

Testing the Vented, 7-Liter Induction Chamber

Report 6 April 2008

The final review and approval of this document before its release to the client is the responsibility of the following person at Technical Safety Services. In signing this cover-sheet, he acknowledges the accuracy of the data and activities reported herein:

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Airflow Performance and Tracer Gas Containment Test Report

1 Title: Testing the Vented, 7-Liter Induction Chamber

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4 Purpose:

This report documents the results of special air flow performance tests conducted by TSS, Inc. upon a VetEquip, Inc. Vented, 7-Liter Induction Chamber. These tests were designed to collect data so that VetEquip, Inc. personnel could evaluate the basic suitability of the 7-Liter Chamber as a containment device for anesthetic gasses; the 7-Liter Chamber is designed to contain these gasses in a manner that protect the worker.

5 Summary:

5.1 Technicians from Technical Safety Services [TSS] performed airflow and tracer gas performance tests on the 7-Liter Chamber on November 29th, 2007.

5.2 The basic test results are tabulated here and described in the following:

Vacuum, "wc	Average Inflow, fpm in slot	Average Inflow, cfm	Tracer gas flow, ml/min	Analogous Rating	Comment
0.20	~100	7	400	0.4 AM 0.08 - SME 2.54	<0.1ppm leakage
0.20	~100	7	2000	2.0 AM 0.19 - SME 0.24	>0.1ppm leakage
0.25	~130	9	400	0.4 AM 0.06 - SME 0.14	<0.1ppm leakage
0.25	~130	9	2000	2.0 AM 0.10 - SME 1.59	<0.1ppm leakage

5.2.1 TSS tested the 7-Liter Chamber at vacuum-settings of 0.20"wg and 0.25"wg measured at the evacuation port/collar, TSS measured average velocities of ~100 and ~130 feet per minute, respectively within the 4.50"x2.25" slot. At the higher speed, this corresponds roughly to a requirement of 9 cubic feet per minute.

- 5.2.2 At both settings, the slot competently, visually captured air the sliding lid, and challenge smoke within the chamber was seen to be wholly captured when the lid is opened and closed.
 - 5.2.3 With the vacuum setting at 0.25"wg, when injecting Sulfur Hexafluoride tracer gas at either ~0.4lpm or ~2lpm in a manner derivative of ASHRAE 110-1995, using a (human) manikin at a simulated, optimal viewing position, there was ≤ 0.10 ppm in the manikin breathing zone. There is no stated acceptance criterion for this tracer result, however any result ≤ 0.10 ppm is typically very acceptable.
- 5.3 The scope of testing was limited to the following items:
- 5.3.1 In the manner of TSS SOP 4-6.v2, "Field Testing of Slot Hoods," TSS determined the capture velocity and the effective distance of capture from the 7-Liter Chamber' slot. This established the ventilation rate for the subsequent tests.
 - 5.3.2 TSS injected tracer gas into the 7-Liter Chamber to mimic the performance of an anesthetic vapor. TSS then sampled for tracer leakage in the breathing zone of a human manikin, positioned above the 7-Liter Chamber to simulate an optimum viewing position, about 14" above the 7-Liter Chamber itself. TSS selected two injection rates, 400 ml/min and 2 l/m, and tested the ability of the 7-Liter Chamber to contain the tracer gas under steady-state conditions as well as the effect of opening and closing the lid.
- 5.4 Test results are discussed in greater detail in section 6 of this report. Cited figures, tables and diagrams are in section 7 of this report. Deviations are cited in Section 8, and Section 9 contains pertinent additional documents used to support the validity of this report.

6 Test Results:

6.1 Capture Velocity versus Vacuum:

6.1.1 Test Method:

In the manner of TSS SOP 4-6, TSS traversed the 7-Liter Chamber in the slot entry plane using a calibrated anemometer while simultaneously adjusting the airflow rate and probing with a neutral-density challenge smoke (titanium tetrachloride, $TiCl_4$). Once the airflows were adjusted so that the smoke was captured along the length of the lid, and smoke in the chamber was visually captured when the lid was opened & closed, TSS recorded the static pressure at the evacuation port/collar.

