SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS5000 | REV. D

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Superseding AS5000C

Fitting, Plug-in Union, Ring Locked, 24 Degree Cone, Fluid Connection, 5080 psi (35 000 kPa), Specification for

RATIONALE

Update the sampling spec to accommodate acceptance number zero.

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1. SCOPE

This SAE Aerospace Standard (AS) establishes the requirements for 24 degree cone AS5827 or EN 6123 flareless Ring locked fitting assemblies per AS5550 and AS5865, for use in aircraft fluid systems at nominal operating pressure of 5080 psi (35 000 kPa) maximum and operating temperature range of -65 to +275 °F (-54 to +135 °C).

The general requirements shall be for, but not limited to, commercial aircraft hydraulic components per AS4941, using port configuration as specified in AS5551.

1.1 Classifications

Type 1 Standard requirement for Proof, Tensile, Fire, and Vibration Test

Type 2 Alternate requirement for Proof, Tensile, Fire, and Vibration Test

NOTE: Type 1 meets requirements of both types.

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.

AMS2486 Conversion Coating of Titanium Alloys Fluoride-Phosphate Type

AMS2488 Anodic Treatment - Titanium and Titanium Alloys, Solution pH 13 or Higher

AMS2700 Passivation of Corrosion Resistant Steels

AMS4928 Titanium Alloy Bars, Wire, Forgings, Rings, and Drawn Shapes, 6Al - 4V, Annealed

AMS4965 Titanium Alloy, Bars, Wire, Forgings, and Rings, 6.0Al - 4.0V, Solution Heat Treated and Aged

AMS4967 Titanium Alloy, Bars, Wire, Forgings, and Rings, 6.0Al - 4.0V, Annealed, Heat Treatable

AMS5731 Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, Tubing, and Rings, 15Cr - 25.5Ni - 1.2Mo - 2.1Ti - 0.006B - 0.30V, Consumable Electrode Melted, 1800 °F (982 °C) Solution Heat Treated

AMS5732 Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, Tubing, and Rings, 15Cr - 25.5Ni - 1.2Mo - 2.1Ti - 0.006B - 0.30V, Consumable Electrode Melted, 1800 °F (982 °C) Solution and Precipitation Heat Treated

AMS5734 Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, and Tubing, 15Cr - 25.5Ni - 1.2Mo - 2.1Ti - 0.006B - 0.30V, Consumable Electrode Melted, 1650 °F (899 °C) Solution Heat Treated

AMS5737 Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, and Tubing, 15Cr - 25.5Ni - 1.2Mo - 2.1Ti - 0.006B - 0.30V, Consumable Electrode Melted, 1650 °F, (899 °C) Solution and Precipitation Heat Treated

AS478	Identification Marking Methods
AS603	Impulse Testing of Hydraulic Hose, Tubing, and Fitting Assemblies
AS1055	Fire Testing of Flexible Hose, Tube Assemblies, Coils, Fittings, and Similar System Components
AS1241	Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft
AS2094	Test Methods for Tube-Fitting Assemblies
AS4941	Aerospace - General Requirements for Commercial Aircraft Hydraulic Components
AS5272	Lubricant, Solid Film, Heat Cured, Corrosion Inhibiting, Procurement Specification
ARP5412	Aircraft Lightning Environment and Related Test Waveforms
ARP5416	Aircraft Lightning Test Methods
AS5550	Fitting Assembly, Ring Locked, Adapter, Flareless to Port, Extra Fine Threads, 5080 psi
AS5551	Fitting Assembly - 24 Degree Cone Flareless per AS5827, 5080 psi, Port Connection, Port Preparation, Installation and Removal of AS5550 and AS5865
AS5620	Titanium Hydraulic Tubing, Ti-3Al-2.5V Cold Worked and Stress Relieved, Up to 35,000 kPa (5080 psi), Requirements for Qualification Testing and Control
AS5827	Fitting End, Flareless, Extra Fine Thread, Design Standard
AS5865	Fitting Reducer Assembly, Ring Locked, Adapter, Flareless to Port, Extra Fine Threads, 5080 psi
AS5975	Fitting Assembly, Straight, Male, Flareless, Axially Swaged, Hydraulic, 5080 psi
AS7003	Nadcap - Program Requirements
AS7112	National Aerospace and Defense Contractors Accreditation Program Requirements for Fluid System Components
AS8879	Screw Threads – UNJ Profile, Inch, Controlled Radius Root with Increased Minor Diameter

2.1.2 U.S. Government Publications

Available from DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: (215) 697-6396, http://quicksearch.dla.mil/.

FED-STD-595	Colors Used in Government Procurement
MIL-HDBK-1655	Fittings, Flareless, Classification of Defects of
MIL-PRF-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base

2.1.3 AECMA Publications

Available on-line at http://www.aecma-stan.org/sales/bookstore.asp or from AECMA, 94-b.5, B-1200 Brussels, Belgium.

EN 6123 Fitting End, 24° Internal Cone, Extra Fine Thread, Flareless Type

2.1.4 ASQ Publications

Available from American Society for Quality, 600 North Plankinton Avenue, Milwaukee, WI, 53202, Tel: 800-248-1946 (United States or Canada) or +1-414-272-8575 (International), www.asq.org.

ASQ Z1.4 Sampling Procedures and Tables for Inspection by Attributes

2.1.5 ASME Publications

Available from American Society of Mechanical Engineers, 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900, Tel: 973-882-1170, www.asme.org.

ASME Y14.38 Abbreviation for Use on Drawings and in Text

2.1.6 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A 370 Steel Products, Mechanical Testing of

2.1.7 ISO Publications

Available from International Organization for Standardization, 1, rue de Varembe, Case postale 56, CH-1211 Geneva 20, Switzerland, Tel: +41 22 749 01 11, www.iso.org.

ISO 2685 Resistance to Fire in Designated Fire Zones

ISO 3161 Aerospace - UNJ Threads, with Controlled Root Radius, for Aerospace - Inch Series

ISO 6773 Aerospace - Fluid Systems - Thermal Shock Testing of Piping and Fittings

ISO 7137 Aircraft - Environmental Conditions and Test Procedures for Airborne Equipment

ISO 7257 Aircraft - Hydraulic Tubing Joints and Fittings - Rotary, Flexure Test

ISO 10583 Aerospace Fluid Systems -Test Methods for Tube/Fitting Assemblies

2.1.8 NAS Publications

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

NAS1638 Cleanliness Requirements of Parts Used in Hydraulic Systems

2.1.9 PRI Publications

Available from Performance Review Institute, 161 Thorn Hill Road, Warrendale, PA 15086-7527, Tel: 724-772-1616, www.pri-network.org.

