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ALTITUDE CHAMBER TESTING OF THE PASSENGER OXYGEN SYSTEM (POS)

George W. Miller

Air Force Research Laboratory
Biosciences and Protection Division
Biobehavioral Performance Branch
Brooks City-Base, TX

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711 Human Performance Wing
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Biosciences and Protection Division
Biobehavioral Performance Branch
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GEORGE W. MILLER	MARK M. HOFFMAN
Technical Monitor	Deputy Division Chief
Biobehavioral Performance Branch	Biosciences and Protection Division
	Human Effectiveness Directorate
	711 Human Performance Wing
	Air Force Research Laboratory

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Biosciences and Protection Division
2485 Gillingham Dr.
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14. ABSTRACT.
AFRL/711 HPW/RHPG, Brooks City-Base TX conducted safe-to-fly testing of the CV-22 Passenger Oxygen System (POS). The CV-22 is an unpressurized aircraft. POS is a self-contained, "roll-on/roll-off" system to support passengers or paratroopers during high altitude operations and patients during medevac. POS includes a device for storing liquid oxygen, regulating the system pressure, and distributing oxygen to cargo area seats. POS is secured on the V-22 like cargo, has removable ballistic protection, and requires no aircraft modifications. One or two POS units can be installed in the CV-22 cargo area. The system successfully passed testing in the passenger, paratrooper, and medevac configurations. Two (2) POS units can support up to 20 passengers to 17,999 feet MSL, up to 16 paratroopers to 24,999 feet MSL, and up to 12 patients to 10,000 feet MSL.

15. SUBJECT TERMS:
Passenger Oxygen System; aircraft oxygen system; safe-to-fly testing; liquid oxygen system; unpressurized aircraft; roll-on/roll-off oxygen system; CV-22; V-22; paratrooper oxygen system; medevac oxygen system.

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Abstract

The Air Force Research Laboratory, 711 Human Performance Wing, Biobehavioral Performance Branch, (AFRL/711 HPW/RHPG), Brooks City-Base TX conducted altitude chamber testing of the CV-22 Passenger Oxygen System (POS). POS development began as an AFRL/711 HPW/RHPG and AFSOC, Hurlburt Field FL collaborative effort funded by USSOCOM, Tampa FL. The primary purpose of the effort was to provide an oxygen system for passengers, thereby, expanding the operating capabilities of the CV-22. The current POS program is managed by the V-22 Joint Program Office, Patuxent River, NAS MD. POS is a self-contained, "roll-on/roll-off" system to support passengers or paratroopers during high altitude operations and patients during medevac. POS includes a device for storing 25 liters of liquid oxygen, regulating the system pressure, and distributing oxygen to cargo area seats. POS is secured on the V-22 like cargo, has removable ballistic protection, and requires no aircraft modifications. One or two POS units can be installed in the CV-22 cargo area. The system successfully passed testing in the passenger, paratrooper, and medevac configurations. POS can support up to 20 passengers to 17,999 feet MSL, up to 16 paratroopers to 24,999 feet MSL, and up to 12 patients to 10,000 feet MSL.

Executive Summary

AFRL/711 HPW/RHPG, Brooks City-Base TX conducted altitude chamber testing of one Passenger Oxygen System (Cobham Mission Systems, Orchard Park NY; P/N B45475-1, S/N 0001) with ballistic armor. The test period was 23 Mar 09 to 03 Apr 09. The system was tested in three configurations: passenger, paratrooper, and medevac. POS delivered adequate oxygen flow and pressure (greater than 60 psig in passenger and paratrooper configurations and 50 psig in the medevac configuration); and was found safe-to-fly to the altitudes and under the conditions noted below. The safe-to-fly letter (Appendix R) was submitted to the V-22 Joint Program Office on 29 Apr 09.

Passenger Configuration: In the passenger configuration POS provided adequate oxygen to prevent hypoxia for up to ten (10) seated and resting passengers (one POS unit) or up to twenty (20) seated and resting passengers (two POS units) to an altitude of 17,999 feet MSL with the personal equipment noted below. Recommend each POS include 1 ea. CRU-79 oxygen regulator with supply hose. This regulator is capable of delivering 100% oxygen in the unlikely event a passenger experiences decompression sickness.

a. AIROX VIII Oxygen Metering Valve (Cobham Mission Systems, P/N 7920015-1M)
b. MBU-12/P Oxygen Mask
c. HGU-55/P Helmet

Paratrooper Configuration: In the paratrooper configuration POS provided sufficient 100% oxygen for pre-breathing and high altitude operations for up to eight (8) paratroopers (one POS unit) or up to sixteen (16) paratroopers (two POS units) to an altitude of 24,999 feet MSL with the standard paratrooper equipment noted below.

a. AIROX VIII Oxygen Metering Valve (Cobham Mission Systems, P/N 7920015)
b. Twin 50 Oxygen Bottles and Manifold (Cobham Mission Systems, P/Ns 8620028-1 and 9320113-3)
c. CRU-79 Oxygen Regulator (NSN 1660-01-139-5691)
d. MBU-12/P Oxygen Mask
e. HGU-55/P Helmet

Medevac Configuration: In the medevac configuration POS delivered sufficient oxygen to up to six (6) patients (one POS unit) or up to twelve (12) patients (two POS units) to an altitude of 10,000 feet MSL with the equipment noted below. POS was capable of delivering an adequate flow even when the individual PTLOX flow selector valves were set to their highest flow setting, 15 liters/minute. POS should only be used with patients after it obtains FDA approval.

a. PTLOX accessory kit (Essex Cryogenics, P/N 19062-50C-0021-0001)
b. Minilator Flow Distributor (Allied Healthcare Products Inc., Model No. LP43)

c. Continuous Flow Medical Oxygen Mask

1.0 Background:

The introduction of the CV-22 Osprey tilt rotor aircraft will provide Special Operations Forces (SOF) the vertical take-off and landing capability of a helicopter with the speed and range of a fixed wing aircraft. The CV-22 is an unpressurized aircraft and capable of operating at altitudes up to 25,000 feet. Integral to the aircraft is an On-Board Oxygen Generating System (OBOGS) designed to support the basic four person aircrew. However, an oxygen system for passengers, paratroopers, and patients would significantly expand the CV-22 operational capabilities. The Passenger Oxygen System would provide flexibility in mission planning, capitalizing on the speed, range, and safety of high altitude flight.

2.0 Passenger Oxygen System (POS) Test Article Description:

The CV-22 POS is a self-contained, "roll-on/roll-off" system to support passengers or paratroopers during high altitude operations and patients during medevac. The combat hardened POS includes a device for storing 25 liters of liquid oxygen, regulating the system pressure, and distributing oxygen to the cargo area seats. POS has removable ballistic protection. The 25 liter container is identical to those currently flown on AF cargo aircraft. An electronic LOX gauging system monitors the quantity of LOX and issues a warning (a flashing light) at 3 liters of LOX remaining. A red button on the control panel activates the LOX gauging display. A "day" and "night" switch adjusts the display illumination to the selected light condition. A picture of the POS is shown in Photograph #1.

Photograph #1: Passenger Oxygen System

3.0 Test Resources: Equipment part numbers and serial numbers are at Appendix Q.

a. Equipment, documents, and resources provided by the V-22 Joint Program Office:

(1) 1 ea. - Passenger Oxygen System with ballistic armor.

(2) 2 ea. - POS Oxygen Supply Hoses.

(3) 2 ea. – POS Distribution Manifolds.

(4) 10 ea. – POS Seat Oxygen Supply Hoses.

(5) 12 ea. – AIROX-VIII Oxygen Metering Valves with clips. (2 ea. were spares.)

(6) 10 ea. - AIROX-VIII Oxygen System with Twin Oxygen Bottles, CRU-79 Breathing Regulator, and appropriate Hoses and Connectors (2 ea. were spares).

(7) POS flight qualification test reports and Acceptance Test Procedure (ATP) results. Draft documents were received.

(8) POS Operating Manual. A draft document was received.

(9) 10 ea. Mask hose adapters (Part No. G002-1060-01).

(10) Test subjects - Most test subjects were V-22 aircrew.

(11) 1 ea. Purge Kit.

b. Equipment and resources provided by AFRL/711 HPW/RHPG:

(1) 10 ea. MBU-12/P Oxygen Masks (2 ea. were modified with gas sampling ports)

(2) 2 ea. PTLOX Medevac auxiliary equipment kit

(3) 10 ea. Standard Helmets

(4) Gaseous oxygen bottles conforming to MIL-PRF-27210G.

(5) Liquid nitrogen conforming to A-A-59503.

(6) Liquid oxygen conforming to MIL-PRF-27210G.

(7) 2 ea. Minilator Flow Distributor

(8) 6 ea. Continuous Flow Medical Oxygen Masks
(9) Test subjects: Some Brooks City-Base subjects participated when V-22 aircrew were unavailable.

c. Resources provided by USAFSAM: Physiology Technicians to support the manned chamber flights.

4.0 Scope:

The intent of the effort was to test the POS while simulating passenger, paratrooper, and patient operations in an altitude chamber at Brooks City-Base TX. The system was designed to support up to ten (10) seated and resting passengers up to 17,999 feet MSL; up to eight (8) paratroopers up to 24,999 feet MSL; and up to six (6) patients up to 10,000 feet MSL. **The manned testing adhered to AFI 11-409, "High Altitude Airdrop Mission Support Program." This AFI is routinely used by USAF flying units. The AFI stipulates prior to flying at cabin altitudes between 18,000 feet and 24,999 feet personnel must first pre-breathe 100% oxygen for 30 minutes below 10,000 feet and remain on 100% oxygen. Pre-breathing removes nitrogen from the body and minimizes the risk of decompression sickness.**

5.0 Schedule:

16-20 Mar 09: Altitude Chamber A5/6 was setup for the unmanned testing.

17-19 Mar 09: POS training provided to chamber personnel. Training provided by Cobham Mission Systems, Orchard Park NY.

23-25 Mar 09: Unmanned testing of AIROX-VIII conducted.

26-27 Mar 09: The unmanned data analyzed. Chamber E setup for the manned testing.

30 Mar 09: Subjects received orientation and training briefings.

31 Mar-03 Apr 09: POS manned testing conducted.

6.0 Method for Unmanned Testing:

Unmanned testing was based on the test plan shown in Appendix A. The unmanned testing only evaluated the performance of the AIROX VIII oxygen metering valve. Although the AIROX VIII is considered standard paratrooper equipment, using it in the passenger configuration as a stand-alone breathing device required unmanned breathing machine testing to verify adequate performance. The AIROX-VIII testing was conducted at inlet pressures of 60 psig, the minimum POS outlet pressure. Also, testing was accomplished at 50 psig for information only. 50 psig is the nominal inlet pressure for an AIROX VIII. A Variable Profile Breathing Simulator (VPBS) or breathing machine was used to induce a breathing pattern. The VPBS breathing profiles used are shown in Table 1. The profiles are based on standardized Brooks City-Base settings for testing regulators.

Photograph #2: AIROX VIII Oxygen Metering Valve with Flow Blinker

Table 1. VPBS Settings

Profile	Peak Flow (LPM-ATPD)	Breathing Rate (BPM)
1	17	8
2	60	12
3	94	20
4	125	40
5	157	25

Several randomly selected AIROX-VIII oxygen metering valves were tested. Oxygen mask used was a MBU-12/P with gas sensing ports. Altitudes for the testing were: Ground Level, 5,000 feet, 10,000 feet, 15,000 feet, 20,000 feet, and 25,000 feet. Data collected during testing at an inlet pressure of 60 psig are at Appendix C (Figures 1-11). Data collected during testing at 50 psig are at Appendix C (Figures 12-23).

Success Criteria for Unmanned AIROX VIII Testing:

a. Average oxygen concentration delivered to the mask during inhalation shall be greater than or equal to the values in Table 2. These oxygen concentrations represent 5,000 feet equivalency.

Table 2. Altitude vs. Minimum Oxygen Concentration

Altitude (Feet)	Minimum Average Oxygen Concentration (%) During Inhalation
Ground Level	21
5,000	21
10,000	26
15,000	32
20,000	41
25,000	52

b. Mask pressures shall comply with Table 3. This table was extracted from the ASCC Air Standards.

Table 3. Peak Inspiratory Flow vs. Mask Cavity Pressure

Peak Inspiratory and Expiratory Flows (L (ATPD) per sec/LPM)	Mask Cavity Pressure (kPa (inch water gauge))		
	Limits to		
	Minimum	Maximum	Maximum Swing
	Without Safety pressure		
0.5/ 30	-0.38 (-1.5)	+0.38 (+1.5)	0.5 (2.0)
1.5/ 90	-0.55 (-2.2)	+0.65 (+2.6)	0.85 (3.4)
2.5/ 150	-1.12 (-4.5)	+1.0 (+4.0)	1.75 (7.0)

7.0 Unmanned Testing Results.

Success Criterion: Average oxygen concentration delivered to the mask during inhalation shall be greater than or equal to the values in Table 2.

FAIL - Data for the testing conducted at an inlet pressure of 60 psig are shown in Appendix C, Figures 1-5. The AIROX VIII produced repeatable data, however, when using VPBS Profiles #3, #4, and #5 the oxygen concentrations delivered were below the success criterion. Data collected using VPBS Profiles #1 and #2 (Figures 1 and 2) passed the testing. Data collected using VPBS Profile #3 failed the success criterion at 21,000 feet and above (Figure 3). Data collected using VPBS Profiles #4 and #5 failed the success criterion at 15,000 feet and above (Figures 4 and 5).

Note: The original goal of the testing was for the AIROX VIII to pass the success criterion up to an altitude of 25,000 feet. Previous contractor provided data showed achievement of this success criterion was possible. However, minimum requirement for the AIROX VIII was to pass the testing up to an altitude of 17,999 feet at VPBS profiles simulating a seated and resting passenger. (Note: Above 17,999 feet decompression sickness (DCS) is more likely and 100% oxygen pre-breathing is needed to minimize this risk. The AIROX VIII can't deliver 100% oxygen because it dilutes the oxygen.) It was determined a seated and resting passenger would seldom exceed the peak flow of 94 LPM (VPBS Profile #3). ASCC Air Standard 61/10B, "Developmental Test and Evaluation of Aircraft Oxygen Delivery Systems," Table 2, "Workloads" notes a maximum peak flow of 70 LPM for the resting condition. Figure 3 showed the AIROX VIII could provide sufficient oxygen when using VPBS Profile #3 at 17,999 feet. These results showed the AIROX VIII could meet the desired minimum requirement.

Success Criterion: Mask pressures shall comply with Table 3.

FAIL - Data collected at an inlet pressure of 60 psig are shown in Appendix C, Figures 6-11. Inhalation pressures at all altitudes were below Table 3 (ASCC Air Standards). As the altitude increased, these differences decreased. Exhalation pressures were generally close to the ASCC Air Standards. The data appeared repeatable.

Note: Although the AIROX VIII did not meet the ASCC Air Standards, there are currently breathing regulators in-use that do not meet the Air Standards. Legacy devices, such as the AIROX VIII, were designed before the Air Standards were published. The AIROX VIII will be used at 10,000 feet and above. Hence, the minimum requirement for the unmanned AIROX VIII testing would be acceptable breathing performance at 10,000 feet and above at a peak flow of 94 LPM (VPBS Profile #3). At 10,000 feet the inhalation pressure was -12 mmHg (Figure 8). This mask pressure, although not in compliance with the ASCC Air Standards, might be viewed as marginally acceptable by a subject. Hence, only manned testing will confirm if AIROX VIII breathing performance is acceptable.

Although the AIROX VIII failed the success criteria, it was determined that it might meet the minimum requirements, as described in the notes above. Hence, it was decided to proceed with the manned testing. The decision was based on 1) AIROX VIII use in passenger mode would be limited to 17,999 feet and below and 2) passengers will remain seated and resting, thereby, their peak breathing flows should be below 94 LPM.

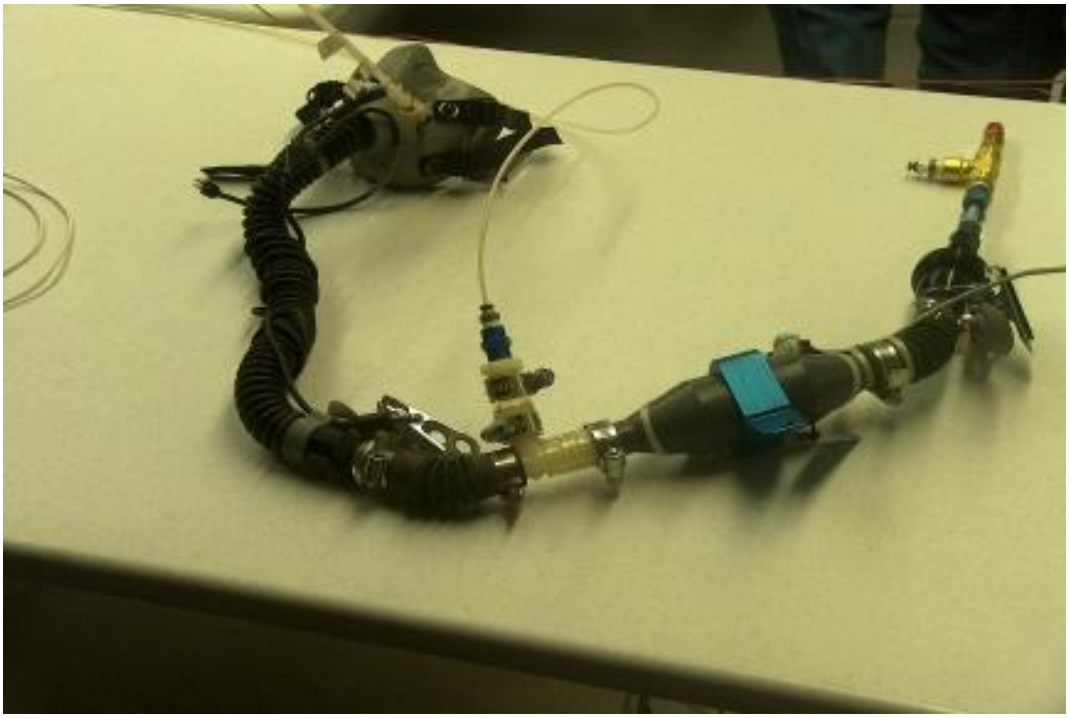
8.0 Methods for Manned Testing:

The system was tested in five manned modes. The details of each mode are described in Appendix B (ICD for Manned Altitude Chamber Testing of the POS) and in Tables 4-8 below. Modes #1 and #4 (passenger configuration) used the AIROX-VIII Oxygen Metering Valve and MBU-12/P oxygen mask. Modes #2 and #3 (paratrooper configuration) used the complete AIROX-VIII Oxygen System with Twin 50 oxygen bottles, CRU-79 oxygen regulator, and

MBU-12/P oxygen mask. This configuration is used routinely by paratroopers. Mode #5 (medevac configuration) integrated the POS with two (2) PTLOX accessory kits.

Photograph #3: Passenger Oxygen System Control Panel

Two or three experienced physiology technicians (PTs) served as inside observers during each of the chamber runs. The technicians breathed from the chamber oxygen system. Prior to initiating each test the chamber was taken to 5,000 feet for an ear and sinus check and then returned to Ground Level. At each test altitude the physiology technicians communicated with the subjects through verbal communication and/or hand signals to ensure the subjects were receiving adequate breathing gas and had no ill effects. On all tests, except Mode #5, two participants were selected to wear an instrumented oxygen mask. The instrumented mask was the same model and make as the other masks but they were modified with sensors and tubing to allow for measurement of breathing gas parameters, such as flow, mask oxygen concentration, mask pressure, gas temperature, and regulator inlet pressure (see Photograph #4). During Mode #5 testing one (1) subject wore a modified continuous flow medical mask. The mask was configured to monitor the oxygen concentration and temperature of the oxygen delivered to the mask. The MBU-12/P masks and helmets were fitted by the Brooks Life Support Shop using technical order procedures.



Photograph #4: Instrumented MBU-12/P Oxygen Mask

Before and after each test, subjects were examined by a medical monitor. After each test the subjects were instructed on the valsalva maneuver to alleviate potential delayed ear blocks caused by breathing high oxygen concentrations for an extended period. Frequent use of the valsalva maneuver after the test and before bedtime significantly reduces the probability of delayed ear blocks. After Mode #3 subjects were instructed not to fly for a 24 hour period. This 24 hour period is required by AFI 11-409 and it reduces the risk of decompression sickness. After Mode #4 the subjects were instructed not to fly for a 22 hour period. The 22 hour period minimized physiological risks but is not required by the AFI. After Mode #5 the subjects were instructed not to fly for a 12 hour period. The 12 hour period minimized physiological risks but is not required by the AFI.

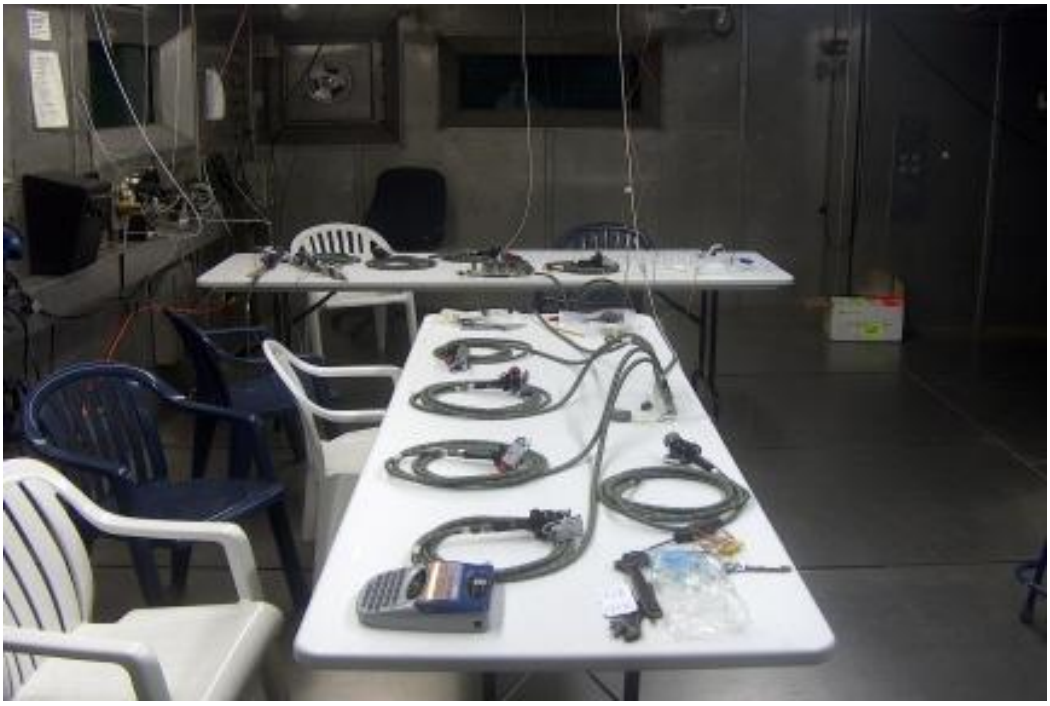
The five modes and number of participants were:

- Mode #1: Passenger (*10 participants*) @ Low Altitude (9,000 feet)
- Mode #2: Paratrooper (*8 participants*) - @ Low Altitudes (Ground Level and 9,000 feet)
- Mode #3: Paratrooper (*8 participants*) @ Altitudes (8,000 feet, 18,000 feet, and 24,999 feet)
- Mode #4: Passenger (*10 participants*) @ Altitudes (15,000 feet and 17,999 feet)
- Mode #5: Medevac *(6 participants)* @ Altitudes (Ground Level and 10,000 feet)

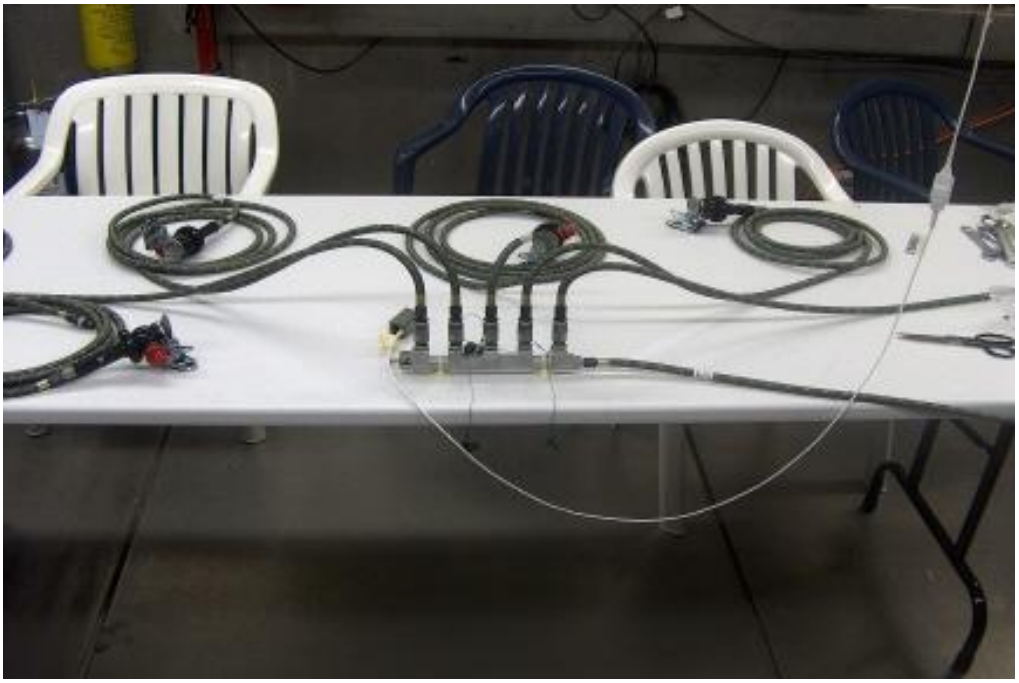
Photograph #5: Instrumentation Station for Manned Testing

Photograph #6: Manned Chamber Flight In-Progress

9.0 Mode #1 Testing Results -- Passenger Configuration at Low Altitude (9,000 feet):



Photograph #7: POS Setup for Passenger Configuration Chamber Flight



Photograph #8: POS Distribution Manifold Setup for Passenger Configuration

Data for Mode #1 testing are at Appendix C (Figures 24-32), Appendix D (Logged Data), and Appendix E (Questionnaires). Table 4 shows the test procedures. The purpose of this test was to acquaint the subjects with the test hardware and to test the POS at a low altitude in the passenger mode.

Table 4. Mode #1 -- Passenger Configuration -- 10 Subjects -- AIROX-VIII Only -- 9,000 feet -- 31 Mar 09.

Event	Time Period
PTs: **POS ON**, check supply pressure (60-85 psig) **Masks up**, breathe on system, check data acquisition PTs: Verify operation of AIROX-VIII flow blinkers	3 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 1)	1 min
Drop masks PTs: **POS OFF**	1 min

Ascend to 5,000 feet for ear and sinus check **Note: Two additional subjects will take ear and sinus check flight, depart chamber, and remain in chamber area**	2 min
Hold at 5,000 feet	5 min
Descend to Ground Level	2 min
Hold at Ground Level	5 min
Ascend to 9,000 feet	**2 min**
PTs: **POS ON**, check supply pressure (60-85 psig) **Masks Up** PTs: Verify operation of AIROX-VIII flow blinkers	1 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 2)	**1 min**
Subjects seated and resting **Instrumented Subjects (#1 and #6) Stand together during last 5 min period**	**30 min**
(Mode #1 Cont.) Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 3)	1 min
Subjects #2, #3, #7, and #8 Drop masks and disconnect from AIROX VIII	**5 min**
Subjects #4 and #9 Drop masks and disconnect from AIROX VIII	**5 min**
Subjects #5 and #10 Drop masks and disconnect from AIROX VIII	**5 min**
All subjects reconnect to AIROX VIIIs and Masks up **Check flow blinker**	**2 min**
Descend to Ground Level	**2 min**

Drop Masks PTs: **POS OFF**	1 min
STOP -- Duration	**74 min**

Figure 24 shows the mask oxygen concentration delivered to Subject #1. The oxygen concentrations are above the minimum oxygen concentration at 9,000 feet (25%). The lowest oxygen concentration observed was 30%.

Figure 25 shows the AIROX VIII peak flows for Subject #1. Subject #1 was seated and resting. Maximum peak flow was about 150 LPM (occurred one time), approximate average peak flow was about 70 LPM, and the minimum peak flow was about 30 LPM. **(Note: ASCC Air Standard 61/10B, "Developmental Test and Evaluation of Aircraft Oxygen Delivery Systems," Table 2, "Workloads" notes a maximum peak flow of 70 LPM for the resting condition.)** The data does show peak flows of 150 LPM are possible even when resting. However, peak flows above 94 LPM (VPBS Profile #3) occurred only occasionally. The figure shows about one breath over a one minute period exceeded 94 LPM.
Figure 26 shows the AIROX VIII inlet pressure (psig), heat exchanger temperature just prior to the POS pressure reducer (ºF), altitude, AIROX VIII outlet temperature (ºF), POS outlet port temperature (ºF), and number of breathers. The AIROX VIII inlet pressure averaged about 75 psig with 10 breathers, 76 psig with 6 breathers, 77 psig with 4 breathers, and 78 psig with 2 breathers. The oscillation in POS outlet pressure decreased as the number of breathers was reduced. The oscillation with 10 breathers was +/-3 psig. The lowest outlet pressure observed was about 72 psig. The lowest POS heat exchanger outlet temperature (just prior to the pressure reducer) was about +67ºF. The AIROX VIII outlet temperature or breathing gas temperature was nearly constant at +75ºF (ambient chamber temperature).

Figure 27 shows the mask oxygen concentration delivered to Subject #6. The oxygen concentrations are above the minimum oxygen concentration at 9,000 feet (25%). The lowest observed oxygen concentration was 37%.

Figure 28 shows the AIROX VIII outlet flows for Subject #6. Subject #6 was seated and resting. The maximum peak flow was 110 LPM (occurred one time), the average peak flow was about 40 LPM, and the minimum peak flow was about 30 LPM. Note Subject #6 peak flows were significantly below those for Subject #1.

Figure 29 shows Subject #1 breathing resistance at 9,000 feet while seated and resting. Mask pressures during inhalation fall outside the ASCC Air Standards.

Figure 30 shows Subject #1 breathing resistance at 9,000 feet while standing. Mask pressures during inhalation fall outside the ASCC Air Standards. However, Subject #1's peak flows appear lower when standing.

Figure 31 shows Subject #6 breathing resistance at 9,000 feet while seated and resting. Mask pressures during inhalation and exhalation fall reasonably close to the ASCC Air Standards.

Figure 32 shows Subject #6 breathing resistance at 9,000 feet while standing. Mask pressures during inhalation and exhalation fall reasonably close to the ASCC Air Standards.

Appendix D shows the data logged during the Mode #1 test. The POS began the test with 22 liters of LOX and after the 30 minute period at 9,000 feet 21 liters were remaining. The highest oxygen concentration measured inside the POS box was 21.6% and the corresponding chamber background oxygen concentration was 21.2% (difference of 0.4%). The concentration of oxygen inside the POS box was measured to verify no significant buildup of oxygen concentration occurred.

Appendix E has the 10 ea. subject post-test questionnaires for Mode #1. Nine (9) subjects found the breathing performance of the AIROX VIII acceptable. One (1) subject noted the breathing performance unacceptable but commented it improved when the number of breathers was reduced.

Mode #1 Success Criteria:

(1) Subjects #1 and #6 mask pressures shall comply with Table 3.

FAIL - Figures 29-32 show the AIROX VIII does not meet the ASCC Air Standards for breathing resistance during inhalation. However, nine (9) of the ten (10) subjects found the breathing performance of the AIROX VIII acceptable, based on questionnaire responses. AIROX VIII breathing performance will improve with altitude.

Note: Some legacy breathing regulators currently in-use are unable to meet the ASCC Air Standards for breathing resistance. However, the goal of the life support community is for new breathing regulators to meet the ASCC Air Standards.

(2) Subjects shall receive an acceptable breathing gas.

PASS - Based on Figures 24 and 27, oxygen concentrations delivered during Mode #1 testing were acceptable. Based on Figure 26, the breathing gas temperature was acceptable. Further, nine (9) of ten (10) subjects found the breathing gas delivered by the AIROX VIII acceptable.

(3) "Frost line" shall occur within heat exchanger piping.

PASS - Based on Figure 26, the lowest temperature at the heat exchanger outlet (just prior to the pressure reducer) with 10 breathers was +67ºF. This temperature confirms the "frost line" was contained within the heat exchanger piping.

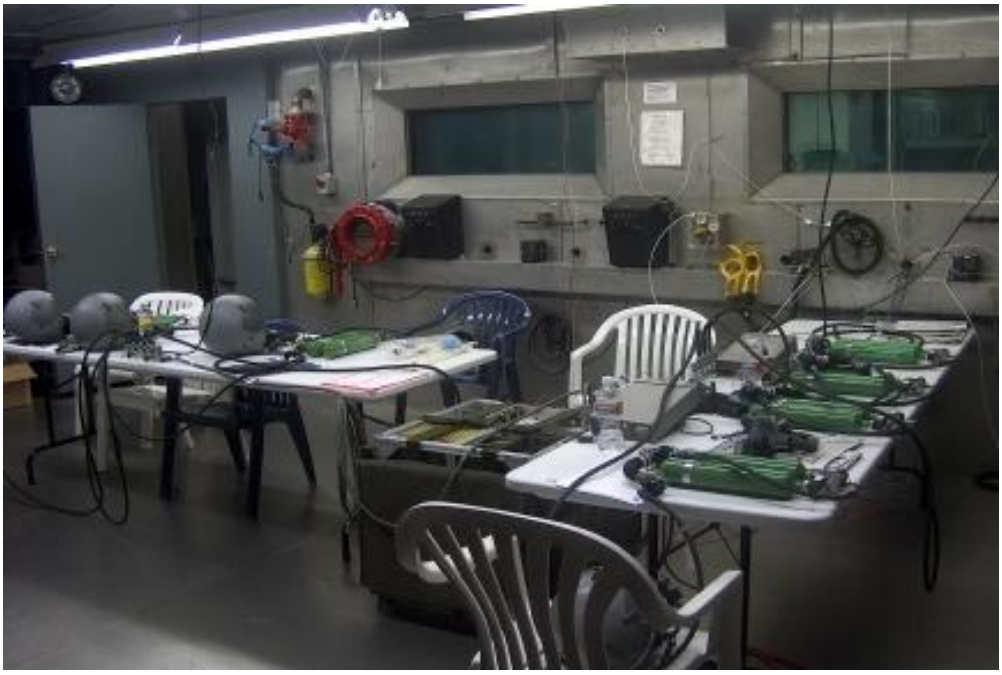
Note: The "frost line" is defined as the location on the heat exchanger where frost formation stops. At this location the temperature will be above +32ºF and it is assured only gaseous oxygen exists downstream of this point.

(4) Supply pressure shall be 60 psig or greater.

PASS - Based on Figure 26, the lowest pressure measured during the Mode #1 testing was about 72 psig.

Mode #1 Testing Summary: The testing showed POS in the passenger configuration could support ten (10) subjects at 9,000 feet. Although the mask pressures did not meet the ASCC Air Standards, nine (9) of ten (10) subjects stated the AIROX VIII performance was acceptable. The AIROX VIII delivered acceptable oxygen concentrations. POS maintained an acceptable breathing gas temperature and outlet pressure.

10.0 Mode #2 Testing Results -- Paratrooper Configuration at Low Altitude (Ground Level and 9,000 feet):



Photograph #9: POS Setup for Paratrooper Configuration Chamber Flight

Data for Mode #2 testing are at Appendix C (Figures 33-41), Appendix F (Logged Data), and Appendix G (Questionnaires). Table 5 shows the test procedures. The purpose of this test was to acquaint the subjects with the paratrooper test hardware and to test the POS at a low altitude in the paratrooper mode. The subjects breathed on the system for about 30 minutes at Ground Level (simulating a Ground Level pre-breathe) and about 10 minutes at 9,000 feet. During Mode #2 testing the subjects were delivered 100% oxygen from the CRU-79 oxygen regulator.

Table 5. Mode #2 -- Paratrooper Configuration -- 8 Subjects -- AIROX-VIII Oxygen System with Twin 50s and CRU-79 Regulator -- 9,000 feet -- 31 Mar 09.

Event	Time Period
PTs: POS ON, check supply pressure (60-85 psig) **Masks up**, breathe on system, and check data acquisition	5 min
Drop masks PTs: **POS OFF**	1 min
Ascend to 5,000 feet for ear and sinus check **Two additional subjects will take ear and sinus check flight, depart chamber, and remain in chamber area**	2 min

Hold at 5,000 feet	5 min
Descend to Ground Level	2 min
PTs: **POS ON**, check supply pressure (60-85 psig) **Masks Up**	1 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 4)	1 min
Subjects Seated and Resting	**30 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 5)	1 min
Subjects #2, #3, #7, and #8 Drop masks and Disconnect from AIROX VIII	**5 min**
Subjects #4 and #9 Drop masks and Disconnect from AIROX VIII	**5 min**
All subjects Masks Up	**2 min**
Ascend to 9,000 feet	**2 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 6)	1 min
Subjects Seated and Resting	**10 min**

Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 7)	1 min
Descend to Ground Level	**2 min**
Drop Masks PTs: **POS OFF**	1 min
STOP -- Duration	**77 min**

Figure 33 shows the mask oxygen concentration delivered to Subject #1. The oxygen concentrations remained at or near 100% throughout the testing. Occasional excursions in the oxygen concentration below 100% (the lowest was about 86%) were attributed to a slight leak possibly at the oxygen measurement probe connection.

Figure 34 shows the peak flows for Subject #1. Subject #1 was seated and resting. Peak flows observed were: maximum peak flow of about 95 LPM (occurred one time), an average peak flow of about 40 LPM, and a minimum peak flow of about 30 LPM.

Figure 35 shows the CRU-79 inlet pressure (psig), heat exchanger temperature (just prior to the POS pressure reducer) (ºF), altitude, regulator outlet temperature (ºF), POS outlet port temperature (ºF), and number of breathers. At Ground Level the CRU-79 average inlet pressure was about 72 psig with eight (8) breathers, 75 psig with four (4) breathers, and 76 psig with two (2) breathers. The oscillation in POS outlet pressure decreased as the number of breathers was reduced. The greatest oscillation was +/-9 psig with eight (8) breathers. The lowest POS outlet pressure/regulator inlet pressure was 61 psig. At 9,000 feet the average pressure was about 75 psig with eight (8) breathers. The oscillation in outlet pressure was about +/-7 psig and the POS lowest pressure was 66 psig. The lowest POS heat exchanger outlet temperature (just prior to the pressure reducer) was +61ºF. The CRU-79 oxygen regulator breathing gas outlet temperature was nearly constant at +79ºF (chamber temperature).

Figure 36 shows the mask oxygen concentration delivered to Subject #6. The oxygen concentration was constant at 100% oxygen. A slight offset in oxygen concentration at 9,000 feet was most likely due to a slight shift in the mass spectrometer calibration.

Figure 37 shows the breathing peak flows for Subject #6. Subject #6 was seated and resting. The peak flows observed were: maximum peak flow of about 97 LPM (occurred one time), average peak flow of about 70 LPM, and a minimum peak flow of about 40 LPM.

Figure 38 shows Subject #1 breathing resistance at Ground Level while seated and resting. Mask pressures during inhalation fall outside the ASCC Air Standards.

Figure 39 shows Subject #6 breathing resistance at Ground Level while seated and resting. Mask pressures during inhalation fall outside the ASCC Air Standards.

Figure 40 shows Subject #1 breathing resistance at 9,000 feet while seated and resting. Mask pressures during inhalation fall slightly outside the ASCC Air Standards. Hence, as the altitude increased the breathing performance of the CRU-79 regulator improved.

Figure 41 shows Subject #6 breathing resistance at 9,000 feet while seated and resting. Mask pressure during inhalation fall outside the ASCC Air Standards.

Appendix F shows the data logged during the Mode #2 test. The POS began the test with 16 liters of LOX and completed the testing with about 10 liters. The highest oxygen concentration measured inside the POS box was 22.1% and the corresponding chamber background oxygen concentration was 21.7% (a difference of 0.4%).

Appendix G shows the 8 ea. subject post-test questionnaires for Mode #2. The eight (8) subjects found the breathing performance of the paratrooper oxygen system while breathing through the CRU-79 oxygen regulator acceptable. However, most found the performance marginally acceptable at Ground Level but better at 9,000 feet. At Ground Level the CRU-79 regulator appeared to vibrate (i.e. "buzz" or "flutter"). One subject found the vibration unacceptable and requested a replacement regulator. After the regulator was replaced performance improved. It was concluded the CRU-79 performance at Ground Level was marginal but acceptable. POS provided the CRU-79 oxygen regulators with ample inlet pressure (lowest pressure observed with eight breathers was 61 psig).

Mode #2 Success Criteria:

(1) Subjects shall receive an acceptable breathing gas.

PASS - Based on Figures 33 and 36, oxygen concentrations delivered during Mode #2 testing were essentially at 100% oxygen. Based on Figure 35, the breathing gas temperature was acceptable. The eight (8) subjects found the breathing performance of the paratrooper oxygen system while breathing through the CRU-79 oxygen regulator acceptable. However, most found the performance marginally acceptable at Ground Level but better at 9,000 feet. Since the lowest inlet pressure delivered to the CRU-79 at Ground Level was 61 psig (well above the CRU-79 minimum operating pressure of 40 psig), the marginal performance at Ground Level was attributed to the characteristics of the CRU-79 oxygen regulator.

(2) "Frost line" shall occur within heat exchanger piping.

PASS - Based on Figure 35, the lowest temperature at the heat exchanger outlet (just prior to the pressure reducer) was about +59ºF. This temperature confirms the "frost line" was contained within the heat exchanger piping.

(3) Breathing gas temperature in the mask breathing hose shall not be greater than 20F below ambient temperature.

PASS - Breathing gas temperature remained at about +79ºF throughout the testing. This temperature was near the chamber ambient temperature.

(4) Supply pressure shall be 60 psig or greater.

PASS - Based on Figure 35, the lowest POS pressure measured during the Mode #2 testing was about 61 psig.

Mode #2 Testing Summary: The testing showed POS in paratrooper configuration could support eight (8) subjects at Ground Level and 9,000 feet. Performance of the CRU-79 oxygen regulator at Ground Level was marginally acceptable. CRU-79 regulator performance did improve with altitude. POS maintained an acceptable oxygen concentration, breathing gas temperature, and outlet pressure.

11.0 Mode #3 Testing Results -- Paratrooper Configuration at Altitude (up to 24,999 feet):

Data for Mode #3 testing are at Appendix C (Figures 42-56), Appendix H (Logged Data), Appendix I (Blood Oxygen Saturation Data), and Appendix J (Questionnaires). Table 6 shows the test procedures. The purpose of this test was to conduct altitude testing of the POS in the paratrooper configuration up to an altitude of 24,999 feet. Oxygen pre-breathing was conducted at 8,000 feet. The subjects were in the seated and resting activity level throughout the testing except for a 10 minute walk-in-place period at 24,999 feet and at 18,000 feet. These 10 minute periods attempted to simulate paratroopers rigging their equipment prior to jumping.

Table 6. - Mode #3 -- Paratrooper Configuration -- 8 Subjects -- 24,999 feet -- 01 Apr 09

Event	Time Period
PTs: POS ON, check supply pressure (60-85 psig) **Masks up**, breathe on system, and check data acquisition Masks Down PTs: POS OFF	1 min
Ascend to 5,000 feet for ear and sinus check	2 min

Two additional subjects take ear and sinus check flight, depart chamber, and remain in chamber area	
Hold at 5,000 feet	5 min
Descend to Ground Level	2 min
Ascend to 8,000 feet	2 min
PTs: POS ON, check supply pressure (60-85 psig) **Masks up**	3 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 8)	1 min
Subjects Seated and Resting **Note: Two additional subjects pre-breathe 100% oxygen outside chamber** **(30 min pre-breathe period required by AFI 11-409)**	**30 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 9)	1 min
Ascend to 24,999 feet	5 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 10)	1 min
Subjects Seated and Resting **(As time permits, check oxygen saturation with finger tip monitor.)**	**5 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS	1 min

(Reading 11)	
Subjects Walk in Place	**10 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 12)	1 min
Descend to 18,000 feet	2 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 13)	1 min
Subjects Seated and Resting **(As time permits, use finger tip oxygen saturation monitor.)**	**5 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 14)	1 min
Subjects Walk in Place	**10 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 15)	1 min
Descend to 9,000 feet	2 min
Drop Masks **PTs: POS OFF**	1 min
Descend to Ground Level	3 min
STOP – Duration	**94 min**

Figure 42 shows the mask oxygen concentration delivered to Subject #1. In the paratrooper configuration the subjects are breathing from the CRU-79 oxygen regulator which delivers 100% oxygen. The oxygen concentrations remained at or near 100% throughout the testing.

Figure 43 shows the peak flows for Subject #1. Subject #1 had activity levels of 1) seated and resting and 2) walk in place. For the seated and resting activity level the maximum peak flow was about 80 LPM (occurred one time), the average peak flow was about 40 LPM, and the minimum peak flow was about 30 LPM. For the walking in place activity level the maximum peak flow was about 78 LPM (occurred one time), the average peak flow was about 45 LPM, and the minimum peak flow was about 30 LPM.

Figure 44 shows the CRU-79 inlet pressure (psig), heat exchanger temperature (just prior to the POS pressure reducer) (ºF), altitude, regulator outlet temperature (ºF), and POS outlet port temperature (ºF). The CRU-79 average inlet pressure was about 75 psig. The highest oscillation in POS outlet pressure occurred while at 8,000 feet and was about +/-7 psig. The lowest POS outlet pressure or regulator inlet pressure was about 65 psig. The lowest POS heat exchanger outlet temperature (just prior to the pressure reducer) was +55ºF. The CRU-79 oxygen regulator outlet temperature was nearly constant at +75ºF.

Figure 45 shows the mask oxygen concentration delivered to Subject #6. The oxygen concentration was constant at 100% oxygen. The slight offset reading above 100% was probably due to a slight shift in the mass spectrometer calibration.

Figure 46 shows the peak flows for Subject #6. Subject #6 had activity levels of 1) seated and resting and 2) walk in place. For the seated and resting activity level the maximum peak flow was about 68 LPM (occurred one time), the average peak flow was about 35 LPM, and the minimum peak flow was about 20 LPM. For the walking in place activity level the maximum peak flow was about 70 LPM (occurred one time), the average peak flow was about 50 LPM, and the minimum peak flow was about 30 LPM.

Figure 47 shows Subject #1 breathing resistance at 8,000 feet while seated and resting during the 100% oxygen pre-breathing. Inhalation mask pressures differ slightly from the ASCC Air Standards.

Figure 48 shows Subject #6 breathing resistance at 8,000 feet while seated and resting during the 100% oxygen pre-breathing. Inhalation mask pressures differ slightly from the ASCC Air Standards.

Figure 49 shows Subject #1 breathing resistance at 24,999 feet while seated and resting. Mask pressures agree reasonably well with the ASCC Air Standards.

Figure 50 shows Subject #6 breathing resistance at 24,999 feet while seated and resting. Mask pressures agree reasonably well with the ASCC Air Standards.

Figure 51 shows Subject #1 breathing resistance at 24,999 feet while walking in place. Mask pressures agree reasonably well with the ASCC Air Standards.

Figure 52 shows Subject #6 breathing resistance at 24,999 feet while walking in place. Mask pressures agree reasonably well with the ASCC Air Standards.

Figure 53 shows Subject #1 breathing resistance at 18,000 feet while seated and resting. Mask pressures differ slightly from the ASCC Air Standards.

Figure 54 shows Subject #6 breathing resistance at 18,000 feet while seated and resting. Mask pressures agree reasonably well with the ASCC Air Standards.

Figure 55 shows Subject #1 breathing resistance at 18,000 feet while walking in place. Mask pressures differ slightly from the ASCC Air Standards.

Figure 56 shows Subject #6 breathing resistance at 18,000 feet while walking in place. Mask pressures differ slightly from the ASCC Air Standards.

Appendix H shows the data logged during the Mode #3 test. The POS began the test with 23 liters of LOX and ended the testing with about 17 liters. The highest oxygen concentration measured inside the POS box was 22.9% and the corresponding chamber background oxygen concentration was 22.1% (a difference of 0.8%).

Appendix I shows the blood oxygen saturation levels during Mode #3 testing. Blood oxygen saturations were between 98-100% throughout the testing.

Appendix J has the 8 ea. subject post-test questionnaires for Mode #3. The eight (8) subjects found the breathing performance of the paratrooper oxygen system while breathing through the CRU-79 oxygen regulator acceptable. Some subjects noted all CRU-79 "flutter" could be eliminated by laterally compressing (i.e. shortening) the breathing hose connecting the CRU-79 to the AIROX VIII. (Note: This observation and suggestion about shortening the hose were communicated to the CRU-79 oxygen regulator technical manager at Oklahoma City Air Logistics Center, Oklahoma City OK.)

Decompression Sickness (DCS) Event: During the Mode #3 testing (paratrooper configuration) one (1) subject experienced decompression sickness. The subject had pre-breathed 100% oxygen for 30 minutes prior to ascent to 24,999 feet. The chamber remained at 24,999 feet for about 20 minutes. The DCS resolved after Ground Level 100% oxygen breathing and hyperbaric oxygen treatment. The Brooks decompression sickness computer model calculates a 2% risk of decompression sickness for these conditions. AFI 11-409 permits aircrew and paratroopers to remain at 24,999 feet for 2 hours.

Mode #3 Success Criteria:

(1) Subjects shall receive an acceptable breathing gas.

PASS - Based on Figures 42 and 45, oxygen concentrations delivered during Mode #3 testing were at 100%. Based on Figure 44, the breathing gas temperature was acceptable. The eight (8) subjects found the breathing performance of the paratrooper oxygen system while breathing through the CRU-79 oxygen regulator acceptable.

(2) "Frost line" shall be within heat exchanger piping.

PASS - Based on Figure 44, the lowest temperature at the heat exchanger outlet (just prior to the pressure reducer) was about +55ºF. This temperature confirms the "frost line" was contained within the heat exchanger piping.

(3) Breathing gas temperature in the mask breathing hose shall not be greater than 20F below ambient temperature.

PASS - Breathing gas temperature remained at about 75ºF throughout the testing. This temperature was chamber ambient temperature.

(4) Supply pressure shall be 60 psig or greater.

PASS - Based on Figure 44, the lowest POS pressure measured during the Mode #3 testing was about 65 psig.

Mode #3 Testing Summary: The testing showed POS in paratrooper mode could support eight (8) subjects up to an altitude of 24,999 feet during rest and moderate activity. Performance of the CRU-79 oxygen regulator was acceptable. POS maintained acceptable oxygen concentrations, breathing gas temperature, and outlet pressure.

12.0 Mode #4 Testing Results -- Passenger Configuration at Altitude (up to 17,999 feet):

Data for Mode #4 testing are at Appendix C (Figures 57-68), Appendix K (Logged Data), Appendix L (Blood Oxygen Saturation Data), and Appendix M (Questionnaires). Table 7 shows the test procedures. The purpose of this test was to conduct altitude testing of the POS in the passenger configuration up to an altitude of 17,999 feet.

Table 7. Mode #4 -- Passenger Configuration -- 10 Subjects -- 17,999 feet -- 02 Apr 09

Event	Time Period
Ascend to 5,000 feet for ear and sinus check **Note: Two additional subjects will take ear and sinus check flight, depart chamber, and remain in chamber area**	2 min

Hold at 5,000 feet	5 min
Descend to Ground Level	2 min
PTs: **POS ON**, check supply pressure (60-85 psig) **Masks up**, check data acquisition PTs: Verify operation of AIROX-VIII flow blinkers **Masks Down** **PTs: POS OFF**	5 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 16)	1 min
Ascend to 9,000 feet	2 min
PTs: **POS ON**, check supply pressure (60-85 psig) **Masks Up** PTs: Verify operation of AIROX-VIII flow blinkers	5 min
Ascend to 17,999 feet	4 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 17)	1 min
Subjects Seated and Resting **Instrumented Subjects (#1 and #6) Stand together for last 5 min** **(As time permits, use finger tip oxygen saturation monitor.)**	**30 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 18)	1 min
Descend to 15,000 feet	1 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 19)	1 min

Subjects Seated and Resting **Instrumented Subjects (#1 and #6) Stand together for last 5 min** **(As time permits, use finger tip oxygen saturation monitor.)**	**30 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 20)	1 min
Descend to 9,000 feet	1 min
Drop Masks **PTs: POS OFF**	1 min
Descend to Ground Level	3 min
STOP -- Duration	**96 min**

Figure 57 shows the mask oxygen concentration delivered to Subject #1 at 17,999 feet and 15,000 feet. The AIROX VIII dilutes the 100% oxygen delivered by the POS. The oxygen concentrations delivered were above the minimum required. Oxygen concentration data for Subject #6 were corrupted by an intermittent electrical connection at the mass spectrometer, and therefore, were not available.

Figure 58 shows the peak flows for Subject #1 while seated and resting and standing (last 5 minutes at each altitude). For seated and resting the maximum peak flow was about 85 LPM (occurred one time), the average peak flow was about 40 LPM, and the minimum peak flow was about 20 LPM. For standing the maximum peak flow was about 75 LPM (occurred one time), the average peak flow was about 50 LPM, and the minimum peak flow was about 30 LPM.

