



AEROSPACE RECOMMENDED PRACTICE	ARP6166™	
	Issued Reaffirmed	2011-07 2016-09
Minisimulator Method		

RATIONALE

ARP6166 has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE

This test method is designed to simulate the synergistic combinations of oil flow, temperature cycling, hot spots, and tribology that would typically be found in a gas turbine engine. The method is intended to quantitatively characterize changes in four basic oil properties that are brought about by exposure to the afore mentioned simulated turbine engine environment: the tendency of aviation lubricants to form coke deposits, viscosity changes, total acid number changes (TAN), and oil consumption.

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 International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

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, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D445-11 Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

2.3 U. S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-9495, <https://assist.daps.dla.mil/quicksearch/>.

FED-STD-791D Method 3410.1 High Temperature Deposit and Oil Degradation Characteristics of Aviation Turbine Oils

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3. METHOD SUMMARY

3.1 Test Operation

The minisimulator test method utilizes the minisimulator apparatus. The essential components of the minisimulator apparatus consist of a bearing housing, an oil circulation system with pump, various heating elements and a motor to drive two test bearings residing in the bearing housing. The test apparatus is brought up to temperature, the oil flow is established, and the bearings are spun at the required speed. Conditions are maintained for 10 hours (1 cycle). The test is then shut down in reverse order and the apparatus is allowed to cool completely. This procedure is repeated 10 times.

3.2 Quantitative Characterization

After each cycle of the test, oil is sampled. The viscosity and total acid number (TAN) are evaluated. After all ten cycles are completed, the apparatus is disassembled. The coke deposits on a variety of components are visually inspected and given a score. These scores are compiled into an overall score that is assigned to the test. Coupons of sample metals are placed in the oil sump to evaluate possible corrosive behavior.

4. MINISIMULATOR APPARATUS

4.1 Assembled Test Head

The essential part of the minisimulator apparatus is the Assembled Test Head. Figure 1 shows an assembly drawing of the Assembled Test Head. Engineering drawings of all custom made components in the Assembled Test Head are shown in Appendix A.

- 4.1.1 The test bearings are two 30-mm bore angular contact ball bearings (Rolls-Royce Corp. part #6889093).
- 4.1.2 The thirteen (Figure 1 does not account for the four jets or the two additional ports in the middle of the head at 6:00 and 9:00) thermocouples are type J (Omega part #ICSS-18G-6). They are mounted to positions on the Test Housing and the Rear End Cap via 1/8-inch male connectors that have been bored through (Swagelok part #SS-200-1-2BT). A spring washer is used to provide axial loading to the Test Bearings (comparable to Nested Spirawave, part number 12492-01 supplied by Smalley Steel Ring Company, Wheeling IL). The Forward Test Bearing is secured by size W-04 lock washer and a size N-04 lock nut. The Rear Test Bearing is secured by the Bearing Retainer which attaches to the Drive Shaft by four cap screws (#3-48x3/8).
- 4.1.3 The oil jets are assembled into upper and lower pairs. All of the jets are connected to male branch tee fittings (Swagelok SS-200-3TTM) that are screwed into female connectors (Swagelok SS-400-7-2). The upper jets are assembled by connecting the shorter jet tubes to a union cross fitting (Swagelok SS-400-4) using two short 1/4-inch sections of tubing. Similarly, the lower jets are assembled by connecting the longer jet tubes to a union tee fitting (Swagelok SS-400-3) again using two short 1/4-inch sections of tubing. The jets are connected to the test head via male connectors (Swagelok SS-200-1-2BT).
- 4.1.4 The air/oil drain line is attached to the Forward End Cap of the assembly by a male connector (Swagelok part #SS-600-1-6).
- 4.1.5 The air/inert gas inlet is attached to the Forward End Cap of the assembly by male elbow (Swagelok part #SS-200-2-2).
- 4.1.6 The Forward and Rear End Caps are attached to the Test Housing via V-Band Clamps (Clampco part #994AR-0500).
- 4.1.7 The rod heater placed on Rear End Cap of the assembly (hot spot heater) is rated at 240V/200W and should be the equivalent of Watlow part #J1E52KW24. The band heaters attached to the Test Housing are rated 240V/1000W and should be the equivalent of Watlow part #ME5A1JP8.
- 4.1.8 The O-ring on the Drive Shaft is size 115 and constructed from Viton A elastomer.

