

Fittings, Tube, Fluid Systems, Separable, Beam Seal,
3000/4000 psi, General Specification For

FSC 4730

RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

NOTICE

This document has been taken directly from U.S. Military Specification MIL-F-85421B, Supplement 1 and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-F-85421B, Supplement 1. Any part numbers established by the original specification remain unchanged.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

Under Department of Defense policies and procedures, any qualification requirements and associated qualified products lists are mandatory for DOD contracts. Any requirement relating to qualified products lists (QPL's) has not been adopted by SAE and is not part of this technical report.

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1. SCOPE:

1.1 Scope:

This specification covers the design requirements and test procedures for separable beam seal fittings which includes end fittings (see 6.10.3), fitting bodies (see 6.10.6), and boss fittings (see 6.10.1) for use in aerospace fluid systems. Design requirements are for class 3000 in corrosion resistant steel (CRES) only and for class 4000 in titanium alloy (Ti) only. Definition of fittings and related terms are defined in 6.10.

1.2 Classification:

Fittings shall be of the following type and pressure classes of the hydraulic system as specified below:

1.2.1 Type:

- a. Type II System - Temperature range -65°F to +275°F (-54°C to +135°C).

1.2.2 Pressure Classes:

- a. Class 3000 - 3000 psi (21,000 kPa) nominal operating pressure where the cutout pressure at the main pressure controlling device is 3000 psig $\pm 15\%$ (21,000 kPa $\pm 15\%$).
- b. Class 4000 - 4000 psi (28,000 kPa) nominal operating pressure where the cutout pressure at the main pressure controlling device is 4000 psig $\pm 15\%$ (28,000 kPa $\pm 15\%$).

2. APPLICABLE DOCUMENTS:

2.1 Government documents:

- 2.1.1 Specifications, standards, and handbooks: The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issue of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

PPP-B-601 Boxes, Wood, Cleated-Plywood

MILITARY

MIL-P-116 Preservation, Methods of
MIL-C-5501 Caps and Plugs, Protective, Dust and Moisture Seal, General Specification for
MIL-H-5606 Hydraulic Fluid, Petroleum Base; Aircraft, Missile and Ordnance

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2.1.1 (Continued):

MIL-S-8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter, General Specification for
MIL-B-43666	Boxes, Shipping, Consolidation
MIL-L-46010	Lubricant, Solid Film, Heat Cured, Corrosion Inhibiting
MIL-H-83282	Hydraulic Fluid, Fire-Resistant, Synthetic Hydrocarbon Base, Aircraft, Metric, NATO Code Number H-537

STANDARDS

MILITARY

MIL-STD-100	Engineering Drawing Practices
MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129	Marking for Shipment and Storage (Part 1 of 4 Parts)
MIL-STD-280	Definitions of Item Levels, Item Exchangeability, Models and Related Terms
MIL-STD-2073-1	DoD Material Procedures for Development and Application of Packaging Requirements

SPECIFICATION SHEETS

MIL-F-85421/1	Fitting End, Standard Dimensions For Beam Seal, Male
MIL-F-85421/2	Fitting End, Standard Dimensions For Bulkhead, Beam Seal, Male
MIL-F-85421/3	Tee, Reducer, Beam Seal, 3000/4000 psi, 3 Male Ends
MIL-F-85421/4	Tee, Reducer, Beam Seal, 3000/4000 psi, Male on Run, Swivel Nut On Branch
MIL-F-85421/5	Tee, Reducer, Beam Seal, 3000/4000 psi, Male on Run and Branch, Swivel Nut on Run
MIL-F-85421/10	Adapter, Beam Seal, 3000/4000 psi, Male To Flareless
MIL-F-85421/11	Union, Beam Seal, 3000/4000 psi, Male Ends
MIL-F-85421/12	Elbow, 90°, Beam Seal, 3000/4000 psi, Male to Male
MIL-F-85421/13	Elbow, 90°, Beam Seal, 3000/4000 psi, Bulkhead, Male Ends
MIL-F-85421/14	Elbow, 90°, Beam Seal, 3000/4000 psi, Male To Female
MIL-F-85421/15	Elbow, 45°, Beam Seal, 3000/4000 psi, Bulkhead, Male Ends
MIL-F-85421/16	Tee, Beam Seal, 3000/4000 psi, Bulkhead on Run, 3 Male Ends
MIL-F-85421/17	Tee, Beam Seal, 3000/4000 psi, Bulkhead on Branch, Male Ends

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the DODSSP, Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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- 2.1.2 Other Government documents, drawings, and publications: The following other Government documents, drawings and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

UNITED STATES GOVERNMENT PRINTING OFFICE

GPO Style Manual

(Copies of the GPO Style Manual are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-0001.)

