AEROSPACE STANDARD

AS5356	REV. A

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Revised 2002-07
Reaffirmed 2015-07

Superseding AS5356

(R) Coupling, Fuel Line, Flexible, 125 psi General Specification for

RATIONALE

AS5356A has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

1.1 Scope:

This specification covers flexible couplings for joining tubing with AS5131 Type A beaded ends for use in aircraft fuel and vent systems (see 6.1).

1.2 Classification:

Couplings shall be of the following size, material, and type as specified.

1.2.1 Size: The size of couplings shall be as specified in Table 2.

1.2.2 Material: The material shall be in accordance with Table 1. The basic material of the coupling is designated by the following code letters:

CODE D - Aluminum
CODE C - Corrosion-resistant steel
CODE T - Titanium

1.2.3 Type: The coupling shall consist of the following types:

Type 1 - Standard coupling with no electrical bonding
Type 2 - Coupling with electrical bonding

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TABLE 1 - Coupling Material

Materials Type	Materials Specification	Finish Specification
Aluminum alloy 2024-T6, 6061-T6	AMS-QQ-A-225/6 AMS-QQ-A-225/8	Anodized per MIL-A-8625 Type II Class 2
Corrosion-resistant steel (Cres)	AMS 5643, AMS 5659 or equivalent	Passivated per AMS-QQ-P-35
Titanium 6AL-4V	AMS 4921 AMS 4965 AMS-T-9046	None None Condition AB-1

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.

AMS 4921	Titanium, Bars, Forgings and Rings, Annealed, 70,000 psi (485 mPa) Yield Strength
AMS 4965	Titanium Alloy, Bars, Forgings and Rings, 6.0Al - 4.0V Solution and Precipitation Heat Treated
AMS 5643	Steel Bars, Forgings, Tubing, and Rings, Corrosion Resistant 16Cr - 4.0Ni - 0.30 (Cb+Ta) - 4.0Cu Solution Heat Treated
AMS 5659	Bar, Forgings and Rings, and Extrusions Corrosion Resistant 15Cr - 45Ni - 0.30 (Cb+Ta) - 3.5Cu Consumable Electrode Melted Solution Heat Treated, Precipitation Hardenable
AMS 5687	Nickel Alloy, Corrosion and Heat Resistant, Wire 74Ni - 15.5Cr - 8.0Fe Annealed
AMS-T-9046	Titanium, Titanium Alloy, Sheet, Strip and Plate
AMS-QQ-P-35	Passivation Treatment for Corrosion Resistant Steel

2.1.1 (Continued):

AMS-QQ-A-225/6	Aluminum Alloy Bar, Rod, and Wire, Rolled, Drawn, or Cold Finished 2024
AMS-QQ-A-225/8	Aluminum Alloy 6061, Bar, Rod, Wire and Special Shapes: Rolled, Drawn or Cold Finished
AS567	Safety Cable, Safety Wire, Key Washers and Cotter Pins, for Propulsion Systems General Practices for Use of
AS1710	Coupling, Fuel, Flexible, Variable Cavity Threaded Type with Ferrules
AS1720	Ferrule End, Coupling, Flexible, Variable, Cavity Threaded, Ferrule Type, Design Standard
AS5131	Tubing End, Design Standard
AS29513	Packing, Preformed, Hydrocarbon Fuel Resistant O-Ring

2.1.2 ASTM Publications: Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 471	Standard Test Method for Rubber Property-Effects of Liquid
ASTM D 3951	Commercial Packaging

2.1.3 ANSI Publications: Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ANSI/ASQC Z1.4	Sampling Procedures and Tables for Inspection and Attributes

2.1.4 U.S. Government Publications: Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

FED-STD-H28/2	Screw Thread Standards for Federal Services Section 2 Unified Inch Screw Threads-UN and UNR Threads Form
MIL-DTL-5624	Turbine Fuel, Aviation, Grades JP-4, JP-5, and JP-5/JP-8 ST
MIL-A-8625	Anodic Coatings for Aluminum and Aluminum Alloys
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-464	Interface Standard Electromagnetic Effects Requirements for Systems
MIL-HDBK-470	Designing and Developing Maintainable Products and Systems
MIL-HDBK-471	Maintainability Verification, Demonstration and Evaluation
MIL-STD-810	Department of Defense Test Method Standard for Engineering Guidelines
MIL-STD-889	Dissimilar Metals

2.2 Definitions:

CONNECTOR: Connector as used herein is defined as a replaceable component, which connects one coupling halve to another coupling halve.

EXCESSIVE WEAR: If original dimensions have been changed or altered by 5% or more.

FAILURE: Failure as used herein is defined as any deformation that would contribute to seal leakage or would promote premature fatigue breakage, unless otherwise determined to be due to a tubing defect.

LEAKAGE: Leakage as used herein is defined as the escape of fluid (gaseous or liquid) from any point of the coupling assembly including the coupling tube junction.

LOT: A lot is defined as products consisting of all parts of a given part number made from the same batch of material and processed at the same time.

TORQUE: Torque as used in this specification is defined as the necessary loads (or assembly stresses) to assure the sealing of fluid at the coupling tube junction without causing damage.

3. REQUIREMENTS:

3.1 First Article:

When specified (see 6.2d), a sample shall be subjected to first article inspection (see 6.4) in accordance with 4.2.

3.2 Materials:

Materials shall conform to applicable specifications and shall be as specified in Table 1. Materials which are not covered by applicable specifications, or which are not specifically described herein, shall be of the lightest practicable weight and compatible with aircraft fuel. All materials shall be resistant to fluids conforming to ASTM Reference Fuels and MIL-DTL-5624 to assure satisfactory operation.

3.2.1 Metals: Metals shall be of a corrosion-resisting material or treated in a manner to render them adequately resistant to corrosion when exposed to climatic and environmental conditions encountered during the service life of the equipment. The use of any protective coating that will crack, chip, or scale with age or extremes of climatic and environmental conditions shall be avoided.

