

AEROSPACE STANDARD

SAE AS5000

Issued 2006-03

Fitting, Plug-in Union, Ring Locked, 24° Cone, Fluid Connection, 5080 psi,
Specification for

RATIONALE

This specification covers requirements for qualification testing and procurement of flareless port fittings for 5000 psi hydraulic components.

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1. SCOPE:

This SAE Aerospace Standard (AS) establishes the requirements for 24° 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 maximum and operating temperature range of -65 to +275 °F.

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, 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 2486	Conversion Coating of Titanium Alloys Fluoride-Phosphate Type
AMS 2488	Anodic Treatment, Titanium and Titanium Alloys, Solution pH 13 or Higher
AMS 2700	Passivation of Corrosion Resistant Steels
AMS 4928	Titanium Alloys, Bars, Wire, Forgings, and Rings, 6Al-4V, Annealed
AMS 4965	Titanium Alloys, Bars, Wire, Forgings and Rings, 6Al-4V, Solution Heat Treated and Aged

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AMS 4967	Titanium Alloys, Bars, Wire, Forgings and Rings, 6Al-4V, Annealed, Heat Treatable
AMS 5731	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 Solution Heat Treated
AMS 5732	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 Solution and Precipitation Heat Treated
AMS 5734	Steel, Corrosion-Resistant, Bars, Wire, Forgings, and Tubing, 15Cr - 25.5Ni - 1.2Mo - 2.1Ti - 0.006B - 0.30V, Consumable Electrode Melted, 1650 °F Solution Heat Treated
AMS 5737	Steel, Corrosion-Resistant, Bars, Wire, Forgings, and Tubing, 15Cr - 25.5Ni - 1.2Mo - 2.1Ti - 0.006B - 0.30V, Consumable Electrode Melted, 1650 °F, Solution and Precipitation Heat Treated
AS478	Identification Marking Methods
AS603	Impulse Testing of Hydraulic Hose Tubing and Fittings 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 Lube, 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° Cone Flareless per AS5827, 5080 psi, Port Connection - Port preparation, Installation and Removal of AS5550 and AS5865

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- | | |
|--------|---|
| AS5620 | Titanium Hydraulic Tubing, Ti-3Al-2.5V Cold Worked and Stress Relieved, Up to 35,000 kPa (5080 psi) and 200 °C (400 °F) |
| AS5827 | Fitting End, Flareless, Extra Fine Thread, 5080 psi, Design Standard |
| AS5865 | Fitting Reducer Assembly, Ring locked, Adapter, Flareless to Port, Extra Fine Threads, 5080 psi |
| AS5975 | Axially Swaged Fitting, Wired-on Nut |
| AS7003 | National Aerospace and Defense Contractors Accreditation Program (NADCAP) Program Requirements |
| AS7112 | National Aerospace and Defense Contractors Accreditation Program Requirements for Fluid System Components |
- 2.1.2 U.S. Government Publications: Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch/>
- | | |
|---------------|---|
| 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 ANSI Publications: Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org
- | | |
|----------------|---|
| ANSI/ASQC 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, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org
- | | |
|------------|---------------------------------------|
| ASTM A 370 | Steel Products, Mechanical Testing of |
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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 Thornhill 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 Radio Technical Commission for Aeronautics Inc., 1828 L Street, NW, Suite 805, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org

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

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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 AMS 4928, AMS 4965 or AMS 4967
CRES A-286 per AMS 5731, AMS 5732, AMS 5734 or AMS 5737

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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. It shall be possible to pass through the fluid passage a ball whose diameter is 0.015 inch 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.

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

3.4 Finish:

3.4.1 Titanium Alloy Fittings: Titanium alloy fitting assemblies shall be anodic treated per AMS 2488 or fluoride phosphate coated per AMS 2486, 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 AMS 2700, and PTFE coating with white color for 5080 psi identification purpose.

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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
- b. Fluid: -65 to +275 °F

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3.6.1.2 Hydraulic Pressures:

- a. Operating pressure: 5080 psi.
- b. Proof pressure: 10,160 psi, alternate 7620 psi as specified by user.
- c. Burst pressure: 20,320 psi

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 (psi) (0% to 10%)
04	20,000
06	19,000
08	18,000
10	17,000
12	16,000
16	15,000
20	14,000

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- 3.6.7 Repeated Assembly: The test assembly shall withstand 8 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 (lbf) Type 1 - Standard	Tensile Load (lbf) Type 2 - Alternate
04	1400	997
06	2700	2244
08	4800	3990
10	7500	6234
12	10,500	8977
16	18,600	15,959
20	29,200	24,936

- 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 fitting assembly shall withstand vibration testing in accordance with 4.6.13 without leakage and shall not show evidence of structural failure of the Test assembly. The presence of detectable crack constitutes a vibration test failure.
- 3.6.14 Fire: The fitting assembly shall withstand a 2000 °F 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.