- 2.2 Non-Government publications:

The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR MECHANICAL ENGINEERS

ASME-B46.1 Surface Texture

(Application for copies should be addressed to the American Society for Mechanical Engineers, 345 East 47th Street, New York, NY 10017.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM-D3951 Packaging, Commercial

ASTM-D1974 Fiberboard Shipping Containers, Methods of Closing, Sealing, and Reinforcing, Standard Practice for

(Applications for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE-AIR1377 Fire Test Equipment for Flexible Hose and Tube Assemblies

SAE-AMS4921 Titanium, Bars, Forgings, and Rings, Annealed, 70,000 psi (485 Mpa) Yield Strength (DoD Adopted)

SAE-AMS4928 Titanium Alloy, Bars, Forgings, & Rings 6AL-4V, Annealed, 120,000 PSI (825 MPA) Yield Strength (DoD Adopted)

SAE-AMS4945 Titanium Alloy Tubing, Seamless, Hydraulic - 3.0Al - 2.5V, Texture Controlled, 105,000 PSI (724 MPA) Yield Strength

SAE-AMS4965 Titanium Alloy, Bars, Forgings, & Rings, 6.0 Al - 4.0V, Solution & Precipitation Heat Treated (DoD Adopted)

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2.2 (Continued):

SAE-AMS5561	Tubing, Steel, Welded & Drawn, Corrosion & Heat Resistant 9.0Mn - 20 Cr - 6.5Ni - 0.28N, High Pressure Hydraulic (DoD Adopted)
SAE-AMS5637	Steel Bars, Corrosion Resistant 18 Cr - 9.0Ni (SAE 30302) Cold Drawn, 125,000 PSI (860 MPA), Tensile Strength
SAE-AMS5643	Steel Bars, Forgings, Tubing and Rings, Corrosion Resistant, 16 Cr-4.0 Ni- 0.30 (Cb+Ta)-4.0 Cu Solution Heat Treated
SAE-AMS5656	Bar, Steel, Forgings & Rings, Corrosion Resistant 9.0Mn - 20Cr - 6.5Ni - 0.27N (DoD Adopted)
SAE-AMS5659	Bar, Forgings, and rings, and Extrusions Corrosion Resistant 15 Cr 0 45 Ni - 0.30 (CD+Ta) - 3.5 Cu Consumable Electrode Melted Solution Heat Treated, Precipitation Hardenable (DoD Adopted)
SAE-ARP603	Hose, Hydraulic, Tubing & Fitting Assemblies, Impulse Testing of (DoD Adopted)
SAE-ARP1185	Flexure Testing of Hydraulic Tubing Joints and Fittings
SAE-AS1055	Hose, Flexible, Tube Assemblies, Coils, Fittings & System Components, Fire Testing of (DoD Adopted)

(Copies of SAE publications may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15098.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence:

In the event of conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets, or MS standards), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS:

3.1 Specification sheets:

The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of conflict between the requirements of this specification and the specification sheet, the specification sheet shall govern.

3.2 Qualification:

The fittings and fitting bodies furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.3 and 6.6).

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3.3 Material:

- 3.3.1 Fittings: The material used shall be titanium alloys and corrosion resistant steels as specified in Table I. The corrosion resistant steel fittings are designed for class 3000 system. The titanium fittings are designed for class 4000, but may be used in both class 3000 and class 4000 systems. The material shall be heat treated, as required, and have surface protection to meet the test requirements of this specification. Recycled materials shall be utilized to the maximum extent possible provided the materials used conform to the applicable material specifications.

TABLE I. Fitting and tubing materials.

Item Name	Titanium (Class 4000)	CRES (Class 3000)
Nuts Internally Threaded	SAE-AMS4965	SAE-AMS5643 or SAE-AMS5659 Condition H1075
Fitting Bodies	SAE-AMS4965, SAE-AMS4928, SAE-AMS4921	SAE-AMS5643 or SAE-AMS5659 Condition H1075 or SAE-AMS5656
Tubing	SAE-AMS4945	SAE-AMS5561
Swivel Wires	SAE-AMS5637 Protected with Solid Film Lubricant per MIL-L-46010 Type I	

- 3.3.2 Tubing: The tubing used for the fabrication of the test fitting assemblies shall be in accordance with Tables I and II.

3.4 Design and construction:

- 3.4.1 Configuration and dimensions: The configuration and dimensions shall conform to requirements of this document and the design requirements specified on the applicable specification sheets of MIL-F-85421/1 through MIL-F-85421/5 and MIL-F-85421/10 through MIL-F-85421/17.
- 3.4.2 Drill offset: On fittings where the fluid passage is drilled from each end, the offset between the drilled holes at the meeting point of the drills shall not exceed .015 inch (.4mm). Angular misalignment shall not exceed two degrees.
- 3.4.3 Reduction in fluid passage (bore) cross-section: Straight and nonreducer shape fittings shall be bored through out the passage such that a ball having a diameter, .020 inch (.5mm) less than the minimum specified bore shall pass through the passage. For nonstraight and nonreducer shape fittings (such as crosses, tees, and elbows etc.) the cross-sectional area at the junction of the fluid passage shall not be smaller than the cross-sectional area of the smallest passage.