PD2001 Qualified Product Management Council Procedures for Qualified Products Group

PD2101 Aerospace Quality Assurance, Product Standard, Qualification Procedures, Fluid Systems

PRI-QPL-AS5000 Fittings, Ring Locked, Flareless per AS5827, 5080 psi, Fluid Connection

2.1.10 RTCA Publications

Available from RTCA, Inc., 1150 18th Street, NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

RTCA/DO-160 Environmental Conditions and Test Procedures for Airborne Equipment

2.2 Abbreviations and Acronyms

Standard abbreviations used in this document and frequently used in aerospace technical documents may be found in ASME Y14.38.

2.3 Definitions

Definitions of terms used in this document and frequently used in aerospace technical documents may be found in the SAE Dictionary of Aerospace Engineering.

3. TECHNICAL REQUIREMENTS

3.1 Qualification

3.1.1 Product Qualification

Fittings furnished under this specification shall be representative of products which have been qualified to the requirements of 3.6 and 4.4. All products shall conform to the requirements of this procurement specification and shall be approved in accordance with the requirements of PD2001 and PD2101 for listing in the Performance Review Institute (PRI) Qualified Products List (QPL) PRI-QPL-AS5000.

3.1.2 Manufacturer Qualification

A manufacturer producing a product in conformance to this procurement specification shall be accredited in accordance with the requirements of PD2101, AS7003, and AS7112, AS7112/2 and shall be listed in a Performance Review Institute (PRI) Qualified Manufacturers List (QML).

3.1.3 Retention of Qualification

The manufacturer shall certify in intervals not exceeding two years that the products listed in PRI-QPL-AS5000 are still available from the listed plant. The manufacturer shall forward his certification letter to PRI for approval. PRI shall confirm retention of qualification. Periodic Control Tests (4.5.3) shall be performed and reported to PRI accordingly.

3.2 Material

Fittings shall be fabricated of materials listed in Table 1 and in compliance with requirements in this specification or as specified on the applicable part standard drawings.

TABLE 1 - MATERIALS

Titanium alloy Ti 6Al-4V per AMS4928, AMS4965, or AMS4967
CRES A-286 per AMS5731, AMS5732, AMS5734, or AMS5737

3.2.1 Heat Treatment

3.2.1.1 Titanium Alloy

Titanium alloy fittings shall be supplied in the final temper as shown in Table 1. When fitting material is purchased in other than the final temper, the heat treatment of the raw material shall be as specified on the applicable part standard drawings.

3.2.1.2 CRES

Unless otherwise specified on the applicable part standard drawings, the hardness of the finished A-286 corrosion resistant steel parts shall be 30 HRC minimum.

3.3 Design and Fabrication

The design and fabrication of the fittings shall be in accordance with the applicable part standard drawings. The fitting ends shall be in accordance with AS5827 or EN 6123 as appropriate.

Dimensional requirements are applicable after heat treatment and protective finishing.

3.3.1 Passages

3.3.1.1 Machining Offset

The offset between the machined holes at the meeting point of the holes shall not exceed 0.010 inch (0.254 mm). It shall be possible to pass through the fluid passage a ball whose diameter is 0.015 inch (0.381 mm) less than the minimum diameter specified for the passage.

3.3.2 Threads

Threads shall be per ISO 3161 or AS8879 as applicable except that the root radius is not required on incomplete threads. External threads on titanium alloy and corrosion resistant steel may be produced by a single point method, cut or rolled.

NOTES: 1. Threads shall not be grit or bead blasted unless required as preparation for application of solid film lubricant.

2. Gaging and conformance requirements for ISO 3161 threads shall follow practices outlined under AS8879 Category I.

3.4 Finish

3.4.1 Titanium Alloy Fittings

Titanium alloy fitting assemblies shall be anodic treated per AMS2488 or fluoride phosphate coated per AMS2486, except that a pretreatment, a modification of the fluoride treatment or a post treatment shall be applied so that the final color of the fittings should be approximately dull gray. Sealing surfaces shall not be bead or grit blasted.

3.4.2 A-286 Corrosion Resistant Steel Fittings

Corrosion resistant steel fitting assemblies shall be solid film lubed per AS5272, Type 2 on all surfaces except none in flow hole. The final color of the fitting assemblies should be approximately gray.

3.4.3 A-286 Lockring shall be passivated per AMS2700, and PTFE coating with white color for 5080 psi (35 000 kPa) identification purpose.

3.5 Identification of Product

All fitting assemblies shall be marked in accordance with AS478 Class C or D or Method 2 or 35 as specified on the applicable part standard drawings in a location not detrimental to the performance of the fitting and not detrimental to the corrosion protection of the fitting.

NOTE: When items cannot be physically marked because of lacking space or because marking would have a deleterious effect, the package shall provide the identification per 5.3.

3.5.1 Manufacturer's Identification

Unless otherwise specified, all fittings shall be marked with the manufacturer's name, CAGE code number or trademark. Package marking identification shall include Lot number.

3.5.2 Size, Method, and Location of Marking

Marking shall be accomplished per those permanent methods listed in AS478 which do not cause surface oxidation or other detrimental effects.

3.5.3 Color Identification

In addition to the markings specified, the fitting assemblies shall be identified by the following colors:

a. Titanium alloys: Dull gray (see 3.4.1) similar to color number 26081 through 26293 or 36081 through 36293 per FED-STD-595.

b. CRES: Gray (see 3.4.2)

NOTE: Not meeting the exact color requirements shall not be cause for rejection.

3.6 Performance

Assemblies shall meet requirements per 3.6.1 through 3.6.17. Port ends of plug-in unions shall be installed per AS5551. Tooling for port preparation, installation, and removal of plug-in unions shall be per AS5551. Fitting nuts and tube ends or caps shall be installed on tube fitting ends of plug-in unions per 4.4.2.5, and tightened to torques specified in Table 5 shall meet the requirements 3.6.2 through 3.6.17.

3.6.1 Environmental Conditions

Fitting assembly shall meet the performance requirements in accordance with this specification when subjected to the natural and induced environments specified herein.

3.6.1.1 Temperature

a. Ambient Air: -65 to +275 °F (-54 to +135 °C)

b. Fluid: -65 to +275 °F (-54 to +135 °C)

3.6.1.2 Hydraulic Pressures

a. Operating pressure: 5080 psi (35 000 kPa)

b. Proof pressure: 10 160 psi (70 000 kPa), alternate 7620 psi (52 500 kPa) as specified by user.

c. Burst pressure: 20 320 psi (140 000 kPa)

3.6.2 Proof Pressure

The fitting assembly shall withstand proof pressure for 3 minutes without leakage, evidence of permanent deformation or other malfunction when tested in accordance with 4.6.2.