- 4.1.9 A pair of 1/8-inch stainless steel tube air cooling coils are not shown in Figure 1. Each coil makes six revolutions around the Test Housing. The coils were made by winding the 1/8-inch SS tubing around a circumference smaller than that of the Test Housing (ensuring a snug contact when placed on the Test Housing). The coils form a single layer on the head (no overlapping). The windings are side by side (six revolutions for 1/8-inch tubing gives 3/4-inch total width for each coil). An air flow is introduced to dissipate heat build-up in the head due to the bearing heaters. The coils are mirror images of one another so that cold air enters at the center of the Test Housing and hot air exits next to each bearing heater (vented to the room).
- 4.1.10 Four stainless steel alignment pins are used in assembly of the Assembled Test Head (0.9 ± 0.01 inch diameter, 0.5 inch long).
- 4.1.11 Air flow (4.6 ± 0.1 L/min) is directed through the Air/Inert Gas Inlet (see Figure 1). The air flow is first passed through a filter (Norgren part #5350-03) then sent through a bubbler so that moist air is introduced at the Air/Inert Gas Inlet.

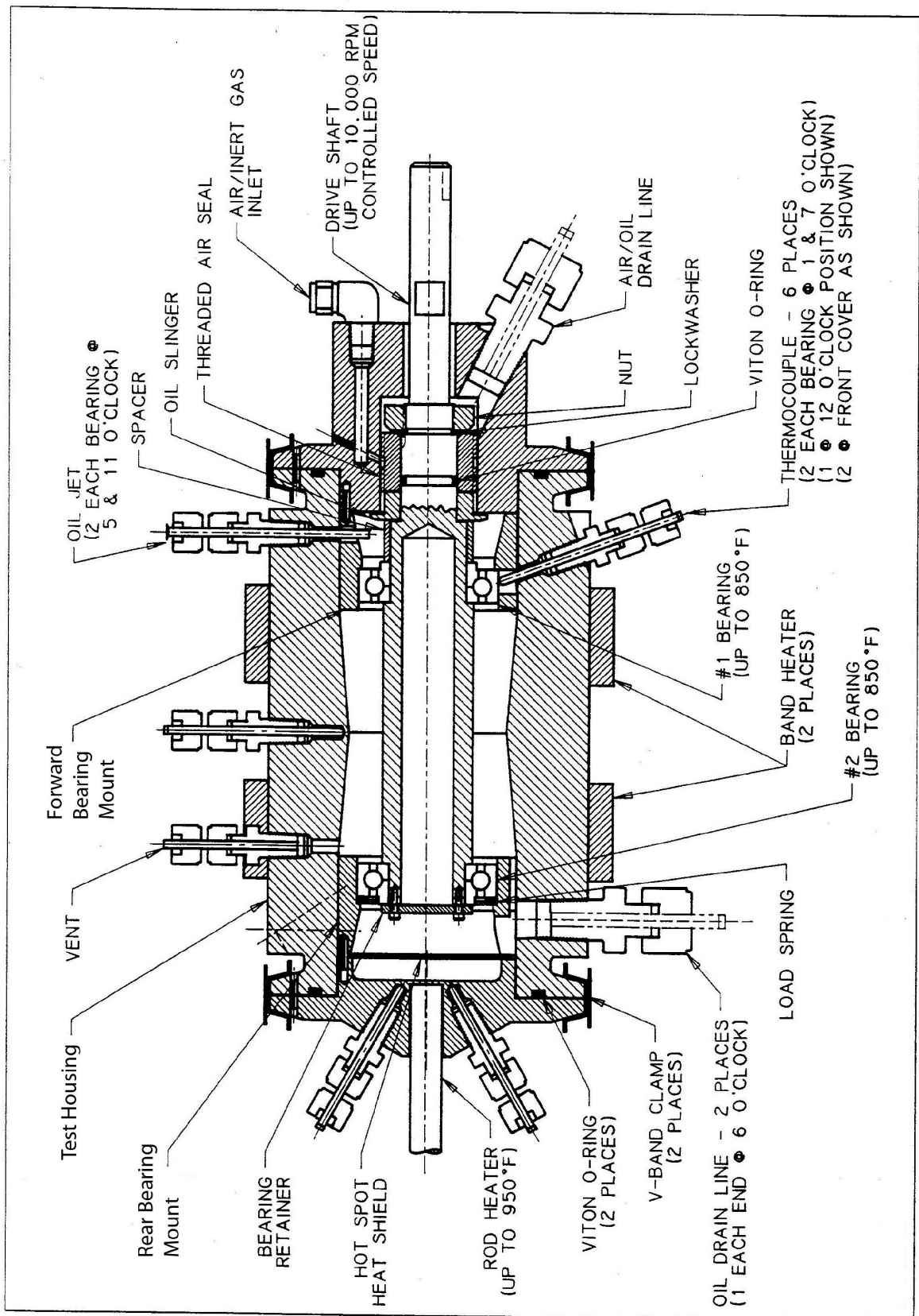


FIGURE 1 - SECTION DRAWING OF THE ASSEMBLED TEST HEAD



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4.2 Drive System

The Assembled Test Head attaches to an inline torque sensor [equivalent to MCRT model 48701V(25-0)] via flexible couplings. The torque sensor in turn attaches to the drive motor. The drive motor should be rated for at least 3 HP and 12 000 RPM (equivalent to Reuland Electric Company model #145-R-0228, rated for 460V, 4A, 3Ø, 200 Hz). A Lancer GPD502 model #L714 inverter is suitable for powering the aforementioned Reuland Electric motor. The Assembled Test Head, torque sensor and drive motor should all be mounted to a robust test stand that adheres to site safety standards.

4.3 Oil Flow System

There is considerable latitude in how the oil flow system is constructed. Figure 2 illustrates a schematic diagram of one such system, describing the essentials that are needed. The oil lines should be ¼" stainless steel tubing with stainless steel compression fitting couplings. Primarily, tubing should be in place to transport oil from an oil sump, to the oil jets on the Assembled Test Head, and then back to the oil sump. Provision must be made to sample oil from the system and add makeup oil to the system. Four thermocouples must be incorporated into the system to measure oil temperature as the oil enters each of the oil jets. A heating tape (310-watt, 6' length, ½" width) should be used to heat the oil jet assembly and the tubing leading up to the oil jet assembly.

