Airflow Performance Testing of the COMPAC^5

Report 25 November 2007

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:

Martin Burke
Field Engineering Manager

date: 11/26/07

Airflow Performance and Tracer Gas Containment Test Report

1 Title: Airflow Performance Testing of the COMPAC^5

2 Site: TSS, Inc.
620 Hearst Avenue
Berkeley, CA 94710

3 Contacts: Marie Carretta
Office Manager
VetEquip, Inc.
7070 Commerce Circle
Pleasanton, CA 94588
1.925.463.1828

Martin Burke
Engineering Manager
TSS, Inc.
1.800.877.7742

4 Purpose:

The purpose of this report is to document the results of special air flow performance tests conducted by TSS, Inc. upon a VetEquip, Inc. COMPAC^5 anesthesia station. These tests were designed to collect data so that VetEquip, Inc. personnel could evaluate the basic suitability of the COMPAC^5 as a containment device for anesthetic gasses used in conjunction with surgical procedures for small animals; the COMPAC^5 is designed to contain these gasses in a manner that protect the worker.

5 Summary:

5.1 Technicians from Technical Safety Services [TSS] performed tests on the COMPAC^5 between August 21, 2007 and October 25, 2007.

5.2 The basic test results follow:

5.2.1 The COMPAC^5 was tested with static pressures in the range of -0.10”wc to -2.00”wc (25cfm to 108cfm, respectively). At all of these flow settings, the intake grille competently captured still air along the full length of the sliding doors.

5.2.2 When injecting ~3.0 lpm tracer gas in a manner derivative of ASHRAE 110-1995, with the (human) manikin at a simulated, optimal viewing position, the maximum leakage was ~0.03 ppm in the manikin breathing zone. There is no stated acceptance criterion for this tracer result, however any result <0.10ppm is typically very acceptable.

5.2.3 Sound levels measured within the animal chambers suggest a Noise Rating of NR58 when operating the COMPAC^5 at -0.25”wc.

5.3 The scope of testing was limited to the following items:

5.3.1 TSS tested the airflow volume as a function of static pressure (vacuum) in the range indicated on the pressure gauge supplied with the COMPAC[5] test article supplied to TSS: 0-2"wc.

5.3.2 In the manner of TSS SOP 4-6 "Field Testing of Slot Hoods," TSS measured the capture velocity and verified that the effective distance of capture from the COMPAC[5]' grille extended to the forward edge of the sliding, access doors.

5.3.3 At several different exhaust air flow rates, TSS injected tracer gas into the COMPAC[5] at 3 liters per minute: one liter per minute into each of the three chambers. TSS then sampled for leakage in the breathing zone of a second, human manikin, positioned above the COMPAC[5] to simulate an optimum viewing position.

5.3.4 TSS measured the noise levels in the COMPAC[5] at different exhaust air flow rates.

5.4 All testing was performed in TSS' laboratory at sea level and the air density was within 2% of 1.00 at all times during these tests. No adjustment for air density was required or made.

5.5 Test results are discussed in greater detail in section 6 of this report. Cited 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 Airflow Volume versus Static Pressure (Vacuum):

6.1.1 Test Method:

TSS placed a 3" diameter, low-resistance flow element on the back of the COMPAC[5] to provide a steady reading for flow through the duct. We measured the airflow in cfm at the center point of 4" duct using a calibrated anemometer, applying an A(k) factor of 0.91 to accommodate the single-point readings. While measuring the air flow, simultaneous vacuum readings were made directly at the outlet collar.

6.1.2 Acceptance Criteria:

There are no formal acceptance criteria applied to this test.

6.1.3 Test Results:

The duct flow and pressure data is presented in Table 1 and plotted Diagram 1.

6.2 Field Testing as a Slot Hood

6.2.1 Test Method:

In the manner of TSS SOP 4-6, TSS placed an anemometer probe in the (~1.75" x 12" = 0.15 ft^2) grille entry plane and measured the air velocity at four points along the grille at the same test-pressures used to establish the flow-pressure curve. Simultaneously, we probed at the far end of the access doors with neutral-density smoke to visualize the airflow capture performance.

6.2.2 Acceptance Criteria:

There are no formal criteria applied to this test, but it is presumed that the smoke capture distance extend to the limit of the doors.

6.2.3 Test Results:

6.2.3.1 At each of the six (6) test pressures, the smoke was thoroughly captured.

6.2.3.2 Because the same six test pressures were used, the average "face" velocities can be used as a simple, field verification of the COMPAC[5] performance. In this case, and average velocity of >=181 feet per minute at the grill corresponded to a minimally-passing test result.

6.2.3.3 The field data is restated on Table 2 of this report.

6.3 Tracer Gas Performance Tests:

6.3.1 Test Method:

With the COMPAC[5] operating normally and providing the flow conditions similar to those described in the previous section, and in a manner derivative of ASHRAE 110-1995, TSS injected Sulfur Hexafluoride tracer gas into the COMPAC[5] so that it would be distributed evenly through each of the three chambers. TSS then sampled for leakage in the breathing zone of a second, human manikin, positioned about 25" above the base of the COMPAC[5] and 6" back.

The flow rate of 3 liters/min was selected as the recommended maximum flow for the COMPAC[5].

With the tracer gas flowing at a nominal 3 liters/min, TSS continuously sampled air from the human manikin-breathing zone for five minutes. TSS used a calibrated Thermo Electron SapphIRe 205B with an inherent sensitivity (LOD) of <=0.007 ppm for the Sulfur Hexafluoride tracer gas. The form of the data from this instrument was logged, 1-second readings stored in an Excel file, available for audit at TSS. After the five minutes, the average concentration of tracer is calculated. With the gas still flowing, all the doors are opened and closed three times over another five minute period and the peak concentration during the "door opening" test is recorded.

TSS repeated this test at each of the six (6) test-pressures.

6.3.2 Acceptance Criteria:

There are no formal criteria applied to this test. As a means of comparison, an average, 5-minute exposure of <=0.10 ppm is typically tolerated in other ventilated enclosures.

6.3.3 Test Results:

6.3.3.1 The COMPAC[5] contained the tracer gas at a level below 0.10 ppm at all six test-pressures.

6.3.3.2 As the magnitude of the test-pressure was reduced, the capture-effectiveness of the COMPAC[5] was also reduced. At the lowest test-pressure used by TSS, -0.10" wc, the COMPAC[5] had an average leakage of 0.03 ppm. However, at such low magnitudes, the "door opening" test reveals that some tracer gas can escape when the doors are opened and closed.