3.6.3 Pneumatic Pressure

The fitting assembly shall be capable of containment of nitrogen gas without evidence of gas bubbles when tested in accordance with 4.6.3.

3.6.4 Impulse

The fitting assembly shall withstand 300 000 impulse pressure cycles at a peak pressure of 150% of operating pressure without leakage when tested in accordance with 4.6.4.

3.6.5 Minimum Burst Pressure Test

The fitting assembly shall withstand burst pressure without any visible leakage, slippage or other failure when tested in accordance with 4.6.5.

3.6.6 Flexure

The fitting assembly when subjected to the stress levels specified in Table 2 shall withstand 10^7 (ten million) flexure cycles without leakage when tested in accordance with 4.6.6.

Bending stress levels are applicable to Titanium or CRES fittings assembled to Titanium 3Al-2.5V titanium tubing per AS5620.

TABLE 2 - BENDING STRESS LEVEL

Fitting Assembly Size	Dynamic Bending stress (0% to 10%)	
	psi	MPa
04	20 000	137.9
06	19 000	131.0
08	18 000	124.1
10	17 000	117.2
12	16 000	110.3
16	15 000	103.4
20	14 000	96.5

3.6.7 Repeated Assembly

The test assembly shall withstand eight repeated assemblies and four installations and removals on the Port end side when tested in accordance with 4.6.7.

3.6.8 Tensile Load

The fitting assembly when assembled without pressure shall withstand an axial load per Table 3 without separation when tested in accordance with 4.6.8.

TABLE 3 - TENSILE LOADS

Fitting Assembly Size	Tensile Load Type 1 - Standard		Tensile Load Type 2 - Alternate	
	lbf	Newton	lbf	Newton
04	1400	6228	997	4435
06	2700	12 010	2244	9982
08	4800	21 351	3990	17 748
10	7500	33 362	6234	27 730
12	10 500	46 706	8977	39 932
16	18 600	82 737	15 959	70 990
20	29 200	129 888	24 936	110 921

3.6.9 Thermal Shock

The fitting assembly shall withstand the temperature and pressure without leakage, evidence of permanent deformation or other malfunction when tested in accordance with 4.6.9.

3.6.10 Overtightening

The fitting assembly when torque tested at both fitting end connections and in accordance with 4.6.10 shall not leak during the proof test and pneumatic test.

3.6.11 Electrical Conductivity

The fitting assembly shall be conductive. The maximum resistance shall be 10 mΩ between the Boss and a Test assembly or a Plug when tested in accordance with 4.6.11.

3.6.12 Salt Spray

The fitting assembly shall be able to pass Electrical conductive test and Burst test after being tested in accordance with 4.6.12.

3.6.13 Vibration

The plug-in union fitting shall withstand vibration testing in accordance with 4.6.13 without leakage at the plug in-union interface and shall not show evidence of structural failure of the plug-in union fitting. The presence of detectable crack in plug-in union fitting constitutes a vibration test failure.

3.6.14 Fire

The fitting assembly shall withstand a 2000 °F (1093 °C) flame for 15 minutes (fire proof rating), or alternate 5 minutes (fire resistant rating) when required by user. Fire test procedures are to be in accordance with 4.6.14. There shall be no leakage detected by visual observation or failure of the test assembly prior to the specified time.

3.6.15 System Pressure

The fitting assembly shall withstand 24 hours exposure at low pressure then 24 hours at operating pressure with no visually detectable escape of fluid from the fitting assembly or the tube fitting interface, when tested in accordance with 4.6.15.

3.6.16 Stress Corrosion

The test assemblies shall not exhibit intergranular or stress corrosion cracking after salt spray exposure when tested in accordance with 4.6.16.

3.6.17 Lightning Strike

The test assemblies sizes -04 and -12 shall not leak after being subjected to 12 lightning strikes when tested in accordance with 4.6.17.

3.7 Workmanship

3.7.1 Machined Surfaces

Machined surfaces of fitting assemblies shall be as specified on the applicable part standard drawings.

3.7.2 Internal Passages

Internal passages of fluid fittings shall be free from burrs, slivers, pressed-on chips or contamination as visible with macroscopic examination at 7X magnification using a light source. Surface defects may be explored by suitable etching and if they can be removed so that they do not appear on re-etching and the required section thickness can be maintained, they shall not be cause for rejection.

3.7.3 Anodic Treatment Contact Marks

Contact areas from anodizing electrodes may show discoloration and impressions. Such discoloration and impressions, due to anodizing contact marks, shall not be cause for rejection if they occur at internal areas and in the tube stop area of the fitting end. Anodizing contact marks occurring on sealing, bearing, or threaded surfaces shall be cause for rejection.

3.7.4 Sealing Surfaces

The surface finish shall be as specified on the part standard drawings and shall retain pressure in testing. There shall be no measurable chatter marks. Sealing surfaces shall not be grit or bead blasted.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

Unless otherwise specified in the contract or purchase order, the supplier is responsible for performing the inspection and test requirements of the Quality Conformance Inspection of 4.5. Except as otherwise specified, the supplier may utilize his own facility or any other laboratory for the performance of the inspection and test requirements. The purchaser reserves the right to perform any of the inspections and tests set forth in this specification, whenever such inspections and tests are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 Inspection Lot

A lot shall consist of finished parts that are identified by one unique part number fabricated from one mill heat of material; or, if an assembly, each component part shall be from one mill heat of material, produced by the same machining operation at approximately the same time in one continuous production run. Splits of one production run into two parallel runs that may be machined at different times constitutes splitting the lot into two distinct lots. Processes such as heat treating, anodic treating and solid lubricant application shall be performed at essentially the same time under the same conditions; processes not meeting the condition shall require the assigning of a distinguishing lot number.

4.2.1 Material Certification

Records of the chemical composition analysis and mechanical property tests showing conformance to the material requirements of this specification shall be available to the procuring activity upon request for each lot of fitting assembly.

4.2.2 Heat Treating Certification

Records of heat treating performed on the materials after purchasing showing conformance to the applicable heat treating specification shall be available to the procuring activity upon request for each lot of fittings.

4.3 Classification of Tests and Inspections

The tests and inspections of the fitting assemblies shall be classified as follows:

a. Qualification inspection (see 4.4)

b. Quality conformance inspection (see 4.5)

c. Periodic control test (see 4.5.3)

4.4 Qualification Inspection

4.4.1 Test Samples

Samples for qualification testing shall have been subjected to all of the applicable requirements of quality conformance inspection (see 4.5).