TABLE II. Fitting and tubing data and stress level for flexure test.

Tubing Size			3000 PSI (21,000 kPa) Operating Pressure CRCS Tubing				4000 PSI (28,000 kPa) Operating Pressure Ti Tubing			
Dash No	OD		Wall Thickness		Stress		Wall Thickness		Stress	
	in	mm	in	mm	psi	kPa	in	mm	psi	kPa
-03	.188	4.76	.020	.508	24,000	168,000	.020	.508	20,000	140,000
-04	.250	6.35	.020	.508	24,000	168,000	.020	.508	19,000	133,000
-05	.313	7.94	.020	.508	24,000	168,000	.028	.711	18,000	126,000
-06	.375	9.53	.020	.508	22,000	154,000	.028	.711	18,000	126,000
-08	.500	12.30	.026	.660	20,000	140,000	.035	.889	17,000	119,000
-10	.625	15.88	.033	.838	18,000	126,000	.044	1.118	17,000	119,000
-12	.750	19.05	.039	.991	16,000	112,000	.052	1.320	17,000	119,000
-14	.875	22.22	-	-	-	-	.061	1.549	16,000	112,000
-16	1.000	25.40	.052	1.32	15,000	105,000	.070	1.778	13,000	91,000
-20**	1.250	31.75	.032*	.813	15,000	105,000	.088	2.235	13,000	91,000
-24**	1.500	38.10	-	-	-	-	.054*	1.372	4,000	28,000

LEGEND:

* 500 psig (3800 kPa) systems for suction lines.

** Sizes -20 and -24 were originally designated as -21 and -25 on revision A of this specification. These sizes will not connect with the original -20 and -24 fittings. See 6.5 for additional information.

Notes:

1. All test assembly wall thicknesses and lengths are shown in Table II and Table IV.
2. Stress values specified are the minimum bending stress for the flexure test per 4.6.6.
3. For test purposes, tubing diameters and wall thicknesses shall be per Table II. If different tube thicknesses are used for aircraft design, additional tests may be required. For use of tubing wall thickness less than .020 inch (.5 mm), special approval must be obtained from the contracting activity.

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- 3.4.4 Tube attachment: The method of joining the tubing to the end fitting (brazing, welding, mechanical attachment, swaging, etc.) shall not adversely affect the properties, strength, or geometry of tubing or end fitting. The joint shall be of a quality compatible with the design and performance requirements of this specification and shall permit inspection by direct measurement, x-ray, or other means.
- 3.4.5 Installation tooling: Size of tool envelope required to install fittings on tubing in aircraft shall be kept to a minimum. The wrench flats or pads of the fittings shall permit use of standard wrenches.
- 3.4.6 Fitting body design: Fitting body shall be designed to prevent failure (see 6.10.4) of sealing surfaces. The sealing interface shall be integral with the fittings. Removable seals are not permitted. Prior to assembly, the female nut shall be pull back in such position that the threaded end of the nut is flush within ± 0.0625 inch (± 1.59 mm) of the outer beam surface. When assembled the fitting body to maximum torque (see 6.10.9) the gap between the threaded end of the nut and hex face of the male fitting body shall be a minimum of .030 inch (.8 mm).
- 3.4.7 Fitting body interface: All male and female end fittings shall be tested using fitting bodies with end configurations conforming to the design standards MIL-F-85421/1 and MIL-F-85421/2. All male fitting bodies tested shall be interchangeable with male fitting bodies dimensioned as shown in the design standards.
- 3.4.8 Threads: All threads shall be in accordance with MIL-S-8879. The surface finish of the thread flanks shall be 63 microinches Ra per ASME-B46.1. Internal threads shall be coated with solid film lubricant per MIL-L-46010, Type I.
- 3.5 Performance:
- The fitting assemblies (see 6.10.5) shall meet the performance requirements of 3.5.1 through 3.5.8.
- 3.5.1 Proof pressure: The fitting assembly shall withstand pressure equal to twice the nominal operating pressure of the system for five minutes without leakage, evidence of permanent deformation, or other malfunction that shall affect assembly or disassembly using the torque values per Table III when tested in accordance with 4.6.2.
- 3.5.2 Burst pressure: The fitting assembly shall not rupture or leak (no more than allowable) at any pressure less than or equal to four times the nominal operating pressure. The test shall be conducted in accordance with 4.6.3 for a minimum of five minutes at burst pressure. The fitting assembly shall not have to meet any disassembly or assembly requirements after this test.

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TABLE III. Torque requirements.