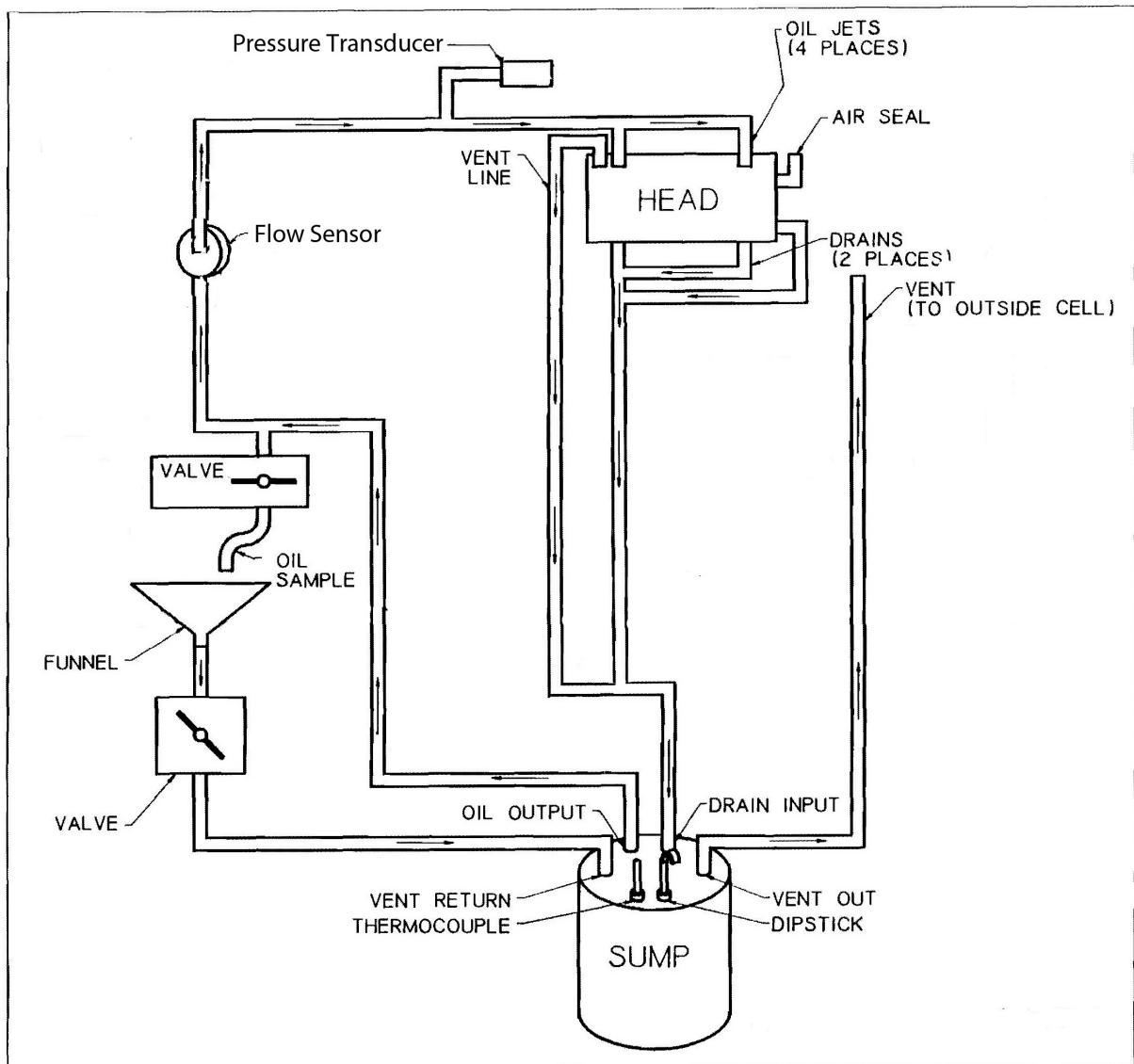


FIGURE 2 - DIAGRAM OF FLOW SYSTEM BASIC CONCEPTS



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4.4 Oil Sump and Pump

- 4.4.1 A gear pump (comparable to Zenith Precision Gear Pump model CPB-5719 supplied by Parker Hannifin Corp., Waltham MA) for cycling oil should be used. To drive the pump, a $\frac{3}{4}$ HP, 1775 RPM motor should be used (equivalent to US Electrical Motors model #F012, 230V/460V, 2.8A/1.4A, 3Ø, 60 Hz). A suitable inverter should be chosen to drive the motor (for the F012 motor, a Lancer GPD402 model #DS703 is appropriate). The pump should be placed within the sump.
- 4.4.2 As with the flow system, there is considerable latitude in how the oil sump system is designed. Provisions should be made to place a 200-mesh screen inline on the inlet to the pump to act as a filter. The sump capacity should be 4 liters, though the designer should keep in mind that the test is run with approximately 1.5 liter of test oil. Any elastomeric o-ring type seals should be