SAE Aerospace
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AEROSPACE RECOMMENDED PRACTICE

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Aircraft Turbine Engine Pneumatic Component Contaminated Air Endurance Test

RATIONALE

ARP4014 has been reaffirmed to comply with the SAE five-year review policy.

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1. SCOPE AND PURPOSE:

This recommended practice describes a method of conducting an endurance test using contaminated air when the applicable specification requires non-recirculation of the contaminants. The objective of the test is to determine the resistance of the engine mounted components to wear or damage caused by the contaminated air.

The method described herein calls for non-recirculation of the contaminants and is intended to provide a uniform distribution of the contaminant at the inlet to the Unit Under Test (UUT).

The UUT may require the use of a hydraulic fluid for actuation of components within the test unit. Contamination of this test fluid is not part of this recommended practice, however, if required by applicable test specification, refer to MAP 749A.

2. APPLICABLE DOCUMENTS:

2.1 Military Specifications:

MIL-E-5007 - Engine, Aircraft, Turbojet and Turbofan, General Specification for

2.2 SAE Publications:

MAP749A - Aircraft & Turbine Engine Fuel System Component Endurance Test (Contaminated Fuel)

3. TEST SETUP (Ref. Fig. 1):

3.1 Air Contamination: The air contamination requirements should be as specified in the applicable specification. Typical military requirements for pneumatic components are given in MIL-E-5007.

3.2 Test Fluid: Fluid, if required, should conform to the applicable specification. The engine primary fuel is recommended, however, if the test facility cannot be safely operated using fuel at high temperature, then the use of a silicone fluid having a specific gravity or viscosity, or both, similar to the engine fluid is recommended.

3.3 Test Fluid Temperature: Control is required as necessary to keep the UUT within its operational limits.

3.4 Test Fluid Pressure: The test fluid pressure should be as specified by the applicable test specification.

3.5 Ambient Temperature: Control required as necessary to keep the UUT within its operational limits. Test equipment used in a hot ambient facility may require special cooling provisions.

3.6 Inlet Air Temperature: The air temperature at the inlet of the UUT should be a minimum of 220°F or as otherwise specified by the applicable specification.