Fitting Size		03	04	05	06	08	10	12	14	16	20	24
Minimum Torque	in-lb	97	151	173	270	432	594	756	918	1242	1512	1620
	N-m	11	17	20	31	49	67	85	104	140	171	183
Maximum Torque	in-lb	108	168	192	300	480	660	840	1020	1380	1680	1800
	N-m	12	19	22	34	54	75	95	115	156	190	203

- 3.5.3 Thermal shock: The fitting assembly shall withstand the temperature and pressure when tested in accordance with 4.6.4 without leakage, evidence of permanent deformation, or other malfunction that shall affect assembly or disassembly of the fitting.
- 3.5.4 Impulse: The fitting assembly shall withstand 200,000 impulse pressure cycles without leakage (see 6.10.7) from the fitting or the fitting-tube junction when tested in accordance with 4.6.5.
- 3.5.5 Flexure: The fitting assembly shall not leak from the sealing surface or the fitting tube junction prior to completion of ten million cycles at the test stress level specified when tested in accordance with 4.6.6.
- 3.5.6 Repeated connection: The fitting assembly shall withstand 25 repeated connections at the minimum and maximum torque values specified in Table III when tested in accordance with 4.6.7 without:
- Leakage at any of the pressure tests of 4.6.7.
 - Inability to assemble the fitting to the point of interface by hand.
 - Nut deformation preventing engagement of nut hex with open end wrench.
- 3.5.7 Pneumatic leakage: The fitting assembly shall withstand pneumatic pressure equal to the maximum operating pressure for five minutes at room temperature without any visible bubbles starting after one minute at pressure or other malfunction that would affect assembly or disassembly using the minimum torque values specified in Table III when tested in accordance with 4.6.8.
- 3.5.8 Fire: The fitting assembly shall withstand a 2000°F (1093°C), 4500 btu/hr (1320 watts) flame for 15 minutes when tested in accordance with 4.6.9. Heat input shall be measured by a .500 inch (12.7 mm) copper tube per SAE-AIR1377. There shall be no leakage detected by visual observation or failure of the test assembly prior to the specified time.
- 3.6 Part numbering of interchangeable parts:

All parts having the same design activity CAGE CODE (Contracting and Government Entity) and part number shall be interchangeable as defined in MIL-STD-280. The item identification and part number requirements of MIL-STD-100 shall govern the design activity part numbers and changes thereto.

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3.7 Dimensions and tolerances:

All pertinent dimensions, threads and tolerances, where interchangeability, operation, or performance of the fitting may be affected, shall be as specified on the MS drawings or specification sheets.

3.8 Weight:

Fitting weights shall not exceed to those values shown on the applicable specification sheets.

3.9 Identification of product:

All fittings shall be identified in accordance with 3.9.1 and 3.9.2.

3.9.1 Marking method: Marking shall be impressed, embossed, laser etched, or electrochemical etched in a location and in a manner not detrimental to the fitting. Where practical, markings shall remain visible, after fitting is installed.

3.9.2 Markings: All end fittings and fitting bodies shall be marked with the manufacturer's name or trademark, the material identification code, and complete part number as detailed in the applicable specification sheet. If space permits, the manufacturer's part number and the manufacturer's CAGE CODE shall be marked to ensure positive identification. The manufacturer's part number and drawing number shall be the same.

3.10 Workmanship:

Remove all burrs and break all sharp edges. Sealing surfaces shall be free of detrimental, radial, and spiral tool marks. Unless a finer finish is specified on applicable drawings, sealing surfaces shall be smooth to a finish of 45 microinches Ra, as defined in ASME-B46.1. All other machined surfaces shall be smooth to 125 microinches Ra. Unmachined surfaces, such as forging surfaces and bar stock flats shall be free of cracks, laps, and seams.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for inspection:

Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examination and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government 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.

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4.1.1 Responsibility for compliance: All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material (see 6.3).

4.2 Classification of inspection:

The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.3).
- b. Quality conformance inspection (see 4.4).

4.3 Qualification inspection:

The qualification inspection shall consist of the inspection methods conducted in the order shown in Table IV for the applicable assembly styles (see figure 1).

4.3.1 Test sample for the qualifying activity: The contractor shall submit to the qualifying activity sixteen untested sample fitting assemblies for each size and tubing type in accordance with Table IV (see 6.3). Threaded fittings designed for permanent attachment to adjacent tubing shall be assembled in accordance with the joint design feature (swage, braze or weld). The inspection shall be in accordance with 4.6.1.

TABLE IV. Fitting assemblies.

Assembly Numbers	* 1-4	5-6	7-12	13-14	15-16
Assembly Style (See Figure 1)	C	A	A	A	B
Length (See Figure 1)	9"	9"	Per SAE-ARP1185	9"	6"
Qualification Test (Perform in Sequence)	4.6.1 4.6.2 4.6.7 4.6.5	4.6.1 4.6.8 4.6.2 4.6.4 4.6.3	4.6.1 4.6.2 4.6.6	4.6.1 4.6.2 4.6.9	4.6.1 4.6.2 4.6.3

*Two samples with 90° elbows and two samples with bulkhead tees.