TSS chose the slot entry plane and the evacuation port/collar as the data sampling points because they would be easy for any competent technician to replicate.

Since the evacuation port/collar on the 7-Liter Chamber does not have any filter or damper components, the essential relationship between capture efficiency and static pressure should not change. TSS performed this test under still air conditions; the cross-currents in the vicinity of the 7-Liter Chamber were <5 fpm.

6.1.2 Acceptance Criteria:

For acceptance, challenge smoke must be captured along the length of the lid, and smoke in the chamber must be visually captured when the lid is opened & closed.

6.1.3 Test Results:

6.1.3.1 The smoke was captured along the length of the lid, and smoke in the chamber was visually captured when the lid was opened & closed when the airflow velocity in the slot entry plane averages >100 feet per minute. This corresponded to a pressure of -0.20" w.c. at the evacuation port/collar. However, in this low velocity allowed a greater than 0.10ppm tracer gas leakage, so TSS successfully repeated the measurements at 0.25"wg vacuum and ~130 fpm.

6.1.3.2 In the 4.50"x2.25" slot, the 130 feet per minute velocity corresponds roughly to 9 cubic feet per minute. TSS has not applied an A_k correction to this value.

6.1.3.3 Diagram 1 illustrates some of the smoke capture properties of the slot.

6.2 Tracer Gas Performance Tests:

6.2.1 Test Method:

With the 7-Liter Chamber operating normally and providing the flow conditions described in the previous section, and in a manner derivative of ASHRAE 110-1995, TSS injected undiluted, 99.97% Sulfur Hexafluoride tracer gas into 'Chamber, then sampled for leakage in the breathing zone of a second, human manikin, positioned about 14" above the patient.

This level of realism is warranted because of concerns that the representative tracer gas flow rate, 400-2,000 ml/min, might result in leakage from the 'Chamber itself and enter the worker's breathing zone. The flow rates of 400 ml/min and 2,000 ml/min were selected as typical for rats/patients to be treated in the 7-Liter Chamber.

With the tracer gas flowing at 400 ml/min., TSS continuously sampled air from the human manikin-breathing zone for five minutes. TSS used a calibrated Thermo Electron Model 205B Miran Sapphre with an inherent sensitivity (LOD) of ≤ 0.007 ppm for the Sulfur Hexafluoride tracer gas. The form of the data from this instrument was 30 consecutive, logged, 10-second readings stored in an Excel file, available for audit at TSS. Three replicates ('trials') of the five-minute test are performed.

After the five minute trials were completed, the effect of the lid was tested ("sash effect"). While logging the leakage concentration *with the gas running*, the lid was opened for two minutes, and then closed for two minutes. Three replicates of this test were also conducted, and the peak value is reported. This test could model the result of an accidental opening of the 'Chamber while the anesthetic gas was in use.

Two different tracer gas flow rates and two different vacuums were compared, resulting in a total of four (4) sets of test data.

6.2.2 Acceptance Criteria:

There are no formal criteria applied to this test. As a means of comparison, an exposure of ≤ 0.10 ppm is typically tolerated in other ventilated enclosures.