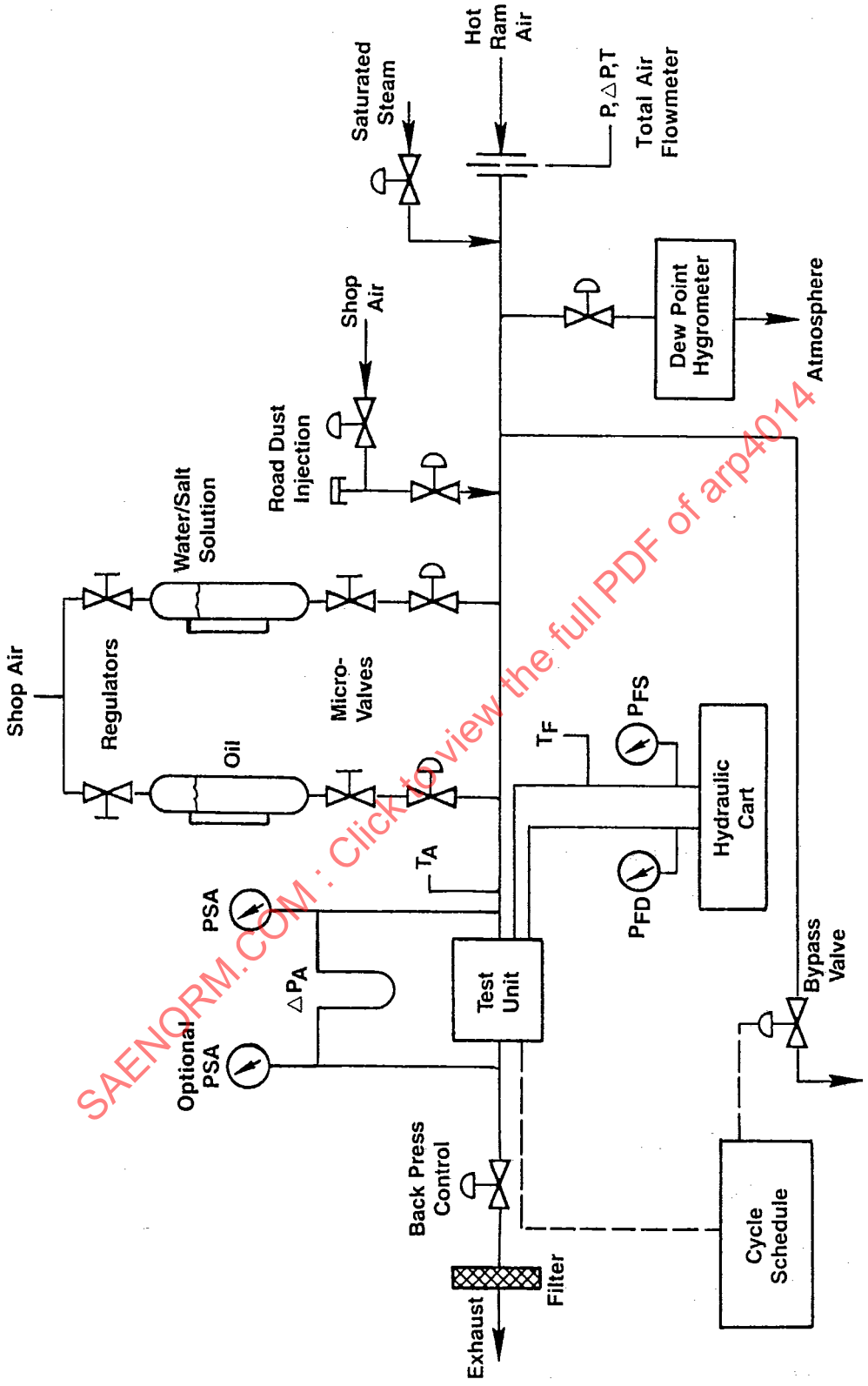

FIGURE 1 - Contaminated Air Test Facility

3.7 Inlet Air Pressure: The air pressure at the inlet of the UUT should be a minimum of 15 psig or as otherwise specified by the applicable specification.

3.8 Mounting: Each component should be mounted by its normal mounting pad for a level flight attitude.

3.9 Plumbing: Actual installation plumbing should be used when possible for connection of test components if two or more components are tested together. Where actual installation plumbing is not available, line sizes, lengths and bends should be duplicated as closely as possible. The matchup of the inlet air line and the opening in the test unit (if not identical to the engine installation) shall be made to prevent contamination in the inlet air from collecting at this interface outside the UUT.

3.10 Facility Filters: A clean-up filter downstream of the facility's backpressure control valve should be used if there is a concern relative to exhausting contaminated air. This filter can be a cotton sateen dust bag sized for the exhaust line.

3.11 Functional Cycling Simulation: The cyclic variations in air flow rate can be accomplished by using a cycle scheduler. Commercial units are available that can be programmed to provide switch closures at various time intervals. With proper interface equipment, this scheduler would open and close valves in the test unit in addition to opening and closing a solenoid-operated rig bypass valve, in the opposite sense, so that the air flow rate through the facility remains essentially constant. If an automatic cycler is used, consideration should also be given to incorporating an auto-abort system to prevent inadvertent damage to the UUT or test facility.

3.12 Termination of Test: The test should be terminated at a point where the engine system components have been operated as required under the applicable specification. These components should be functionally tested using the specified clean air after the completion of the contamination test requirements.

4. TEST CIRCUIT:

4.1 Circuit Schematic: A typical system arrangement is shown in Fig. 1.

4.2 Circuit Components:

4.2.1 Location: The functional location of the circuit components should be as shown in Fig. 1. The locations of the contamination inputs to the inlet line shall be downstream of the UUT Bypass Valve, so that none of the contamination is dumped overboard. The flow rate in the inlet line must be sufficient to avoid settling of solid contaminants and resultant "slugging."