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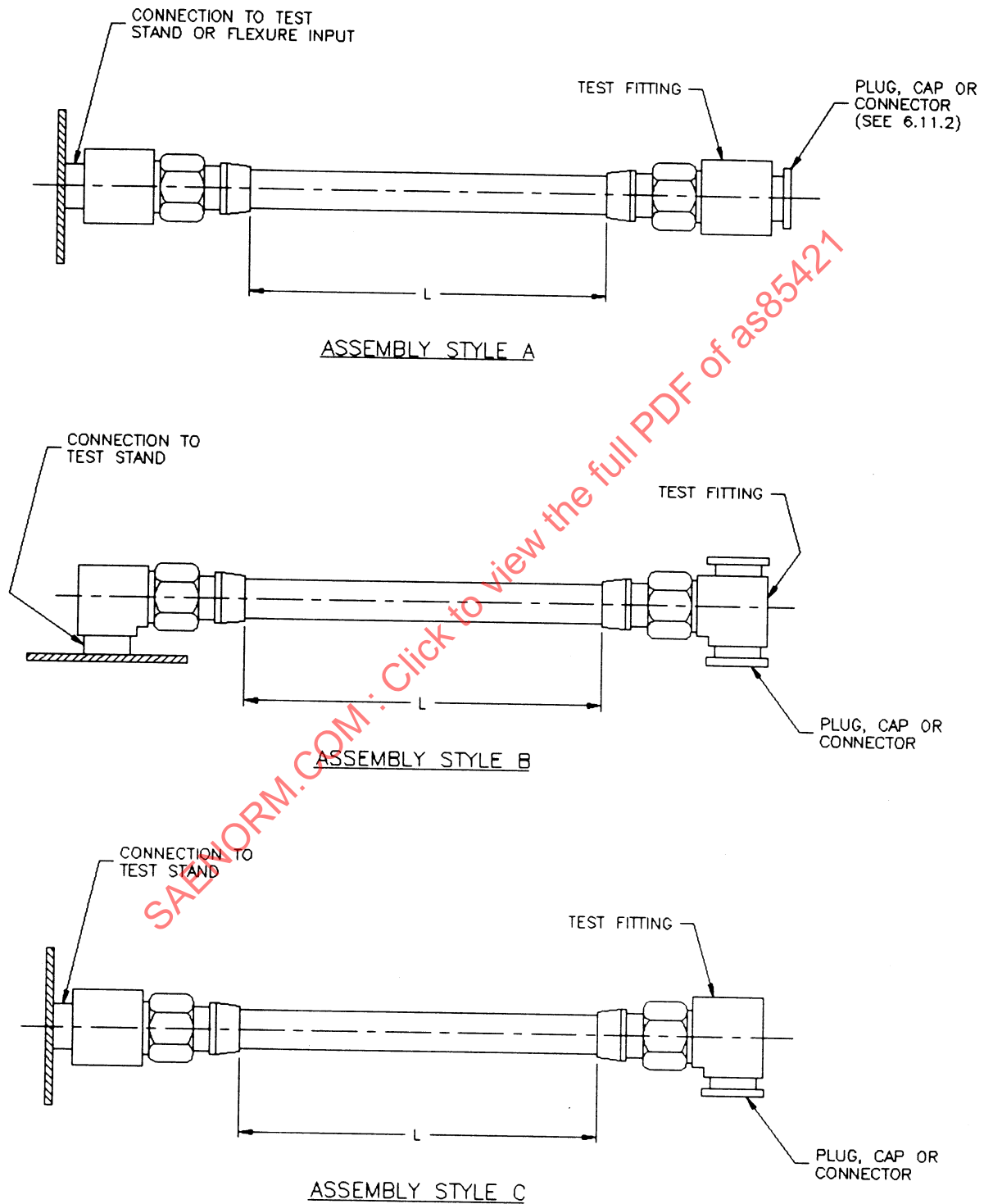


FIGURE 1. Fitting assembly styles for testing.

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4.3.2 Retention of qualification: The retention of qualification shall consist of certification by the manufacturer to demonstrate compliance of the qualified fittings with the requirements of this specification. Certification shall be signed by a responsible official of management, attesting that the listed product(s) is still available from the listed plant, can be produced under the same conditions as originally qualified, i.e., same process, materials, construction, design, manufacturer's part number or designations, and meets the requirements of the current issue of the specification. Certification shall be conducted at intervals not exceeding two years. The activity responsible for certification approval is the qualifying activity (see 6.6).

4.4 Quality conformance inspection:

The following tests shall be conducted from each lot of fittings submitted for inspection. The test sequence shall be in accordance with Table V (see 6.3).

