SAE Aerospace
An SAE International Group

AEROSPACE STANDARD

SAE AS5958

Issued 2006-01

Fittings, Axially Swaged Tube with Flareless Separable, Fluid System
5080 psi (35,000 kPa),
Specification for

RATIONALE

This specification was prepared to provide the performance requirements for axially swaged, field attachable, 5080 psi, tube fittings.

1. SCOPE:

1.1 Scope:

This SAE Aerospace Standard (AS) establishes the requirements for externally swaged titanium tube fittings on titanium tubing with flareless separable fitting for use in hydraulic supply and return aerospace fluid systems up to operating pressure of 5080 psig (35,000 kPa) maximum and an operating temperature range of -65 to +275 °F (-54 to +135 °C).

2. 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.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
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SAE WEB ADDRESS: **http://www.sae.org**

2.1 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 2700	Passivation of Corrosion Resistant Steels
AMS 4928	Titanium Alloy Bars, Wire, Forgings, Rings and Drawn Shapes 6Al - 4V - Annealed
AMS 4945	Titanium Alloy Tubing, Seamless, Hydraulic 3Al - 2.5V, Controlled Contractile Strain Ratio Cold Worked, Stress Relieved
AMS 4946	Titanium Alloy Tubing, Seamless, Hydraulic, 3Al -2.5V, Texture Controlled, Cold Worked, Stress Relieved
AMS 4965	Titanium Alloy, Bars, Wire, Forgings, and Rings 6.0Al - 4.0V Solution Heat Treated and Aged
AMS 5637	Steel, Corrosion Resistant, Bars and Wire 18Cr - 9.0Ni (SAE 30302) Solution Heat Treated and Cold Drawn 125 ksi (862 MPa) Tensile Strength
AMS 5685	Steel, Corrosion Resistant, Safety Wire, 18Cr - 11.5Ni, 305 Wire, Solution Heat Treated, Cold Finished
AS478	Identification Marking Methods
AS603	Impulse Testing of Hydraulic Tubing Joints and Fittings
AS1055	Fire Testing of Flexible Hose, Tube Assemblies, Coils, Fittings, and Similar System Components
ARP1185	Flexure Testing of Hydraulic Tubing Joints and Fittings
AS1241	Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft
AS1376	Wrench Pads for Fluid Fittings Machined from Alternate Shapes of Material
ARP4784	Performance and Evaluation Criteria, Surface Defects, Requirements
ARP5412	Aircraft Lightning Enviroment and Related Test Wave Forms

AS5620	Titanium Hydraulic Tubing, T-3Al-2.5V CWSR, Up to 35,000 kPa (5080 psi) Requirements for Qualification Testing and Control
AS5827	Fitting End, Flareless, Extra Fine Thread, Design Standard
AS5959	Axially Swaged Fittings, Intallation and Inspection Procedure
AS5974	Fitting Assembly, Adapter, Straight, Female Flareless, Axially Swaged, Hydraulic, 5080 psi
AS5975	Fitting Assembly, Adapter, Straight, Male Flareless, Axially Swaged, Hydraulic, 5080 psi
AS7003	National Aerospace and Defense Contractors Accreditation Program (NADCAP)
AS7112	National Aerospace and Defense Contractors Accreditation Program Requirements for Fluid System Components

2.2 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/

MIL-DTL-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-DTL-83133	Turbine Fuels, Aviation, Kerosene Types, NATO F-34 (JP-8), NATO F-35, and JP-8 + 100
MIL-PRF-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordnance (Inactive for New Design as of 29 March 1996)
MIL-PRF-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base
MIL-PRF-87257	Hydraulic Fluid, Fire Resistant; Low Temperature, Synthetic Hydrocarbon Base, Aircraft and Missile

2.3 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 B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)

2.4 ASTM Publications:

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

ASTM A 580	Standard Specification for Stainless Steel Wire
ASTM E 8	Tension Testing for Metallic Materials

2.5 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

2.6 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

2.7 AECMA Publications:

Available from European Assoc. of Aerospace Ind., Gulledelle 94, B-1200 Brussels, Belgium.

prEN 6123	Aerospace Series Fitting End, 24° Internal Cone, External Thread, Flareless Type, Extra Fine Thread Pitch, Dimension Inch Series

2.8 ISO Publications:

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org

ISO 7137	Enviormental Conditions and Test Procedures For Airborne Equipment

3. TECHNICAL REQUIREMENTS:

3.1 Qualification:

Fittings supplied in accordance with this document shall be representative of products which have been subjected to and which have successfully passed the qualification tests specified in this standard.

3.1.1 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, and shall be listed in a Performance Review Institute (PRI) qualified Manufacturers List (QML).

3.1.2 Product Qualification: 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 a Performance Review Institute (PRI) Qualified Parts List (QPL).

3.2 Materials:

The fitting materials shall be uniform in quality, free from defects, consistant with good manufacturing practices and shall conform to the applicable specifications and the requirements specified herein.

3.2.1 Bars and Forgings:

AMS 4928	Titanium Alloy Bars, Wire, Forgings, Rings and Drawn Shapes 6Al - 4V - Annealed
AMS 4965	Titanium Alloy, Bars, Wire, Forgings, and Rings 6.0Al - 4.0V Solution Heat Treated and Aged

3.2.2 Wire:

AMS 5637	Steel, Corrosion Resistant, Bars and Wire 18Cr - 9.0Ni (SAE 30302) Solution Heat Treated and Cold Drawn 125 ksi (862 MPa) Tensile Strength
AMS 5685	Steel, Corrosion Resistant, Safety Wire, 18Cr - 11.5Ni, 305 Wire, Solution Heat Treated, Cold Finished
ASTM A 580	Steel, Corrosion Resistant, Wire, 302 or 305 Condition A

3.2.3 Reinforcement:

Composite — A high strength carbon fiber/epoxy resin composite may be used as a reinforcement over the ring.

3.2.4 Tube Requirements:

Titanium tubing shall be in accordance with AS5620 and shall meet the requirements of AMS 4946 and/or AMS 4945.

3.3 Design and dimensions shall be such that fittings will meet all requirements of this specification and the associated aerospace standard part drawings.

3.4 Fabrication:

3.4.1 Fluid Passages:

3.4.1.1 Drill Offset: In the run, tees where the fluid passage is bored from each end, the offset between the bores at the meeting point shall not exceed 0.015 in. A sphere with a 0.020 smaller diameter shall be capable of traversing the bore intersection. The cross sectional area of the bore junction of angle fittings shall not be less than the cross-sectional area of the smaller passage. The mismatch in straight couplings shall be controlled such that a maximum OD tube (nominal +0.003) will pass through the entire fitting.

3.4.2 Finish:

3.4.2.1 Titanium: No requirement

CRES: Passivation per AMS 2700

3.4.2.2 Coating Color: The outer ring surface shall be partially or completely colored blue with a pigmented polytetrafluoroethylene (PTFE) or fluid resistant paint to indicate a maximum of 5080 psi (35,000 kPa) operating pressure.

3.4.2.3 Dry Lube: The fitting may be dry lubed to facilitate the fitting assembly process.

3.5 Identification of Product:

All parts shall be identified in accordance with the instructions specified in 3.5.1 and 3.5.2.

3.5.1 AS Standard Symbol and Manufacturer's Trademark: Unless otherwise specified, all fittings shall be marked with the letters "AS" or AS part number," if space permits, the manufacturer's identification or trademark, manufacturer's part number and 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.

3.6 Performance:

Fittings and tubing when attached per AS5959 or fitting manufacturer's authorized procedures shall meet the following performance requirements:

3.6.1 Environmental Conditions: Permanent and separable fittings shall meet the performance in accordance with this specification when subjected to the natural and induced environments specified herein.