6.3.3.3 The data is plotted as Diagram 2-8 and summarized in Table 3.

6.4 Noise Levels in the COMPAC[5]:

6.4.1 Test Method:

TSS used a calibrated, Type-1 microphone and octave band analyzer to measure and record the sound levels in the COMPAC[5] chambers at three of the test-pressures: -1.00” wc, -0.50” wc, and -0.25” wc.

6.4.2 Acceptance Criteria:

There are no formal criteria applied to this test.

6.4.3 Test Results:

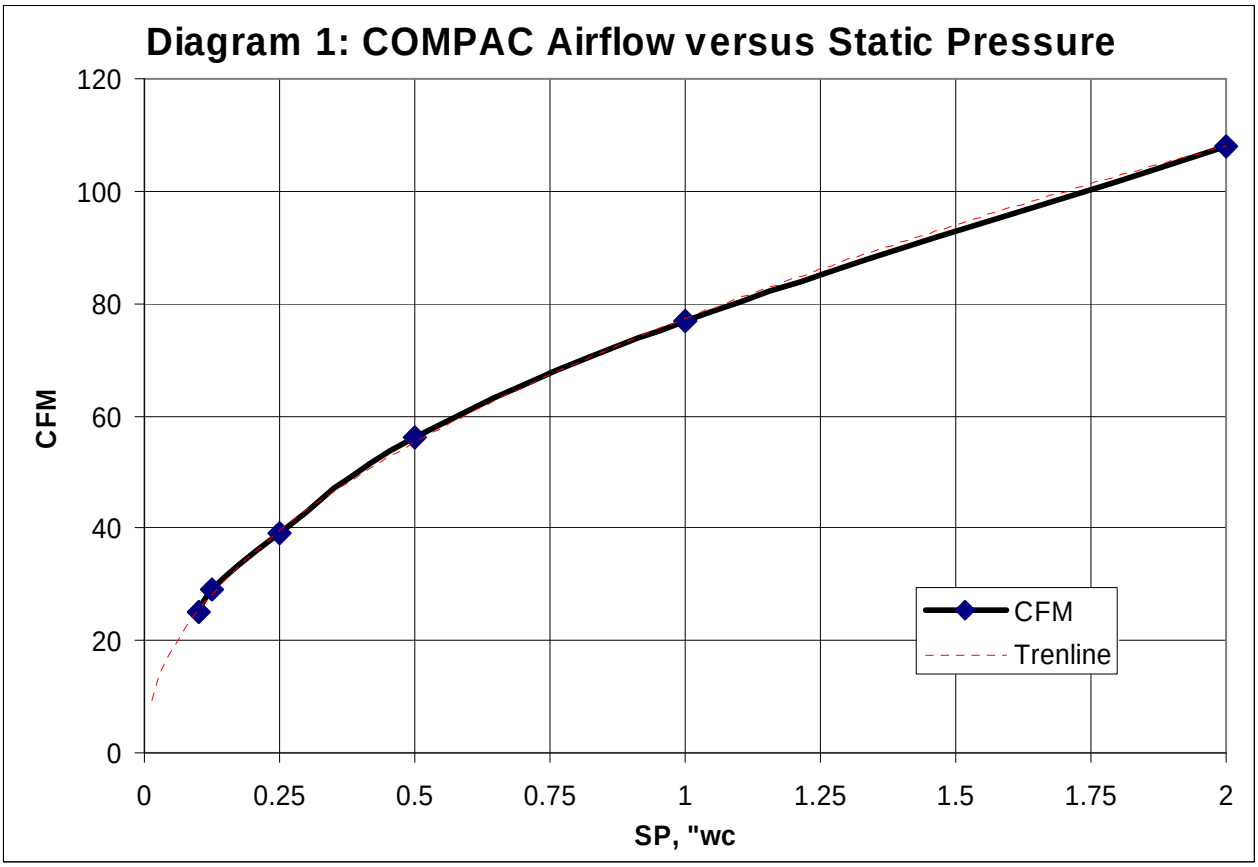
6.4.3.1 As the magnitude of the static pressure increases, so does the air velocity through the grille, resulting in greater noise in the chambers.

6.4.3.2 At -0.25” wc, the *Noise Rating* [NR] of the COMPAC[5] is approximately NR58. That is, the peak reading at -0.25” wc (at 250 Hz) matches NR58 on the ISO Noise Rating Curves.