3.2.1.1 Aluminum Alloy Parts: All aluminum alloy parts shall be in accordance with Table 1 and shall be anodized in accordance with MIL-A-8625, Type II, class 2.

3.2.1.2 Steel Parts: All steel parts shall be of corrosion-resistant steel in accordance with Table 1.

3.2.1.3 Titanium: Titanium shall be in accordance with Table 1.

3.2.1.4 Magnesium and Copper: Magnesium and copper shall not be used.

3.2.2 Fungus-Proof Materials: Materials which are not nutrients for fungi shall be used to the greatest extent practicable. In cases where materials that are nutrients for fungi must be used, such materials shall be treated with fungicidal agent as approved by the contracting activity or procuring activity.

3.2.3 Dissimilar Metals: Combinations of tubing and all contacting coupling parts shall be compatible in accordance with MIL-STD-889.

3.3 Design and Construction:

The coupling shall be designed for connection of AS5131 type A beaded tube ends and shall meet the requirements of Figure 1 and Table 2.

3.3.1 Threads: Screw threads shall conform to FED-STD-H28/2. All threaded parts shall be securely locked in such a manner as to prevent loosening under test conditions specified herein and under normal service usage. Safety wire per AMS 5687 shall be installed in accordance with AS567. Wrenching features shall conform to Figure 1. Pipe threads shall not be used.

3.3.2 Angular Misalignment: The coupling shall be capable of being installed with a maximum tubing installation misalignment of 3° in any direction.

3.3.3 Flexure: The coupling shall provide for 1° flexure in any direction from any installed position. The coupling shall provide for a variation in space between tubing ends of 0.062 to 0.188 inch.

3.3.4 Permanent Deformation: Installation of the coupling on tubing ends under conditions specified herein shall not produce a permanent deformation of the coupling.

3.3.5 Tubing: The coupling shall be capable of connecting tubing having an outside diameter and wall thickness as specified in Table 3.

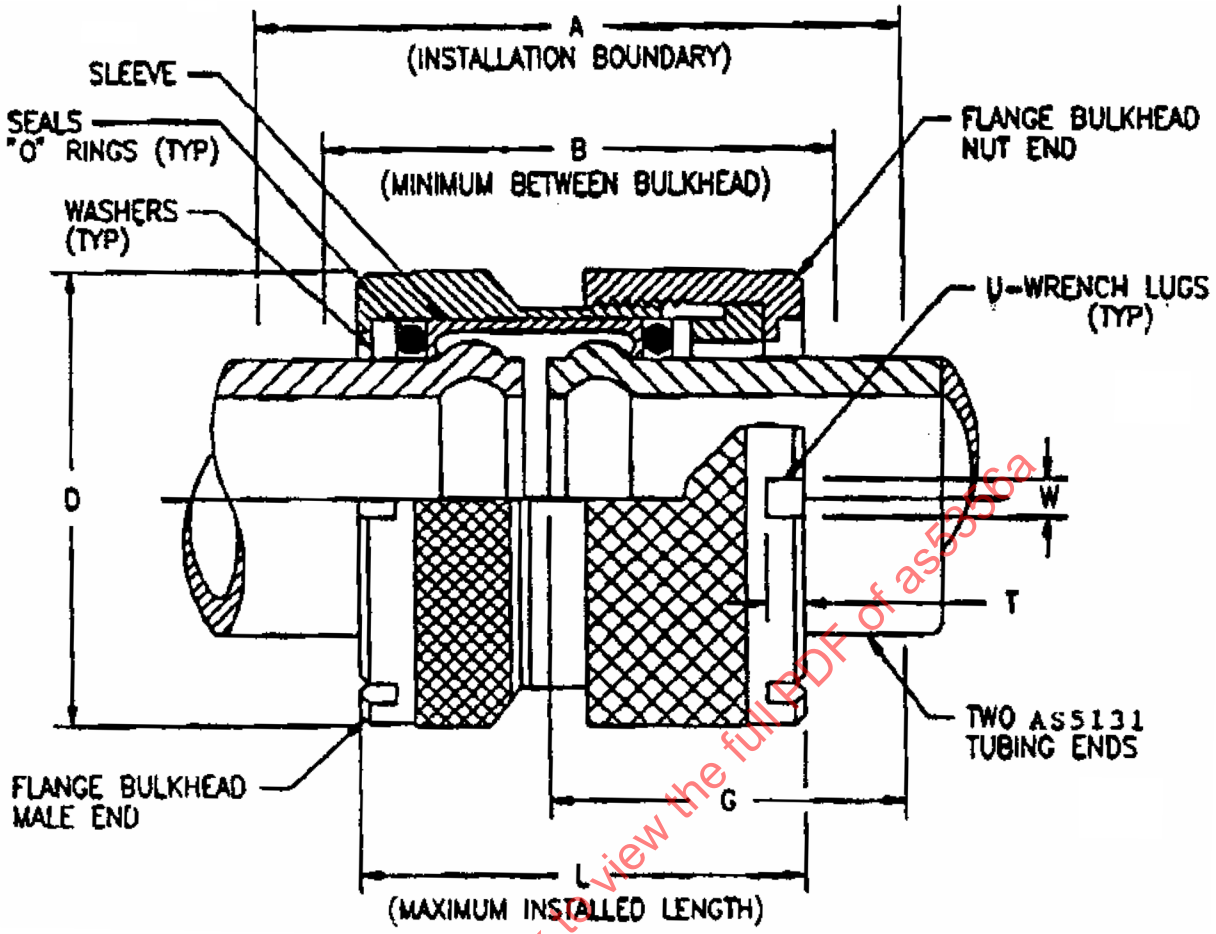

FIGURE 1 - Wrenching Features Typical Installation of Type 1 Fuel Coupling (Two AS5131 Tubing Ends)