Figure 59 shows the AIROX VIII inlet pressure (psig), regulator outlet temperature (ºF), heat exchanger temperature (just prior to the POS pressure reducer) (ºF), POS outlet port temperature (ºF), and altitude. The AIROX VIII average inlet pressure was about 76 psig with ten (10) breathers. The oscillation in POS outlet pressure was about +/-2.5 psig. The lowest POS outlet pressure/AIROX VIII inlet pressure was about 73 psig. The lowest POS heat exchanger outlet temperature (just prior to the pressure reducer) was +61ºF. The AIROX VIII outlet temperature was nearly constant at +74ºF.

Figure 60 shows the peak flows for Subject #6 while seated and resting and standing (last 5 minutes at each altitude). For seated and resting the maximum peak flow was about 105 LPM (occurred one time), the average peak flow was about 55 LPM, and the minimum peak flow was about 20 LPM. For standing the maximum peak flow was about 85 LPM (occurred one time), the average peak flow was about 60 LPM, and the minimum peak flow was about 45 LPM.

Figure 61 shows Subject #1 breathing resistance at 17,999 feet while seated and resting. Mask pressures differ slightly from the ASCC Air Standards.

Figure 62 shows Subject #6 breathing resistance at 17,999 feet while seated and resting. Mask pressures differ slightly from the ASCC Air Standards.

Figure 63 shows Subject #1 breathing resistance at 17,999 feet while standing. Mask pressures differ slightly from the ASCC Air Standards.

Figure 64 shows Subject #6 breathing resistance at 17,999 feet while standing. Mask pressures differ slightly from the ASCC Air Standards.

Figure 65 shows Subject #1 breathing resistance at 15,000 feet while seated and resting. Mask pressures differ slightly from the ASCC Air Standards.

Figure 66 shows Subject #6 breathing resistance at 15,000 feet while seated and resting. Mask pressures differ slightly from the ASCC Air Standards.

Figure 67 shows Subject #1 breathing resistance at 15,000 feet while standing. Mask pressures differ slightly from the ASCC Air Standards.

Figure 68 shows Subject #6 breathing resistance at 15,000 feet while standing. Mask pressures differ slightly from the ASCC Air Standards.

Appendix K shows the data logged during the Mode #4 testing. The POS began the test with 23 liters of LOX and ended the test with about 19 liters. The highest oxygen concentration measured inside the POS box was 22.6% and the corresponding chamber background oxygen concentration was 22.3% (a difference of 0.3%).

Appendix L shows the blood oxygen saturation levels during Mode #4 testing. Blood oxygen saturation levels varied between 96-100% while breathing from the AIROX VIII. The blood oxygen saturation levels measured at 5,000 feet while breathing air ranged between 92-96%.

Appendix M has the 10 ea. subject post-test questionnaires for Mode #4. The ten (10) subjects found the breathing performance of the POS passenger configuration acceptable.

Mode #4 Success Criteria:

(1) Subjects #1 and #6 average oxygen concentration delivered to the mask during inhalation shall comply with Table 2.

PASS - Based on Figure 57, oxygen concentrations delivered during Mode #4 testing complied with Table 2. Also, the blood oxygen saturation levels were in the range of 96-100% throughout the testing.

(2) Subjects #1 and #6 mask pressure shall comply with Table 3.

FAIL - Based on Figures 61-68, the mask pressures differed from Table 3. However, the differences were generally slight and based on Appendix M (subject questionnaires) the ten (10) subjects found the breathing performance of the AIROX VIII acceptable.

(3) Subjects shall receive an acceptable breathing gas.

PASS - Based on Figure 59, the breathing gas temperature was acceptable. Based on Appendix M, the ten (10) subjects found the breathing performance of the AIROX VIII acceptable.

(4) "Frost line" shall be within heat exchanger piping.

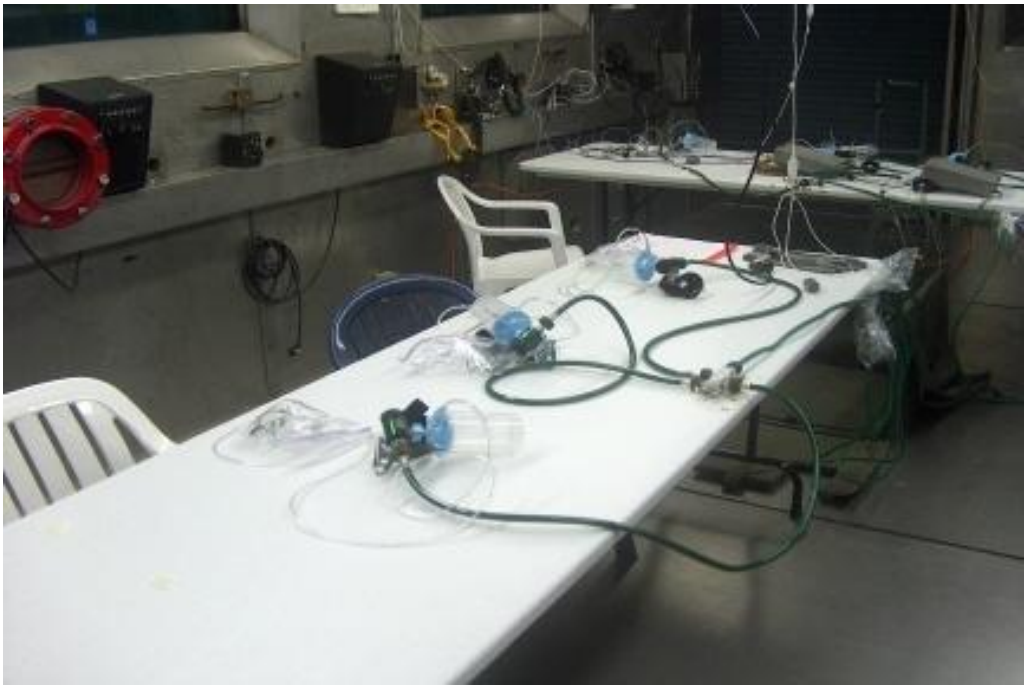
PASS - Based on Figure 59, the lowest temperature at the heat exchanger outlet (just prior to the pressure reducer) was about +61ºF. This temperature confirms the "frost line" was contained within the heat exchanger piping.

(5) Supply pressure shall be 60 psig or greater.

PASS - Based on Figure 59, the lowest pressure measured during the Mode #4 testing was about 73 psig.

Mode #4 Testing Summary: The testing showed POS in passenger configuration could support ten (10) seated and resting subjects up to an altitude of 17,999 feet. Breathing performance and oxygen concentrations delivered by the AIROX VIII oxygen metering valve were acceptable. POS maintained acceptable breathing gas temperature and outlet pressure.

13.0 Mode #5 Testing Results -- Medevac Configuration at Altitude (Ground Level and 10,000 feet):



Photograph #10: POS Setup for Medevac Chamber Flight

Data for Mode #5 testing are at Appendix C (Figures 69 and 70), Appendix N (Logged Data), Appendix O (Blood Oxygen Saturation Data), and Appendix P (Questionnaires). Table 8 shows the test procedures. The purpose of this test was to conduct altitude testing of the POS in the medevac configuration up to an altitude of 10,000 feet.

Table 8. Mode #5 -- Medevac Configuration -- 6 Subjects -- 10,000 feet -- 03 Apr 09

Event	Time Period
Ascend to 5,000 feet for ear and sinus check **Note: Two additional subjects take ear and sinus check flight, depart chamber, and remain in chamber area**	2 min
Hold at 5,000 feet **Take O2 saturation readings at end of period.**	5 min
Descend to Ground Level	2 min

PTs: POS ON (Medevac Switch Only), check supply pressure (45-55 psig) Dial-in 12 liters/min setting on each subject's flow switch	1 min
Medical masks on	2 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 21)	1 min
Subjects Seated and Resting **15 min point: Take O2 saturation readings.** **Change flow switches to 15 LPM** **30 min point: Take O2 saturation readings.**	**30 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 22)	1 min
Ascend to 10,000 feet	2 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 23)	1 min
Subjects Seated and Resting **5 min point: Take O2 saturation readings.** **Change flow switch settings to 12 LPM**	**15 min**

15 min point: Take O2 saturation settings.	
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 24)	1 min
Descend to Ground Level	2 min
Masks down **PTs: POS OFF**	**1 min**
STOP -- Duration	**66 min**

Figure 69 shows the mask oxygen concentration delivered to Subject #1 at Ground Level and 10,000 feet. In the medevac configuration a continuous flow of 100% oxygen was delivered to a standard, disposable, continuous flow medical mask. At the mask the oxygen was diluted. The average oxygen concentrations delivered at Ground Level with flow settings of 12 and 15 LPM were about 45% and 55%, respectively. The average oxygen concentration at 10,000 feet with flow settings of 12 and 15 LPM were about 55% and 62%, respectively.

Figure 70 shows the mask hose temperature (ºF), POS pressure reducer outlet pressure (psig), heat exchanger temperature just prior to the POS pressure reducer (ºF), and PTLOX flow selector setting (LPM). The POS outlet pressure was constant at 50 psig. POS lowest heat exchanger outlet temperature (just prior to the pressure reducer) was +56ºF. The average mask hose temperature was about +70ºF.

Appendix N shows the data logged during the Mode #5 testing. The POS began the test with 19 liters of LOX and ended the testing with about 13 liters. The highest oxygen concentration measured inside the POS box was 21.9% and the corresponding chamber background oxygen concentration was 22.0% (a difference of 0.1%).

Appendix O shows the blood oxygen saturation levels during Mode #5 testing. Blood oxygen saturation levels ranged between 97-100% during the testing. The blood oxygen saturation levels at 5,000 feet breathing air ranged between 90-96%.

Appendix P has the 6 ea. subject post-test questionnaires for Mode #5. The six (6) subjects found the breathing performance of the medevac configuration acceptable.

Mode #5 Success Criteria:

(1) Subjects shall receive an acceptable breathing gas.

PASS - In Appendix P the six (6) subjects noted the breathing gas was acceptable. Based on Figure 69, the oxygen concentration was acceptable. Based on Figure 70, the breathing gas temperature was approximately chamber ambient temperature.

(2) PTLOX Accessory Kits integrate to POS.

PASS - The POS was integrated to two PTLOX accessory kits. Two flow distributors (Allied Healthcare Products Inc., Model No. LP43) with hoses were required to support six (6) subjects. The flow distributors and hoses were not part of the PTLOX accessory kits.

(3) POS supply pressure remains at 50 +/-5 psig.

PASS - Based on Figure 70, the POS outlet pressure was constant at 50 psig.

Mode #5 Testing Summary: The testing showed POS in medevac configuration could support six (6) subjects up to an altitude of 10,000 feet. Performance of the POS, PTLOX accessory kits, and auxiliary hardware was acceptable. POS maintained an acceptable oxygen concentration, breathing gas temperature, and outlet pressure.

14.0 Conclusions:

Unmanned testing of the AIROX VIII oxygen metering valve showed it could deliver sufficient oxygen to a seated and resting passenger up to an altitude of 17,999 feet. This conclusion was based on the assumption a seated and resting passenger would seldom breathe at peak flows above 94 LPM. Justification for this assumption is based on: 1) ASCC Air Standard 61/10B, "Developmental Test and Evaluation of Aircraft Oxygen Delivery Systems," Table 2, "Workloads" notes a maximum peak flow of 70 LPM for the resting condition; and 2) the manned testing showed peak flow for a seated and resting subject seldom exceeded 94 LPM. Figure 3 showed the oxygen concentration delivered at VPBS Profile #3 (94 LPM) and 17,999 feet was above the 5,000 feet equivalency curve. Inhalation pressures for the AIROX VIII at all altitudes were below the ASCC Air Standards. However, the subjects noted the breathing performance of the AIROX VIII was acceptable.

Mode #1 manned testing of the POS passenger configuration showed POS could support ten (10) seated and resting subjects at 9,000 feet. Although the AIROX VIII did not meet the ASCC Air Standards for breathing resistance during inhalation, nine (9) of the ten (10) subjects found the breathing performance acceptable. Oxygen concentrations delivered were acceptable. Also, breathing gas temperature was acceptable. The lowest temperature at the POS heat exchanger outlet (just prior to the pressure reducer) with ten (10) breathers was +67ºF. This temperature confirmed the "frost line" was contained within the heat exchanger piping. The lowest pressure measured during the Mode #1 testing was about 72 psig.

Mode #2 manned testing of the POS paratrooper configuration at Ground Level and 9,000 feet showed POS could support eight (8) subjects. The oxygen concentration delivered was 100% oxygen. The breathing gas temperatures were acceptable. The subjects found the breathing performance of the paratrooper oxygen system while breathing through the CRU-79 oxygen regulator acceptable. However, most found the performance marginally acceptable at Ground Level but better at 9,000 feet. At Ground Level the CRU-79 regulator appeared to vibrate. Minimum POS delivery pressure to the CRU-79 at Ground Level was 61 psig. The minimum operating pressure for a CRU-79 regulator is 40 psig. The vibration observed was attributed to the characteristics of the CRU-79 oxygen regulator. The lowest temperature at the heat exchanger outlet (just prior to the pressure reducer) was about +59ºF. This temperature confirmed the "frost line" was contained within the heat exchanger piping. Breathing gas temperature was at about +79ºF.

Mode #3 manned testing of the POS paratrooper configuration at 8,000 feet, 18,000 feet, and 24,999 feet showed the system could support eight (8) resting or moderately active subjects. Oxygen concentration delivered was 100% oxygen. Blood oxygen saturation readings throughput the testing remained at 98-100%. Breathing gas temperature was acceptable. The eight (8) subjects found the breathing performance of the paratrooper oxygen system acceptable. The lowest temperature at the heat exchanger outlet (just prior to the pressure reducer) was about +55ºF. This temperature confirmed the "frost line" was contained within the heat exchanger piping. The lowest POS supply pressure was about 65 psig. One (1) subject experienced decompression sickness during Mode #3 testing. The DCS resolved after Ground Level 100% oxygen breathing and hyperbaric oxygen treatment. The subject had pre-breathed 100% oxygen for 30 minutes prior to ascent to 24,999 feet. The chamber remained at 24,999 feet for about 20 minutes. The Brooks decompression sickness computer model calculates a 2% risk of decompression sickness for this condition. AFI 11-409 permits a 2 hour period at 24,999 feet.

Mode #4 manned testing of the POS passenger configuration at 15,000 feet and 17,999 feet showed the system could support ten (10) seated and resting subjects. Blood oxygen saturation levels were at 96-100% throughout the testing. Oxygen concentrations delivered were above the values noted in Table 2 for 5,000 feet equivalency. Mask pressures did not comply with the ASCC Air Standards (Table 3), however, the differences were generally slight and the ten (10) subjects found the breathing performance of the AIROX VIII acceptable. Breathing gas temperature was acceptable. The lowest temperature at the heat exchanger outlet (just prior to the pressure reducer) was about +61ºF. This temperature confirmed the "frost line" was contained within the heat exchanger piping. The lowest pressure measured was about 73 psig.

Mode #5 manned testing of the POS medevac configuration at Ground Level and 10,000 feet showed POS could support six (6) subjects. Blood oxygen saturation levels were at 97-100% throughout the testing. The oxygen concentration delivered was acceptable. Breathing gas temperature was acceptable. The POS was integrated to components from two PTLOX accessory kits. Two flow distributors (Allied Healthcare Products Inc., Model No. LP43) with hoses were ordered separately and were required to support the six (6) subjects. POS outlet pressure was constant at 50 psig.

The ambient oxygen concentration within the POS box did not build-up significantly during the testing. The oxygen sensor was located near the LOX converter and below the electronics. The highest oxygen concentration measured inside POS was 22.9% while the corresponding chamber background oxygen concentration was 22.1% (a difference of +0.8%).

The safe-to-fly letter (Appendix R) was submitted to the V-22 Joint Program Office on 29 Apr 09. The significant results of the testing are presented below.

(1) In the passenger configuration POS provided adequate oxygen to prevent hypoxia for up to ten (10) seated and resting passengers (one POS unit) or up to twenty (20) seated and resting passengers (two POS units) to an altitude of 17,999 feet MSL with the personal equipment noted below.

a. AIROX VIII Oxygen Metering Valve (Cobham Mission Systems, P/N 7920015-1M)
b. MBU-12/P Oxygen Mask
c. HGU-55/P Helmet

(2) In the paratrooper configuration POS provided sufficient 100% oxygen for pre-breathing and high altitude operations for up to eight (8) paratroopers (one POS unit) or up to sixteen (16) paratroopers (two POS units) to an altitude of 24,999 feet MSL with the standard paratrooper equipment noted below.

a. AIROX VIII Oxygen Metering Valve (Cobham Mission Systems, P/N 7920015)
b. Twin 50 Oxygen Bottles and Manifold (Cobham Mission Systems, P/Ns 8620028-1 and 9320113-3)
c. CRU-79 Oxygen Regulator (NSN 1660-01-139-5691)
d. MBU-12/P Oxygen Mask
e. HGU-55/P Helmet

(3) In the medevac configuration POS delivered sufficient oxygen to up to six (6) patients (one POS unit) or up to twelve (12) patients (two POS units) to an altitude of 10,000 feet MSL with the equipment noted below.

a. PTLOX accessory kit (Essex Cryogenics, P/N 19062-50C-0021-0001)
b. Minilator Flow Distributor (Allied Healthcare Products Inc., Model No. LP43)
c. Continuous Flow Medical Oxygen Mask

15.0 Acknowledgements:

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Rick Brezinsky (Wyle Labs) - POS Logistics
Nathan Dillon (General Dynamics) - POS Data Collection
Bill Ercoline (Wyle Labs) - Associate Investigator
Lt Col John Gibbons (711 HPW/RHP) - Medical Monitor
MSgt Kevin Johnson (711 HPW/RHPG) - Chamber Operations
Jim Leach (711 HPW/SE) - Safety
Tommy Miller (Rothe) - POS Configuration Setup
TSgt Mike Norris (711 HPW/RHPG) - Subject Scheduling
Maj Michael Rutter (711 HPW/RHPG) - Medical Monitor
Bill Storm (Wyle Labs) - Associate Investigator and Data Collection
Capt Christopher Vojta (711 HPW/RHPG) - Medical Monitor
Physiology Technicians (USAFSAM) - Chamber Operations

APPENDIX A

Test Plan for Passenger Oxygen System (POS)
Altitude Chamber Testing

G. Miller **Issue J, 27 Mar 09**
AFRL/711 HPW/RHPG
Brooks City-Base TX

Test Plan for Passenger Oxygen System (POS)
Altitude Chamber Testing

1.0 Background:

The introduction of the CV-22 will provide Special Operations Forces (SOF) the vertical take-off and landing capability of a helicopter with the speed and range of a fixed wing aircraft. The CV-22 is an unpressurized aircraft and capable of operating at altitudes up to 25,000 feet. Integral to the aircraft is an OBOGS that can support a basic aircrew of four. However, an oxygen system for passengers, paratroopers, and patients would significantly expand the CV-22 operational capabilities. A passenger oxygen system would provide flexibility in mission planning, capitalizing on the speed, range, and safety of high altitude flight.

2.0 Test Article Description:

The CV-22 passenger oxygen system is a self-contained, "roll-on/roll-off" system to support passengers or paratroopers during high altitude operations and patients during medevac. The combat hardened POS includes a device for storing 25 liters of liquid oxygen, regulating the system pressure, and distributing oxygen to the cargo area seats. The 25 liter container is identical to those currently flown on AF cargo aircraft. Further, the POS is similar to the PTLOX. POS is secured on the CV-22 like cargo.

3.0 Test Items:

a. Items to be provided by the CV-22 Program Office are noted below. It is planned these items will be provided to the test agency on or before 09 Mar 09.

(1) 1 ea. - Passenger Oxygen System with Ballistic Protection. **(RECEIVED)**

(2) 2 ea. - POS Oxygen Supply Hoses. **(RECEIVED)**

(3) 2 ea. – Distribution Manifolds. **(RECEIVED)**

(4) 10 ea. – Seat Oxygen Supply Hoses. **(RECEIVED)**

(5) 12 ea. – AIROX-VIII Oxygen Metering Valves (2 ea. are spares) with clips. **(RECEIVED)**

(6) 10 ea. - AIROX-VIII Oxygen System with Twin Oxygen Bottles, CRU-79 Breathing Regulator, and appropriate Hoses and Connectors (2 ea. are spares). **(RECEIVED)**

(7) POS flight qualification test reports and Acceptance Test Procedure (ATP) results. **(DRAFT DOCUMENTS RECEIVED)**

(8) POS Operating Manual. **(DRAFT RECEIVED)**

(9) 10 ea. – Mask hose adapters (Part No. G002-1060-01). **(RECEIVED)**

(10) Test subjects, if required. **(10 IDENTIFIED)**

(11) Purge Kit **(RECEIVED)**

b. Items provided by the test agency:

(1) 10 ea. – MBU-12/P Oxygen Masks (2 ea. are modified MBU-12s with gas sampling port/s) **(ON-SITE)**

(2) 2 ea. – PTLOX Medevac auxiliary equipment kit **(ON-SITE)**

(3) 10 ea. – Standard Helmets **(ON-SITE)**

(4) Cobham person/s to provide training and support the test effort. **(ON-CONTRACT)**

(5) Gaseous oxygen bottles conforming to MIL-PRF-27210G. **(ON-SITE)**

(6) Liquid nitrogen conforming to A-A-59503. **(ON-CONTRACT)**

(7) Liquid oxygen conforming to MIL-PRF-27210G. **(ON-CONTRACT)**

4.0 <u>Scope</u>:

The intent of the effort is to test the POS while simulating passenger, paratrooper, and patient operations in an altitude chamber at Brooks City-Base TX. The system was designed to support up to ten (10) seated and resting passengers; up to eight (8) paratroopers; and up to six (6) patients. Maximum test altitude will be 24,999 feet. T**he testing will to adhere to AFI 11-409, "High Altitude Airdrop Mission Support Program." These procedures are routinely used by USAF flying units.** The POS qualification test reports will be delivered to the test agency for review. The testing will not commence until the POS has successfully completed contractor flight qualification testing and ATP testing, and these technical data are reviewed by the test agency. Manned testing will not commence until the unmanned testing has been successfully completed.

5.0 Schedule:

16 and 20 Mar 09: Altitude Chamber A5/6 setup and calibrations.

17 - 19 Mar 09: POS training for core personnel. Training provided by Cobham, Orchard Park NY.

23 - 25 Mar 09: Unmanned testing of AIROX-VIII only at chamber A5/6.

26 - 27 Mar 09: Preliminary data analysis. Setup of Altitude Chamber E and calibrations.

30 Mar 09: Subject Orientation/Training, Subjects Sign Informed Consent Documents, and Altitude Chamber E setup finalized. Cobham provides on-site test support.

31 Mar - 03 Apr 09: Manned Testing. Cobham provides on-site test support.

06 Apr 09: Ship POS Equipment.
04 May 09: Safety-of-Flight Letter complete.
03 Jul 09: Final Report complete.

6.0 Unmanned Testing:

a. AIROX-VIII shall be supplied with 60 psig gaseous oxygen conforming to MIL-PRF-27210G (Aviator's Breathing Oxygen) using Altitude Chamber A5/6 oxygen supply.

b. Testing will be conducted using a Variable Profile Breathing Simulator (VPBS).
VPBS breathing profiles used will be those shown in Table 1.

Table 1. VPBS Settings.

Profile	Peak Flow (LPM-ATPD)	Breathing Rate (BPM)
1	17	8
2	60	12
3	94	20
4	125	40
5	157	25

c. A minimum of three (3) randomly selected AIROX-VIII valves will be tested. If performance is not repeatable, more valves will be tested. All remaining AIROX-VIIIs will be spot checked at 10,000 feet, 15,000 feet, and 20,000 feet using VPBS profile #2 only. Oxygen mask will be a modified MBU-12 with gas sensing port/s.

d. Altitudes for comprehensive testing will be: Ground Level, 5,000 feet, 10,000 feet, 15,000 feet, 20,000 feet, and 25,000 feet.

e. Data Channels:

(1) AIROX-VIII Outlet Flow (Ambient Liters/Minute)
(2) Mask Oxygen Concentration or AIROX-VIII Outlet Oxygen Concentration (%)

(3) Mask Pressure (mm Hg)

f. Data Plots:

(1) 1 ea. – Average Oxygen Concentration During Inhalation (20-100%) for AIROX-VIII #1, AIROX-VIII #2, and AIROX-VIII #3 and Minimum Oxygen Concentration (Table 2) vs. Altitude (G/L to 25,000 Feet) at **VPBS Profile #1**.

(2) 1 ea. – Average Oxygen Concentration During Inhalation (20-100%) for AIROX-VIII #1-12 and Minimum Oxygen Concentration (Table 2) vs. Altitude (G/L to 25,000 Feet) at **VPBS Profile #2**.

(3) 1 ea. – Average Oxygen Concentration During Inhalation (20-100%) for AIROX-VIII #1, AIROX-VIII #2, and AIROX-VIII #3 and Minimum Oxygen Concentration (Table 2) vs. Altitude (G/L to 25,000 Feet) at **VPBS Profile #3**.

(4) 1 ea. – Average Oxygen Concentration During Inhalation (20-100%) for AIROX-VIII #1, AIROX-VIII #2, and AIROX-VIII #3 and Minimum Oxygen Concentration (Table 2) vs. Altitude (G/L to 25,000 Feet) at **VPBS Profile #4**.

(5) 1 ea. – Average Oxygen Concentration During Inhalation (20-100%) for AIROX-VIII #1, AIROX-VIII #2, and AIROX-VIII #3 and Minimum Oxygen Concentration (Table 2) vs. Altitude (G/L to 25,000 Feet) at **VPBS Profile #5**.

(6) 1 ea. – Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) for AIROX-VIII #1, AIROX-VIII #2, AIROX-VIII #3, and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) for **Ground Level**.

(7) 1 ea. – Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) for AIROX-VIII #1, AIROX-VIII #2, AIROX-VIII #3, and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) for **5,000 feet**.

(8) 1 ea. – Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) for AIROX-VIII #1, AIROX-VIII #2, AIROX-VIII #3, and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) for **10,000 feet**.

(9) 1 ea. – Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) for AIROX-VIII #1, AIROX-VIII #2, AIROX-VIII #3, and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) for **15,000 feet**.

(10) 1 ea. – Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) for AIROX-VIII #1, AIROX-VIII #2, AIROX-VIII #3, and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) for **20,000 feet**.

(11) 1 ea. – Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) for AIROX-VIII #1, AIROX-VIII #2, AIROX-VIII #3, and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) for **25,000 feet**.

g. Success Criteria:

(1) Average oxygen concentration delivered to the mask during inhalation shall be greater than or equal to the values in Table 2.

Table 2. Altitude vs. Minimum Oxygen Concentration

Altitude (Feet)	Minimum Average Oxygen Concentration (%) During Inhalation
Ground Level	21
5,000	21
10,000	26
15,000	32
20,000	41
25,000	52

(2) Mask pressures shall comply with Table 3.

Table 3. Peak Inspiratory Flow vs. Mask Cavity Pressure

Peak Inspiratory and Expiratory Flows (L (ATPD) per sec)	Mask Cavity Pressure (kPa (inch water gauge))		
	Minimum	Limits to Maximum	Maximum Swing
		Without Safety pressure	
0.5	-0.38 (-1.5)	+0.38 (+1.5)	0.5 (2.0)
1.5	-0.55 (-2.2)	+0.65 (+2.6)	0.85 (3.4)
2.5	-1.12 (-4.5)	+1.0 (+4.0)	1.75 (7.0)

7.0 Manned Testing:

a. 31 MAR 09 -- TEST #1 -- 10 SUBJECTS -- PASSENGER CONFIGURATION (AIROX-VIII ONLY) -- ONE TIME:

Purpose: Overall system functional and interfaces test; subject orientation; and assess passenger configuration at Low Altitude.

(1) POS will be purged, if required. POS will be filled with liquid oxygen. Verify POS LOX quantity display works. Place POS in the chamber. Place Passenger/Paratrooper ON-OFF switch to the ON position. Verify supply pressure of approximately 70 psig. Monitor LOX level, supply pressure, heat exchanger temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration throughout testing. Monitor the chamber oxygen concentration with a mass spectrometer or appropriate oxygen sensor to verify 23% oxygen is not exceeded.

(2) POS will be configured to supply oxygen to ten (10) AIROX-VIII Oxygen Metering Valves at 10 seats.

(3) Two (2) physiology technicians (PT) will serve as inside observers.

(4) Ten (10) **seated and resting** subjects will breathe on the system for **30.0 minutes** at **9,000 feet**. Manually record time, LOX quantity, oxygen supply pressure, oxygen concentration inside POS, and chamber background oxygen concentration at beginning of 30 minute period and at the end of this period. Verify each subject is receiving oxygen by checking the AIROX-VIII in-line flow blinker. Subject #1 and Subject #6 will wear modified MBU-12 oxygen masks with gas sensing port/s. Subjects will communicate using hand signals.

(5) Ten (10) subjects will breathe on the system while **walking in place** for **15.0 minutes** at **Ground Level**. Manually record time, LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration at beginning of 15 minute period and at the end of this period. Verify each subject is receiving oxygen by checking the AIROX-VIII in-line flow blinker. Subjects drop masks. Subjects will be instructed on valsalva maneuver to alleviate possible delayed ear blocks.

(6) Photograph/record approximate location of "frost line" on POS heat exchanger.

(7) Data:

(a) Subject #1 and #6 AIROX-VIII Outlet Flow (Ambient Liters/Minute).

(b) Subject #1 and #6 Mask Oxygen Concentration (%).

(c) Subject #1 and #6 Mask Pressure (mm Hg).

(d) LOX level readings, supply pressure readings, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration.

(e) Subject Questionnaire.

(f) Photograph/record of frost line location.

(8) Data Plots:

(a) 1 ea. – **Subject #1** Average Oxygen Concentration during Inhalation (20-100%) and Minimum Oxygen Concentration (Table 2) vs. Time (minutes).

(b) 1 ea. – **Subject #6** Average Oxygen Concentration during Inhalation (20-100%) and Minimum Oxygen Concentration (Table 2) vs. Time (minutes).

(c) 1 ea. – **Subject #1** Regulator Outlet Flow vs. Time (minutes).

(d) 1 ea. – **Subject #6** Regulator Outlet Flow vs. Time (minutes).

(e) 1 ea. – **Subject #1** Regulator Outlet Temperature vs. Time (minutes).

(f) 1 ea. – **Subject #6** Regulator Outlet Temperature vs. Time (minutes).

(g) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) during **Rest**.

(h) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) during **Walk in Place Activity**.

(i) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) during **Rest**.

(j) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) during **Walk in Place Activity**.

(9) Success Criteria:

(a) Subjects #1 and #6 mask pressures shall comply with Table 3.

(b) Subjects shall receive an acceptable breathing gas.

(c) "Frost line" shall occur within heat exchanger piping.

(d) Supply pressure shall be 60 psig or greater.

b. 31 MAR 09 -- TEST #2 -- 8 SUBJECTS -- GROUND LEVEL ONLY -- PARATROOPER CONFIGURATION (AIROX-VIII, TWIN 50s, AND CRU-79) -- ONE TIME:

Purpose: Overall system functional and interfaces test; subject orientation; assess paratrooper configuration at Ground Level.

(1) Place POS Passenger/Paratrooper ON-OFF switch to the ON position. Verify supply pressure of approximately 70 psig. Monitor system LOX level and supply pressure during the testing. Chamber large door and building outer door will remain open. Monitor the chamber oxygen concentration with a mass spectrometer or appropriate oxygen sensor to verify 23% oxygen is not exceeded.

(2) POS will be configured to supply oxygen to eight (8) seats.

(3) Two (2) physiology technicians will serve as inside observers.

(4) Eight (8) **seated and resting** subjects will breathe on an AIROX-VIII Oxygen System with Twin 50 Oxygen Bottles and CRU-79 Breathing Regulator for **30 minutes** at **Ground Level**. Manually record time, LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration at beginning of 30 minute period and at the end of this period. Subject #1 and Subject #6 will wear modified MBU-12 oxygen masks with gas sensing port/s. Subjects will communicate using hand signals.

(5) Eight (8) subjects will breathe on the system while **walking in place** for **15.0 minutes** at **Ground Level**. Manually record time, LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration at beginning of 15 minute period and at the end of this period. Subjects drop masks. Subjects will be instructed on valsalva maneuver to alleviate possible delayed ear blocks.

(6) Photograph/record approximate location of "frost line" on POS heat exchanger.

(7) Data:

(a) Subjects #1 and #6 Regulator Outlet Flow (Ambient Liters/Minute)

(b) Subjects #1 and #6 Mask Oxygen Concentration (%)

(c) Subjects #1 and #6 Mask Pressure (mm Hg)

(d) Subjects #1 and #6 Regulator Outlet Temperature (F)

(e) LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration.

(f) Photograph/record of frost line location.

(g) Subject Questionnaire.

(8) Data Plots:

(a) 1 ea. – **Subject #1** Average Oxygen Concentration during Inhalation (20-100%) and Minimum Oxygen Concentration (Table 2) vs. Time (minutes).

(b) 1 ea. – **Subject #6** Average Oxygen Concentration during Inhalation (20-100%) and Minimum Oxygen Concentration (Table 2) vs. Time (minutes).

(c) 1 ea. – **Subject #1** Regulator Outlet Flow vs. Time (minutes).

(d) 1 ea. – **Subject #6** Regulator Outlet Flow vs. Time (minutes).

(e) 1 ea. – **Subject #1** Regulator Outlet Temp. vs. Time (minutes).

(f) 1 ea. – **Subject #6** Regulator Outlet Temp. vs. Time (minutes).

(g) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) during **Rest**.

(h) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) during **Walk in Place Activity**.

(i) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) during **Rest**.

(j) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) during **Walk in Place Activity**.

(9) Success Criteria:

(a) Subjects shall receive an acceptable breathing gas.

(b) "Frost line" shall occur within heat exchanger piping.

(c) Breathing gas temperature in the mask breathing hose shall not be greater than -20F below ambient temperature.

(d) Supply pressure shall be 60 psig or greater.

c. 01 APR 09 -- TEST #3 -- 8 SUBJECTS -- PARATROOPER CONFIGURATION (AIROX-VIII, TWIN 50s, AND CRU-79) -- ONE TIME:

Purpose: Assess paratrooper configuration at altitude.

(1) POS will be purged, if required. POS will be filled with liquid oxygen. Place POS inside the chamber. Verify POS LOX quantity display works. Place POS Passenger/Paratrooper ON-OFF switch to the ON position. Verify supply pressure of approximately 70 psig. Monitor system LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration during the testing. Subject oxygen saturation readings will be taken, as time permits. Chamber shall have a continuous air purge. Monitor the chamber oxygen concentration with a mass spectrometer or appropriate oxygen sensor to verify 23% oxygen is not exceeded.

(2) POS will be configured to supply oxygen to eight (8) seats.

(3) Eight (8) subjects will be taken to 5,000 feet for ear and sinus check and then returned to Ground Level. Two (2) physiology technicians will serve as inside observers.

(4) Eight (8) seated subjects will **pre-breathe** on the AIROX-VIII Oxygen System with Twin 50 Oxygen Bottles and CRU-79 Breathing Regulator for **30.0 minutes at Ground Level.** The Twin 50s should be at least half full. Manually record time, LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration at beginning of 30 minute period and at the end of this period. Subject #1 and Subject #6 will wear modified MBU-12 oxygen masks with gas sensing port/s. Subjects will communicate using hand signals. Physiology technicians will breathe from the chamber oxygen system in 100% mode.

(5) Chamber altitude will be taken to **24,999 feet** at a standard rate. During **15.0 minute** time period all subjects will: **5.0 minutes seated and resting**; **10.0 minutes walk-in-place**. Manually record time, LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration at beginning and end of 5 and 10 minute periods. Subjects take their seats. Chamber will descend to 18,000 feet.

(6) Chamber will remain at **18,000 feet** for 15 minutes. During the **15.0 minute** time period all subjects will: **5.0 minutes seated and resting**; **10.0 minutes walk-in-place**. Manually record time, LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration at beginning and end of 5 and 10 minute periods. Subjects take their seats. Chamber descends to 10,000 feet.

(7) Chamber will remain at **10,000 feet** for 15 minutes. During the **15.0 minute** time period all subjects will: **5.0 minutes seated and resting**; **10.0 minutes walk-in-place**. Manually record time, LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration at beginning and end of 5 and 10 minute periods. Subjects take their seats.

(8) Chamber will descend to **Ground Level**. Subjects drop masks. Subjects will be instructed on valsalva maneuver to alleviate delayed ear blocks. Subjects will be instructed not to fly for 24 hour period per AFI 11-409.

(9) Photograph/record approximate location of "frost line" on POS heat exchanger.

(10) Subject Questionnaire: Subjects will complete a questionnaire after each test.

(11) Data:

(a) Subjects #1 and #6 Regulator Outlet Flow (Ambient Liters/Minute)

(b) Subjects #1 and #6 Regulator Mask Oxygen Concentration (%)

(c) Subjects #1 and #6 Mask Pressure (mm Hg)

(c) Subjects #1 and #6 Regulator Outlet Temp. (F)

(d) Chamber Altitude (Feet)

(e) LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration

(f) Subject questionnaire.

(12) Data Plots:

(a) 1 ea. – **Subject #1** Average Oxygen Concentration during Inhalation (90-100%), Altitude (Feet), and 99% Oxygen Line vs. Time (minutes).

(b) 1 ea. – **Subject #6** Average Oxygen Concentration during Inhalation (90-100%), Altitude (Feet), and 99% Oxygen Line vs. Time (minutes).

(c) 1 ea. – **Subject #1** Regulator Outlet Flow and Altitude (Feet) vs. Time (minutes).

(d) 1 ea. – **Subject #6** Regulator Outlet Flow and Altitude (Feet) vs. Time (minutes).

(e) 1 ea. – **Subject #1** Regulator Outlet Temp. vs. Time (minutes).

(f) 1 ea. – **Subject #6** Regulator Outlet Temp. vs. Time (minutes).

(g) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **Ground Level** while **Resting**.

(h) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **24,999 feet** at **Rest**.

(i) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **24,999 feet** during **Walk in Place**.

(j) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **18,000 feet** while at **Rest**.

(k) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **18,000 feet** during **Walk in Place**.

(l) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **10,000 feet** while at **Rest**.

(m) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **10,000 feet** during **Walk in Place**.

(n) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **Ground Level** while **Resting**.

(o) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **24,999 feet** at **Rest**.

(p) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **24,999 feet** during **Walk in Place**.

(q) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **18,000 feet** while at **Rest**.

(r) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **18,000 feet** during **Walk in Place**.

(s) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **10,000 feet** while at **Rest**.

(t) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **10,000 feet** during **Walk in Place**.

(13) Success Criteria:

(a) Subjects shall receive an acceptable breathing gas.

(b) "Frost line" shall be within heat exchanger piping.

(c) Breathing gas temperature in the mask breathing hose shall not be greater than -20F below ambient temperature.

(d) Supply pressure shall be 60 psig or greater.

d. 02 APR 09 -- TEST #4 – 10 SUBJECTS -- PASSENGER CONFIGURATION (AIROX-VIII ONLY) -- ONE TIME:

Purpose: Assess passenger configuration at altitude.

(1) POS will be purged, if required. POS will be filled with liquid oxygen. Verify POS LOX quantity display works. Place POS in the chamber. Place Passenger/Paratrooper ON-OFF switch to the ON position. Verify supply pressure of approximately 70 psig. Monitor LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration throughout testing. Subject oxygen saturation readings will be taken, as time permits. Chamber shall have a continuous air purge. Monitor the chamber oxygen concentration with a mass spectrometer or appropriate oxygen sensor to verify 23% oxygen is not exceeded.

(2) POS will be configured to supply oxygen to ten (10) AIROX-VIII Oxygen Metering Valves at 10 seats.

(3) Ten (10) subjects will be taken to 5,000 feet for ear and sinus check and then returned to Ground Level. Two (2) physiology technicians (PT) will serve as inside observers.

(4) Ten (10) **seated and resting** subjects will breathe on the system at **Ground Level** for **10 minutes**. Manually record time, LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration at beginning and end of 10 minute period. Verify each subject is receiving oxygen by checking the AIROX-VIII in-line flow blinker. Subject #1 and Subject #6 will wear modified MBU-12 oxygen masks with gas sensing port/s. Subjects will communicate using hand signals. Physiology technicians will breathe from the chamber oxygen system.

(5) Chamber altitude will be taken to **17,999 feet** at a standard rate. Chamber will remain at 17,999 feet for **20.0 minutes**. During **20.0 minute** time period all subjects will: **10.0 minutes seated and resting**; **10.0 minutes walk-in-place**. Manually record time, LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration at beginning and end of each 10 minute period. Chamber will descend to 15,000 feet.

(6) Chamber will remain at **15,000 feet** for **20.0 minutes**. During 20.0 minute time period all subjects will: **10.0 minutes seated and resting**; **10.0 minutes walk-in-place**. Manually record time, LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration at beginning and end of each 10 minute period. Chamber will descend to 10,000 feet.

(7) Chamber will remain at **10,000 feet** for **20.0 minutes**. During 20.0 minute time period all subjects will: **10.0 minutes seated and resting**; **10.0 minutes walk-in-place**. Manually record time, LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration at beginning and end of each 10 minute period.

(8) Chamber will descend to **Ground Level**. Subjects drop masks. Subjects will be instructed on valsalva maneuver to alleviate delayed ear blocks. Subjects will be instructed not to fly for 22 hour period.

(9) Photograph approximate location of "frost line" on POS heat exchanger.

(10) Data:

(a) Subject #1 and #6 AIROX-VIII Outlet Flow (Ambient Liters/Minute).

(b) Subject #1 and #6 Mask Oxygen Concentration (%).

(c) Subject #1 and #6 Mask Pressure (mm Hg).

(d) Subject #1 and #6 AIROX-VIII Outlet Temp. (F)

(e) Chamber Altitude (Feet).

(f) LOX level and supply pressure readings.

(g) Subject questionnaire.

(11) Data Plots:

(a) 1 ea. – **Subject #1** Average Oxygen Concentration during Inhalation (90-100%), Altitude (Feet), and Minimum Oxygen Concentration (Table 2) vs. Time (minutes).

(b) 1 ea. – **Subject #6** Average Oxygen Concentration during Inhalation (90-100%), Altitude (Feet), and Minimum Oxygen Concentration (Table 2) vs. Time (minutes).

(c) 1 ea. – **Subject #1** Regulator Outlet Flow and Altitude (Feet) vs. Time (minutes).

(d) 1 ea. – **Subject #6** Regulator Outlet Flow and Altitude (Feet) vs. Time (minutes).

(e) 1 ea. – **Subject #1** Regulator Outlet Temp. vs. Time (minutes).

(f) 1 ea. – **Subject #6** Regulator Outlet Temp. vs. Time (minutes).

(g) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **Ground Level** while **Resting**.

(h) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **17,999 feet** at **Rest**.

(i) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **17,999 feet** during **Walk in Place**.

(j) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **15,000 feet** while at **Rest**.

(k) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **15,000 feet** during **Walk in Place**.

(l) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **10,000 feet** while at **Rest**.

(m) 1 ea. – **Subject #1** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **10,000 feet** during **Walk in Place**.

(n) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **Ground Level** while **Resting**.

(o) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **17,999 feet** at **Rest**.

(p) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **17,999 feet** during **Walk in Place**.

(q) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **15,000 feet** while at **Rest**.

(r) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **15,000 feet** during **Walk in Place**.

(s) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **10,000 feet** while at **Rest**.

(t) 1 ea. – **Subject #6** Minimum and Maximum Mask Pressure (-20 to +20 mm Hg) and Minimum and Maximum Mask Cavity Pressures (Table 3) vs. Peak Flow (0-160 LPM) at **10,000 feet** during **Walk in Place**.

(14) Success Criteria:

(a) Subjects #1 and #6 average oxygen concentration delivered to the mask during inhalation shall comply with Table 2.

(b) Subjects #1 and #6 mask pressure shall comply with Table 3.

(c) Subjects shall receive an acceptable breathing gas.

(d) "Frost line" shall be within heat exchanger piping.

(e) Supply pressure shall be 60 psig or greater.

e. 03 APR 09 -- TEST #4 – 6 SUBJECTS -- PATIENT CONFIGURATION (USING PTLOX ACCESSORY KITS) -- ONE TIME:

Purpose: Assess patient configuration at altitude.

(1) POS will be purged, if required. POS will be filled with liquid oxygen. System will be placed inside the chamber. Verify POS LOX display works. PTLOX Accessory Kits will be connected to the POS medical outlets. Ensure flow valves on kits are OFF. Place POS Medical ON-OFF switch to the ON position. Verify supply pressure of approximately 50 psig. Manually monitor LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration during the testing. Subject oxygen saturation readings will be taken, as time permits. Chamber shall have a continuous air purge. Monitor the chamber oxygen concentration with a mass spectrometer or appropriate oxygen sensor to verify 23% oxygen is not exceeded.

(2) Six (6) subjects will be taken to 5,000 feet for ear and sinus check and then returned to Ground Level. Two (2) physiology technicians will serve as inside observers.

(3) System will be configured to supply oxygen to six (6) subjects. The oxygen flow for each subject will be set to a **12 liters/minute** using the kit selector switches.

(4) **Seated and resting** subjects will breathe on the POS for **30.0 minutes** at **Ground Level**. Manually record time, LOX quantity, oxygen supply pressure, heat exchanger

outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration at beginning of 30 minute period and at the end of this period.

(5) Chamber altitude will be taken to **10,000 feet** at a standard rate. **Seated and resting** subjects will breathe on the POS for **15.0** minutes. Manually record time, LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, POS outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration at beginning of 15 minute period and at the end of this period.

(6) Chamber will descend to **Ground Level**. Subjects drop masks.

(7) Data:

(a) Subjects complete questionnaire.

(b) LOX quantity, oxygen supply pressure, heat exchanger outlet temperature, oxygen concentration inside POS, and chamber background oxygen concentration.

(8) Success Criteria:

(a) Subjects shall receive an acceptable breathing gas.

(b) PTLOX Accessory Kits integrate to POS.

(c) POS supply pressure remains at 50 +/-5 psig.

8.0 <u>Reports</u>:

a. Safety-of-Flight Letter will be submitted within 30 days after completion of testing (**04 May 09**).

b. Final Report will be submitted within 90 days after completion of testing (**03 Jul 09**).

APPENDIX B

Informed Consent Document for Manned Altitude Chamber Testing of CV-22 Passenger Oxygen System (POS)

27 Mar 09

INFORMATION PROTECTED BY THE PRIVACY ACT OF 1974

Informed Consent Document for
Manned Altitude Chamber Testing of CV-22
Passenger Oxygen System (POS)

711 HPW/RHPG, Brooks City-Base, Texas 78235

Principal Investigator: George Miller (AFRL/711 HPW/RHPG)
Associate Investigators: Bill Storm (Wyle Labs) and Bill Ercoline (Wyle Labs)
Medical Monitor: LtCol John Gibbons (AFRL/711 HPW/RHP)

1. Nature and Purpose: You have been offered the opportunity to participate in the "Manned Altitude Chamber Testing of CV-22 Passenger Oxygen System (POS)" **test and evaluation** study. Your participation will occur at the Brooks City-Base altitude chamber facility during 30 Mar-03 Apr 09.

The purpose of this test and evaluation is to evaluate the capability of a Passenger Oxygen System (POS) to provide breathing oxygen for passengers in the cargo area of the CV-22. T**he testing will adhere to stipulations in AFI 11-409, High Altitude Airdrop Mission Support Program." These procedures are routinely used by USAF flying units.**

The addition of the CV-22 aircraft to the Special Operations Forces offers vertical take-off and landing capability of a helicopter combined with the speed and range of a fixed wing aircraft. The CV-22 aircraft has an On-Board-Oxygen-Generating System that supports the basic four-person aircrew. However, given that the aircraft is unpressurized, a second oxygen system is required if passengers are to travel in the cargo area of the aircraft. The capability to carry passengers at altitude would significantly expand the CV-22 operational capabilities. The results of this evaluation will aid in determining a safe-to-fly rating for the POS.

The CV-22 passenger oxygen system is a self-contained, "roll-on/roll-off" system to support passengers or paratroopers during high altitude operations and patients during medevac. The combat hardened POS includes a device for storing 25 liters of liquid oxygen, regulating the system pressure, and distributing oxygen to the cargo area seats. The 25 liter container is identical to those currently flown on AF cargo aircraft. Further, the POS is similar to the existing Patient Therapeutic Liquid Oxygen System (PTLOX). POS will be secured on the CV-22 like cargo.

A total of up to **18** volunteer participants may be enrolled in this study. To be eligible for participation you must be active duty military and hold a current AF FORM 1042 (*Medical Recommendation for Flying or Special Operational Duty*) or equivalent and current altitude chamber training certification. You must be between 20 and 50 years of age. Both male and females may participate. Female volunteers will have a urine pregnancy test within 72 hours prior to any altitude chamber exposure. Female volunteers will be excluded if they are pregnant or attempting to become pregnant.

The POS will be evaluated in five modes. Two of the testing modes require 10 participants, two modes require 8 participants, and one requires 6 participants. Thus not all of the 18 enrolled volunteers will participate in each of the chamber tests, although all 18 of you will be qualified for each test and should plan to participate in at least one or more of the tests. You and the other participants will be required to be present and available at the chamber facility during the preparation and conduct of your scheduled test. As noted, for each test to be valid a precise number of participants are required. Two additional participants will be required to be present at each test to protect against the expense incurred by having to cancel any of the chamber tests should participants become ill or otherwise unavailable to participate. The onsite time requirement is about 3.5 hours on **Day One**, 3.5 or 6 hours on **Day Two (31 Mar 09)**, and 5 hours/each on **Days Three and Four (01 and 02 Apr 09),** and 3.5 hours on **Day Five (03 Apr 09)**. On Day One subject orientation is planned. On 31 Mar 09 two low altitude chamber flights are planned. On the remaining days one chamber flight is planned per day. The participation time includes preparation time and post-test time (including a questionnaire, see attached example). Thus, your total on-site time for participation in the study could be a maximum of about 23 hours.

2. Experimental Procedures: If you are qualified and decide to participate you will be given an orientation and safety briefing one day prior to commencing the testing. Operating and safety procedures specific to the test will be explained along with general information. You will receive a thorough review of the objective of the study, a review on the use of the oxygen equipment, and instructions on completion of the one-page questionnaire. Prior to each of your chamber runs the schedule and procedures for that day's run will be reviewed. Your questions and comments are encouraged at these briefings.

The system will be tested in five operating modes. The details of each operating mode are in Tables I-V below. Modes #1 and #4 will use the AIROX-VIII Oxygen Metering Valve and MBU-12/P oxygen mask. Although the AIROX-VIII is a military qualified item, using it in the planned configuration is a new approach. The safety and effectiveness of this configuration will be confirmed by unmanned testing using a breathing machine prior to beginning manned testing. Modes #2 and #3 will use the complete AIROX-VIII Oxygen System with Twin 50 oxygen bottles, CRU-79 oxygen regulator, and MBU-12/P oxygen mask. This configuration is presently used routinely by paratroopers. Mode #5 will use the PTLOX accessory kit with oxygen flow control valve and a medical mask. These items are presently used routinely by the medevac community.

Two experienced physiology technicians (PTs) will serve as inside observers during each of your chamber runs. The technicians will breathe from the chamber oxygen system, not from the POS. Prior to initiating each of the test conditions you will be taken to 5,000 feet for an ear and sinus check and then returned to Ground Level. At each test altitude the physiological technicians will confirm with you through verbal communication and/or hand signals that you are receiving an adequate breathing gas. During the tests two participants will be selected to wear an instrumented oxygen mask. The instrumented mask is the same model and make as the other masks being used in the study except it has been modified with some sensors and tubing to allow for the measurement of breathing gas parameters, such as flow, mask oxygen concentration, mask pressure, gas temperature, and regulator inlet pressure. If you are selected to wear this mask you will wear it just like you would the other non-instrumented masks. You will not be responsible for its operation.

After chamber testing of **Modes #1 and #2** you will be instructed on the valsalva maneuver to alleviate potential delayed ear blocks which are caused by breathing a high oxygen concentration gas for an extended period. Frequent use of the valsalva maneuver after the test and before bedtime will significantly reduce the probability of delayed ear block. After **Mode #3** you will be instructed on the valsalva maneuver and instructed **not to fly for a 24 hour period**. This 24 hour period is required by AFI 11-409 and it reduces the risk of decompression sickness. After **Mode #4** you will be instructed on the valsalva maneuver and instructed **not to fly for a 22 hour period**. After **Mode #5** you will be instructed on the valsalva maneuver and instructed **not to fly for a 12 hour period**.

The five modes and number of participants are:

- Mode #1: Passenger (*10 participants*) @ Altitude (Max: 9,000 feet)
- Mode #2: Paratrooper (*8 participants*) - @ Altitude (Max: 9,000 feet)
- Mode #3: Paratrooper (*8 participants*) @ Altitude (Max: 24,999 feet)
- Mode #4: Passenger (*10 participants*) @ Altitude (Max: 17,999 feet)
- Mode #5: Medevac *(6 participants)* @ Altitude (Max: 10,000 feet)

Tables I-V show the detailed test events for each mode. Please review the events for each mode. Also, the subject agenda is provided below Table V.

Table I. Day Two (31 Mar 09) - <u>Mode #1</u> - Passenger (10 Participants) - AIROX-VIII Only - Altitude.

Purpose: System functional and interfaces test, subject orientation, and assess system at Low Altitude.