- a. Non-destructive test (see 4.4.2)
- b. Destructive test (see 4.4.3)

TABLE V. Quality conformance test

Test	Design Requirement Paragraph	Inspection Method Paragraph
<u>Non-destructive test</u> Examination of product	3.4.1	4.4.2
<u>Destructive test</u> (perform in sequence)		
(1) Proof pressure	3.5.1	4.6.2
(2) Pneumatic leakage	3.5.7	4.6.8

4.4.1 Inspection sampling: Unless otherwise specified in the contract or purchase order, sample fittings from each lot shall be selected at random in accordance with MIL-STD-105. For non-destructive test the sample inspection shall be level II at an Acceptable Quality Level (AQL), as specified in the contract. For destructive test, the sampling inspection shall be level S-1 at an acceptable quality level of zero percent defects. The sample fittings selected for the destructive test shall be those used for the non-destructive test.

4.4.2 Non-destructive test: The non-destructive test shall be conducted in accordance with the examinations of 4.6.1 and 4.4.2.1.

4.4.2.1 Preparation for delivery: All end fittings, fitting bodies, and fitting assemblies shall be visually examined to ascertain that their preparation for delivery shall be in accordance with section 5 of this specification.

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4.4.3 Destructive tests: The following destructive tests shall be conducted in sequence in the order specified:

- a. Proof Pressure Test 4.6.2.
- b. Pneumatic Test 4.6.8.

After the destructive testing, the test samples shall not be shipped or considered part of the contract or order.

4.4.4 Failure of sampling test: When fittings fail to pass a sampling test, the entire lot (see 6.10.8) represented by the sample shall be rejected. The reason for the failures shall be reported (see 6.3).

4.5 Test conditions:

4.5.1 Test fluids: The test fluids used shall be MIL-H-83282 or MIL-H-5606.

4.5.2 Test temperature: All tests except the burst pressure test, the thermal shock test, the impulse test, and the fire test shall be conducted at an ambient temperature of 60°F (16°C) to 100°F (38°C) and a fluid temperature of 60°F (16°C) to 170°F (77°C).

4.6 Inspection methods:

4.6.1 Examination of product: All end fittings, fitting bodies, and fitting assemblies from each lot shall be examined to determine conformance with this specification and the applicable standards with respect to material, design, dimensions, finish, marking, and workmanship.

4.6.1.1 Material inspection: Fitting and tubing material shall meet the requirements of 3.3. The chemical analysis, mechanical properties, and heat treatment shall be in accordance with the material specifications shown in Table I.

4.6.2 Proof pressure test: Fitting assemblies shall be connected to a pressure source with one end free to move and proof pressure tested at a pressure value equal to two times the nominal operating pressure for a minimum period of five minutes. Use minimum torque values for both ends. Rate of pressure rise shall be 20,000 ±5000 psi (140,000 ±35,000 kPa) per minute. The exterior of the test fitting assembly including the fitting tube joint shall be clean and dry and show no evidence of test fluid prior to testing. At the end of the test, wipe the exterior of fitting assembly with a clean, dry towel and examine for evidence of leakage. Any evidence of fluid on a clean dry towel, after wiping the test connection, shall constitute failure of the test.

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- 4.6.3 Burst pressure test: Fitting assemblies shall be connected to a pressure source and burst pressure tested at a pressure value equal to four times the nominal operating pressure. Use minimum torque values for both ends. The pressure shall be increased at a rate of 20,000 $\pm$ 5000 psi (140,000 $\pm$ 35,000 kPa) per minute until the assembly bursts, leaks or four times the operating pressure is obtained. Test samples 5 and 6 shall be tested at the ambient temperature (see 4.5.2), and test samples 15 and 16 shall be tested at the maximum rated temperature of 275°F (135°C) $\pm$ 10%. No more than one drop of fluid at the joint (both the beam seal end and tube attachment end) is permissible.
- 4.6.4 Thermal shock test: Use MIL-H-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 2. After the test fitting is filled with hydraulic fluid, the ambient temperature of the test chamber shall be reduced to -65°F $\pm$ 2°F (-54°C $\pm$ 1°C) for a minimum of two hours. At the end of this period, while the test chamber is still at -65°F (-54°C), test fluid at 275°F $\pm$ 5°F (135°C $\pm$ 3°C) shall be suddenly introduced into the test assembly at a minimum pressure of 50 psi (350 kPa). Within 15 seconds after the hot fluid has filled the fitting assembly, a proof pressure test shall be performed in accordance with 4.6.2.
- 4.6.5 Impulse test: Test fitting assemblies shall be tested in accordance with SAE-ARP603 with the following deviations or additions. Fittings for 500 psi (3500 kPa) suction systems as designated in Table II shall not be impulse tested.
- a. Duration of test: 200,000 cycles minimum.
 - b. Temperature: 275°F (135°C) $\pm$ 10% for 200,000 cycles.
 - c. Rate of rise: 175,000 to 300,000 psi/second (1,225,000 to 2,100,000 kPa/second).
 - d. Cycling rate: 70 $\pm$ 5 cycles per minute.
 - e. Wave form: Per SAE-ARP603.
 - f. Surge peaks: 140 to 157% of nominal operating pressure.
 - g. Assembly torque: Minimum torque value per Table III.
- 4.6.6 Flexure test: Fitting assemblies shall be tested in accordance with the flexure test procedure of SAE-ARP1185 except as noted herein. For -03 size, the test assembly shall be five inches (127 mm) in length, test samples shall be assembled using maximum torque values per Table III. Fitting assemblies shall be tested to a minimum bending stress indicated in Table II at room temperature with static internal pressure equal to nominal operating pressure maintained. The bending stress shall be calculated from strain values measured with suitable strain gages on each assembly.

