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EVALUATION OF A LIP-SEAL HYDRAULIC FITTING FOR THE F-14 AIRCRAFT

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A new type of lip-seal fitting was evaluated for possible use on the F-14 aircraft. This fitting would be used interchangeably with the Resistoflex Dynatube which is now being exclusively used. Impulse, proof, burst, repeat assembly, and flexure testing was completed on representative samples. Three samples of sizes 6 mm, 9 mm, 13 mm and 25 mm were tested in accordance with MIL-F-18280 and Grumman Aerospace Company specification SP-G-017A. They successfully passed all tests. Compatibility with the Resistoflex

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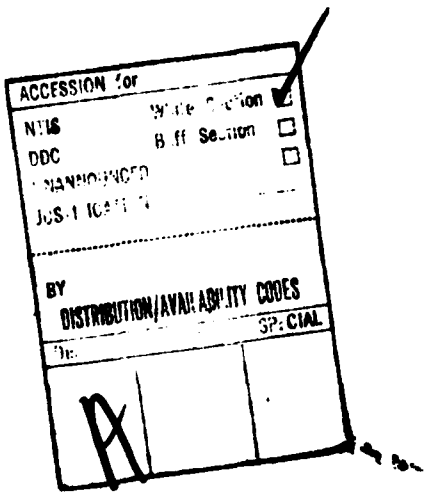
Dynatube connector is established and it is recommended that this fitting be used interchangeably with the Dynatube fitting.



EVALUATION AND DISCUSSION

BACKGROUND

As requested by the Naval Air Systems Command (AIR-530312) under AIRTASK A530-5303/001-2/7000-000-001, Work Unit TS 804, the Naval Air Development Center evaluated a new type of lip-seal fluid system fitting manufactured by Titeflex Company of Springfield, Massachusetts.

This limited evaluation was to be performed in conjunction with a complete test program conducted by the manufacturer.

The primary use for this fitting is on the F-14 hydraulic system. However, it is expected that it will find interchangeable use with the Resistoflex Dynatube lip-seal fitting that is being designed into new Navy aircraft such as the F-18 and AV-8B.

TEST DESCRIPTION

In order to assess a representative sample of types, sizes and tube materials, the evaluation was conducted on 6 mm (1/4"), 9 mm (3/8"), 13 mm (1/2") and 25 mm (1") size fittings. Six samples of each size were provided for the tests. The 6 mm (-4) size fitting was stainless steel welded to 321 stainless steel tubing, The 9 mm (-6) size was a titanium fitting internally swaged to MIL-T-6845 304 stainless steel tubing. The 13 mm (-8) and 25 mm (-16) sizes were Ti-6AL-4V titanium alloy fittings welded to Ti-3AL-2.5V titanium alloy tubing.

Tests conducted were in accordance with MIL-F-18280 fluid fitting specification with the flexural test stress levels as established by Grumman Aerospace Company Specification SP-G-017A. The following tests were conducted and the minimum requirements are as stated.

1. Proof and Burst Pressure - After impulsing, each sample was proof pressure tested to 400 bars (6000 psi) and burst pressure tested to 800 bars (12,000 psi). The fitting must remain functional at 400 bars (6000 psi). At 800 bars (12,000 psi) the fitting must not leak, crack or blow off the tube.

2. Impulse Testing - Three samples of each size were subjected to 200,000 impulse cycles at a peak pressure of 300 bars (4500 psi) with a rate of rise of 21,800 bars per second (321,000 psi per second). The samples must not exhibit any leakage during the test. See Figure 1 for a pressure time oscilloscope trace of the impulse cycle.

3. Flexural Strength - Three samples of each size were subjected to 10 million flexural cycles at various dynamic stress levels. The samples were filled with MIL-H-5606 hydraulic fluid and pressurized to 200 bars (3000 psi). The minimum flexural stress required was 101.3 megapascals (14,700 psi) as specified in Grumman Aerospace Company SP-G-017A.

4. Repeat Assembly - Two samples of each size were subjected to the repeat assembly test. Eight repeat assemblies were conducted on both samples using MIL-H-5606 hydraulic fluid as a lubricant. Proof and burst pressure checks were conducted to assure proper performance.