fabricated from Viton A material. Figure 3 shows a drawing of an example pump/sump arrangement. In this arrangement, three heaters are employed to maintain temperature. The upper band heater is a Watlow part #ME6J1JP6B rated at 480V/1000W. The lower band heater is a Watlow part #ME6J1JP5 rated at 480V/1250W. The bottom ring heater is a Chromalox part #127FP rated at 240V/550W. Provisions should be made to mount coupons of sample metals.

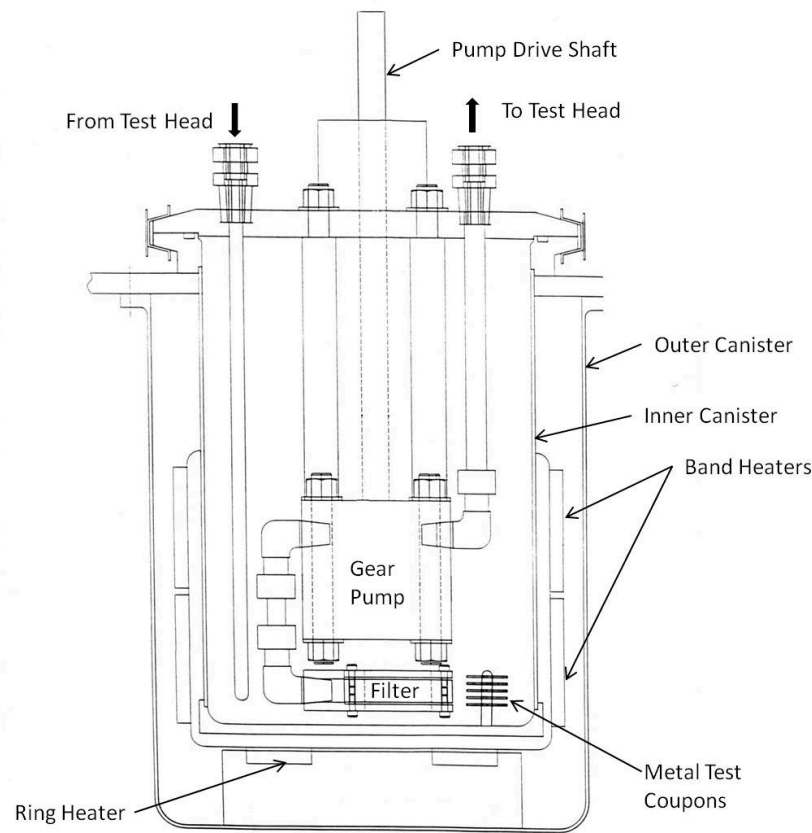


FIGURE 3 - DIAGRAM OF POTENTAIL PUMP/SUMP SYSTEM

4.5 Control and Data System

The detailed design of the system control and data acquisition is left to the user. The control system must allow for temperature based control of the heaters for the sump, the forward and rear Test Bearings, and hot spot. A variable transformer (120 V, 10 A) is typically used to apply power to the heating tape for the oil supply line. A system for logging process data (all measured temperatures, oil flow rate, motor speed, and torque) versus time should be designed or purchased.