TABLE 2 - Dimension and Weight Requirements for Type 1 and Type 2 Couplings

Dash No.	Tube OD Ref	A ±0.010	B Min	D Max	G Min	L Max	U Qty	Seal MS29513 Ref[1]
-04	0.250	3.390	1.810	0.890	1.220	1.762	--	-010
-06	0.375	3.610	2.62	1.100	1.289	1.954	4	-110
-08	0.500	3.610	2.62	1.230	1.291	1.954	4	-112
-10	0.625	3.610	2.62	1.360	1.291	1.954	4	-114
-12	0.750	3.840	2.62	1.480	1.300	2.230	4	-210
-16	1.000	4.010	2.840	1.730	1.430	2.350	8	-214
-20	1.250	4.010	2.840	1.980	1.430	2.350	8	-218
-24	1.500	4.500	3.130	2.470	1.580	2.600	8	-325
-28	1.750	4.500	3.130	2.720	1.580	2.600	8	-327
-32	2.000	4.500	3.130	2.970	1.580	2.600	8	-329
-40	2.500	4.500	3.130	3.470	1.580	2.600	12	-333
-48	3.000	4.500	3.130	3.970	1.580	2.600	12	-337
-56	3.500	4.610	3.190	4.600	1.580	2.650	16	-341
-64	4.000	4.610	3.190	5.100	1.580	2.650	16	-345
-72	4.500	4.740	3.190	5.660	1.710	2.650	16	-349
-80	5.000	5.270	3.470	6.231	1.800	2.930	16	-429
-88	5.500	5.270	3.470	6.680	1.800	2.930	16	-433
-96	6.000	5.980	3.700	7.230	1.920	3.160	16	-437

[1] See the detail dimensions on AS29513 for the corresponding sizes.

TABLE 2 - Dimension and Weight Requirements for Type 1 and Type 2 Couplings (Continued)

Dash No.	W Min	T ±0.010	Weight (lb) Max Type 1 Al	Weight (lb) Max Type 1 CRES	Weight (lb) Max Type 1 Ti	Weight (lb) Max Type 2 AL	Weight (lb) Max Type 2 CRES	Weight (lb) Max Type 2 Ti
-04	--	--	0.030	0.106	0.056	0.035	0.122	0.064
-06	0.187	0.135	0.040	0.125	0.071	0.043	0.131	0.082
-08	0.187	0.135	0.046	0.138	0.086	0.053	0.159	0.099
-10	0.187	0.135	0.056	0.163	0.105	0.064	0.187	0.121
-12	0.187	0.135	0.078	0.210	0.146	0.090	0.215	0.168
-16	0.187	0.135	0.130	0.250	0.243	0.150	0.288	0.280
-20	0.187	0.135	0.142	0.310	0.265	0.163	0.360	0.305
-24	0.250	0.135	0.242	0.580	0.452	0.278	0.667	0.520
-28	0.250	0.135	0.255	0.720	0.476	0.293	0.830	0.550
-32	0.250	0.135	0.294	0.770	0.549	0.338	0.886	0.631
-40	0.250	0.145	0.350	1.051	0.653	0.403	1.209	0.751
-48	0.250	0.145	0.438	1.310	0.818	0.504	1.507	0.941
-56	0.250	0.160	0.563	1.780	1.051	0.647	2.047	1.209
-64	0.250	0.160	0.633	2.030	1.182	0.728	2.335	1.360
-72	0.250	0.160	0.812	2.280	1.516	0.934	2.622	1.743
-80	0.250	0.175	1.140	3.310	2.128	1.311	3.685	2.447
-88	0.250	0.175	1.200	3.300	2.240	1.380	3.800	2.580
-96	0.250	0.175	1.450	3.500	2.334	1.668	4.025	2.684

TABLE 3 - Tubing Size and Wall Thickness

Tube OD	Nominal Wall Thickness AL	Nominal Wall Thickness CRES	Nominal Wall Thickness Ti	Tube OD	Nominal Wall Thickness AL	Nominal Wall Thickness CRES	Nominal Wall Thickness Ti
0.250	0.028	0.020	[1]	2.000	0.035	0.035	[1]
0.375	0.028	0.020	[1]	2.500	0.042	0.035	[1]
0.500	0.035	0.020	[1]	3.000	0.042	0.035	[1]
0.675	0.035	0.020	[1]	3.500	0.049	0.049	[1]
0.750	0.035	0.020	[1]	4.000	0.049	--	[1]
1.000	0.035	0.020	[1]	4.500	0.065	--	[1]
1.250	0.035	0.025	[1]	5.000	0.065	--	[1]
1.500	0.035	0.020	[1]	5.500	0.065	--	[1]
1.750	0.035	0.035	[1]	6.000	0.065	--	[1]

[1] Wall thickness to be specified by the qualifying activity.

3.4 Seal:

The seal, which is used for testing purposes only and is not furnished as part of the flexible coupling, shall be in accordance with AS29513 of the applicable size specified in Table 2.

3.5 Configuration, Dimensions, and Weight:

The configuration, dimensions and weight shall be in accordance with Figure 1 and Table 2.

3.6 Performance:

The coupling, when installed in any position (attitude), shall meet all the performance requirements when tested as specified in Section 4 of this specification.

3.6.1 Visual Examination:

3.6.1.1 Coupling: When visually examined as specified in 4.5.1.1, the coupling shall conform to the requirements of this specification.

3.6.1.2 Inspection for Delivery: When visually examined as specified in 4.5.1.2, the shipping container shall conform to the requirements of this specification.

3.6.2 Proof Pressure: The coupling assembly shall be designed to withstand a proof pressure of 250 psi ± 5 psi. A decrease in pressure when pressurized to proof pressure or any leakage (see 2.2) shall be cause for rejection of the coupling.

