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400 Commonwealth Drive, Warrendale, PA 15096-0001

# AEROSPACE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

SAE ARP4912

Issued 1996-12

## DESIGN RECOMMENDATIONS FOR SPARE SEALS IN LANDING GEAR SHOCK STRUTS



1. PURPOSE:

This SAE Aerospace Recommended Practice (ARP) provides recommendations on cavity design and the installation of elastomer type spare seals in these cavities.

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

MIL-G-4343
MIL-H-5606
MIL-H-83282
MIL-P-25732
MIL-P-83461

3. RECOMMENDATIONS:

3.1 Spare seal cavities should be designed with maximum bottom radii, both to eliminate stress risers and to distinguish the spare seal cavity from the actual seal glands. Half round cavities may be considered for rod type T-Seals or O-rings.

3.2 All spare seal cavity edges are to be smooth and free of sharp edges and burrs to eliminate seal damage during installation.

3.3 Design considerations must assure that spare seals cannot function as a static seal. Since MIL-Specs require seal elastomers to swell 10 to 20% in MIL-H-5606 and 5 to 15% in MIL-H-83282, these increases in volume must be considered.

3.4 Spare seal cavities should be located downstream (nonpressurized side) of the active static seals. This location minimizes fluid contact, reducing seal swell which can make seal installation difficult or impossible. Seal swell in excess of 15% increase in circumference has been seen after 500 h in MIL-H-5606.

3.5 Seals should be lubricated and packed in grease in the spare seal cavities. A list of recommended greases with typical swell is included in Appendix A.

3.6 Seals are to be stored in their "as molded" configuration. When seals are turned inside out and stretched over the lower bearing, excessive stress is applied to the dynamic sealing surfaces.

3.7 If seals are installed in separate grooves, backup rings may be stored with the seals.

3.8 Several aircraft have recently been designed with active spare seals. This design as shown in Figure 1 uses two seals in tandem with a normally open valve arrangement between them to eliminate a pressure differential across the inboard or spare seal. When the outboard seal fails, the valve is closed and the inboard seal becomes the primary seal. Although the life of this seal is not as long as the outboard seal, it is a spare seal arrangement that should be considered.

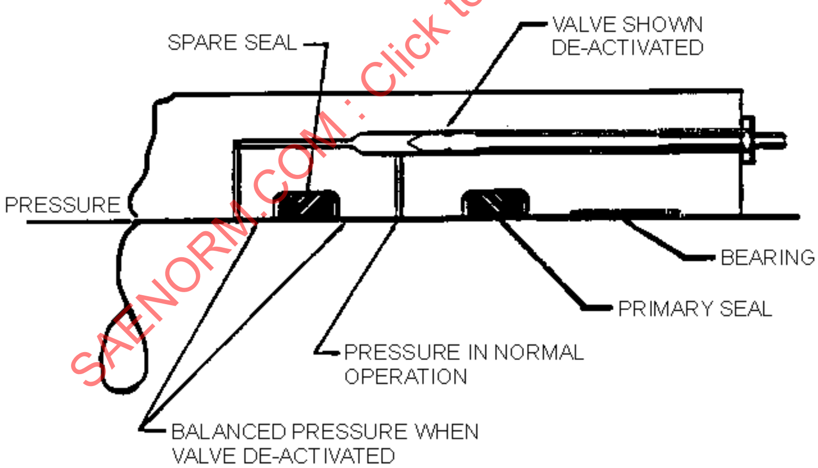


FIGURE 1 - Dowty Aerospace LG-Gloucester

3.9 This document addresses nitrile type seals used with common mineral oil strut fluids, such as MIL-H-5606 and MIL-H-83282. Phosphate ester systems using Skydrol or Hyjet fluids with EPR type elastomers may exhibit different stretch and swell characteristics and require alternate compatible greases for installation.

3.10 Design considerations should include the prevention of pressure trapping between the static seal and spare seals.

3.11 Recommended spare seal cavity dimensions are shown in tabular form in Figure 2.

3.12 The spare seal gland size and location should not allow deformation of the lower bearing created by extention loads of the piston during aircraft take off.

## 4. TEST RESULTS:

Several tests have been run to guide the designer in addressing the permanent set and swell of stored seals. These tests all utilized an elastomer meeting the MIL-P-25732 specification.

4.1 In the first test typical seals were stretched on mandrels 5, 10, 15, and 20% larger than the standard rod diameter for these seals, then aged 500 h in MIL-H-5606 fluid at 160 °F. The results are shown in Figure 3. This test was originally planned to extend to 1000 h but fluid swell expanded the seal diameter beyond the mandrel diameter after 500 h exposure.