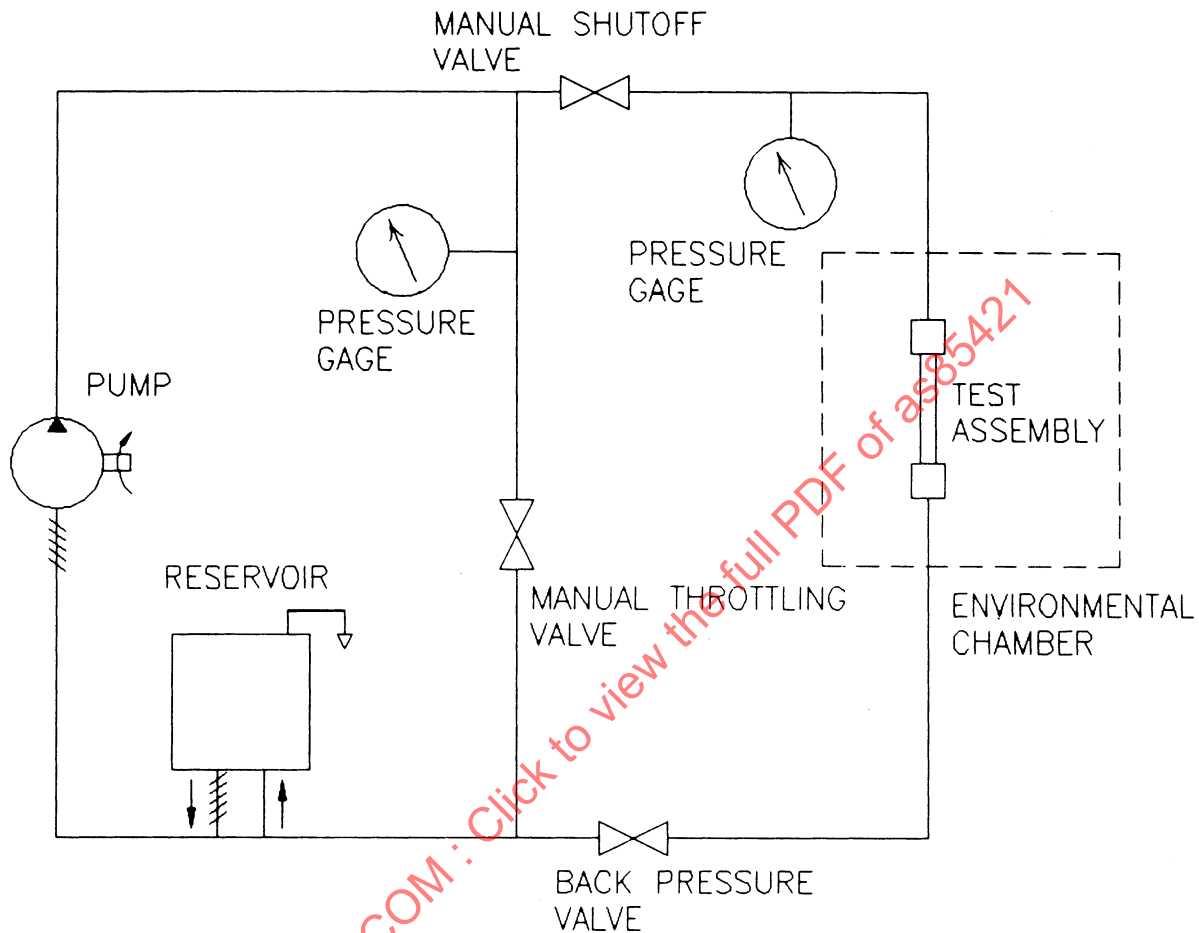


FIGURE 2. Typical setup for thermal shock testing.