3.6.3 Fuel Resistance: The coupling assembly shall not leak (sufficient to form a drop) nor show evidence of damage when subjected to high temperature aging at 200 °F, low temperature fuel aging at -65 °F and air dry out at 200 °F when tested as specified in 4.5.3

3.6.4 Vibration: The coupling assembly shall show no evidence of malfunction or structural failure and shall pass the proof pressure test (see 4.5.2) after exposure to vibration levels as specified in 4.5.4.

3.6.5 Repeated Assembly: There shall be no evidence of deformation, damage nor degradation in the connecting ability of the coupling after 25 repeated assembly and disassembly operations when tested as specified in 4.5.5 and shall pass the proof pressure test as specified in 4.5.2.

3.6.6 Salt Fog: The coupling assembly shall be capable of passing the salt fog test, specified in 4.5.6, without any malfunction nor degradation due to corrosion. Threads, connecting surfaces and sealing surfaces shall be free of corrosion. The coupling shall be capable of passing the proof pressure test (see 4.5.2).

3.6.7 Sand and Dust: The coupling assembly shall show no damage such as cracking of internal parts, evidence of malfunction when tested as specified in 4.5.7 and shall pass the proof pressure test (see 4.5.2).

3.6.8 Flexure Performance: The coupling assembly, when tested as specified in 4.5.8 with a 3° tubing misalignment and flexed at ±0.5° for 28,800 cycles followed by the proof pressure test, shall show no evidence of leakage, rupture, permanent set, permanent deformation or damage.

3.6.9 Surge Pressure: The coupling assembly shall withstand 50,000 pressure surge cycles without evidence of malfunction or leakage when tested at room temperature as specified in 4.5.9.

3.6.10 Burst Pressure:

3.6.10.1 Burst Pressure at Temperature Extremes: The coupling assembly shall not rupture nor show evidence of leakage at any pressure when tested as specified in 4.5.10.1.

3.6.10.2 Burst Pressure at Room Temperature: The coupling assembly shall not rupture nor show evidence of leakage at any pressure when tested as specified in 4.5.10.2.

3.6.11 Electrical Bonding: For Type II coupling only. The electrical resistance of the coupling assembly when measured from tube to tube, across the coupling, shall not exceed 1.0 Ω when tested as specified in 4.5.11. The coupling design shall include internal bonding provision to meet electrical and lightning protection requirements of MIL-STD-464.

3.7 Maintainability:

The coupling assembly when installed in aircraft shall not require periodic maintenance. The seals installed in the coupling shall be easily replaceable with no damage to other parts and shall be able to be removed with a minimum of disturbance or displacement of the installed coupling and tubing. The coupling system maintainability requirements shall be integrated with the over all aircraft system maintainability programs. The guidelines for aircraft system maintainability programs and details relating to component and subsystem performance maintainability can be found in MIL-HDBK-470 and MIL-HDBK-471 respectively.

3.8 Reliability:

The coupling assembly shall be designed to withstand the strains, vibrations, temperature environment incident to aircraft installation and services usage. The reliability of the coupling assembly shall be an integral part of reliability requirements of the total aircraft systems.

3.9 Part Numbering of Interchangeable Parts:

All parts having the same manufacturer's part number shall be interchangeable.

3.10 Identification Marking of Product:

The coupling assemblies shall have the following markings (see 6.5):

AS5356-XXX (size, material, and dash number)
Manufacturer's name
Material code
Type (Type 1 or Type 2)

3.11 Workmanship:

The coupling shall be fabricated and finished with no defects, cracks, burrs, tool marks, or sharp edges. All dimensions shall be kept within the tolerances specified.

4. VERIFICATION:

4.1 Classification of Inspection:

a. First article inspection (see 4.2)
b. Conformance inspection (see 4.3)

4.2 First Article Inspection:

First article inspection shall consist of all examinations and tests specified in Table 4.

TABLE 4 - First Article Test

Item	Test Description	Design Requirement	Test Method
1	Visual examination	3.6.1.1	4.5.1
2	Proof pressure test	3.6.2	4.5.2
3	Fuel resistant test	3.6.3	4.5.3
4	Vibration	3.6.4	4.5.4
5	Repeated assembly	3.6.5	4.5.5
6	Salt fog	3.6.6	4.5.6
7	Sand and dust	3.6.7	4.5.7
8	Flexure	3.6.8	4.5.8
9	Surge pressure	3.6.9	4.5.9
10	Electrical bonding	3.6.11	4.5.10
11	Burst pressure	3.6.10	4.5.10
12	Disassembly and inspection	3.6.10	4.5.10.3
13	Inspection for delivery	3.6.1.2	4.5.1.2

4.2.1 First Article Samples: Unless otherwise specified in the contract or order, as soon as practicable after the award of the contract or order, the manufacturer shall submit two couplings of each size and material specified in the contract or order and two complete sets of detail and assembly drawings. The samples shall be representative of the construction, workmanship, components, and materials to be used during production. When a manufacturer is in continuous production of these units from contract to contract, submission of further first article samples on a new contract may be waived at the discretion of the acquiring activity (see 6.2d). Approval of the first article samples or the waiving of the first article inspection does not waive the requirements of submitting to the quality conformance inspection.

4.2.2 First Article Data: Upon completion of the first article inspection test, the activity responsible for conducting the test (see 6.2d) shall report to contracting activity or procuring activity, the results of the test with appropriate recommendations (6.3).

4.3 Conformance Inspection:

Conformance inspection shall consist of:

a. Individual inspection (see 4.3.1)
b. Sampling inspection (see 4.3.2)

4.3.1 Individual Inspection: Each coupling shall be visually examined to determine that the coupling complies with the requirements specified in 4.5.1. Any coupling failing to pass the examination shall be rejected.

4.3.2 Sampling Inspection: The sample size shall be selected in accordance with ANSI/ASQCZ1.4 inspection level I, acceptable quality level (AQL) as specified in the contract and shall pass the tests listed in Table 5, except to be performed at room temperature. If this sample fails to pass this test, the lot represented by this sample shall be rejected.