Event	Time

	Period
PTs: **POS ON**, check supply pressure (60-85 psig) **Masks up**, breathe on system, check data acquisition PTs: Verify operation of AIROX-VIII flow blinkers	3 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 1)	1 min
Drop masks PTs: **POS OFF**	1 min
Ascend to 5,000 feet for ear and sinus check **Note: Two additional subjects will take ear and sinus check flight, depart chamber, and remain in chamber area**	2 min
Hold at 5,000 feet	5 min
Descend to Ground Level	2 min
Hold at Ground Level	5 min
Ascend to 9,000 feet	**2 min**
PTs: **POS ON**, check supply pressure (60-85 psig) **Masks Up** PTs: Verify operation of AIROX-VIII flow blinkers	1 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 2)	**1 min**
Subjects seated and resting **Instrumented Subjects (#1 and #6) Stand together during last 5 min period**	**30 min**

(Mode #1 Cont.) Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 3)	1 min
Subjects #2, #3, #7, and #8 Drop masks and disconnect from AIROX VIII	**5 min**
Subjects #4 and #9 Drop masks and disconnect from AIROX VIII	**5 min**
Subjects #5 and #10 Drop masks and disconnect from AIROX VIII	**5 min**
All subjects reconnect to AIROX VIIIs and Masks up **Check flow blinker**	**2 min**
Descend to Ground Level	**2 min**
Drop Masks PTs: **POS OFF**	1 min
STOP -- Duration	**74 min**

Table II. Day Two (31 Mar 09) - Mode #2 - Paratrooper (8 Participants) - AIROX-VIII Oxygen System with Twin 50s and CRU-79 Regulator - Altitude.

Purpose: System functional and interfaces test, subject orientation, and assess system at Low Altitude.

Event	Time Period
PTs: POS ON, check supply pressure (60-85 psig) **Masks up**, breathe on system, and check data acquisition	5 min
Drop masks PTs: **POS OFF**	1 min
Ascend to 5,000 feet for ear and sinus check **Two additional subjects will take ear and sinus check flight, depart chamber, and remain in chamber area**	2 min

Hold at 5,000 feet	5 min
Descend to Ground Level	2 min
PTs: **POS ON**, check supply pressure (60-85 psig) **Masks Up**	1 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 4)	1 min
Subjects Seated and Resting	**30 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 5)	1 min
Subjects #2, #3, #7, and #8 Drop masks and Disconnect from AIROX VIII	**5 min**
Subjects #4 and #9 Drop masks and Disconnect from AIROX VIII	**5 min**
All subjects Masks Up	**2 min**
Ascend to 9,000 feet	**2 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS	1 min

(Reading 6)	
Subjects Seated and Resting	**10 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 7)	1 min
Descend to Ground Level	**2 min**
Drop Masks PTs: **POS OFF**	1 min
STOP -- Duration	**77 min**

Table III. Day Three (01 Apr 09) - Mode #3 - Paratrooper (8 Participants) Altitude
Purpose: Assess paratrooper configuration at altitude.

Event	Time Period
PTs: POS ON, check supply pressure (60-85 psig) **Masks up**, breathe on system, and check data acquisition Masks Down PTs: POS OFF	1 min
Ascend to 5,000 feet for ear and sinus check **Two additional subjects take ear and sinus check flight, depart chamber, and remain in chamber area**	2 min
Hold at 5,000 feet	5 min
Descend to Ground Level	2 min
Ascend to 8,000 feet	2 min
PTs: POS ON, check supply pressure (60-85 psig) **Masks up**	3 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration	1 min

PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 8)	
Subjects Seated and Resting **Note: Two additional subjects pre-breathe 100% oxygen outside chamber** **(30 min pre-breathe period required by AFI 11-409)**	**30 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 9)	1 min
Ascend to 24,999 feet	5 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 10)	1 min
Subjects Seated and Resting **(As time permits, check oxygen saturation with finger tip monitor.)**	**5 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 11)	1 min
Subjects Walk in Place	**10 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 12)	1 min
Descend to 18,000 feet	2 min
Record Time, Heat Exchanger Temperature,	1 min

and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 13)	
Subjects Seated and Resting **(As time permits, use finger tip oxygen saturation monitor.)**	**5 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 14)	1 min
Subjects Walk in Place	**10 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 15)	1 min
Descend to 9,000 feet	2 min
Drop Masks **PTs: POS OFF**	1 min
Descend to Ground Level	3 min
STOP -- Duration	**94 min**

Table IV. Day Four (02 Apr 09) - Mode #4 - Passenger (10 Participants) @ Altitude
Purpose: Assess passenger configuration at altitude.

Event	Time Period
Ascend to 5,000 feet for ear and sinus check **Note: Two additional subjects will take ear and sinus check flight, depart chamber, and remain in chamber area**	2 min
Hold at 5,000 feet	5 min
Descend to Ground Level	2 min
PTs: **POS ON**, check supply pressure (60-85 psig) **Masks up**, check data acquisition PTs: Verify operation of AIROX-VIII flow blinkers	5 min

Masks Down **PTs: POS OFF**	
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 16)	1 min
Ascend to 9,000 feet	2 min
PTs: **POS ON**, check supply pressure (60-85 psig) **Masks Up** PTs: Verify operation of AIROX-VIII flow blinkers	5 min
Ascend to 17,999 feet	4 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 17)	1 min
Subjects Seated and Resting **Instrumented Subjects (#1 and #6) Stand together for last 5 min** **(As time permits, use finger tip oxygen saturation monitor.)**	**30 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 18)	1 min
Descend to 15,000 feet	1 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 19)	1 min
Subjects Seated and Resting **Instrumented Subjects (#1 and #6) Stand together for last 5 min** **(As time permits, use finger tip oxygen saturation monitor.)**	**30 min**

Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 20)	1 min
Descend to 9,000 feet	1 min
Drop Masks **PTs: POS OFF**	1 min
Descend to Ground Level	3 min
STOP -- Duration	**96 min**

Table V. Day Five (03 Apr 09) - Mode #5 - Medevac (6 Participants) @ Altitude

Purpose: Assess medevac configuration at altitude.

Event	Time Period
Ascend to 5,000 feet for ear and sinus check **Note: Two additional subjects take ear and sinus check flight, depart chamber, and remain in chamber area**	2 min
Hold at 5,000 feet **Take O2 saturation readings at end of period.**	5 min
Descend to Ground Level	2 min
PTs: POS ON (Medevac Switch Only), check supply pressure (45-55 psig) Dial-in 12 liters/min setting on each subject's flow switch	1 min
Medical masks on	2 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 21)	1 min
Subjects Seated and Resting	**30 min**

15 min point: Take O2 saturation readings. **Change flow switches to 15 LPM** **30 min point: Take O2 saturation readings.**	
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 22)	1 min
Ascend to 10,000 feet	2 min
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 23)	1 min
Subjects Seated and Resting **5 min point: Take O2 saturation readings.** **Change flow switch settings to 12 LPM** **15 min point: Take O2 saturation settings.**	**15 min**
Record Time, Heat Exchanger Temperature, and Chamber Background Oxygen Concentration PTs: Call out LOX Level, Supply Pressure, and Oxygen Concentration Inside POS (Reading 24)	1 min
Descend to Ground Level	2 min
Masks down **PTs: POS OFF**	**1 min**

STOP -- Duration	**66 min**

Agenda for Subjects

30 Mar 09 - All Subjects Report - No chamber test today
0830 - 1000 hrs Subject Orientation (B. 170 upstairs conf. room)
1000 - 1130 hrs Flight Doc Interview/Exam (B. 170)
1300 - 1600 hrs Subject Equipment Fitting (Helmet, MBU-12/P mask, flight suit, and flight gloves) (B. 170 Life Support Shop - LSS)

31 Mar 09 - Mode #1 - 12 Subjects Report/ 10 Subjects Participate in Test - Max. Altitude 9,000 feet
0830 - 0900 hrs Flight Doc Interview/Exam (B. 170)
0900 - 0930 hrs Pickup Subject Equipment (B. 170 Life Support Shop)
0930 - 1000 hrs Pre-chamber Test Briefing (B. 160 Chamber E)
1000 - 1115 hrs Chamber Flight (B. 160 Chamber E)
1115 - 1215 hrs Flight Doc Interview/Exam, Complete Questionnaire/Debrief, and Return Subject Equipment to LSS

31 Mar 09 - Mode #2 - 10 Subjects Report/ 8 Subjects Participate in Test - Max. Altitude 9,000 feet
1330 - 1400 hrs Pre-chamber Test Briefing (B. 160 Chamber E)
1400 - 1515 hrs Chamber Flight (B. 160 Chamber E)
1515 - 1615 hrs Flight Doc Interview/Exam, Complete Questionnaire/Debriefing and Return Subject Equipment to LSS

01 Apr 09 - Mode #3 - Paratrooper Configuration - 10 Subjects Report/ 8 Subjects Participate in Flight - Max. Altitude 24,999 feet
0800 - 0830 hrs Flight Doc Interview/Exam (B. 170)
0830 - 0900 hrs Pickup Subject Equipment (Life Support Shop) and Report to Chamber
0900 - 0930 hrs Pre-chamber Flight Briefing (B. 160 Chamber E)
0930 - 1130 hrs Chamber Flight (B. 160 Chamber E)
1130 - 1300 hrs Flight Doc Post Interview/Exam, Complete Questionnaire/ Debriefing, and Return Subject Equipment to LSS (B. 170)

02 Apr 09 - Mode #4 - Passenger Configuration - 12 Subjects Report/ 10 Subjects Participate in Flight - Max. Altitude 17,999 feet
1200 - 1230 hrs Flight Doc Interview/Exam (B. 170)
1230 - 1300 hrs Pickup Subject Equipment (Life Support Shop) and Report to Chamber
1300 - 1330 hrs Pre-chamber Flight Briefing (B. 160 Chamber E)
1330 - 1530 hrs Chamber Flight (B. 160 Chamber E)
1530 - 1700 hrs Flight Doc Post Interview/Exam, Complete Questionnaire/ Debriefing, and Return Subject Equipment to LSS (B. 170)

03 Apr 09 - Mode #5 - Medevac Configuration - 8 Subjects Report/ 6 Subjects Participate in Flight - Max. Altitude 10,000 feet
1230 - 1300 hrs Flight Doc Interview/Exam (B. 170)
1300 - 1330 hrs Pickup Subject Equipment (Flight Suit and Gloves Only)
1330 - 1400 hrs Pre-chamber Flight Briefing (B. 160 Chamber E)
1400 - 1500 hrs Chamber Flight (B. 160 Chamber E)
1500 - 1600 hrs Flight Doc Check, Complete Questionnaire/Debriefing, and Return LSS Equipment

3. Discomfort and risks: Discomforts and potential risks that may occur during the CV-22 POS evaluation include the following:

Abdominal Gas Expansion. Gas pains of even moderate severity may produce marked lowering of blood pressure, and eventually fainting, if relief is not obtained. Discomfort can be reduced by belching or passing of flatus. Occurrence of gas pains can be reduced by avoiding gas-forming foods and carbonated beverages prior to altitude exposure. You will be returned to Ground Level on the rare occasion when trapped abdominal gas cannot be released and results in unrelieved abdominal pain.

Dental Pain (barodontalgia). This rare complication generally can be avoided by not participating in an altitude exposure after recent dental work (72 hours prior to chamber flight). Pain generally results from trapped gas expanding in a single tooth and aggravating the tooth nerve. If pain occurs, you will be returned to Ground Level, which usually relieves the pain. If the dental pain persists, you will be referred to a dentist.

Dry gas effect. The oxygen that will be used as a breathing gas contains very little moisture, and may cause a drying effect on your upper airways or eyes. No permanent or long-lasting damage is expected from such drying, but you can stop participation in this evaluation, if symptoms exceed a tolerable level. You should maintain hydration prior to any chamber flight.

Decompression Sickness (DCS). DCS can occur when the pressure surrounding the body is reduced, resulting in the formation of nitrogen bubbles within the body and a wide possible range of symptoms. Based on the short duration of altitude exposure required for each test session and the use of oxygen pre-breathe prior to high altitude exposures, it is unlikely that you will develop DCS. Nevertheless, you should be aware of the following types and symptoms of DCS:

Bends - this is by far the most common type of DCS, and consists of pain in the joints or large muscle masses. Larger joints like the shoulders, elbows, knees, and ankles are the usual sites involved. The pain can range from mild to severe, but would normally be expected to have an intensity of 1 to 4 on a scale of 1 to 10. The pain frequently increases in intensity with movement of the joint or muscle mass involved.

Skin Manifestations - this type of DCS involves peculiar sensations of the skin that may be accompanied by a mottled (reddish or purplish) and diffuse rash. The DCS is caused by very small bubbles of nitrogen under the skin producing a stimulus to specialized nerves, causing various sensations known as paresthesia (itching, sensations of hot and cold, and tingling). The mottled rash may be localized in a small area or may be diffused over the body. A slight swelling of the skin may be noted and a slight increase of temperature may occur. The rash does not always disappear with descent and may last for several hours.

Chokes - are rare but potentially dangerous. The chokes indicate that bubbles exist in the smaller blood vessels in the lungs and possibly in the tissue of the trachea (windpipe). The symptoms are deep pain centrally located under the sternum (breast bone), a dry progressive cough, and difficulty with inspiration. There may be a sense of suffocation and apprehension. Chokes require urgent medical evaluation and hyperbaric treatment. The Medical Observer will evaluate the participant's condition and manage referral and transportation to Hyperbaric Medicine, Wilford Hall Medical Center. Participants will be provided information on how to contact Hyperbaric Medicine should any symptoms occur after a chamber flight.

Neurological Manifestations - in rare cases the brain and/or spinal cord may be affected by nitrogen bubbles. The most common symptoms are disturbances in vision, varying from blind spots in the visual field to flashing and/or flickering lights. Other symptoms include severe persistent headache, partial paralysis, loss of speech or hearing, vertigo, or loss of orientation. Numbness and tingling of one arm, leg, or side of the body may occur. Circulatory shock, or failure of circulatory control, is a possible effect of neurological involvement. Neurological manifestations require immediate medical evaluation and hyperbaric treatment. The Medical Observer will evaluate the participant's condition and manage referral and transportation to Hyperbaric Medicine, Wilford Hall Medical Center. Participants will be provided information on how to contact Hyperbaric Medicine should any symptoms occur after a chamber flight.

Although extremely unlikely, rare manifestations of DCS could result in death or disability. Normally, DCS symptoms clear when the altitude chamber is returned to Ground Level. If any symptoms do not clear, you may be treated in a hyperbaric chamber to obtain relief. Notification of Hyperbaric Medicine personnel for consultation and potential treatment will be handled by the Medical Observer. Hyperbaric oxygen is a medical modality that requires an increase in ambient pressure (generally 30 psig, or 2 atmospheres greater than ambient) while breathing 100% oxygen through a mask. There are risks associated with this treatment and these will be explained in a separate consent procedure should intervention be required.

Ear and sinus block. This refers to pressure or pain that may occur in the ears or sinuses during chamber ascent or descent. It is caused by an inability to equalize pressure within the middle ear or sinuses when the pressure within the chamber is changing. To help determine if you will have any such problems during a test session, an ear and sinus check will be conducted, as the initial part of each chamber exposure, by ascending to 5,000 ft and returning to Ground Level. If later problems occur despite this precaution, the following

procedures will be followed (IAW AFI 11-403): valsalva, cough against breathing pressure, bounce the chamber altitude plus 2,000 feet, use nasal spray (Afrin), and lastly, use a politzer bag. A maxillary sinus block may cause referred pain to the upper teeth, and thus be mistaken for barodontalgia (pain in the teeth produced by changes in barometric pressure). However, barodontalgia generally occurs in a single tooth as opposed to several teeth at once. An ear block may occur up to several hours after breathing pure oxygen, and may cause ear pain. You will be told to valsalva after the test and each hour until retiring for the evening. This technique reduces the oxygen concentration in the ears and the probability of ear discomfort. You will be given a telephone number for help or advice after normal working hours. You can reduce the possibility of experiencing an ear or sinus block by not taking part in an altitude chamber flight if you have a cold, sore throat, or congestion. You should inform the medical observer during the pre-flight check of any such symptoms that are ongoing or recently occurred, and you should also mention any self-medications you may have recently taken.

Hypoxia. Hypoxia is a state of oxygen deficiency that causes an impairment of function. It is a potential risk associated with altitude exposure when the breathing gas does not contain sufficient oxygen or is not delivered with sufficient positive pressure. Aircrew life support equipment is intended to prevent such deficiencies. Symptoms of hypoxia may include air hunger, numbness, tingling, headache, fatigue, nausea, hot and cold flashes, euphoria, and visual changes. The chamber flight conducted during the physiological training course includes an opportunity for you to experience your hypoxia symptoms. You may experience similar symptoms if you allow yourself to hyperventilate during a chamber flight (breathe too fast and deep). Hyperventilation in the chamber may be caused by anxiety. You should always immediately inform the chamber crew if you are experiencing any symptoms during a chamber flight. Failure to correct hypoxia or hyperventilation can lead to unconsciousness. The chamber crew continuously monitors your actions and responses during any flight. If you have symptoms sufficiently strong to affect your response or produce discomfort, the chamber will be immediately returned to Ground Level. Any hypoxia symptoms you have will resolve during the descent to Ground Level. Resolution of hyperventilation symptoms will require you to control your rate and depth of breathing.

Ruptured Ear Drum. In the event of an emergency, the altitude chamber may be returned to Ground Level at a rapid rate. With such a rapid pressure change, you may experience a ruptured ear drum and/or ear pain.

Equipment malfunction. Consequences of equipment malfunction may include you not being able to breathe or having difficulty breathing. **If at any time you have difficulty breathing during the system testing, drop your mask.** The altitude exposure will be terminated and immediate descent to Ground Level will be initiated.

4. **Precautions for female participants:** If you are pregnant or breast feeding, you are not eligible for this equipment evaluation. If you are sexually active, you should take precautions to avoid the possibility of becoming pregnant. You are advised to use an effective contraceptive method including abstinence, since it is not known how these

procedures could affect an unborn child. You will submit to a urine pregnancy test conducted by the base clinic personnel, at no cost to you, within 72 hours prior to any altitude exposure. If you become pregnant during the course of your participation in this evaluation, or feel you might be pregnant, contact the Medical Monitor for additional information.

5. **Benefits:** You are not expected to benefit directly from participation in this equipment evaluation.

6. **Compensation:** As an active duty military member, you will receive your normal active duty pay and flight pay, if on flying status. As a participant, and if not on flying status, you will also be entitled to incentive pay for experimental stress for altitude exposure ($150 per month) as detailed in the DoD Manual for Military Pay and Allowances, Chapter 3, Section A, General Provisions, Sections 20301, 20302, and 20303. Section E, Experimental Stress Duty, 20341, paragraphs a, b, and c also apply and give conditions of entitlement. Eligibility for incentive pay will be for only one payment of incentive pay per month despite the number of exposures or level of participation. You will bear no costs for medical testing.

7. **Alternatives:** Choosing not to participate is an alternative to volunteering for this study.

8. **Entitlements and confidentiality:**

a. Records of your participation in this study may only be disclosed according to federal law, including the Federal Privacy Act, 5 U.S.C. 552a, and its implementing regulations. Your personal information will be stored in a locked cabinet in an office that is locked when not occupied. Electronic files containing your personal information will be password protected and stored only on a DoD server. It is intended that the only people having access to your information will be the researchers named above. When no longer needed, your information will be destroyed in a secure manner (shredding). Complete confidentiality for military personnel cannot be promised because information bearing on your health may be required to be reported to appropriate medical or command authorities.

b. Your entitlements to medical and dental care and/or compensation in the event of injury are governed by federal laws and regulations, and that if you desire further information you may contact the base legal office. In the event of a test related injury, you may contact the medical monitor of this test and evaluation study.

c. If an unanticipated event (medical misadventure) occurs during your participation in this study, you will be informed. If you are not competent at the time to understand the nature of the event, such information will be brought to the attention of your next of kin.

Next of kin or designated health care agent (if needed):

Name_____

d. The decision to participate in this equipment evaluation is completely voluntary on your part. No one may coerce or intimidate you into participating in this program. You are participating because you want to. George Miller, or an associate, has adequately answered any and all questions you have about this study, your participation, and the procedures involved. George Miller, or an associate, will be available to answer any questions concerning procedures throughout this study. If significant new findings develop during the course of this test and evaluation, which may relate to your decision to continue participation, you will be informed. You may withdraw this consent at any time and discontinue further participation in this study without prejudice to your entitlements. The investigator or medical monitor of this study may terminate your participation in this study if she or he feels it to be in your best interest. If you have any questions or concerns about your participation in this study or your rights as a test participant, please contact Lt Col John Gibbons.

e. Your participation in this study may be photographed, filmed or audio/videotaped. Your consent is needed to use these media for training and data collection purposes. Any release of records of your participation in this study may only be disclosed according to federal law, including the Federal Privacy Act, 55 U.S.C. 552a, and its implementing regulations. This means personal information will not be released to unauthorized sources without your permission. These recordings will be used for publication (technical report), and may be used as part of a briefing during a CV-22 Passenger Oxygen System (POS) program review. Both Government personnel and POS contractors may be present at such a briefing. Your name will not be associated with any recording used for a briefing or pictures used for a technical report. With your permission, a recording of your test session may be provided to the contractor responsible for POS development to help with that development process. Although you will normally be wearing a helmet and mask, there may be photographs or portions of videotapes where your face can be identified. If you do not give your permission for use of such recordings, it will not affect your ability to take part in this study. All recordings will be stored in a locked cabinet in a room that is locked when not occupied. Only the investigators of this study will have access to these media. They will be maintained for approximately one year after completion of the study report and then destroyed by shredding.

YOU ARE MAKING A DECISION WHETHER OR NOT TO PARTICIPATE. YOUR SIGNATURE INDICATES THAT YOU HAVE DECIDED TO PARTICIPATE HAVING READ THE INFORMATION PROVIDED ABOVE.

Volunteer Signature_____Date_____

Volunteer Name (printed) _____

Advising Investigator Signature _____ Date _____

Investigator Name (printed) _____

Witness Signature _____Date _____

Witness Name (printed) _____

We may wish to present some of the video/audio recordings from this study at scientific conventions or use photographs in journal publications. If you consent to the use of your image for publication or presentation in a scientific or academic setting, please sign below.

Volunteer Signature_____Date_____

Privacy Act Statement

Authority: We are requesting disclosure of personal information, to include your Social Security Number. Researchers are authorized to collect personal information (including social security numbers) on test participants under The Privacy Act-5 USC 552a, 10 USC 55, 10 USC 8013, 32 CFR 219, 45 CFR Part 46, and EO 9397, November 1943.

Purpose: It is possible that latent risks or injuries inherent in this experiment will not be discovered until sometime in the future. The purpose of collecting this information is to aid researchers in locating you at a future date if further disclosures are appropriate.
Routine Uses: Information (including name and SSN) may be furnished to Federal, State, and local agencies for any uses published by the Air Force in the Federal Register, 52 FR 16431, to include, furtherance of the test and evaluation involved with this study and to provide medical care.
Disclosure: Disclosure of the requested information is voluntary. No adverse action whatsoever will be taken against you, and no privilege will be denied you based on the fact you do not disclose this information. However, your participation in this study may be impacted by a refusal to provide this information.

Approved for public release; distribution unlimited, Public Affairs Case File No. 09-411, 26 August 2009;
approval given by 311th Public Affairs Office, Brooks City-Base, Texas

EXAMPLE _-- CV-22 POS Questionnaire

Manned Testing of CV-22 Passenger Oxygen System (POS)

Participant Number _____	**Date/Time _____**

Testing Mode (circle)

Passenger (Max: 9,000 ft)	Paratrooper (Max: 9,000 ft)	Paratrooper (Max: 24,999 ft)	Passenger (Max:17,999 ft)	Medevac (Max:10,000 ft)

Participant Oxygen Mask (circle):

Non-instrumented **Instrumented**

Did you receive an acceptable breathing gas? (circle) Yes No

If No, circle the altitude(s) at which you experienced any problems.

Mode #1: Passenger- 9,000 ft
Comments:

Mode #2: Paratrooper- G/L 9,000 ft
Comments:

Mode #3: Paratrooper - G/L 24,999 ft 18,000 ft
Comments:

Mode #4: Passenger: 9,000 ft 17,999 ft 15,000 ft
Comments:

Mode #5: Medevac: G/L 10,000 ft
Comments:

APPENDIX C
POS DATA PLOTS

Figure 1: AIROX VIII Average Oxygen Concentration vs. Altitude
VPBS Profile #1 - 60 psig Inlet Pressure

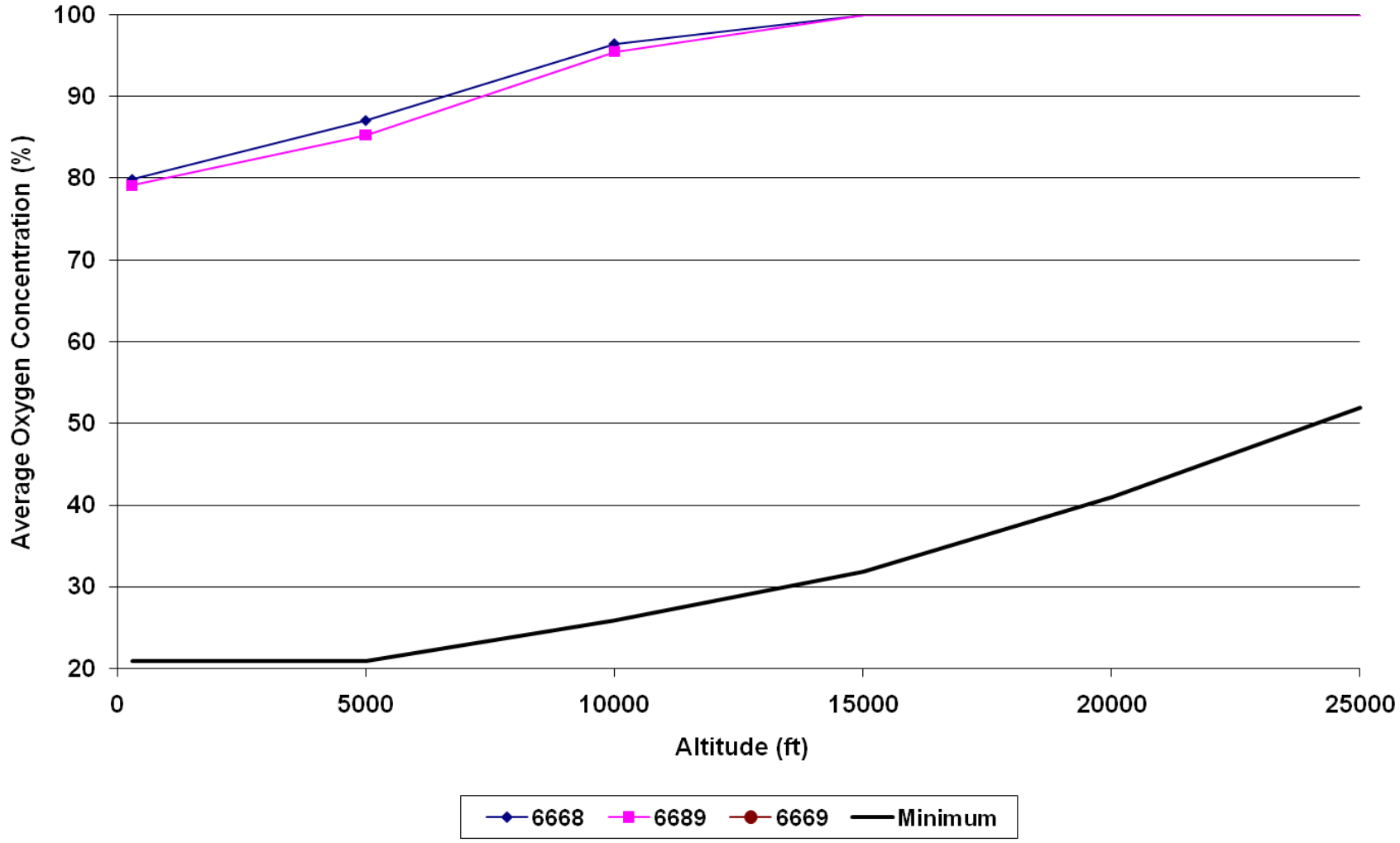


Figure 2: AIROX VIII Average Oxygen Concentration vs. Altitude
VPBS Profile #2 - 60 psig Inlet Pressure

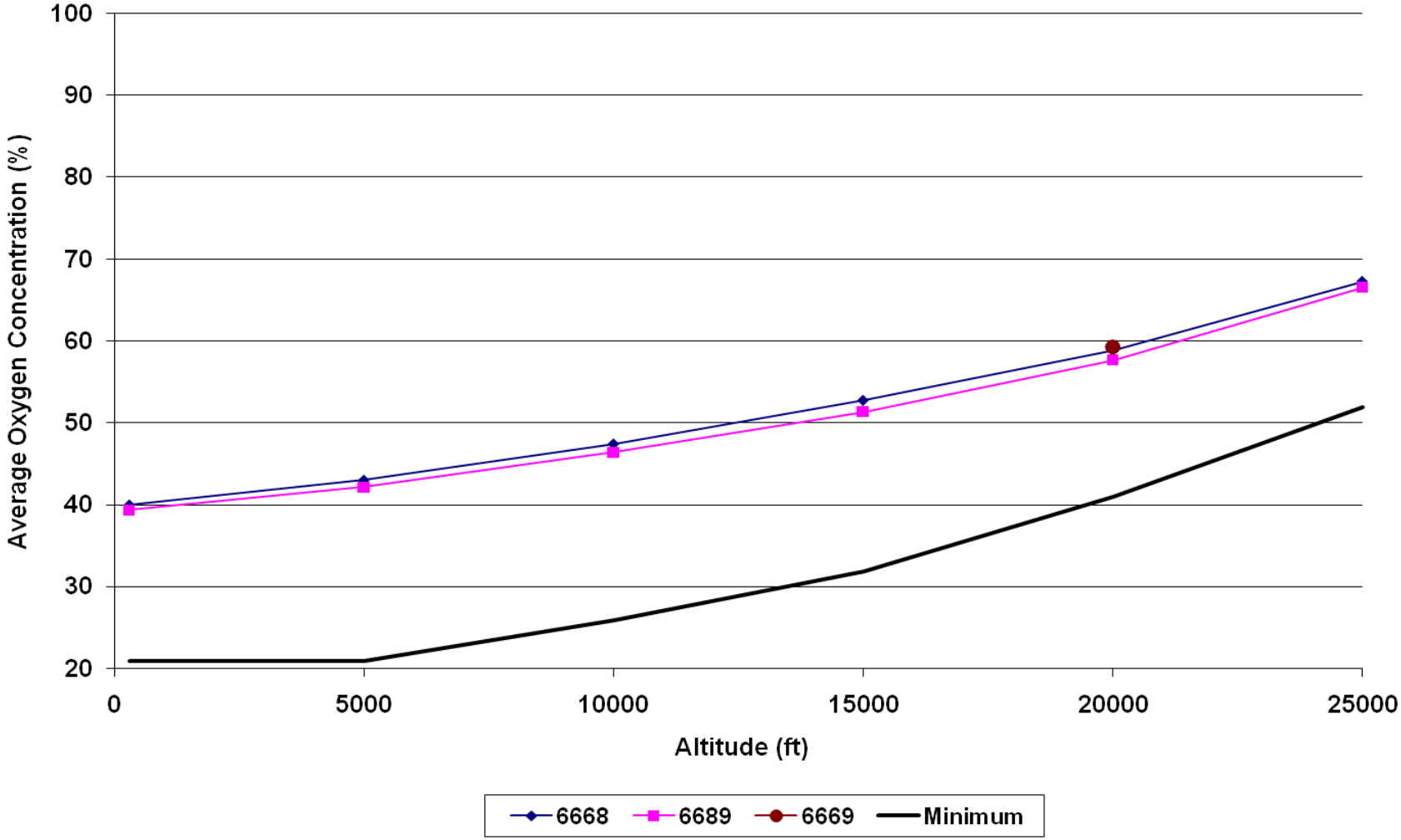


Figure 3: AIROX VIII Average Oxygen Concentration vs. Altitude
VPBS Profile #3 - 60 psig Inlet Pressure

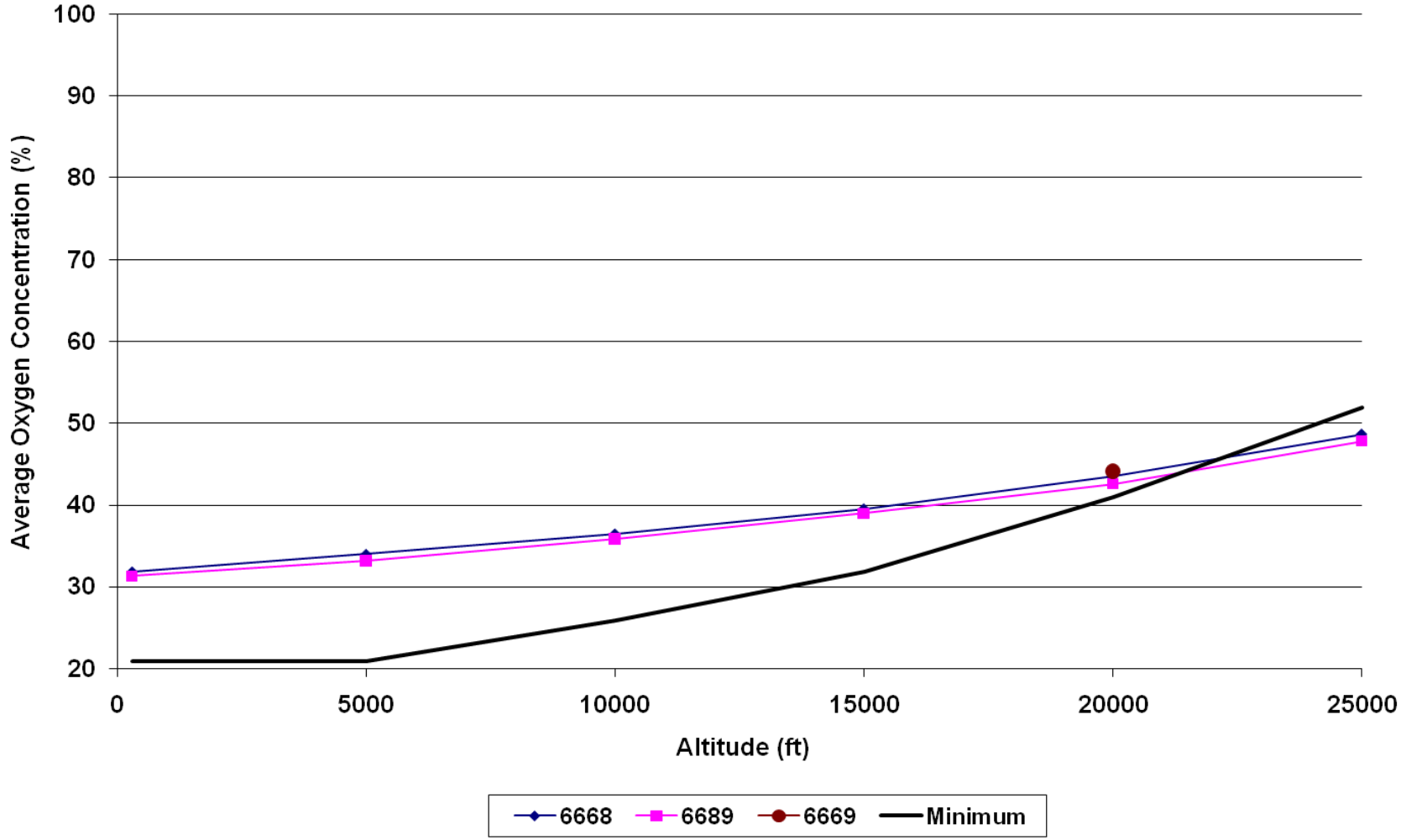


Figure 4: AIROX VIII Average Oxygen Concentration vs. Altitude
VPBS Profile #4 - 60 psig Inlet Pressure

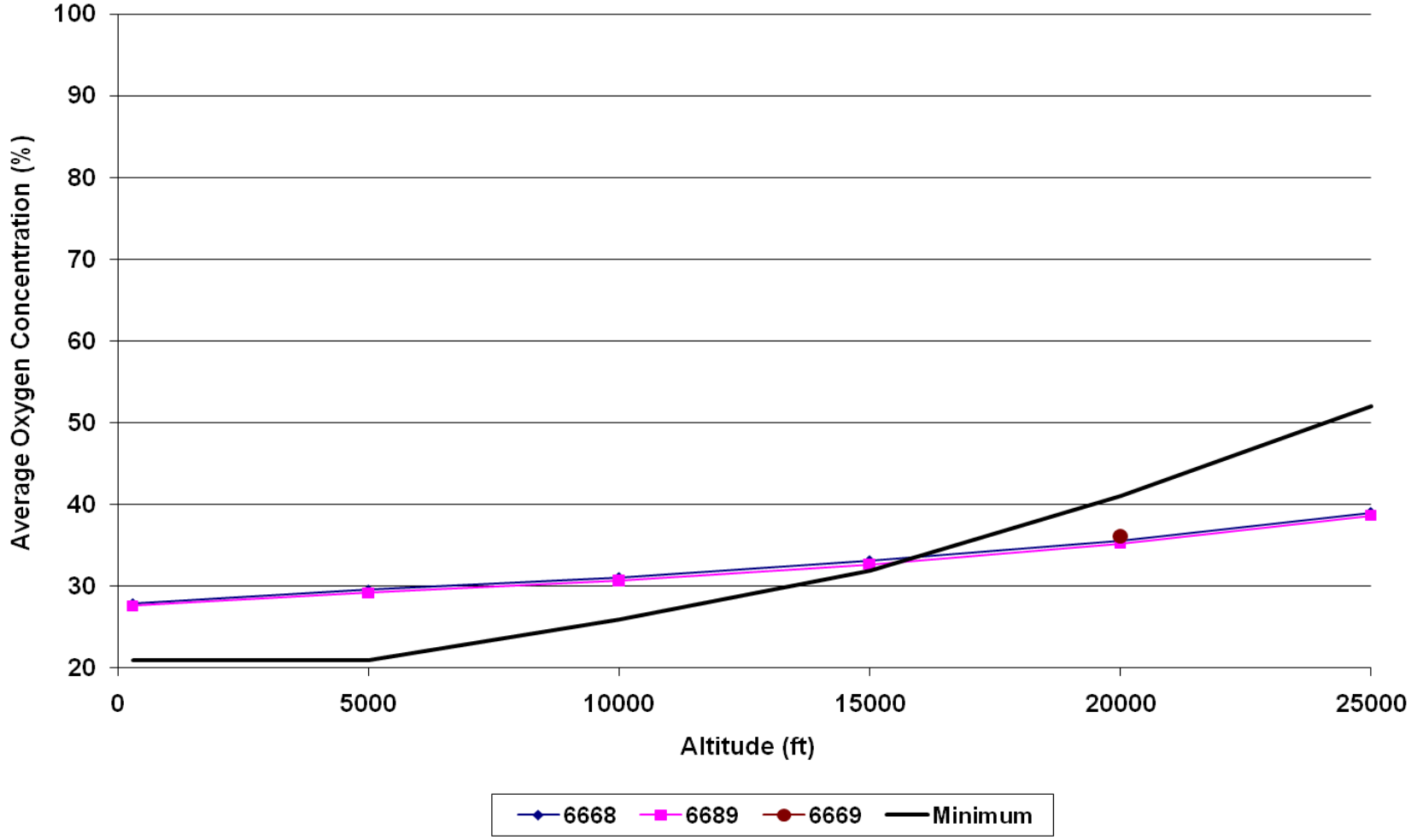


Figure 5: AIROX VIII Average Oxygen Concentration vs. Altitude
VPBS Profile #5 - 60 psig Inlet Pressure

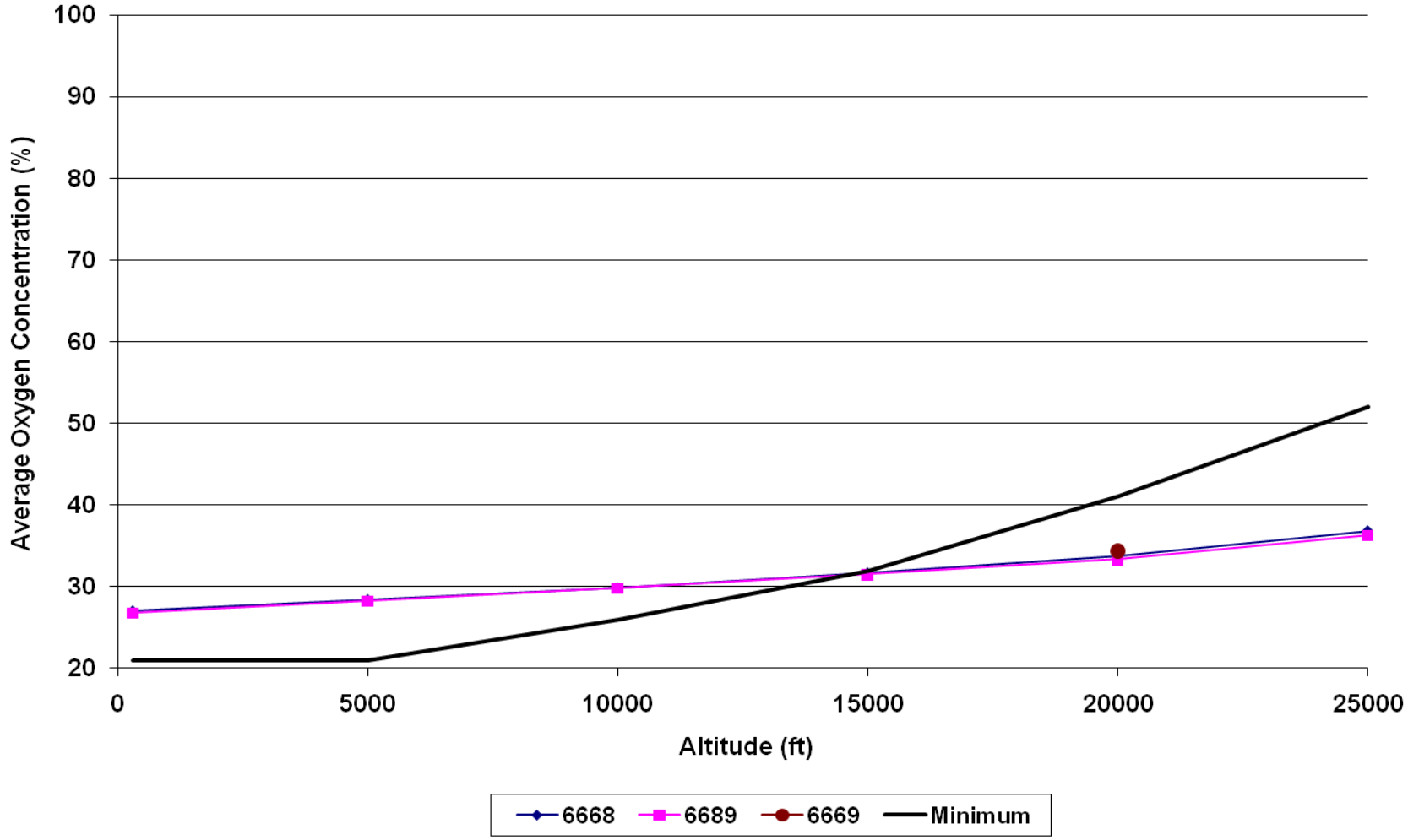
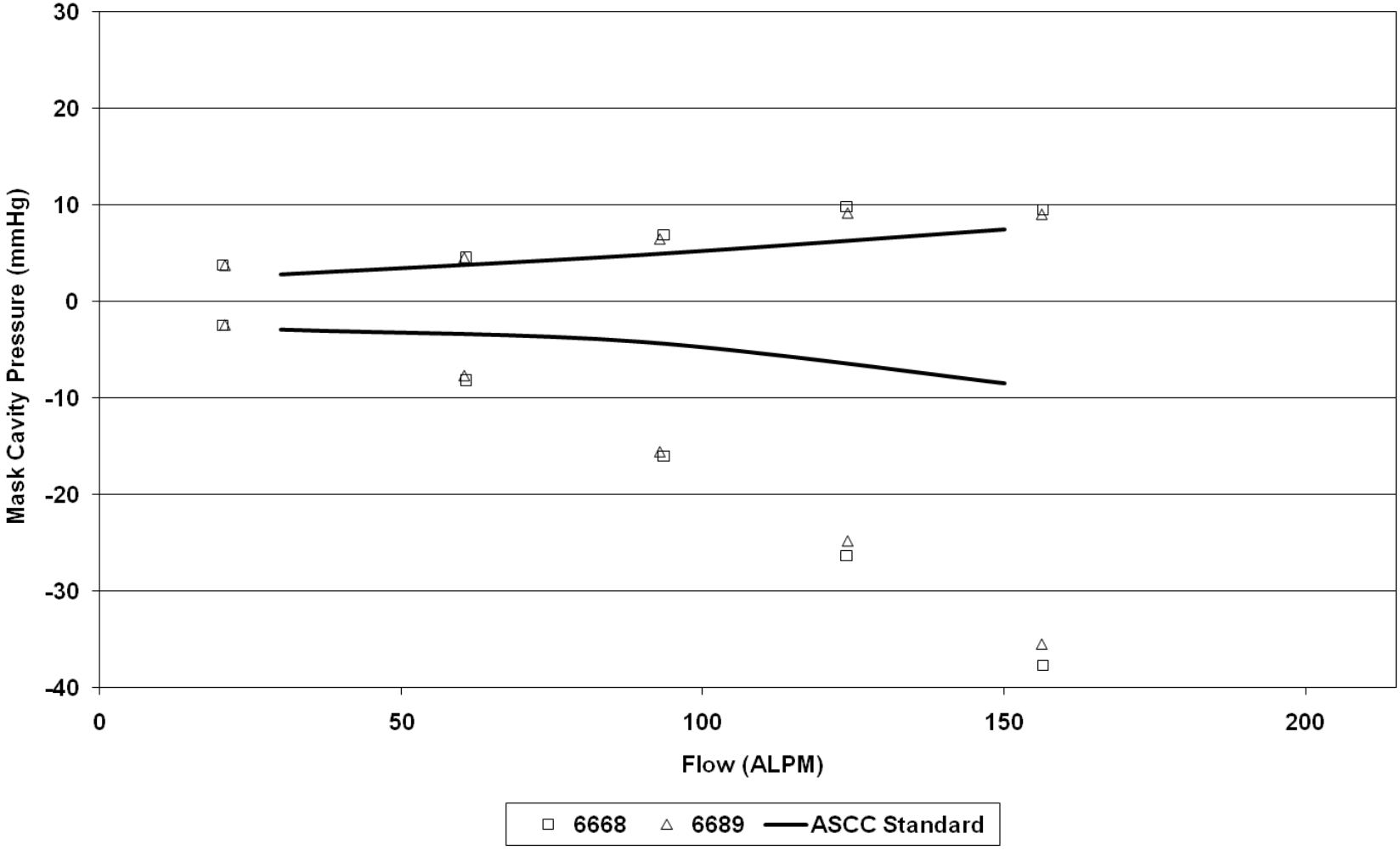
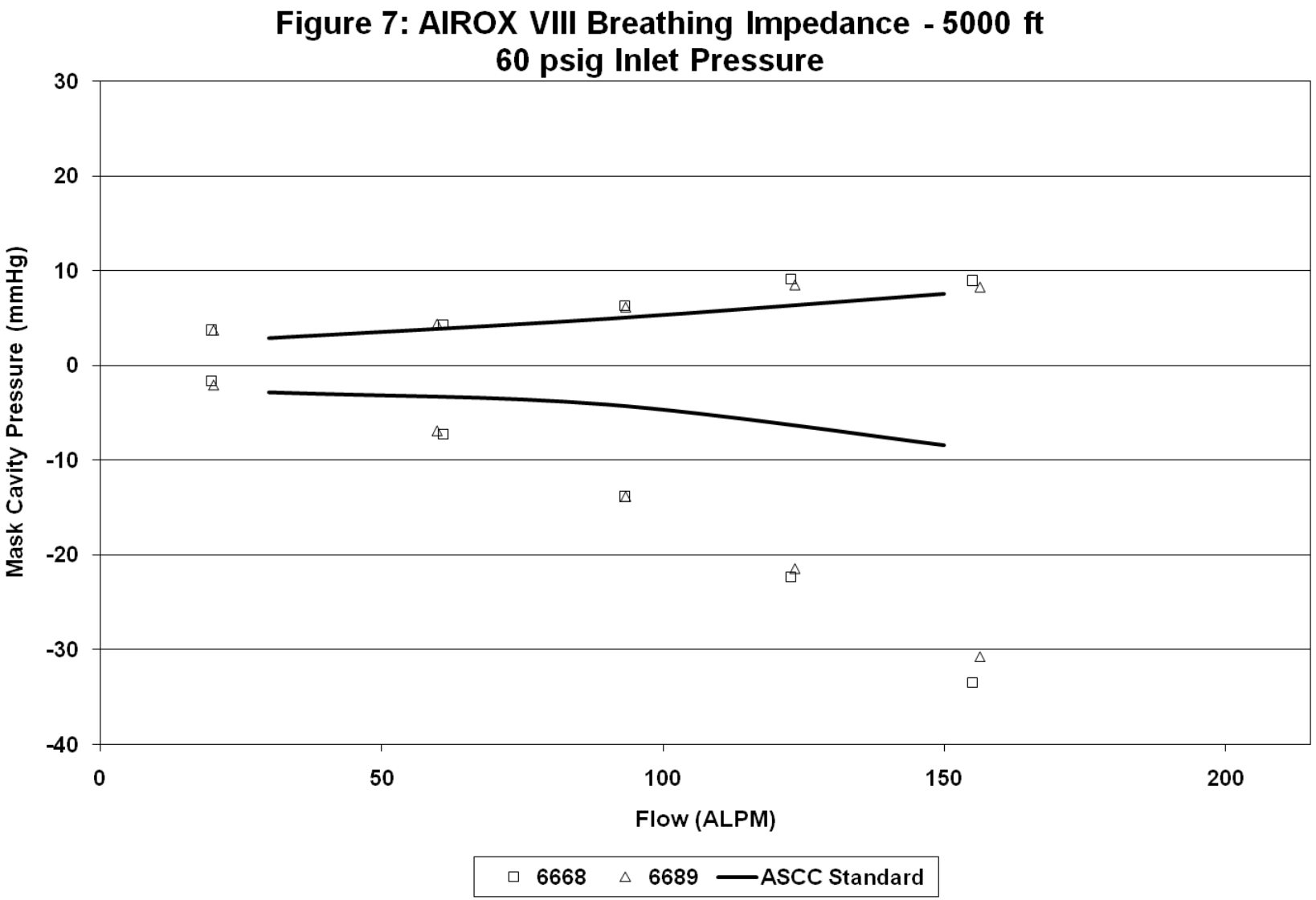