4.4.2 Fitting Installation and General Testing Practice

4.4.2.1 Thread Lubricant

Threads and sleeve shoulder on tube ends shall be lubricated with hydraulic fluid conforming to AS1241 or MIL-PRF-83282 except no lubricating fluid shall be applied to nuts already coated with solid film lubricant.

4.4.2.2 Plug-in Union Installation

Port ends of Plug-in Unions shall be lubricated per 4.4.2.1 and installed per AS5551, using installation torques per Table 4.

TABLE 4 - PLUG-IN UNION PORT END, INSTALLATION TORQUE

Fitting Assembly Port Size	Installation Torque			
	Minimum		Maximum	
	lbf.in	N.m	lbf.in	N.m
04	60	6.8	100	11.3
06	180	20.3	245	27.7
08	430	48.6	510	57.6
10	600	67.8	680	76.8
12	855	96.6	945	106.8
16	800	90.4	1260	142.4
20	1520	171.7	1680	190.0

4.4.2.3 Fitting assembly shall be connected to 3Al-2.5V Titanium tubing per AS5620. No lubricant allowed on flareless contact sealing surfaces. Tube end shall be bottomed firmly into the test assembly, without side load, to permit the nut to spin freely when hand tightening to the hand-tight position. The nut shall then be tightened per torque values specified in Table 5 using “Double torquing method” as follows:

- Torque to value specified in Table 5.

- Loose the Nut one full turn without disconnecting the assembly.

- Re-torque to value specified in Table 5.

TABLE 5 - TUBE FITTING-NUT ASSEMBLY TORQUE

Fitting Assembly Size	Tube OD size	Wall Thickness		Nut Installation Torque			
				Minimum		Maximum	
		in	mm	lbf.in	N.m	lbf.in	N.m
04	0.250	0.025	0.635	88	9.9	133	15.0
06	0.375	0.030	0.762	177	20.0	221	25.0
08	0.500	0.040	1.016	398	45.0	487	55.0
10	0.625	0.050	1.270	531	60.0	646	73.0
12	0.750	0.059	1.499	707	79.9	867	98.0
16	1.000	0.079	2.007	885	100.0	1080	122.0
20	1.250	0.098	2.489	1017	115.0	1248	141.0

4.4.2.4 Test Fluids

Unless otherwise specified, fluid conforming to AS1241 or MIL-PRF-83282 shall be the test fluid.

4.4.2.5 Test Reporting

For each test required in 4.4, a test report shall be prepared providing the following information as a minimum:

a. The place of testing.

b. The date of testing.

c. The identification of the test technician or engineer responsible for the observing and recording of the measured or observed data.

d. An identification serial number of each test sample with the description of the test samples traceable to design drawings, and revisions, the material and processing records and the production inspection records for the samples.

e. The identification of the test or measuring equipment and the next date of calibration of instruments or measuring equipment used for determination of quantitative data.

f. The ambient temperature of the testing location.

g. The temperature of the test sample or the immediate area around the test sample during testing if other than ambient temperature.

h. The type of fluid used in testing.

i. Actual measured quantitative data shall be recorded. Any revisions or deletions shall be done by crossing out the original data, not erasing it, so that it is still legible. Revisions or deletions should be signed and dated by the person making the changes. Calculated data shall be presented with the formula used for calculation and with the identification of all terms.

j. Photographs of test equipment and examples of tested samples shall be included if applicable.

k. The identification of the agency responsible for the test report with the name or title and address of a point of contact person or persons who can provide technical information or answer questions concerning the testing and the report.

4.5 Quality Conformance Inspection

4.5.1 Sampling

4.5.1.1 Sampling for Nondestructive Tests

Samples for heat treatment, threads, finish, dimensions, marking, surface defects, and workmanship shall be taken at random in accordance with ARP9013, with an Initial Reliability Requirement (I.R.R.) as shown in Tables 6A and 6B, and Acceptance Number zero. A statistical method for product acceptance which provides equivalent or greater quality assurance than this sampling procedure may be used. Example tables are shown in Table 6B. An equivalent and or greater quality assurance than 98% IRR as in APR9013 is 8% LQ under ISO 2859-2.

TABLE 6A - CLASSIFICATION OF DEFECTS

Fitting End - Design Standard		Fitting Assembly	
IRR	Defects[1]	IRR	Defects[1]
98%	Depth, seal diameter to fitting end Finish of seal area (cone and O-ring) Coaxiality, thread to conical seal	98%	Offset, internal burrs Threads
95%	Fluid bore diameter O-ring seal diameter Surface finish Diameters Thread, length, size and form	95%	Lockring dimension Marking Overall length Surface finish, radii, chamfer, color Bore diameter O-ring seal diameter
92%	Remainder	92%	Remainder

[1]Refer to design standards and part standard drawings for explanations of the terms used in this column.

In Place of a 98% IRR under ARP9013, an alternative is an 8% LQ under ISO 2859-2.
In placeof a 95% IRR under ARP9013, an alternative is an 20% LQ under ISO 2859-2.
In Place of a 92% IRR under ARP9013, an alternative is an 32% LQ under ISO 2859-2.

TABLE 6B - SAMPLING INSPECTION, TABLES FOR ISOLATED LOT APPLICATIONS

Initial Reliability Requirement (I.R.R.)	98%
Lot size up to 25	Sample size is All
26-52	25
53-57	26
58-63	27
64-74	28
75-104	29
105-126	30
127-181	31
182-303	32
304-693	33
694 or larger	34

Initial Reliability Requirement (I.R.R.)	95%
Lot size up to 10	Sample size is All
11-22	10
23-33	11
34-80	12
81-4371	13
4372 or larger	14

Initial Reliability Requirement (I.R.R.)	92%
Lot size up to 6	Sample size is All
7-12	6
13-32	7
33 or larger	8

The above tables are useful for product made in moderate to large lots, where the samples are selected with an auditable randomization method and any measurements required are performed with equipment having at least a 4:1 ratio between the tolerance width and the certified measurement accuracy. For product made in smaller lots or where other sampling methods are preferred, the mathematical protection of the sampling method must be published, justified on the basis of recognized statistical principles, and must demonstrably produce equivalent or greater quality assurance.

4.5.2 Examination and Inspection Methods

Using the sampling of 4.5.1, each lot of fitting assemblies shall be examined and inspected as specified in Table 7.

