



AEROSPACE RECOMMENDED PRACTICE

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DYNAMIC TESTING SYSTEM FOR OXYGEN BREATHING EQUIPMENT

1. PURPOSE

The purpose of this recommended practice is to establish and/or outline a system and instrumentation for dynamic testing of breathing oxygen demand regulators and/or demand regulator mask and hose assemblies. Dynamic testing, simulating the human breathing capabilities, will insure the reliability and stability of crew oxygen breathing systems.

2. SCOPE

This ARP covers a system and method to be used, at all appropriate altitudes, in testing of breathing oxygen systems consisting of demand regulator, connecting hose, and mask, or regulator and helmet systems, or individual components.

3. GENERAL REQUIREMENTS

- 3.1 Breathing Machine - The breathing simulator used in this system shall produce an essentially sinusoidal pattern. The simulator shall be adjustable to produce any cycle from 5 to 48/min. The simulated tidal volume shall be adjustable from 0 cc to 3.5 liters.
- 3.2 System Cleanliness - All material used in the dynamic test system downstream from the regulator under test shall be free of oil and grease and suitable for use with low pressure 100% oxygen and the pressures designated by the regulator specification.
- 3.3 Leakage - The complete system shall be leak free. Leakage measured as altitude drop shall not exceed 200 ft per minute at a 50,000 ft altitude, with all air and vacuum valves closed. The 200 fpm drop is based on a computed volume of two cubic feet.
- 3.4 System Equipment - Recommended equipment (equivalent adequate alternates may be used). See Fig. 1 and 1A.
 - 3.4.1 Pump - small diaphragm type (Index 1, Fig. 1), used to circulate exhaled mixture through oxygen partial pressure meter, or gas analyzer (Index 5, Fig. 1). Suggested source: Neptune-Dyna Pump, Model #2.
 - 3.4.2 Sensitive Altimeter (Index 2), used as a rate of climb indicator.
 - 3.4.3 Breathing Machine (Index 3) Scott or equivalent.
 - 3.4.4 Altitude Test Chamber (Index 4), size, type, and connection suitable for equipment to be tested.
 - 3.4.5 Oxygen Partial Pressure Meter (Index 5) Beckman or equivalent.
 - 3.4.6 Vacuum Source (Index 6) adequate for the altitude and flow requirements of the equipment under test.
 - 3.4.7 Equipment to be tested (Index 7).
 - 3.4.8 Altitude Gage, Absolute (Index 8) Haas, Wallace Tiernan, or equivalent.

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- 3.4.9 Oxygen Line Pressure Regulator (Index 9), pressure range and flow as required for the equipment to be tested. (If low pressure oxygen, 10 to 100 psi, is required, a gage should be installed in the oxygen line inside the altitude chamber).
- 3.4.10 Oxygen Source (Index 10), pressure and quantity adequate for the equipment to be tested.
- 3.4.11 Surge Tank (Index 11) 50 gal capacity vessel, required to dampen breathing machine pulsations.
- 3.4.12 Bleed Valve (Index 12) Normally a diluter demand regulator dilutes the oxygen with air from a "great big world;" therefore, dilution air must be added to the "test chamber world." The quantity bled into the chamber must be equal to the ambient air percentage minute volume removed by the breathing machine and altitude control valve.
- 3.4.13 Flow Meter (Linear Type) (Index 13) used to measure bleed air flows, as explained in 3.4.12. (ARO or American)
- 3.4.14 Check Valve (Index 14), capacity must be greater than the lpm of the maximum setting on the breathing machine; resistance must be less than 0.5 in. of water at maximum flow rate of the breathing machine.
- 3.4.15 Valve - small in line type shut off (Index 15), Hoke or equivalent, used to meter flow through oxygen analyzer.
- 3.4.16 Altitude Control (Index 16) 1/2 in. NPT needle valve.
- 3.4.17 Air Control Valve (Index 17), for chamber, used only to drop chamber altitude rapidly. This valve is not necessary on small chambers and is for convenience only.
- 3.4.18 Balance Line (Index 18) to equalize altitude pressure across breathing machine pistons.
- 3.4.19 Check valve, same as 3.4.14 above (Index 19). This valve shall be located as close as possible to the chamber outlet.