4.2 Since seal swell was clearly the predominant factor, several nitrile seal materials were immersed in commercial strut fluids and volume swell results of long-term soaks are shown in Figure 4.

4.3 To isolate the effects of long-term tensile set without the effects of fluid, the test described in 4.1 was repeated in air at 160 °F. The results of these tests are shown in Figure 5.

4.4 In a further attempt to isolate stored seals from fluid swell, a 7441-ft T-Ring was installed with a typical 5% stretch and sealed in the groove with a viscous silicone grease (Dow Corning DC-55). The assembly was then dipped into MIL-H-5606 fluid once a week to simulate downstream seal leakage. After six months the seal was removed and measured seal swell was only 1.5% of the original diameter.

4.5 The seals used in these tests were T-Seals of the following type as shown in Table 1:

TABLE 1

| Part Number | Dimensions | Application |
|---|---|---|
| 7451FT | 11.500 OD x .275 Cx | 747 MLG Dynamic Strut Seal |
| 7441FT | 7.510 OD x .275 Cx | DC-10 NLG Dynamic Strut Seal |
| 7339FT | 3.640 OD x .210 Cx | 737 NLG Dynamic Strut Seal |



## 5. CONCLUSIONS:

5.1 Seal swell due to fluid contact is a major problem when attempting to install a seal that has been exposed to hydraulic fluid.

5.2 Tensile set, even if seal is stretched 20%, should not be cause for concern.

5.3 By locating the spare seal downstream from the static seal and packing it in a low swell grease, minimum swell and less installation difficulty will be encountered.



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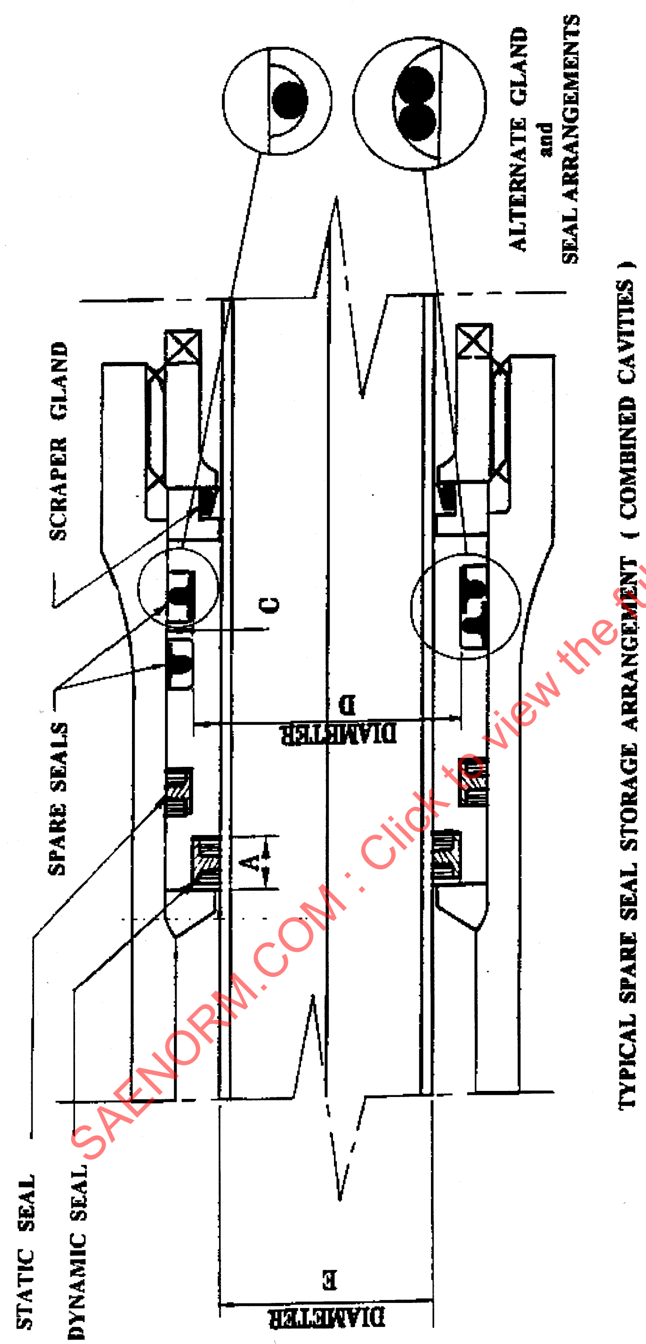