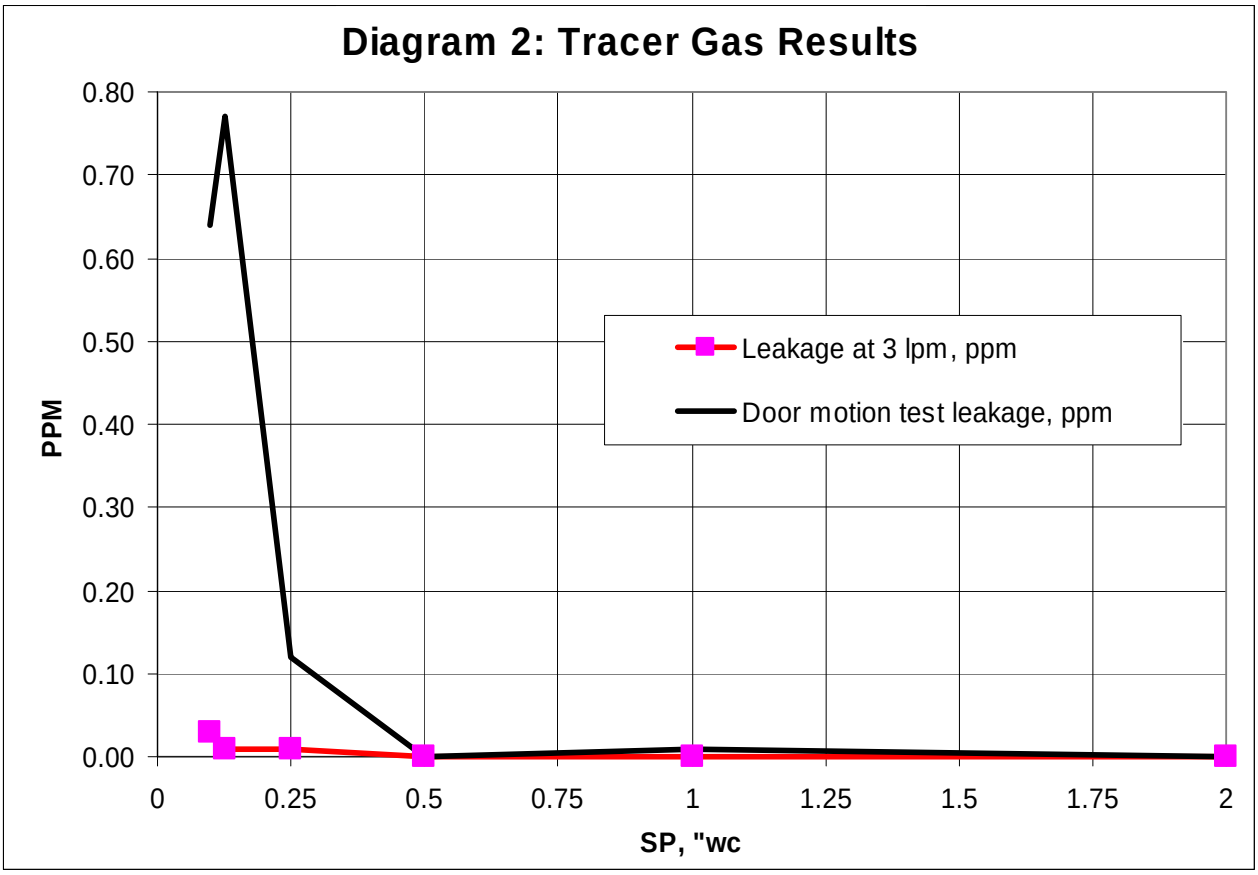
6.4.3.3 The data is plotted as Diagram 9 and summarized in Table 4.

7 Diagrams and Tables:

Item	Description
Diagram 1	Airflow vs. Static Pressure
Diagram 2	Tracer Gas Test Results
Diagram 3	Tracer Gas Test Plot: -2.00” wc Static Pressure
Diagram 4	Tracer Gas Test Plot: -1.00” wc Static Pressure
Diagram 5	Tracer Gas Test Plot: -0.50” wc Static Pressure
Diagram 6	Tracer Gas Test Plot: -0.25” wc Static Pressure
Diagram 7	Tracer Gas Test Plot: -0.125” wc Static Pressure
Diagram 8	Tracer Gas Test Plot: -0.10” wc Static Pressure
Diagram 9	Noise in Chamber vs. Static Pressure
Table 1	Airflow vs. Static Pressure
Table 2	Airflow Velocity at Grille vs. Static Pressure
Table 3	Tracer Test Results vs. Static Pressure
Table 4	Noise in Chamber vs. Static Pressure



(SP = static pressure, or vacuum at the outlet collar of the COMPAC[5])



(The data suggests that the COMPAC5 begins to lose its ability to capture below 0.125”wc. At no time during our tests did the average Leakage (red trace above) exceed 0.10ppm)