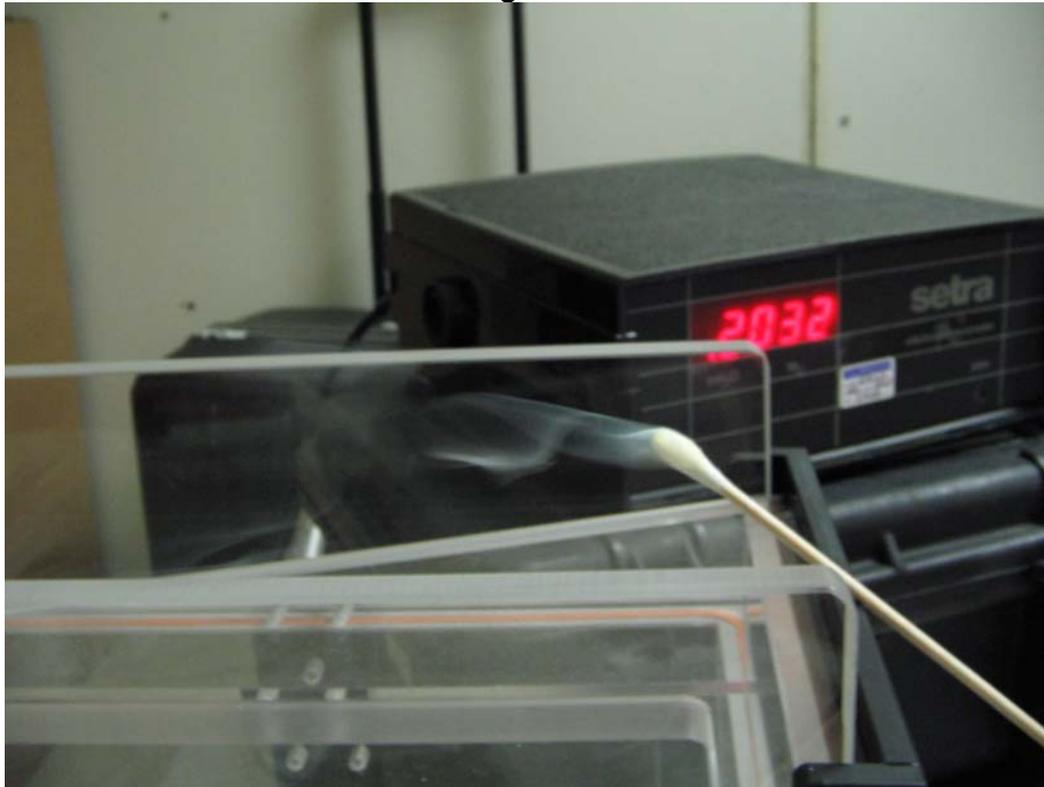
6.2.3 Test Results:

- 6.2.3.1 Testing the 7-Liter Induction Chamber at 0.20"wg with 2,000ml/min tracer gas had a leakage of 0.19ppm. All three of the trials in this configuration were above 0.10ppm.
- 6.2.3.2 None of the other test positions had readings >0.10 "wg during the 5-minute runs.
- 6.2.3.3 Sash effect results range from 0.14-2.54ppm. There is no consensus standard for acceptance of this data.
- 6.2.3.4 The plotted tracer gas data and corresponding tables are included as Figures 2-6.