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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.

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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.

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TABLE 4 - Plug-in Union Port End, Installation Torque

Fitting Assembly Port Size	Installation Torque (lbf.in)	
	Min.	Max
04	60	100
06	180	245
08	430	510
10	600	680
12	855	945
16	800	1260
20	1520	1680

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 in	Nut Installation Torque (lbf.in)	
			Min	Max
04	.250	.025	88	133
06	.375	.030	177	221
08	.500	.040	398	487
10	.625	.050	531	646
12	.750	.059	707	867
16	1.000	.079	885	1080
20	1.250	.098	1017	1248

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.

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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 ANSI/ASQC Z1.4, Single Sampling Plan, Inspection Level II with an AQL as shown in Table 6 and Acceptance Number zero. A statistical method for product acceptance which provides equivalent or greater quality assurance than this sampling procedure may be used.

TABLE 6 - Classification of Defects

Fitting End - Design Standard		Fitting Assembly	
Class	Defects ¹	Class	Defects ¹
Major 1.5%	Depth, seal diameter to fitting end Finish of seal area (cone and O-ring) Coaxiality, thread to conical seal	Major 1.5%	Offset, internal burrs
Minor A 4.0%	Fluid bore diameter O-ring seal diameter Surface finish Diameters Thread, length, size and form	Minor A 4.0%	Threads Lockring dimension Marking Overall length Surface finish, radii, chamfer, color Bore diameter O-ring seal diameter
Minor B 6.5%	Remainder	Minor B 6.5%	Remainder
¹ Refer to design standards and part standard drawings for explanations of the terms used in this column.			
Classes of Defects, Defect Characteristics, and AQLs			
Class	Classification	AQL	
Major	Likely to result in failure or to reduce materially the usability of the unit of product for its intended purpose	1.5%	
Minor A	May have a slight effect on usability	4.0%	
Minor B	Has essentially no effect on usability	6.5%	

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- 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, alternate 7620 psi for a minimum period of 3 minutes. The rate of pressure rise shall be 21,700 psi/min $\pm$ 5400 psi/min. The test shall be conducted at ambient temperature.

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- 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 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 (150% of operating pressure). The cycle rate shall be 70 cycles per minute $\pm$ 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
 - b. 72,000 cycles at ambient (room) temperature
 - c. 3000 cycles at -40 °F
 - d. 15,000 cycles at +200 °F
 - e. 60,000 cycles at ambient (room) temperature

Additional Fatigue Cycles: Continue the test with any of four same test assemblies until failure or completion of 450,000 cycles at a temperature of +230 °F.

- 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.
 - b. Two test assemblies shall be from Salt spray test and tested at 200 °F.
 - c. Two test assemblies shall be from Impulse test and tested at room temperature.

Test assemblies shall be subjected to 20,320 psi minimum pressure for 3 minutes at a rate of 21,750 psi per minute $\pm$ 5440 psi per minute.

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- 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 from the weld or sleeve tail (at 90° 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 15×10^6 psi.

The test shall continue with four of the test assemblies up to failure or completion of 20 million cycles, increasing the bending stress by 2,000 psi every two 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 millimeter/minute $\pm$ 0.3 millimeter/minute until failure occurs.

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4.6.9 Thermal Shock Test shall be per ISO 6773: Two test assemblies selected from the Pneumatic test shall be subjected 3 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 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. The fluid shall then be pressurized to 10,160 psi, alternate 7620 psi 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, alternate 7620 psi 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 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. The fluid shall then be pressurized to 10,160 psi, alternate 7,620 psi 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, alternate 7620 psi 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.

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The electrical conductivity shall be measured using a MilliOhmmeter 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.

