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SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J2384

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Air Dryer Test Procedure

1. ***Scope—***This SAE Recommended Practice establishes uniform Test Procedures for desiccant Air Dryers used in vehicles with compressed air systems per SAE J2383. Continuous flow desiccant Air Dryers are excluded from the scope of this document

2. ***References***

2.1 **Applicable Publications—**The following publication forms a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale PA, 15096-0001.

SAE J2383—Air Dryer Installation Procedure

2.1.2 ASTM PUBLICATION—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 117—Standard Test Method of Salt Spray (Fog) Testing

3. ***Definitions***

3.1 **Adsorption—**The tendency of molecules from a surrounding fluid to concentrate on the surface of a solid due to the attractive forces between molecules.

3.2 **Air Dryer—**A device that cools, filters, and dries the air delivered by an air compressor.

3.3 **Compressor Load Cycle—**The time during which the air compressor is building air pressure in an air system.

3.4 **Compressor Unload Cycle—**The time during which the air compressor is not building air pressure in an air system.

3.5 **Desiccant—**A substance that adsorbs and desorbs moisture from air.

3.6 **Desorption—**The tendency of adsorbed molecules to transfer from the surface of a solid into the surrounding fluid in response to changes in their partial pressure or temperature.

3.7 **Dew Point—**Temperature at which water vapor begins to condense. For the purposes of this document, Dew Point will be assumed to be measured at System Pressure.

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3.8 Dew Point Depression (DPD)—Outside ambient temperature minus the dew point temperature in the air system reservoirs.

3.9 Integral Purge Air Dryer—A dryer for which the air for regeneration is internal to the dryer.

3.10 Outlet Check Valve—A valve that prevents downstream air from flowing back through the air dryer.

3.11 Purge Cycle—The time during which the air dryer is undergoing decompression and regeneration.

3.12 Purge Tank Air Dryer—A dryer for which the air for regeneration comes from a dedicated external reservoir.

3.13 Purge Valve—A valve that allows the collected moisture and contamination to be expelled from the air dryer during the purge cycle.

3.14 Purge Volume—The air used by the Air Dryer for regeneration, expressed in Standard Liters (scf).

3.15 Regeneration—The controlled flow of air back through the desiccant to remove moisture and contaminants.

3.16 Regeneration Valve—A valve that controls the amount of air from the air reservoirs that is used for regeneration in a System Purge Air Dryer.

3.17 Relative Humidity (RH)—The ratio of water vapor content present to the maximum water vapor content obtainable, for a specified temperature and pressure.

3.18 System Purge Air Dryer—A dryer for which the air for regeneration comes from the air system reservoirs.

3.19 Turbo Cut-Off Valve—A valve that closes the dryer inlet during the compressor unload cycle to avoid engine turbocharge pressure loss.

4. Instrumentation and Equipment

4.1 Devices to measure temperature, ±1.8 °C (3 °F).

4.2 Devices to measure pressure, ±2% of indicated value.

4.3 A device to measure flow rate, ±2% of indicated value.

4.4 A device to measure time, ±0.5 s.

4.5 A device to measure voltage, ±2% of indicated value.

4.6 A device to measure amperage, ±2% of indicated value.

4.7 A device to control ambient temperature, ±1.8 °C (3 °F).

4.8 A device(s) to heat and saturate air.

4.9 A device to measure dew point temperatures, ±0.6 °C (1 °F).

4.10 A device to measure air leakage, ±2% of indicated value.

4.11 A device to record or count cycles.

4.12 A 1/2 in NPT pipe plug with a 1.5 mm ± 0.1 mm (0.06 in ± 0.004 in) orifice or equivalent.

4.13 Pressure reservoirs of 32.8, 49.2 and 65.6 L ± 2 L (2000, 3000, and 4000 in^3 ± 120 in^3).

4.14 A salt spray test unit capable of ASTM B 117.

4.15 A vibration test unit capable of controlling frequency sweeps and g loading.

5. Air Dryer Test Procedures

5.1 Air Dryer Operation

5.1.1 TEST CONDITIONS—Unless otherwise stated, test parameters will be as follows:

a.	Ambient Temp	19 to 25 °C (67 to 77 °F)
b.	Mounting	As in Service
c.	Ambient Air Flow	none
d.	System Pressure	8.3 to 9.0 bar (120 to 130 psig)
e.	Flow Rate	455 to 510 slpm (16 to 18 scfm)

5.1.2 PRESSURE RELIEF OPERATION—With the Outlet Port plugged and no pressure at the Control Port, apply increasing pressure to the Inlet Port at 0.7 to 1 bar/s (10 to 15 psi/s). Record the pressure at which the Inlet Port Pressure is relieved. Decrease the pressure at the Inlet Port at the rate of 0.7 to 1 bar/s (10 to 15 psi/s). Record the Inlet Port pressure at which the relief function closes.