To insure compatibility between the Titeflex dual seal fittings and the Resistoflex Dynatube, all tests were conducted using the Dynatube boss fitting mated to the Titeflex dual seal fitting being tested.

RESULTS

Proof Pressure Test

All assemblies satisfactorily withstood the 400 bar (6000 psi) proof pressure test.

Pressure Impulse Test

All test assemblies satisfactorily completed 200,000 impulse cycles without failure, blow off or leakage. All samples also withstood the 400 bar (6000 psi) proof pressure check following the impulse test and the 800 bar (12,000 psi) burst pressure test.

Flexural Strength Test

All sizes successfully withstood the minimum flexural stress for 10 million cycles as established by Grumman Specification SPG-017B. As indicated in Table I, one -4 size sample cracked after 561,600 cycles at a flexural stress level of 206 megapascals (30,000 psi). This stress is twice the required level. The -4 size did successfully pass the test at a total stress of 226 megapascals (32,875 psi).

Repeat Assembly Test

This test was passed successfully by two samples of each size. There was no leakage after the repeat assemblies and subsequent proof pressure check.

CONCLUSIONS

Based on the abbreviated tests conducted, it is concluded that the Titeflex dual seal fitting is satisfactory for use in aircraft hydraulic systems. Also, compatibility with the Resistoflex Dynatube has been demonstrated by using mating dynatube connectors. The repeat assembly test demonstrated this compatibility conclusively since there were no failures after eight repeat assemblies. As a result, it is further recommended that the dual seal fitting be used interchangeably with the dynatube female hydraulic fitting.

TABLE I - RESULTS OF FLEXURAL TEST

Size	Tubing Material	Torque N.M (in-lbs)	Internal Stress MPa (psi)	Flexural Stress MPa (psi)	Total Stress MPa (psi)	Total Cycles	Remarks
6mm (-4)	321 SS 1/8 H	17 (150)	54.3 (7,875)	137.9 (20,000)	192.2 (27,875)	10,108,000	Passed
6mm (-4)	321 SS 1/8 H	17 (150)	54.3 (7,875)	172.3 (25,000)	226.6 (32,875)	10,108,000	Passed
6mm (-4)	321 SS 1/8 H	17 (150)	54.3 (7,875)	206.8 (30,000)	261.1 (37,875)	561,000	Tubing Cracked at Weld
9mm (-6)	304 SS	33 (290)	38.6 (5,600)	103.4 (15,000)	142.0 (20,600)	10,108,000	Passed
9mm (-6)	304 SS	33 (290)	38.6 (5,600)	172.3 (25,000)	210.9 (30,600)	10,108,000	Passed
9mm (-6)	304 SS	33 (290)	38.6 (5,600)	206.8 (30,000)	245.4 (35,600)	10,108,000	Passed
13mm (-8)	Ti Alloy	56 (500)	57.3 (8,320)	103.4 (15,000)	160.7 (23,320)	10,108,000	Passed
13mm (-8)	Ti Alloy	56 (500)	57.3 (8,320)	137.8 (20,000)	195.1 (28,320)	10,108,000	Passed
13mm (-8)	Ti Alloy	56 (500)	57.3 (8,320)	172.3 (25,000)	229.6 (33,320)	10,108,000	Passed
25mm (-16)	Ti Alloy	133 (1,180)	60.8 (8,820)	103.4 (15,000)	164.2 (23,820)	10,108,000	Passed
25mm (-16)	Ti Alloy	133 (1,180)	60.8 (8,820)	137.8 (20,000)	198.6 (28,820)	10,108,000	Passed
25mm (-16)	Ti Alloy	133 (1,180)	60.8 (8,820)	172.3 (25,000)	234.0 (33,820)	10,108,000	Passed