TABLE 7 - QUALITY CONFORMANCE INSPECTION

Examination or Inspection	Requirement Paragraph	Examination or Inspection Paragraph
Material requirements	3.2	4.2.1
Hardness of Steel fittings	3.2.1.2	4.7.1
Design and Dimensions	3.3	4.5.2.1
Finish	3.4	4.5.2.1
Identification of Product	3.5	4.5.2.1
Workmanship	3.7	4.5.2.1

4.5.2.1 Examination of Product

Each lot of fitting assemblies shall be examined to determine conformance with this specification and the applicable standard with respect to material, dimensions, passages, threads, wall thickness, surface defects, finish, marking, and workmanship. MIL-HDBK-1655 defines defects of various fitting assemblies.

4.5.3 Periodic Control Tests

Four sample fitting assemblies of any size shall be selected at random at intervals of sixty days production or after 10 000 parts whichever is greater, and results reported to PRI.

4.5.3.1 Pneumatic Leakage Test

Fitting assemblies shall be tested per 4.6.3.

4.5.3.2 Repeated Assembly Test

Fitting assemblies shall be tested per 4.6.7.

NOTE: Retesting - In the event of leakage or galling, the problem shall be found and corrected. The test shall be repeated using eight specimens.

4.6 Performance Tests

4.6.1 All fitting assemblies shall be visually inspected to determine conformance to this document, with respect to materials, size and workmanship

4.6.1.1 Tube Preparation

Tubes shall be cut square within 0°30’ and all burrs removed from inside and outside of the tube ends. The break or chamfer on either outside diameter or inside diameter shall not exceed 25% of the tube wall thickness.

4.6.2 Proof Pressure Test

All test assemblies, except test assemblies for Tensile Load test, shall be Proof Pressure tested per ISO 10583. Connect test assemblies to a source of pressure with one end free to move. Bleed all air from the system before any pressure is applied. Proof test at 10 160 psi (70 000 kPa), alternate 7620 psi (52 500 kPa) for a minimum period of 3 minutes. The rate of pressure rise shall be 21 700 psi/min (150 000 kPa/min) ± 5400 psi/min (37 200 kPa/min). The test shall be conducted at ambient temperature.

4.6.3 Pneumatic Pressure Test shall be per ISO 10583

Six test assemblies shall be disassembled then solvent cleaned from hydraulic fluid and allowed to air dry. Test assemblies shall be re-assembled using minimum torque on both Port end side (Table 4) and Nut end side (Table 5). Pressurize with nitrogen at 5080 psi (35 000 kPa) for 3 minutes while submerged in water at ambient temperature.

4.6.4 Impulse Test shall be per ISO 10583 and ISO 6772

Six test assemblies shall be subjected to 300 000 impulse cycles at a peak pressure of 7620 psi (525 000 kPa) (150% of operating pressure). The cycle rate shall be 70 cycles per minute ± 5 cycles per minute with each cycle constituting a rise from backpressure per ISO 6772 to peak pressure. The test shall be conducted using AS1241 Phosphate Ester fluid at the following temperature sequence:

a. 150 000 cycles at +200 °F (+93 °C)

b. 72 000 cycles at ambient (room) temperature

c. 3000 cycles at -40 °F (-40 °C)

d. 15 000 cycles at +200 °F (+93 °C)

e. 60 000 cycles at ambient (room) temperature

Additional Fatigue Cycles: Continue the test with any of at least three same test assemblies until failure or completion of 450 000 cycles at a temperature of +230 °F (+110 °C).

4.6.5 Minimum Ultimate Pressure Burst

Test shall be per ISO 10583. Six test assemblies shall be connected to a pressure source of MIL-PRF-83282 hydraulic fluid with one end unrestrained. Caps or tube assemblies may be used at the free end. The test shall be conducted as follows:

a. Two test assemblies shall be from Proof test and tested at 200 °F (93 °C).

b. Two test assemblies shall be from Salt spray test and tested at 200 °F (93 °C).

c. Two test assemblies shall be from Impulse test and tested at room temperature.

Test assemblies shall be subjected to 20 320 psi (140 000 kPa) minimum pressure for 3 minutes at a rate of 21 750 psi (150 000 kPa) per minute ± 5440 psi (37 500 kPa) per minute.

4.6.6 Flexure Test shall be per ISO 10583

Six test assemblies shall be tested for 10 million flexure cycles with a Bending stress level specified in Table 2. During the test a constant internal pressure equal to nominal operating pressure shall be applied.

NOTE: Ports shall be in accordance with AS5551. Before the start of the test (one sample per size), the bending stress shall be incremented 2000 psi five times and the dynamic deflection recorded to achieve proper stress increases without having to disassemble the test assemblies after testing is started. These deflection measurements shall be used for the four test assemblies requiring the increased stress cycle.

Test assemblies shall be assembled using minimum torque on both Port end side (Table 4) and Nut end side (Table 5) and shall be subjected to rotary flexure using the cantilever method. Tubing length and test configuration shall be in accordance with ISO 7257. Two strain gages shall be mounted on the tube 0.188 inch (4.775 mm) from the weld or sleeve tail (at 90 degree angle apart). The test assemblies shall be installed on the flexure test machine and the displacement adjusted to the calculated strain levels of Tension and Compression. The strain shall be measured dynamically while the test assemblies are cycled at the test rate of 1500 to 3500 cycles per minute with no internal pressure applied. The highest of the four strain readings, tension and compression for each strain gage, shall be multiplied by the Modulus of Elasticity of the tubing to calculate the bending stress. The value of the Modulus of Elasticity for titanium tubing is 15 x 10^6 psi (103 421.4 MPa).

The test shall continue with at least three of the test assemblies up to failure or completion of 20 million cycles, increasing the bending stress by 2000 psi (13.8 MPa) every 2 million cycles.

4.6.7 Repeated Assembly Test shall be per ISO 10583

Two test assemblies from the Pneumatic pressure test shall be subjected to eight installation/removal cycles on Nut end Flareless side, and four installation/removal cycle on Port end side. All threaded connections shall be lubricated using MIL-PRF-83282 hydraulic fluid prior to assembly. There shall be none of the following defects:

a. Leakage during the Proof pressure re-test.

b. Inability to reassemble the test assemblies to the interfacing components (coupling nuts, boss manifold) by hand.

4.6.8 Tensile Load Test shall be per ISO 10583

Two test assemblies shall be assembled using minimum torque on both Port end side (Table 4) and Nut end side (Table 5). All threaded connections shall be lubricated using MIL-PRF-83282 hydraulic fluid prior to assembly. The tension load per Table 3 shall be applied at a constant speed of 4.0 mm/min ± 0.3 mm/min until failure occurs.