7 Diagrams and Tables:

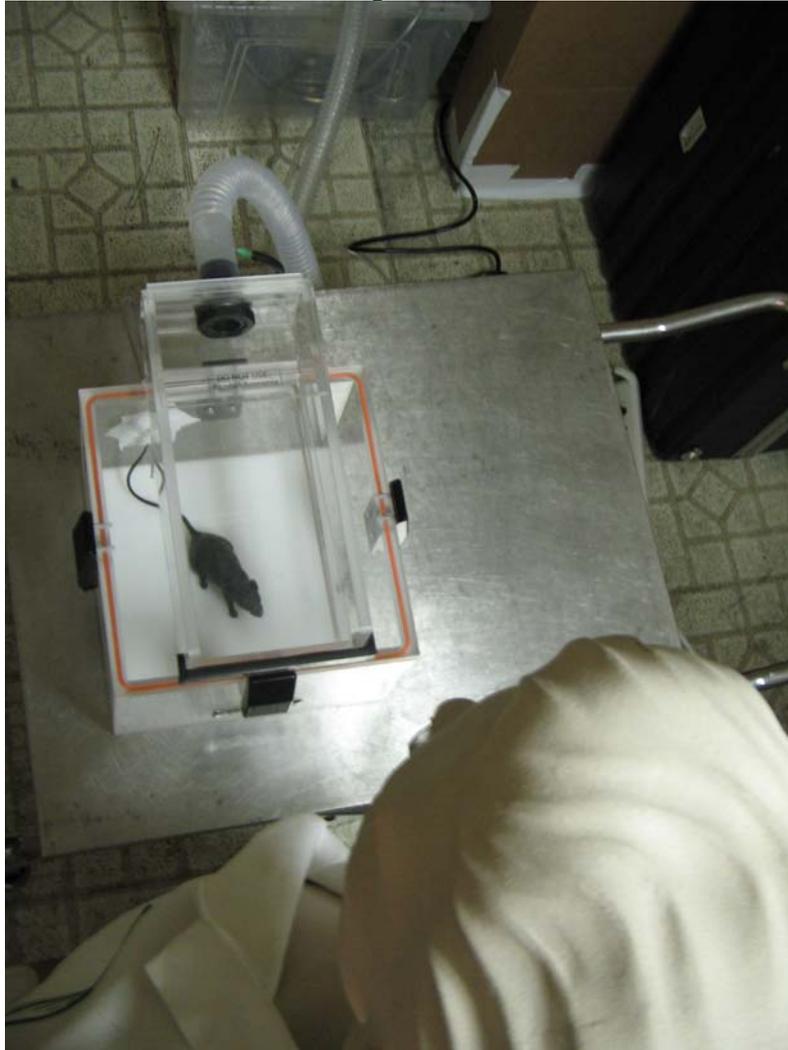
Item	Description
Figure 1	Elevation of 7-Liter Chamber Showing Airflow Capture
Figure 2	Tracer Gas Test Geometry
Figure 3	Tracer Gas Leakage Plot & Table: 0.20"wg Vacuum and 400 ml/min
Figure 4	Tracer Gas Leakage Plot & Table: 0.20"wg Vacuum and 2,000 ml/min
Figure 5	Tracer Gas Leakage Plot & Table: 0.25"wg Vacuum and 400 ml/min
Figure 6	Tracer Gas Leakage Plot & Table: 0.25"wg Vacuum and 2,000 ml/min

Figure 1



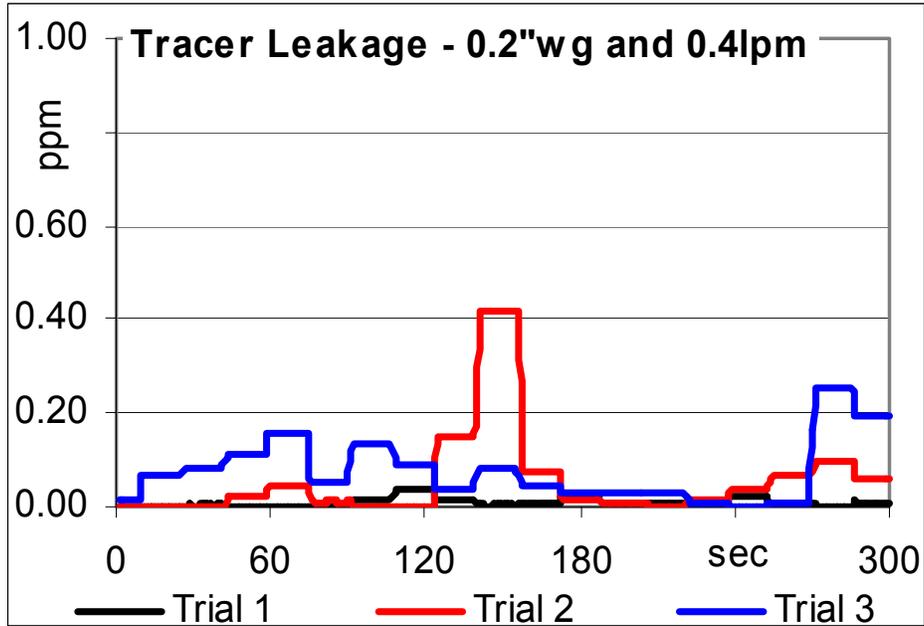
Elevation of 7-Liter Chamber Showing acceptable airflow capture at 0.20"wg vacuum.
Airflow capture improves for all values of vacuum greater than 0.20"wc.