3.6.1.1 Pressures:

a. Supply in accordance with Table 1A

b. Return in accordance with Table 1B

3.6.1.2 Temperature:

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

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

TABLE 1A - Supply Pressures

Operating Pressure (Min.)	Proof Pressure (Min.)	Burst Pressure (Min.)
5080 psi (35,000 kPa)	10,160 psi (70,000 kPa)	20,320 psi (140,000 kPa)

TABLE 1B - Return Pressures

Dash Size	Tube Size (in)	Operating Pressure Minimum (psi)	Proof Pressure Minimum (psi)	Burst Pressure Minimum (psi)
04	0.250	3000	6000	12000
06	0.375	3000	6000	12000
08	0.500	2000	4000	8000
10	0.625	2000	4000	8000
12	0.750	1500	3000	6000
16	1.000	1500	3000	6000

3.6.2 Proof Pressure: Test assemblies shall withstand pressure equal to two times the design operating pressure for 5 min without visually detectable escape of fluid from the fitting assembly or the tube fitting interface or evidence of permanent deformation when tested in accordance with 4.6.2.

3.6.3 Gaseous Leakage: Test assemblies shall be capable of containment of nitrogen gas without evidence of gas bubbles appearing at the tube/fitting interface, when tested in accordance with 4.6.3. No bubbles shall appear after 1 minute at pressure.

3.6.4 Impulse: Fittings shall pass 300,000 impulse cycles without leakage or other failure, when tested in accordance with 4.6.4.

3.6.5 Burst Pressure: Burst pressure shall be as specified in Table 1A and 1B. The fittings shall withstand burst pressure without leakage, slippage, or other failure when tested in accordance with 4.6.5.

3.6.6 Flexural Strength: Fittings shall withstand 10,000,000 cycles of flexure at the stress levels specified in Table 2A and 2B, when tested in accordance with 4.6.6 without leakage or other failure.

3.6.7 Re-Use (Separable Only): The separable fitting shall be capable of eight reuses, when tested in accordance with 4.6.7.

3.6.8 Joint Strength: Test assemblies shall withstand, without separation, a tensile load as specified in Table 3, when tested in accordance with 4.6.8.

3.6.9 Thermal Shock: The fitting assembly shall withstand the temperature and pressure, when tested in accordance with 4.6.9 without leakage, evidence of permanent deformation, or other malfunction that shall affect assembly or disassembly of the fitting.

3.6.10 Overtightening Torque (Separable only): The fittings shall pass a proof and gaseous leakage test after being subjected to two times the maximum torque for size -04 through -08 and 1.5 times the maximum torques for sizes -10 through -16 to the values specified in Table 4, when tested in accordance with 4.6.10.

3.6.11 Fitting Conductivity: The fitting shall be conductive. The maximum resistance shall be 10 mΩ between the two tubes connected to the fitting, when tested in accordance with 4.6.11.

3.6.12 Vibration: The tube assembly shall withstand vibration testing without leakage or other malfunction, when tested in accordance with 4.6.12.

3.6.13 System Pressure: Test assemblies shall withstand 24 h exposure at low pressure and 24 h at operating pressure with no visually detectable escape of fluid from the fitting assembly or the tube fitting interface, when tested in accordance with 4.6.13.

3.6.14 Fitting Twisting (Separable Only): The separable fitting shall not twist more than 2°, when torqued in accordance with 4.6.14.

3.6.15 Fitting/Tube Rotation Torque: The nut shall not loosen or the tube rotate, when subjected to 1.5 times assembly torque in accordance with 4.6.15.

3.6.16 Stress Corrision: The tube/fitting joint shall not exhibit intergranular or stress corrosion cracking after salt spray exposure in accordance with 4.6.16.

3.6.17 Lightning Strike: The fitting assembllies, sizes 04 and 12, Shall not leak after being subjected to 12 lightning strikes when tested in accordance with 4.6.17.

NOTE: This requirement pertains to commercial jet aircraft of composite construction.

3.6.18 Fire: The fitting assembly shall withstand a 2000 °F (1093 °C) flame for 15 min, when tested in accordance with 4.6.18. There shall be no leakage detected by visual observation or failure of the test assembly prior to the specified time.

TABLE 2A - Supply Bending Stresses

Tube Size	Tube Wall Thickness (in)	Minimum Endurance Limit /1/ Tube Bending Stress (psi) /2/	Minimum Endurance Limit /1/ Tube Bending Stress (kPa) /2/	Minimum Endurance Limit /1/ Tube Bending S/N Curve
0.250	.022-.025	20,000	137,900	2.4
0.375	.030-.032	19,000	131,000	2.6
0.500	.040-.043	18,000	124,000	2.8
0.625	.050-.054	17,000	117,200	3.0
0.750	.059-.065	16,000	110,300	3.2
1.000	.079-.088	15,000	103,400	3.4

NOTES:

/1/ Intersection of the indicated S/N characteristic curve versus stress at the endurance limit (i.e., 1 x 10^7).

/2/ Refer to Figure 1 for characteristic curves.

TABLE 2B - Return Bending Stresses

Tube Size	Tube Wall Thickness (in)	Minimum Endurance Limit /1/ Tube Bending Stress (psi) /2/	Minimum Endurance Limit /1/ Tube Bending Stress (kPa) /2/	Minimum Endurance Limit /1/ Tube Bending S/N Curve
0.250	.016	20,000	137,900	2.4
0.375	.019	19,000	131,000	2.6
0.500	.022	18,000	124,000	2.8
0.625	.020	17,000	117,200	3.0
0.750	.020	16,000	110,300	3.2
1.000	.028	15,000	103,400	3.4

NOTES:

/1/ Intersection of the indicated S/N characteristic curve versus stress at the endurance limit (i.e., 1 x 10^7).

/2/ Refer to Figure 1 for characteristic curves.

TABLE 3 - Supply and Return Minimum Joint Strength

Tube Size	Supply Joint Strength (lb)	Supply Joint Strength (N)	Return Joint Strength (lb)	Return Joint Strength (N)
0.250	1100	4895	589	2621
0.375	2800	12460	1325	5896
0.500	4700	20915	1570	6987
0.625	7900	35155	2453	10915
0.750	11900	52955	2644	11188
1.000	16750	74537	4710	20960

TABLE 4 - Torques

Dash Size	Assembly Torque (in-lb)			Overtightening (m.N)
	Min.	Max.	Overtightening	
4	88	133	266	30
6	177	221	442	50
8	398	442	884	100
10	531	575	862	98
12	707	752	1128	128
16	885	929	1394	158

3.7 Workmanship:

Machined surfaces of fittings shall be free from burrs, longitudinal or spiral tool marks. A burr is defined as any localized sharp deviation from the true contour of the part, as implied by the production drawing, the extreme excursion of which falls outside the tolerance envelope defined on the drawing, and/or any thin deviation of lesser magnitude which can be dislodged during normal assembly or operation. Unless a finer finish is specified on the applicable drawings, all machined surfaces shall not exceed 125 microinch Ra as defined in ASME B46.1. Unmachined surfaces, such as forging surfaces and bar stock flats, shall be free from blisters, fin folds, seams, laps, cracks, or segregations as defined in ARP4784, and except for forging parting lines, shall not exceed 250 microinch Ra. The surface texture of forging parting plane shall be 500 microinch Ra per ASME B46.1. Surface defects may be explored by suitable etching, and if they can be removed so that they do not appear on re-etching, they shall not be cause for rejection.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Unless as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the procuring activity. The procuring activity reserves the right to perform any of the inspections set forth in the specification, where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of Inspection:

The examining and testing of fittings shall be classified as:

a. Qualification inspections (4.3)

b. Quality conformance inspections (4.4)

4.3 Qualification Inspections:

4.3.1 Qualification Test Samples: Test samples shall consist of the number of samples and lengths specified in Table 5. All specimens for each fitting size are required for qualification.