TABLE 5 - Conformance Inspection

Item	Test Description	Design Requirement	Test Method
1	Visual examination	3.6.1.1	4.5.1.1
2	Proof pressure test	3.6.2	4.5.2
3	Fuel resistance test	3.6.3	4.5.3
4	Vibration test	3.6.4	4.5.4
5	Repeated assembly test	3.6.5	4.5.5
6	Electrical bonding	3.6.11	4.5.11

4.3.3 Rejection and Retest: When one or more items from a lot fail the specified test, acceptance of all items in the lot shall be withheld until the extent and cause of failure are determined. When corrections have been made, all tests shall be repeated (see 6.3).

4.3.3.1 Resubmitted Lot: Where a lot has been rejected by the procuring activity or contracting activity, a new sample may be resubmitted for tests, after the manufacturer has corrected the defects and submitted to the procuring activity or contracting activity for approval (see 6.3).

4.4 Test Conditions:

4.4.1 Test Fluid: Unless otherwise specified, the test fluid shall be in accordance with ASTM Reference Fluid A (iso-octane, 100%) or ASTM Reference Fluid B (iso-octane 70%; Toluene, 30%) as defined in ASTM D 471.

4.4.2 Temperature and Pressure: The temperature and pressure specified in Table 6 shall apply to all tests required by this specification.

TABLE 6 - Temperatures and Pressures

Temperature (±5 °F) Ambient	Pressure (±5 psi) Operating	Pressure (±5 psi) Proof	Pressure (±5 psi) Burst
-65 to +200 °F	125	250	375

4.4.3 Test Assembly: Each assembly shall consist of two pieces of tubing, approximately 12.75 inches long, with (AS5131) bead on one end of each tube. The tube assemblies shall be joined by the test coupling as shown in Figure 1 to make up the test assembly. For the fuel resistance test, each test assembly shall be closed on one end. Unless otherwise specified, O-ring seals shall conform to MS29513. If seal leakage occurs during testing, the test coupling shall not be re-torqued. If seal leakage occurs during the tests specified in 4.5.2 (proof pressure test), 4.5.3.1 (high temperature fuel aging phase I), 4.5.3.2 (high temperature fuel aging phase II), 4.5.3.3 (low temperature fuel aging), and 4.5.4 (vibration tests), record the cause of failure, the name of the test and when failure occurred, install a new seal or seals and continue the test (see 6.3).

4.4.4 Tubing Wall Thickness: The tubing used in testing the coupling shall have a minimum wall thickness as specified in Table 3.

4.5 Inspection Methods:

4.5.1 Visual Examination:

4.5.1.1 Coupling: The coupling shall be visually examined to determine conformance to this specification with respect to configuration, dimensions, weight and roughness of machined surface.

4.5.1.2 Inspection for Delivery: The fully prepared shipping container, containing couplings, shall be visually examined to determine that the packaging, packing and marking conform to Section 5 of this specification.

4.5.2 Proof Pressure: The coupling test assembly shall be subjected to a proof pressure of 250 psig at +200 °F for 5 minutes using ASTM Reference Fuel B. After completion of this test, drain the test assembly and refill with ASTM Reference Fuel A test fluid and repeat proof pressure test at 250 psig and -65 °F for a period of 5 minutes. Any leakage, rupture, permanent set, permanent deformation, or damage of any part of the test coupling shall be cause for rejection.

4.5.3 Fuel Resistance Test:

4.5.3.1 Phase I - High Temperature Fuel Aging: ASTM Reference Fuel B test fluid shall be circulated in a coupling test assembly for 72 hours while at 200 °F and 125 psig. During the final 8 hours of this test, the assembly shall be vibrated in accordance with 4.5.4. Upon completion, and while still mounted in accordance with 4.5.4, the coupling test assembly shall be proof tested at 250 psig and +200 °F and held at that pressure and temperature for a minimum of 1 minute. There shall be no evidence of leakage or deformation of the coupling. Any leakage or damage to the coupling shall be cause for rejection.

4.5.3.2 Phase II - High Temperature Fuel Aging: ASTM Reference Fuel A test fluid shall be circulated in a coupling test assembly for 72 hours with the fluid at +200 °F and 125 psig. During the final 8 hours of this test, the assembly shall be vibrated in accordance with 4.5.4. Upon completion of the vibration test, and while still mounted in accordance with 4.5.4, the coupling test assembly shall be proof tested at 250 psig and +200 °F with the pressure and temperature held for a minimum of 1 minute. There shall be no evidence of leakage or deformation of the coupling. Any leakage or damage to the coupling shall be cause for rejection.

4.5.3.3 Low Temperature Fuel Aging: ASTM Reference Fuel A test fluid shall be circulated in a coupling test assembly for 72 hours with the fluid at 250 psig and -65 °F. During the final 8 hours of this test, the coupling assembly shall be vibrated in accordance with 4.5.4. Upon completion of the vibration test, and while still mounted in accordance with 4.5.4, the assembly shall be proof tested at 250 psig and at -65 °F with the pressure and temperature held for a minimum of 1 minute. There shall be no evidence of leakage or deformation of the coupling. Any leakage or damage to the coupling shall be cause for rejection.

4.5.3.4 Air Dry Out: Upon completion of the low temperature fuel aging test, the coupling test assembly shall be drained, cap or caps removed, and the coupling test assembly with both ends open shall be placed in an air oven for 168 hours at +200 °F. The low temperature fuel-aging test of 4.5.3.3 shall be repeated upon completion of the air dry out test.

4.5.4 Vibration Test:

4.5.4.1 Vibration Test Setup: The coupling test assembly shall be mounted on a vibration test fixture as shown in Figure 2 with an angular displacement of 3° between tube centerline. The distance between test assembly and table supports, with the coupling located in the center of the assembly, shall be 20 inches for all sizes. The X and Y axes of the test assembly shall be parallel to the vibration table and the direction of vibration shall be perpendicular to the vibration table.