Figure 6: AIROX VIII Breathing Impedance - Ground Level 60 psig Inlet Pressure





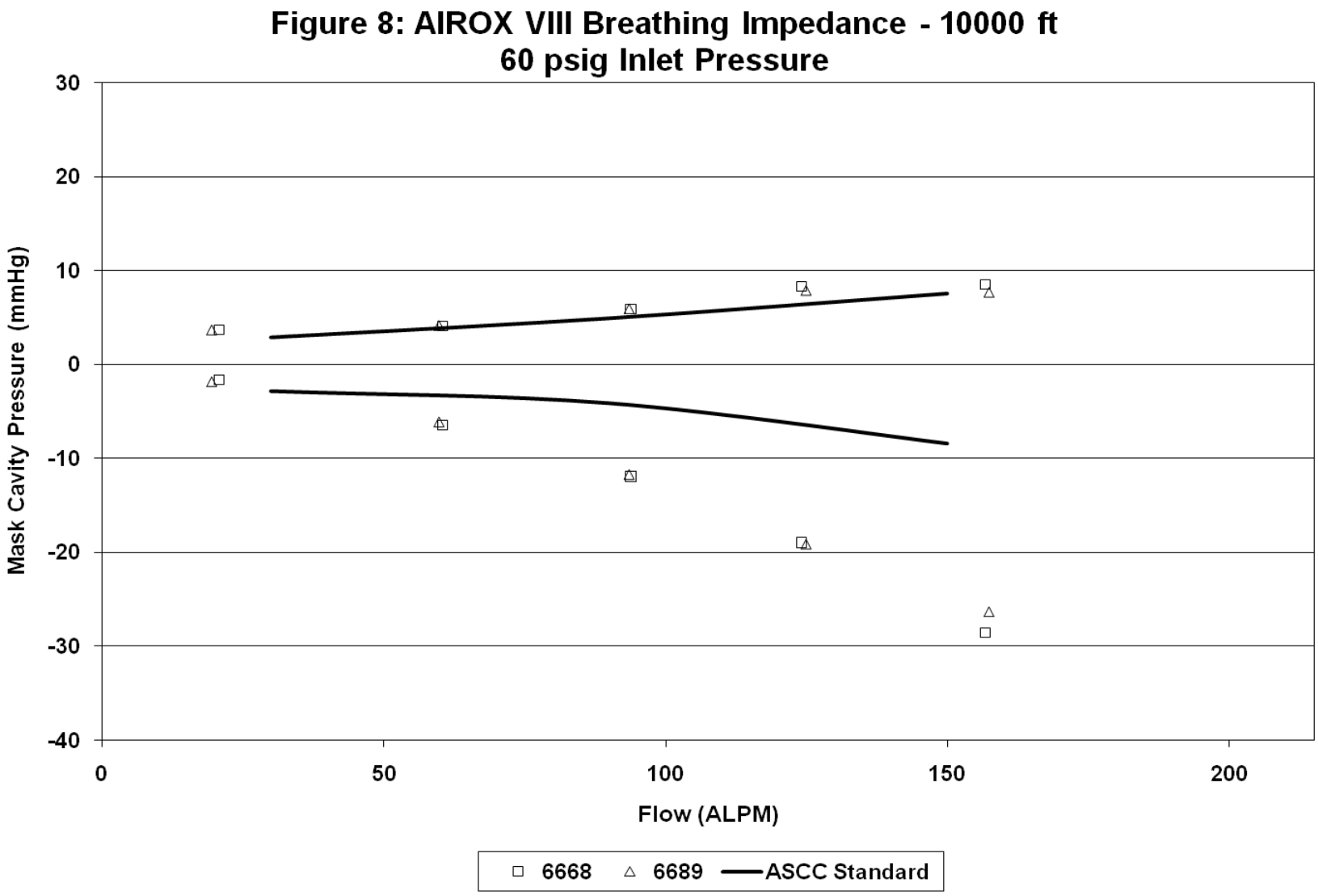
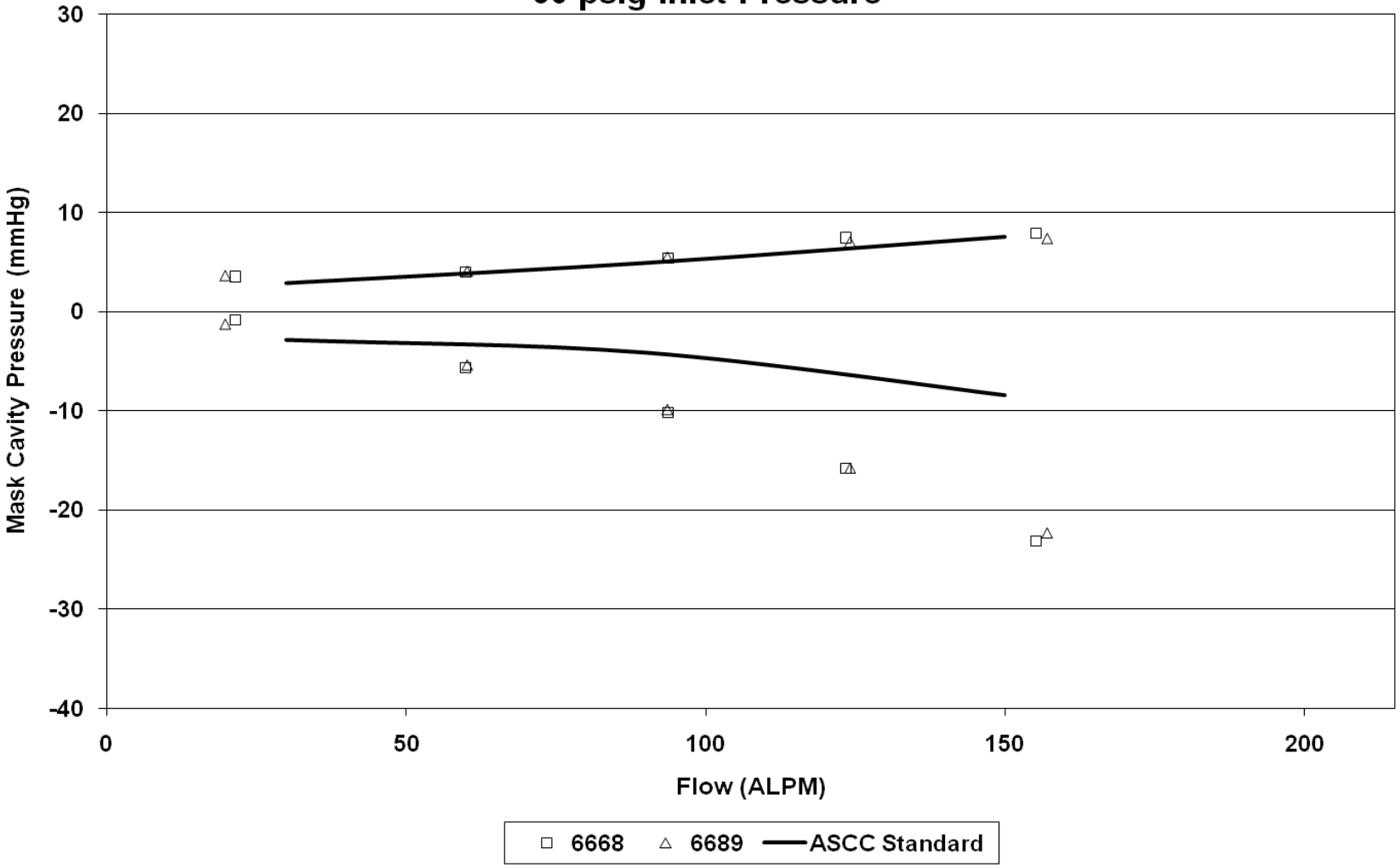
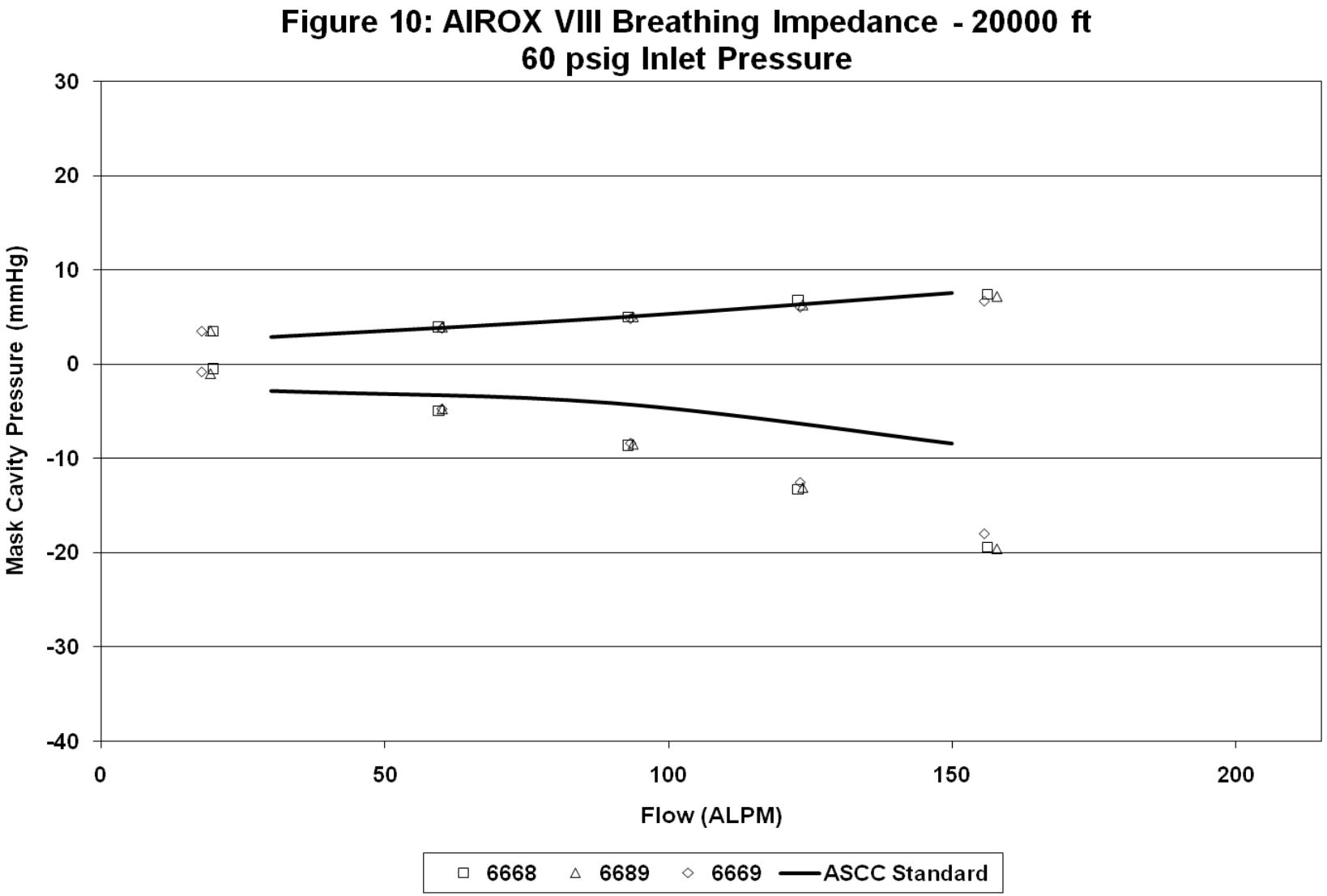
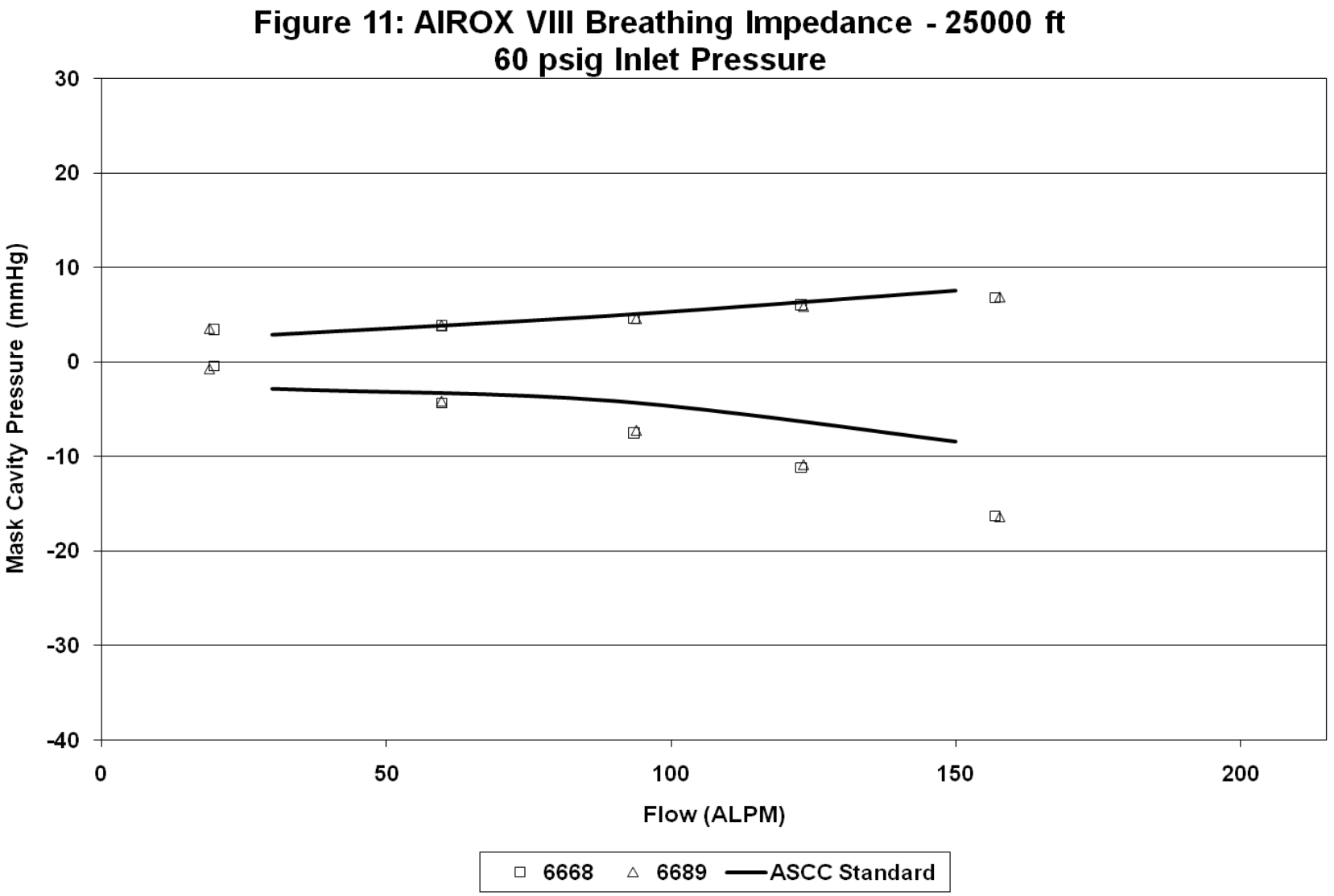


Figure 9: AIROX VIII Breathing Impedance - 15000 ft 60 psig Inlet Pressure







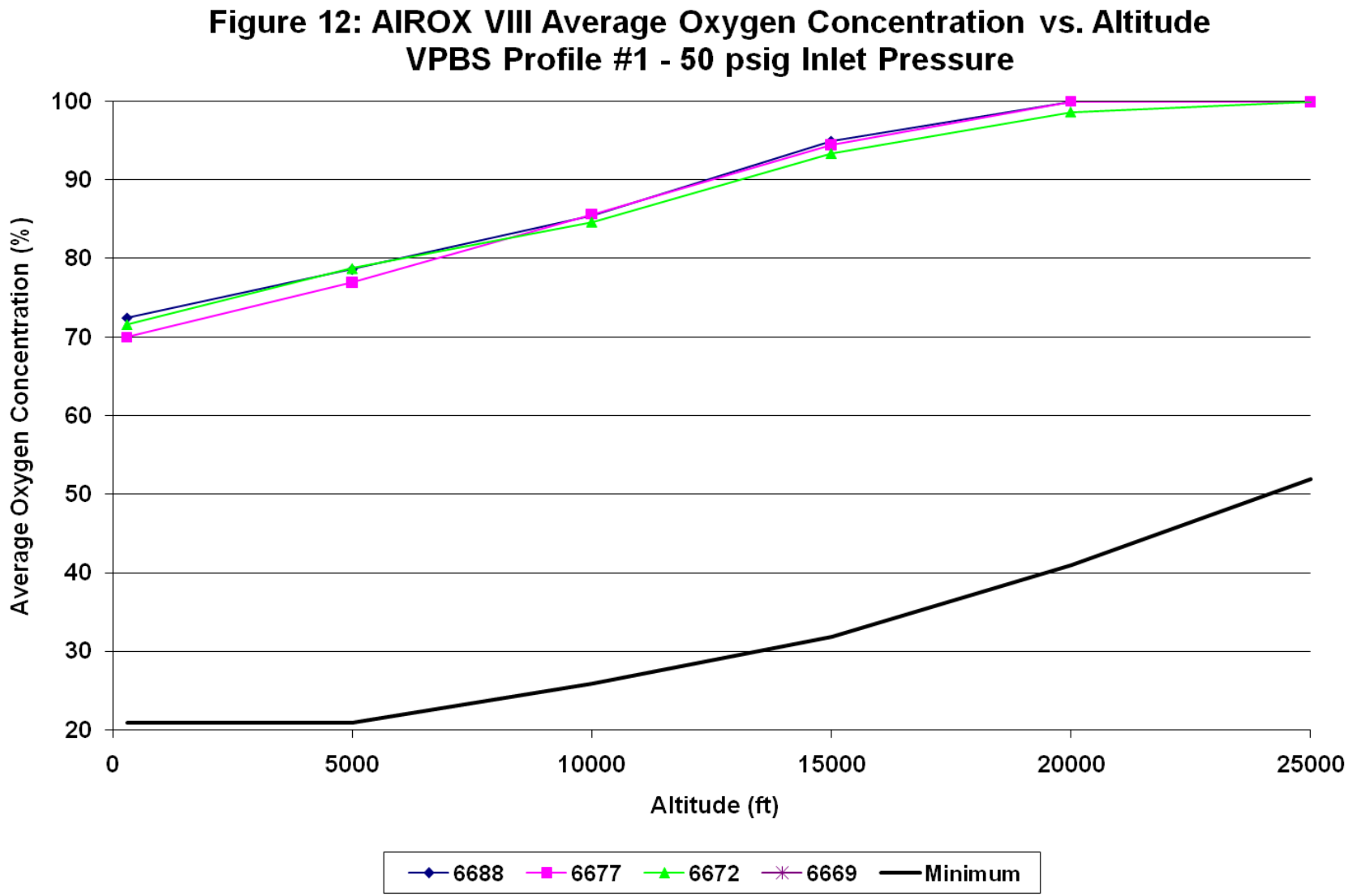


Figure 13: AIROX VIII Average Oxygen Concentration vs. Altitude
VPBS Profile #2 - 50 psig Inlet Pressure

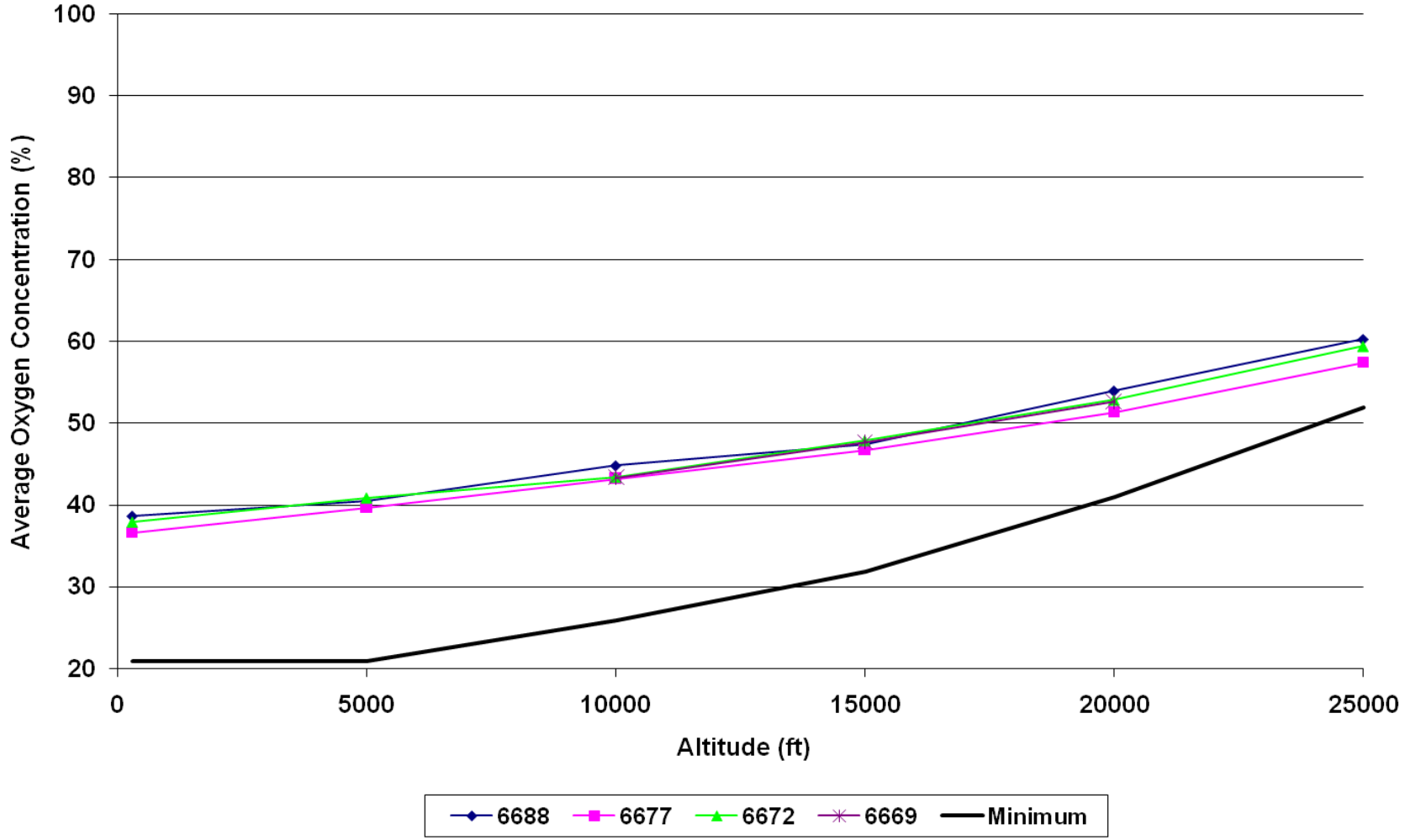


Figure 14: AIROX VIII Average Oxygen Concentration vs. Altitude
VPBS Profile #2 - 50 psig Inlet Pressure

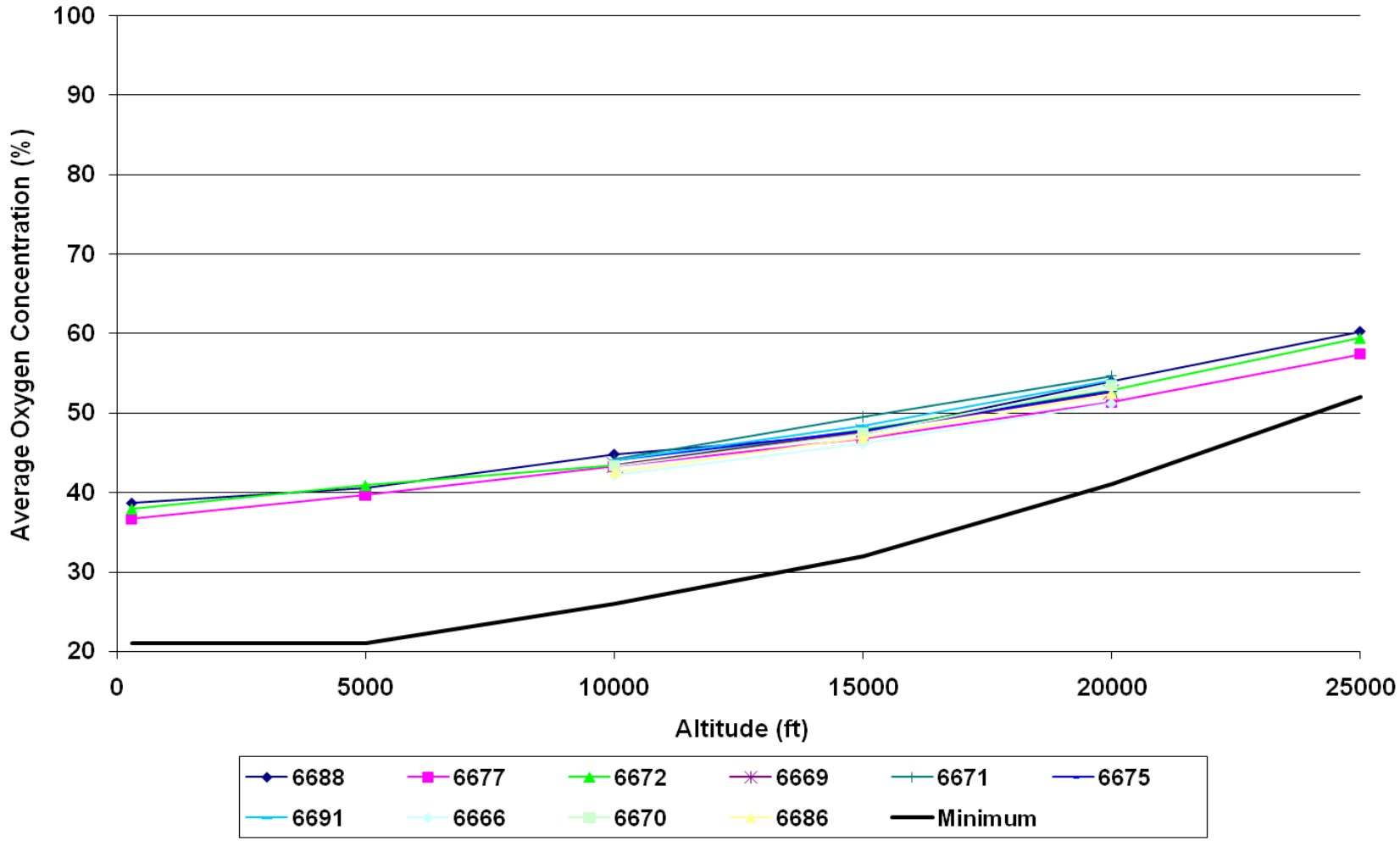


Figure 15: AIROX VIII Average Oxygen Concentration vs. Altitude
VPBS Profile #3 - 50 psig Inlet Pressure

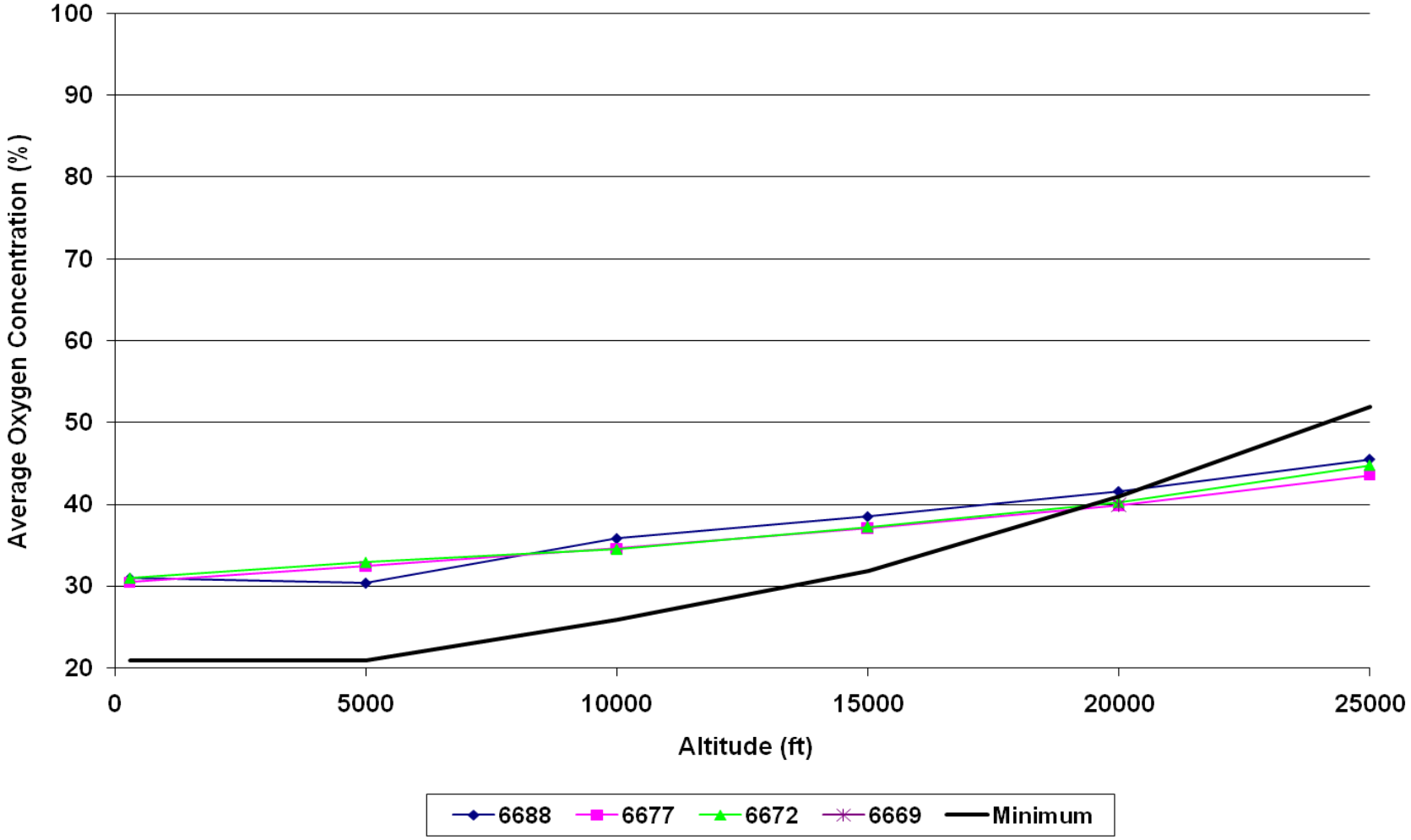
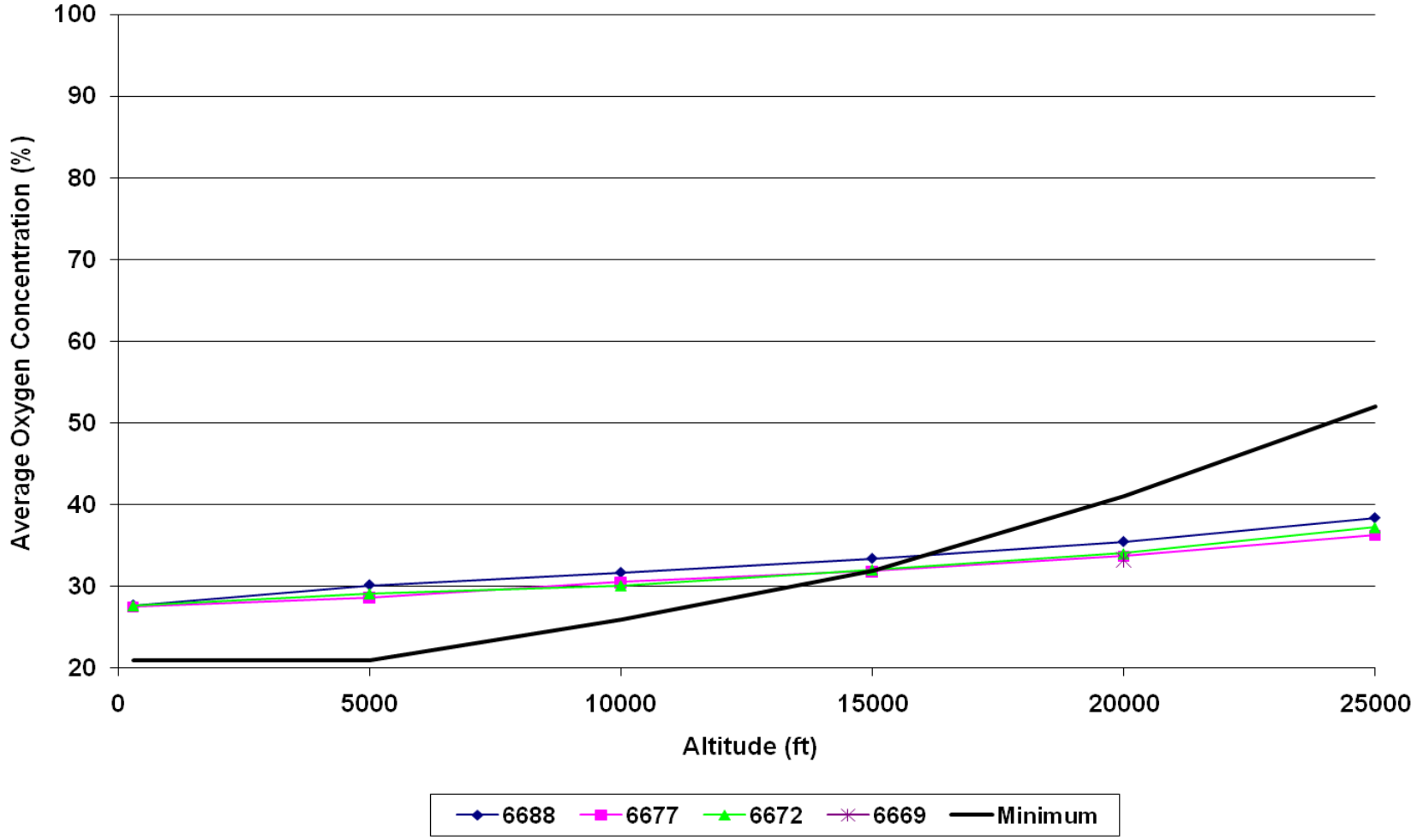
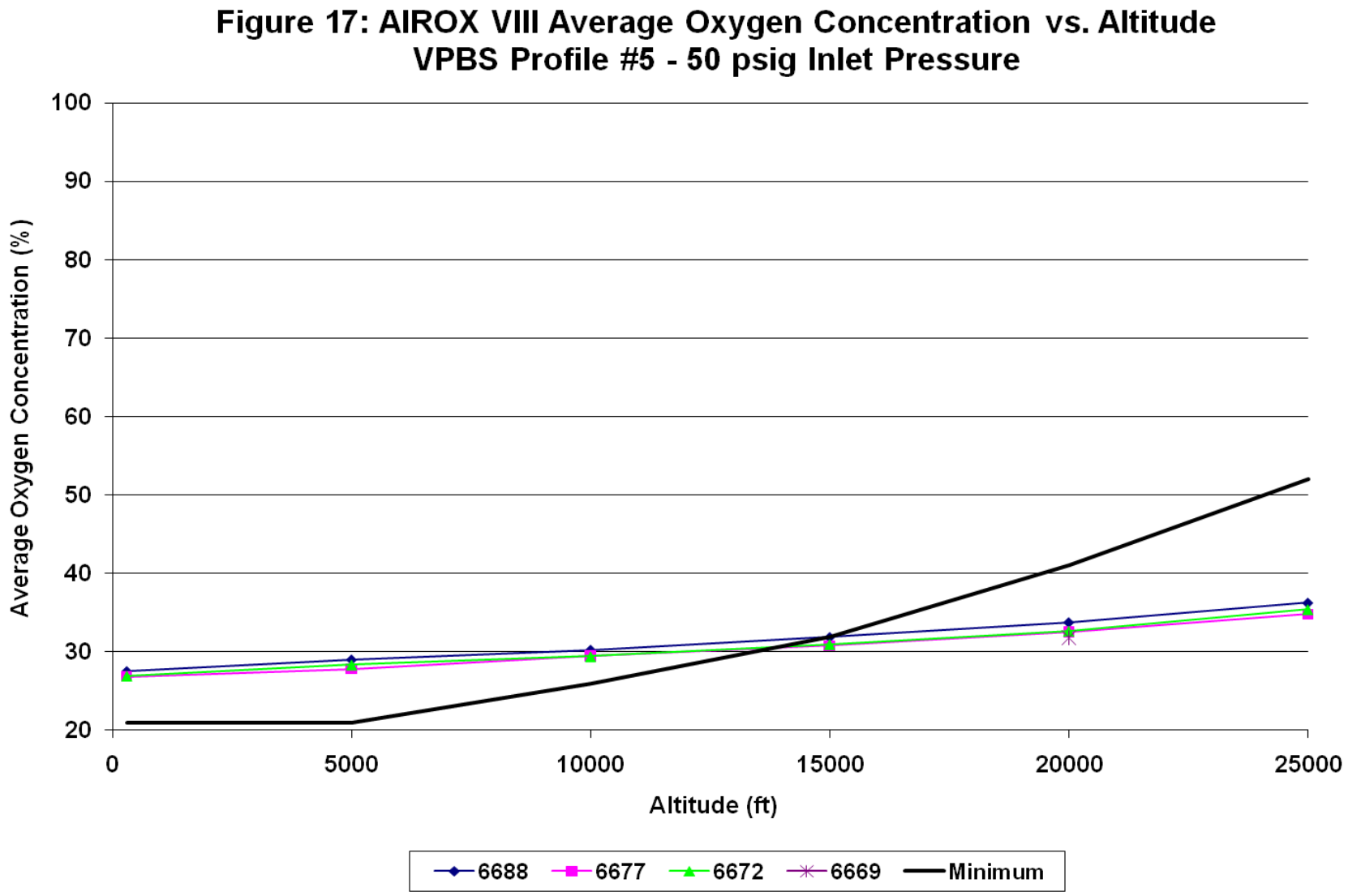
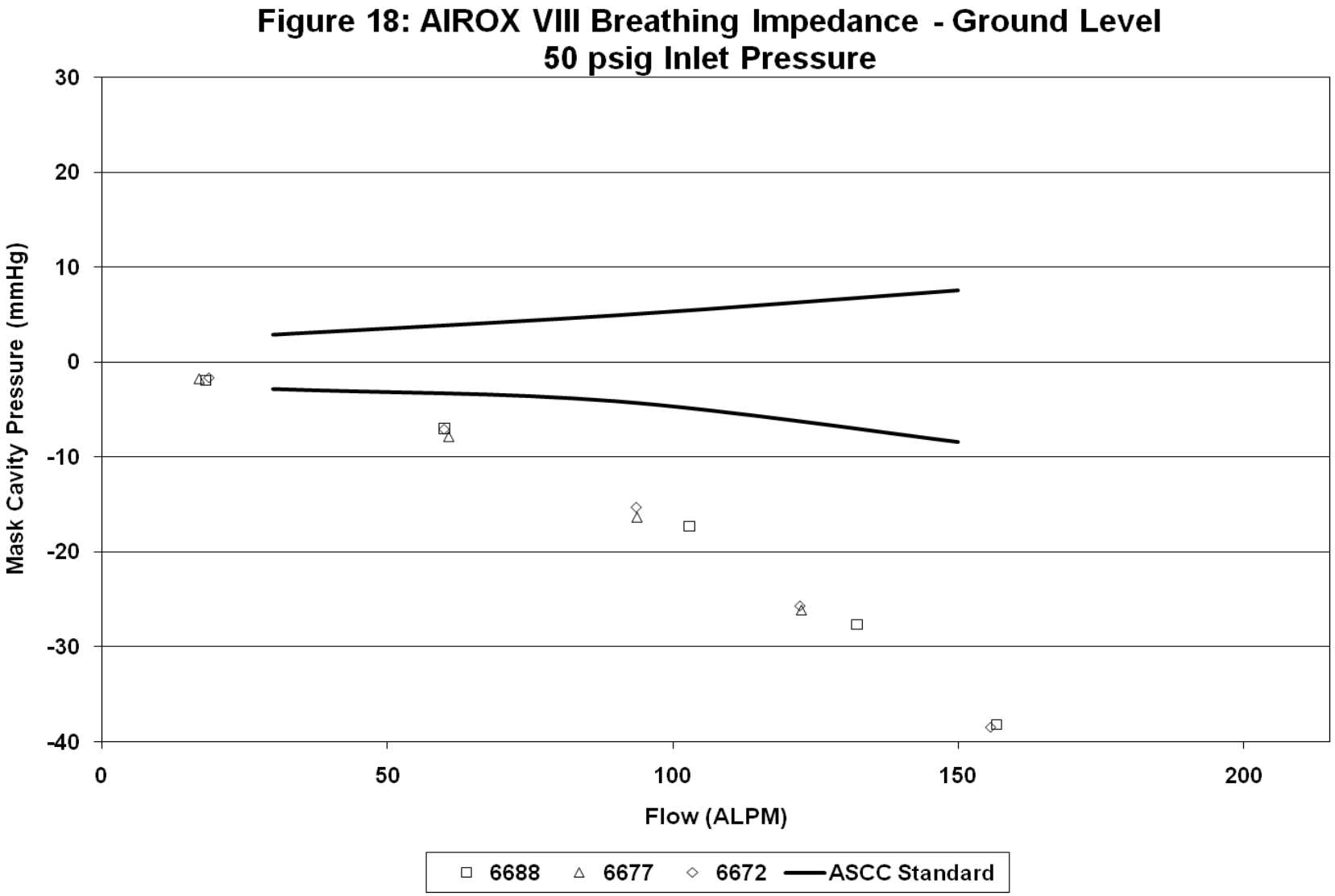


Figure 16: AIROX VIII Average Oxygen Concentration vs. Altitude
VPBS Profile #4 - 50 psig Inlet Pressure







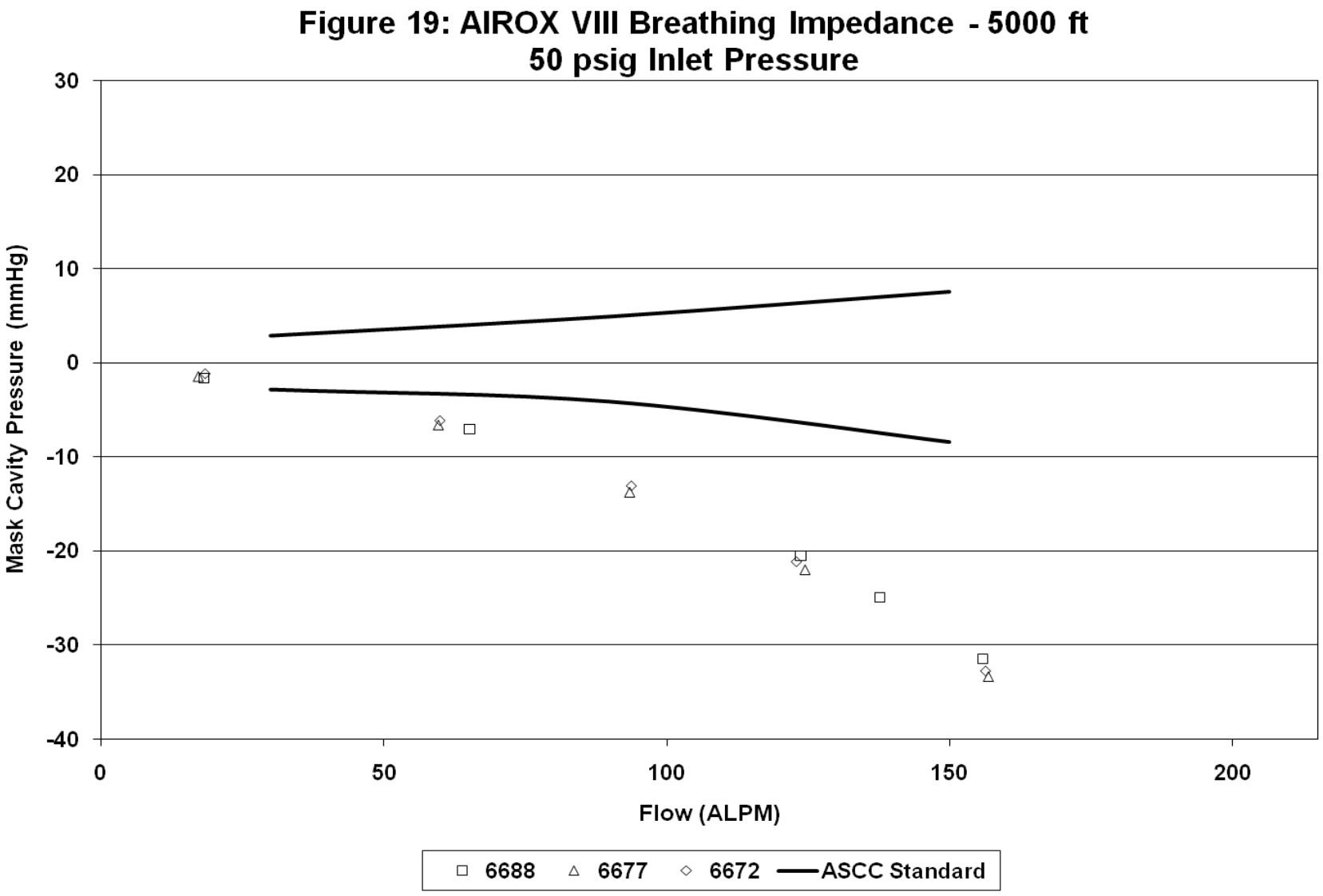


Figure 20: AIROX VIII Breathing Impedance - 10000 ft 50 psig Inlet Pressure

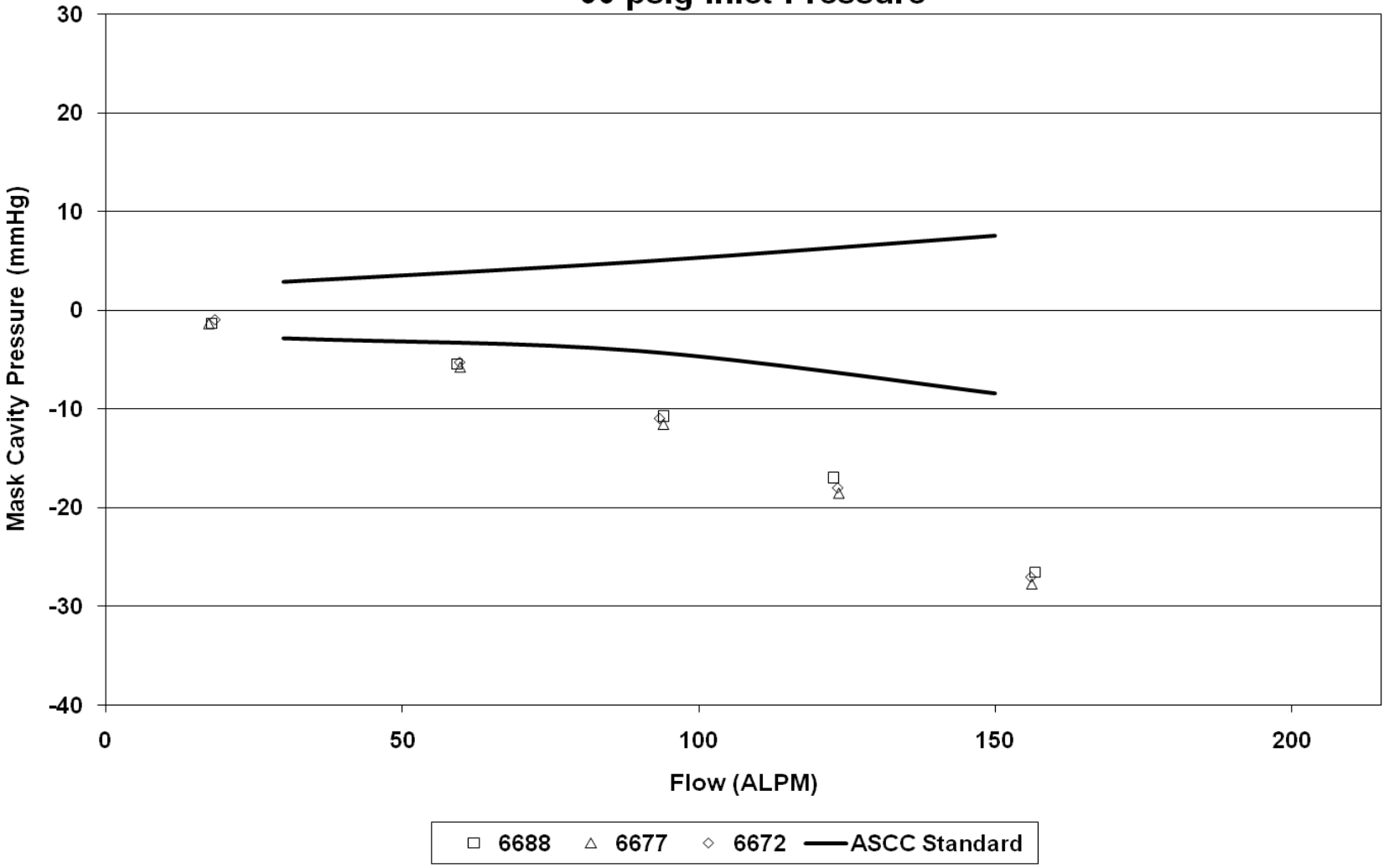
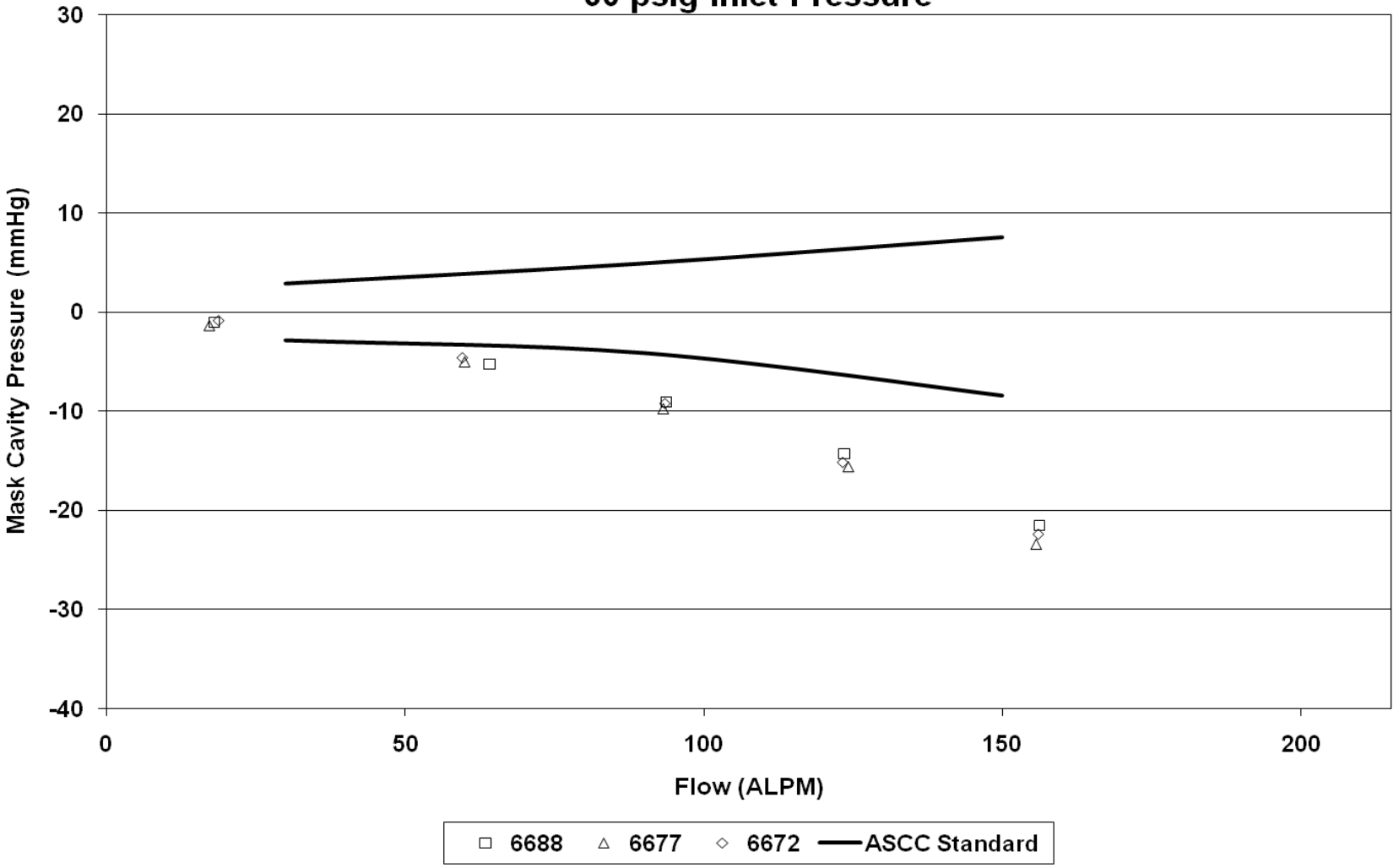
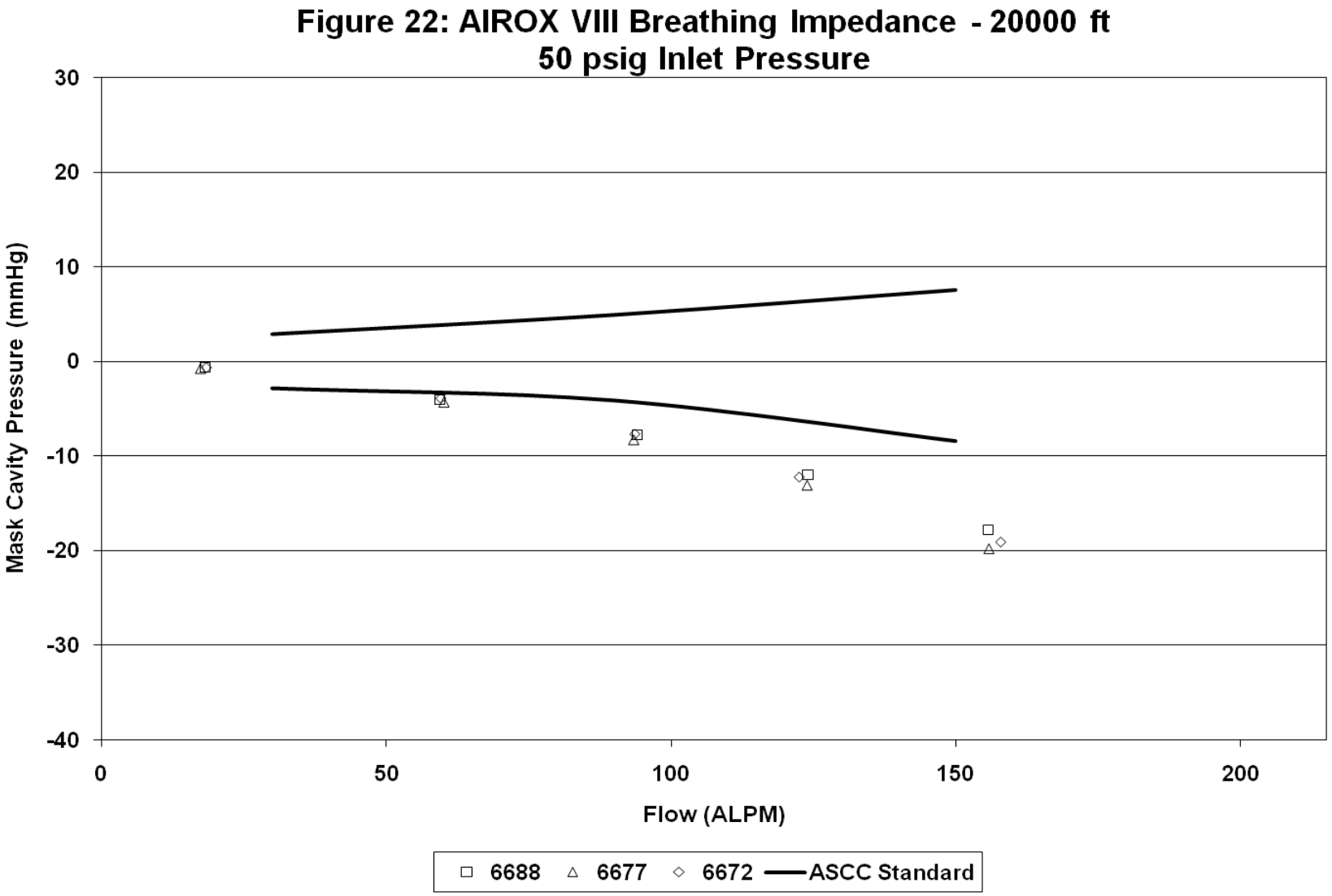