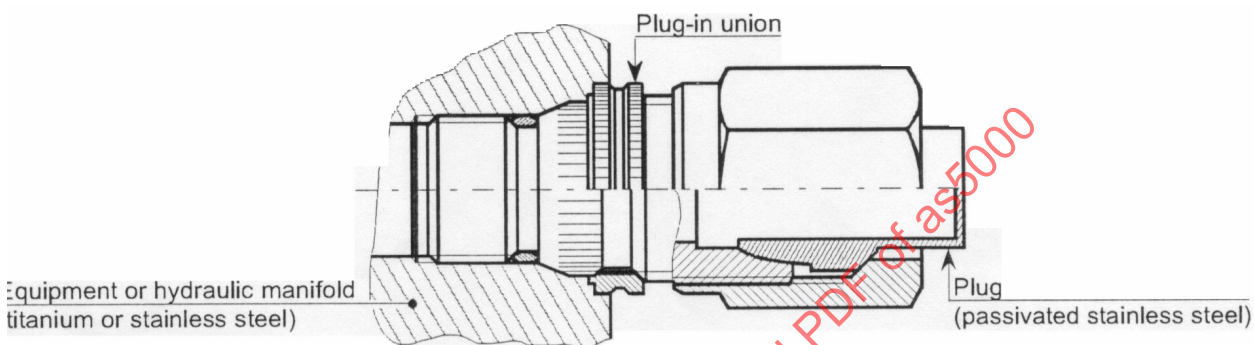


FIGURE 1 - Electrical Conductivity Test Set-up

- 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 Figure 2.1 or Figure 2.2 or Figure 2.3.

Test assemblies shall be filled with MIL-PRF-83282 hydraulic fluid and pressurized to 5080 psi 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 test assemblies shall be inspected and shall show no evidence of structural failure of the tube or fitting. The presence of a detectable crack constitutes a vibration test failure. There shall be no leakage of hydraulic fluid.

4.6.13.1 Standard Vibration Test: Test shall use AS5620 tube and tube lengths are per Table 8. Eight 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 3 and curve P as defined in RTCA/DO-160E.
- c. If the test assemblies are axisymmetric, testing needs to be performed in only 1 axis perpendicular to the tube centerline.

Test assemblies shall be installed in a test fixture as illustrated in Figures 2.1, 2.2 or 2.3.

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 aluminum plate. Accelerometer shall be mounted at the middle of the tube assembly.