4.6.9 Thermal Shock Test shall be per ISO 6773

Two test assemblies selected from the Pneumatic test shall be subjected three times to the following test procedures:

4.6.9.1 Hot Test Chamber Testing

The test assemblies shall be mounted inside the environmental chamber, heated to +200 °F (93 °C) and stabilized for a minimum of 2 hours. After stabilization of test assembly, MIL-PRF-83282 hydraulic fluid shall be suddenly introduced into the test assembly at -40 °F (-40 °C). The fluid shall then be pressurized to 10 160 psi (70 000 kPa), alternate 7620 psi (52 500 kPa) Proof pressure within 20 seconds and held for 1 minute. The pressure shall then be released for 1 minute, then pressurized again for 1 minute at 10 160 psi (70 000 kPa), alternate 7620 psi (52 500 kPa) Proof pressure and released. The test assemblies shall be observed during the two pressurization periods to determine any leakage.

4.6.9.2 Cold Test Chamber Testing

The test assemblies shall be mounted inside the environmental chamber, cooled to -40 °F (-40 °C) and stabilized for a minimum of 2 hours. After stabilization of test assembly, MIL-PRF-83282 hydraulic fluid shall be suddenly introduced into the test assembly at +200 °F (93 °C). The fluid shall then be pressurized to 10 160 psi (70 000 kPa), alternate 7620 psi (52 500 kPa) Proof pressure within 20 seconds and held for 1 minute. The pressure shall then be released for 1 minute, then pressurized again for 1 minute at 10 160 psi (70 000 kPa), alternate 7620 psi (52 500 kPa) Proof pressure and released. The test assemblies shall be observed during the two pressurization periods to determine any leakage.

4.6.10 Overtightening Torque Test

Two test assemblies shall be torque tested using 2 times (for sizes 04, 06, and 08) and 1.5 times (for sizes 10, 12, 16, and 20) the maximum B-nut torque values per Table 5 and the Port side installation torque values per Table 4.

The test assemblies shall then be subjected to the Proof test per 3.6.2 and Pneumatic test per 3.6.3.

There shall be none of the following defects:

a. Leakage during the Proof pressure test.

b. Leakage during the Pneumatic test.

All threaded connections shall be lubricated with MIL-PRF-83282 hydraulic fluid prior to assembly.

4.6.11 Electrical Conductivity Test

Two test assemblies set up in accordance with Figure 1 shall be assembled to the minimum Nut end torque as specified in Table 5. The electrical conductivity shall be measured at 4 points as follows:

a. Without Plug: Ohmic resistance shall be measured from Boss to Inner Cone flareless surface.

b. With Plug: Ohmic resistance shall be measured from Boss to Plug.

The electrical conductivity shall be measured using a MilliOhmeter with a direct current of 1 Ampere minimum, accurate to within 1%. A resistance of 10 mΩ maximum is acceptable between the Boss and Test assembly or Plug.

The electrical conductivity shall be tested before and after the Salt Spray test of 28 or 56 days as specified in 3.6.12.

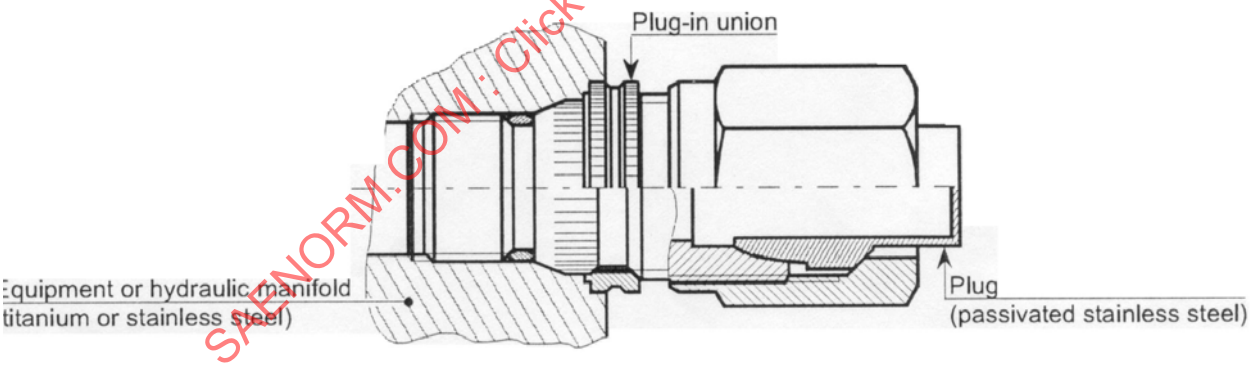

FIGURE 1 - ELECTRICAL CONDUCTIVITY TEST SET-UP

4.6.12 Salt Spray Test shall be per RTCA/DO-160D, Section 14

Two test assemblies shall be able to pass Electrical Conductivity test per 3.6.11 and Burst test per 3.6.5 after being subjected to salt spraying in accordance with procedure in RTCA/DO-160D, para 14.3.6, using apparatus as described in RTCA/DO-160D, para 14.3.

Duration of Salt spraying:

a. 56 days for sizes 04, 06, 08, 10, 12, and 16.

b. 28 days for size 20.

4.6.13 Vibration Test

Test assemblies shall be installed on a test fixture as illustrated in either options of Figures 2, 3, or 4.

Test assemblies shall be filled with MIL-PRF-83282 hydraulic fluid and pressurized to 5080 psi (35 000 kPa) operating pressure. Each test assembly shall be tested using either

a. Standard Vibration test as defined in 4.6.13.1 or

b. Alternate Vibration test as defined in 4.6.13.2.

The Alternate Vibration test may be used only if the test installation has no resonant frequencies below 40 Hz. Resonance frequencies are defined as response peaks that are greater than twice the input acceleration amplitude.

After exposure to the vibration test, the plug-in union fitting shall be inspected and shall show no evidence of structural failure. The presence of a detectable crack constitutes a vibration test failure. There shall be no leakage of hydraulic fluid at plug-in union fitting interface.

4.6.13.1 Standard Vibration Test

Test shall use AS5620 tube and tube lengths are per Table 8. Two test assemblies shall be vibration tested according to RTCA/DO-160E, Section 8, categories R and H for Fixed-Wing aircraft, using the Robust sinusoidal test procedure except as follows:

a. Performance testing is not applicable.

b. Two test assemblies of each size shall be tested using modified curve W as specified in Figure 5 and curve P as defined in RTCA/DO-160E.

c. If the test assemblies are axisymmetric, testing needs to be performed in only one axis perpendicular to the tube centerline.

Test assemblies shall be installed in a test fixture as illustrated in Figures 2, 3, or 4.