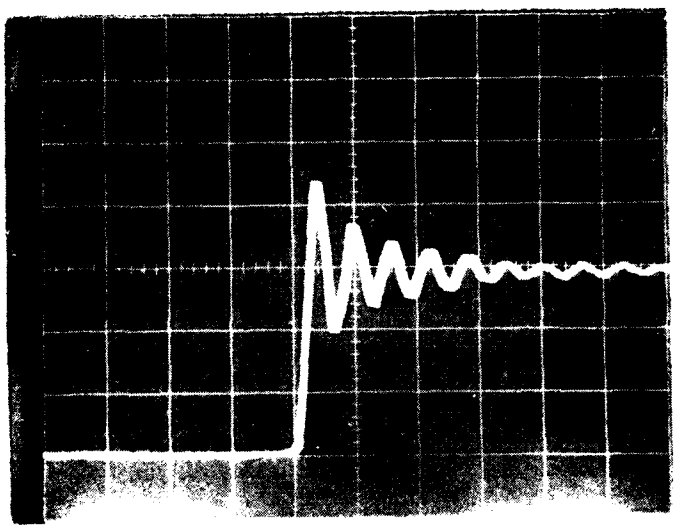


FIGURE 1. OSCILLOSCOPE TRACE OF PRESSURE IMPULSE CYCLE. ONE HORIZONTAL CENTIMETER EQUALS 50 MS AND ONE VERTICAL CENTIMETER EQUALS 68 BARS (1000 PSI)

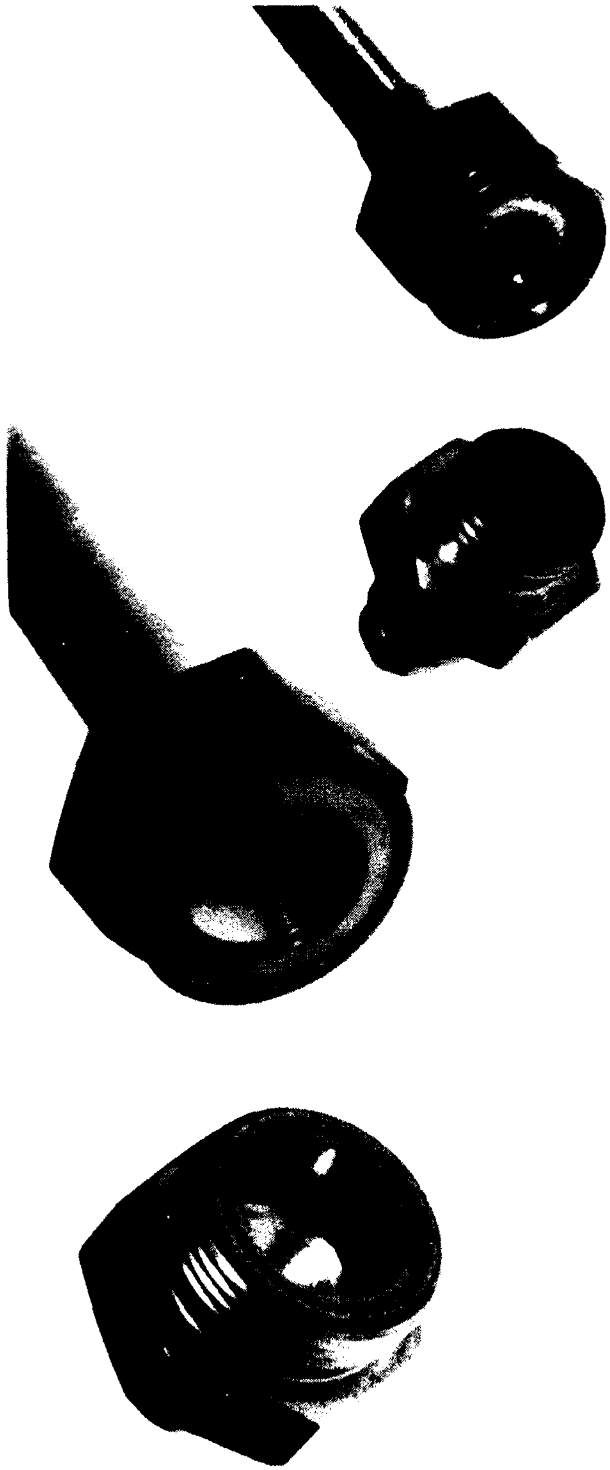


FIGURE 2. TITEFLEX DUAL SEAL LIP SEAL FITTING (WELDED AND SWAGED TYPES) SHOWN WITH MATING DYNATUBE BOSS FITTINGS

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