Diagram 3: Tracer Gas Test Plot: -2.00” wc Static Pressure

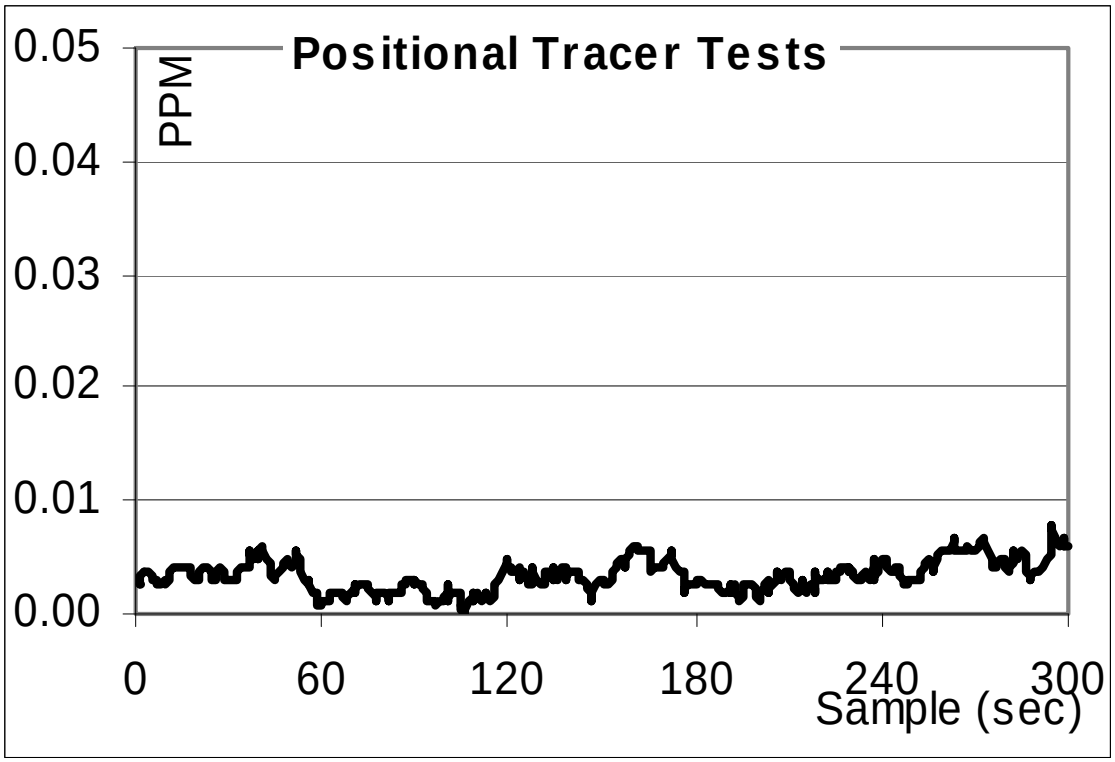


Diagram 4: Tracer Gas Test Plot: -1.00" wc Static Pressure

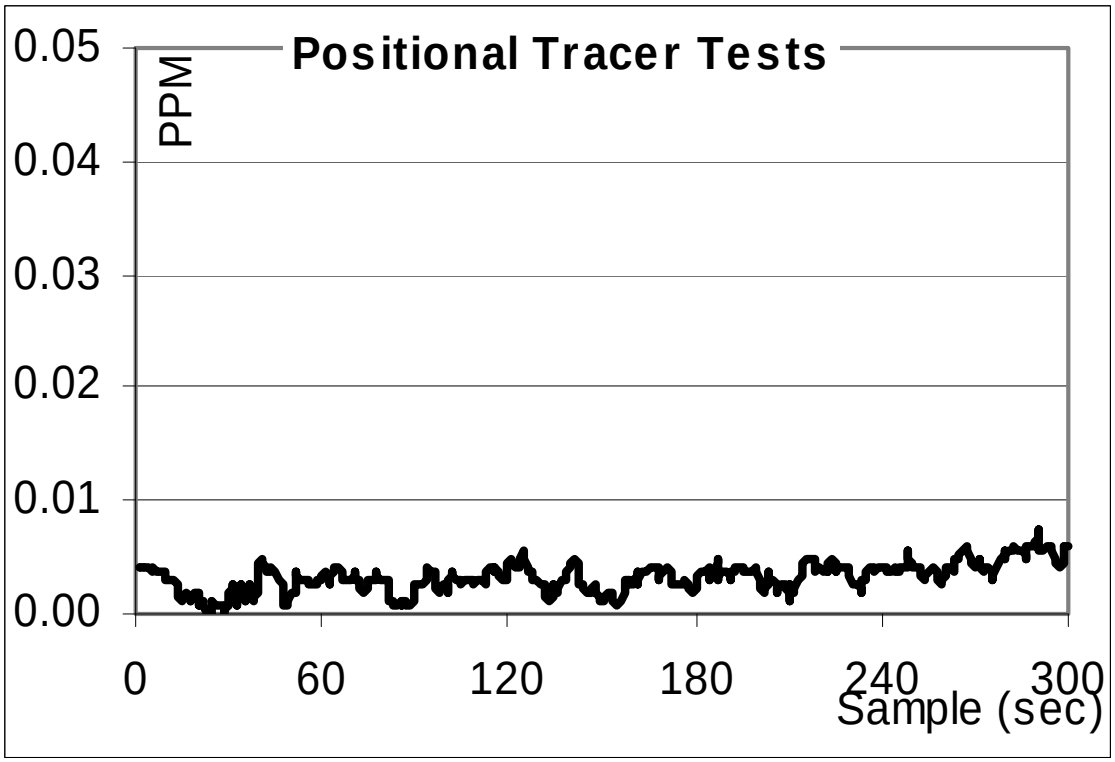


Diagram 5: Tracer Gas Test Plot: -0.50” wc Static Pressure

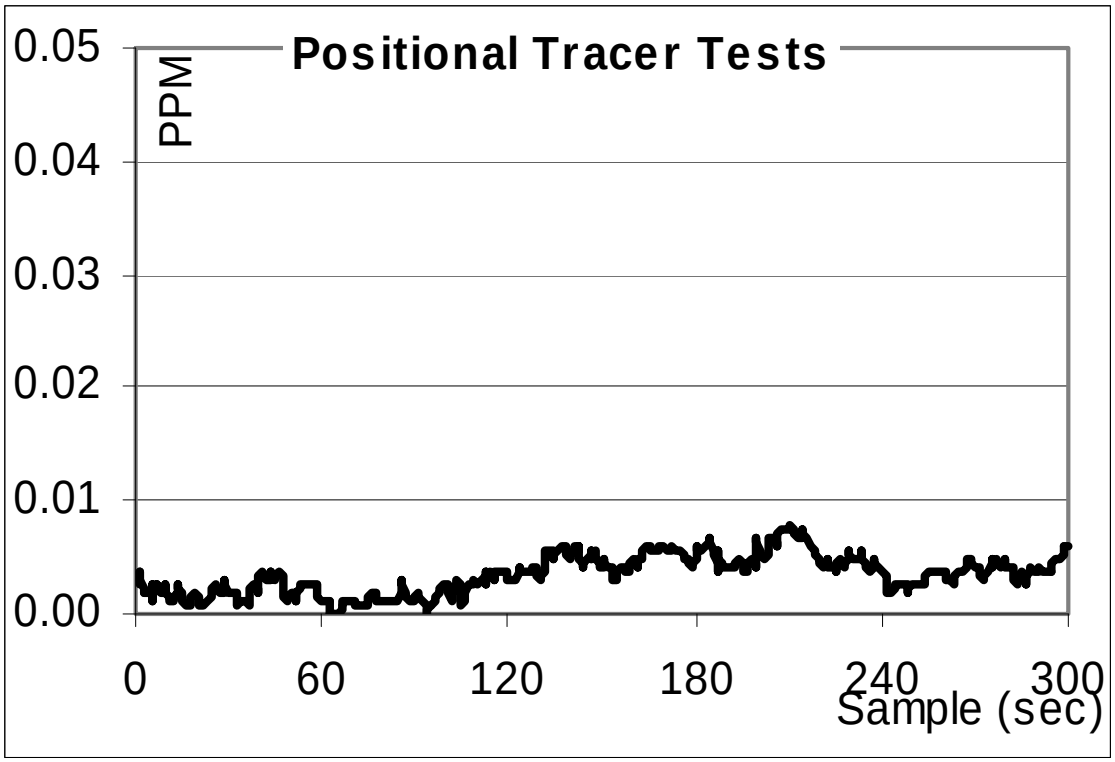