4.3.2 Qualification Test Sequence: Test sequence and procedure shall be as specified in Table 6A and 6B.

TABLE 5 - Length /1/ and Configuration /2/ of Test Samples in Inches

Tube Size	All Other Tests	Flexure /3/	Fire/Lightning Strike	Vibration	Stress Corrosion
.250	6	6.0	10	/4/	/5/
.375	6	7.5	10	/4/	/5/
.500	8	9.0	10	/4/	/5/
.625	8	10.0	10	/4/	/5/
.750	8	11.5	10	/4/	/5/
1.000	8	12.5	10	/4/	/5/

/1/ Length shall be free tube length between the fittings.
/2/ All samples shall be straight to straight, except impulse samples shall have a “tee” on one end.
/3/ Six samples shall have a straight fitting and two shall have a tee fitting. See Figure 2.
/4/ See Table 9.
/5/ See Figure 13.

TABLE 6A - Supply Qualification Test Schedule

Test	Test Para.	1, 2	3, 4	5	6	7	8	9	10	11, 12	13, 14	15 to 20	21, 22	23, 24	25, 26	27 to 32 /3/	33, 34	35, 36 /1/	37 to 40 /2/	41 to 43 /4/
Inspection	4.6.1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Fuel Ageing	4.5.2			3	3															
Fluid Immersion	4.5.3					3	3													
Corrosion Cond.	4.5.4										4							3		
Proof pressure	4.6.2	2, 4	2, 4	2	2	2	2	2	2	2	2	2	2		2	2		2		2
Gaseous pressure	4.6.3	5	5		5		5		4										2	
Impulse	4.6.4			**4**	4	**4**	4	**3**	3											
Burst	4.6.5			**5**	**7**	**5**	**7**	**4**	**6**	4	6							**4**		
Flexure	4.6.6											3	3							
Re-use	4.6.7		3																	
Joint Strength	4.6.8													**2**						
Thermal Shock	4.6.9														3					
Overtightening	4.6.10	3																		
Conductivity	4.6.11										3, 5									
Vibration	4.6.12															3				
System pressure	4.6.13				6		6		5				4			4				
Tube twisting	4.6.14									3										
Fitt. / tube rotat. trq	4.6.15																2			
Stress corrosion /1/	4.6.16																	3		
Lightning Strike /2/	4.6.17																		3	
Fire	4.6.18																			3

/1/ Size -10 only
/2/ Sizes -4 and -12 only
/3/ Alternate method requires 6 samples and only two required for standard method.
/4/ Size -16 only

NOTE: Bold figures are for tests ran up to rupture or specimens subjected to additional tests.

TABLE 6B - Return Qualification Test Schedule

Test	Test Paragraph	1, 2	3, 4	5 to 12	13, 14	15 to 20 /1/
Inspection	4.6.1	1	1	1	1	1
Gaseous Pressure Proof	4.6.3	2	2	2	2	2
Impulse	4.6.2	3	3	3	3	3
Burst	4.6.4	--	4	--		
Flexure	4.6.5	**4**	--	--		
Joint Strength	4.6.6	--	--	4		
Vibration	4.6.8				4	
	4.6.12					4

/1/ Alternate method requires 6 samples and only two required for Standard method.

NOTE: Bold figures are for tests ran up to rupture.

4.3.3 Test Report, Test Samples, and Data: The following data shall be available and submitted when requested:

a. Test Report: The test report shall include a record of all processes used to fabricate the samples including the number, revision level and inspection results, a report of all tests and outline description of the tests and conditions, outlined in MIL-HDBK-831.

b. Test Samples: Test samples when requested by the procuring activity and subjected to qualification testing, shall not be shipped as part of contract order.

c. Drawings: Three sets of assembly and subassembly shall have a cut-away section showing all details in their normal assembly position. The drawing shall identify all details and subassemblies.

NOTE: Log sheets and recorded test data shall remain on file at the source test facility and are not to be sent to the qualifying activity unless specifically requested.

4.3.4 Qualification Inspection Methods: Qualification inspection methods shall consist of all the examinations and tests specified under 4.6.

4.4 Quality Conformance Inspections:

Quality conformance inspections shall consist of the following tests:

Individual tests (see 4.4.1) (100% inspection)

4.4.1 Individual Tests: Each fitting shall be subjected to the following tests:

4.4.1.1 Examination of Product (see 4.6.1)

4.4.2 Rejection and Retest: Where one or more items selected from a lot fails to meet the specifications, all items in the lot shall be rejected.

4.4.2.1 Resubmitted Lots: Once a lot (or part of a lot) has been rejected by a procuring activity (government or industry), and before it can be resubmitted for tests, full particulars concerning the cause of rejection, and the action taken to correct the defects in the lot, shall be furnished in writing by the supplier.

4.4.3 Inspection Procedures: All inspection plans shall be single sample plans with an accept number of zero.

4.5 Test Conditions:

4.5.1 Preparation of Samples:

4.5.1.1 Unless otherwise specified, the length of sample assemblies shall be in accordance with Table 5.

4.5.1.2 At least one test sample for each series of tests shall be assembled with tooling used to qualify any other manufacturer's fittings listed on the QPL.

4.5.2 Fuel Aging; The samples shall be filled with "Low Density" fluid and then pressurizes a to 5080 psi (35,000 kPa) and , while maintaining the pressure at room temperature, the samples shall be immersed in the fluid for 8 to 10 h and then allowed to air dry for 1 h. Then the samples will be placed at a temperature of -65 °F(-54 °C) for 8 to 10 h. This sequence of fluid immersion and low temperature exposure shall be repeated 20 times in accordance with Table 7. The fuels used shall be one of the following listed in Table 8.

TABLE 7 - Fluid Sequense

Sequence	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Fluid used F : fuel W : water	F	F	F	W	F	F	F	W	F	F	F	W	F	F	F	W	F	F	F	W

TABLE 8 - Fuels

Specification	Fuel
US MILITARY	MIL-DTL-5624 Rev T98 : JP-5 MIL-DTL-83133 Rev E99 : JP-8
US ATM	ASTM D 1655-00 : JET A ASTM D 1655-00 : JET A1
FRANCE	AIR3404 AIR3405
UK	DEF STAN 91-86 (NATO F44) DEF STAN 91-91 (Jet A1, NATO F35)
RUSSIAN	GOST 10227-86 : RT GOST 10227-86 : TS-1
CHINESE	N°3 Jet Fuel

4.5.3 Hydraulic Fluid Immersion: The samples shall be fully preconditioned in "Low Density" AS1241 Type IV fire resistant fluid or the system hydraulic fluid, as applicable. The sample shall be filled with AS1241 hydraulic fluid or system hydraulic fluid, as applicable, and then shall be pressurized to operating pressure. While maintaining the pressure at room temperature, the sample shall be immersed in AS1241 or system fluid, as applicable, for 8 to 10 min and then allowed to air dry for the remainder of 1 h. Then the samples shall be aged at +275 °F (+135 °C) in air for 8 to 10 h. This sequence of hydraulic fluid immersion and high temperature exposure shall be repeated 10 times.

NOTE: During high temperature exposure, the pressure inside the samples shall not be greater than 5080 psi (35,000 kPa).

4.5.4 Corrosion Conditioning: A salt spray test according to RTCA/DO 160, Section 14 shall be performed for a minimum of 56 days (the RTCA procedure, i.e., the exposure to the salt fog for a period of a minimum of 48 h and then the storage in an ambient temperature for a minimum of 48 h for drying, must be repeated in order to reach 56 days).

4.5.5 Test Fluids: Unless otherwise specified, the pressure test fluid shall be hydraulic oil conforming to MIL-PRF-5606, MIL-PRF-87257, or water. Where a high temperature test fluid is required, the test fluid shall be MIL-PRF-83282 hydraulic fluid.

4.5.6 Pressure Measurement: Unless otherwise specified, all pressures shall have a tolerance of -0 to +5%.

4.5.7 Temperature Measurements: Unless otherwise specified, temperature measurements shall be taken within 6 in of the fitting under test. Unless otherwise specified, all temperatures shall have a tolerance of +15 °F, -5 °F (+9 °C, -2 °C).

4.6 Performance Tests:

4.6.1 All fittings 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 0.5° and all burrs removed from inside and outside of the tube ends. The break or chamfer on either the outside diameter or inside diameter shall not exceed 25% of the tube wall thickness.