5.1.3 TURBO CUT-OFF VALVE OPERATION—With the Outlet Port plugged and System Pressure at the Control Port, increase the pressure at the Inlet Port from 0 to System Pressure in 1 bar (15 psi) increments. Record the pressure at which the Inlet Port air leakage exceeds 100 sccm.

5.1.4 REGENERATION VALVE OPERATION (FOR SYSTEM PURGE DRYERS ONLY)—With the dryer Outlet Port piped to a 65 L ± 1 L (4000 in^3 ± 60 in^3) reservoir, increase the pressure at the dryer Inlet Port to System Pressure. Apply System Pressure to the Control Port and record the pressure drop in the reservoir. Repeat with a 50 L ± 1 L (3000 in^3 ± 60 in^3) reservoir in place of the 65 L reservoir.

5.1.5 HEATER AND THERMOSTAT OPERATION—With the manufacturers specified voltage ±1 V applied to the heater connection, record the heater wattage draw versus ambient temperature in 10 °C (18 °F) decreasing increments over the full range of the heater performance. Repeat for increasing temperature increments.

5.2 Dryer Performance

5.2.1 PRESSURE DROP DURING CHARGE—With air flowing at 140, 280, and 420 slpm ± 10 slpm (5, 10, and 15 scfm ± 0.3 scfm) through the dryer and 8.3 bar ± 0.1 bar (120 psig ± 2 psig) maintained at the Outlet Port, record the difference in pressure between the Inlet and Outlet Ports.

5.2.2 FLOW CAPACITY—With 1.4 bar ± 0.1 bar (20 psig ± 1 psig) applied at the Inlet Port and the Outlet Port open, record the flow rate of air through the dryer.

5.2.3 DRYER CAPACITY—Supply the dryer with air at 71 °C ± 2 °C (160 °F ± 3 °F), 340 slpm ± 10 slpm (12 scfm ± 0.3 scfm), and 97 to 100% RH. Connect the dryer Outlet Port to a test system as described in Figure 1 or equivalent. Cycle the air pressure in the test system through a 1.4 bar ± 0.1 bar (20 psig ± 1 psig) range at pressures between 6.8 to 8.4 bar (98 to 122 psig). The unload cycle time is to be 2 times greater than the load cycle time ±1 s, for a 33% duty cycle. Cycle until the Dew Point Temperature of the air in the reservoirs has stabilized. Record the test system reservoir volume and the reservoir air DPD22, where DPD22 is the Dew Point Depression assuming the ambient temperature is 22 °C (72 °F). This assumption ignores the minor error that will occur due to the actual ambient which is to be controlled between 19 to 25 °C (67 to 77 °F). Then increase the reservoir volume and repeat. Continue to increase the reservoir volume and

repeat until the reservoir DPD22 is less than 17 °C (30 °F). Calculate the volume of air treated per cycle at which the reservoir air is at 17 °C (30 °F) DPD22. Then, for System Purge Air Dryers, subtract the purge volume. The resulting volume is the Dryer Capacity, expressed as Standard liters (scf).

