



# AEROSPACE RECOMMENDED PRACTICE

ARP6179™

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## Evaluation of Gas Turbine Engine Lubricant Compatibility with Elastomer O-Rings

### RATIONALE

ARP6179 has been reaffirmed to comply with the SAE Five-Year Review policy.

#### 1. SCOPE

This test method provides procedures for exposing specimens of elastomer materials (AS 568-214 size O-rings) representative of those used in gas turbine engines to lubricants or reference fluids under defined time and temperature conditions. This test includes both suspended and compressed O-rings. Resultant changes in the O-ring's physical properties (tensile strength, elongation, hardness, mass, volume, and compression set) are measured to determine the amount of deterioration of the elastomer.

#### 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.

##### 2.1 SAE Publications

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Telephone: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), Web address: <http://www.sae.org>.

- AS568 Aerospace Size Standard for O-rings
- ARP5088 Test Method for the Determination of Total Acidity in Polyol Ester and Diester Gas Turbine Lubricants by Automatic Potentiometric Titration

##### 2.2 ASTM International Publications

Available from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, Web address: <http://www.astm.com>.

- ASTM D395 Standard Test Methods for Rubber Property - Compression Set.
- ASTM D412 Standard Test Methods for Rubber Properties in Tension.

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- ASTM D445 Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity).
- ASTM D471 Standard Test Method for Rubber Property - Effect of Liquids
- ASTM D1414 Standard Test Methods for Rubber O-Rings.
- ASTM D1415 Standard Test Method for Rubber Property - International Hardness.
- ASTM D4636 Standard Test Method for Corrosiveness and Oxidation Stability of Hydraulic Oils, Aircraft Turbine Engine Lubricants, and Other Highly Refined Oils.

### 3. WARNING

This document may involve hazardous materials, operations, and equipment. This document does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

### 4. APPARATUS

#### 4.1 Glassware identical to that used in ASTM D4636, except where noted:

- 4.1.1 Glass Test Tube (identical to that in ASTM D4636, Section 5.1.1): 5.0 +/- 0.3cm O.D., 45.0 cm long, with open end formed as a standard taper 71/60 female ground glass joint.
- 4.1.2 Three neck top (identical to that in ASTM D4636, Section 5.1.2) with a male standard taper 71/60 ground glass joint bottom and top female openings: 2 of which have standard taper 10/30 ground glass joints and 1 of which has a standard taper 24/40 ground glass joint opening.
- 4.1.2.1 One of the standard taper 10/30 joints is to be used for inserting a monitoring "J" Type thermocouple while the second is to be plugged.
- 4.1.2.2 The standard taper 24/40 joint is to be left open. Should there be a safety concern, an air cooled condenser (15 mm I.D. heavy wall by 500 mm long) may be employed, but its use must be reported.

#### 4.2 Compression Set – Suspended O-ring Assembly:

##### 4.2.1 Washer, One (1):

- 316 Series Stainless Steel
- 12.7 mm (0.5 inch) screw size, 1.57 mm (0.062 inch) thickness
- Such as McMaster-Carr #90107A033

##### 4.2.2 Hex Nuts, Six (6):

- 1/2 inch-13 Thread
- 316 Series Stainless Steel
- Such as McMaster-Carr #94819A055

##### 4.2.3 Threaded Rod, One (1):

- 1/2 inch-13 Thread
- 316 Series Stainless Steel
- Cut to an approximate 30.5 cm (12 inch) length
- Such as McMaster-Carr #93250A155

#### 4.2.4 Washer, Two (2):

- 300 Series Stainless Steel
- 12.7 mm (0.5 inch) ID x 19 mm (0.75 inch) OD x 0.40 mm (0.016 inch) thick
- Precision shaft-spacing washers
- Such as McMaster-Carr #99040A800

NOTE: You must specify the thickness when ordering these washers. They are used to prevent galling of the panels when the nuts are tightened.

#### 4.2.5 Stainless Steel Wire:

- 0.8 mm (0.032 inch) diameter
- Approximately 1.8 m (6 ft) needed per test

#### 4.2.6 Panels, Four (4):

- 316 Series Stainless Steel
- Thickness: 3.18 mm (0.125 inch)  $\pm$  0.13mm (0.005 inch)
- Washer-shaped panel dimensions: 38 mm (1.5 inch OD) x 12.7 mm (0.5 inch ID)  $\pm$  0.25 mm (0.010 inch)
- Surface Finish: Ground to a maximum roughness of 0.254  $\mu$ m (10  $\mu$  inch)
- Two small holes 1.5 mm (0.06 inch) drilled through the surface of the panel at 10.3 mm (0.406 inch) radius from the center (See Figure A1 in Appendix A).