4.5.4.2 Vibration Test: The vibration shall be conducted in accordance with MIL-STD-810 method 514.3 and the applicable test conditions of Table 7.

4.5.5 Repeated Assembly: The coupling assembly shall be tested with repeated assembly and disassembly for 25 operations. There shall be no evidence of damage or degradation in the connecting ability of the coupling. After the repeated assembly, the coupling assembly shall be subjected to the proof pressure test as specified in 4.5.2. Any leakage or malfunction shall be cause for rejection of the coupling assembly.

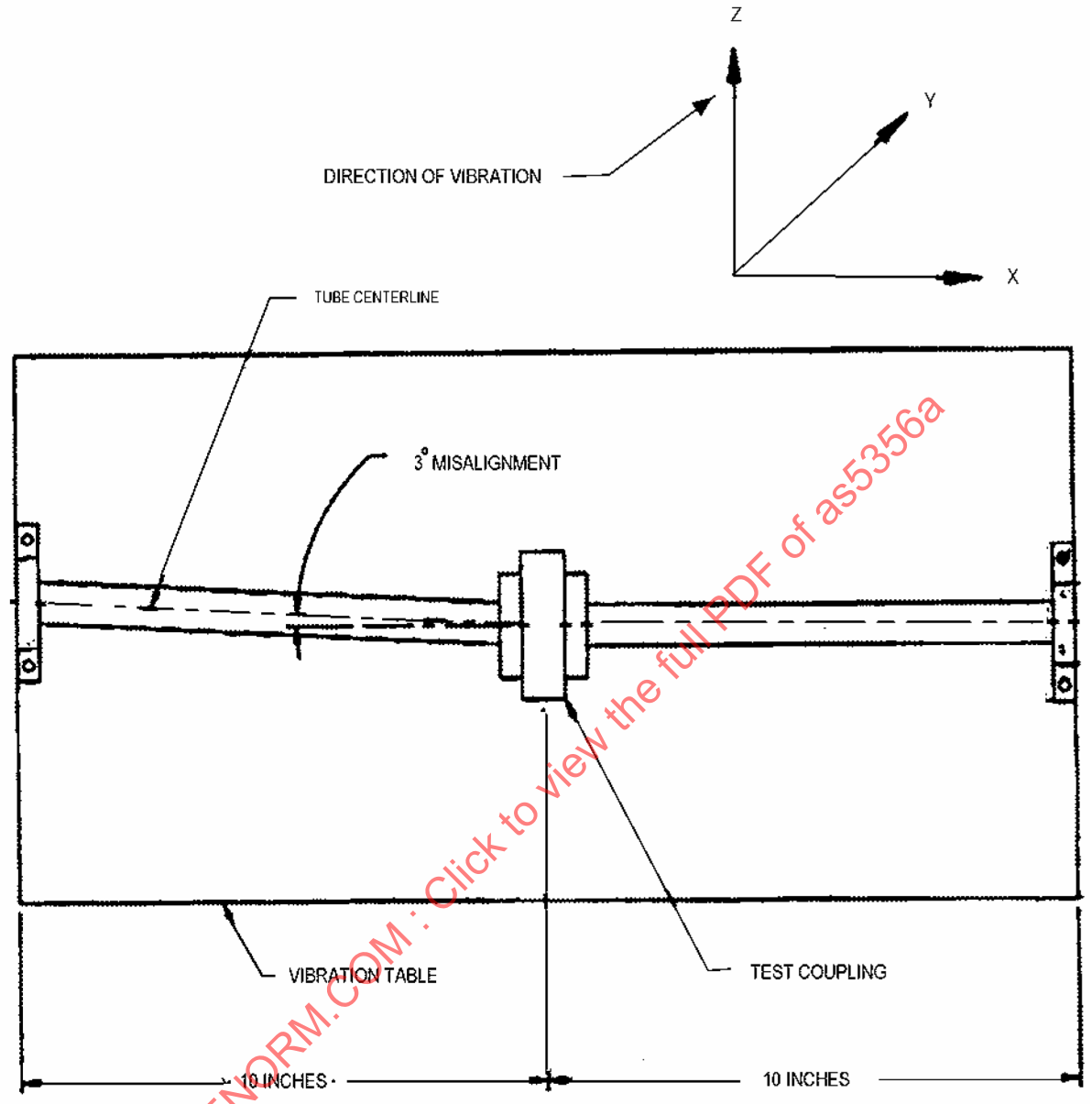

FIGURE 2 - Vibration Test Setup

TABLE 7 - Vibration Tests

Type of Equipment	MIL-STD-810E Test Procedure	MIL-STD-810E Test Conditions
Propeller aircraft or jet engine	I	I - 3.4.1
Jet aircraft	I	I - 3.4.2
Helicopter	I	I - 3.4.3
Ground vehicles	I	I - 3.4.7

4.5.6 Salt Fog: The coupling test assembly shall be exposed to salt fog for 168 hours in accordance with MIL-STD-810, method 509.2. After the 168 hours of exposure the test specimen shall be examined for evidence of corrosion or other damage of the finish. The proof pressure test shall then be performed in accordance with 4.5.2. Any leakage or failure shall be cause for rejection of the test coupling.

4.5.7 Sand and Dust: The coupling test assembly shall be mounted in a dust chamber and the sand and dust test conducted in accordance with MIL-STD-810, method 510.1. After the test, the coupling test assembly shall be subjected to the proof pressure test in accordance with 4.5.2 using ASTM Reference Fluid B for leakage and malfunction. Any leakage or malfunction during the test shall be cause for rejection of the test coupling.