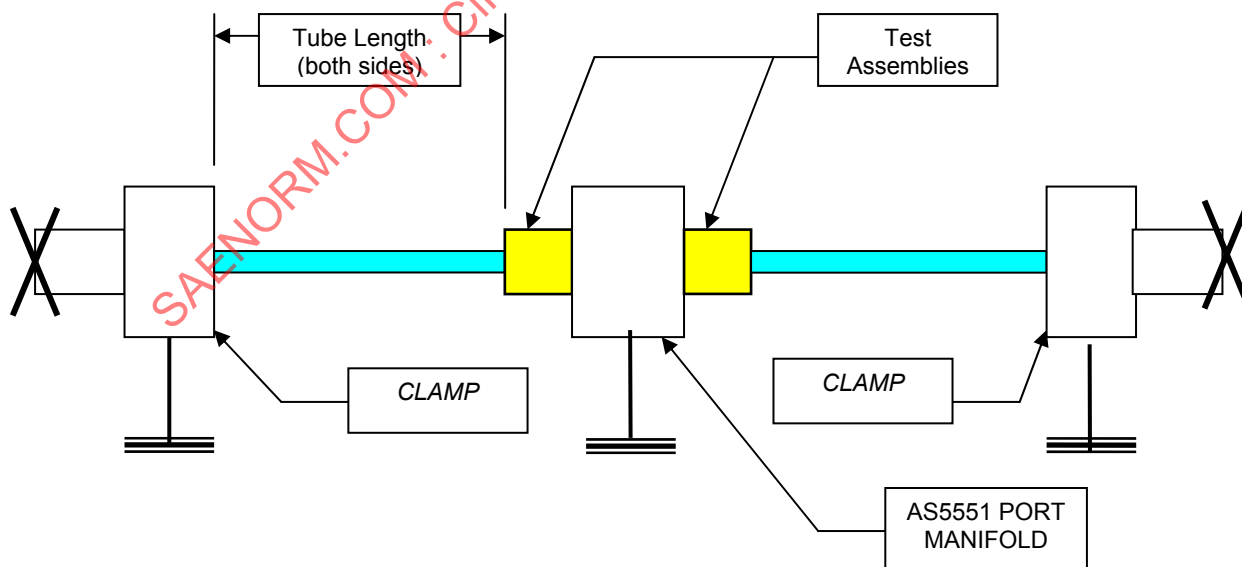


FIGURE 2.1 - Vibration Test Set-up, Option I

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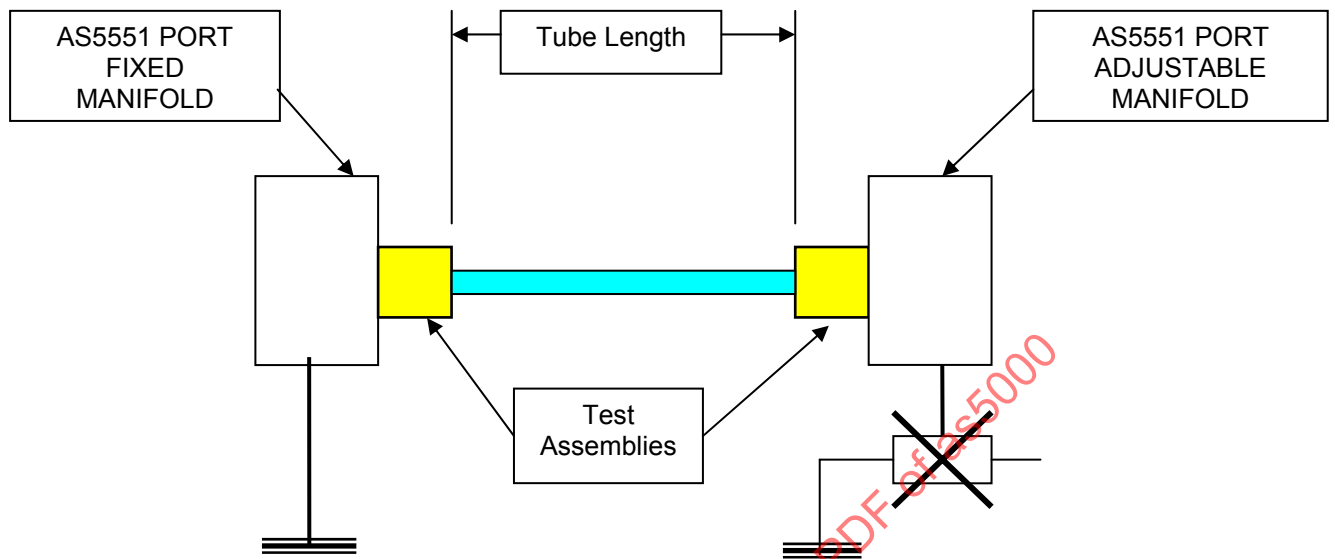