Figure 21: AIROX VIII Breathing Impedance - 15000 ft 50 psig Inlet Pressure





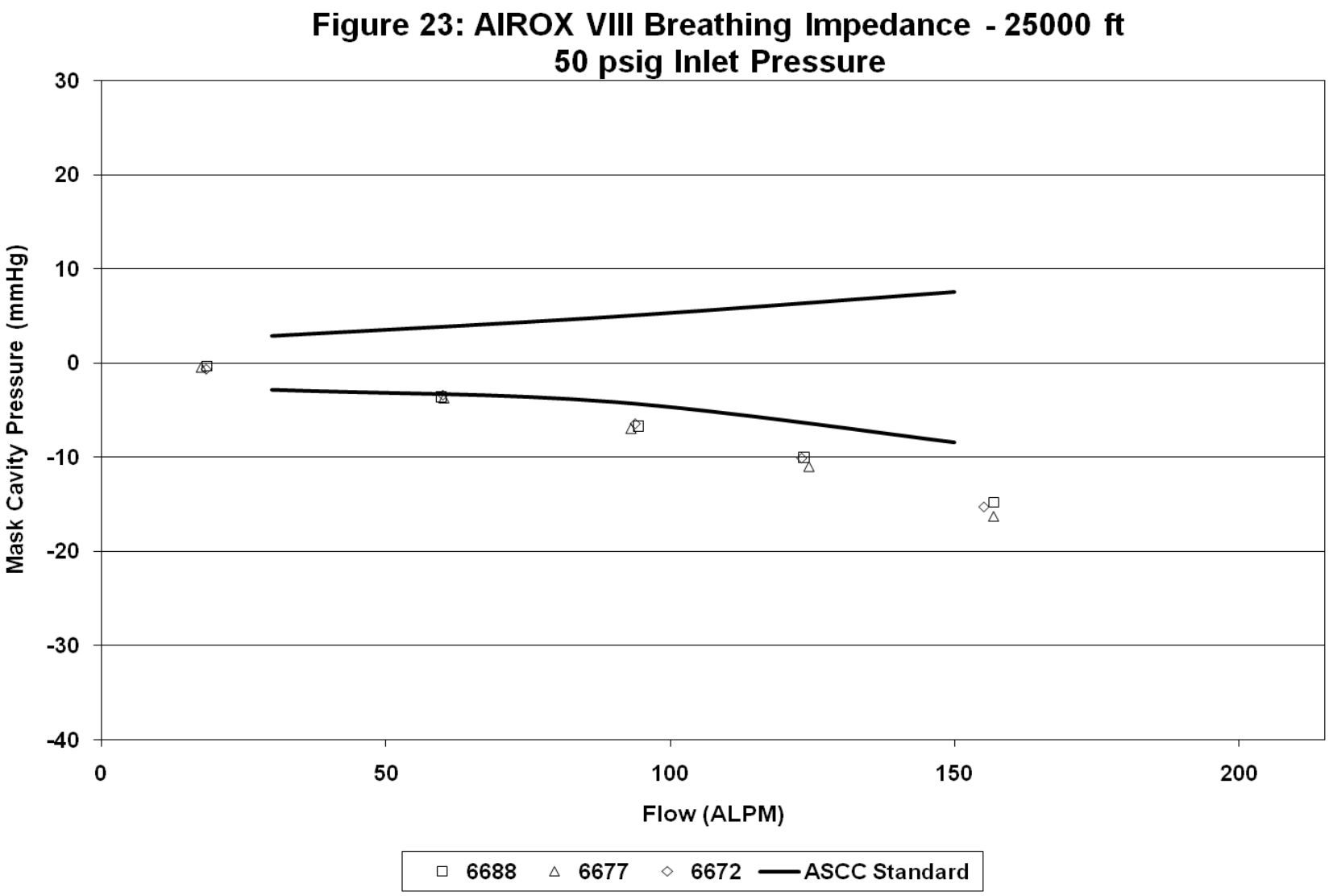


Figure 24: POS - AIROX VIII Only
Subject #1 Average Oxygen Concentration
Mode #1 - Passenger Configuration - 10 Breathers

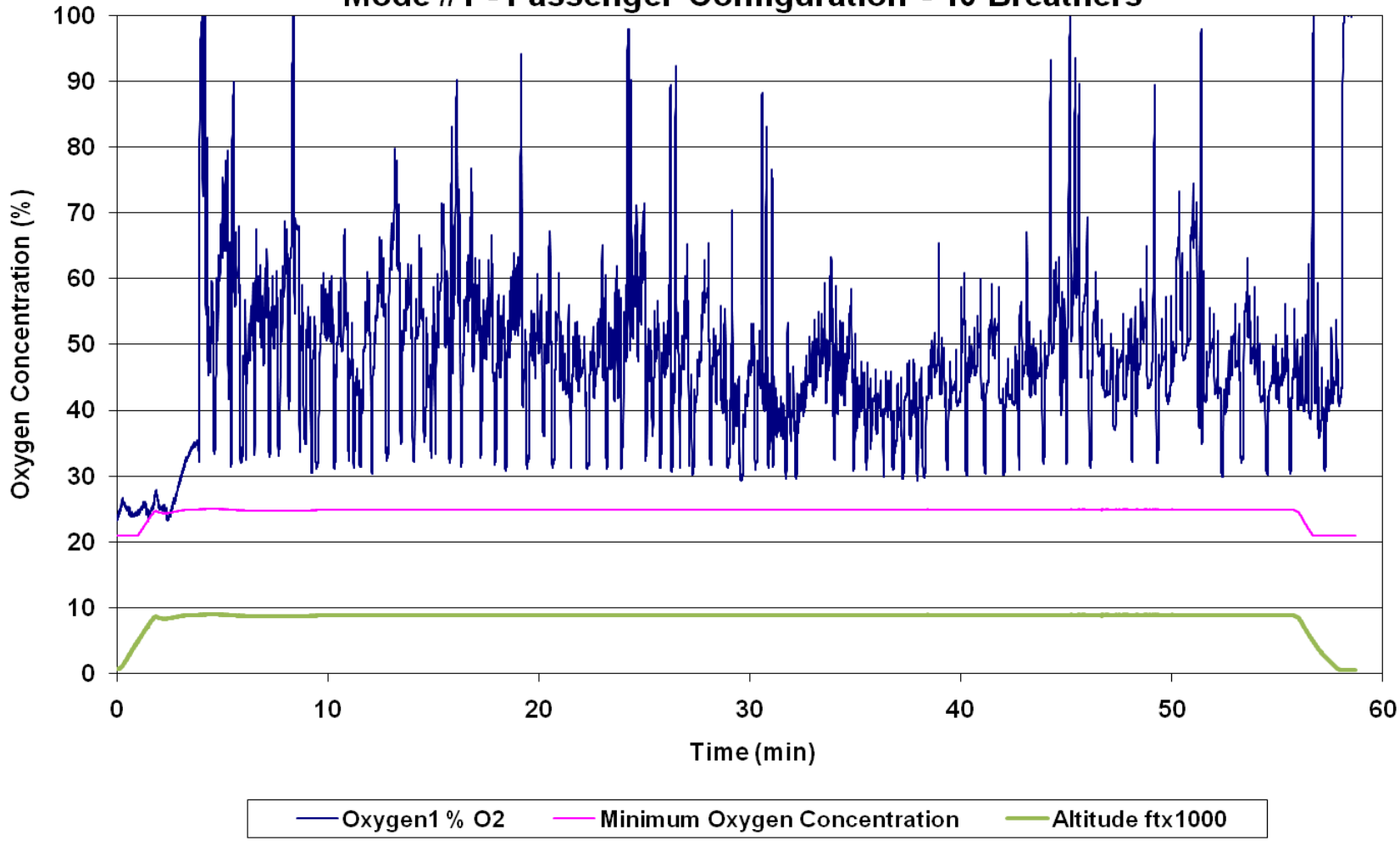


Figure 25: POS - AIROX VIII Only
Subject #1 Regulator Outlet Flow
Mode #1 - Passenger Configuration - 10 Breathers

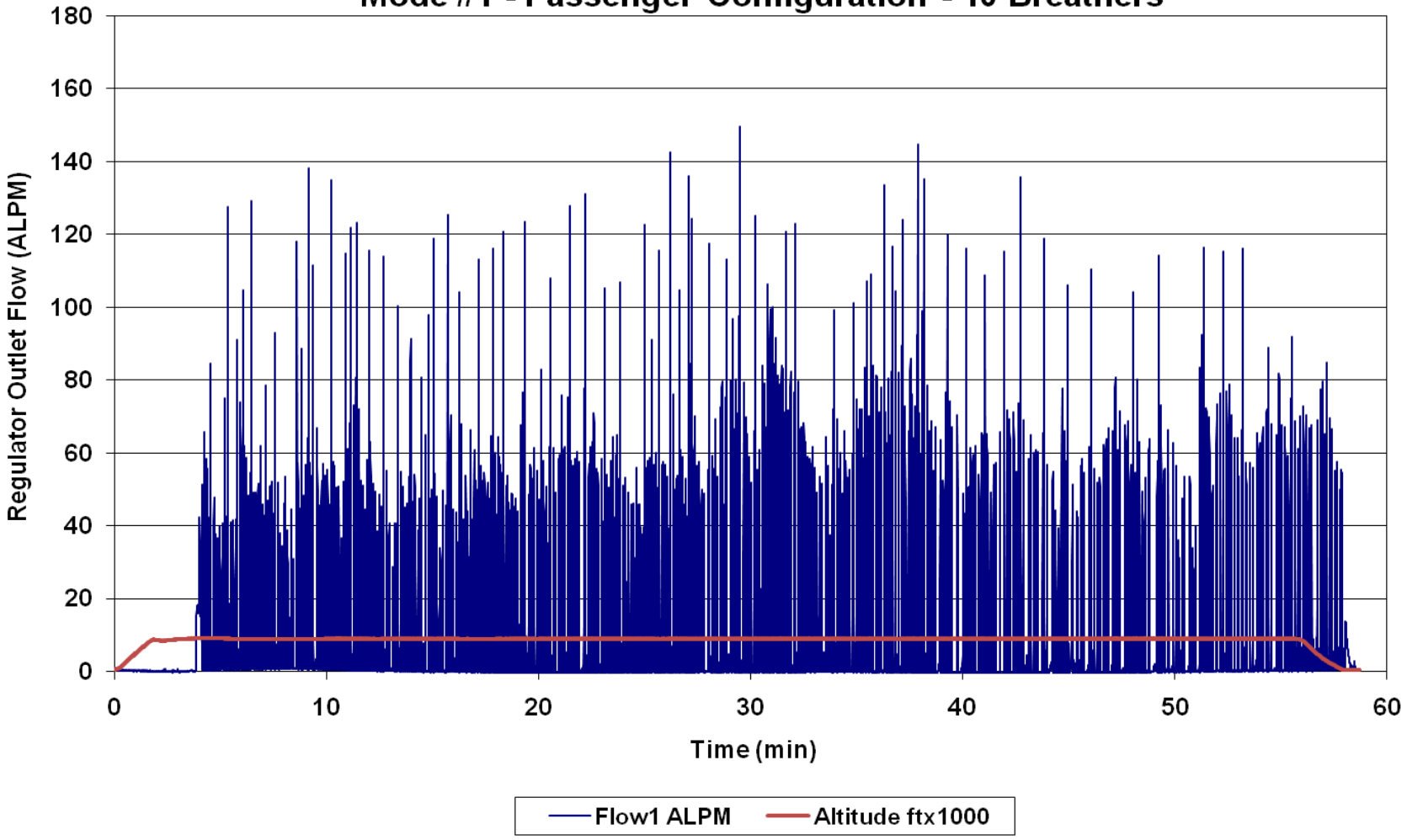


Figure 26: POS - AIROX VIII Only
POS Temperatures and Regulator Inlet Pressure
Mode #1 - Passenger Configuration - 10 Breathers

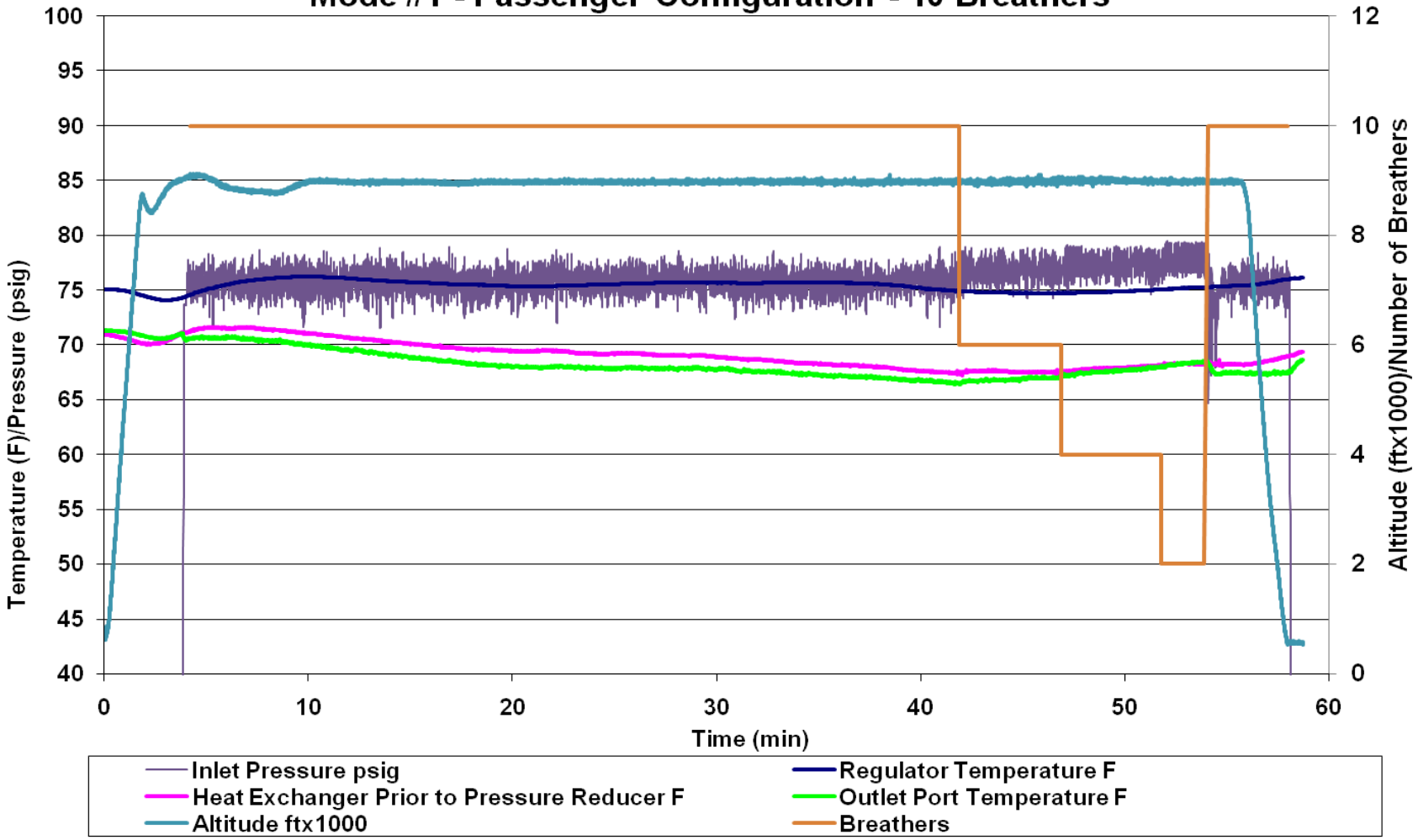


Figure 27: POS - AIROX VIII Only
Subject #6 Average Oxygen Concentration
Mode #1 - Passenger Configuration - 10 Breathers

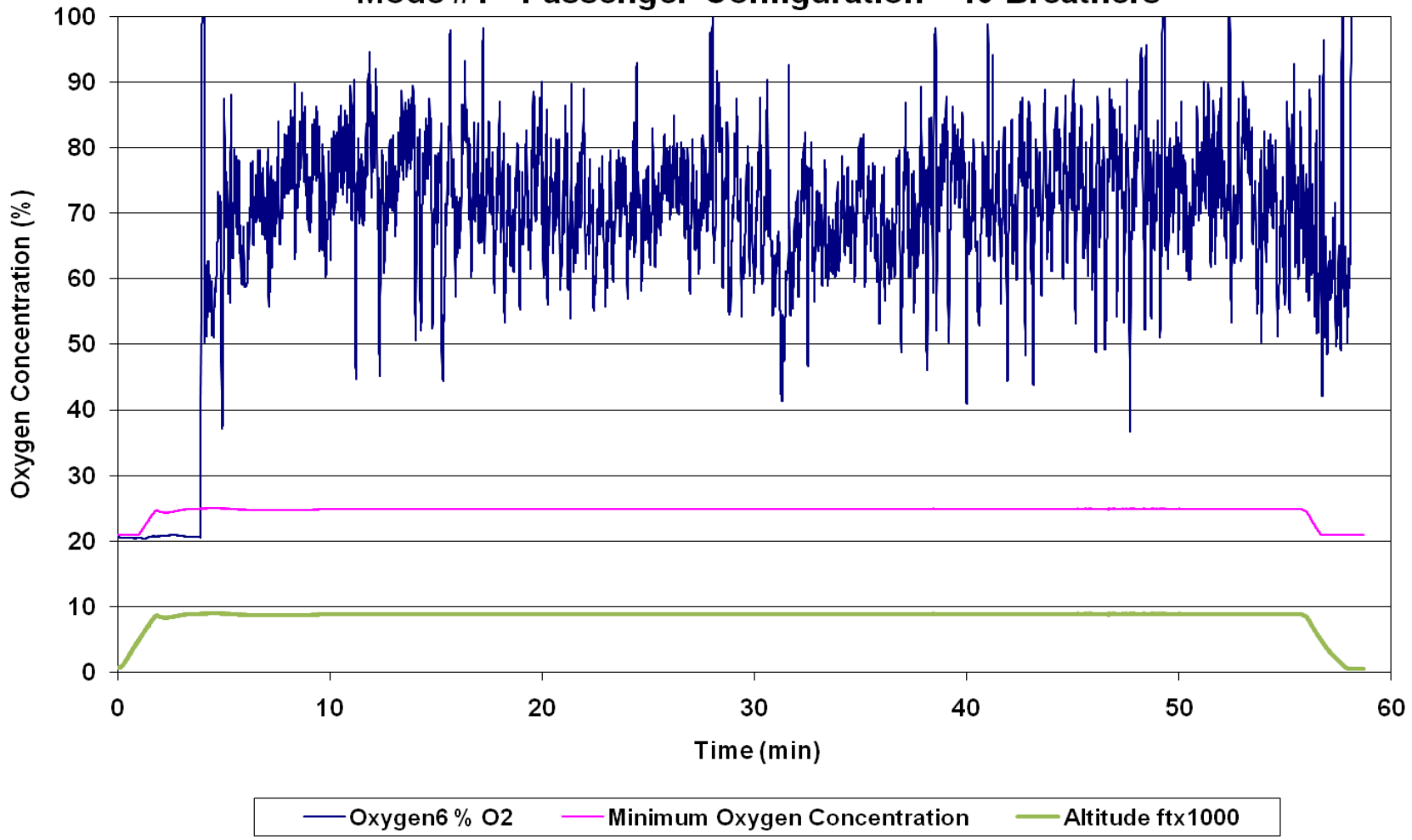
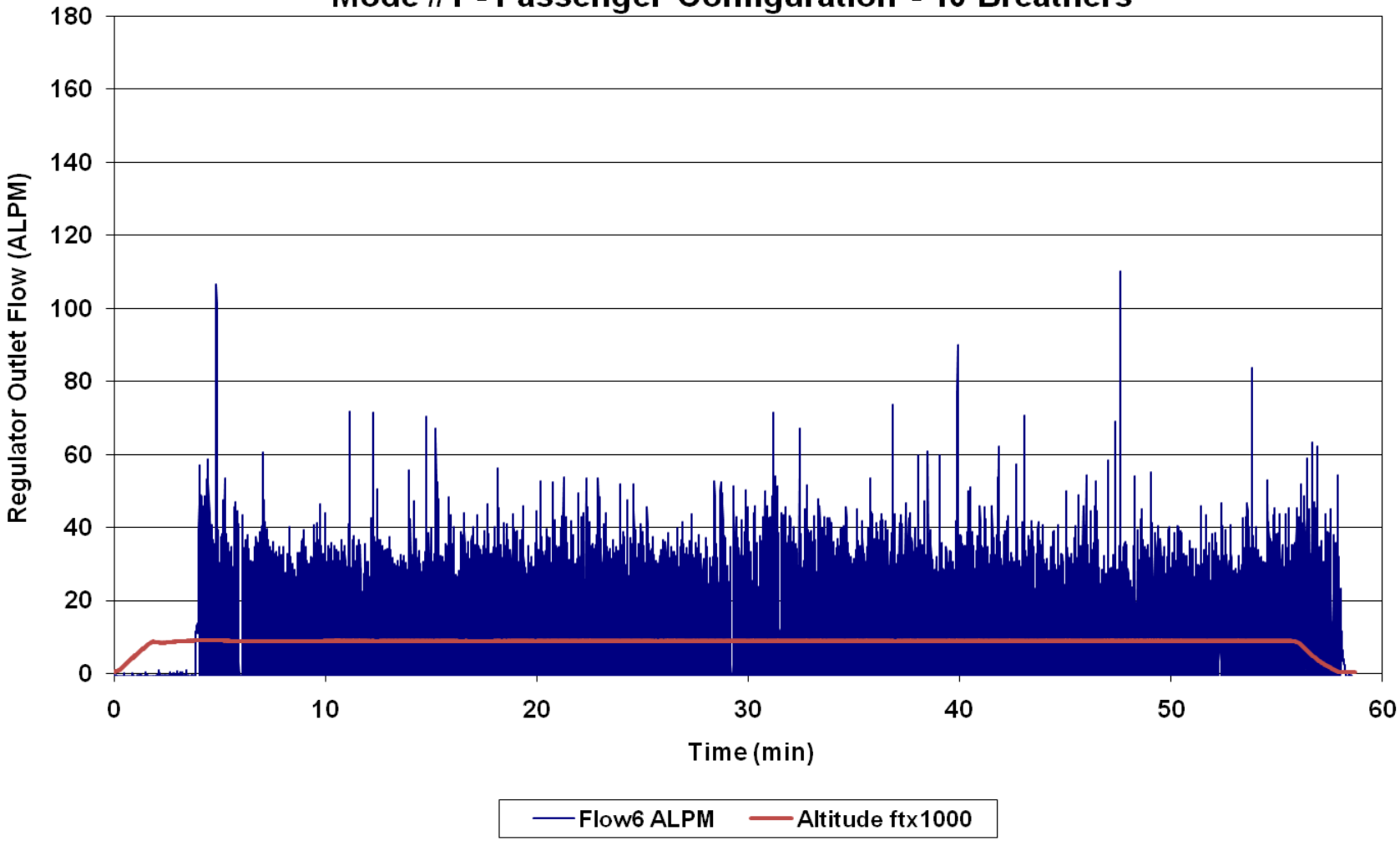


Figure 28: POS - AIROX VIII Only
Subject #6 Regulator Outlet Flow
Mode #1 - Passenger Configuration - 10 Breathers



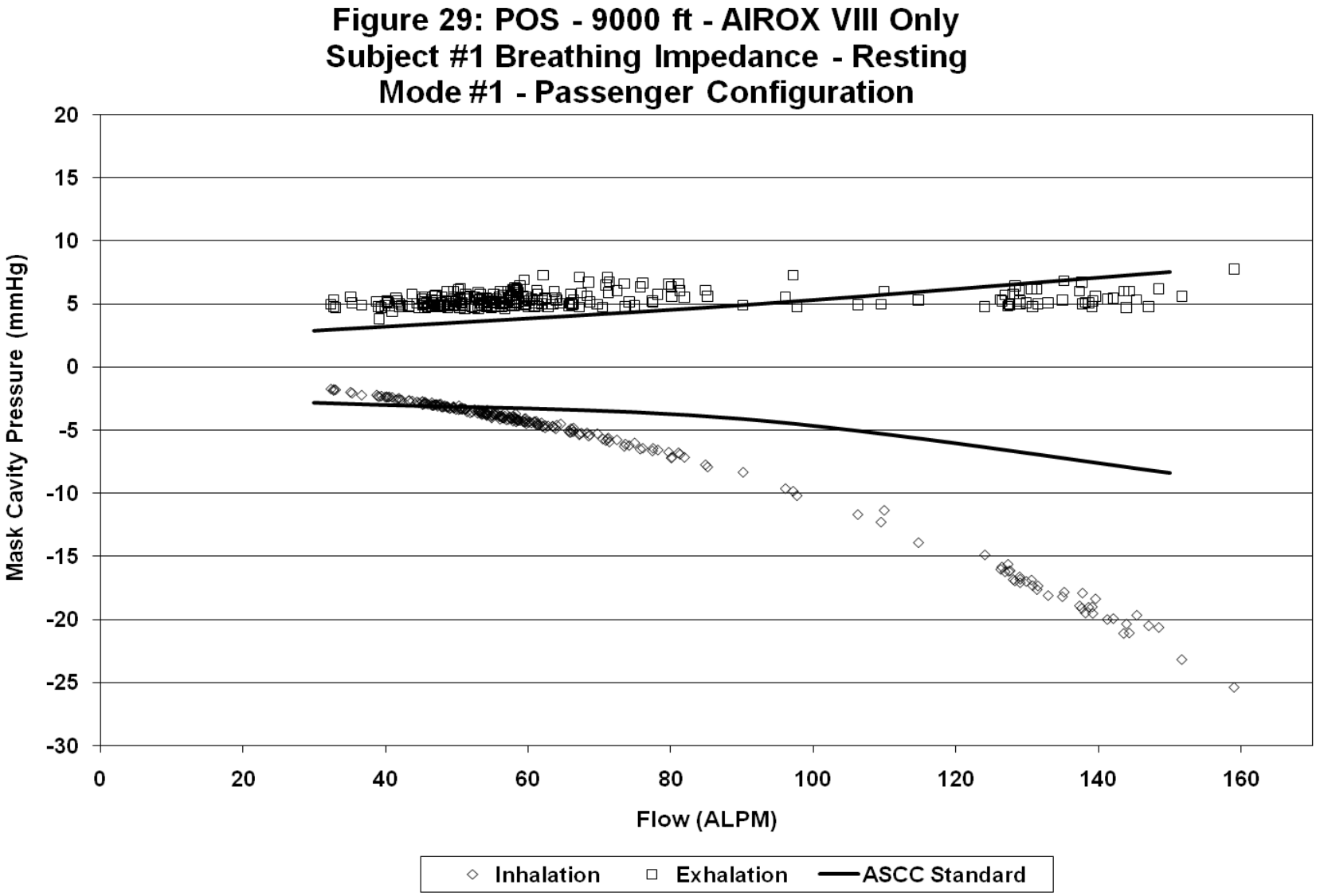


Figure 30: POS - 9000 ft - AIROX VIII Only
Subject #1 Breathing Impedance - Standing
Mode #1 - Passenger Configuration

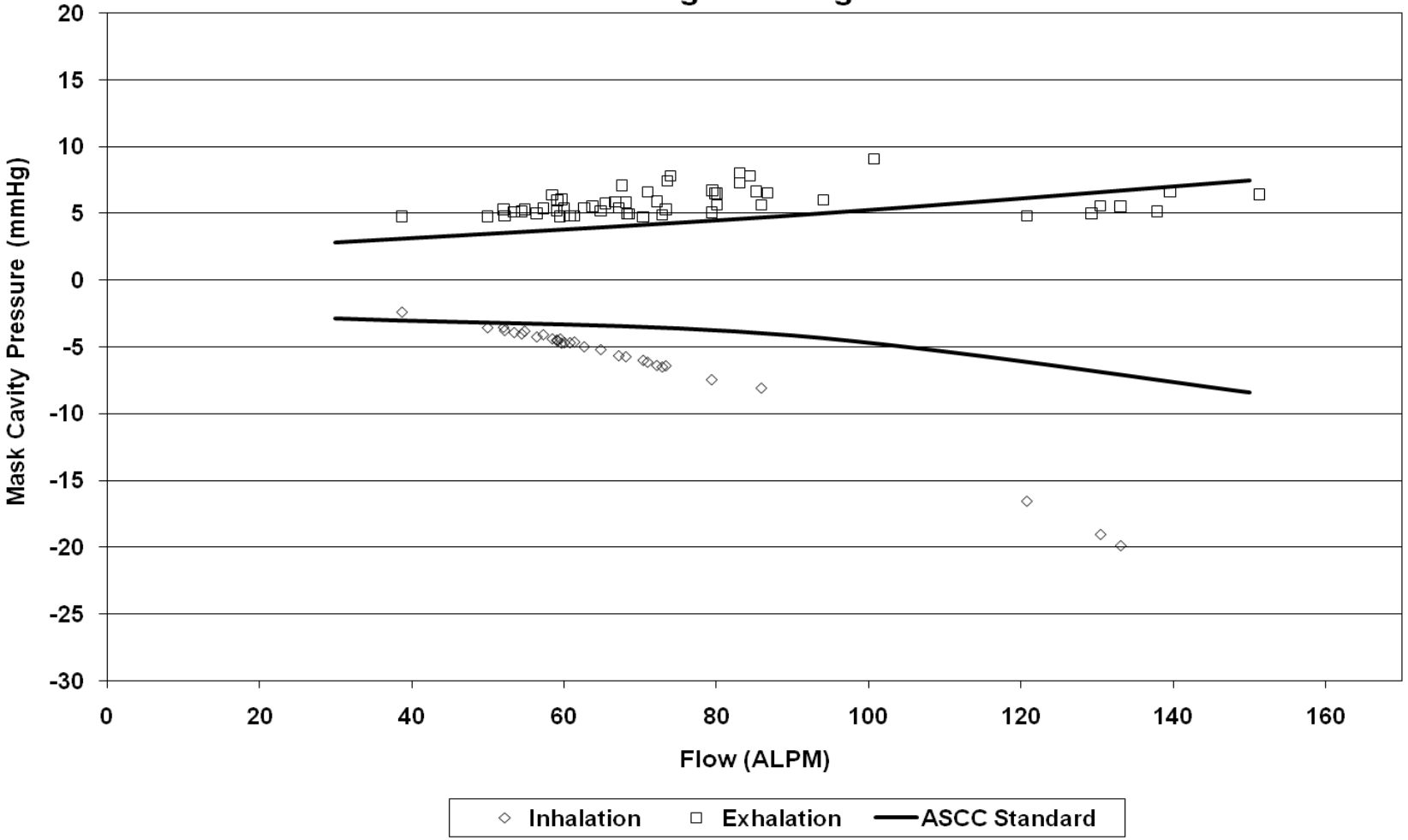


Figure 31: POS - 9000 ft - AIROX VIII Only
Subject #6 Breathing Impedance - Resting
Mode #1 - Passenger Configuration

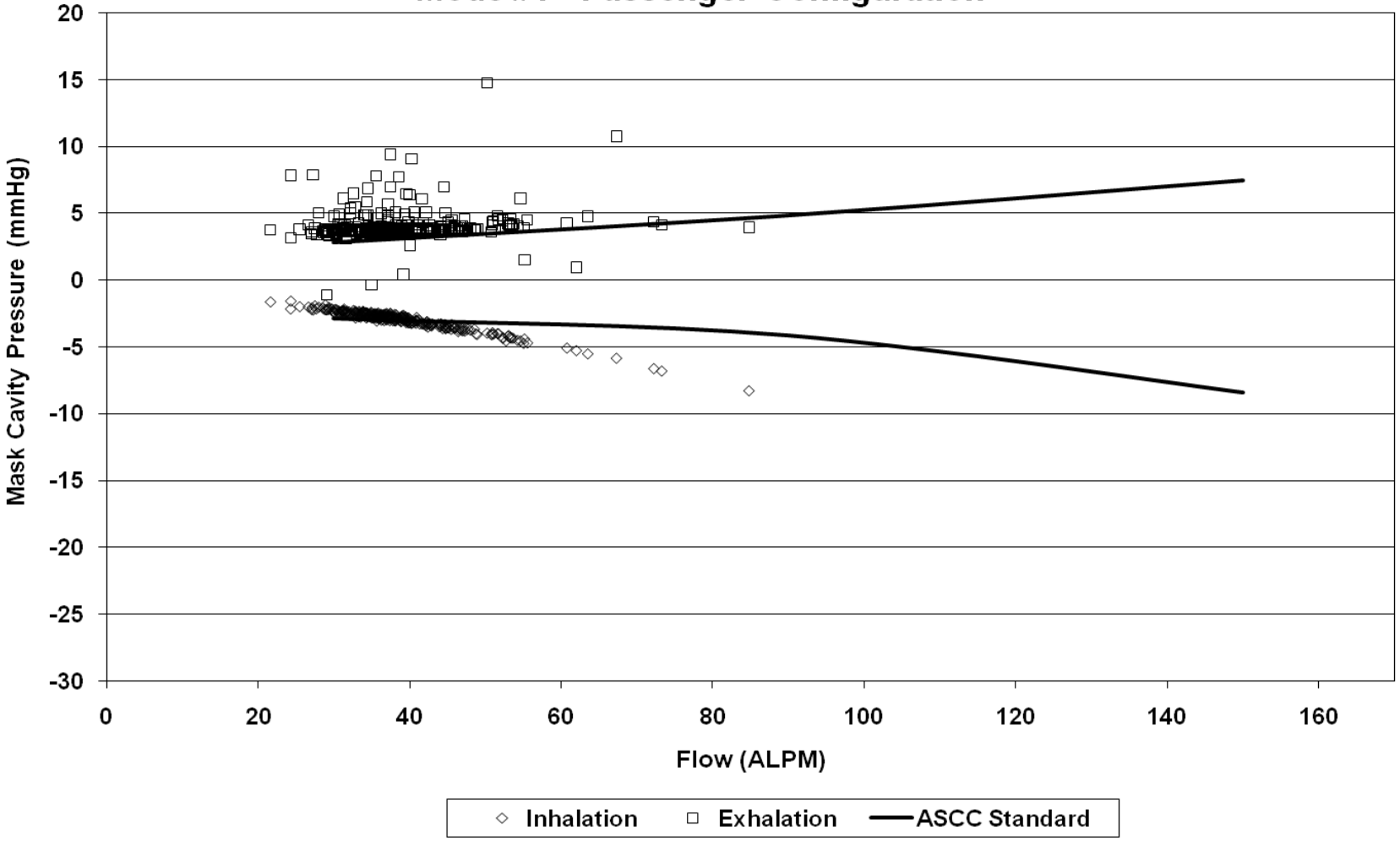


Figure 32: POS - 9000 ft - AIROX VIII Only
Subject #6 Breathing Impedance - Standing
Mode #1 - Passenger Configuration

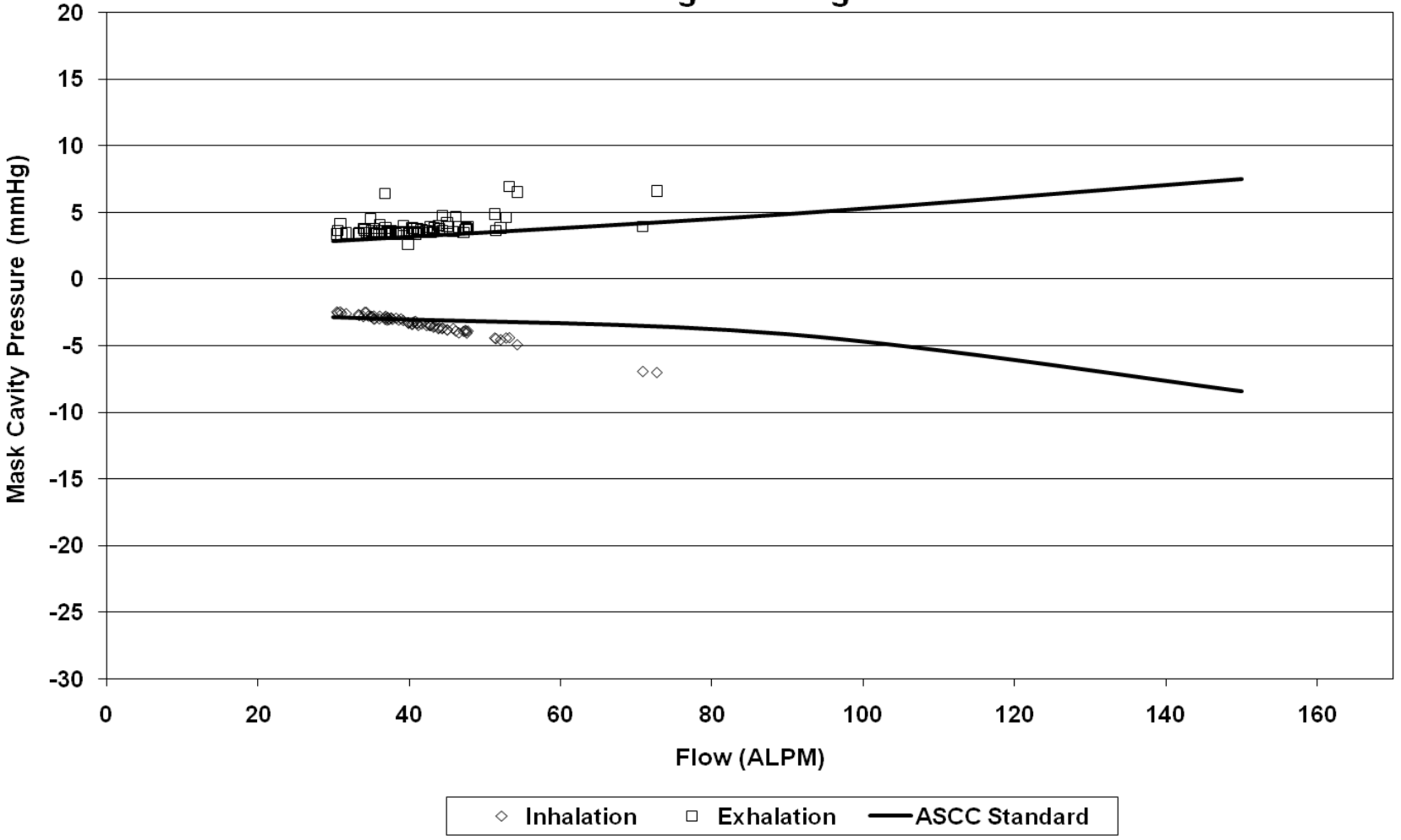


Figure 33: POS
Subject #1 Average Oxygen Concentration
Mode #2 - Paratrooper Configuration - 8 Breathers

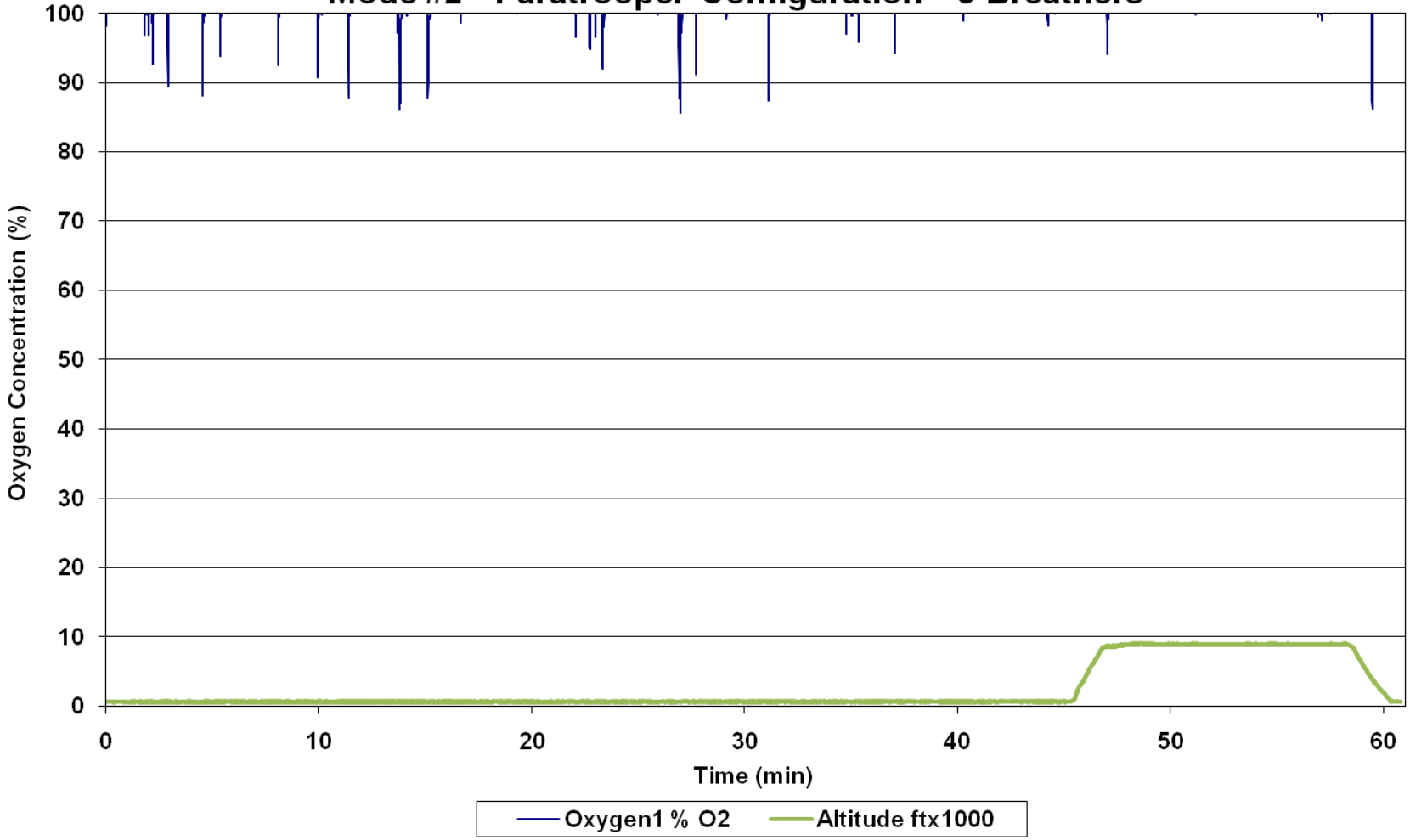
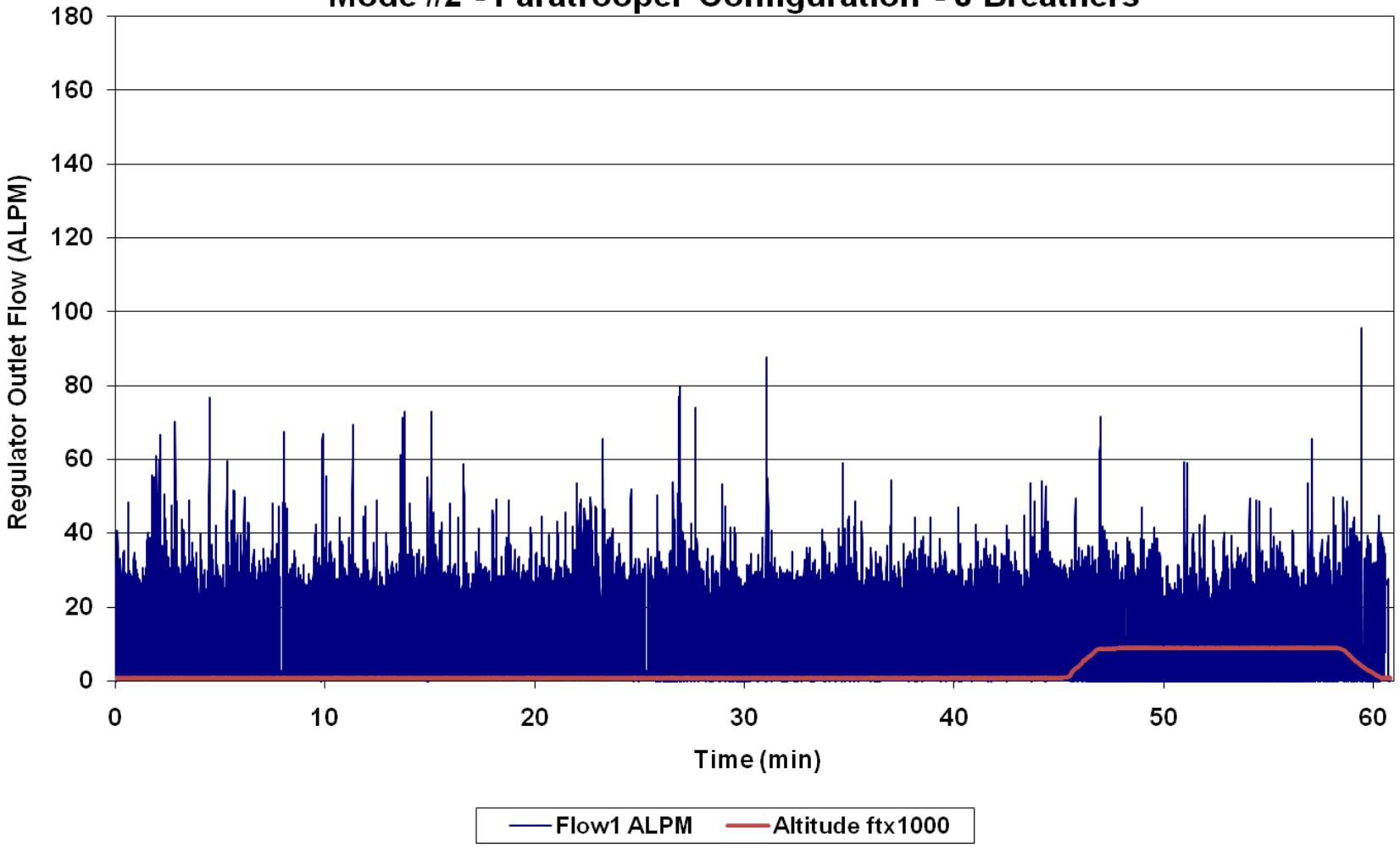


Figure 34: POS
Subject #1 Regulator Outlet Flow
Mode #2 - Paratrooper Configuration - 8 Breathers



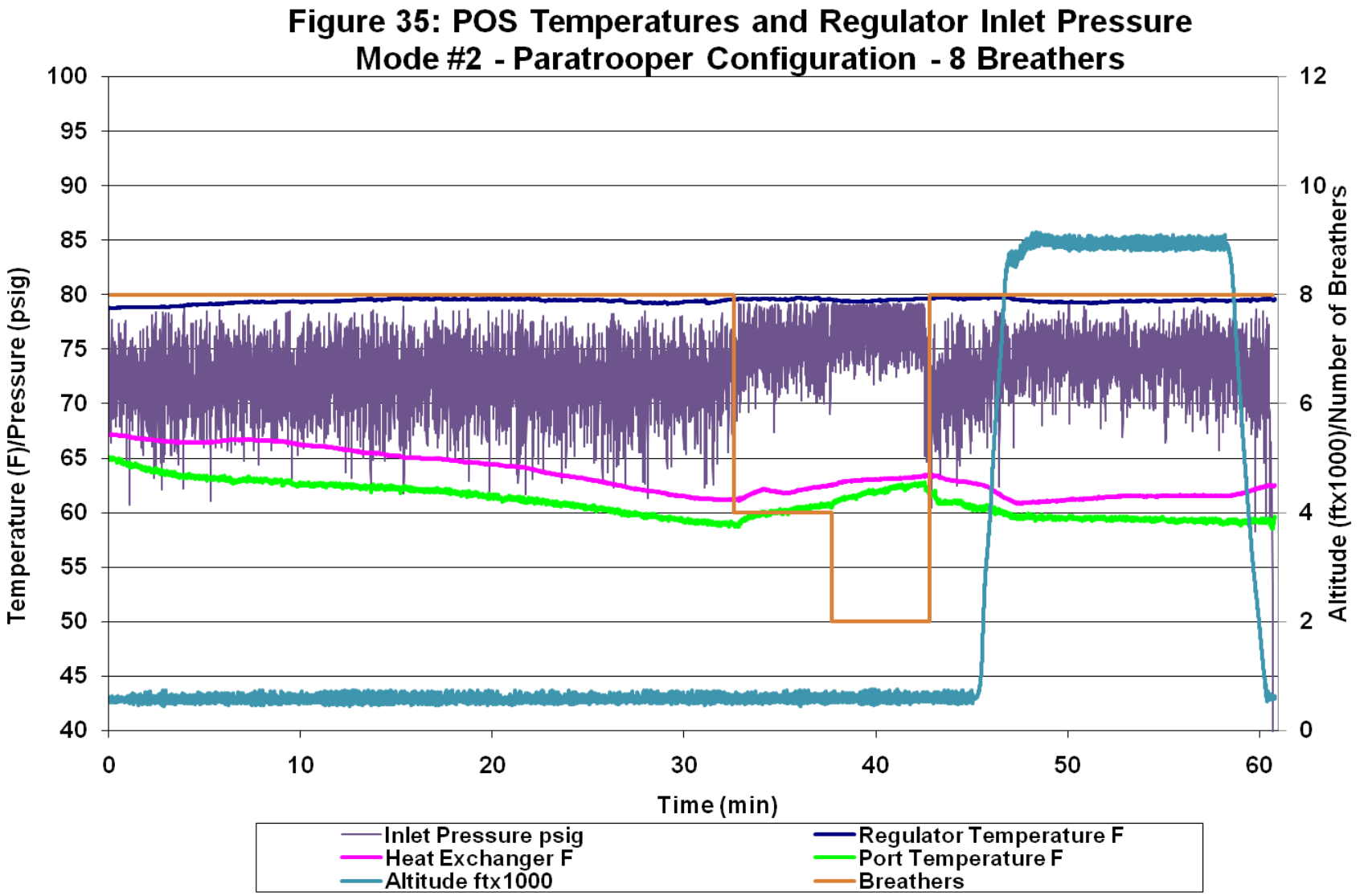


Figure 36: POS
Subject #6 Average Oxygen Concentration
Mode #2 - Paratrooper Configuration - 8 Breathers

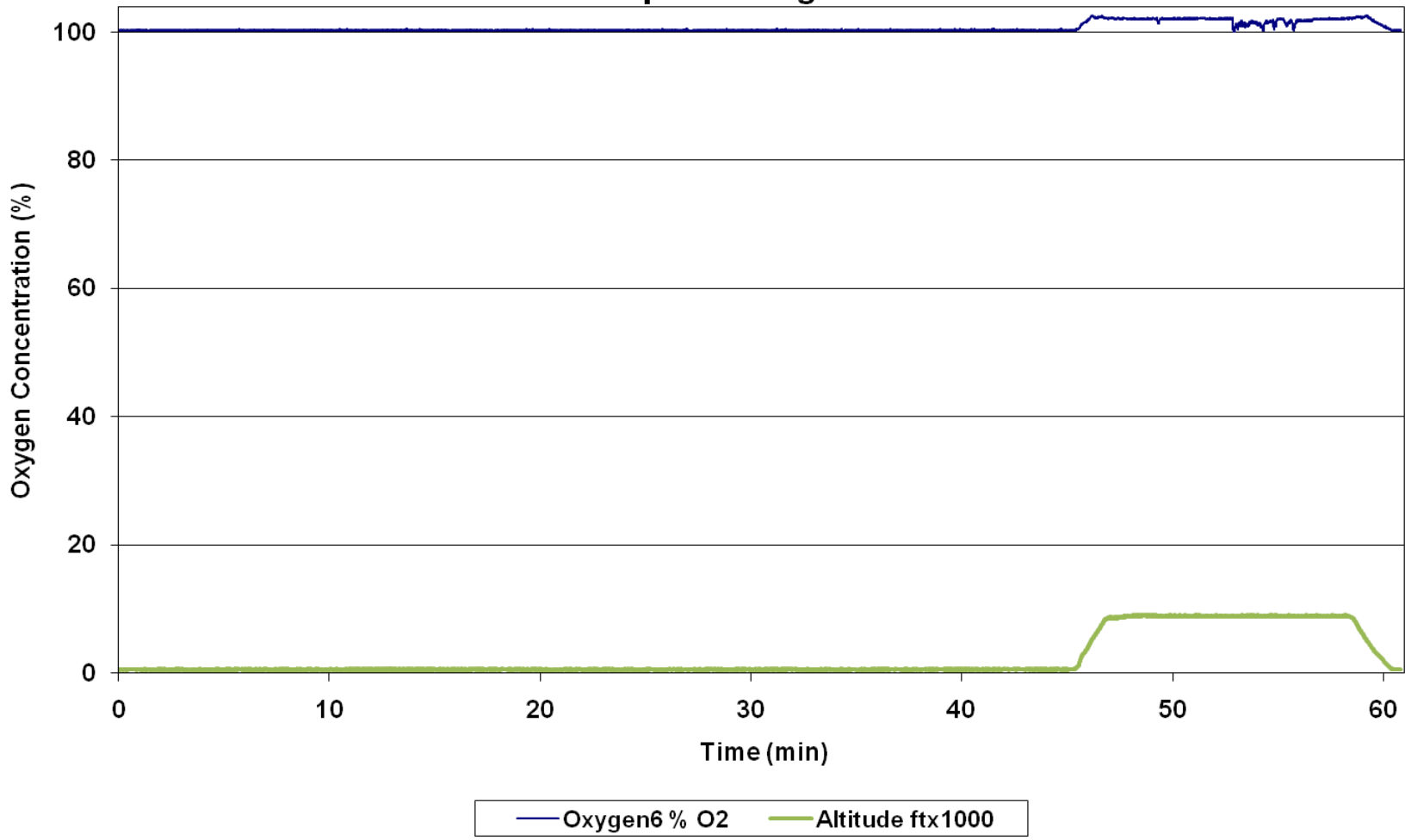


Figure 37: Subject #6 Regulator Outlet Flow
Mode #2 - Paratrooper Configuration - 8 Breathers