Diagram 6: Tracer Gas Test Plot: -0.25" wc Static Pressure

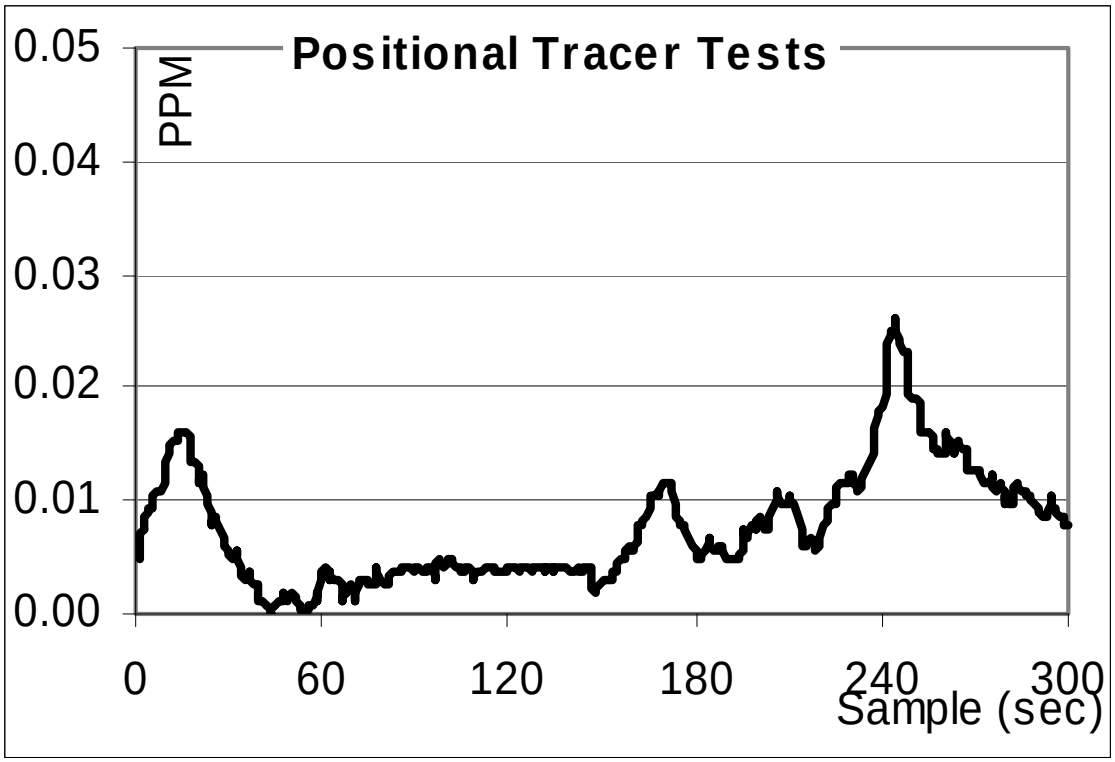
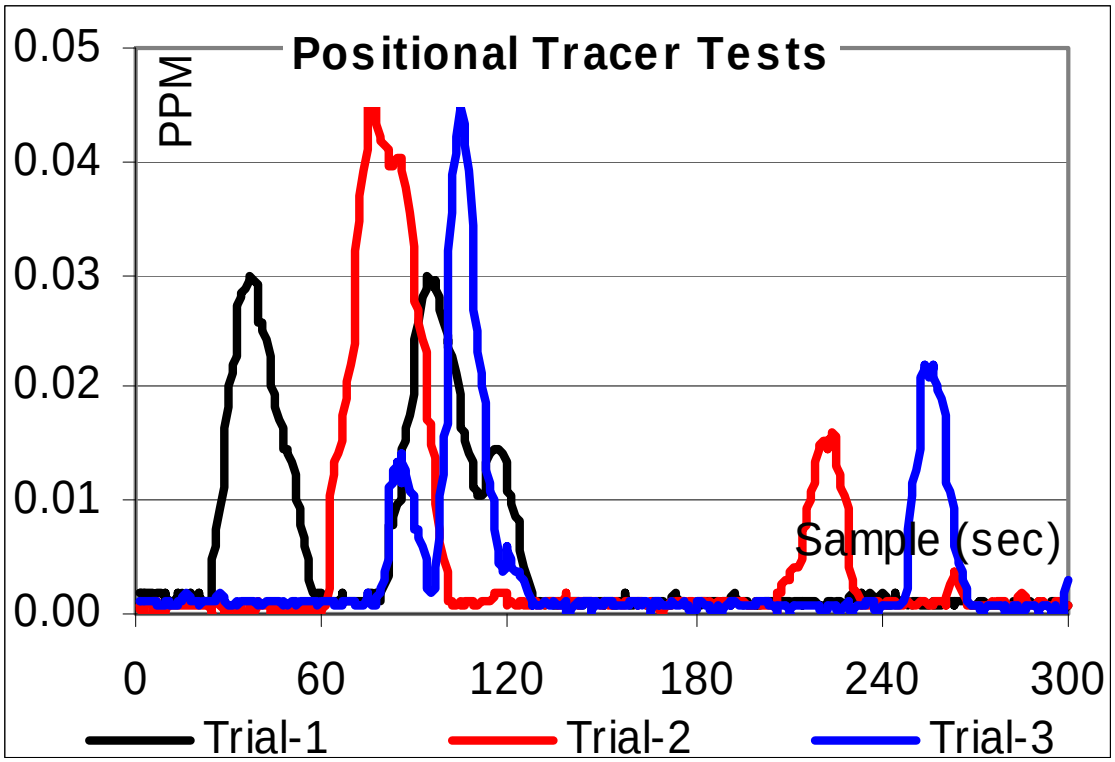


Diagram 7: Tracer Gas Test Plot: -0.125” wc Static Pressure



(Three replicates were done at this pressure, where the capture-ability of the COMPAC5 is just beginning to break down)