FIGURE 2.2 - Vibration Test Set-up, Option II

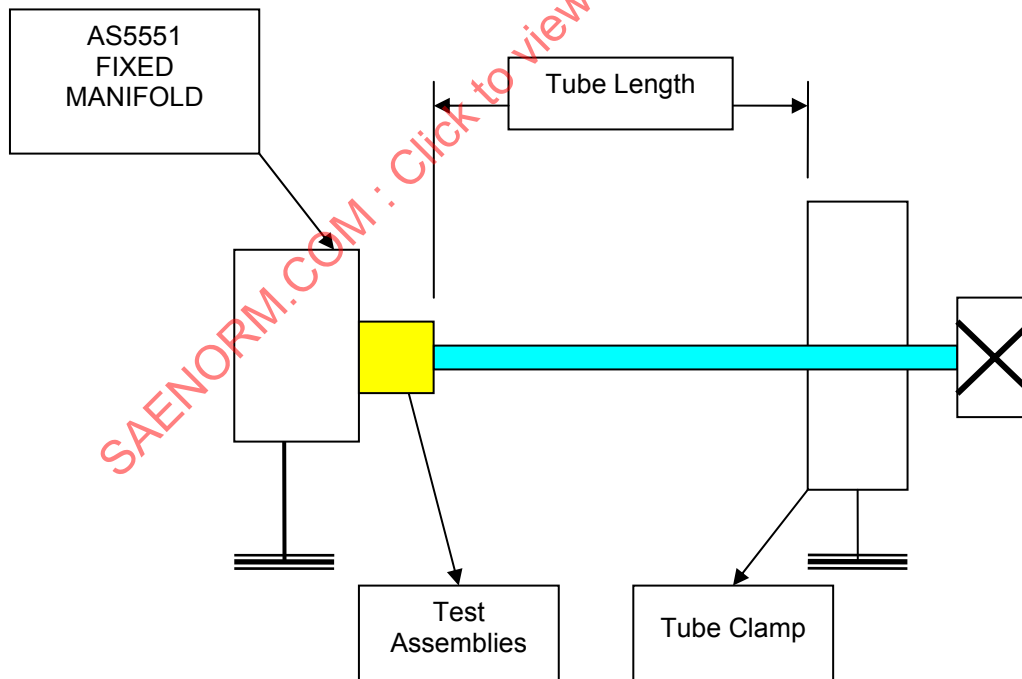


FIGURE 2.3 - Vibration Test Set-up, Option III

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

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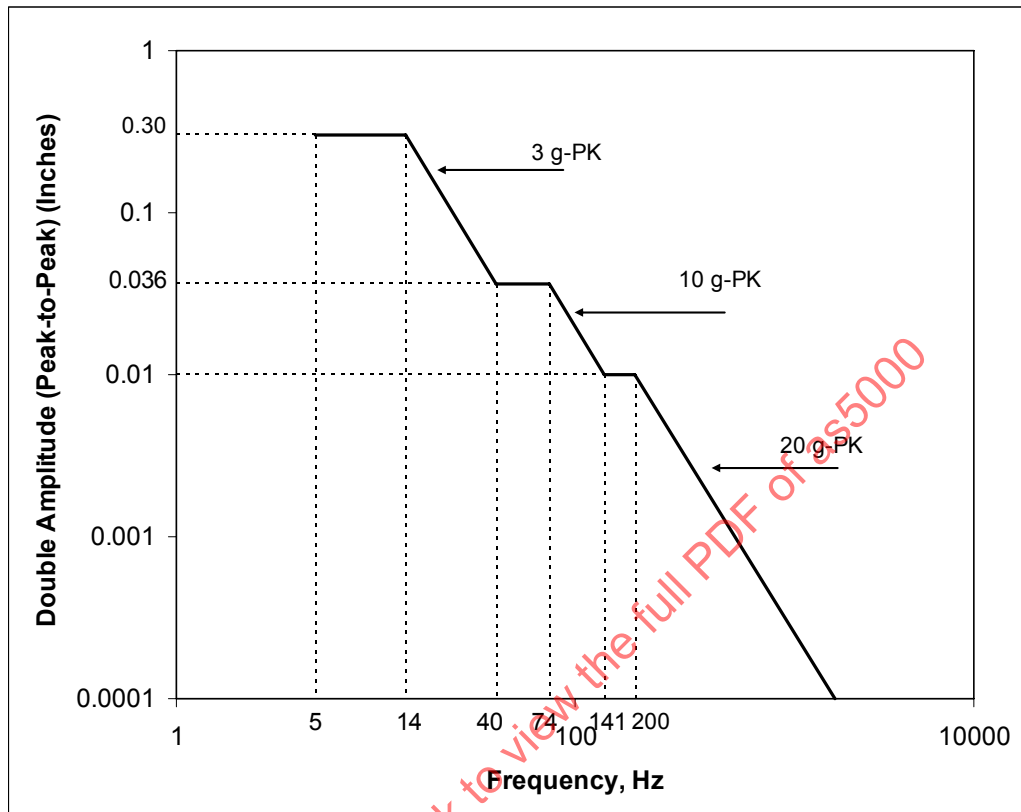


FIGURE 3 - Modified Curve W

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	360
06	17.32	440
08	19.68	500
10	22.05	560
12	24.41	620
16	27.95	710
20	31.50	800

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Test assemblies shall be installed in a test fixture as illustrated in Figures 2.1 (Option I), 2.2 (Option II), or 2.3 (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 (Figure 4 and Figure 5) below are for explanatory purpose only. For accurate values, refer to ISO 7137, Test procedure 2.2 or RTCA/DO-160D.