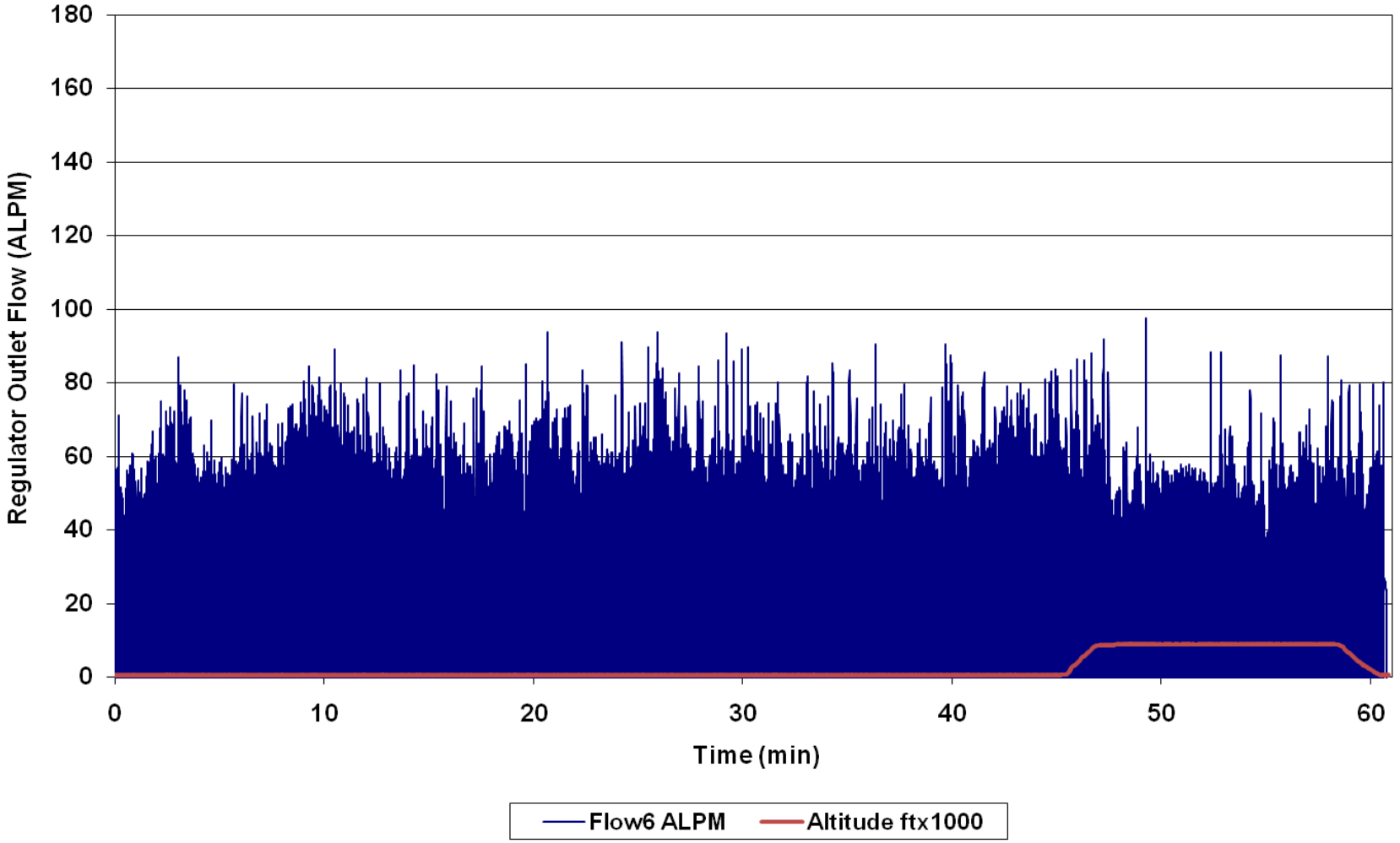


Figure 38: POS
Subject #1 Breathing Impedance - Ground Level - Resting
Mode #2 - Paratrooper Configuration

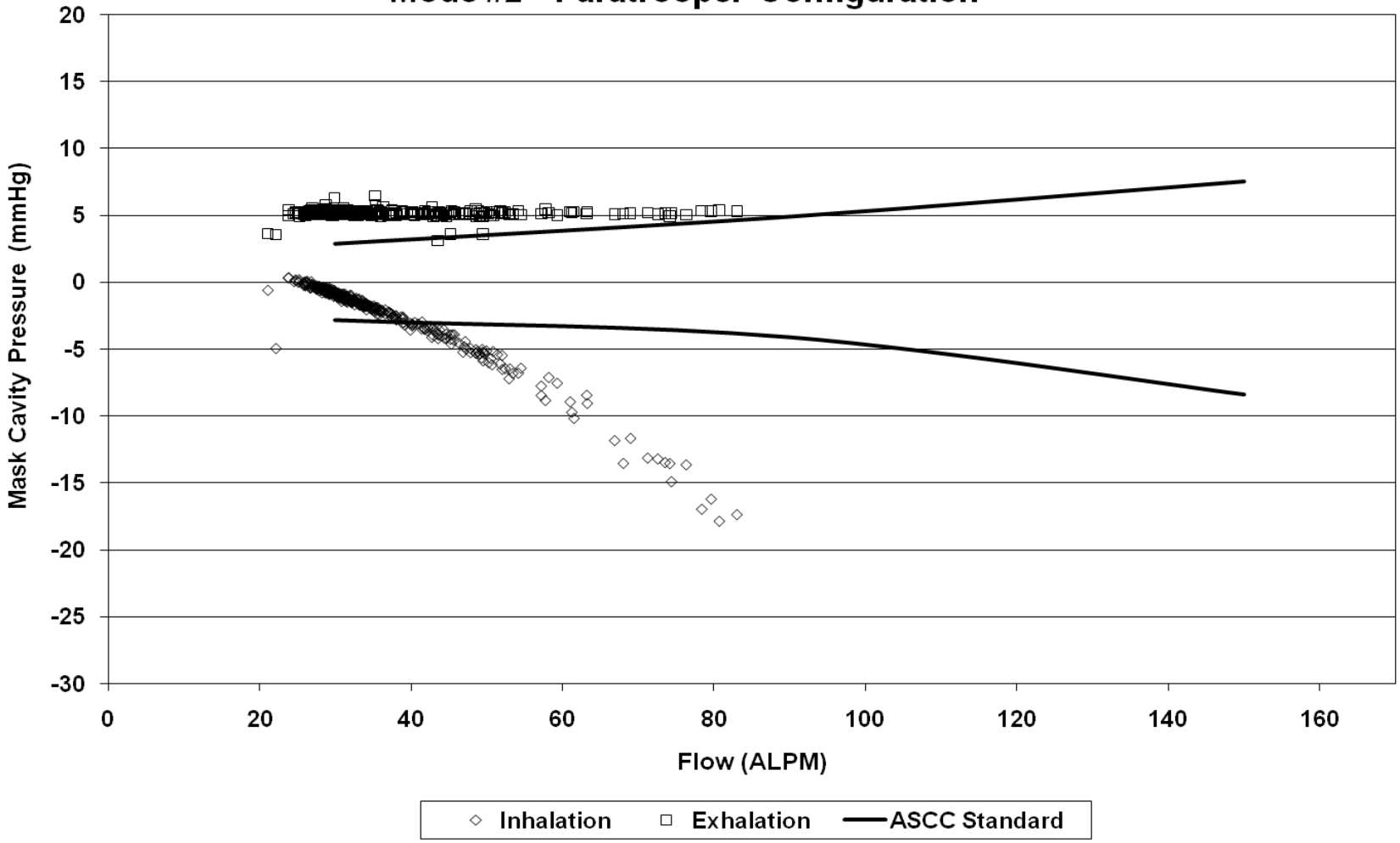


Figure 39: POS
Subject #6 Breathing Impedance - Ground Level - Resting
Mode #2 - Paratrooper Configuration

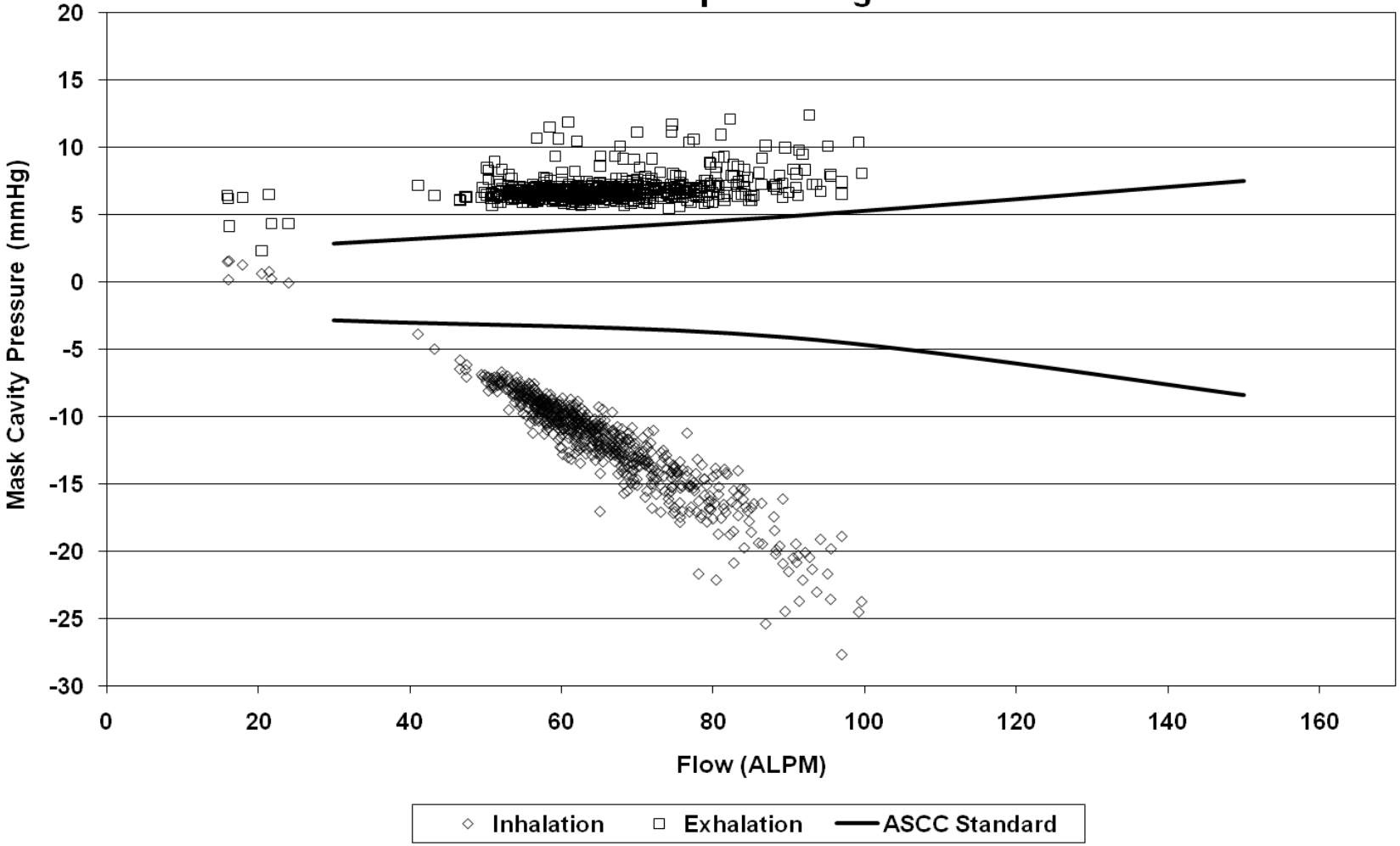


Figure 40: POS
Subject #1 Breathing Impedance - 9000 ft - Resting
Mode #2 - Paratrooper Configuration

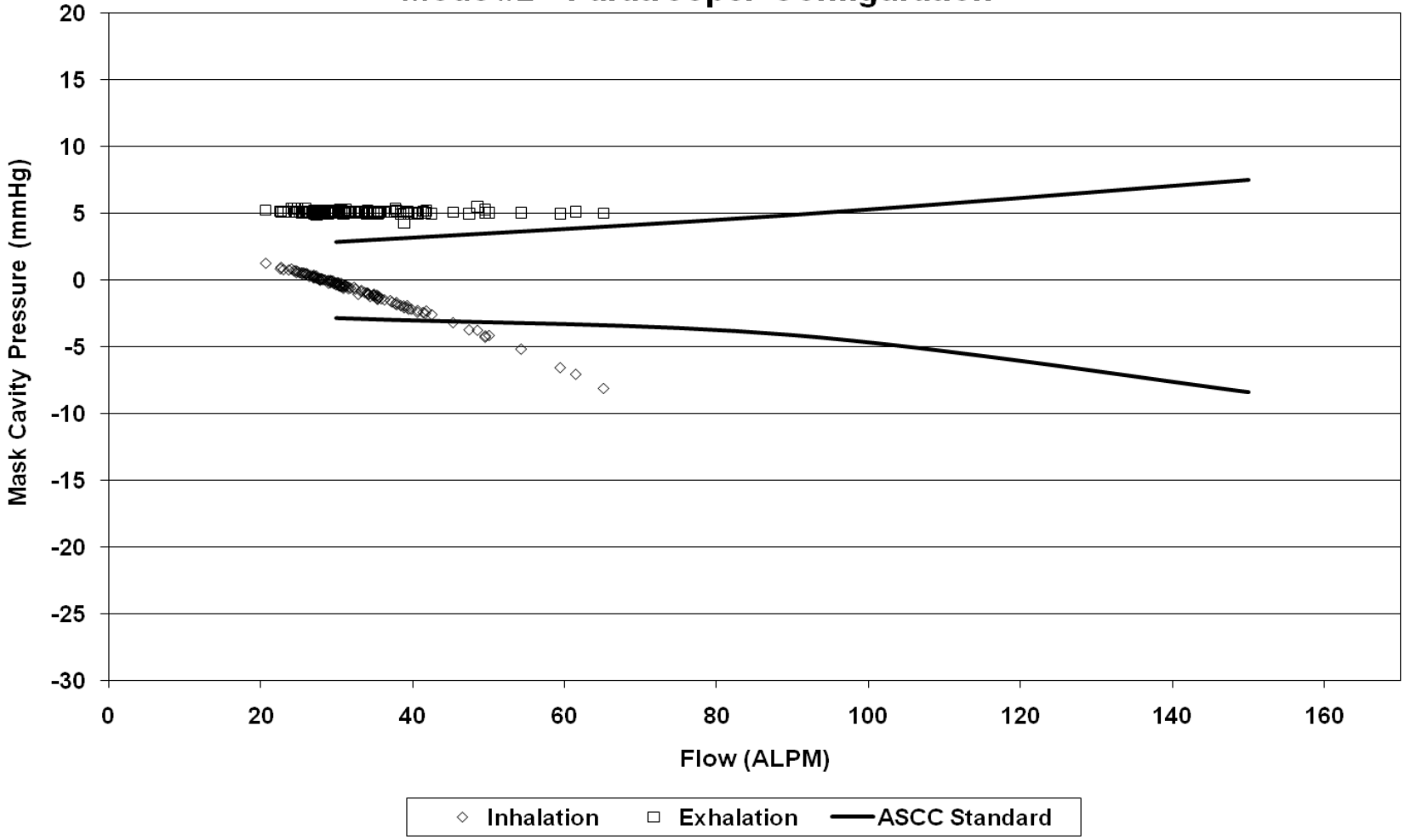


Figure 41: POS
Subject #6 Breathing Impedance - 9000 ft - Resting
Mode #2 - Paratrooper Configuration

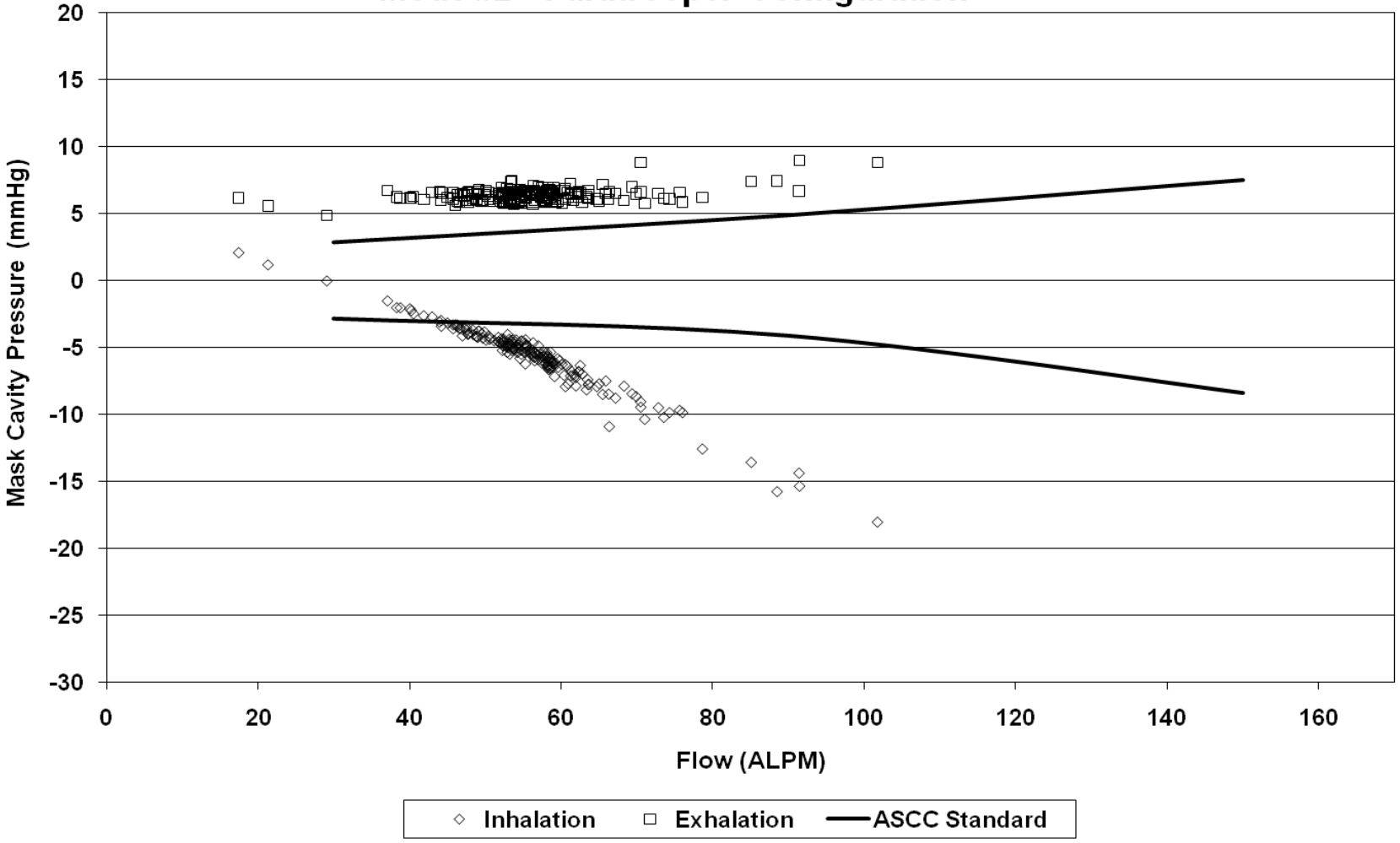


Figure 42: POS
Subject #1 Average Oxygen Concentration
Mode #3 - Paratrooper Configuration - 8 Breathers

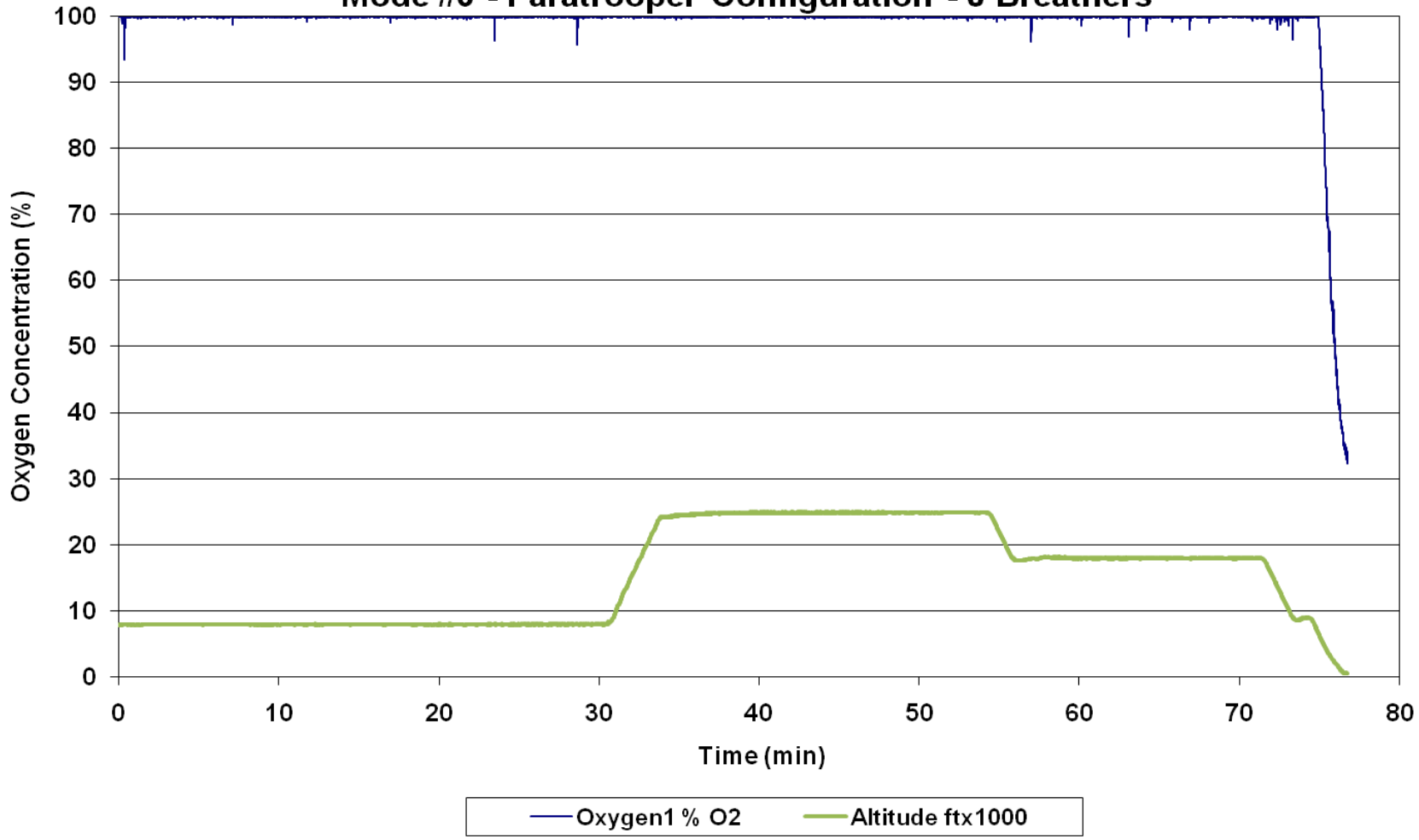


Figure 43: POS
Subject #1 Regulator Outlet Flow
Test #3 - Paratrooper Configuration - 8 Breathers

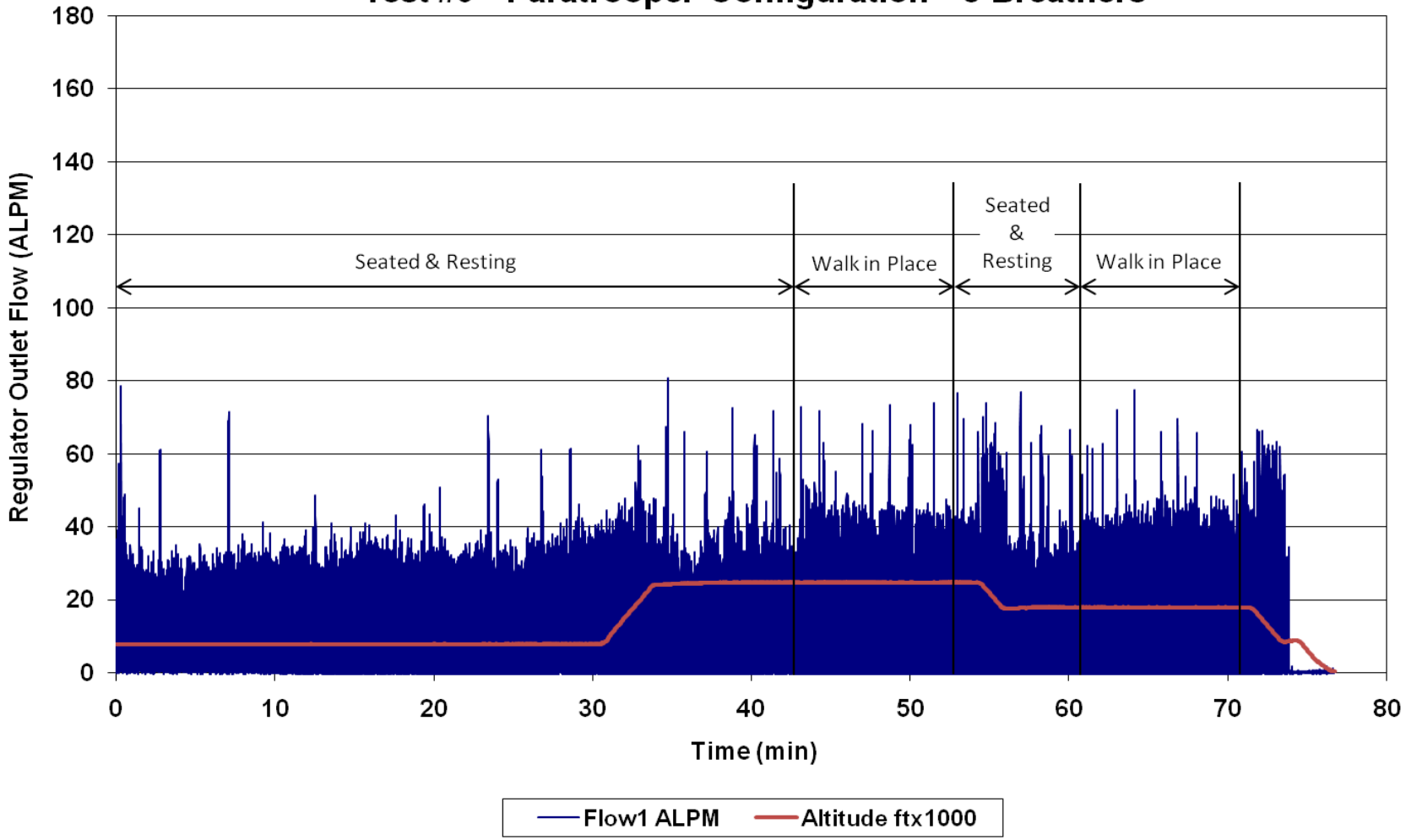


Figure 44: POS
Temperatures and Regulator Inlet Pressure
Mode #3 - Paratrooper Configuration

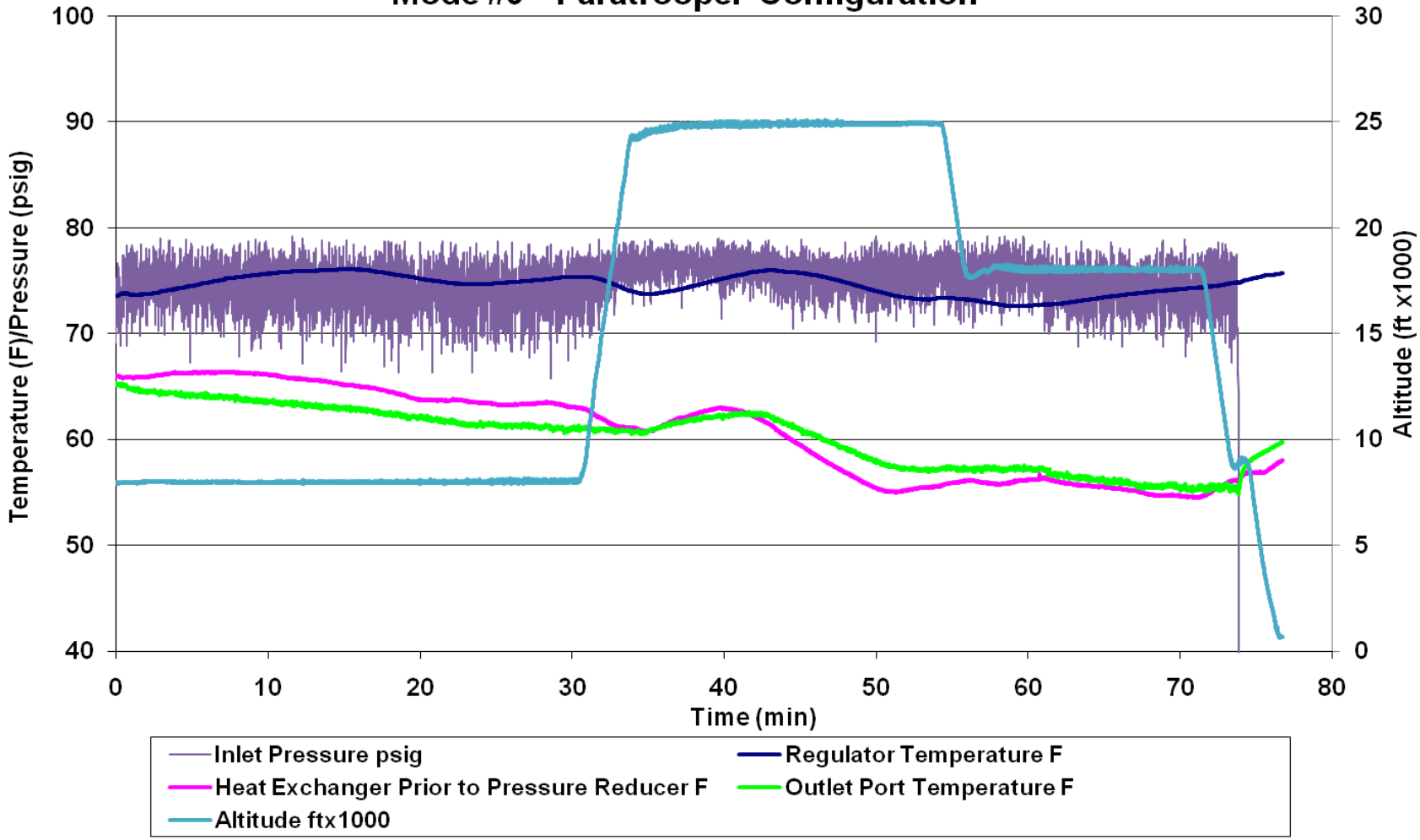


Figure 45: POS
Subject #6 Average Oxygen Concentration
Mode #3 - Paratrooper Configuration

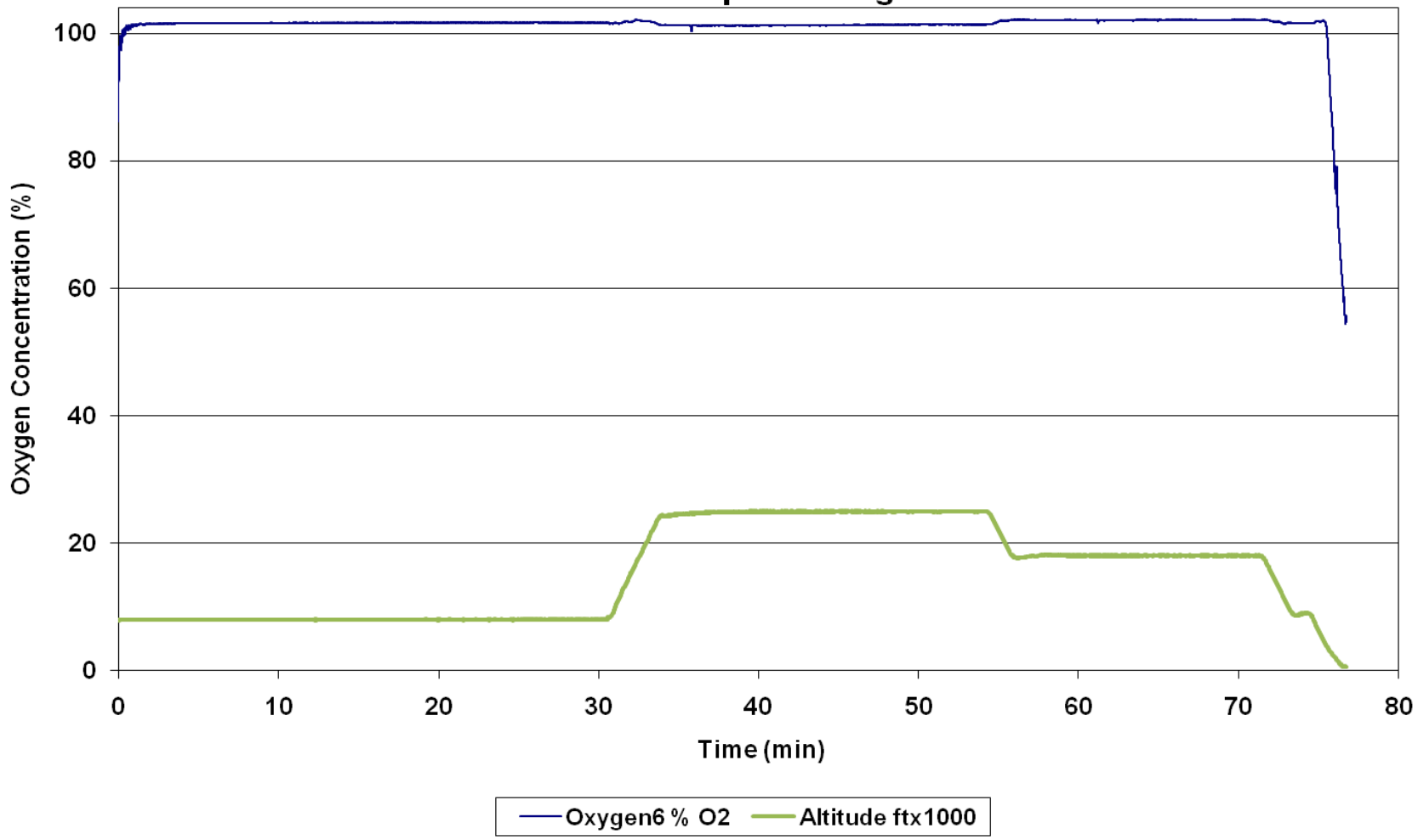


Figure 46: POS
Subject #6 Regulator Outlet Flow
Mode #3 - Paratrooper Configuration

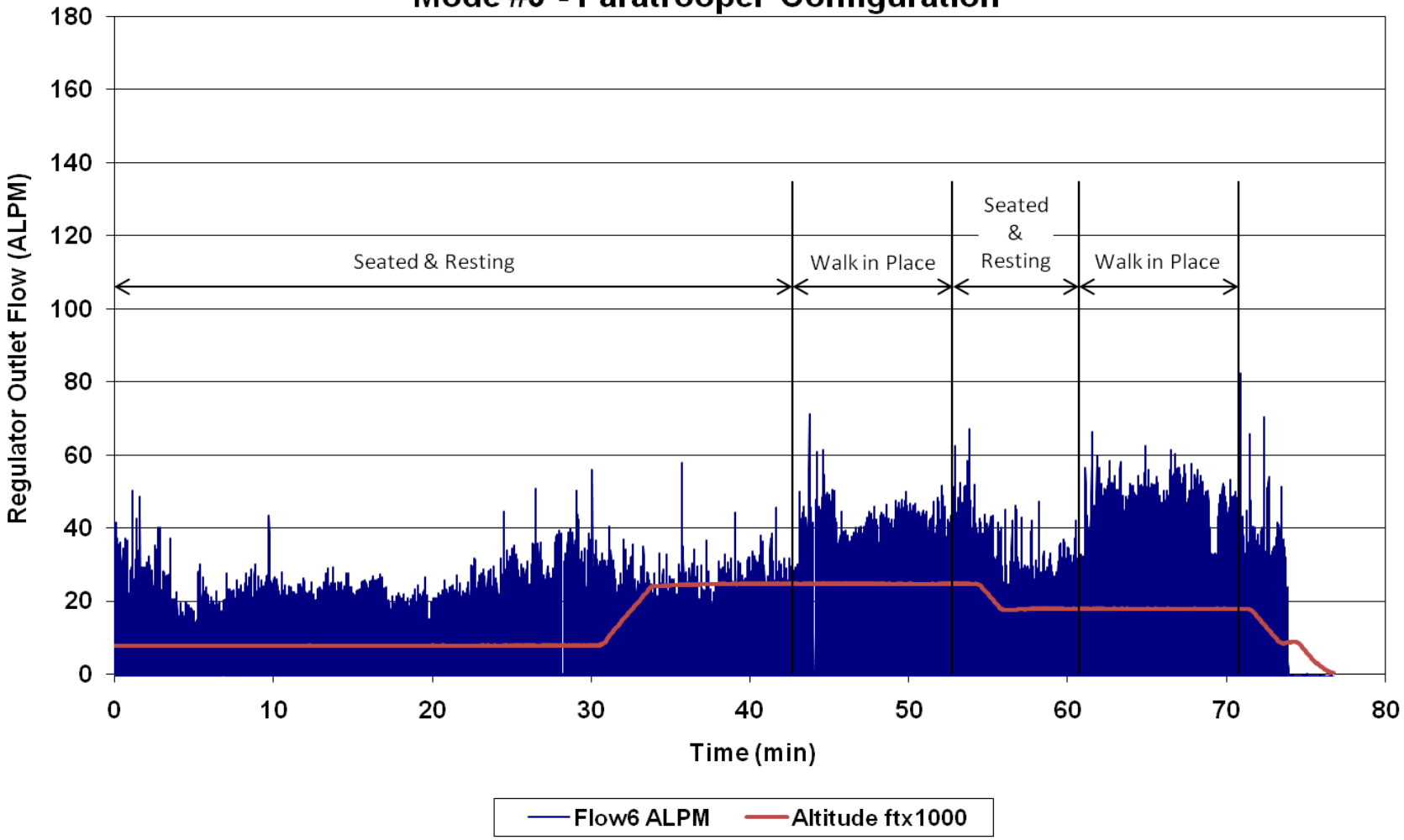


Figure 47: POS
Subject #1 Breathing Impedance - 8000 ft - Resting
Mode #3 - Paratrooper Configuration

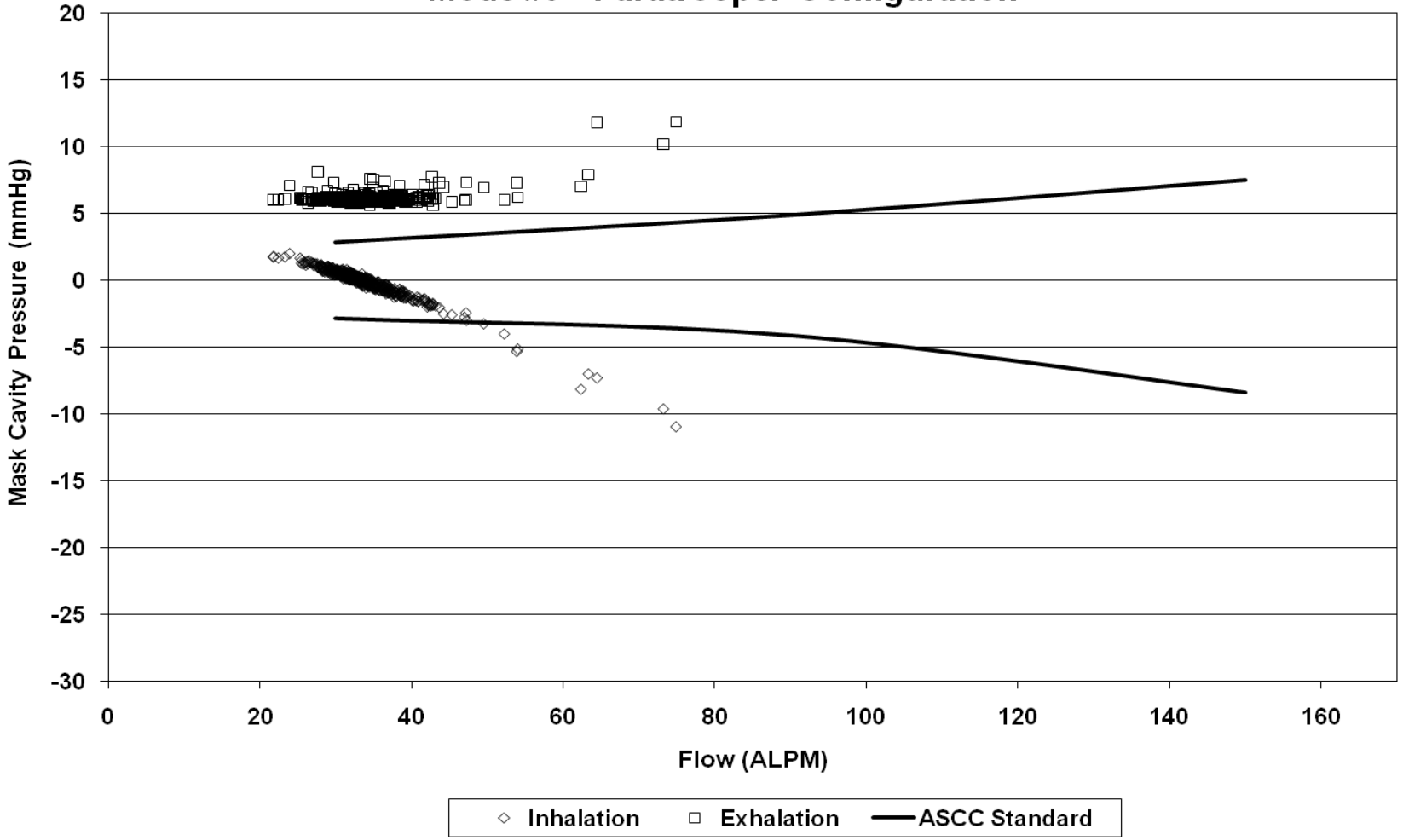


Figure 48: POS
Subject #6 Breathing Impedance - 8000 ft - Resting
Mode #3 - Paratrooper Configuration

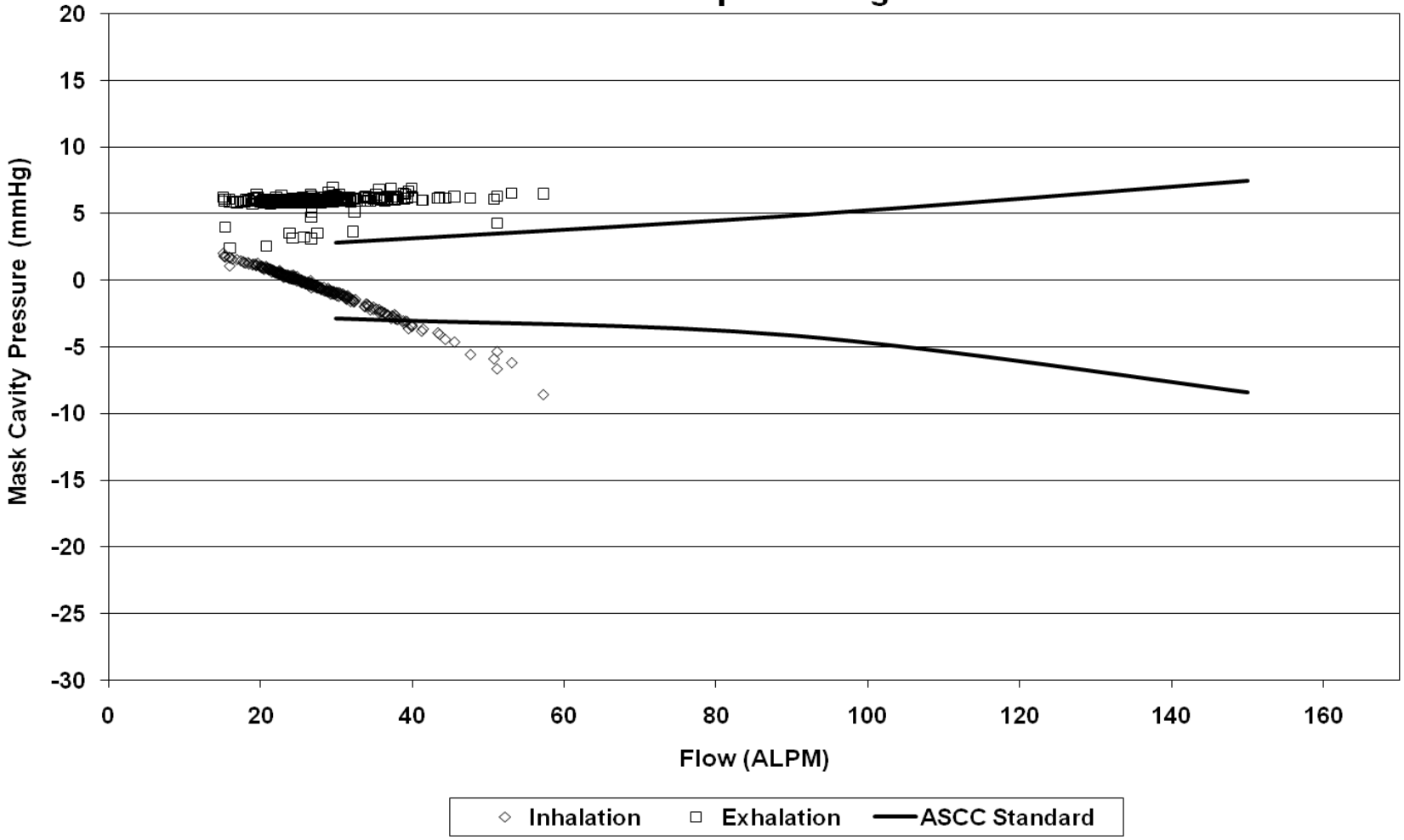


Figure 49: POS
Subject #1 Breathing Impedance - 24999 ft - Resting
Mode #3 - Paratrooper Configuration

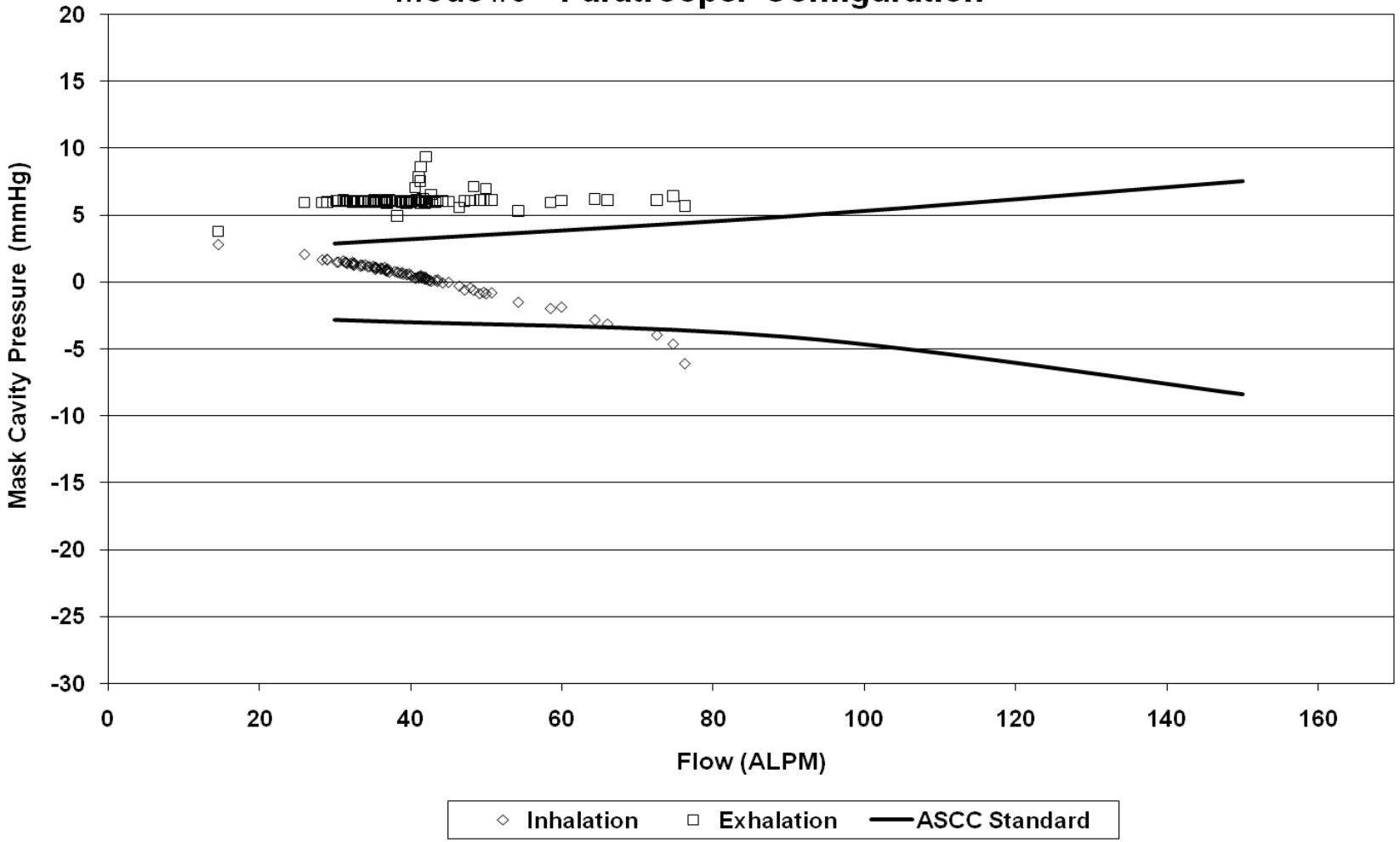


Figure 50: POS
Subject #6 Breathing Impedance - 24999 ft - Resting
Mode #3 - Paratrooper Configuration

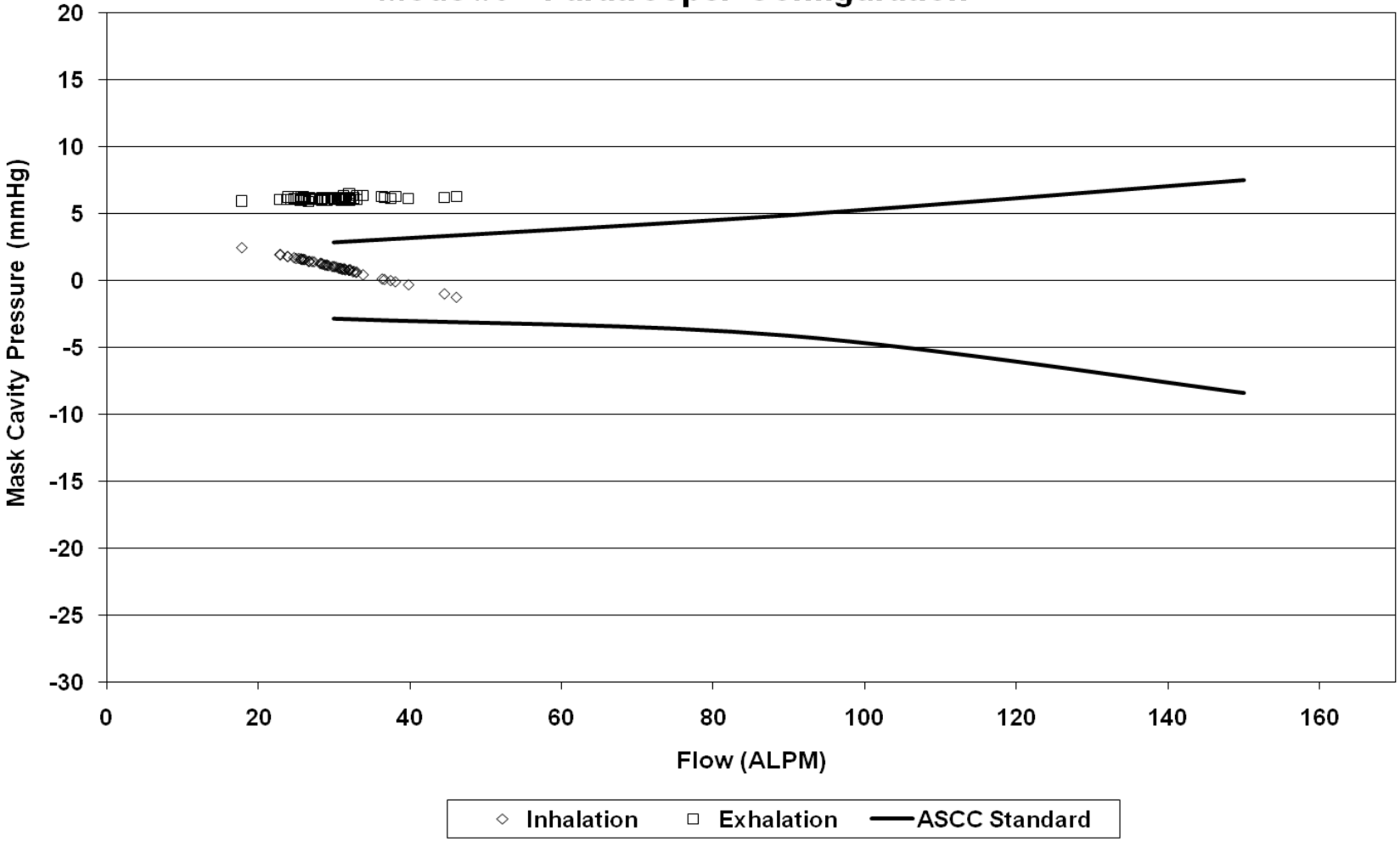


Figure 51: POS
Subject #1 Breathing Impedance - 24999 ft - Walking
Mode #3 - Paratrooper Configuration