4.5.8 Flexure: The tubing on one side of the coupling test assembly shall be rigidly fixed while the other tube shall be mounted eccentrically on a power driven spindle. The test setup shall provide 1° flexure in any direction with an initial 3° misalignment between the tubing center- lines. ASTM Reference A fuel shall be introduced into the coupling test assembly at a pressure of 12 psig (see Figure 3). The test fluid temperature shall be maintained at +200 °F for the first 4 hours test period and -65 °F during the second 4 hour period. The test assembly shall be flexed for 8 hours at a minimum frequency of 60 cycles per minute (cpm).

At the completion of the test, a proof pressure test shall be conducted at a pressure of 250 psig and -65 °F for 3 minutes. There shall be no evidence of leakage, rupture, permanent set, permanent deformation or damage of any part of the coupling. Any leakage or damage of the coupling during the test shall be cause for rejection of the test coupling.

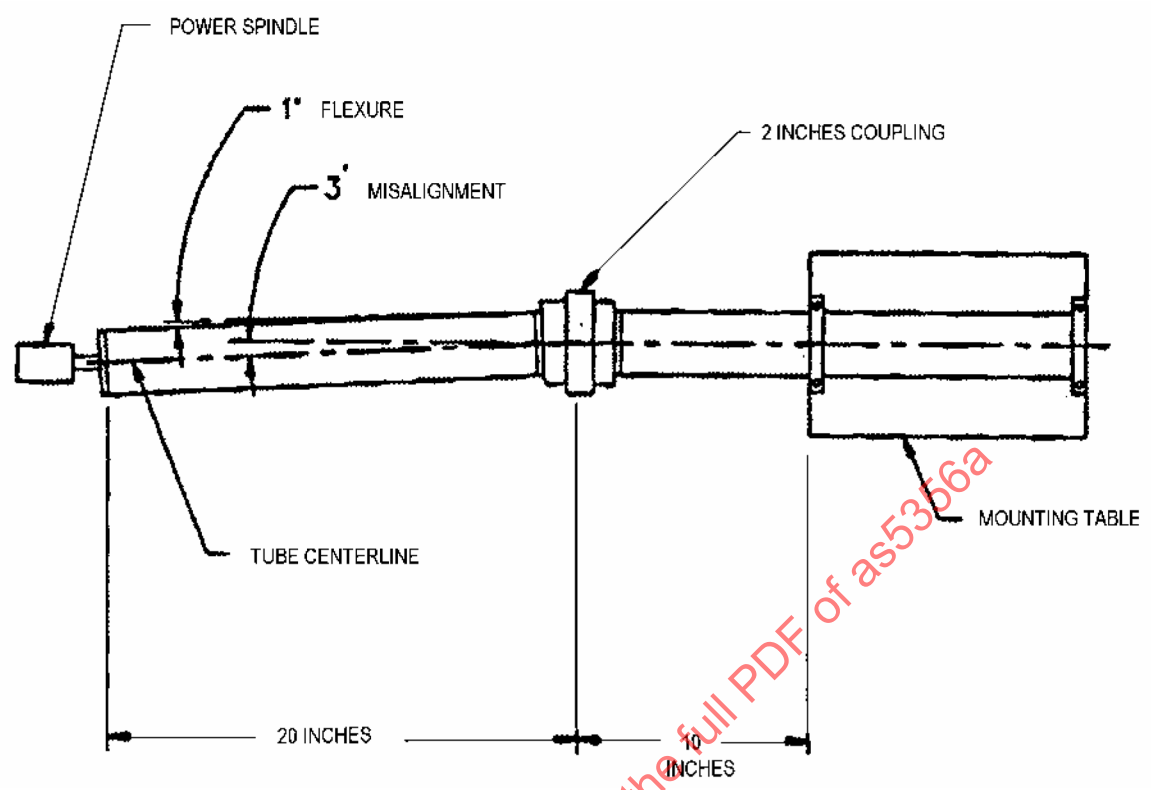

FIGURE 3 - Flexure Test

4.5.9 Surge Pressure:

4.5.9.1 Test Setup: Two 2 inch couplings shall be assembled with three lengths of 2 inches OD x 0.035 inch wall thickness, type 6061-T6 aluminum alloy tubing (see Table 1) to make up a pressure surge cycle test assembly (see Figure 4). Two test assemblies shall be used as shown in Figure 5.

a. The middle section of the tube assemblies shall be in the form of a capped or plugged tee. One end of the assembly shall be capped and ported through the cap for connection of an adapter to provide for filling of fluid and pressurization. The other end shall be capped and ported to accept a pressure transducer with a response in the order of 30 milliseconds (ms) (see Figure 5).

b. Each tube assembly shall be filled with ASTM Reference Fuel A test fluid and mounted so that movement of the tube assemblies shall not be restricted.