Figure 2



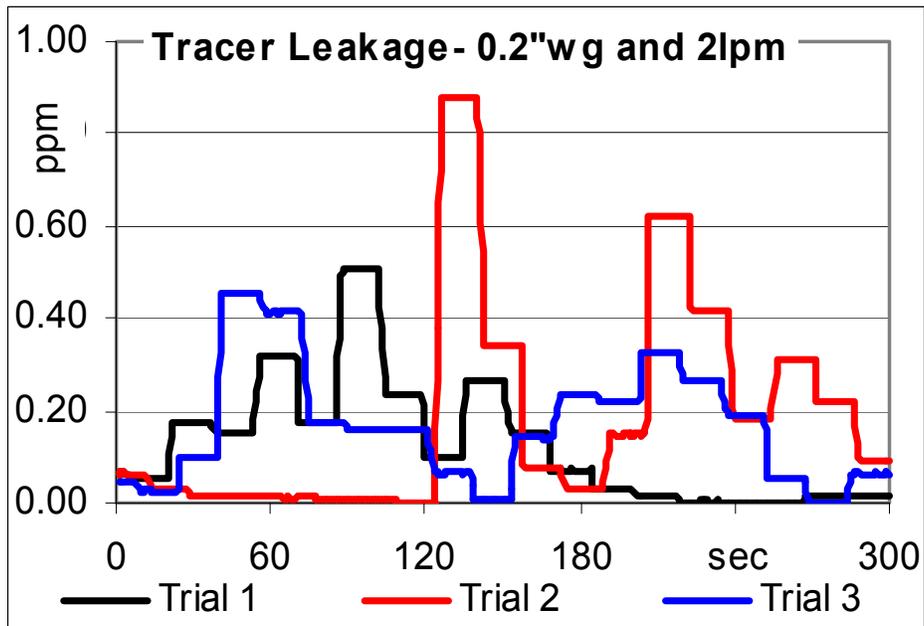
Tracer Gas Test Geometry (~14" viewing distance to top of Chamber; Simulated Rodent)

Figure 6



Trial	#1	#1	#3
Rating	0.01 ppm	0.05 ppm	0.08 ppm
Sash Effect	2.54 ppm	1.19 ppm	0.67 ppm

Figure 7



Trial	#1	#1	#3
Rating	0.13 ppm	0.19 ppm	0.17 ppm
Sash Effect	0.10 ppm	0.24 ppm	0.13 ppm