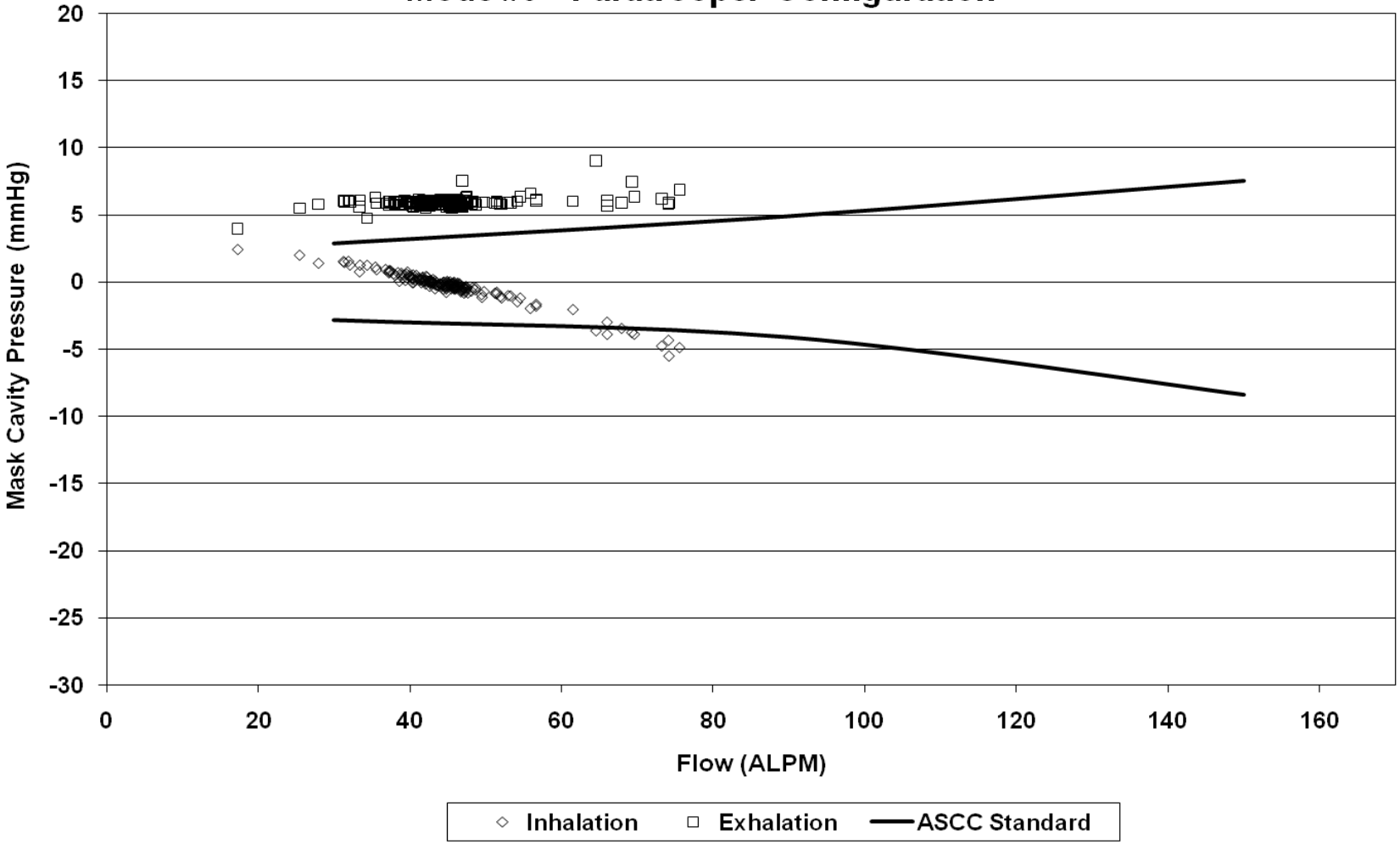


Figure 52: POS
Subject #6 Breathing Impedance - 24999 ft - Walking
Mode #3 - Paratrooper Configuration

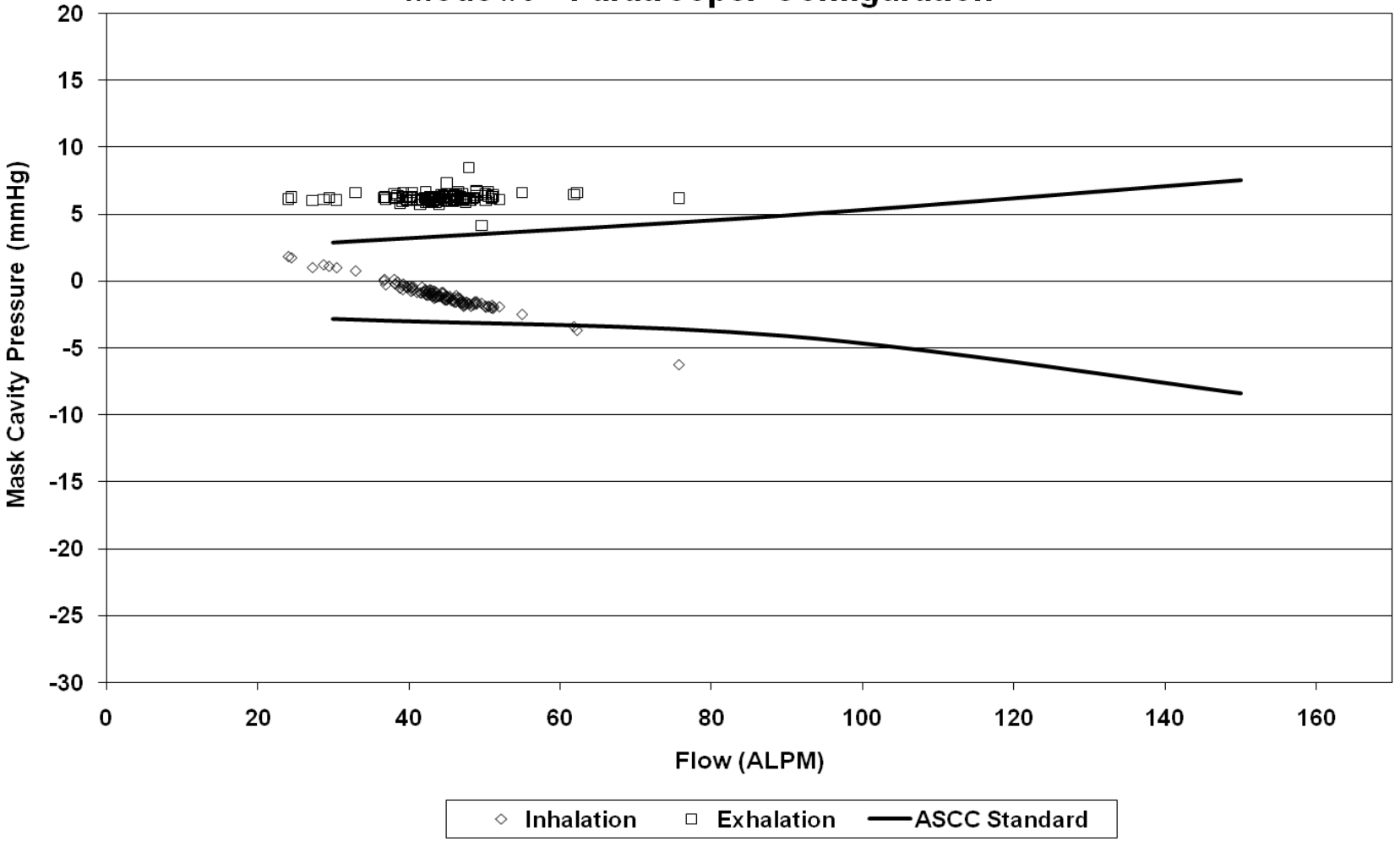


Figure 53: POS
Subject #1 Breathing Impedance - 18000 ft - Resting
Mode #3 - Paratrooper Configuration

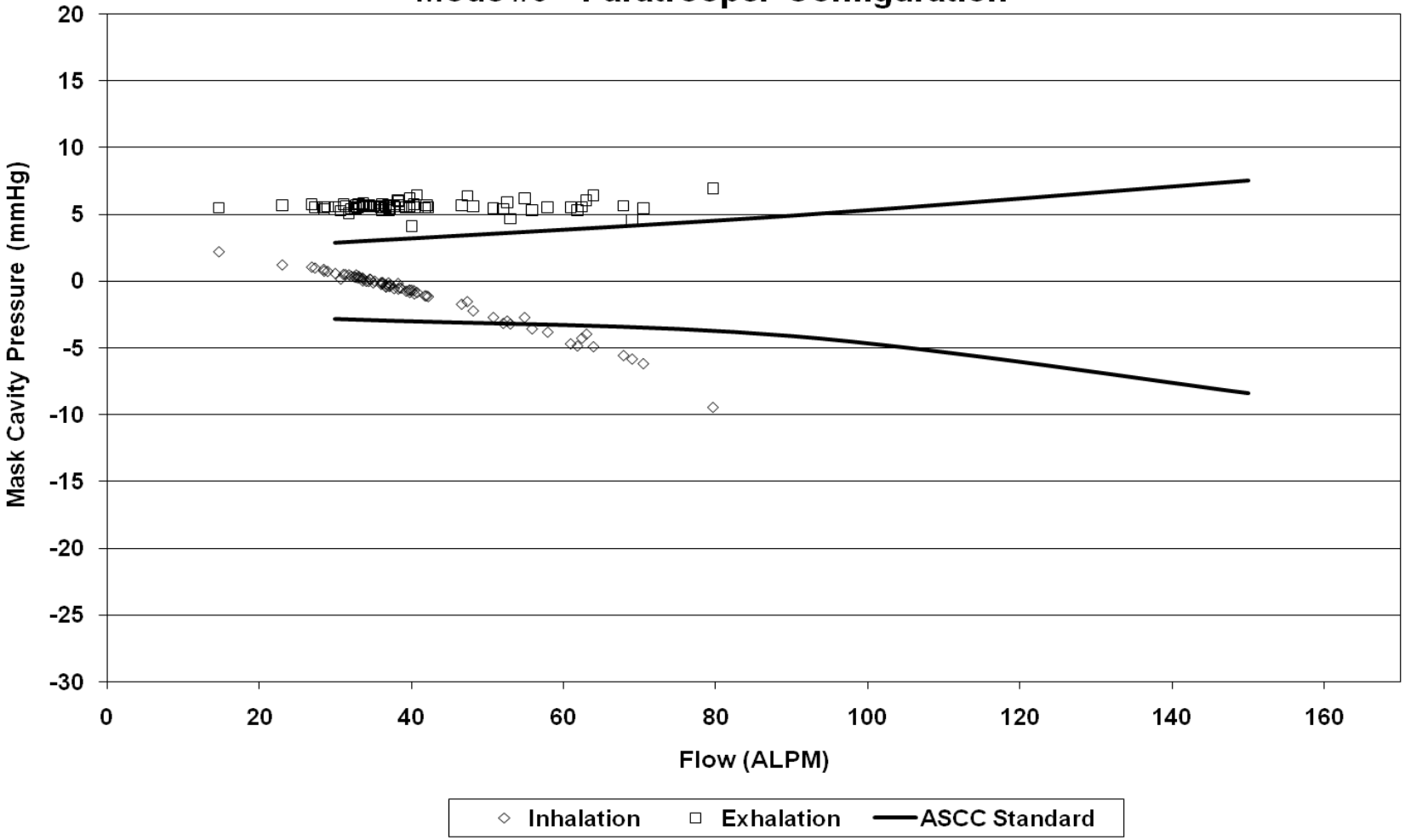


Figure 54: POS
Subject #6 Breathing Impedance - 18000 ft - Resting
Mode #3 - Paratrooper Configuration

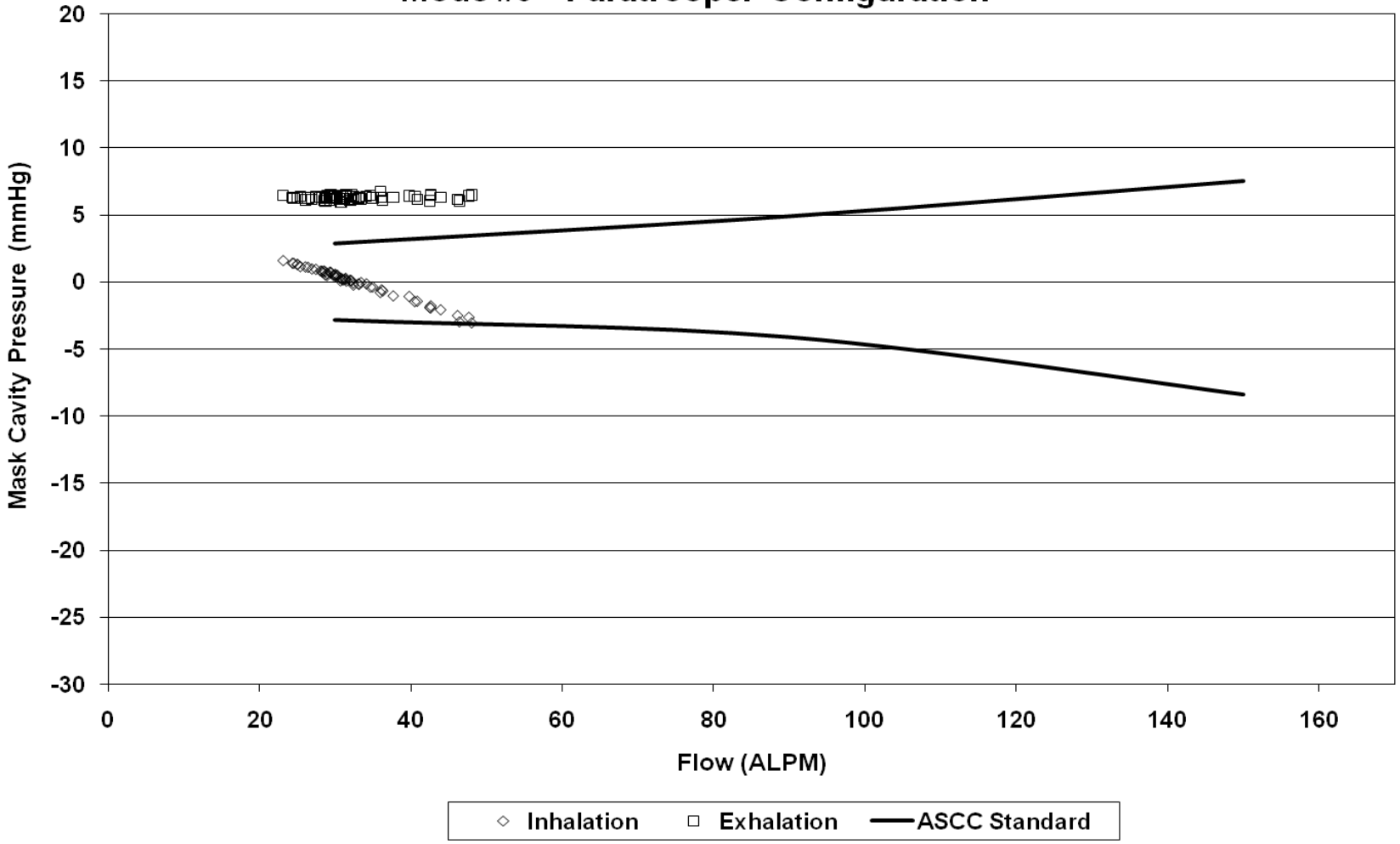


Figure 55: POS
Subject #1 Breathing Impedance - 18000 ft - Walking
Mode #3 - Paratrooper Configuration

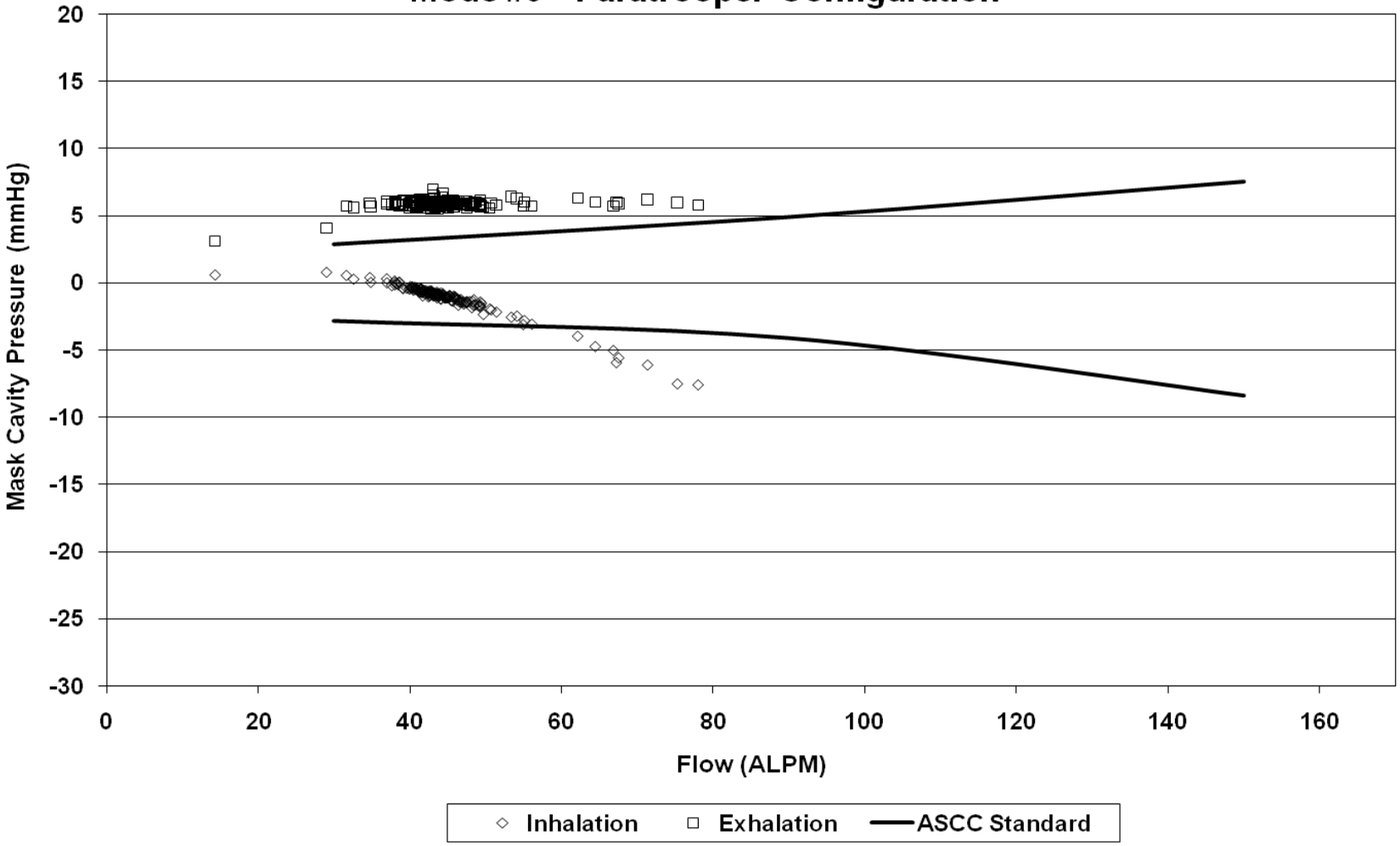


Figure 56: POS
Subject #6 Breathing Impedance - 18000 ft - Walking
Mode #3 - Paratrooper Configuration

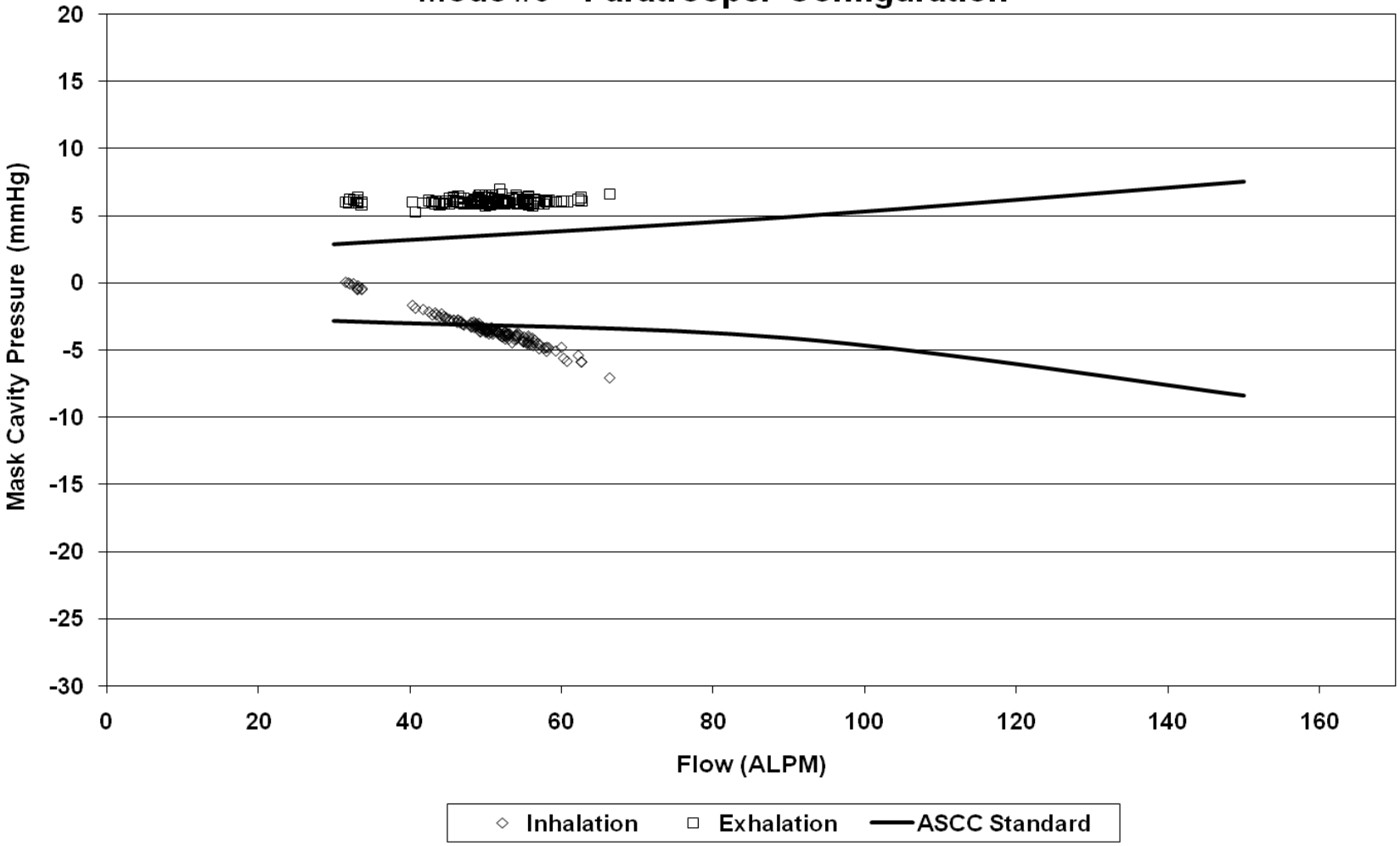


Figure 57: POS - AIROX VIII Only
Subject #1 Average Oxygen Concentration
Mode #4 - Passenger Configuration - 10 Breathers

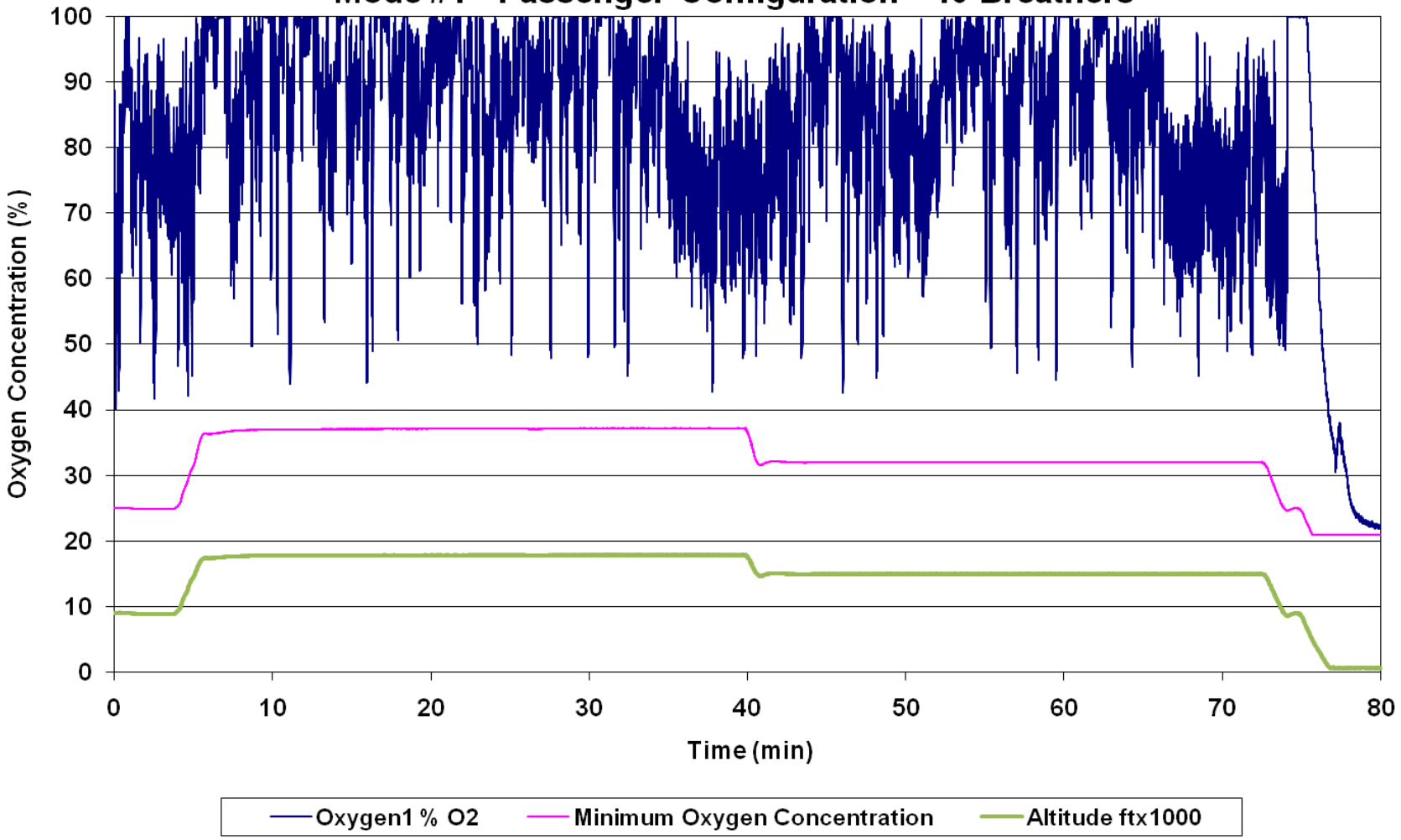
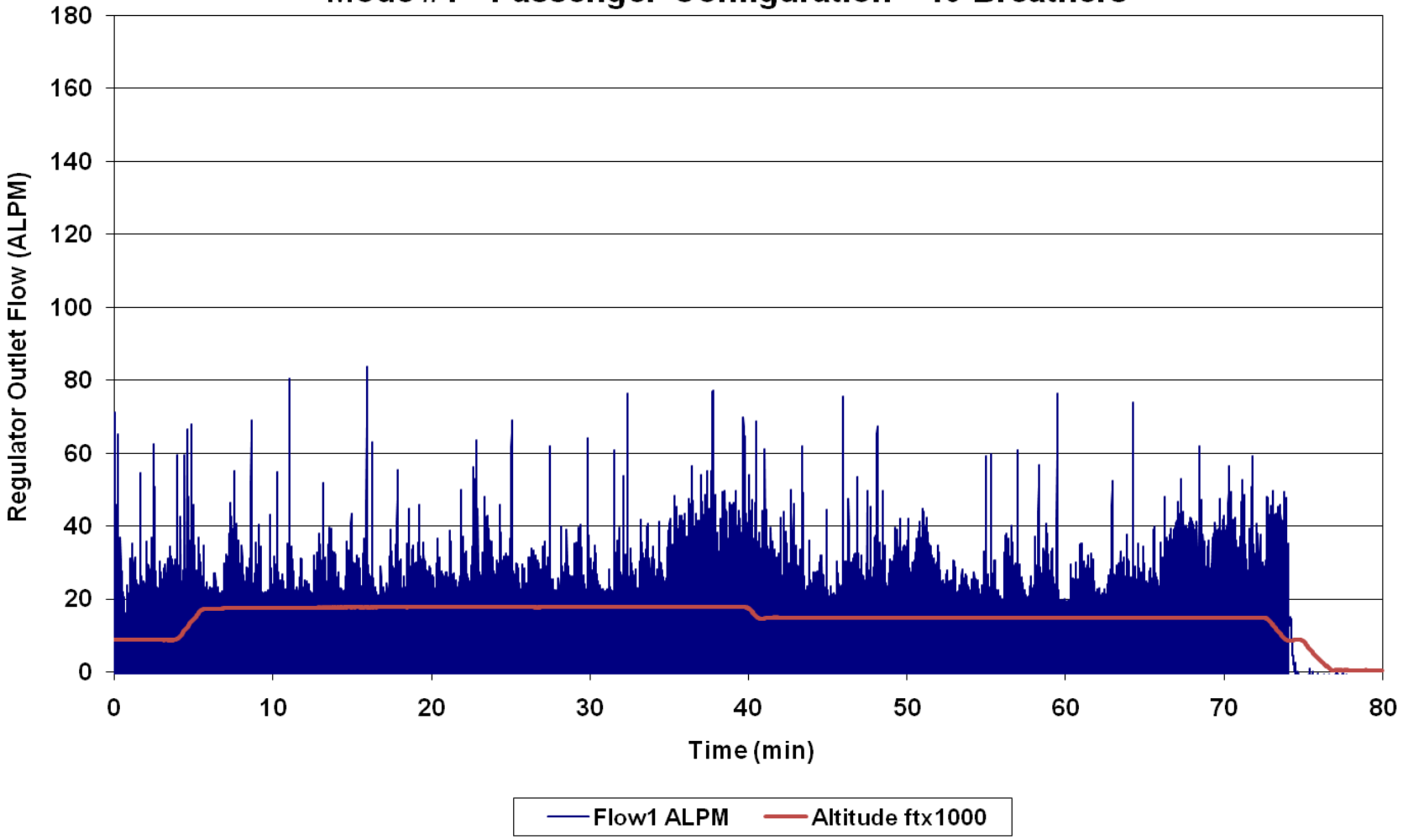


Figure 58: POS - AIROX VIII Only
Subject #1 Regulator Outlet Flow
Mode #4 - Passenger Configuration - 10 Breathers



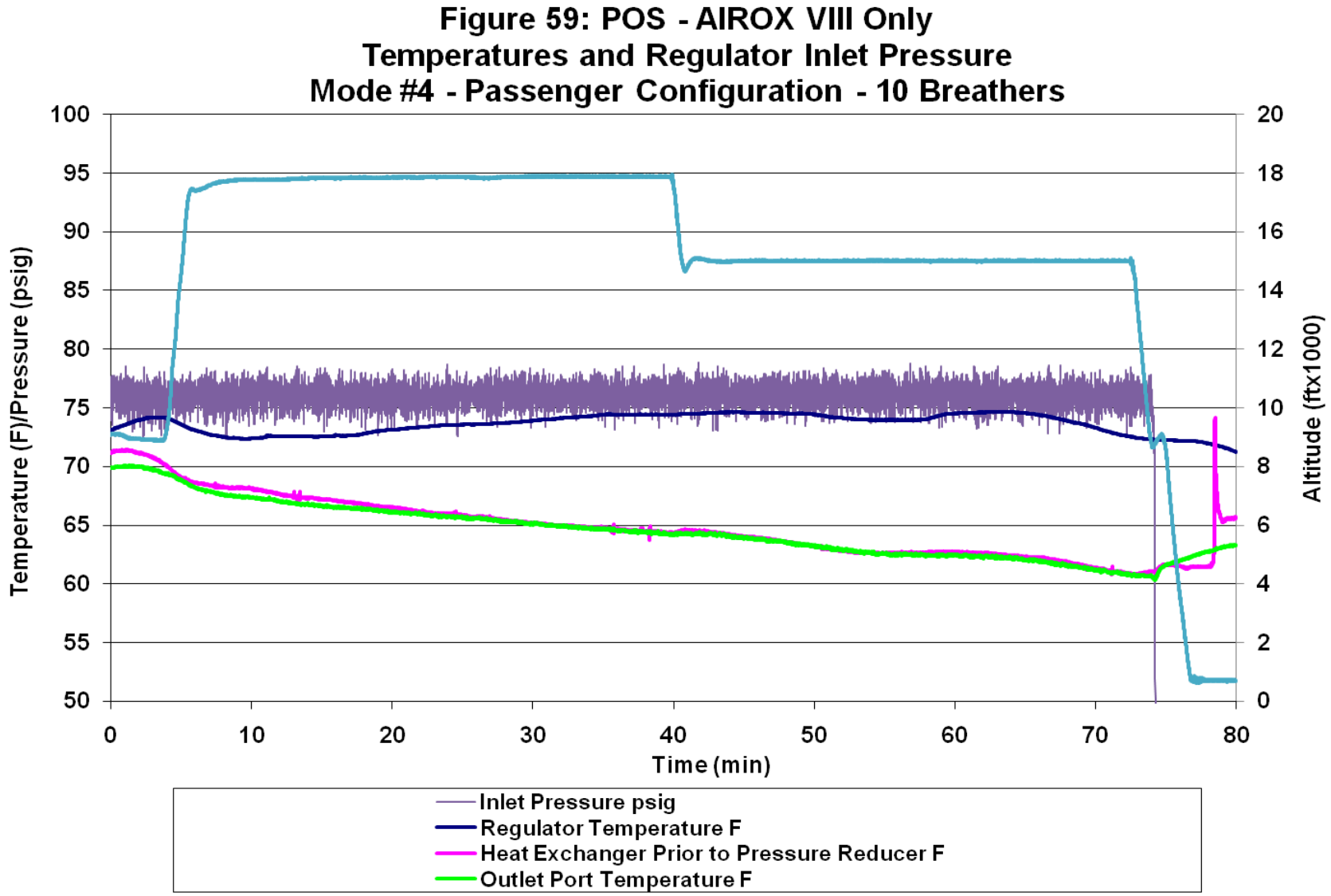


Figure 60: POS - AIROX VIII Only
Subject #6 Regulator Outlet Flow
Mode #4 - Passenger Configuration - 10 Breathers

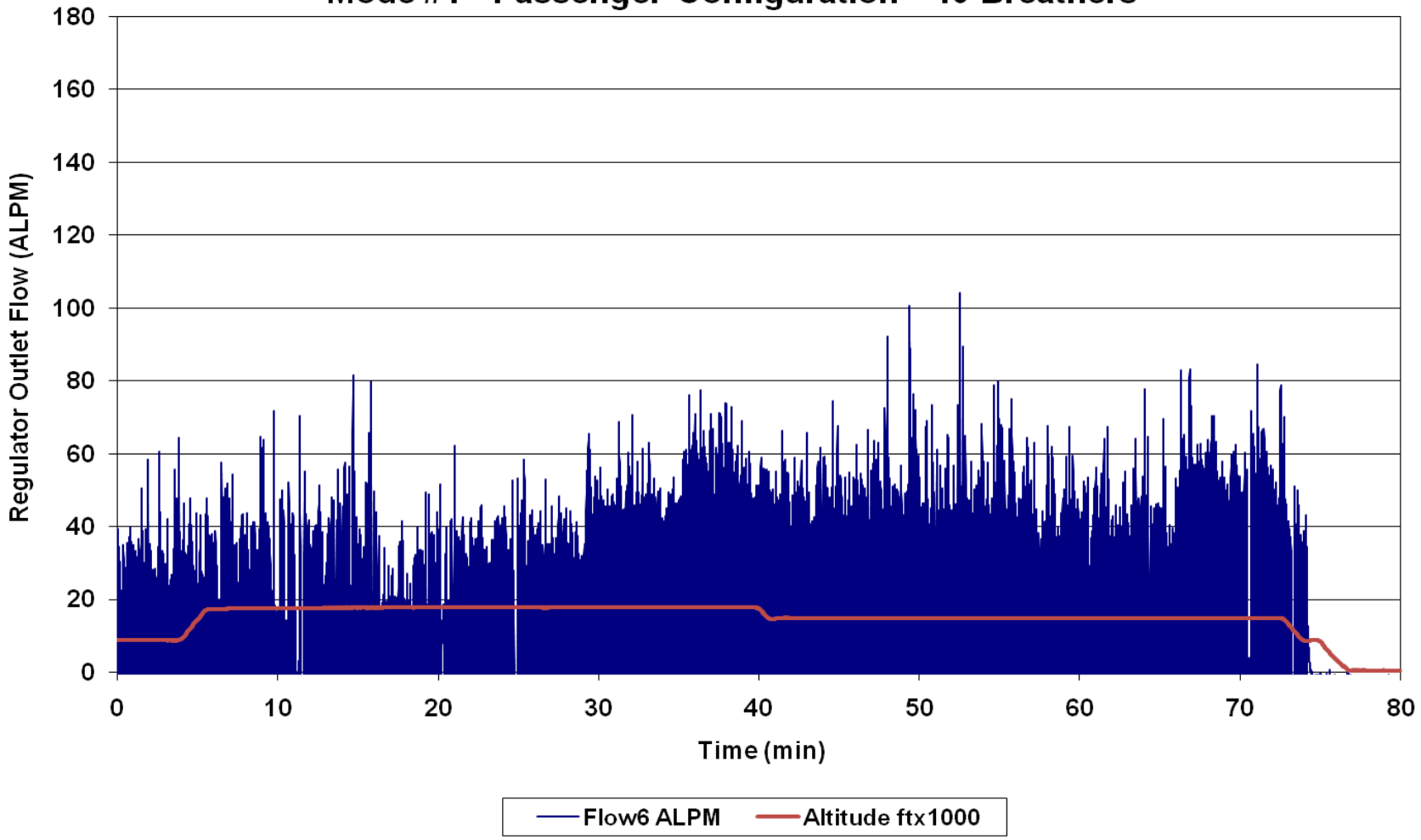


Figure 61: POS
Subject #1 Breathing Impedance - 17999 ft - Resting
Mode #4 - Passenger Configuration

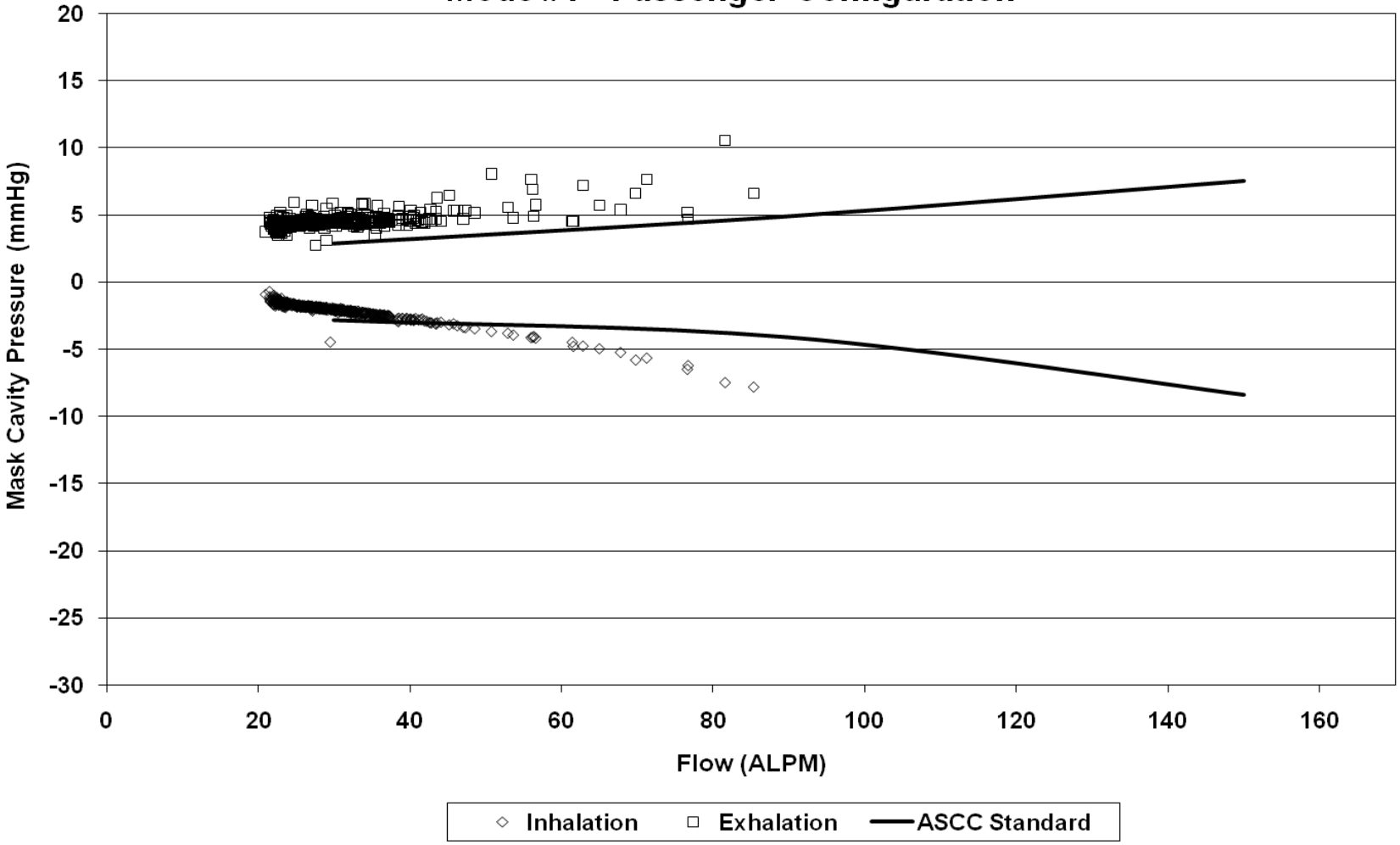


Figure 62: POS
Subject #6 Breathing Impedance - 17999 ft - Resting
Mode #4 - Passenger Configuration

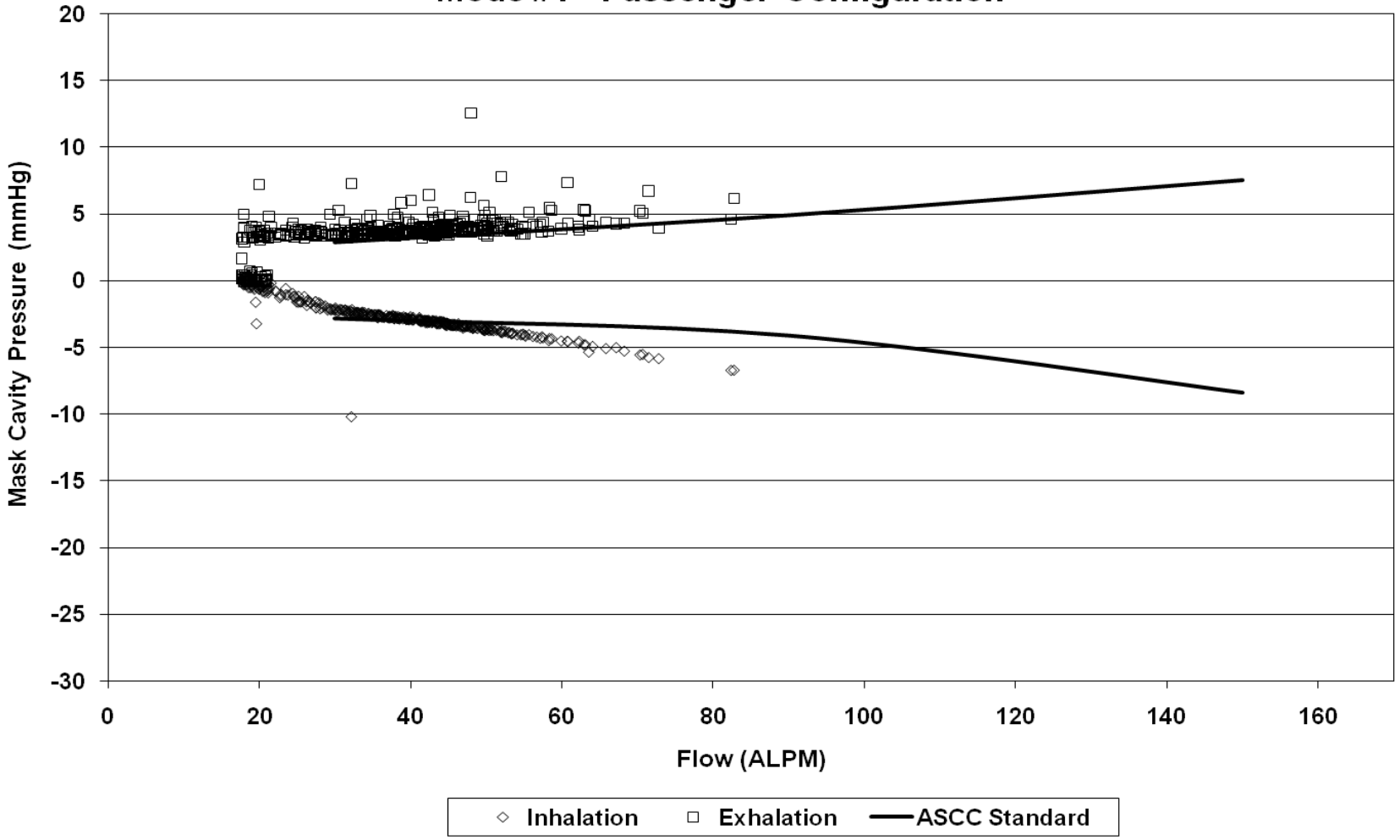


Figure 63: POS
Subject #1 Breathing Impedance - 17999 ft - Standing
Mode #4 - Passenger Configuration

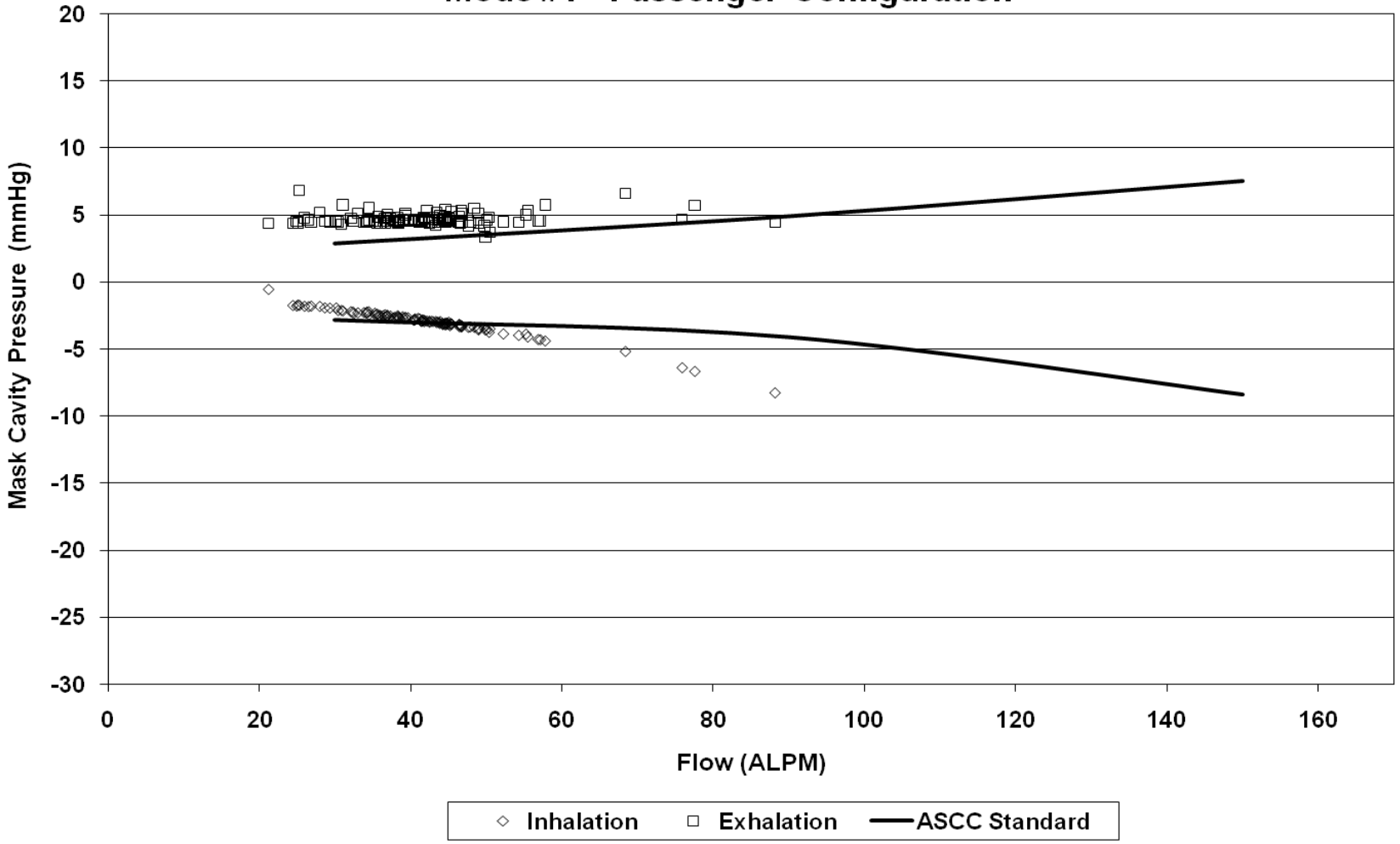


Figure 64: POS
Subject #6 Breathing Impedance - 17999 ft - Standing
Mode #4 - Passenger Configuration

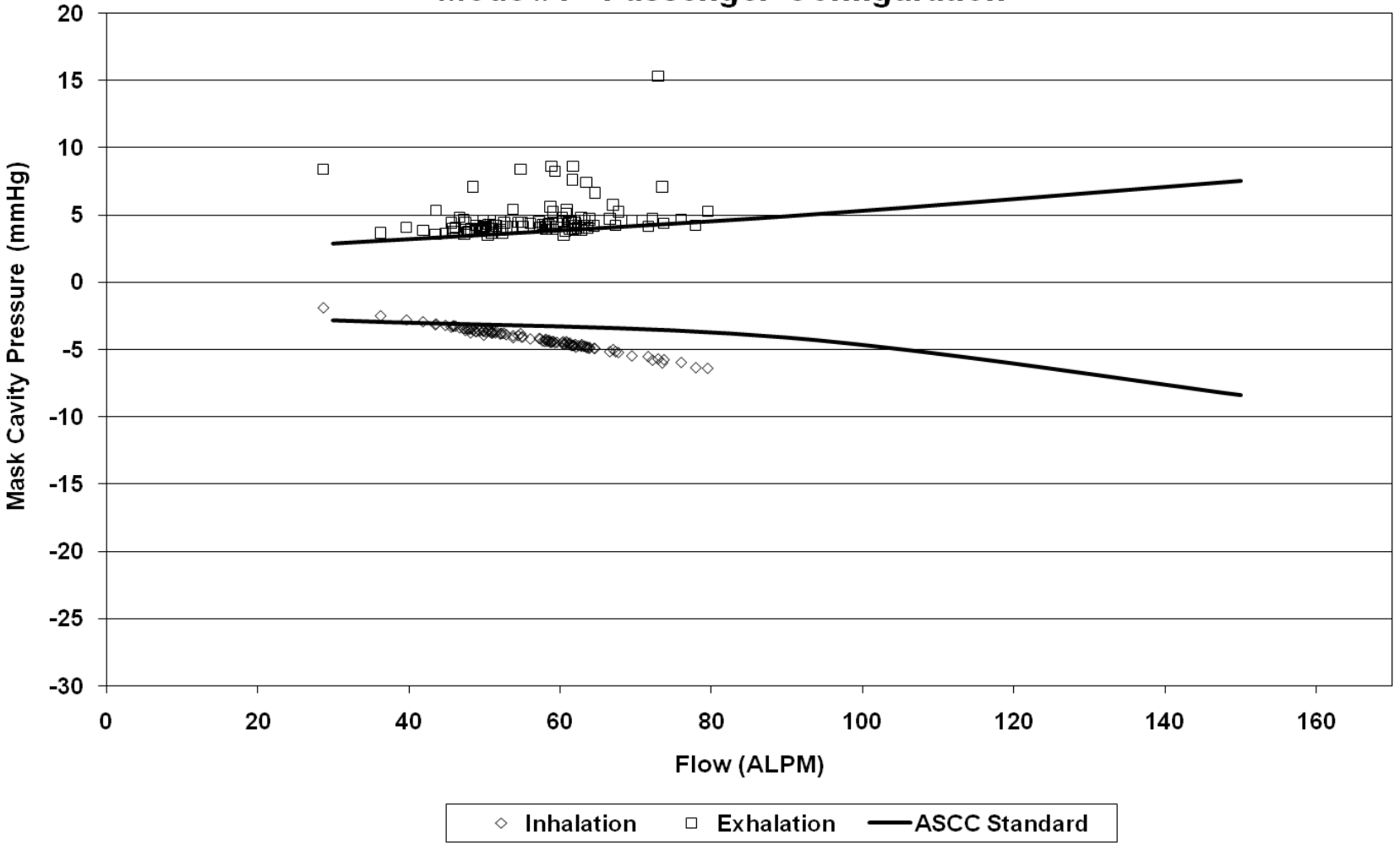


Figure 65: POS
Subject #1 Breathing Impedance - 15000 ft - Resting
Mode #4 - Passenger Configuration