5. APPARATUS PREPARATION

5.1 Cleaning

The goal of the system cleaning is to regenerate the system after a test such that there is uniformity of surface finish from test to test. The components of the minisimulator test section must be prepared so as to have clean, polished surfaces. The following steps should be followed:

- 5.1.1 Clean all parts of the minisimulator with an initial solvent wash to remove any oil residue from the previous test. Any kerosene-like solvent is acceptable (example – Premium Gold Solvent from Safety Kleen).
- 5.1.2 Once the parts have air-dried, they should be placed in a heated sonic bath charged with a water/detergent mixture.
- 5.1.3 The parts are then scrubbed with cleanser and thoroughly rinsed. While wet, the parts are given a final rinse with purified water and allowed to air-dry in a clean, covered, stainless steel pan. A nonabrasive scrub cloth should be used to clean the test head components, pump components, sump, and fittings. Nylon-bristle test tube brushes are recommended for use in cleaning the interior of the stainless steel tubing of the minisimulator system. Aggressive deposits within the minisimulator test section often remain even after sonic cleaning. A soft metal (i.e. brass) rod is useful in flaking off persistent carbon deposits. Even a wire brush can be used to remove deposits from test section components, but surfaces should be polished with 600-grit wet-sand paper to remove scratch marks. It should be noted that all oil-wetted parts should be handled with gloves once they have been cleaned.

5.2 Assembly

The two primary elements of the minisimulator that require assembly are the sump and test section.

- 5.2.1 Assemble the gear pump. The elements of the pump should be lubricated with the test oil as they are connected. In particular, the gears should be primed with oil and rotated to ensure uniform coverage. Once all layers of the pump are together, the assembly should be loosely bolted together. Using either the inlet or outlet fitting as a support, the pump should be secured in a vice so that the bolts can be tightened. By suspending the pump, the various layers of the assembly can be adjusted for proper alignment. The four bolts should be tightened gradually in an “X” pattern while the shaft is repeatedly turned by hand to ensure proper alignment.
- 5.2.2 The assembled pump can then be installed into the sump system consistent with details of the user designed sump system.
- 5.2.3 Mount the metal sample coupons in the sump. The coupons should be cleaned, polished, and weighed before they are installed.
- 5.2.4 The remainder of the sump system should be assembled. The detailed procedures for assembling the sump system should be customized to the sump design that has been developed by the user.
- 5.2.5 Once assembled, the sump canister should then be filled with 1510 ± 5 mL of the fresh test fluid. If O-ring seals are incorporated into the design, new O-rings should be used for each test.
- 5.2.6 The assembly of the test head begins with an initial solvent wash of the two test Test Bearings. The Test Bearings come vacuum-sealed with a coating of mineral oil. After the initial rinse (using heptane), each Test Bearing is placed in a beaker of fresh solvent and then placed in a sonic bath for 15 minutes. Each Test Bearing should then be rinsed off with fresh heptane and dried off with an oil-free, moisture-free air supply.
- 5.2.7 A Test Bearing consists of a split inner race and an outer race/cage/ball assembly. The split inner race has two distinct sides. The “pull” side of the inner race has a ledge next to the cage lands to allow a bearing puller to grasp for removal. The non-pull side of the inner race is placed on the shaft first followed by the outer race assembly and then finally the pull side of the inner race.