#### 4.2.7 Spacers, Three (3):

- 316 Series Stainless Steel
- Thickness: 2.64 mm (0.104 inch)  $\pm$  0.05 mm (0.002 inch)
- Tube-shaped spacer dimensions: 19.0 mm (0.75 inch) OD x 12.7 mm (0.50 inch) ID  $\pm$  0.25 mm (0.010 inch)
- Surface Finish: Maximum roughness of 0.81  $\mu$ m (32  $\mu$  inch)

#### 4.2.8 Triangular Teflon Spacer, One (1): See Figure A2 in Appendix A.

#### 4.3 Additional Apparatus Requirements:

- 4.3.1 Hollow Teflon Rod, One (1): 31.8 mm (1.25 inch) OD x 22.2 mm (0.875 inch) ID (such as McMaster-Carr #8547-K16) cut to approximately 2.54 cm (1 inch) in length.
- 4.3.2 Aluminum Block or Sand Heater Bath heating unit capable of maintaining a temperature of  $\pm$  2 °C.
- 4.3.3 Analytical Balance capable of weighing out to the nearest 0.001 gram equipped with a density determination kit such as Fisher Scientific Cat. No. 13-635-161.
- 4.3.4 Micro Hardness Tester conforming to ASTM D1415, such as Wallace Model H12. Results may differ if a different hardness tester type is used. If a different hardness tester type is used, it must be reported.
- 4.3.5 Bench Top Micrometer equipped with a presser foot capable of measuring the thickness of O-rings to the nearest 0.02 mm (0.001 inch), such as B.C Ames Comparator No. 2 or equivalent.
- 4.3.6 Tensile Tester:
  - The tensile testing machine shall conform to the requirements specified in Section 3 of ASTM D412, with exception of the grips.
  - The grips shall be replaced with ball-bearing spools 9 mm (0.375 inch  $\pm$  0.002 with 32 RHR) in diameter, and be capable of being brought within 19 mm (0.75 inch) center-to-center distance at their closest approach.

4.3.7 Glass Thermometer or Calibrated Thermocouple, 70 cm (27.6 inches), sheathed, Type “J”

4.3.8 Torque Wrench capable of generating and measuring 68 N·m (50 lb<sub>r</sub>·ft) of torque.

## 5. REAGENTS AND/OR MATERIALS

### 5.1 Test Elastomer Specimens:

5.1.1 Each elastomer type to be evaluated must be O-ring size AS 568-214.

5.1.2 Thirty (30) O-rings are required for baseline measurements (7.2).

5.1.3 Three (3) O-rings are required for the compression set assembly (6.4.1).

5.1.4 Five (5) O-rings are required for the suspended set assembly (6.4.2).

5.1.5 Recommended test O-ring material types and conditions are given in Table 1. This list is not all inclusive and other materials, such as AMS7257, could be tested using this method although the time and temperature may need to be modified.

TABLE 1 – RECOMMENDED O-RING MATERIAL TYPES AND TESTING CONDITIONS

| Classification | Specification | Test Temperature  | Testing Time (hours) | Condition |            |
|----------------|---------------|-------------------|----------------------|-----------|------------|
|                |               |                   |                      | Suspended | Compressed |
| Fluorocarbon   | AMS 7276      | 175±2°C (347±4°F) | 70                   | X         | N/A        |
| Fluorocarbon   | AMS 7276      | 175±2°C           | 480                  | N/A       | X          |
| Fluorocarbon   | AMS-R-83485   | 175±2°C           | 480                  | X         | X          |

NOTE: For oil qualification purposes with AMS7276 O-rings, it is suggested to characterize a single batch of AMS7276 material. Characterization may be performed by using oils such as a MIL-PRF-23699 STD class and/or Reference Oil 300. Data collected from four AMS7276 batches indicated possible AMS7276 batch-to-batch variation for several properties. The testing was performed by five laboratories with four oils using the recommended conditions stated in Table 1.

5.1.6 Each O-ring must be visually inspected before testing. Specimens that exhibit obvious flaws at any point on the surface, such as infringement, non-uniform surface, nicks, cracks, bubbles, etc shall not be tested.