4.6.2 Hydraulic Proof Test: Test assemblies shall be mounted to a pressure source and pressurized to two times the design operating pressure and held for 5 min. Rate of pressure rise shall be 20,000 psi/min (137,894 kPa/min.) ± 5000 psi (34,474 kPa).

4.6.3 Gaseous Leakage Test: Test specimens shall be solvent cleaned and air dried prior to test and shall not have been exposed to oil prior to this test. The specimens shall be connected to a gaseous nitrogen pressure source and immersed in a safety tank filled with water. The specimens shall then be pressurized to 50 to 100 psig (345 to 690 kPa) at room temperature. The test is then repeated at operating pressure. This test duration for each segment shall be 5 min.

4.6.4 Impulse Test: Six test assemblies of each tube/ fitting combination to be qualified shall be tested. Impulse testing shall be in accordance with AS603. The maximum temperature shall be +275 °F ± 5 °F (+135 °C ± 15 °C). The minimum temperature shall be -65 °F ± 5 °F (-54 °C ± 15 °C). The impulse cycle rate shall be 70 cpm ± 5 cpm. The rate of pressure rise shall be 125,000 to 300,000 psi/s. Hydraulic fluid shall be used as the testing media. Specimens shall complete a minimum of 300,000 impulse cycles and continue to 450,000 cycles or failure.

4.6.5 Burst Pressure Test: Test assemblies shall be pressurized to the proof pressure and held at that pressure for 5 min. The pressure shall then be increased at a rate of 20,000 psi/min (137,894 kPa/min) ± 5000 psi/min (34,474 kPa/min) until destruction occurs. No burst, slippage, leakage, or other failure shall occur at a pressure below the burst pressure as specified in Table 1A and 1B.

4.6.6 Flexural Strength: The flexural test shall be performed in accordance with ARP1185, except the stress level shall be per Table 2A and 2B. Bending stresses shall be applied by the rotary flex method. The stress imposed will be the dynamic bending stress. The bending stress shall be measured by two strain gages mounted 90° apart on the tube 0.188 in ± 0.031 in from the tube fitting interface. Testing shall be conducted with the specimen pressurize to the operating pressure. The cycling rate of flexure shall be 30 to 60 cps. Data points generated by testing shall be plotted on an S/N curve (stress/number of cycles). Refer to Figure 1. Two straight specimens in each size shall complete 10,000,000 cycles without leakage or other failure. Six other samples, four with straight fittings and two with tee-shaped fittings, shall be tested at higher stress levels to develop a fatigue (S/N) curve. Any of these six samples that complete 10,000,000 cycles need not be tested to failure.

4.6.6.1 Rotary Beam Method: Figure 2 illustrates the flexural loading by imposing a concentrated rotating load on the free end of the tube assembly.