Diagram 8: Tracer Gas Test Plot: -0.10" wc Static Pressure

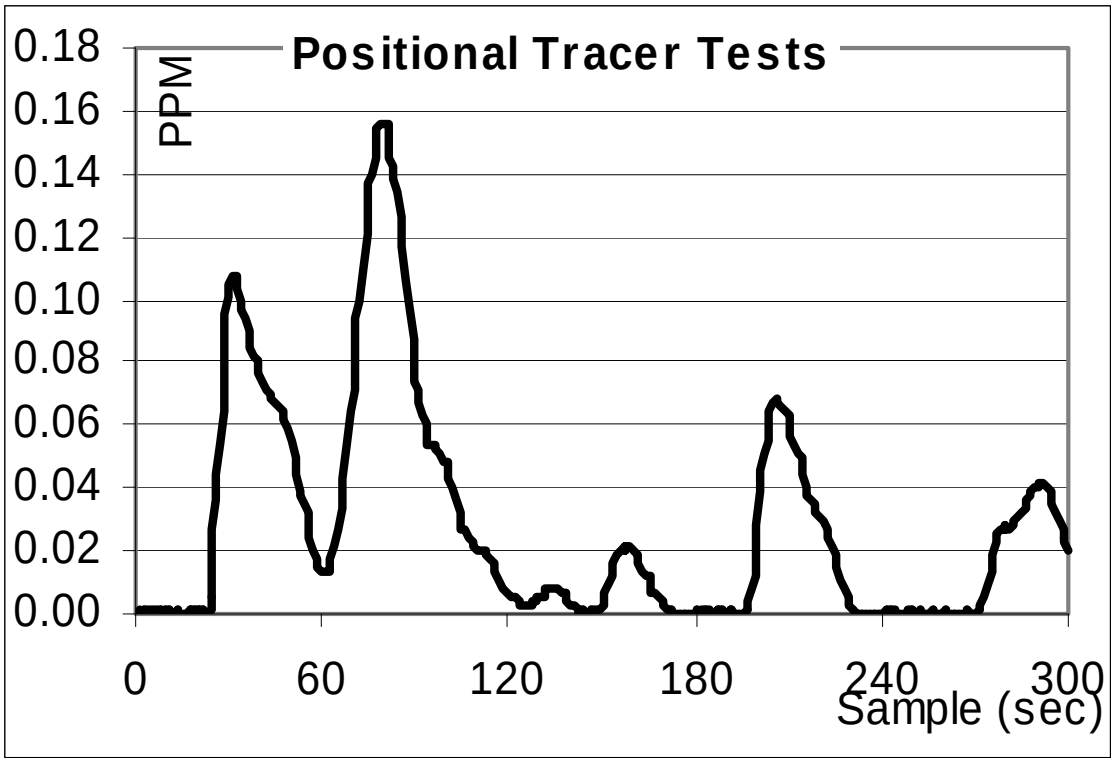


Diagram 9: Noise in Chamber vs. Static Pressure

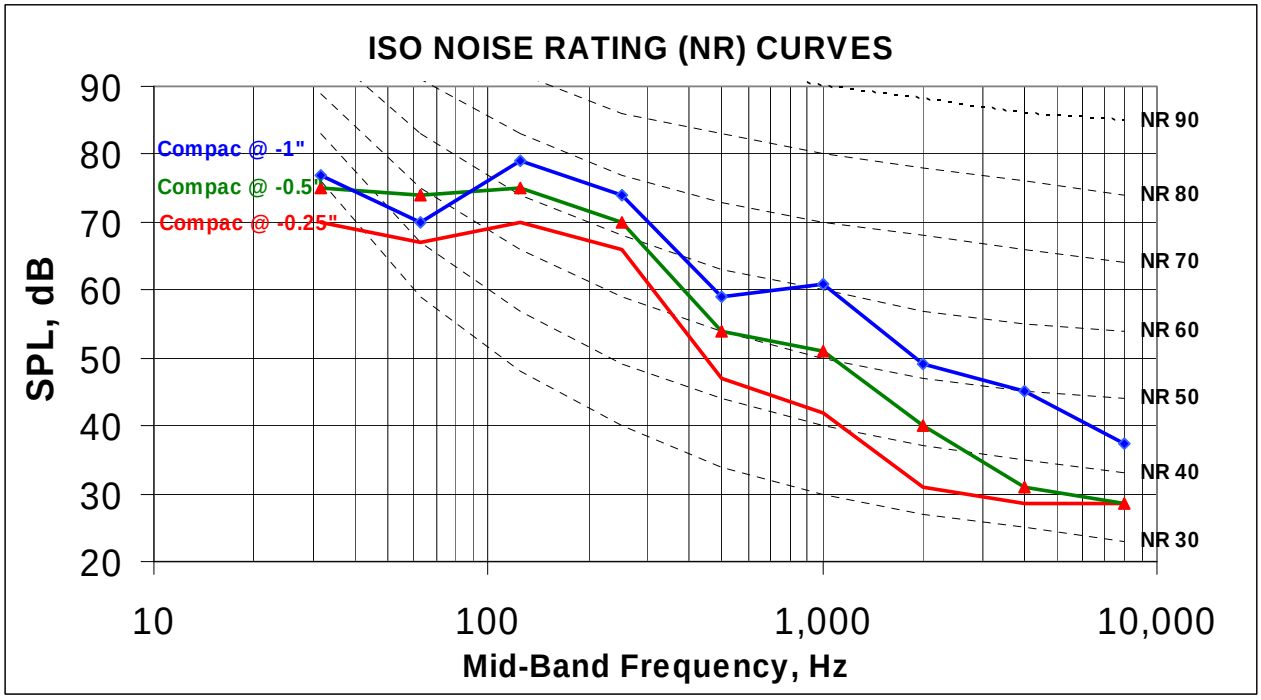


TABLE 1: COMPAC5 Airflow versus Static Pressure

Static Pressure, "wc	2	1	0.5	0.25	0.125	0.1
Duct Velocity, fpm	2420	1730	1260	870	650	560
Duct Diameter, in.	3	3	3	3	3	3
Corr. Factor	0.91	0.91	0.91	0.91	0.91	0.91
Volume, cfm	108	77	56	39	29	25

TABLE 2: COMPAC5 Airflow Velocity at Grille versus Static Pressure

Static Pressure, "wc	2	1	0.5	0.25	0.125	0.1
Vel-A	695	482	386	263	202	176
Vel-B	695	484	373	274	215	192
Vel-C	710	515	382	270	226	187
Vel-D	720	525	367	271	203	168
Avg. Vel.	705	502	377	270	212	181
Small-Volume Smoke Test	Pass	Pass	Pass	Pass	Pass	Pass

TABLE 3: COMPAC5 Tracer Gas Results versus Static Pressure

Static Pressure, "wc	2	1	0.5	0.25	0.125	0.1
Leakage at 3 lpm, ppm	0.00	0.00	0.00	0.01	0.01	0.03
Door motion test leakage, ppm	0.00	0.01	0.00	0.12	0.77	0.64

TABLE 4: Noise in Chamber vs. Static Pressure

	Decibels at Mid-Band Frequency									Weighted	
Site ID	31.5	62.5	125	250	500	1000	2000	4000	8000	dB-A	dB-C
Fan off	54	53	47	38	35	33	30	28.5	28.5	41	58
Compac @ -0.25"	70	67	70	66	47	42	31	28.5	28.5	58	74
Compac @ -0.5"	75	74	75	70	54	51	40	31	28.5	61	76
Compac @ -1"	77	70	79	74	59	61	49	45	37.5	67	83
Room @ -0.25"	67	64	63	50	46	39	33	29	28.5	50	68
Room @ -0.5"	67	63	63	52	48	41	38	30	28.5	51	69
Room @ -1"	67	63	64	52	51	48	47	43	34	55	68

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:

The following pages contain photocopies of documents pertinent to this report. Calibration certificates are archived at the main office of Technical Safety Services.