4. CALIBRATION

- 4.1 The system shall be calibrated for each altitude and breathing rate call out in the specification for equipment to be tested.

The following items may be calibrated and adjusted at normal pressure:

- 4.1.1 Volume and cycle rate of breathing machine.
- 4.1.2 Oxygen Partial Pressure Meter ± 2 mm on air, ± 1 mm on 100% oxygen.
- 4.1.3 Pressure Gages.
- 4.2 The following must be calibrated at each altitude called out in the equipment specification.
 - 4.2.1 Absolute Pressure Gage (Altimeter) - each test altitude ± 10 feet.
 - 4.2.2 Oxygen Partial Pressure Analyzer or Gas Analyzer - each test altitude ± 2 mm.
 - 4.2.3 System leakage at 50,000 ft altitude - less than 200 fpm with all valves closed.

5. OPERATION NOTES

The system outlined in this standard will dynamically test demand oxygen regulators and diluter demand oxygen regulators alone, or in combination with mask and hose assemblies.

The test chamber can be sized to accommodate various regulator, hose and mask combinations, as well as helmet regulator systems for all altitude tests. Explosive decompression tests can be accomplished by the addition of pressure transducers and recorders. For explosive decompression, the sensitive altimeter must be isolated with a valve or removed. The parameters for calibration, instruments and tolerances are adequate for dynamic testing of the equipment and system outlined above.

6. TYPICAL TESTING OPERATION (All Index Numbers refer to Fig. 1)

6.1 Install regulator (7) in test chamber (4).

NOTE: If a mask regulator combination is installed, bypass valve (20) must be open and valve (21) closed. This will direct the total exhalation through the mask exhalation valve.