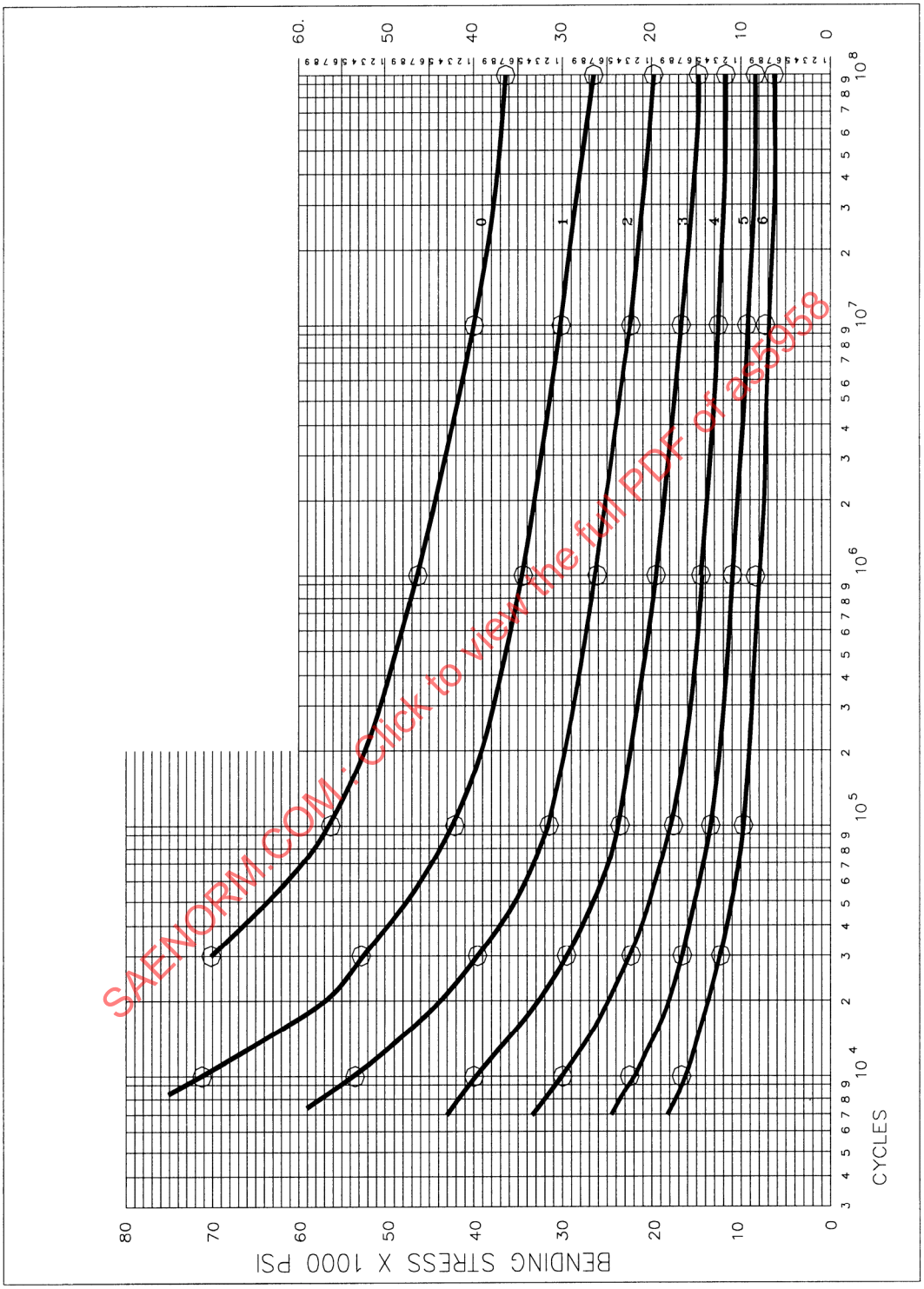

FIGURE 1 - Flexure Fatigue Test S/N Curve

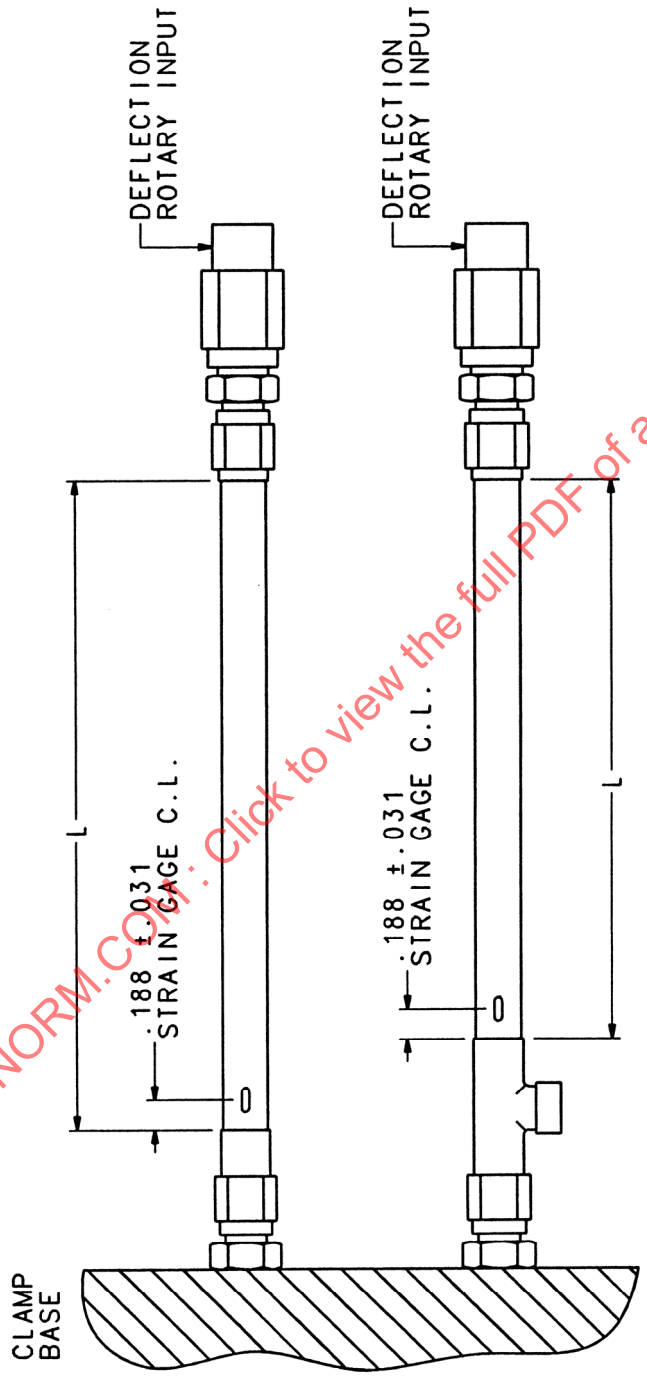

FIGURE 2 - Rotary Test Specimen

4.6.7 Re-Use, Separable End Only: Screw together and unscrew the threaded connections eight times. The initial tightening shall consist of of loosening the nut after the initail tightening and re-tightening. Each cycle shall include the complete removal of the fitting from the mating adapter. One half the threaded connections shall use minimum torque and the other half shall use maximum torque values shown in Table 4. Following the first, fourth and eight installation, conduct a proof test. After the eigth installation there shall be no evidence of the following defects:

- Leakage during any of the proof test
- Inability to assemble the fitting to the interface point by hand
- Nut deformation preventing engagement of the nut hexigon with an open-end wrench
- Gasous leakage following the final installation.

4.6.8 Joint Strength Test: Test assemblies shall be mounted in a tensile test machine and be tested in accordance with ASTM E 8 at a head travel rate of 0.15 in/min ± 0.05 in/min. Strength requirements shall be per 3.6.8.

4.6.9 Thermal Shock Test: Use MIL-PRF-5606 hydraulic fluid for this test. The fitting assembly shall be mounted in a high temperature test set up with one end free to move. A typical test set up is shown in Figure 3. After the test, the fitting shall be filled with hydraulic fluid, the ambient temperature of the test chamber shall be reduced to -65 °F ± 2 °F (-54 °C ± 1 °C) for a minimum of 2 h. At the end of this period, while the test chamber is still at -65 °F (-54 °C), test fluid at 275 °F ± 5 °F (135 °C ± 3 °C) shall be suddenly introduced into the test assembly at a minimum pressure of 50 psi (350 kPa). Within 15 s after the hot fluid has filled the fitting assembly, a proof pressure test shall be performed in accordance with 4.6.2.

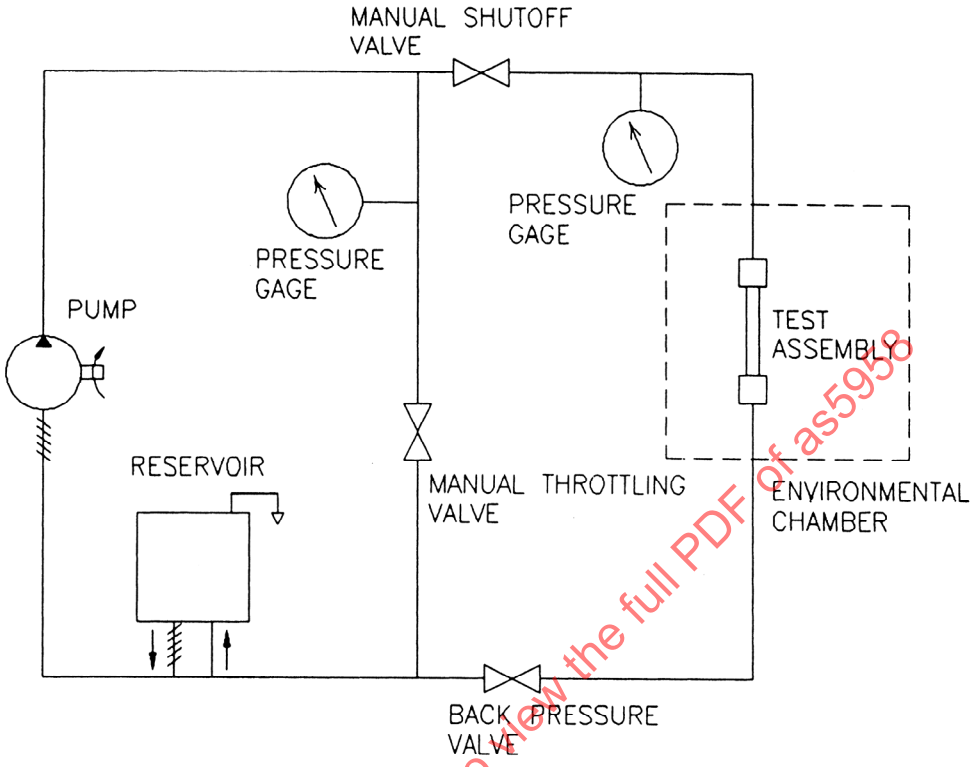

FIGURE 3 - Typical Setup for Thermal Shock Testing

4.6.10 Overtightening Torque (Separable Only): The separable fitting shall be torqued to an adapter with a prEN6123, AS5827 or equivalent interface. The torque shall be 2 times the maximum installation for sizes -04 to -08 and 1.5 times the maximum installation torque for sizes -10 to -16. There shall be no leakage when proof pressure tested per 4.6.2 and gaseous leakage tested per 4.6.3.

4.6.11 Fitting Conductivity: A titanium adapter shall be attached to the end fitting using the minimum assembly torque. Ohmic resistance measurements shall be carried out twice for each test sample in order to confirm the value. An Ohmeter with four measurement test points can be used with a direct current of 1A minimum with a measurement accuracy of 1%. Measurement shall be performed between point 1 and point 2 (see Figure 4). This test shall be performed before and after corrosion conditioning per 4.5.4. The test report shall provide measured resistance values.

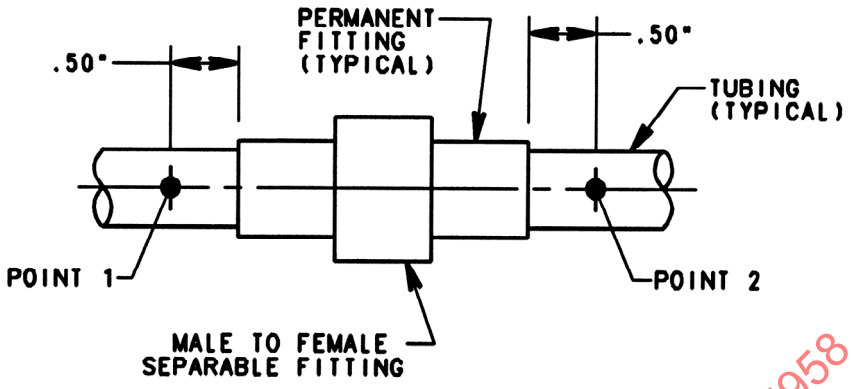

FIGURE 4 - Fitting Conductivity

4.6.12 Vibration: Test assemblies shall be installed on a test fixture as illustrated in Figure 5 and Table 9. The test assemblies shall be filled with hydraulic fluid and pressurized to nominal operating pressure. Each test assembly shall be tested using either:

a. Standard Vibration test defined in 4.6.12.1, or

b. Alternate Vibration test defined in 4.6.12.2. 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 equipment 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.