Each test shall be performed with a section of straight tube connected to the test assembly. Test assemblies shall be assembled using minimum torque on both the Port end side (Table 4) and on the Nut end side (Table 5). The outer end of the tube shall be clamped to the test bench and plugged. Clamping material shall be 0.500 inch (12.700 mm) aluminum plate. Accelerometer shall be mounted at the middle of the tube assembly.

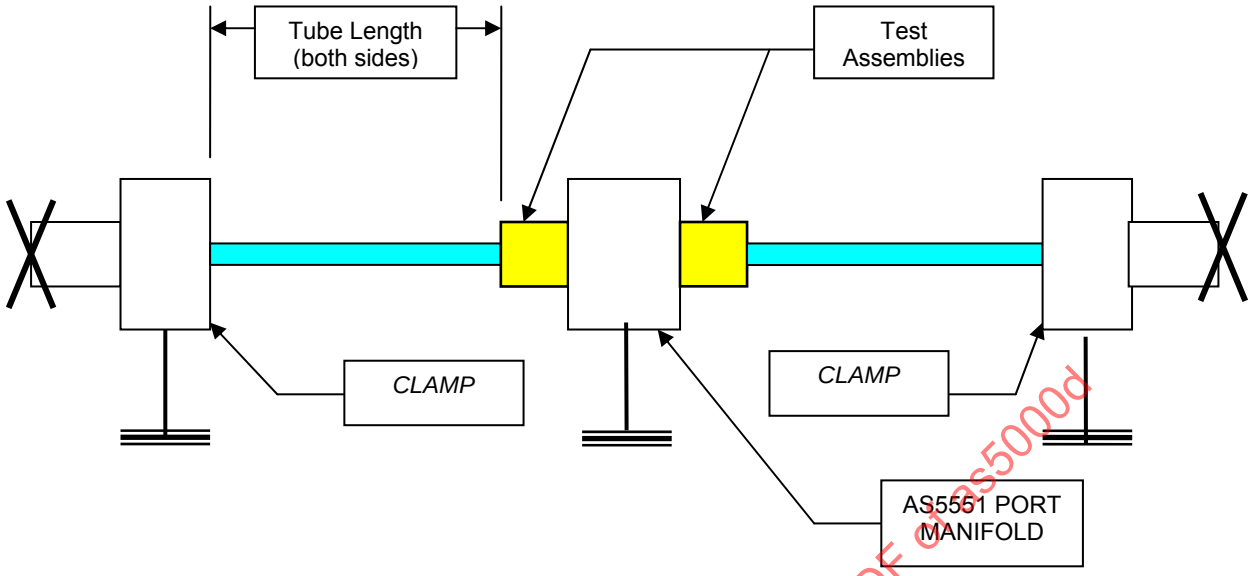

FIGURE 2 - VIBRATION TEST SET-UP, OPTION I

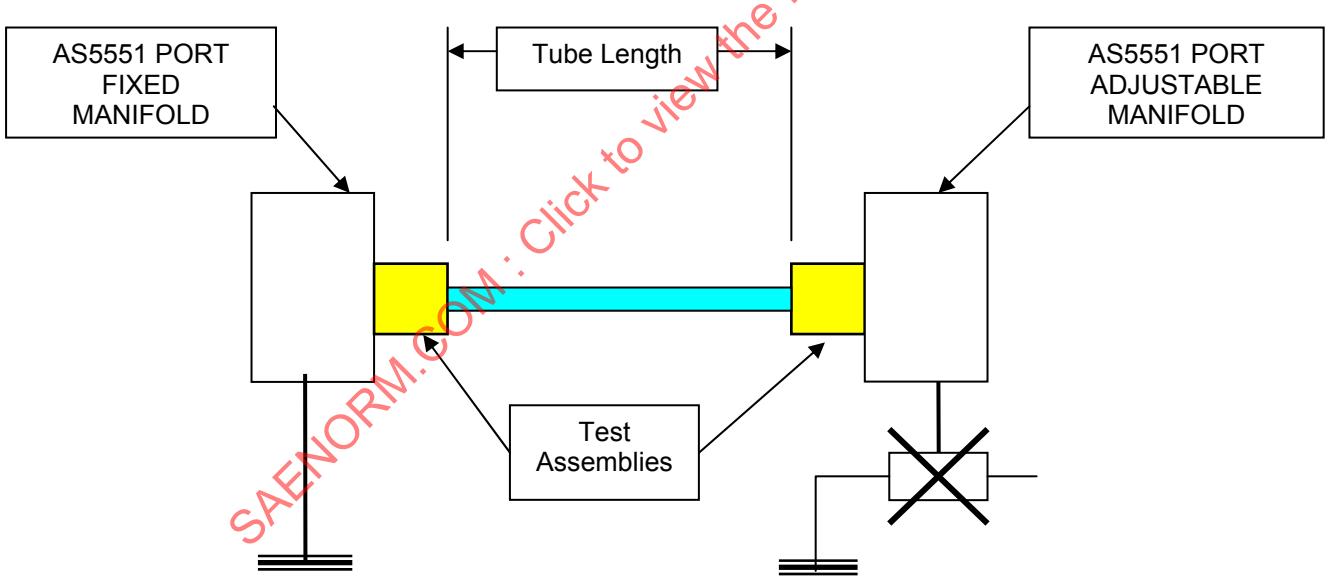

FIGURE 3 - VIBRATION TEST SET-UP, OPTION II

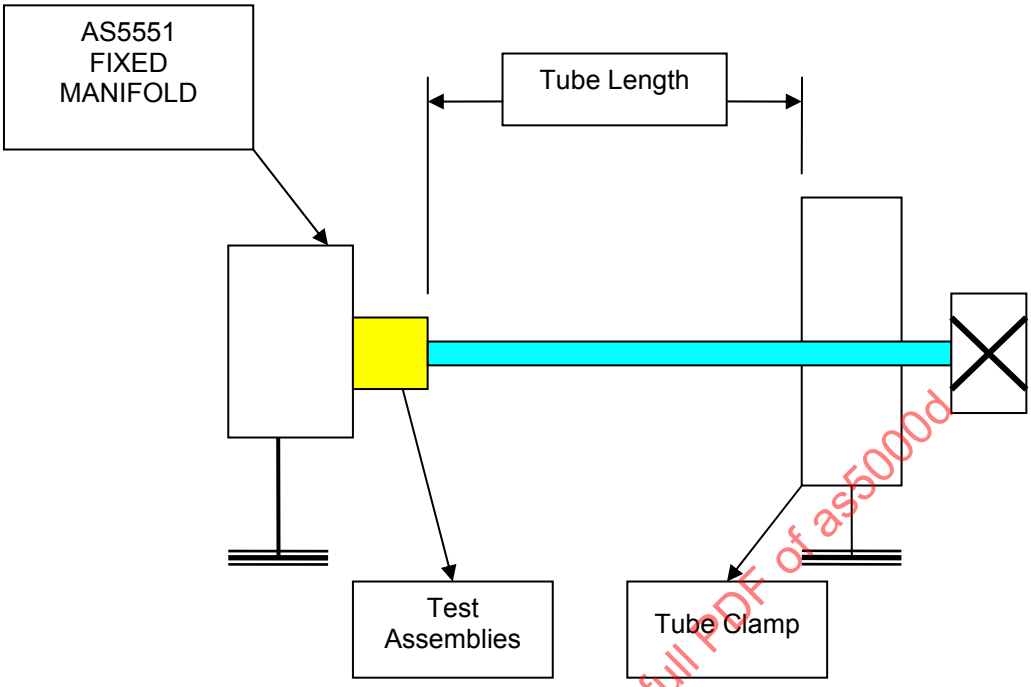

FIGURE 4 - VIBRATION TEST SET-UP, OPTION III

For all three options,  symbol means a connection to the test bench vibrating plate.

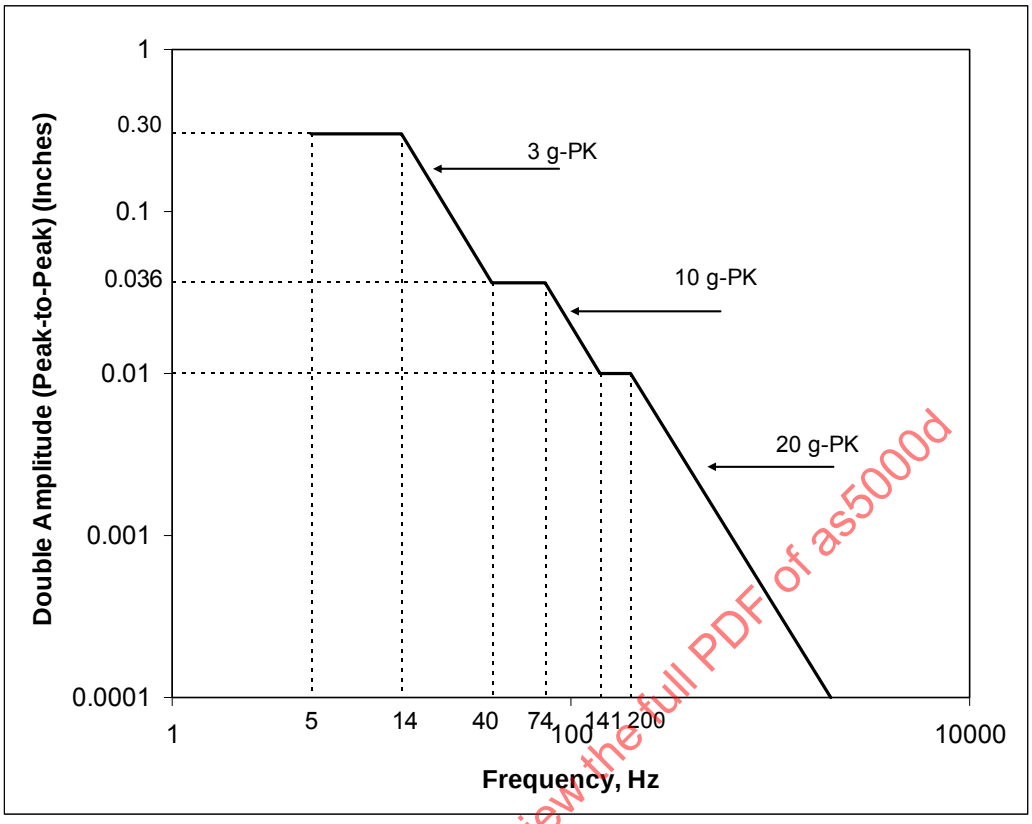

FIGURE 5 - MODIFIED CURVE W

4.6.13.2 Alternate Vibration Test

Six Test assemblies shall be tested to requirements for Normal Flight Conditions. Tests shall use MIL-PRF-83282 hydraulic fluid and AS5620 tube, with tube lengths per Table 8:

TABLE 8 - TUBE LENGTH - ALTERNATE VIBRATION TEST

Fitting Size	Length (inch)	Length (mm)
04	14.12	358.6
06	17.32	440.0
08	19.68	500.0
10	22.05	560.1
12	24.41	620.0
16	27.95	710.0
20	31.50	800.1

Test assemblies shall be installed in a test fixture as illustrated in Figures 2 (Option I), 3 (Option II), or 4 (Option III).

Each test shall be performed with a section of straight tube connected to the test assembly. Test assemblies shall be assembled using minimum torque on both Port end side (Table 4) and Nut end side (Table 5).The outer end of the tube shall be clamped to the test bench and plugged. Accelerometer shall be mounted at the middle of the tube assembly.