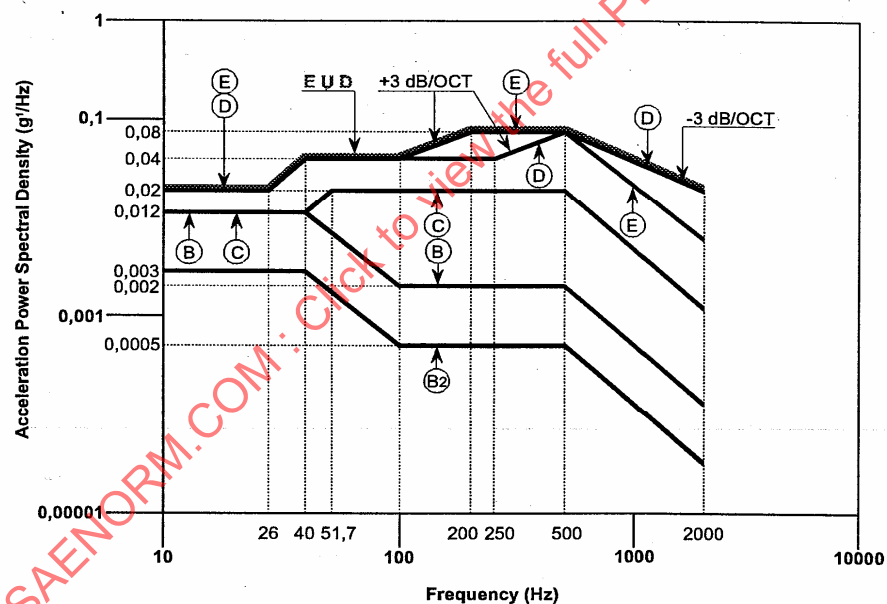


FIGURE 4 - Vibration Test Reduction Curves - E U D

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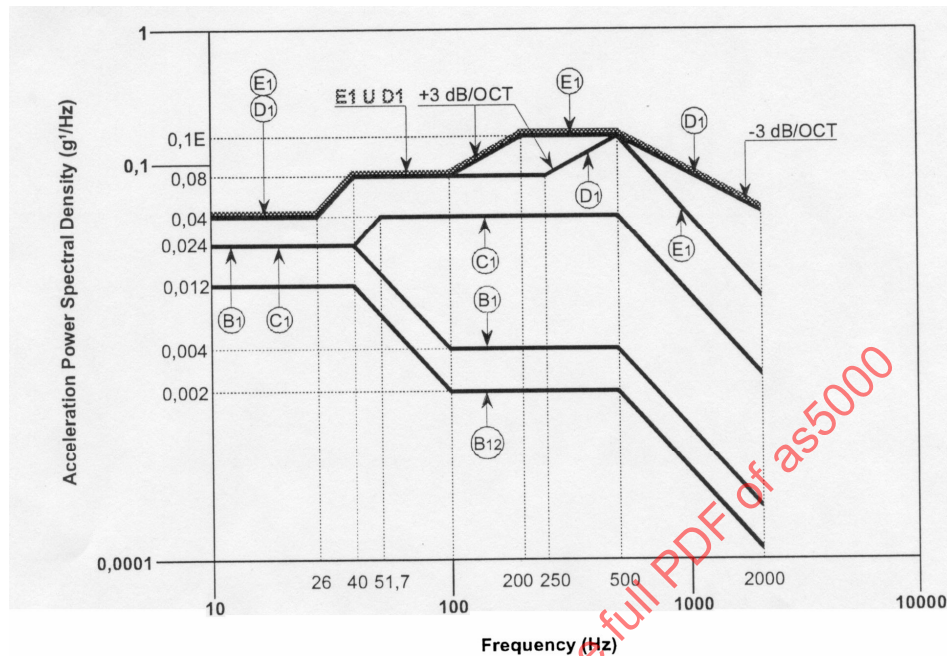


FIGURE 5 - Vibration Test Reduction Curves - E1 U D1

- 4.6.14 Fire Test: Three Test assemblies shall be tested for 15 minutes fire proof or alternate 5 minutes fire resistant in accordance with AS1055, alternate ISO 2685. Tested pressure shall be 5080 psi operating pressure and with a flow rate of 0.13 gallon per minute for fire proof rating ($1 \times ID^2$) or to 0.71 gallon per minute for fire resistant rating ($5 \times ID^2$). The entire Test assembly plus a length of tubing shall be subjected to the flame.
- 4.6.15 System Pressure Test: Ten Test assemblies shall be pressurized with MIL-PRF-83282 hydraulic fluid for 24 hours at 50 to 60 psi, then 24 hours at 5080 psi operating pressure with no visually detectable escape of fluid from the Test assembly or the tube fitting interface. Test assemblies shall be taken from Impulse, Flexure and Vibration tests.
- 4.6.16 Stress Corrosion test shall be per ISO 10583: Two test assemblies shall be subjected to the stress corrosion test. Install the Test assembly in a test apparatus which imposes a bending stress level equal to $85\% \pm 5\%$ of the specified tubing yield strength (0.2% proof stress) minimum at the tubing/fitting interface. Apply 5080 psi operating pressure without removing the bending stress and subject the assembly to Salt spray test per 3.6.12. After salt spray exposure, subject the Test assemblies to Burst test per 3.6.5 at ambient (room) temperature. The Test assemblies shall then be sectioned and the tube/fitting joint metallurgically examined for intergranular or stress corrosion cracking.