4.6.12.1 Standard Vibration Test: Test assemblies shall be vibration tested as specified in 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 6, 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.

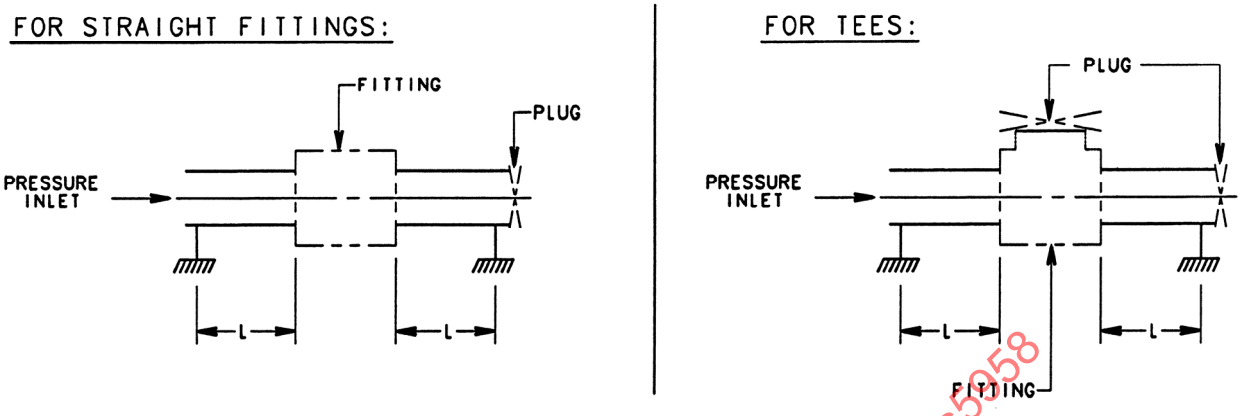

FIGURE 5 - Vibration Test Setup

TABLE 9 - Test Lengths

Fitting Size	Length L (in)	Length L (mm)
04	5.7	145
06	8.7	220
08	9.8	250
10	11	280
12	12.2	310
16	14	355

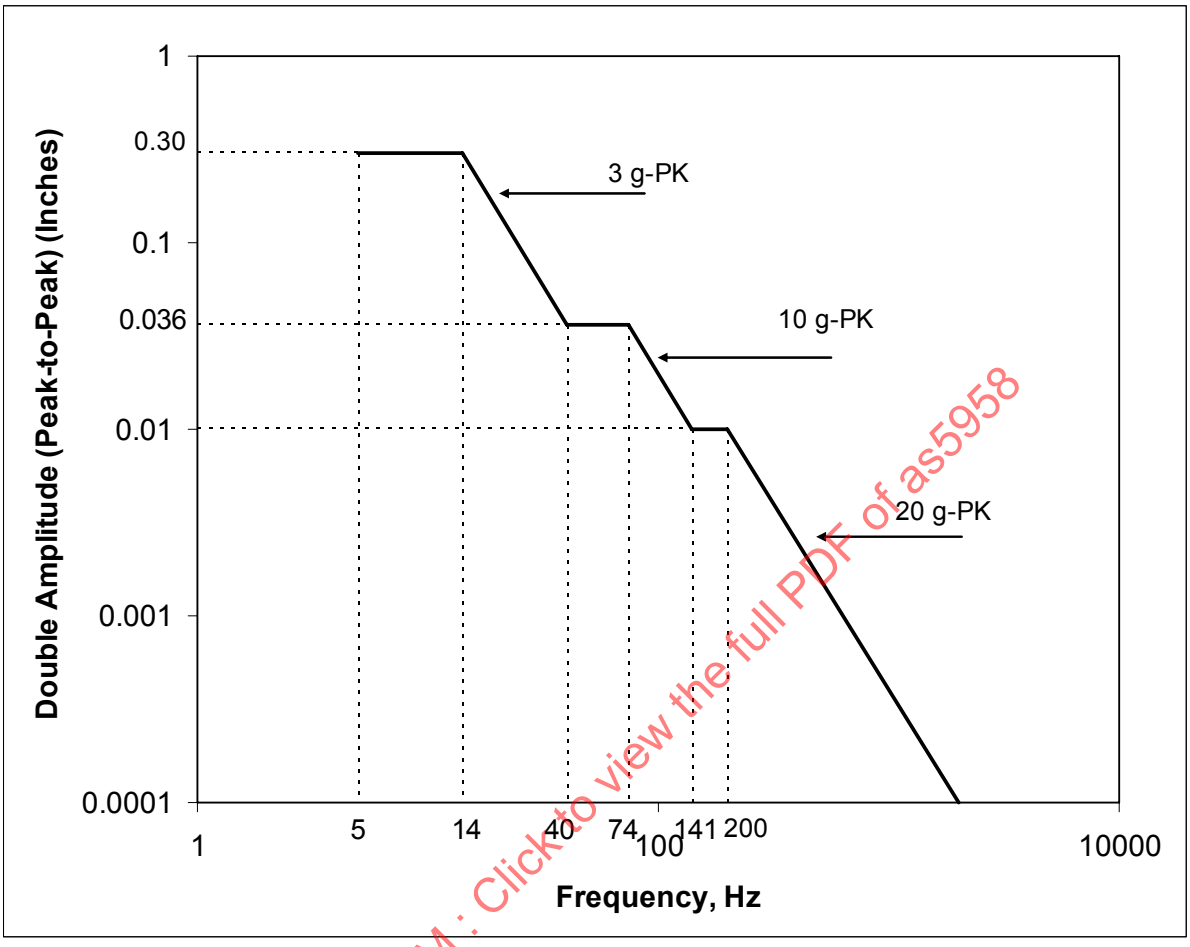

FIGURE 6 - Modified Curve W

4.6.12.2 Alternate Vibration Test: Test assemblies shall be installed on a test fixture as illustrated in Figure 5 and Table 9. Testing shall include both 4.6.12.2.1 Normal Flight Conditions and 4.6.12.2.2 Windmilling - Sustained Engine Imbalance tests.

4.6.12.2.1 Normal Flight Conditions: Six assemblies shall be tested in accordance with ISO 7137, 2.2 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: see below);
Two assemblies with curve P, W (sizes: see below).

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

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 gearbox	noted S3

All curves in a given category must be performed.

According to the areas the fittings will be placed in, series are to be performed according to Table 10:

TABLE 10 - Series

Fitting Size	Series HP
04	S1 & S3
06	S1 & S3
08	S1 & S3
10	S1 & S3
12	S1 & S3
16	S1 & S2 & S3

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 fittings, but would allow to running the testing with only two samples following four curves rather than three sets of two samples following three, three and two curves respectively.

