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AERONAUTICAL RECOMMENDED PRACTICE

ARP492

AIRCRAFT FUEL PUMP CAVITATION ENDURANCE TEST

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Revised

1. PURPOSE:

1.1 This recommended practice defines a procedure for testing aircraft fuel pumps for the purpose of evaluating and comparing their resistance to deterioration in endurance running under cavitating conditions.

1.2 The procedure recommended herein is based on experience gathered by a number of laboratories conducting component qualification tests to MIL-E-5009A. It is intended to produce a uniform, reproducible, cavitating condition similar to that which is prescribed by paragraph 4.3.2.3.6 of MIL-E-5009A.

1.3 The procedure recommended herein is not intended to provide a test for the purpose of compliance with MIL-E-5009A. Since the test defined herein does not provide for operation at (simulated) altitude conditions, this test cannot establish altitude performance of the article tested.

2. SCOPE:

2.1 This procedure is intended to apply to any aircraft fuel pump which supplies liquid hydrocarbon fuel either directly to an aircraft engine or to another pump mounted on an aircraft engine, except that it is not intended to apply to a fuel pump mounted in a fuel tank.

2.2 The procedure will be defined in terms of a recommended test set-up and a recommended testing method.

3. GENERAL REQUIREMENTS:

3.1 Fuel: MIL-F-5624 JP-4.

3.1.1 Fuel Temperature: 130°F.

3.1.2 Tank Pressure Above Fuel Surface: Test cell ambient pressure.

3.1.3 Fuel Flow: The flow requirement corresponding to 1.15 ram ratio at sea level for the engine concerned.

3.1.4 Fuel Discharge Pressure: The pressure requirement for the flow requirement of 3.1.3.

3.2 Inlet Condition: An inlet pressure depressed below tank pressure to produce 0.3 V/L minimum as defined by the 1946 CRC Handbook.

3.3 Duration of Test: 50 hours total.

3.4 Pump Speed: As required for the pump application.

4. DETAIL REQUIREMENTS:

4.1 Test Set-up: The equipment should be in accordance with Figure I subject to the limitations provided therein except as enumerated here:

4.1.1 Fuel Tank:

4.1.1.1 Shape of the tank is optional.

4.1.1.2 Insulation of the tank is optional.

4.1.1.3 The size of the tank shall be sufficient to contain a test fuel volume equivalent to the flow rate for at least two minutes of operation at the test condition.

4.1.2 Fuel Inlet Line: The critical elements of the inlet line bear specific notation in Figure I and should be included. The remaining configuration is flexible within the limitations here:

4.1.2.1 Inherent Pressure Loss:

(a) The pressure loss from p_0 to p_1 at the test flow rate should not exceed $\frac{1}{2}$" hg. This pressure loss shall be defined as $p_0 - p_1 + p_H$ is the pressure equivalent of H.

(b) The pressure loss from p_0 to p_2 at the test flow rate with valves A and B open wide should not exceed 2" hg.

4.1.3 Fuel Bypass Line: Any pump discharge flow in excess of the requirements of paragraph 3.1.3 should be bypassed in a manner consistent with the pump installation for the applicable engine.

4.1.4 Additional Test Equipment: All necessary devices for testing other than already shown should be placed in the discharge line.

4.2 General Method of Testing:

4.2.1 Test set-up should conform to paragraph 4.1.

4.2.2 Preparation for Test:

(a) Add fresh MIL-F-5624 JP-4 to the fuel tank. The fuel volume in the tank must equal or be greater than the volume rate of test flow for two minutes. The elevations of the fuel level in the tank and the pump inlet port should coincide within 6". The tank should be vented to the ambient pressure in the test cell.

(b) In the heating cycle, the test pump may be used for circulating. The rate of heat addition to the fuel mass in the tank should not exceed 4°F. per minute. A record of fuel temperature during the heating cycle should be maintained and included with the test data. At no time during the heating cycle should the tank fuel temperature be permitted to exceed 132°F.

(c) With the inlet line throttle valves (A and B) open wide and with the fuel temperature maintained at 130°F. ± 2°F., establish the speed, flow and discharge pressure conditions for the cavitation test. Operate at these conditions for a minimum of 15 minutes to stabilize the fuel at the tank conditions (i.e. test cell ambient pressure), unless overshoot of temperature had previously occurred in (b) in which case an extra 5 minutes should be allowed for each °F. of overshoot. A record of the stabilization cycle should be maintained and included with the test data.

(d) Using the method outlined in the 1946 CRC Handbook, utilizing both the tank and inlet fuel temperature along with the tank pressure on the surface of the fuel, calculate the inlet pressure required to establish 0.3 V/L minimum at the pump inlet. A previous determination of the fuel vapor pressure should be adjusted to compensate for the weathering effect of the heating cycle (subtract 0.2 PSI from the RVP unless experience dictates otherwise).

(e) Adjust the inlet throttling valves to obtain the desired inlet pressure for the test while maintaining the other test conditions. The order of adjustment should be to throttle the downstream valve first to produce approximately 50% of the line loss required. The remainder of the line loss should then be obtained by throttling the upstream valve. Any further adjustment to maintain the desired inlet pressure should be made with the upstream valve. The desired inlet pressure should be maintained throughout the testing within ± 0.2" hg.

(f) At this point a fuel sample should be withdrawn from the fuel system to establish the RVP of the fuel at the start of the run.

4.2.3 Cavitation Testing:

(a) Operate for 50 hours at 0.3 V/L minimum using a tank fuel temperature of 130°F. ± 2°F. while maintaining an inlet pressure consistent with 0.3 V/L at the observed inlet fuel temperature. The tank should remain vented to the test cell ambient pressure and the calculations for V/L should reflect this tank pressure, the tank fuel temperature, the inlet pressure and the inlet fuel temperature.

(b) At the end of each run, another fuel sample should be withdrawn to prove that the vapor pressure of the fuel has not diminished below the specification value for JP-4 and to demonstrate that 0.3 V/L minimum has been maintained for the entire run.

(c) A run is defined as any period of continuous operation. Fuel changes should be made at intervals not exceeding 10 hours of operation. All runs are cumulative towards the 50 hour total endurance time.

(d) The following data should be observed at intervals (during each run) not exceeding 1 hour:

1. Temperature
   Test cell T_a
   Tank fuel T_1
   Inlet fuel T_2
   Discharge fuel (before throttle valve) T_3

2. Pressure
   Test cell ambient ("HGA) P_a
   Tank pressure above fuel ("HGA) P_o
   Pump inlet ("HGA) P_2
   Pump discharge (PSIG) P_3

3. Fuel flow (to be maintained at the value specified in 3.1.3 minus zero, plus 10%)

4. Time of day

In addition to these data, the RVP of the fuel should be entered on the record sheet for the beginning and end of each run. The RVP at any point (of time) during a run may be determined by a uniform gradient between samples.

5. SUGGESTED TESTING TECHNIQUES:

5.1 Test cell ambient pressure may be interpreted to include all atmospheric pressures above 28 "HGA.

5.2 Insulation of the tank and lines and added recirculation of the tank fuel may be necessary to provide temperature stability.

5.3 A test tank with adjustable elevation will provide flexibility for meeting the requirements of test fuel volume and fuel level elevation.

5.4 A slow heating cycle of approximately 2°F. per minute will reduce the undesirable weathering of fuel during the preparation for test.

5.5 Data observations at 15 minute intervals will prevent loss of valid test time due to loss of test conditions.