- 5.2.8 The Drive Shaft has very close tolerances to the bore diameter of the Test Bearings. As such, mounting the Test Bearings requires the inner race halves to be heated on a hot plate for thermal expansion to increase the bore diameter. When heating the inner races, the part should be flipped every 30 seconds to ensure uniform heating. A pair of laboratory tongs is recommended for handling the hot races by using the curved stems of the tongs to grip the cage lands. Care should be taken during the heating process so that no oxide layer forms due to overheating. Additionally, the Drive Shaft is wetted with the test oil to more easily slide the inner race pieces into place.
- 5.2.9 The Rear Test Bearing is always mounted first, and to do so requires the Drive Shaft to be standing vertically, supported by its drive side. It should be noted that the serial number of each Test Bearing is recorded along with its position (forward or rear).
- 5.2.10 Once the non-pull side half of the inner race is seated with its face butted against the edge of the Drive Shaft, the outer race assembly is seated on the inner race track. Fresh test oil should then be applied to the balls. Oil should also be reapplied to the top of the Drive Shaft in preparation for the pull side half of the inner race.
- 5.2.11 When mounting the “pull” side of the inner race, only the added ledge must be gripped since the cage lands need to descend into the outer race assembly. Once the Rear Test Bearing is completely assembled, the Bearing Retainer is secured onto the end of the shaft with four cap screws. The Drive Shaft can then be inverted so that the Forward Test Bearing can be mounted (using the same procedure as the Rear Test Bearing).
- 5.2.12 Once the forward Test Bearing is in place, the spacer is added to the shaft followed by the oil slinger. A new, clean Viton-A O-ring (size 115) is then wetted with test oil and slid into its recess on the shaft. The air seal is then added (with the “R” side up) followed by the lock washer and lock nut.
- 5.2.13 With the Drive Shaft assembly complete, the Test Housing should be suspended on an assembly stand (user designed) using the two threaded mounting holes on the rear end of the Test Housing.
- 5.2.14 The rear drain fitting and the head vent fitting should be installed first. As with all fittings attached to the test head, a suitable high-temperature anti-seize compound (Crawford Fitting Company Silver Goop, as an example) should be used on the threads. Care should be taken when applying the compound not to contaminate the oil-wetted surfaces of the fitting.
- 5.2.15 The rear bearing heater should then be slid into position on the Test Housing. The clamping system for the rear band heater will have to be modified in order to accommodate the head vent fitting. Next, the air cooling coils are added followed by the forward bearing heater.
- 5.2.16 The forward drain fitting is then added followed by the seven thermocouple ports and the four oil jet ports. Assembly of the jets requires precise positioning to ensure oil spray is directed to the Test Bearings. For jet assemblies that have not previously been properly aligned/positioned, do not fully tighten oil jet fittings until after the alignment is completed later in the procedure (see section 5.2.19).
- 5.2.17 With the forward end of the Test Housing pointing up, the Forward Bearing Mount should be slid into the Test Housing. As with all sliding contacts within the Test Housing, the surfaces should first be primed with the test oil to ease assembly.
- 5.2.18 Install a new, clean Viton-A O-ring (size 237) wetted with test oil on the forward face of the Test Housing. Insert the Forward End Cap into the Test Housing and secure with a V-Band Clamp. Stainless steel alignment pins should be used to correctly position the Forward Bearing Mount and the Forward End Cap with respect to the Test Housing.
- 5.2.19 The Assembled Test Head is then inverted so that the rear end is pointing up. Gripping the outer race of the rear Test Bearing, the shaft assembly is then lowered into place so that the outer race of the Forward Test Bearing slides into the Forward Bearing Mount. The Load Spring is then set atop the face of the outer race of the Rear Test Bearing. The Rear Bearing Mount is then inserted with its stainless steel alignment pin in place.