Where (E U D) and (E1 U D1) are defined in Figures 7 and 8 as follows:

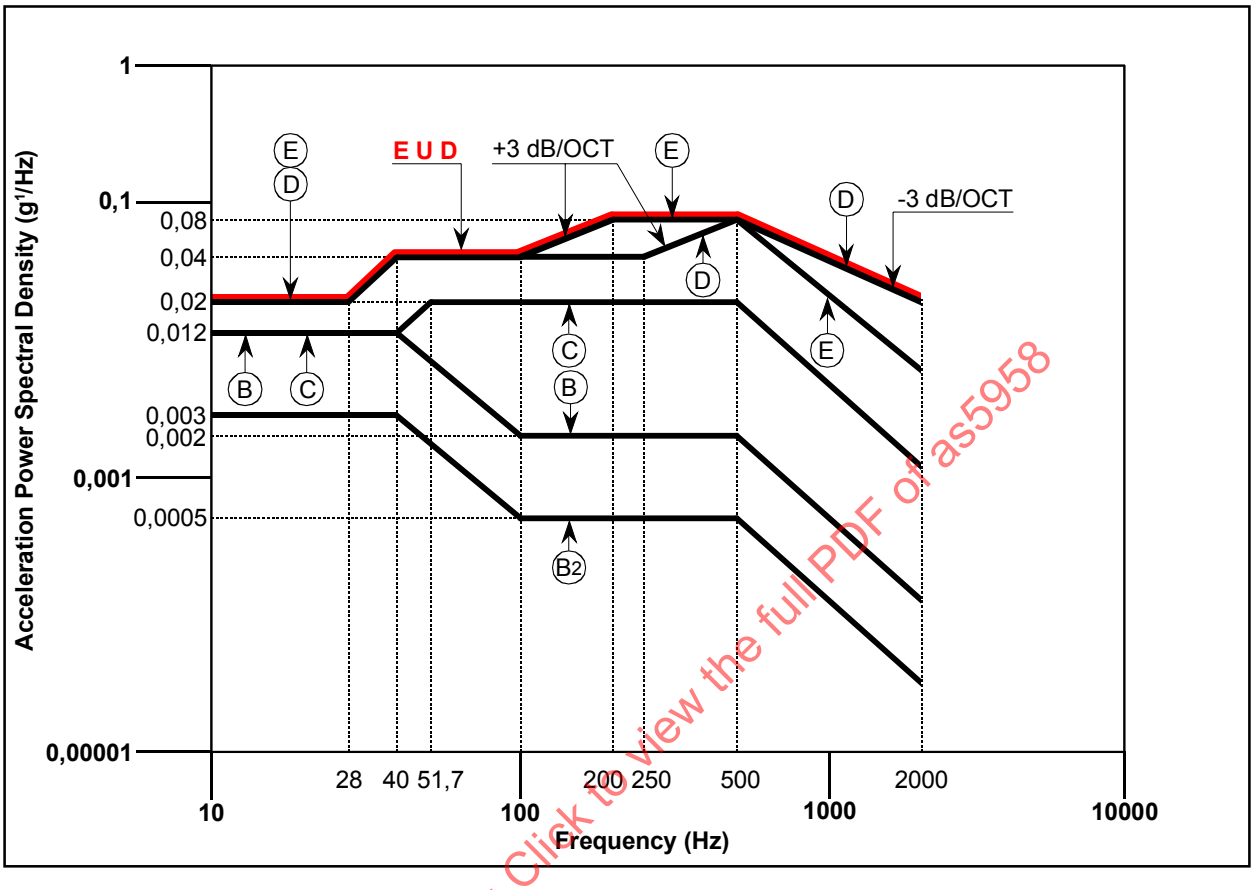

FIGURE 7 - Curve E U D

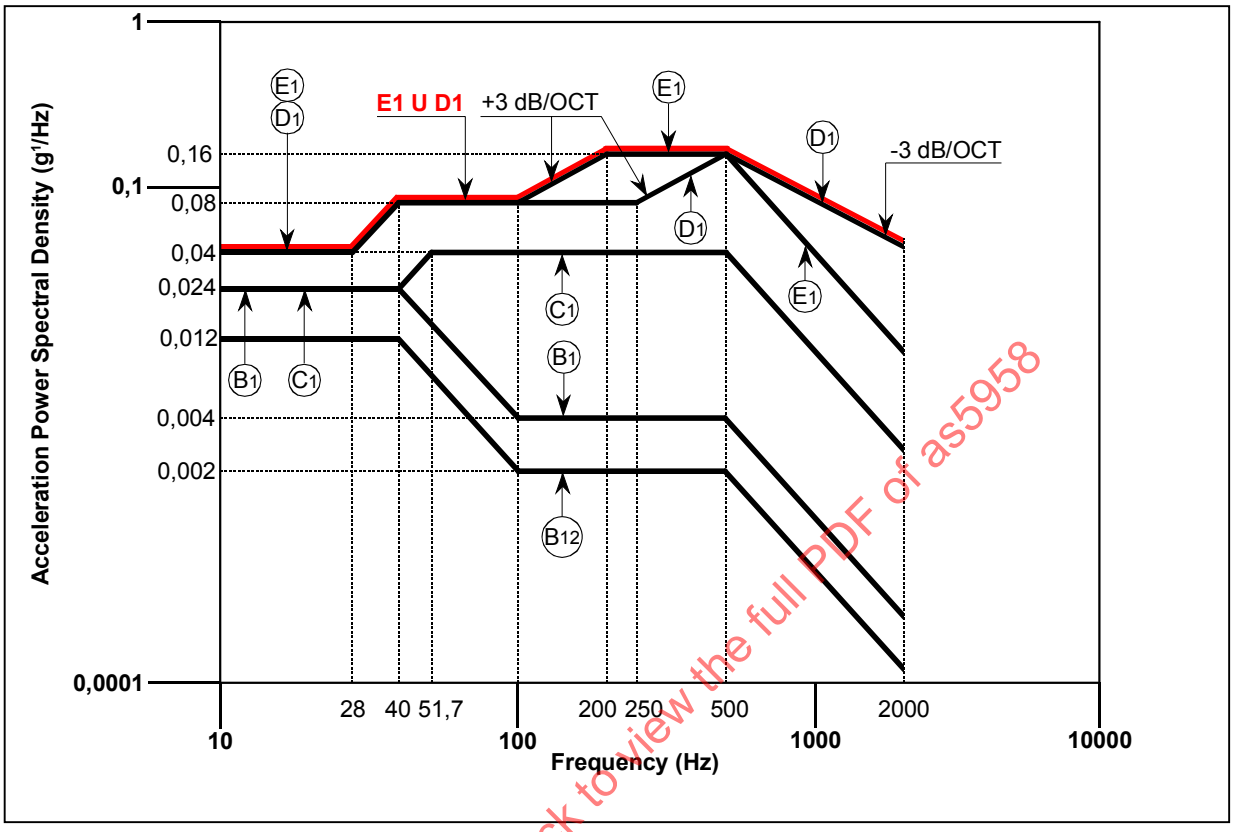

FIGURE 8 - Curve E1 U D1

NOTE: Figures 7 and 8 are explanatory only. For accurate values, refer to ISO 7137.

4.6.12.2.2 Windmilling - Sustained Engine Imbalance: Two assemblies shall be tested if the test installation has a resonance below 20 Hz. If there is no resonance below 20 Hz, the windmilling test does not need to be performed.

NOTE: According to the area the fitting will be placed in, different windmilling testing curves will have to be performed. Curves to be performed are shown in Table 11.

TABLE 11 - Windmilling Curves

Size Code	Curve
04	1BF, Figure 10
06	1AF, Figure 9
08	1BF, Figure 10
10	3A, Figure 11
12	3A, Figure 11
16	5B, Figure 12

In each of the equipment's three orthogonal axes, perform the following sinusoidal test procedure:

Step 1: Between 6 and 15 Hz (cruise phase)

With the equipment operating, sweep cycle the vibration frequency over the appropriate frequency range from the lowest (6 Hz) to the highest (up-sweep) to the lowest (down-sweep) with a logarithmic sweep rate not to exceed 0.5 octave/minute. During the initial up-sweeps, record plots of the accelerometers at the response locations selected and identify the critical frequencies.

Critical frequencies are defined at those frequencies where:

mechanical vibration resonance have peak acceleration amplitudes greater than twice the input acceleration amplitude, or

a change in performance or behavior is noticeable whether or not performance standards are exceeded.

If any, select the most severe frequency.

For the critical frequency identified (if one), dwell at this frequency for 160 minutes minimum. During the resonance dwell, the applied frequency shall be adjusted, if necessary, to maintain the maximum acceleration response at the vibration resonance being dwelled.

Any change in the critical frequency that occurs during the test shall be noted.

If no critical frequency is identified, then no dwells need to be performed. Continue sweep cycling the vibration frequency over the appropriate frequency range with a logarithmic sweep rate not to exceed 0.5 octave/minute for 160 minutes minimum.