Description	Pages
Calibration Certificates	20-24

EQ 901
NC071372

Certificate of Calibration

Certificate No: 1052781J4080005

Submitted By: TECHNICAL SAFETY SERVICES
620 HEARST AVE.
BERKELEY, CA 94710

Serial Number:	J4080005	Date Received:	4/10/2007
Customer ID:		Date Issued:	4/14/2007
Model:	CA-22 CALIBRATOR	Valid Until:	4/14/2008
Test Conditions:		**Model Conditions:**	
Temperature:	18°C to 29°C	As Found:	IN TOLERANCE
Humidity:	20% to 80%	As Left:	IN TOLERANCE
Barometric Pressure:	890 mbar to 1050 mbar		

SubAssemblies:

Description: **Serial Number:**

Calibration Procedure: 58V937

Reference Standard(s):

I.D. Number	Device	Last Calibration	Date Calibration Due
ET0000523	B&K / QUEST ENSEMBLE	6/15/2006	6/15/2007
S00335	FLUKE PM6666	7/21/2005	7/21/2007
T00230	FLUKE 45 MULTIMETER	3/20/2006	3/20/2008

Measurement Uncertainty:

+/- 2.6% ACOUSTIC (0.22DB)+/- 1.4% VAC +/- 0.001% HZ
Estimated at 95% Confidence Level (k=2)

APPROVED FOR CLIENT USE
APR 23 2007
BY: _____ FOR TSS, INC.
www.techsafety.com

Calibrated By: _____ 4/14/2007
WARREN BALL Service Technician

Reviewed/Approved By: _____ 4/14/2007
Technical Manager/Deputy

This report certifies that all calibration equipment used in the test is traceable to NIST, and applies only to the unit identified under equipment above. This report must not be reproduced except in its entirety without the written approval of Quest Technologies.

QUEST
TECHNOLOGIES, INC.
1060 CORPORATE CENTER DRIVE • OCONOMOWOC, WISCONSIN 53066-4828
800-245-0779 • 262-567-9157 • FAX 262-567-4047 • INTERNET ADDRESS: http://quest-technologies.com

098-393 Rev. B

ACCREDITED Certificate No. 1326.01

ISO9001 Certificate No. 6854

TECHNICAL SAFETY SERVICES, INC.

Page 1 of 1

JUL 30 2007

BY: _____ FOR TSS, INC.

www.techsafety.com

INSTRUMENT CALIBRATION RECORD

FACILITY	Technical Safety Services, Inc	DB ID NO.	EQ 43	TSS Cal Event	NC072712
ADDRESS	620 Hearst Avenue	MFGR.	Setra		
CITY, STATE	Berkeley, California	MODEL	339-1		
ZIP	94710	TYPE	Pressure Indicator		
DEPARTMENT	Calibration	S/N	182188		
CONTACT	Dick Capell	BLDG.	620 Hearst Avenue		
PHONE	1.510.845.5591	RM.	Calibration Laboratory		

AS FOUND STATUS:	REASON FOR SERVICE:	FINAL TEST STATUS: 0-1.0" ✓ 7/30/07	
☐ IN TOLERANCE	☒ SCHEDULED	☐ CALIBRATED	☒ LIMITED CAL. 0.0 – 0.4"wc ONLY RRC
☒ OUT OF TOLERANCE	☐ UNSCHEDULED	☒ OUT OF TOLERANCE	
☐ INOPERATIVE	☐ NEW UNIT	☐ INOPERATIVE	

UNITS MEASURED AND TEST POINTS:		AS FOUND TEST DATA: STANDARD	INSTRUMENT	TOL. (+/-)	IN TOL.?	FINAL TEST DATA: STANDARD	INSTRUMENT	TOL. (+/-)	IN TOL.? (Y/N)
0.00	"wc	0.0000	0.0000	0.002	Y	0.0000	0.0000	0.002	Y
0.125	"wc	0.1240	0.1247	0.002	Y	0.1240	0.1247	0.002	Y
0.25	"wc	0.2500	0.2508	0.002	Y	0.2500	0.2508	0.002	Y
0.50	"wc	0.4965	0.4972	0.002	Y	0.4965	0.4972	0.002	Y
1.00	"wc	0.9982	1.0001	0.002	Y	0.9982	1.0001	0.002	Y
2.00	"wc	1.9926	1.9969	0.002	N	1.9926	1.9969	0.002	N

NIST TRACEABLE STANDARDS USED	SERIAL/ID NUMBER	STD. CAL. DATE	CAL. DUE DATE
Heise PTE-1	TSS EQ 1187	1/8/07	1/8/08
Heise HQS-1	TSS EQ 930	2/16/07	8/16/07
Barometric Pressure (29.97"Hg)	TSS EQ 1409	09/26/06	09/26/07
Temp/rH (21C / 54%rH)	TSS EQ 362	04/09/07	04/09/08

COMMENTS: TUR > =4:1

CALIBRATED BY (PRINT)	CALIBRATED BY (SIGN)	CALIBRATION DATE	CAL. DUE DATE
Richard Capell	Richard Capell	7/30/2007	7/30/2008

Facility	Technical Safety Services, Inc	**Event #**	NC073194
Address	620 Hearst Avenue	**TSS DB ID**	EQ8
City,State ZIP	Berkeley, CA 94710	**Manufacturer**	TSI
Department	Calibration	**Model**	8355
Contact	Brian Harrington	**Type**	Anemometer
Phone	(510) 845-5591	**Serial Number**	403007
Building/Rm.	620 / Calibration Lab		

Calibrated By (Print)	Calibrated By (Sign)	Calibration Date	Calibration Due Date
Brian Harrington		18 SEP 2007	18 SEP 2008

As Found Status	Reason For Service	Final Test Status	
☒ In Tolerance	☒ Scheduled	☒ Calibrated	☐ Calibrated (Limited)
☐ Out Of Tolerance	☐ Unscheduled	☐ Out of Tolerance	
☐ Inoperative	☐ Other:	☐ Inoperative	