- 5.2.20 *This step is only required when the oil jet assembly is new and requires proper alignment. If the alignment of the oil jet assembly has already been accomplished, skip to section 5.2.21.* Using a wash bottle, heptane should be sprayed into each of the two rear jets. The jet should be adjusted so that the spray is aimed into the gap between the outer race of the Test Bearing and the cage. Once positioned correctly, the jet fittings can be fully tightened. Next, seat a new, clean, oil-wetted Viton-A O-ring (size 237) into the recess on the rear face of the Test Housing. Slide the Rear End Cap into position and insert alignment pin through it and the Test Housing before sealing with the V-Band Clamp. Invert the Assembled Test Head so the forward end is facing up. Remove the Forward End Cap. As was done with the rear oil jets, spray heptanes into the two forward jets and adjust the jets so that the spray is aimed into the gap between the outer race of the Test Bearing and the cage. Extra caution must be used when positioning the forward jets because they can contact the Drive Shaft if seated too deeply. The shaft will rotate freely as long as there is clearance between the tips of the jets and the Coupler. Once positioned correctly with unobstructed bearing rotation, the jet fittings can be fully tightened. As the ferrules are now fixed, the jets should now be removed to prevent possible damage in the following steps. Replace the Forward End Cap and V-Band Clamp assuring that the two alignment pins are again in place. Again invert the Assembled Test Head so the rear end is facing up. Remove the Rear End Cap. (Note: the same O-ring can be used when the Rear End Cap is replaced in step 5.2.22).
- 5.2.21 Place the Hot Spot Heat Shield against the face of the Rear Bearing Mount.
- 5.2.22 Seat a new, oil-wetted Viton-A O-ring (size 237) into the recess on the rear face of the Test Housing. Insert the Rear End Cap into the Test Housing. Using another stainless steel alignment pin, align the Rear End Cap with the Test Housing. There will be a gap between the Rear End Cap and the Test Housing due to the presence of the Load Spring, and the gap will prevent the V-Band Clamp from being tightened. Nonetheless, the V-Band Clamp is loosely placed around the Assembled Test Head.
- 5.2.23 Remove the Assembled Test Head from the assembly stand taking care to not apply any load to the tip of the Drive Shaft. Use a pair of blocks placed under the forward end cap to support the Assembled Test Head so that the forward end of the Drive Shaft is suspended. Place the blocks and Assembled Test Head in a hydraulic press and use the press to gradually seal the gap between the Rear End Cap and the Test Housing. When there is no longer a gap the press load should be recorded, and the V-Band Clamp should be tightened to seal the Rear End Cap to the Test Housing.
- 5.2.24 Mount the Assembled Test Head back into its assembly stand with the forward end of the Drive Shaft pointed up.
- 5.2.25 Install the oil jets. Once the oil jets are in place, the shaft should be checked to see whether it freely rotates. The forward oil jets can contact the Spacer on the Drive Shaft if their port fittings are too tight. If rubbing is detected, these fittings should be loosened until unobstructed rotation occurs.
- 5.2.26 The Assembled Test Head can now be removed from its assembly stand and mounted onto the motor frame using a flexible coupling to connect the Drive Shaft to the in-line torque sensor.
- 5.2.27 Connect oil delivery and return lines to the pump/sump assembly.
- 5.2.28 Apply heating tapes and insulation to the oil delivery line leading to the oil jets so that the oil temperature in the delivery line can be maintained at a level near that of the sump temperature.
- 5.2.29 Insert the rod heater into the recess in the Rear End Cap to simulate an engine hot spot. The heater is secured into place by wrapping a braided, high-temperature insulation rope between the two thermocouples above and below the hot spot. The rear end cap is then covered with ceramic fiber insulation.
- 5.2.30 Apply insulation to the oil delivery lines and jets as well as the bearing heaters.

6. TEST PROCEDURE

The test procedure is for an individual test cycle. The procedure described here is for the standard 100-hour minisimulator test protocol. For the standard test protocol, ten test cycles are carried out and specific target temperatures and flow rates are specified (see below). Other protocols may be developed using other target temperatures and flow rates.

6.1 System Check

- 6.1.1 The bubbler should be filled with 80 mL of distilled water. Each cycle typically consumes approximately 20 mL so this amount is added before the start of the next cycle to maintain the 80-mL start volume.
- 6.1.2 After the first test cycle, the sump is to be charged with fresh oil make-up to give a 1500 mL total. The make-up volume is typically from 20-30 mL for each cycle.
- 6.1.3 Prior to beginning a test, the electrical systems of the minisimulator should be checked. The four heater controllers should be set at 38 °C (100 °F) so that heating of the four elements (forward bearing, rear bearing, sump, and hot spot) can be verified without stressing the oil.
- 6.1.4 Pump operation should be checked once the oil temperature has peaked. The oil should be allowed to circulate at the minimum pump speed for at least 30 minutes. The system should be checked for leaks and connections tightened if necessary. Depending on the volume of oil used to charge the sump, the excess should be drained from the system so that 1500 mL remains. Of the amount removed, 10 mL should be saved for a 0-hour sample.