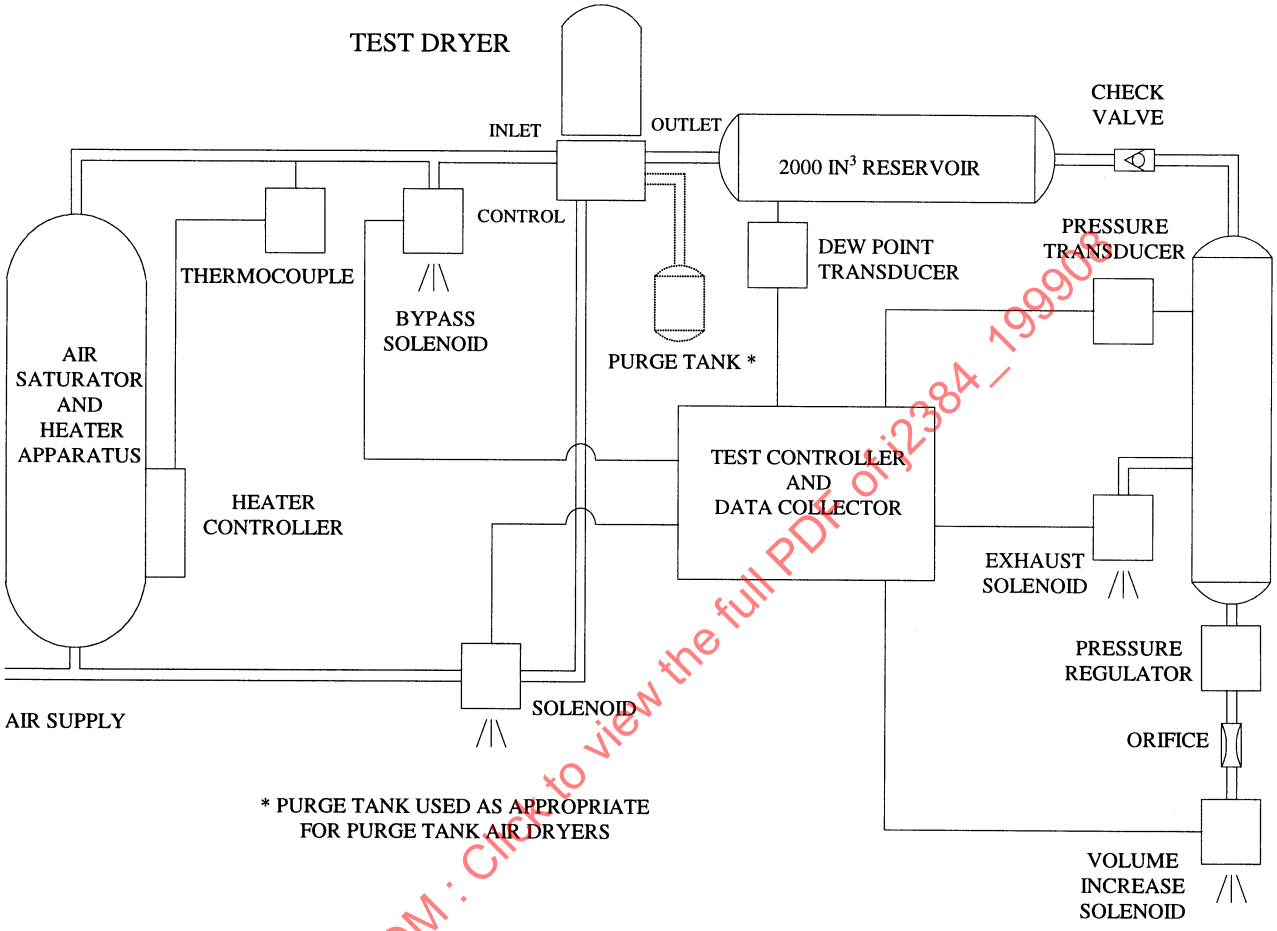

FIGURE 1—TEST SYSTEM

Note that in the test system of Figure 1, the purpose of the 'bypass solenoid' is to permit the continual flow of supply air to help maintain near constant dryer inlet temperatures. During the load cycle, the 'bypass solenoid' is closed and supply air flows through the dryer. During the unload cycle, the 'bypass solenoid' is open and the supply air flows out to atmosphere. The purpose of the 'volume increase solenoid' is to permit a controlled leak from the reservoir during the load cycle to simulate a larger reservoir.

Note that the 32.8 L (2000 in^3) reservoir volume in the test system of Figure 1 is important in determining the purge volume of System Purge Air Dryers. For System Purge Air Dryers, the Dryer Capacity test may also be run with a larger reservoir in place of the 32.8 L reservoir, as long as the reservoir size used for the test is reported with the Dryer Capacity result.

Note that fresh desiccant may perform abnormally during initial testing. To avoid this temporary condition, Capacity testing should be repeated until the results are stable.