5.1.7 Each O-ring must be identified for the subsequent property measurements and determinations. The identification of each O-ring shall not include any method which changes the physical integrity of the O-ring. Nor shall any O-ring be marked with inks or paints.

5.2 The minimum oil volume needed for Recommended Testing Conditions is given below in Table 2.

TABLE 2 – OIL VOLUME REQUIREMENTS BASED ON THE RECOMMENDED TESTING CONDITIONS

| Test Length (hours) | Total Oil Volume Required (mL) | Starting Oil Volume (mL) | # of Oil Changes | Volume of Oil for Changes (mL) | Volume of Oil for Cool Down (mL) |
|---------------------|--------------------------------|--------------------------|------------------|--------------------------------|----------------------------------|
| 70                  | 600                            | 300                      | 0                | 0                              | 300                              |
| 480                 | 2100                           | 300                      | 5                | 1500                           | 300                              |

NOTE: For 480-Hour Test: Two 96 hour intervals and four 72 hour time intervals are required. The order of these time intervals is at the discretion of the operating laboratory. A suggestion is to schedule the time intervals in the following sequence: 72, 96, 72, 96, 72, 72. The test initially begins with an oil volume of 300 mL. Oil changes, as detailed in Section 6.8, would take place at the end of each of the first five time intervals. At the end of the last time interval the jig is transferred to an oil volume of 300 mL for cool down as stated in Section 6.9.4. This particular interval sequence allows testing to begin either on a Tuesday or Friday which would consequently end on a Monday or Thursday, respectively. None of the applicable oil changes would occur during a weekend. The impetus for performing oil changes is to keep the oil's total acid number in a range consistent with oil in service.

5.3 Acetone for glassware and hardware cleaning.

5.4 Stiff steel or brass wire brush.

5.5 Steel wool, Grade 000.

## 6. PROCEDURE

6.1 Determine the O-ring Batch Baseline Property (7.2) and the Individual O-ring Pre-Test (7.3) suspended and/or compressed measurements.

6.2 Set the heating unit (4.3.2) to the desired setting and allow it to stabilize at the intended test temperature for at least 30 minutes prior to inserting test cell assembly.

6.3 Ensure the apparatus has been cleaned using the procedures in Section 9.

### 6.4 Assembly

NOTE: This procedure describes assembly of the suspended and compressed O-ring sets into a complete test cell. The operator may choose to only test suspended or compressed O-rings under conditions such as those specified in Table 1.

#### 6.4.1 Compression Set Assembly:

6.4.1.1 Thread two nuts (4.2.2) onto the threaded rod (4.2.3) so that the bottom of the last nut is approximately 5.40 cm (2.125 inches) from one end of the threaded rod. Using two wrenches tighten these nuts against each other firmly (upper jam nut stack).

6.4.1.2 Secure one of the jam nuts vertically in a vice so that the short (bottom) end of the threaded rod is pointing up.

6.4.1.3 Place one of the thin washers (4.2.4) on the nut from the 5.40 cm (2.125 inch) end.

6.4.1.4 Cut each of the three O-rings to be compressed (5.1.3) and remove a length of 6.35 mm (0.25 inches). This allows for increased oil flow to the compressed O-ring specimens. This requires each O-ring to be cut, straightened out, and cut again to remove the length of 6.35 mm.

6.4.1.5 Stack the compression set parts onto the upright rod in the following order: panel (4.2.6), O-ring (5.1.3), spacer (4.2.7). Be sure that each O-ring does not block the small oil holes and is evenly centered on the spacer. Repeat this stacking order two times. Insert a piece of the stainless steel wire (4.2.5) through the oil holes in each panel to align them vertically on the rod during assembly.

6.4.1.6 Place the final panel (4.2.6) on the threaded rod.

6.4.1.7 Using the stainless steel wire recheck to determine that the oil holes of all four (4) panels are aligned. Remove the stainless steel wire after rechecking the holes.

6.4.1.8 Place one of the thin washers (4.2.4) on the rod against the last panel.

6.4.1.9 Thread a nut (4.2.2) on the rod and twist until it is hand tight against the thin washer.

6.4.1.10 Using a torque wrench tighten the nut from the previous step to 68 N·m (50 lbf·ft).

6.4.1.11 Place the large washer (4.2.1) onto the rod, against the nut.

6.4.1.12 Thread another nut (4.2.2) against the large washer and tighten to 34 N·m (25 lbf·ft) while holding the adjacent nut with a wrench, forming the lower jam nut stack. See Photograph B1 in Appendix B.