4.2.1 (Continued):

The physical location of the circuit components will depend greatly on the facility configuration and the temperature of the air being used, for example, whether or not the UUT is in a hazardous environment relative to human safety. The contamination inputs to the inlet line should be as close to the UUT as possible, that is, less than 24 in, to reduce the amount of contamination that could collect on the wall of the inlet line. The inlet line should have a good electrical ground to prevent a build-up of static electricity which could cause contamination to collect in this line.

4.2.2 Contamination - Liquid contaminants, oil and salt water, may be contained in separate reservoirs and pressurized with a regulated supply of shop air. At the outlet of these reservoirs, a microvalve can be used to set the flow rate for each liquid (drops per minute) and this rate continuously supplied to the inlet air during the test. A length of 1/8 to 1/4 in diameter tubing, with a 90 deg gradual bend, is recommended for supplying the liquid contaminates coaxial and near the center of the inlet air stream. A ball valve or solenoid valve should be installed between the microvalve and inlet line to shut off these liquid contaminants during facility shutdown. It is recommended to put a liquid level gauge on each reservoir to use as an extra check that the proper flow rate is being applied.

The standpipe for introduction of the solid contaminant (sand and road dust) must be located in an operator-safe area, so that measured amounts of contaminant can be added at specific intervals during the test. The length of line between the UUT inlet pipe and standpipe downstream valve is not critical. This line should be a straight piece of smooth I.D tubing, and contain no fittings which can trap the solid contaminants.

4.2.3 Dew Point Hygrometer: The water vapor in the inlet air can be measured using a Dew Point Hygrometer. The sensor can be mounted within a few feet of the inlet line so long as it is maintained within its operating temperature limits. The display unit should be located in the operator's control console. The bleed-off air line for the sensor should be located upstream of all contamination inputs to the inlet air line to prevent erroneous readings.

4.2.4 Hydraulic Cart: If a hydraulic supply is required, it should be connected to the UUT with actual (or simulated) engine plumbing lines.

4.3 Instrumentation Calibration: In absence of company standards on calibration schedules, the instrumentation used should be calibrated within a 30-day period prior to starting the test and again within a 30-day period following completion of the test.

5. TEST METHOD:

5.1 Test Preparation: Each facility system should be adjusted and tested for proper operation prior to starting the test. The regulated air supply to the liquid reservoirs and the microvalves should be adjusted to establish the specified flow rate with the microvalves submitted to actual system backpressure.

The pressure and time required to blow the solid contaminants into the inlet air line can be tested without this line being connected, but with proper backpressure, to verify proper operation of the system.

The cycle scheduler, UUT and hydraulic cart should be set up using clean air and run for at least a 1 h trial period prior to introducing any contamination.

5.2 Test:

5.2.1 The test system should be started and advanced to the first test condition as required by the duty cycle at a rate as required by the applicable specification.

5.2.2 Upon reaching the first test conditions, the contamination should be introduced. The ball valves permitting the liquid contamination to enter the system should be fully opened allowing the liquids to drip into the inlet line at the preset rate established by settings of the microvalves and regulated air supply. To avoid trapping contaminant, the ball valves should be as close as possible to the microvalves. The first charge of solid contamination should be blown into the system during the first cycle.

5.2.3 Repeated applications of solid contamination into the system should be applied as required by the applicable specification.

5.2.4 The flow rate of the liquid contamination into the system should be monitored, recorded, and trimmed if necessary, no less than four times during the test at time intervals when it is planned to consume 20, 40, 60 and 80% of the total liquid contamination.

5.2.5 Recordings should be made to insure component compliance with the applicable specification.

5.2.6. The test shall continue for the time or cycles specified in the applicable specification.

5.2.7 The contamination system should be shut down within a 1-min time period and the air flow to the UUT bypassed within the next 1-min period in event of a malfunction or scheduled shutdown period.

5.2.8 If shutdown/bypass periods are part of the applicable specification, the entire system should remain undisturbed during these shutdown periods.

5.2.9 If a complete facility shutdown is required, system maintenance may be performed after the shutdown so long as the UUT is not disturbed.