Test Point	Units	As Found Test Data				Final Test Data			
		Standard	Instrument	Tolerance(±)	In Tol.?	Standard	Instrument	Tolerance(±)	In Tol.?
1	FPM	0	0	3	Yes	0	0	3	Yes
2	FPM	35	35	3	Yes	35	35	3	Yes
3	FPM	65	65	3	Yes	65	65	3	Yes
4	FPM	100	101	3	Yes	100	101	3	Yes
5	FPM	160	161	5	Yes	160	161	5	Yes
6	FPM	330	331	10	Yes	330	331	10	Yes
7	FPM	650	645	19	Yes	650	645	19	Yes
8	FPM	1000	990	30	Yes	1000	990	30	Yes
9	FPM	1460	1470	44	Yes	1460	1470	44	Yes
10	FPM	2510	2490	75	Yes	2510	2490	75	Yes
11	FPM	4520	4520	136	Yes	4520	4520	136	Yes
12	FPM	8000	8000	240	Yes	8000	8000	240	Yes
1	°F	74.07	74.3	0.5	Yes	74.07	74.3	0.5	Yes

NIST Traceable Standards Used	Serial/TSS ID Number	Calibration Date	Calibration Due Date
TSI Certifier Wind Tunnel	EQ209	04 JUN 2007	04 DEC 2007
Thermometer	EQ366	17 OCT 2006	17 OCT 2007
Barometer	EQ1409	26 SEP 2006	26 SEP 2007

Environmental Conditions	
Temperature: 23.32°C	Pressure: 29.898"Hg

Comments
1) Velocity TUR≥1:1
2) Temp TUR≥2:1
3) Reference TSI 8355 OEM Certificate of Calibration and Testing
4) 'As Found Test Data' = 'Final Test Data' (no adjustment)

Bios International Calibration Certificate

EQ 1322
NC063930

Report No. 52460
Product DCL-H
Serial No. 103023
Cal. Date 31 October 2006
Cal due. 30 October 2007

Technical Safety Services, Inc.
620 Hearst Ave
Berkeley CA 94710
Acct. No. TECSAF
PO No.

NVLAP® NVLAP Lab Code 200661

As Received Test Data

Calibration Standards Used

All units tested in accordance with Bios International Corporation test number PR05-2 Rev B or PR01-10 Rev D using high-purity bottled nitrogen.

Asset Number	Description	Cal Date	Due Date
ML-500-24 100499	ML-500 Medium Flow Cell	11/21/2005	11/21/2006
ML-500-44 100392	ML-500 High Flow Cell	12/19/2005	12/19/2006

Technician Jonathan Ramos **Lab. Pressure** 744.19 mmHg
Lab. Temperature 22.2 °C

Instrument Reading (ml/min)	Lab Standard Reading (ml/min)	Lab Standard Unit No.	Deviation	Allowable Deviation	Condition Shipped
501	500.75	100499	0.05 %	1.00%	in tolerance
4997	5006	100392	-0.18%	1.00%	in tolerance
29960	30055	100392	-0.32%	1.00%	in tolerance

The allowable deviation consists of the RSS of the expanded uncertainties of the working standards (0.25%), experimental errors (0.25%), and the error of the device under test (DUT), which is the remainder of the allowable deviation.

As Shipped Test Data

Calibration Standards Used

All units tested in accordance with Bios International Corporation test number PR05-2 Rev B or PR01-10 Rev D using high-purity bottled nitrogen.

Asset Number	Description	Cal Date	Due Date
ML-500-44 100392	ML-500 High Flow Cell	12/19/2005	12/19/2006
ML-500-24 100499	ML-500 Medium Flow Cell	11/21/2005	11/21/2006

Technician Jonathan Ramos **Lab. Pressure** 756.56 mmHg
Lab. Temperature 22.2 °C

Instrument Reading (ml/min)	Lab Standard Reading (ml/min)	Lab Standard Unit No.	Deviation	Allowable Deviation	Condition Shipped
502.1	500.45	100499	0.33 %	1.00%	in tolerance
5009	5002.5	100392	0.13 %	1.00%	in tolerance
30090	30085	100392	0.02 %	1.00%	in tolerance

The allowable deviation consists of the RSS of the expanded uncertainties of the working standards (0.25%), experimental errors (0.25%), and the error of the device under test (DUT), which is the remainder of the allowable deviation.

Each DryCal flow calibrator is dynamically tested by comparing it to a laboratory standard primary piston prover of much higher accuracy (±0.25% or better) but of similar operating principles. Flow generators of ±0.03% stability are used for the comparison. Use of provers of similar construction to the device under test assures the validity of the flow generator as a transfer standard. The primary laboratory standards are qualified by direct measurement of their dimensions (diameter, length of measured path, time base) against NIST traceable gauges and instruments (NIST numbers available upon request). A rigorous analysis of their accuracy in accordance with the International Guide to Uncertainty in Measurements has been performed, assuring their traceable accuracy. Test procedures ensure temperature matching of the laboratory standards and the device under test.

APPROVED FOR CLIENT USE

NOV 0 6 2006

BY: FOR TSS, INC.
www.techsafety.com

Bios International Corporation
10 Park Place, Butler, NJ 07405 USA
www.biosint.com

Printed 31 October 2006
Page 1 of 2

EQ 1751

ThermoFisher
SCIENTIFIC

The world leader
in serving science

SAPPHIRE CALIBRATION VERIFICATION

DATE: 26-Jun-07 **TEMP:** Ambient
PRESSURE: 760 mm Hg
CUSTOMER: Technical Safety Services Inc.
P#: P706-0898
SERIAL #: 205B-79934-435 **SET NAME:** N2O
SALES ORDER #: 35246 **APPLIC. CHEMIST :** Laurie Faraone
Laurie Faraone

N2O

Range: 0-5 ppm
Wavelength: 4.5 µm
Pathlength: Long
MDL: 0.1 ppm ***

INJECTION VOLUME (µl)	ACTUAL CONCENTRATION (ppm)	INSTRUMENT READING (ppm)	% ERROR of READING
5.0	2.2	2.3	2.2
10.0	4.4	4.4	-0.9
20.0	8.9	8.9	0.09

*** Approximate MDL based on noise levels.

APPROVED FOR CLIENT USE

JUL 16 2007

BY: _____ FOR TSS, INC.
www.techsafety.com

Air Quality Instruments
Environmental Instruments
27 Forge Parkway
Franklin, MA
02038
(508) 520-0430
(508) 520-1460 fax
www.thermofisher.com