Figure 8

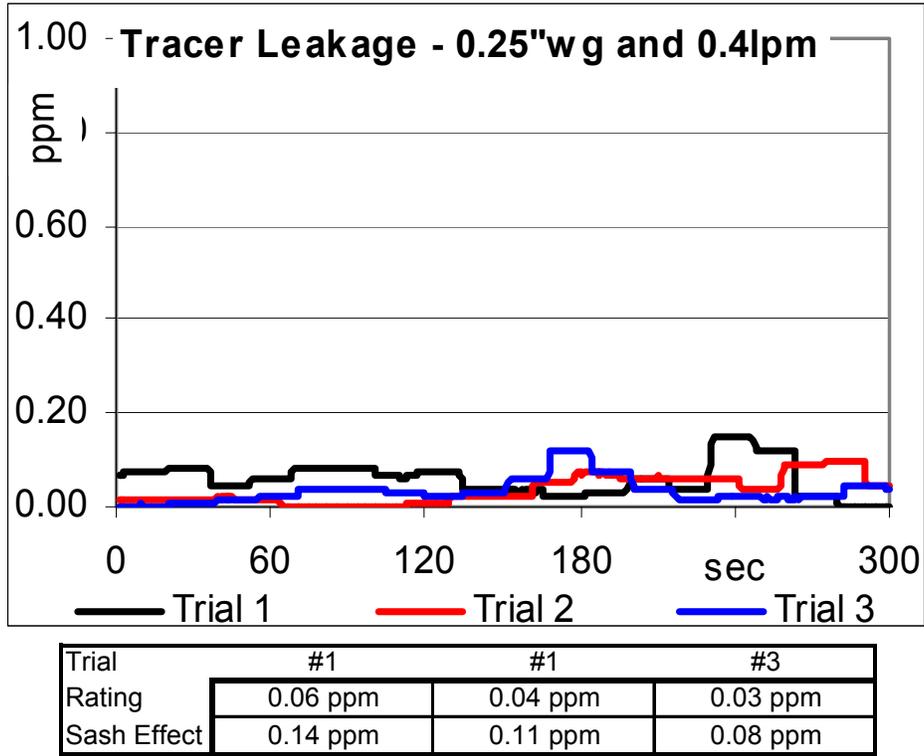
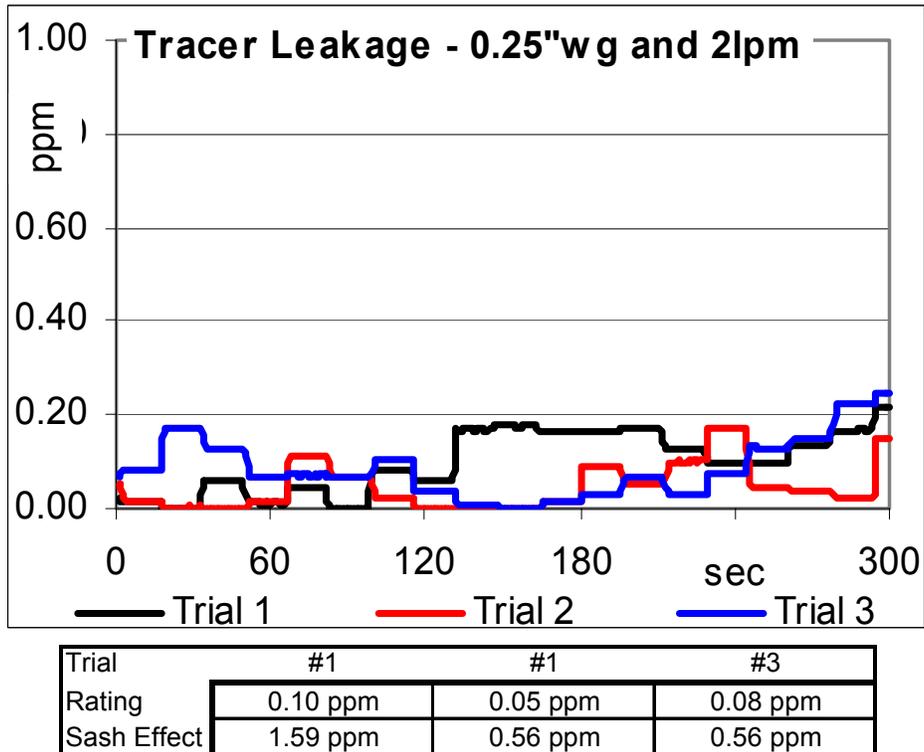


Figure 9



8 Discrepancies and Alterations:

The following is a list of known discrepancies and alterations made with regard to this project. The changes made after the date of testing were corrections of errors in the recorded field data.

- 8.1 The only attestable deviation from TSS' normal, field documentation practices was the automatic recording of data to an Excel spreadsheet. TSS anticipates no diminution in the data integrity as a consequence of this change.

9 Pertinent Additional Documentation:

Original field data and calibration certificates are archived at the main office of Technical Safety Services, Inc.