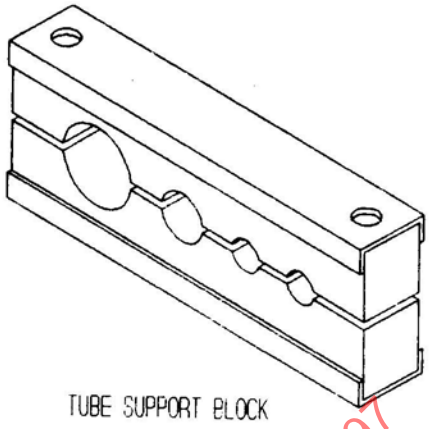
The common practice of mounting two or more clamps with a single bolt, known as butterflying, should be kept to a minimum. Here again, brackets or base mounting are preferred. Butterflying should not be used for primary support.



5.5 Loop Clamps Versus Saddle Clamps or Line Blocks:

Clamp loads may become excessive to obtain full life cycle either because of environment or the mass to be supported. For general use in aircraft, loop style clamps should be limited to a diameter of 1 in for liquid-filled lines and 2 in for air duct piping. Saddle style clamps, or line blocks, should be used for larger diameters. In landing gear, flap, and some engine areas, liquid-filled lines or cables should be limited to a diameter of 5/8 in for loop style clamps because of the loads and vibration experienced in these areas.





5.6 Titanium Tubing:

The clamping of titanium tubes requires special consideration, as follows:

a. Care should be taken not to dent or scratch tubes during installation or removal. See AIR1388 for permissible dent and chafing requirements.

b. Clamp cushioning materials should be checked for compatibility with titanium before use, especially chlorine based elastomers. See MIL-C-85052 and MIL-C-85449 for titanium compatibility tests.

c. Do not clean tubes with chlorinated solvents.

d. Do not mark tubes with graphite or carbon based pencils or marking instruments.

e. Do not use dri-film lubricants other than MIL-L-46010 on installations.

6. WIRING INSTALLATIONS:

While the preceding discussions may be applicable to both tube and wire and cable installations, there are various situations common only to wire and cable installations. An attempt to show and describe many of these conditions follows. However, it is suggested Specification MIL-W-5088 be consulted before proceeding with the design and installation of any wiring.

6.1 Bend Radius:

The most common problem in wiring is a bend radius that is too small. This can be particularly critical on coaxial cable installations where crimping of the cable can cause multiple-system failures. Another result of too small a bend radius is abrasion, which can result in electrical fires.