5.2.4 RESERVE CAPACITY— Continue the testing in 5.2.3, further increasing the reservoir volume until the stabilized DPD22 is less than 5 °C (9 °F). Calculate the volume of air treated per cycle at which the reservoir air is at 5 °C (9 °F) DPD22. Then, for System Purge Air Dryers, subtract the purge volume. Then subtract the Dryer Capacity. The resulting volume is the Reserve Capacity, expressed in Standard liters (scf).

Note that fresh desiccant may perform abnormally during initial testing. To avoid this temporary condition, Reserve Capacity testing should be repeated until the results are stable.

5.2.5 RECOVERY—Continue the testing in 5.2.4 but with the test system reservoir volume set to the volume calculated as the Dryer Capacity. Cycle the test system until the reservoir DPD22 has reached 14 °C (25 °F). Recovery is the number of cycles necessary to change the reservoir DPD22 from 5 °C (9 °F) to 14 °C (25 °F).

Note that fresh desiccant may perform abnormally during initial testing. To avoid this temporary condition, Recovery Capacity testing should be repeated until the results are stable.

5.2.6 DRYER EFFICIENCY—Dryer Efficiency (%) = 100 x Drying Capacity (5.2.3) /(Drying Capacity + Purge Volume). Note, both Drying Capacity and Purge Volumes are to be expressed in Standard liters (scf).

5.3 Air Dryer Leakage

5.3.1 ASSEMBLY LEAKAGE—With the Outlet and Purge Tank Port plugged and the Control Port open, apply System Pressure to the Inlet Port. Measure and record the leakage.

5.3.2 CONTROL LEAKAGE—With the Outlet and Inlet Ports open and the Purge Tank port plugged, apply System Pressure to the Control Port. Measure and record the leakage.

5.3.3 OUTLET LEAKAGE—With the Inlet and Purge Tank Ports plugged, apply System Pressure to the Control and Outlet Ports. Measure and record the leakage of the pressure at the Outlet Port.

5.4 Environmental Test

5.4.1 LOW TEMPERATURE LEAKAGE—Condition the assembly for a minimum of 20 h at –40 °C ± 1 °C (–40 °F ± 2 °F) with zero pressure applied. While maintaining the ambient and test air temperatures at –40 °C ± 1 °C (–40 ± 2 °F), perform the leakage tests per 5.3.

5.4.2 LOW TEMPERATURE FUNCTION—With a 65 L ± 1 L (3965 in^3 ± 60 in^3) reservoir at the Outlet, cycle the dryer, 1-min charge and 1-min purge, for a minimum of 8 h. Inlet air is to be at 50% ± 10% RH, 52 °C ± 3 °C (125 °F ± 5 °F), and 200 slpm ± 15 slpm (7 scfm ± 0.5 scfm). Stop the cycling with the Purge Valve closed and drop the ambient temperature to –18 °C ± 1 °C (0 °F ± 2 °F). After 12 h minimum, activate the heater at rated ±0.5 V, and re-start the dryer cycling. Record the cycles until the purge valve opens.

5.4.3 HIGH TEMPERATURE DURABILITY—Cycle the dryer at the conditions of 5.1.1 and with dryer air inlet temperature at 80 °C ± 5 °C (176 °F ± 9 °F). Cycle the dryer at a rate between 5 and 40 cycles per minute for 100 000 cycles. During the test, the dryer outlet port is to have a 1.5 mm ± 0.1mm (0.060 in ± 0.004 in) orifice to atmosphere or an equivalent method to insure that the Outlet Check Valve cycles. At the completion of the cycles, perform the leakage tests of 5.3. Then disassemble the dryer and record any failed parts.

5.5 Durability Test—Cycle a dryer at the conditions of 5.1.1 except at rated System Pressure and without flow rate restriction. Cycle through full pressure sweeps up to within 0.3 bar (5 psi) of rated System Pressure and down to at most 0.3 bar (5 psi), for 1 000 000 cycles. Integral Purge Dryers may add a quick exhaust feature to help vent the purge volume and accelerate the test. During the test, the dryer outlet port must have a 1.5 mm ± 0.1mm (0.060 in ± 0.004 in) orifice to atmosphere or an equivalent method to insure that the Outlet Check Valve cycles. At the completion of the cycles, test the dryer per of 5.1 and 5.3. Then disassemble the dryer and record any failed parts.