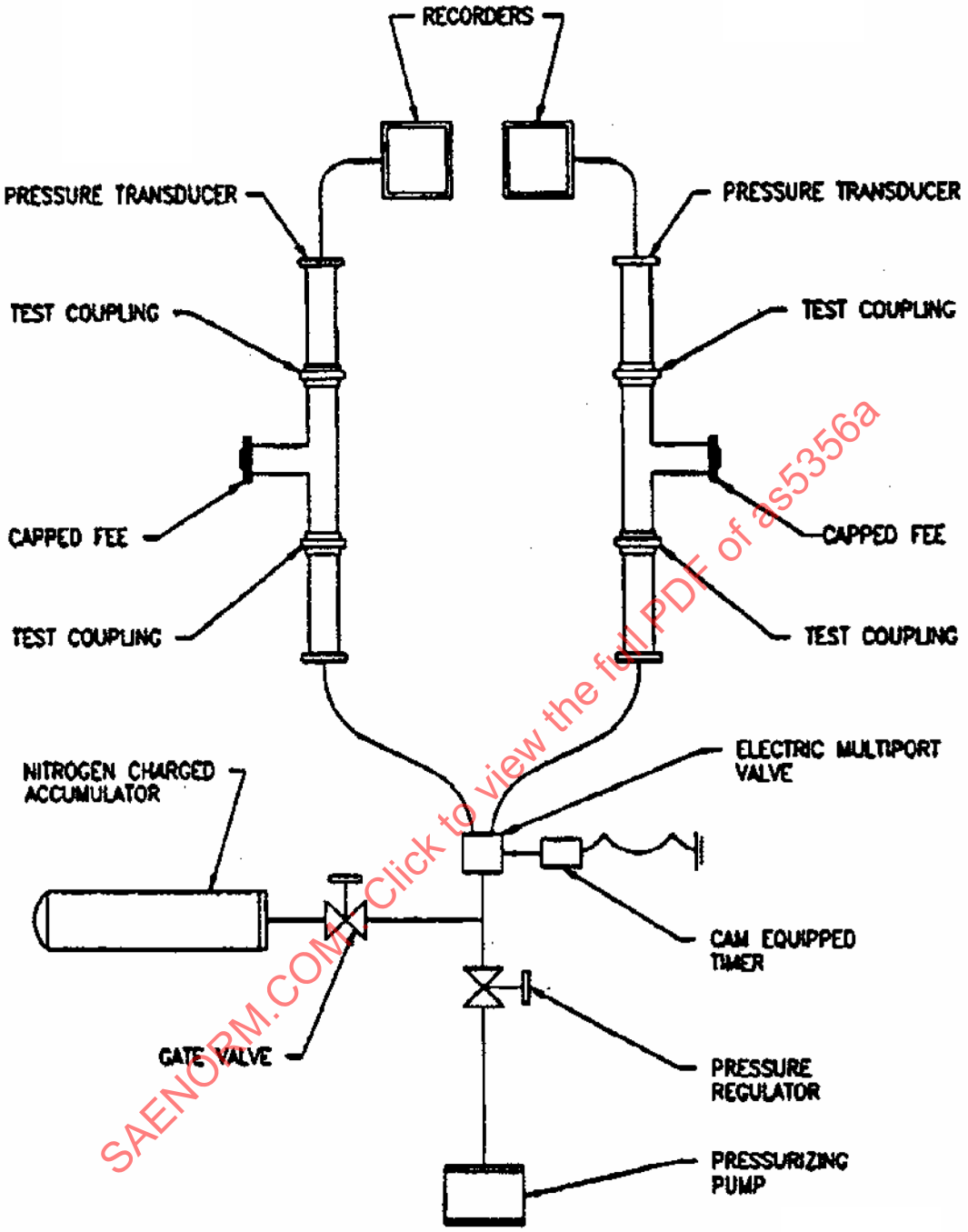

FIGURE 4 - Surge Pressure Test Set-Up

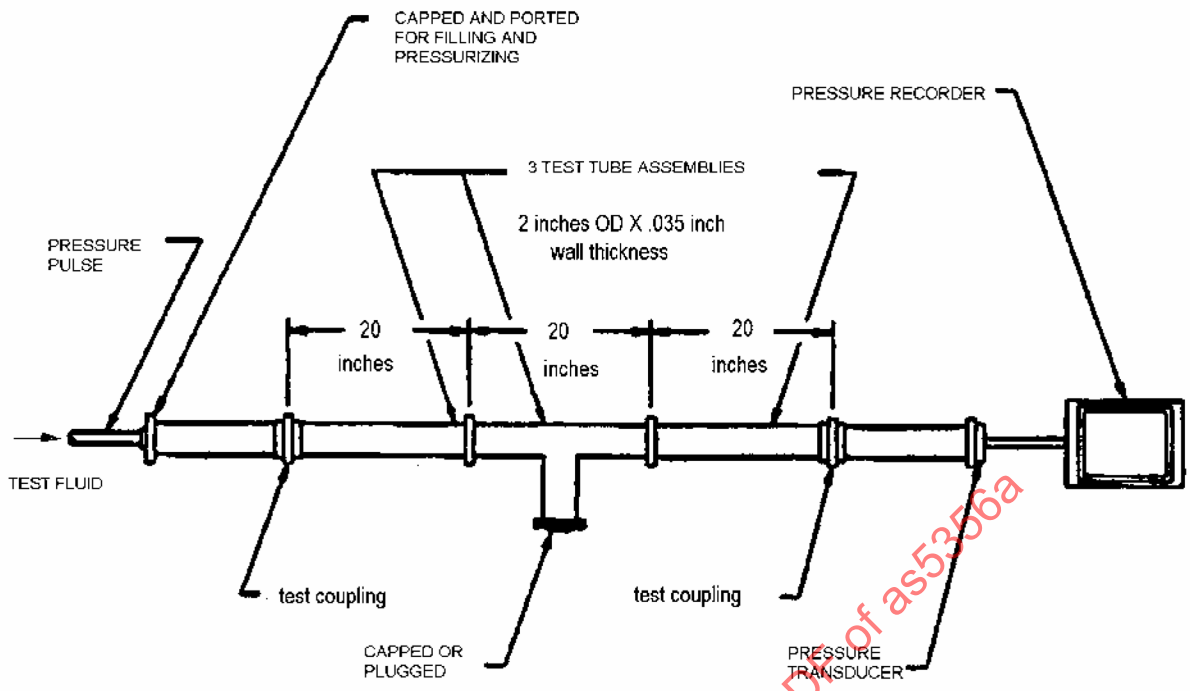

FIGURE 5 - Surge Pressure Test System

4.5.9.2 Pressurization Source: The pressurization source shall be designed to impose a pressure of 0 to 180 psig and back to 0 psig in a time period of 60 milliseconds (ms) with a rate of cycling of one cycle every 2 seconds. Means shall be provided to vary this pressure to each assembly in alternate operation.

a. The pressurizing system shall also include means to ensure a constant pressure being applied to the assembly at each cycle.

4.5.9.3 Instrumentation: Each coupling test assembly shall have its pressure transducer connected to a pressure recorder equipped with a galvanometer and electronic counter to record the cycling pressure of each assembly (see Figure 5).