- 4.6.6.1 Combined stress: The fitting assemblies shall meet the requirements of combined stress for a specific material used. The combined stress shall be the bending stress produced when tested with 4.6.6 plus the axial stress caused by the internal pressure which is calculated by the following formula:

$$S = P \left(\frac{d^2}{D^2 - d^2} \right)$$

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4.6.6.1 (Continued):

where:

S = axial tensile stress due to internal pressure

P = internal pressure (operating pressure)

d = tube inside diameter

D = tube outside diameter

- 4.6.7 Repeated connection: The fitting assemblies shall be tested by connecting and disconnecting each end a total of 25 times. Initially, one end shall be tightened to maximum torque and the other end shall be tightened to minimum torque with no external lubricant added. After each tightening, the fitting assembly shall be disassembled and the sealing faces shall be rotated 60 to 90 degrees with respect to each other. Then the sealing surfaces and threads shall be lubricated with MIL-H-83282 or MIL-H-5606 fluid and the fitting ends shall be reconnected. After the fifth tightening operation, the fitting assembly shall be subjected to the pneumatic test in accordance with 4.6.8 except the maximum and minimum torques shall be retained. For the next tightening operation, the torque at each end shall be switched from minimum to maximum and vice versa. The pneumatic test shall be performed and the torques shall be alternated after every fifth tightening operation. Any leak during the pneumatic test shall constitute a failure of the test.
- 4.6.8 Pneumatic test: The test assemblies shall be pressure tested at room temperature at a value equal to the nominal operating pressure for a minimum period of five minutes. The test fluid shall be dry, oil free compressed air or nitrogen. The test assemblies shall be prepared without use of oil during assembly or prior to testing. Any oil or grease used for tubing attachment shall be completely removed before test. Test assemblies shall be prepared using minimum torque values specified in Table III. Any visible bubbles or other malfunction that would affect assembly or disassembly shall constitute a failure of the test.
- 4.6.9 Fire test: The assemblies shall be mounted in a horizontal plane that lies on the axis of the burner. One end of each test assembly shall be torqued to minimum torque and the other end torqued to maximum torque per Table III. The portion of the flame in which the assembly is to be tested shall deliver a minimum heat output of 4500 btu per hour (1320 watts) as measured by a .500 inch (12.7 mm) copper tube mounted per SAE-AIR1377. Width of the flame shall be such that the 2000°F (1093°C) temperature shall occur (as measured by thermocouple) for a minimum distance of 8 inches (203 mm). The entire fitting connection plus a length of tubing shall be subjected to the flame. During the test, the end connection subjected to the flame shall be subjected to in-line vibration at the rate of 2000 cycles per minute through a total amplitude of not less than .125 inch (3.2 mm), i.e., a displacement of .063 inch (1.6 mm) each side of the neutral position. The assembly shall be subjected to SAE No. 20 oil at a pressure equal to the rated system pressure and at an oil temperature of 200°F-230°F (93°C-110°C). The flow rate shall be flow in gallons per minute equal to $1 \times \text{the ID}^2$ measured in inches. For tolerances and details of test, refer to SAE-AS1055 and SAE-AIR1377.

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5. PACKAGING:

5.1 Preservation:

Preservation shall be Level A or Commercial as specified (see 6.2).

5.1.1 Level A:

5.1.1.1 Cleaning: All parts shall be free from grease, oil, dirt or any other foreign material. Any process or combination of processes that will accomplish thorough cleaning without damage to the parts shall be acceptable.

5.1.1.2 Preservative: Preservative shall not be used.

5.1.1.3 Unit packing: The unit pack shall be preserved in accordance with Method 1C-10 or Method 1C-3 as specified in MIL-P-116. The threaded ends of the fittings shall be protected with aluminum alloy or rigid plastic caps in accordance with MIL-C-5501. The surface area of the backing board to be used in Method 1C-10 shall be 15 by 12 inches (381 by 305mm). The backing board shall be preprinted or a label enclosed in the unit pack with identification in accordance with MIL-STD-129. The waterproof bag used in Method 1C-3 shall be preprinted or a label enclosed with identification in accordance with MIL-STD-129. The number of items in a unit pack shall be as specified in the contract or order (see 6.2), if it does not specify in the contract or order, it shall be determined in accordance with MIL-STD-2073-1.

5.1.1.4 Intermediate container: Unless otherwise specified, the unit packs shall be packed in intermediate containers in accordance with MIL-STD-2073-1 (see 6.2).

5.1.2 Commercial preservation: Commercial preservation shall be in accordance with ASTM-D3951.

5.2 Packing:

Packing shall be Level A, Level B or Commercial.

5.2.1 Level A: Unit packs preserved as indicated in 5.1.1.3 and packed in intermediate containers shall be packed in wooden containers conforming to MIL-B-43666 Types I and II or PPP-B-601 overseas type.

5.2.2 Level B: Unit packs preserved as indicated in 5.1.1.3 and packed in intermediate containers shall be packed in fiberboard containers conforming to PPP-B-636 weather-resistant type.

5.2.3 Commercial packing: Unit packs preserved as indicated in 5.1.2 and packed in intermediate containers in accordance with ASTM-D3951 shall be packed in outer containers in accordance with ASTM-D3951.