6.2 Adjust the oxygen supply regulator (9) to provide specification supply pressure.

6.3 Start pump (1) and adjust valve (15) for correct flow through the oxygen partial pressure meter or gas analyzer.

6.4 Close chamber and, by use of valve (16), raise the chamber altitude to the specification test altitude.

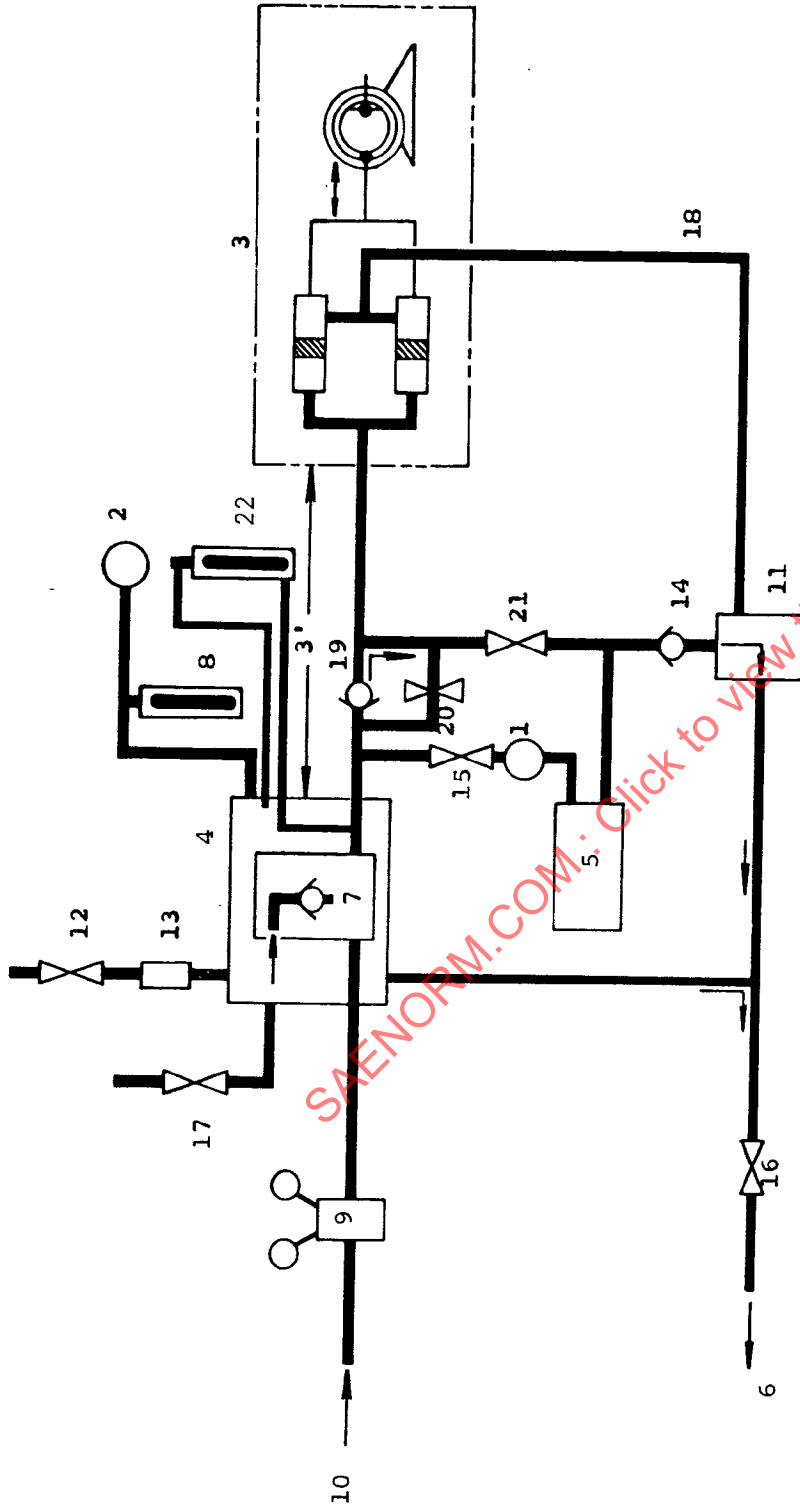
6.5 Start the breathing machine, previously adjusted to the tidal volume and rate specification, by use of vacuum valve (16) and chamber bleed valve (12). Balance the chamber at test altitude (Use the sensitive altimeter (2) as a rate of climb indicator to adjust chamber altitude balance). Observe flowmeter (13); the flow of air into the chamber should be 5 - 10% greater than the dilution air flow through the regulator.

6.6 Read and record the oxygen partial pressure on analyzer (5).

NOTE: Operation of the dynamic tester is the same for other altitudes, oxygen inlet pressures, tidal volumes, and respiratory rates.

6.7 Chamber altitude is lowered by slowly closing vacuum valve (16) and adding air to the chamber through valve (17).

PREPARED BY
COMMITTEE A-10, AIRCRAFT OXYGEN EQUIPMENT



1. Diaphragm Pump
2. Sensitive Altimeter
3. Breathing Machine
4. Altitude Chamber
5. Oxygen Partial Pressure Meter or Gas Analyzer
6. Vacuum Source
7. Equipment to be tested
8. Altitude Gage (Absolute)
9. Oxygen Supply Pressure Regulator
10. Oxygen Source
11. Surge Tank
12. Chamber Bleed Valve

13. Linear Flow Meter
14. Check Valve
15. Gas Analyzer or Oxygen Partial Pressure Meter Flow Control Valve
16. Altitude Control Valve
17. Air in Chamber Valve
18. Breathing Machine Altitude Balance Line
19. Check Valve
20. By Pass Valve (Used when testing Masks)
21. Valve (Used when testing Masks)
22. Manometer or inches of water differential gage

SCHEMATIC OF TYPICAL DYNAMIC TEST SYSTEM
FIGURE 1