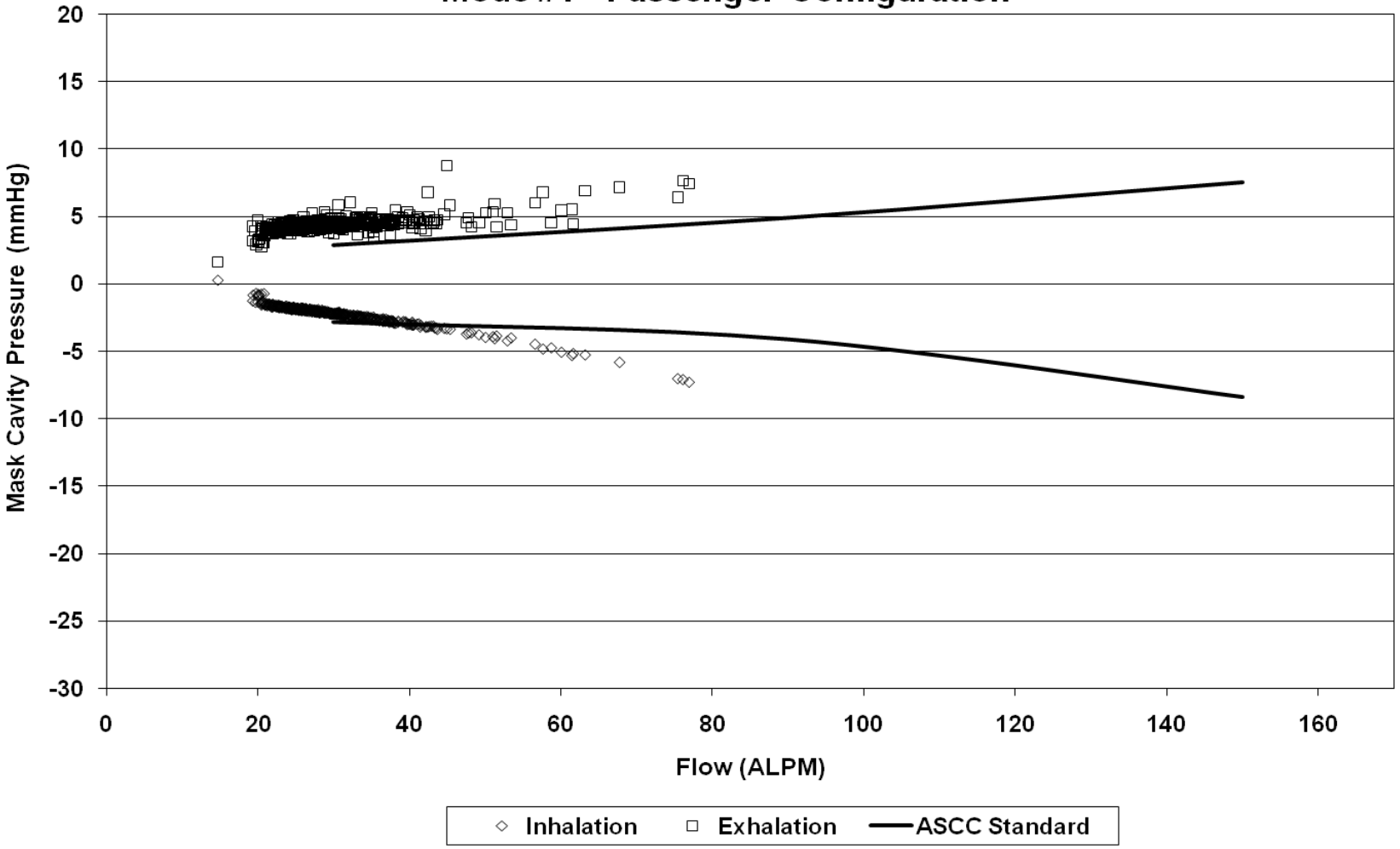


Figure 66: POS
Subject #6 Breathing Impedance - 15000 ft - Resting
Mode #4 - Passenger Configuration

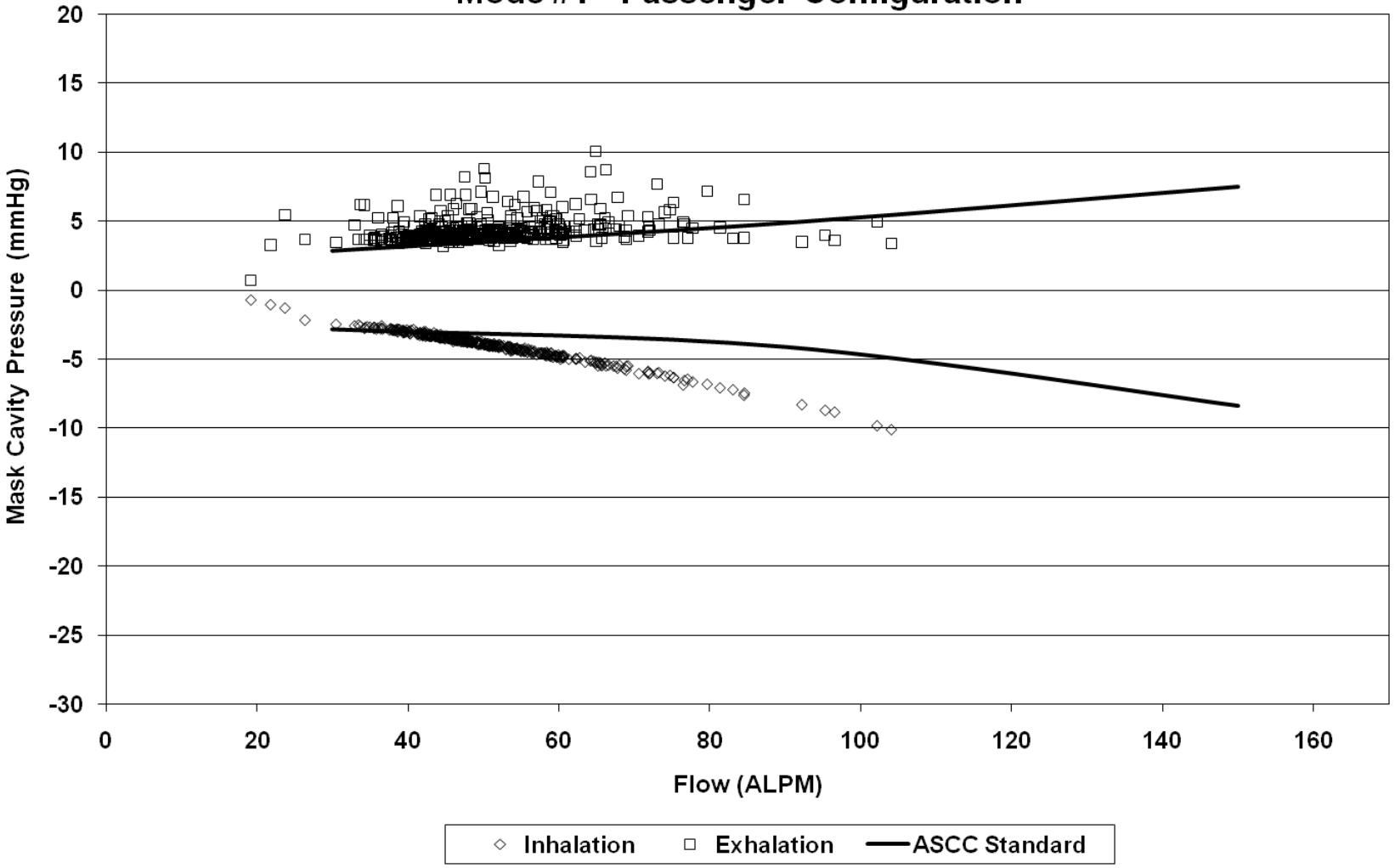


Figure 67: POS
Subject #1 Breathing Impedance - 15000 ft - Standing
Mode #4 - Passenger Configuration

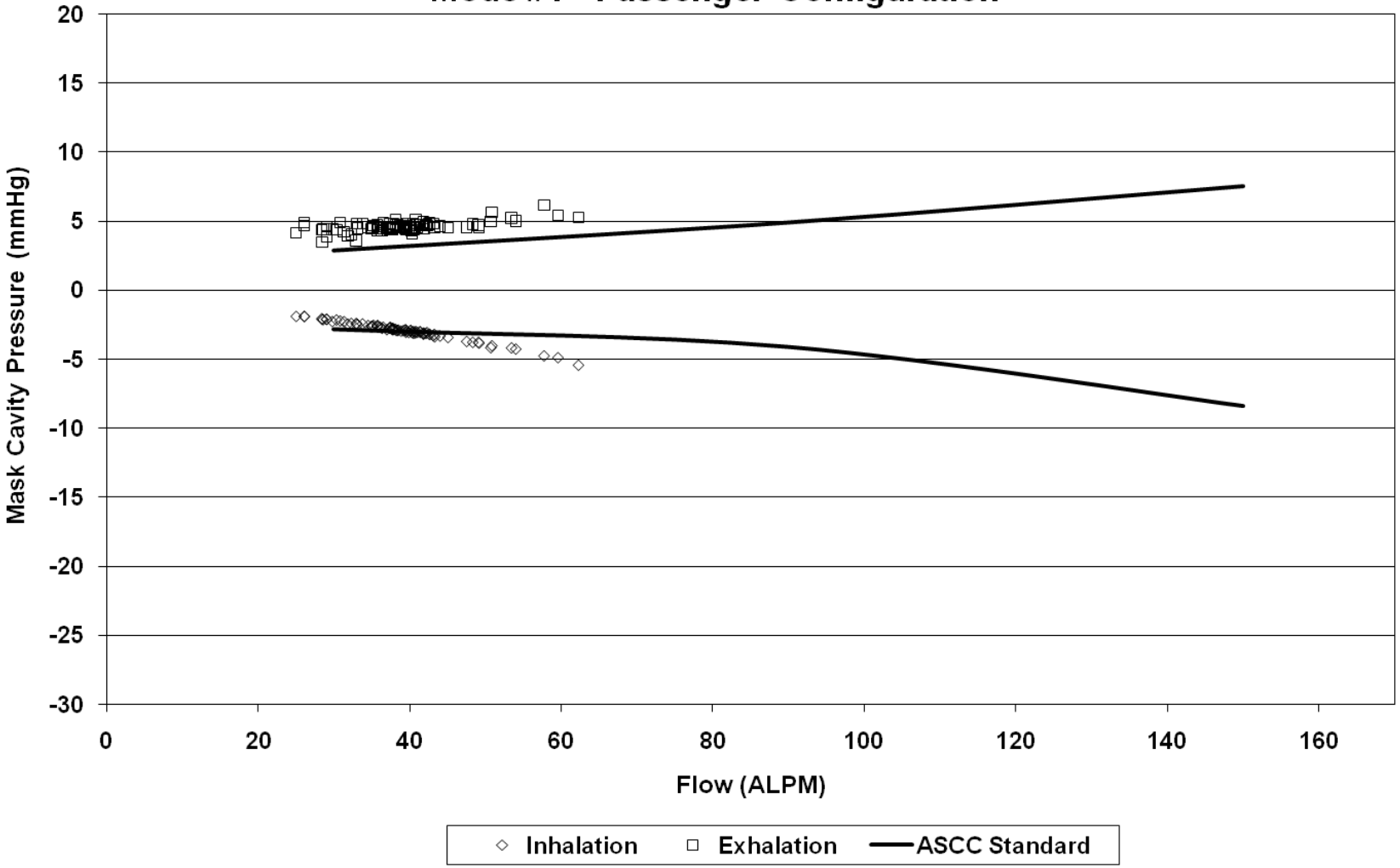


Figure 68: POS
Subject #6 Breathing Impedance - 15000 ft - Standing
Mode #4 - Passenger Configuration

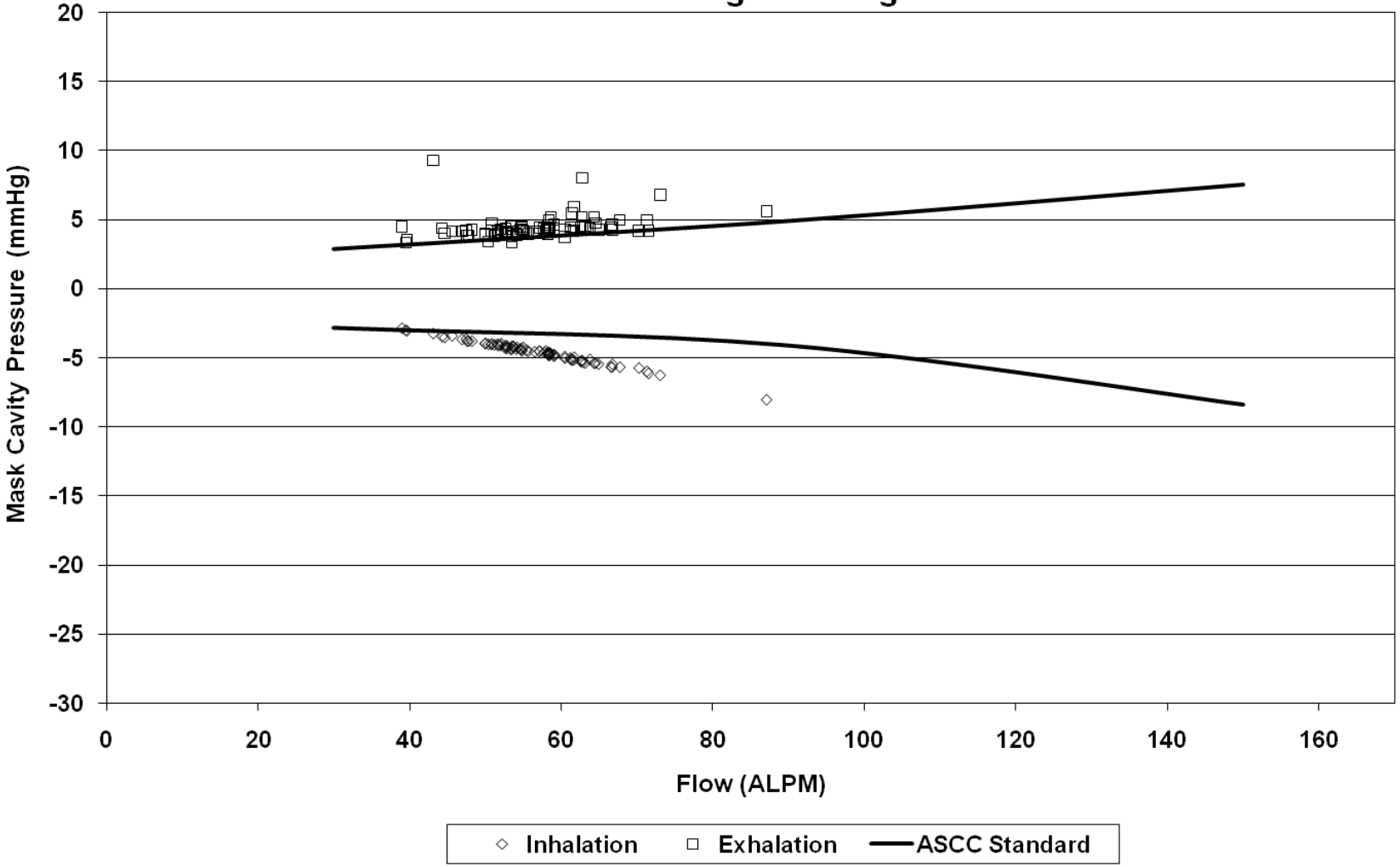


Figure 69: POS
Subject #6 Average Oxygen Concentration
Mode #5 - Medevac Configuration - 6 Breathers

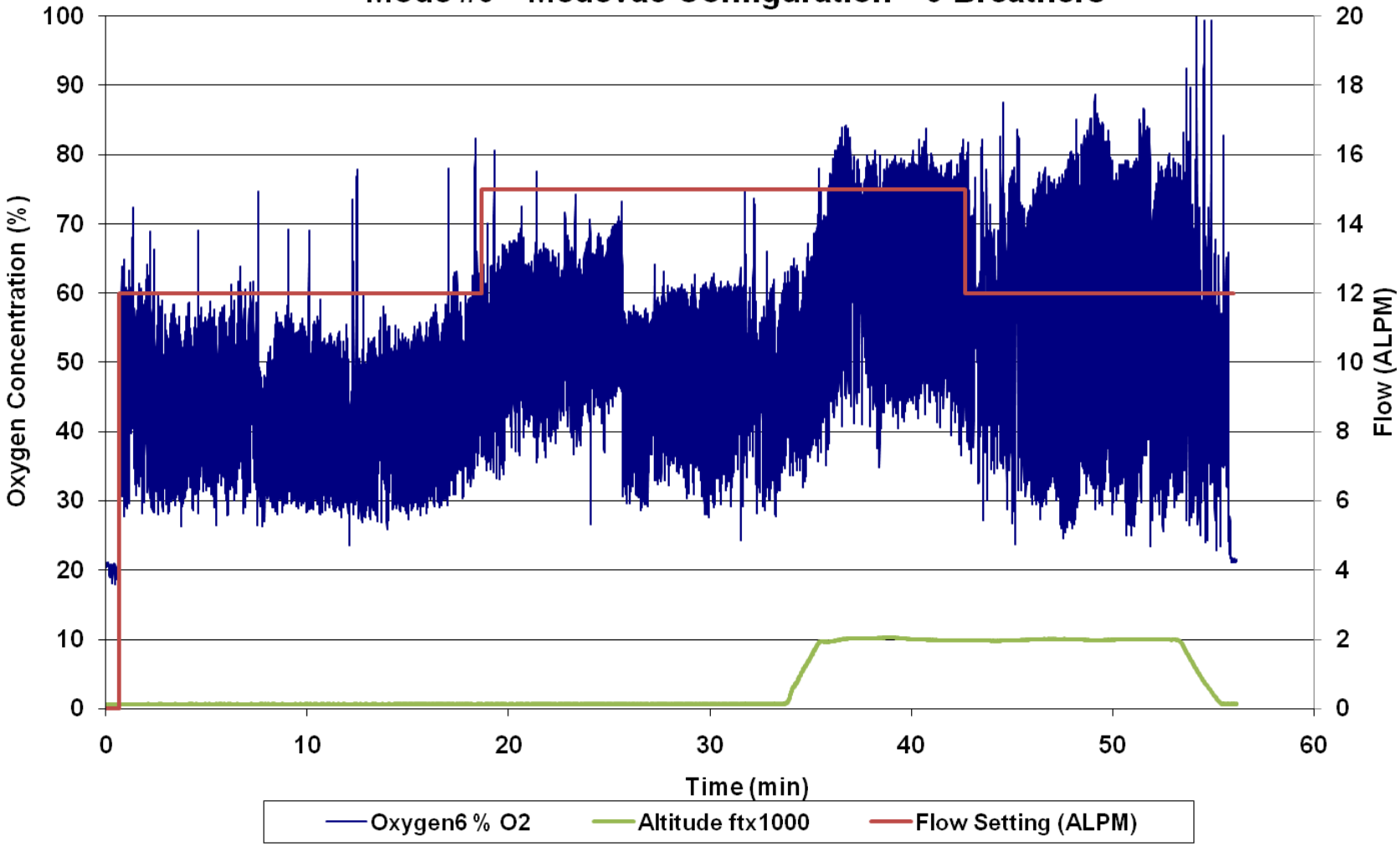
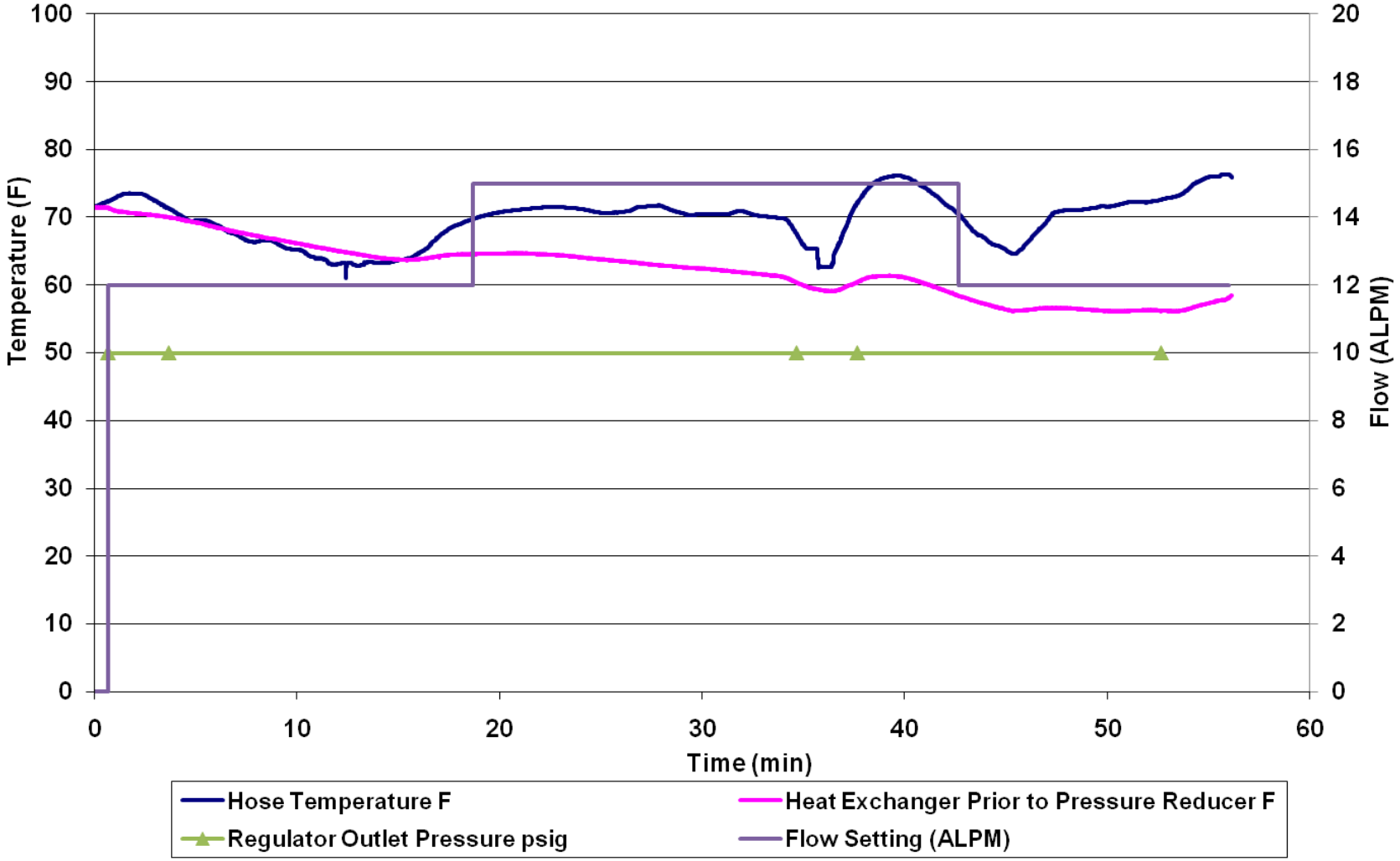


Figure 70: POS Temperatures and Regulator Outlet Pressure
Mode #5 - Medevac Configuration - 6 Breathers



APPENDIX D
MODE #1 LOGGED DATA

Mode #1 - Passenger (10 Participants) - AIROX-VIII Only - Altitude.
Purpose: System functional and interfaces test, subject orientation, and assess system at low altitude.

Date: 31 Mar 09

POS DATA/MODE #1

Event	Event Duration	Time of Day	LOX Quantity (liters)	O_2 Supply Pressure (psig)	O_2 Conc. Inside POS (%) / O_2 Conc. Inside Chbr (%)	Heat Exchanger
Masks up, breathe on system;	3 min					
check data acq. POS on						
Data acqusition #1	**1 min**	10:10	22	60	21.0/20.8	69.89
Drop Masks; POS off	1 min					
Ascend to 5,000 ft. for ear & sinus check	2 min	10:12				
Hold at 5,000 ft	5 min	10:15				
Descend to Ground Level	2 min					
Hold at Ground Level	5 min	10:17				
Ascend to 9,000 ft	2 min	10:22				
Masks up; POS on	1 min	10:26				
Data acquisition #2	**1 min**	10:28	22	70	21.1/20.8	71.51
Ss seated and resting; #1 & #6 stand during last 5 min	30 min	10:28				
Data acquisition #3	**1 min**	10:58	21	75	21.6/21.2	68.19
#2, #3, #7, #8 drop masks & disconnect from AIRVOX VIII	5 min	11:04				
#4 and #9 drop masks & disconnect from AIRVOX VIII	5 min	11:09				
#5 and #10 drop masks & disconnect from AIRVOX VIII	5 min	11:14				
All Ss reconnect & masks up	2 min	11:16				
Descend to Ground Level	2 min					
Drop masks; POS off; Stop	1 min					

APPENDIX E

MODE #1 QUESTIONNAIRES

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #1: Passenger @ Low Altitude

Participant Questionnaire

Date: 31 MAR 09

Chamber Position: #1

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #1: Passenger @ Low Altitude

Participant Questionnaire

Date: 31 MAR 09

Chamber Position: # 2

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #1: Passenger @ Low Altitude

Participant Questionnaire

Date: 3-31-09

Chamber Position: #3

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #1: Passenger @ Low Altitude

Participant Questionnaire

Date: 31 MAR09

Chamber Position: # 4

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* Yes (No)

If 'No' please comment.

The system pressure was much better after the first group disconnected. I felt like I had to suck air instead of breathing normally until there were less people using the POS.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #1: Passenger @ Low Altitude

Participant Questionnaire

Date: 3/31/09

Chamber Position: #5

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #1: Passenger @ Low Altitude

Participant Questionnaire

Date: 31 MAR 09

Chamber Position: # 6

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

NO Noticible Change when other testers Removed themselves from the system

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #1: Passenger @ Low Altitude

Participant Questionnaire

Date: 31 MAR 09

Chamber Position: #7

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #1: Passenger @ Low Altitude

Participant Questionnaire

Date: 31 MAR 09

Chamber Position: # 8

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

- System worked good.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #1: Passenger @ Low Altitude

Participant Questionnaire

Date: 3-31-09

Chamber Position: # 9

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

When I would move my Head around it became Dificult to exhale. It worked fine when still.

WFS: Movement seemed to cause the problem.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #1: Passenger @ Low Altitude

Participant Questionnaire

Date: 31 MAR 09

Chamber Position: # 10

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

APPENDIX F
MODE #2 LOGGED DATA

Mode #2 - Paratrooper (8 Participants) - AIROX-VIII Oxygen System with Twin 50s and CRU-79 Regulator - Altitude.

Purpose: System functional/interface test, subject orientation, assess system at low altitude.

Date: 31 Mar 09

POS DATA/Mode #2

Event	Event Duration	Time of Day	LOX Quantity (liters)	O_2 Supply Pressure (psig)	O_2 Conc. Inside POS (%) / O_2 Conc. Inside Chbr (%)	Heat Exchanger
Masks up, breathe on system; check data acq. POS on	5 min	14:13				
Drop masks; POS off	1 min					
Ascend to 5,000 ft. for ear & sinus check	2 min					
Hold at 5,000 ft.	5 min					
Descend to Ground Level	2 min	14:20				
Masks up; POS on	1 min	14:29				
Data acqusition #4	1 min	14:29	16	70	21.7/21.5	67.29
Ss seated and resting	30 min	15:00				
Data acquisition #5	1 min	15:01	12	70	21.6/21.4	61.40
#2, #3, #7, #8 drop masks & disconnect from AIROX VIII	5 min	15:02				
#4 & #9 drop masks & disconnect from AIROX VIII	5 min	15:07				
All Ss masks up	2 min	15:12				
Ascend to 9,000 ft.	2 min	15:14				
Data acquisition #6	1 min	15:17	11	75	21.9/21.3	60.88
Ss seated and resting	10 min	15:17				
Data acquisition #7	1 min	15:27	10	70	22.1/21.7	61.53
Descend to Ground Level	2 min					
Drop masks; POS off; Stop	1 min					

APPENDIX G

MODE #2 QUESTIONNAIRES

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #2: Paratrooper @ Low Altitude

Participant Questionnaire

Date: 31 mar 09

Chamber Position: # 7

Did you receive acceptable breathing gas at Ground Level? *(circle)* (Yes) No

at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #2: Paratrooper @ Low Altitude

Participant Questionnaire

Date: 3-31-09

Chamber Position: # 4

Did you receive acceptable breathing gas at Ground Level? *(circle)* ~~Yes~~ No

at 9,000 ft? *(circle)* Yes No

If 'No' please comment. Breathing was a bit difficult at ground level but was able to be done.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #2: Paratrooper @ Low Altitude

Participant Questionnaire

Date: 31 MAR 09

Chamber Position: # 1

Did you receive acceptable breathing gas at Ground Level? *(circle)* (Yes) No
at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

It's not comfortable, but doable. Regulator buzzing was annoying but didn't seem to effect my breathing. Def easier to breath at higher alt.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #2: Paratrooper @ Low Altitude

Participant Questionnaire

Date: 31 MAR 09

Chamber Position: # 2

Did you receive acceptable breathing gas at Ground Level? *(circle)* (Yes) No
at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #2: Paratrooper @ Low Altitude

Participant Questionnaire

Date: 31 MAR 09

Chamber Position: # 8

Did you receive acceptable breathing gas at Ground Level? *(circle)* (Yes) No
at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Every breath taken in was accompanied by a vibration

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #2: Paratrooper @ Low Altitude

Participant Questionnaire

Date: 3-31-09

Chamber Position: # 9

Did you receive acceptable breathing gas at Ground Level? *(circle)* ~~Yes~~ No
at 9,000 ft? *(circle)* Yes No

If 'No' please comment.

Hard to Breath on the Deck and ethale as altitude
Began to Rise it was easier to breath at 9000 ft
Heavy. Virbations Both times and if I didn't
ethale Right away it was Forced Out.
I had the AIR But had to Force it in and out

(1)

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #2: Paratrooper @ Low Altitude

Participant Questionnaire

Date: 3/31/09

Chamber Position: # 6

Did you receive acceptable breathing gas at Ground Level? *(circle)* (Yes) No
at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Before the fix, vibration was extramly bad.
I would not have used it with that much vibration.
No change in the ability to breath from ground, 9000

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #2: Paratrooper @ Low Altitude

Participant Questionnaire

Date: 31 MAR 09

Chamber Position: # 7

Did you receive acceptable breathing gas at Ground Level? *(circle)* (Yes) No
at 9,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Ground level breathing was acceptable, but laborous. It was difficult to both inhale and exhale. The restriction to exhaling was not constant (approx. 60% of the time) but persistant. Inhaling was further exasperated by a constant "fluttering" of what must have been a diaphram in the regulator (can be described best like a tuba sound, with the reverberation)

At altitude, breathing in was improved upon, but still not what I would call "perfect". The exhaling improved, but was still associated with an intermittant restriction.

APPENDIX H
MODE #3 LOGGED DATA

Mode #3 - Paratrooper (8 Participants) @ Altitude
Purpose: Assess paratrooper configuration at altitude.

Date: 1 Apr 09

POS DATA/Mode #3

Event	Event Duration	Time of Day	LOX Quantity (liters)	O_2 Supply Pressure (psig)	O_2 Conc. Inside POS (%) / O_2 Conc. Inside Chbr (%)	Heat Exchanger
Ascend to 5,000 ft.	2 min	9:13				
Hold at 5,000 ft.	5 min	9:15				
Descend to Ground Level	2 min	9:20				
Ascend to 8,000 ft.						
Masks up; POS on	3 min	9:20				
Data acquisition #8	**1 min**	9:28	23	70	21.1/20.9	65.87
Ss seated & resting	30 min					
Data acquisition #9	**1 min**	9:57	20	70	22.0/21.8	63.15
Ascend to 24,999 ft.	5 min	9:58				
Data acquisition #10	**1 min**	10:04	20	70	22.8/22.0	61.85
Ss seated & resting	5 min					
Data acquisition #11	**1 min**		20	75	22.9/22.1	61.80
Ss walk in place	10 min	10:10				
Data acquisition #12	**1 min**		19	75	22.9/22.2	55.49
Descend to 18,000 ft.	2 min	10:23				
Data acquisition #13	**1 min**		19	75	22.2/22.1	56.07
Ss seated & resting	5 min					
Data acquisition #14	**1 min**		18	75	22.2/21.7	56.24
Ss walk in place	10 min	10:28				
Data acquisition #15	**1 min**	10:38	17	75	22.3/21.7	54.58
Descend to 9,000 ft.	2 min					
Drop masks; POS off	1 min					
Descend to GL; Stop	3 min					

APPENDIX I
MODE #3 BLOOD OXYGEN SATURATION LEVELS

Date: 1 Apr 09

Blood Oxygen Level/Mode 3 - Paratrooper @ Altitude

Event	Event Duration	Time of Day	Chamber Position									
			1	2	3	4	5	6	7	8	9	10
Ascend to 5,000 ft.	2 min											
Hold at 5,000 ft.	5 min											
Descend to GL	2 min											
Ascend to 8,000 ft.												
Masks up; check data acq.	3 min											
Data acquisition #8	1 min											
Ss seated & resting	**30 min**		99	99	100	100		99	99	99	99	
Data acquisition #9	1 min											
Ascend to 24,999 ft.	5 min											
Data acquisition #10	1 min											
Ss seated & resting	**5 min**		99	98	99	99		98	98	98	99	
Data acquisition #11	1 min											
Ss walk in place	**10 min**		99	99	100	99		99	98	99	99	
Data acquisition #12	1 min											
Descend to 18,000 ft.	2 min											
Data acquisition #13	1 min											
Ss seated & resting	**5 min**		99	98	98	99		99	99	99	99	
Data acquisition #14	1 min											
Ss walk in place	**10 min**		99	98	99	98		99	99	99	99	
Data acquisition #15	1 min											
Descend to 9,000 ft.	2 min											
Drop masks; POS off	1 min											
Descend to G; +Stop	3 min											

APPENDIX J

MODE #3 QUESTIONNAIRES

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #3: Paratrooper @ Altitude

Participant Questionnaire

Date: 4-1-05

Chamber Position: # 1

Did you receive acceptable breathing gas at ~~Ground Level~~ 8,000 ft.? *(circle)* (Yes) No

at 24,999 ft? *(circle)* (Yes) No

at 18,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Breathing was Better than yesterday

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #3: Paratrooper @ Altitude

Participant Questionnaire

Date: 4/1/09

Chamber Position: # 2

Did you receive acceptable breathing gas at ~~Ground Level~~ 8,000 ft.? *(circle)* (Yes) No

at 24,999 ft? *(circle)* (Yes) No

at 18,000 ft? *(circle)* (Yes) No

If 'No' please comment.

- Compressing the small flex hose (4"-6") the flutering stops. this worked at all Alt's.
- Flutering was at all Alt.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #3: Paratrooper @ Altitude

Participant Questionnaire

Date: 1 Apr 09

Chamber Position: # 4

Did you receive acceptable breathing gas at ~~Ground Level~~ 8,000 ft? *(circle)* (Yes) No

at 24,999 ft? *(circle)* (Yes) No

at 18,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #3: Paratrooper @ Altitude

Participant Questionnaire

Date: 1 APR 09

Chamber Position: # 3

Did you receive acceptable breathing gas at ~~Ground Level?~~ 6,000 ft. *(circle)* (Yes) No

at 24,999 ft? *(circle)* (Yes) No

at 18,000 ft? *(circle)* (Yes) No

If 'No' please comment.

NSTR

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #3: Paratrooper @ Altitude

Participant Questionnaire

Date: 1 APR 09

Chamber Position: # 6

Did you receive acceptable breathing gas at ~~Ground Level~~ 8,000 ft? *(circle)* (Yes) No

at 24,999 ft? *(circle)* (Yes) No

at 18,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #3: Paratrooper @ Altitude

Participant Questionnaire

Date: 14 Aug 09

Chamber Position: #7

Did you receive acceptable breathing gas at ~~Ground Level~~ 8,000 ft? *(circle)* ~~Yes~~ No
at 24,999 ft? *(circle)* Yes No
at 18,000 ft? *(circle)* Yes No

If 'No' please comment.

Def better at higher altitude.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #3: Paratrooper @ Altitude

Participant Questionnaire

Date: 1 APR 09

Chamber Position: #8

Did you receive acceptable breathing gas at ~~Ground Level~~ 4,000 ft? *(circle)* (Yes) No
at 24,999 ft? *(circle)* (Yes) No
at 18,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Oxygen level was acceptable at all altitudes, but experienced the same low Frequency "flutter" as previous Flight (all altitudes).

Through trial and error, discovered that by compressing the small extension hose (6") going to the Crew-79, the Fluttering would stop... completely. I tried moving the Crew-79 in all axis to see if any effect, but again, compressing the small extension hose made breathing much smoother with elimination of the Fluttering.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #3: Paratrooper @ Altitude

Participant Questionnaire

Date: 4-01-09

Chamber Position: # 9

Did you receive acceptable breathing gas at ~~Ground Level~~ 8,000 ft? *(circle)* (Yes) No

at 24,999 ft? *(circle)* (Yes) No

at 18,000 ft? *(circle)* (Yes) No

If 'No' please comment.

APPENDIX K
MODE #4 LOGGED DATA

Mode #4 - Passenger (10 Participants) @ Altitude
Purpose: Assess passenger configuration at altitude.

Date: 2 Apr 09

POS DATA/Mode #4

Event	Event Duration	Time of Day	LOX Quantity (liters)	O_2 Supply Pressure (psig)	O_2 Conc. Inside POS (%) / O_2 Conc. Inside Chbr (%)	Heat Exchanger
Ascend to 5,000 ft.	2 min					
Hold at 5,000 ft.	5 min					
Descend to Ground Level	2 min					
Masks up & POS on, Verify AIROX-III ops; then Masks down & POS off	5 min					
Data acquisition #16	**1 min**		23	70	21.2/21.2	71.31
Ascend to 9,000 ft.	2 min					
Masks up; POS on	5 min					
Ascend to 17,999 ft.	4 min					
Data acquisition #17	**1 min**		22	75	21.7/21.4	not recorded
Ss seated & resting	30 min					
Data acquisition #18	**1 min**		21	75	22.5/22.2	64.40
Descend to 15,000 ft.	1 min					
Data acquisition #19	**1 min**		20	75	22.3/22.1	not recorded
Ss seated & resting	30 min					
Data acquisition #20	**1 min**		19	70	22.6/22.3	not recorded
Descend to 9,000 ft.	1 min					
Drop masks; POS off	1 min					
Descend to GL; Stop	3 min					

APPENDIX L
MODE #4 BLOOD OXYGEN SATURATION LEVELS

Date: 2 Apr 09

Blood Oxygen Level (%)/Mode 4 - Passenger @ Altitude

Event	Event Duration	Time of Day	Chamber Position									
			1	2	3	4	5	6	7	8	9	10
Ascend to 5,000 ft.	2 min											
Hold at 5,000 ft.	5 min	~ 13:00	94	92	94	94	94	94	95	94	94	96
Descend to Ground Level	2 min											
Masks up & POS on, Verify AIROX-III ops; then Masks down & POS off	5 min											
Data acquisition #16	1 min											
Ascend to 9,000 ft.	2 min											
Masks up; POS on	5 min											
Ascend to 17,999 ft.	4 min											
Data acquisition #17	1 min											
Ss seated & resting	**30 min**	13:25	98	98	98	99	98	98	98	99	98	98
		13:39	99	98	97	96	98	98	98	98	98	98
		13:52	98*	97	97	97	96	98*	98	99	98	98
Data acquisition #18	1 min											
Descend to 15,000 ft.	1 min											
Data acquisition #19	1 min											
Ss seated; resting	**30 min**	13:58	98	97	97	97	97	98	98	98	98	98
		14:13	97	98	97	98	100	98	98	98	98	99
		14:26	99*	98	99	98	100	98*	98	98	99	99
Data acquisition #20	1 min											
Descend to 9,000 ft.	1 min											
Drop masks; POS off	1 min											
Descend to GL; Stop	3 min											

* Subjects' #1 and #6 O_2 saturation levels were recorded after having them walk in place for the last 5 minutes of each 30 minute period.

APPENDIX M

MODE #4 QUESTIONNAIRES

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #4: Passenger @ Altitude

Participant Questionnaire

Date: 02 Apr 09

Chamber Position: #1

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

at 17,999 ft? *(circle)* (Yes) No

at 15,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #4: Passenger @ Altitude

Participant Questionnaire

Date: 02 APR 2009

Chamber Position: # 2

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No
at 17,999 ft? *(circle)* (Yes) No
at 15,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #4: Passenger @ Altitude

Participant Questionnaire

Date: 2 APR 09

Chamber Position: # 3

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No
at 17,999 ft? *(circle)* (Yes) No
at 15,000 ft? *(circle)* (Yes) No

If 'No' please comment.
Overall flow was very good. Noticed no issues with altitude changes.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #4: Passenger @ Altitude

Participant Questionnaire

Date: 2 Apr 09

Chamber Position: # 4

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

at 17,999 ft? *(circle)* (Yes) No

at 15,000 ft? *(circle)* (Yes) No

If 'No' please comment.

– Had no vibrations

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #4: Passenger @ Altitude

Participant Questionnaire

Date: 2 APR 09

Chamber Position: # 5

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

at 17,999 ft? *(circle)* Yes No

at 15,000 ft? *(circle)* Yes No

If 'No' please comment.

NSTR

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #4: Passenger @ Altitude

Participant Questionnaire

Date: 4/-02-09

Chamber Position: # 6

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

at 17,999 ft? *(circle)* (Yes) No

at 15,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #4: Passenger @ Altitude

Participant Questionnaire

Date: 02 APR 09

Chamber Position: # 7

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

at 17,999 ft? *(circle)* (Yes) No

at 15,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #4: Passenger @ Altitude

Participant Questionnaire

Date: 2 APR 09

Chamber Position: # 8

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No
at 17,999 ft? *(circle)* (Yes) No
at 15,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #4: Passenger @ Altitude

Participant Questionnaire

Date: 2 Apr 09

Chamber Position: # 9

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No
at 17,999 ft? *(circle)* (Yes) No
at 15,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #4: Passenger @ Altitude

Participant Questionnaire

Date: 02 Nov 05

Chamber Position: # 10

Did you receive acceptable breathing gas at 9,000 ft? *(circle)* (Yes) No

at 17,999 ft? *(circle)* ~~Yes~~ No

at 15,000 ft? *(circle)* (Yes) No

If 'No' please comment.

APPENDIX N
MODE #5 LOGGED DATA

Mode #5 - Medevac (6 Participants) @ Altitude
Purpose: Assess patient configuration at altitude.

Date: 3 Apr 09

POS DATA/Mode #5

Event	Event Duration	Time of Day	LOX Quantity (liters)	O_2 Supply Pressure (psig)	O_2 Conc. Inside POS (%) / O_2 Conc. Inside Chbr (%)	Heat Exchanger
Ascend to 5,000 ft.	2 min					
Hold at 5,000 ft.	5 min					
Descend to Ground Level	2 min					
POS on; Dial-in 12 L/min flow	1 min					
Medical masks on	2 min					
Data acquisition #21	**1 min**	13:24	19	50	20.9/20.9	71.42
Ss seated & resting	30 min					
Data acquisition #22	**1 min**	13:58	15	50	21.3/21.5	61.67
Ascend to 10,000 ft.	2 min					
Data acquisition #23	**1 min**	14:01	15	50	21.5/21.3	59.19
Ss seated & resting	15 min					
Data acquisition #24	1 min		13	50	21.9/22.0	56.29
Descend to GL	2 min					
Drop masks; POS off; Stop	1 min					

APPENDIX O
MODE #5 BLOOD OXYGEN SATURATION LEVELS

Date: 3 Apr 09

Blood Oxygen Level (%)/Mode 5 - Medevac

Event	Event Duration	Time of Day	Chamber Position					
			1	2	3	6	7	8
Ascend to 5,000 ft.	2 min							
Hold at 5,000 ft.	5 min	13:32	93	90	92	96	96	95
Descend to Ground Level	2 min							
POS on; Dial-in 12 L/min flow	1 min							
Medical masks on	2 min							
Data acquisition #21	1 min							
Ss seated & resting	30 min	13:42	95	97	100	99	99	99
		13:57	98	98	99	99	99	99
Data acquisition #22	1 min							
Ascend to 10,000 ft.	2 min							
Data acquisition #23	1 min							
Ss seated & resting	15 min	14:06	99	98	99	99	98	99
		14:16	98	98	98	99	99	99
Data acquisition #24	1 min							
Descend to GL	2 min							
Drop masks; POS off; Stop	1 min							

APPENDIX P

MODE #5 QUESTIONNAIRES

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #5: Medevac

Participant Questionnaire

Date: 3 Apr 09

Chamber Position: # 1

Did you receive acceptable breathing gas at Ground Level? *(circle)* (Yes) No

at 10,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #5: Medevac

Participant Questionnaire

Date: 3 APR 09

Chamber Position: # 2

Did you receive acceptable breathing gas at Ground Level? *(circle)* (Yes) No

at 10,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #5: Medevac

Participant Questionnaire

Date: 03 APR 09

Chamber Position: # 3

Did you receive acceptable breathing gas at Ground Level? *(circle)* (Yes) No

at 10,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #5: Medevac

Participant Questionnaire

Date: 3 APR 09

Chamber Position: # 6

Did you receive acceptable breathing gas at Ground Level? *(circle)* (Yes) No

at 10,000 ft? *(circle)* (Yes) No

If 'No' please comment.

NS7R

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #5: Medevac

Participant Questionnaire

Date: 08 April 09

Chamber Position: # 7

Did you receive acceptable breathing gas at Ground Level? *(circle)* (Yes) No

at 10,000 ft? *(circle)* (Yes) No

If 'No' please comment.

Manned Testing of CV-22 Passenger Oxygen System (POS)

Mode #5: Medevac

Participant Questionnaire

Date: 3 APR 09

Chamber Position: # 8

Did you receive acceptable breathing gas at Ground Level? *(circle)* (Yes) No

at 10,000 ft? *(circle)* (Yes) No

If 'No' please comment.

APPENDIX Q

EQUIPMENT

1. Passenger Oxygen System with Ballistic Armor, P/N B45475-1, S/N 0001

2. AIROX VIII Oxygen Metering Valve, 12 ea., P/N 7920015-1M, Cobham Mission Systems, Orchard Park NY.

S/N: 6675, 6672, 6671, 6670, 6668, 6666, 6669, 6686, 6688, 6677, 6691, 6689

3. Standard Paratrooper Systems: AIROX VIII Oxygen System with Twin 50 Oxygen Bottles and CRU-79 Oxygen Regulator.

Oxygen Bottles, P/Ns 8620028-1
Oxygen Manifold, P/N 9320113-3
AIROX VIII, P/N 7920015
CRU-79, NSN 1660-01-139-5691

Oxygen Bottles S/Ns: TW50-43, TW50-42, TW50-41, TW50-45, TW50-37, TW50-44, TW50-39, TW50-46, TW50-40, TW50-38

Oxygen Manifold S/Ns: 0647, 0669, 0667, 0668, 0778, 0740, 0674, 0666, 0665, 0784

AIROX VIII S/Ns: 6187, 6143, 6179, 6146, 6007, 6029, 6041, 6046, 6012, 6183

CRU-79 S/Ns: 000037441, 000037444, 000036711, 000036699, 000037450, 000037451, 000037456, 000036704, 000037442, 000036710

4. Purge Kit, P/N F137-1015-3, S/N 1046

5. PTLOX Accessory Kits, P/N 19062-50C-0021-0001, Essex Cryogenics, S/N R186 and R197

6. MBU-12/P Oxygen Masks

7. HGU-55/P Helmets

8. Instrumentation:

a. Marquette Electronics, MGA-1100 Medical Gas Analyzer, S/N H2C21168G, Calibration: Each Day

b. Marquette Electronics, M-100 Laboratory Gas Analysis System, S/N J6CS0004G, Calibration: Each Day

c. Oxigraf Model O2 Oxygen Analyzer, S/N 02-01572, Calibration: Each Day

d. Oxigraf Model O2 Oxygen Analyzer, S/N 02A-00211, Calibration: Each Day

e. Propac PhysioLogic Monitor, Model 242, S/N GA002457, Calibration Date: 09/2008

f. Sense Pro Pulse Oximeter, S/N AC05100223

g. BCI International Pulse Oximeter, S/N 703597630, Calibration Date: 03/2009

h. 2 ea. Flow meters, Pneumotachograph, Fleisch, Calibration: Each Day

APPENDIX R

POS SAFE-TO-FLY LETTER

DEPARTMENT OF THE AIR FORCE

AIR FORCE RESEARCH LABORATORY

29 Apr 09

MEMORANDUM FOR V-22 Joint Program Office
47123 Buse Road
Patuxent River MD 20670-1547
ATTN: James Jackson

FROM: AFRL/711 HPW/RHP
2215 First Street (Building 33)
Wright-Patterson AFB OH 45433-7028

SUBJECT: Safe-to-Fly Letter for Passenger Oxygen System (POS)

1. At the request of the V-22 Joint Program Office, AFRL/711 HPW/RHPG, Brooks City-Base TX conducted altitude chamber testing of the Passenger Oxygen System (Cobham Mission Systems, Orchard Park NY; P/N B45475-1, S/N 0001) with ballistic armor. The overall test period was 23 Mar 09 to 03 Apr 09. The system was tested in three configurations: passenger, paratrooper, and medevac. POS delivered adequate oxygen flow and pressure (greater than 60 psig in passenger and paratrooper configurations and 50 psig in the medevac configuration); and was found safe-to-fly to the altitudes and under the conditions noted below.

a. <u>Passenger Configuration</u>: In the passenger configuration POS provided adequate oxygen to prevent hypoxia for **up to ten (10) seated and resting passengers (one POS unit) or up to twenty (20) seated and resting passengers (two POS units) to an altitude of 17,999 feet MSL** with the personal equipment noted below. Recommend each POS include 1 ea. CRU-79 oxygen regulator with supply hose. This regulator is capable of delivering 100% oxygen in the unlikely event a passenger experiences decompression sickness.

(1) AIROX VIII Oxygen Metering Valve (Cobham Mission Systems, P/N 7920015-1M)
(2) MBU-12/P Oxygen Mask
(3) HGU-55/P Helmet

b. <u>Paratrooper Configuration</u>: In the paratrooper configuration POS provided sufficient 100% oxygen for pre-breathing and high altitude operations for **up to eight (8) paratroopers**

(one POS unit) or up to sixteen (16) paratroopers (two POS units) to an altitude of 24,999 feet MSL with the standard paratrooper equipment noted below.

(1) AIROX VIII Oxygen Metering Valve (Cobham Mission Systems, P/N 7920015)
(2) Twin 50 Oxygen Bottles and Manifold (Cobham Mission Systems, P/Ns 8620028-1 and 9320113-3)
(3) CRU-79 Oxygen Regulator (NSN 1660-01-139-5691)
(4) MBU-12/P Oxygen Mask
(5) HGU-55/P Helmet

c. <u>Medevac Configuration</u>: In the medevac configuration POS delivered sufficient oxygen to **up to six (6) patients (one POS unit) or up to twelve (12) patients (two POS units) to an altitude of 10,000 feet MSL** with the equipment noted below. POS was capable of delivering an adequate flow even when the individual PTLOX flow selector valves were set to their highest flow setting, 15 liters/minute. **POS should only be used with patients after it obtains FDA approval.**

(1) PTLOX accessory kit (Essex Cryogenics, P/N 19062-50C-0021-0001)
(2) Minilator Flow Distributor (Allied Healthcare Products Inc., Model No. LP43)
(3) Continuous Flow Medical Oxygen Mask

2. Unmanned and manned tests were conducted according to procedures defined in:

a. "Informed Consent Document for Manned Altitude Chamber Testing of CV-22 Passenger Oxygen System (POS)," 27 Mar 09.

b. "Test Plan for Passenger Oxygen System (POS) Altitude Chamber Testing," Issue J, 27 Mar 09.

3. If you have any questions, my POC for this effort is George Miller (210-536-8128 or DSN 240-8128). A final report for the effort will be submitted in 60 days.

///signed///
TIMOTHY S. WOODRUFF, Lt Col, USAF, BSC
Chief, Biobehavioral Performance Branch