| NOMINAL SEAL CROSS SECTION | ACTIVE SEAL GLAND LENGTH | ROD DIAMETER | SPARE SEAL CAVITY: CAVITY LENGTH B, SINGLE CAVITY | SPARE SEAL CAVITY: CAVITY LENGTH B, COMBINED CAVITY | SPARE SEAL CAVITY: CAVITY DEPTH C | SPARE SEAL CAVITY: CAVITY DIAMETER D |
|---|---|---|---|---|---|---|
| 1/4 | A | E | A+.020 | 1.75(A+.020) | .300 | 1.05E (MAX) |
| 3/8 | A | E | A+.020 | 1.75(A+.020) | .450 | 1.05E (MAX) |

FIGURE 2 - Typical Spare Seal Storage Arrangement (Separate Cavities)

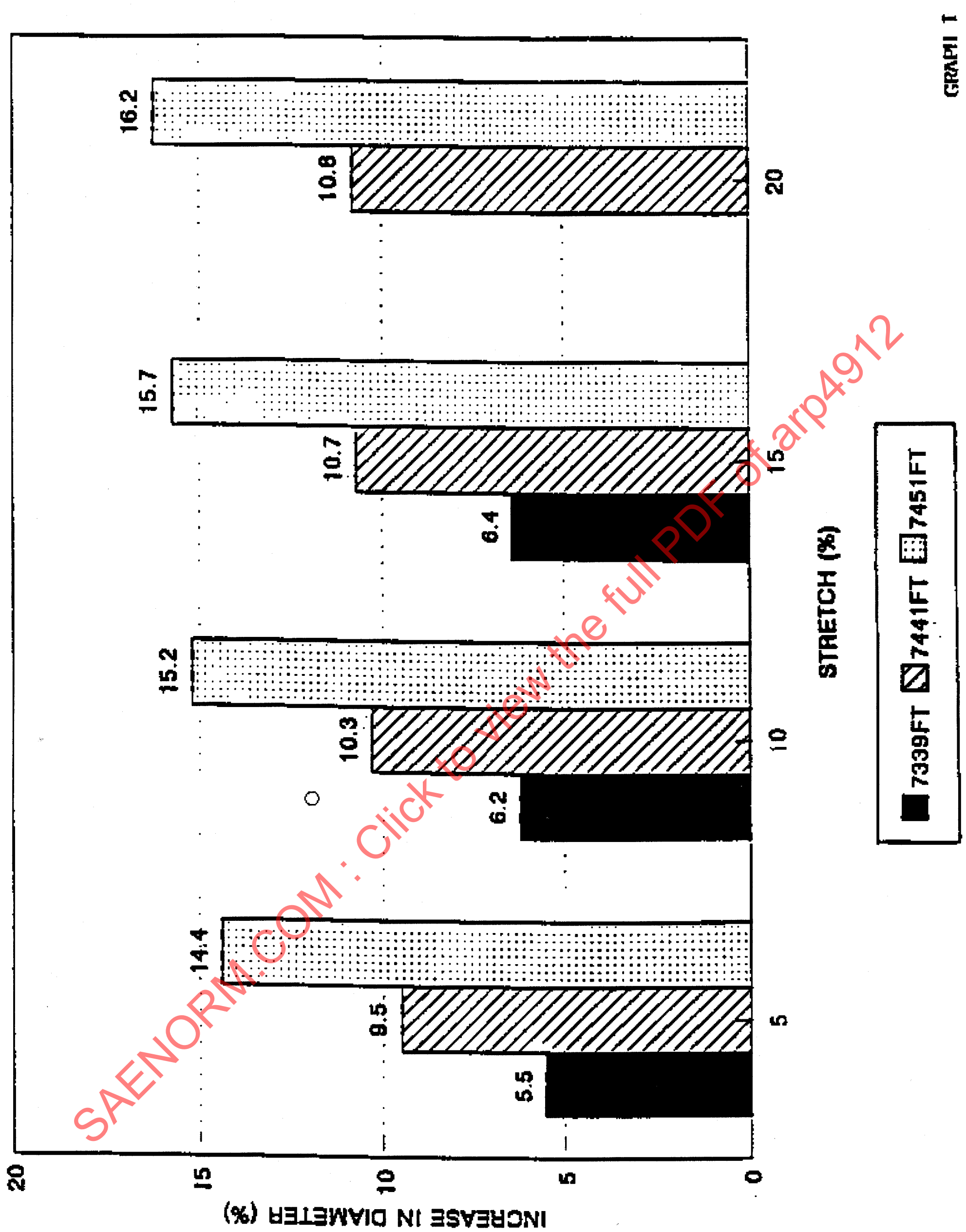


FIGURE 3 - Effect of Stretch and Fluid on Diametrical Change at 160 °F

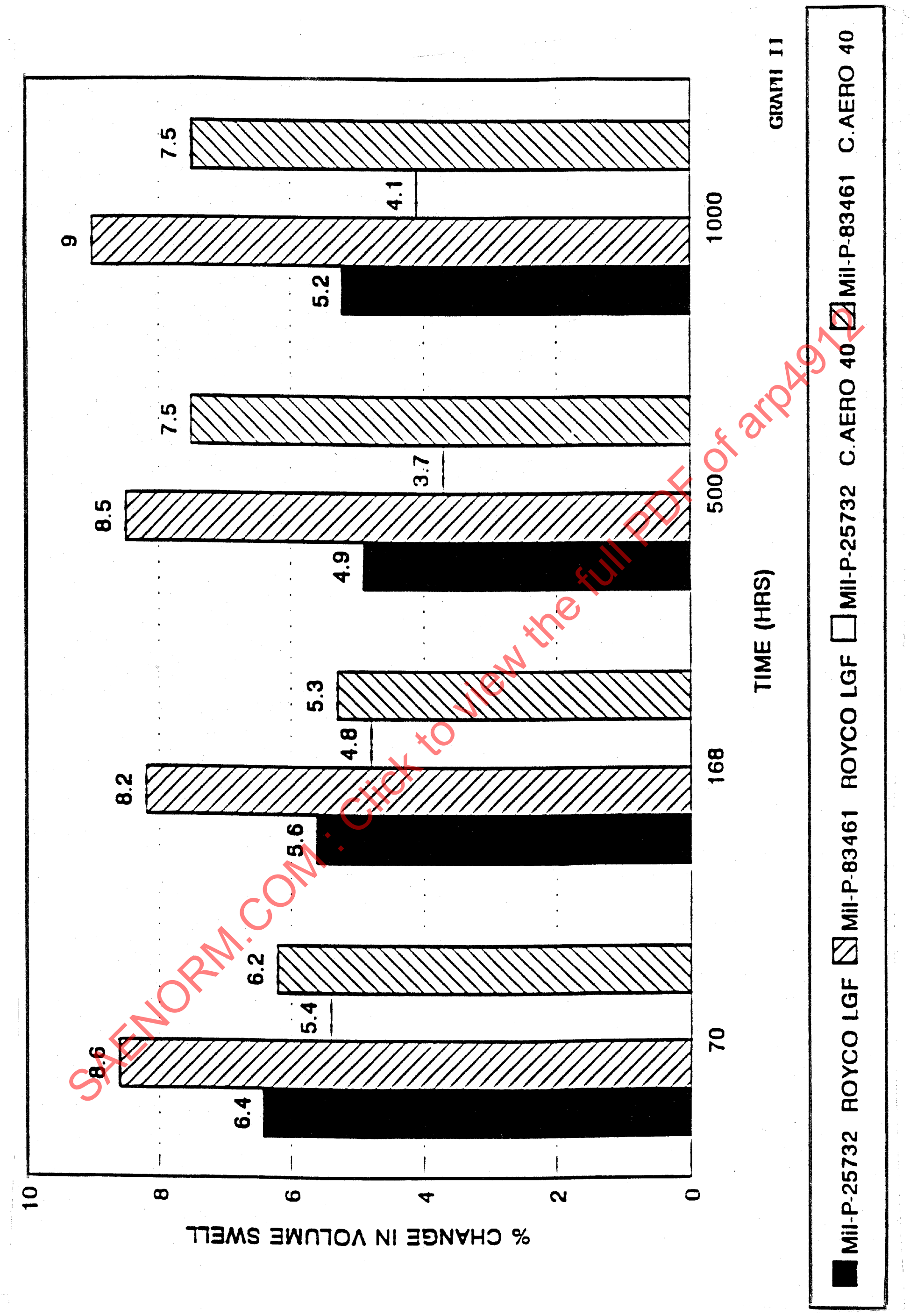


FIGURE 4 - Effect of Fluid on Volume Change WRT Time
(At Temperature = 165 °F, With -214 O-rings)