4.6.13.2.1 Normal Flight Conditions

Six Test assemblies shall be tested in accordance with ISO 7137, Test procedure 2.2 or RTCA/DO-160D, Section 8 with a vibration level depending on the aircraft area concerned, category T curves:

- Two assemblies with curves E, E1, P (all sizes);

- Two assemblies with curves D, D1, P (sizes given below);

- Two assemblies with curve P, W (sizes given below).

Test procedure used shall be "Robust vibration test procedure-fixed-wing aircraft".

Series to be performed are as follows:

- E, E1, and P: for wing and wheel well noted S1

- D, D1, and P: for nacelle and pylon noted S2

- W and P: for landing gear, engine and gear box noted S3

All curves in a given category must be performed. Test series shall be performed according to Table 9.

TABLE 9 - VIBRATION TEST SERIES

Fitting Size	Test Series
04	S1 and S3
06	S1 and S3
08	S1 and S3
10	S1 and S3
12	S1 and S3
16	S1, S2 and S3
20	S1

NOTE: A test reduction can be achieved by running tests according to the following series:

S4: (E U D), (E1 U D1) and P: This series would be valid for series S1 and S2. Or

S5: (E U D), (E1 U D1), P and W to comply with S1, S2, and S3 series to cover all areas. This would be more demanding for the test assemblies, but would allow to run the testing with only two test assemblies following four curves rather than three sets of two samples following three, three, and two curves.

Where (E U D) and (E1 U D1) are defined as follow:

NOTE: The two illustrations (Figures 6 and 7) below are for explanatory purpose only. For accurate values, refer to ISO 7137, Test procedure 2.2 or RTCA/DO-160D.