6.2 Start-Up

- 6.2.1 Apply power to the heat tape. The heat tape is powered by a variable transformer. The power supplied to the tape should be slowly increased in 10% intervals every ~10 minutes until the desired temperature is achieved. The ramp rate for this process should be tailored to ensure that the heat tape is at full power when the rest of the system achieves operating temperatures.
- 6.2.2 Begin heating up the system. As previously alluded to, there are four temperature readings that are used for process control: the sump, the forward bearing, the rear bearing, and the hot spot. There are actually two thermocouples each associated with the forward Test Bearing, the rear Test Bearing and the hot spot. Either of the two may be used for the process control. The other thermocouple reading is monitored for archival quality control purposes only. The four temperature controllers are starting at 38 °C (100 °F). The temperature ramp should be such that the targets for the four process control temperatures reach their target in 1.5 hours. For the standard 100 hour minisimulator test protocol, the target temperatures are: sump 205 °C (401 °F), forward Test Bearing 260 °C (500 °F), rear Test Bearing 260 °C (500 °F), and hot spot 300 °C (572 °F). It is important that temperatures are not allowed to overshoot their target values. Since the three heater/process thermocouple pairs located on the Assembled Test Head are not independent of one another, temperature overshoot is a very real concern. For example, increasing power into the hot spot heater will cause both the temperature of the hot spot thermocouple and of the rear Test Bearing thermocouple to rise. It may take the operator several trial runs to establish proper procedures, such as ramp and soak recipes, to achieve the proper temperature ramp.
- 6.2.3 When the sump temperature reaches 52 °C (125 °F), the pump motor should be engaged to start oil circulation. The target flow rate for the standard test protocol is 200 mL/min. The oil flow rate must be used as a process variable to control the pump motor speed since oil viscosity will be changing with temperature. The system pressure should be noted to verify oil is reaching the Test Bearings. Note that establishing oil flow will have an effect on system temperature in the sump and the Assembled Test Head.
- 6.2.4 When one of the four Test Bearing thermocouples reaches 205 °C (401 °F), the drive motor is to be powered on and the speed ramped to 2000 rpm. Excessive noise and/or high torque (greater than 1 inch-pound) may be an indication of Test Bearing failure or possible assembly misalignment and could warrant aborting the test cycle. If satisfactory operation occurs, the valve to the air seal should be opened to introduce moist air into the Test Head at a flow rate of 4.6±0.1 L/min. Note that starting the drive motor will affect the temperatures of the Assembled Test Head.

- 6.2.5 The temperature of the oil jets should be monitored during warm-up to ensure no clogging is occurring. Since a clogged jet has no oil flowing through it, the temperature will be significantly less than its adjacent jet. A temperature gradient of 5-10 °C (9-18 °F) is typically characteristic of a partial obstruction within the jet; a 50 °C (90 °F) temperature gradient suggests that a jet is completely blocked. A test cycle can be completed with only three working jets, but before the next test cycle, the necessary fittings should be removed from the oil line to the clogged jet and a clean wire used to ream the inside of the jet tube. The fittings should be replaced along with any insulation material that was removed.
- 6.2.6 When the thermocouple located in the center of the Assembled Test Head reaches 288 °C (550 °F), establish air flow to the air cooling coil. The air flow rate should be 12±1 L/min.
- 6.2.7 When the coolest of the four Test Bearing thermocouples reaches 249 °C (480 °F), the drive motor is slowly increased to the target speed. For the standard test protocol, that speed is 10 000 rpm and the increase from 2000 rpm should be made over the course of two minutes. Again, torque and noise should be noted to ensure safe operation. Note that increasing speed will have an effect on system temperatures.
- 6.2.8 Begin data logging when the target speed is reached.

6.3 Cool-Down

After the 10-hour test cycle has been completed, the following steps should be taken to shut down the test.

- 6.3.1 Stop the data logging process.
- 6.3.2 Reduce the Test Bearing speed to 2000 rpm over the course of 2 minutes.
- 6.3.3 All heaters should be powered off (including variable transformer for heating tape).
- 6.3.4 Remove a 10 mL oil sample from the system. Sampling should be done such that the oil sample is characteristic of the whole oil system.
- 6.3.5 After all four Test Bearing thermocouple readings fall below 205 °C (401 °F), adjust motor speed to 0 rpm and power down motor drive.
- 6.3.6 Stop air flow to the air seal.
- 6.3.7 Adjust pump motor to minimum speed and then turn off power to pump motor.

6.4 Oil Recovery

- 6.4.1 After the last cycle is completed, the oil remaining in the system should be pumped out and the volume measured. The sump may be heated slightly (125-150 °F) to increase the fluidity of the oil, but the oil should be allowed to reach room temperature before recording the amount recovered.
- 6.4.2 Some oil residuals will remain in the system even after the sump is purged. Most of what remains is in the bottom of the sump. Some may also reside within the lower oil jets since they do not drain completely. All additional oil residual should be collected upon disassembly (see following sections).

6.5 Disassembly of Apparatus

- 6.5.1 Care should be taken throughout the disassembly of the Assembled Test Head to ensure that coke deposits are not inadvertently removed.
- 6.5.2 Remove all of the ceramic fiber insulation from the rig. It is likely that much of this can be reused for the next test; pieces soiled with oil or condensed vapors should be discarded.
- 6.5.3 The heat tape used on the oil delivery line should be carefully unwound and inspected for frayed insulation and exposed wires. If no damage is found, the heat tape may be reused in the next test.