At the completion of the test, the equipment shall be inspected and shall show no evidence of structural failure of any internal or external component.

Note that the time spent performing the initial up-sweeps may be included in the total sweep time (160 min).

Step 2: Between 3 and 6 Hz (descent phase)

With the equipment operating, perform one sinusoidal linear frequency sweep from the highest (6 Hz) to the lowest (3 Hz) at a sweep rate not to exceed 0.0025 Hz/s.

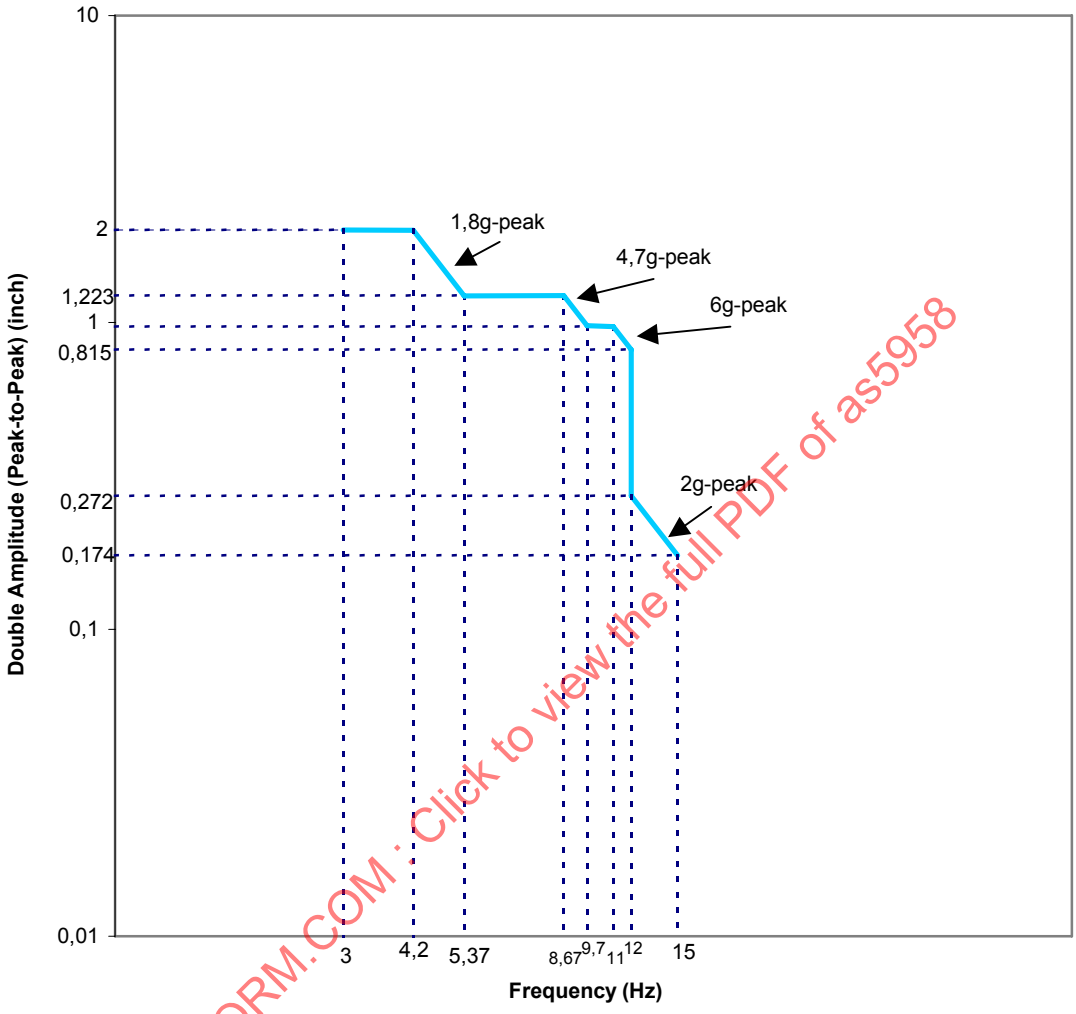

FIGURE 9 - Curve 1AF

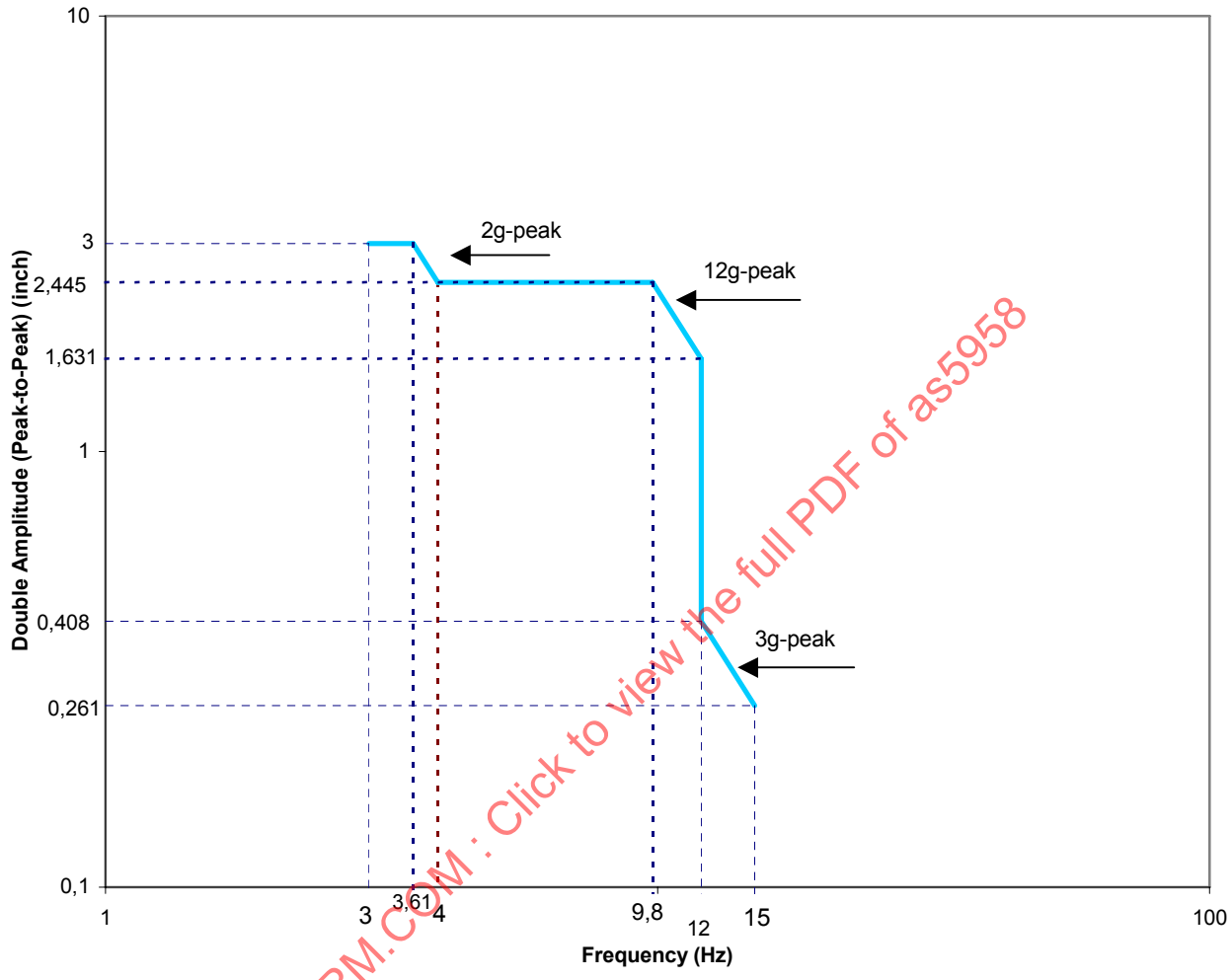

FIGURE 10 - Curve 1BF