Airflow Testing the Improved DSx Vented, Warming Table

Report 15 August 2004

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:

Airflow Performance and Tracer Gas Containment Test Report

- 1 Title: Testing the Improved DSx Vented, Warming Table
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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. DSx surgical table. These tests were designed to collect data so that VetEquip, Inc. personnel could evaluate the basic suitability of the DSx table as a containment device for anesthetic gasses used in conjunction with surgical procedures for small animals; the DSx 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 DSx on May 23rd and August 8th, 2004, respectively.
 - 5.2 The subject DSx unit differs from the one tested by TSS in 2003, (see September 2003 report). This improved version has larger air channels so that considerably less vacuum is needed to achieve a 100 foot per minute (fpm) capture velocity above its grill.
 - 5.3 The basic test results follow:
 - 5.3.1 Using a TSS-supplied vacuum source, and with the VetEquip-supplied four foot (4') tube connected to the DSx, the proximal grille (the one closest to the waste gas scavenging outlet/collar) had a 100 fpm capture velocity at ~0.56" above the grille with a collar vacuum of -0.5" wc. The distal grille achieved the same velocity and capture distance with a collar vacuum of -0.7" wc.

- 5.3.2 At these flow settings, both the proximal and distal grilles competently capture still air from within a two-inch (2") radius, respectively.
- 5.3.3 When injecting ~0.4 lpm tracer gas in a manner derivative of ASHRAE 110-1995, with the (human) manikin at a simulated, optimal viewing position, there was ~0.02 ppm in the manikin breathing zone for either grille. There is no stated acceptance criterion for this tracer result, however any result <0.10ppm is typically very acceptable.
- 5.4 The scope of testing was limited to the following items:
 - 5.4.1 TSS tested the airflow volume as a function of vacuum, measuring the pressure at the 'Outlet, and along the tubing at 2' and 4'.
 - 5.4.2 In the manner of TSS SOP 4-6.v2 "Field Testing of Slot Hoods" to determine the capture velocity and the effective distance of capture from the DSx' grille.
 - 5.4.3 With the airflows adjusted to ~100 fpm at ~0.56" above the grilles, and with the DSx operating normally through the four foot (4') tubing, TSS injected tracer gas into a (mock-) surgical nose cone attached to a rat manikin. TSS then sampled for leakage in the breathing zone of a second, human manikin, positioned above the DSx to simulate an optimum viewing position.
- 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 <u>Test Results:</u>

- 6.1 Airflow Volume versus Vacuum:
 - 6.1.1 Test Method:

TSS erected a 4" diameter, low-resistance, laminar flow sensing element over the proximal (closest to the outlet) DSx grille. We measured the airflow in cfm at the center point of 4" duct using a calibrated anemometer, applying an A(k) factor of 0.9 to accommodate the single-point readings. While measuring the air flow, simultaneous vacuum readings were made directly at the outlet collar, two feet (2') and four feet (4') downstream from the collar using the standard, VetEquip, Inc.-supplied exhaust hose.

Once the readings were done for the proximal grille, the unit was reconfigured to allow air to flow through the distal grille and the test was repeated.

6.1.2 Acceptance Criteria:

There are no formal acceptance criteria applied to this test.

- 6.1.3 Test Results:
 - 6.1.3.1 The airflow 'efficiency' through the proximal grille is higher than that of the distal grille.
 - 6.1.3.2 The proximal and distal grille data are presented in Tables 1-2, respectively. This data is also plotted as Diagrams 1-6.
 - 6.1.3.3 Diagram 6 may be of particular interest because it compares the (May 2003) data from the unmodified DSx to that for the current model. The current model moves about ten times (10x) more air for a given vacuum, especially in the lower pressure ranges.

6.2 Field Testing as a Slot Hood

6.2.1 Test Method:

In the manner of TSS SOP 4-6.v2, TSS placed an anemometer probe above the proximal grille, and adjusted the probe distance to achieve ~100 feet per minute. Finally, we probed about the grille with neutral-density smoke to visualize the airflow capture performance and measure the distance at which the capture remains effective.

As with the airflow-vs.-vacuum testing, once the readings were done for the proximal grille, the unit was reconfigured to allow air to flow through the distal grille and the test was repeated.

6.2.2 Acceptance Criteria:

There are no formal criteria applied to this test, but it is presumed that the smoke capture distance should be a large enough hemispheroid to collect stray vapors.

- 6.2.3 Test Results:
 - 6.2.3.1 The distal grille had lower velocity and a smaller capture distance.
 - 6.2.3.2 The proximal and distal grille data is restated here.

	Proximal Grille	Distal Grille	
Capture Velocity	100	100	fpm
Vacuum (at collar)	0.486	0.702	"wc
Distance at 100 fpm	0.56	0.56	inches
Smoke Capture Distance, Vertical	2	2	inches
Smoke Capture Distance, Lateral	2	2	inches

- 6.3 Tracer Gas Performance Tests:
 - 6.3.1 Test Method:

With the DSx 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 a mock-surgical nose cone attached to a rat manikin, 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, about 400 ml/min, might result in high velocity jets about the face of the patient. If these jets were of sufficient vigor, they could overcome the capture velocity and enter the surgeon's breathing zone. The flow rate of 400ml/min was selected as typical for rats/patients to be treated on the DSx.

With the tracer gas flowing at a nominal 400 ml/min, TSS continuously sampled air from the human manikin-breathing zone for five minutes. TSS used a calibrated Foxboro Miran 1A 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 gas is shut off and the average concentration of tracer is calculated.

As with both previous test sections, once the readings were done for the proximal grille, the unit was reconfigured to allow air to flow through the distal grille and the test was repeated.

6.3.2 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.

- 6.3.3 Test Results:
 - 6.3.3.1 Both grilles have similar tracer gas performance results. The leakage to the operator-breathing zone is very low: ~0.02 ppm. These results are effectively the same as those from earlier tracer gas trials on the unmodified DSx.
 - 6.3.3.2 The data for both grilles is plotted as Diagram 7, and cursorily restated here:

	Proximal Grille	Distal Grille	
Tracer Gas (SF6) Flow	404	398	ml/min
Vacuum at collar	0.50	0.70	"wc
Gas in Operator Breathing Zone	0.02	0.02	ppm

7 <u>Diagrams and Tables:</u>

Item	Description
Diagram 1	Proximal DSx Airflow vs. Vacuum (Low-Range)
Diagram 2	Proximal DSx Airflow vs. Vacuum (High-Range)
Diagram 3	Distal DSx Airflow vs. Vacuum (Low-Range)
Diagram 4	Distal DSx Airflow vs. Vacuum (High-Range)
Diagram 5	Proximal vs. Distal (at outlet)
Diagram 6	Modification Benefit
Diagram 7	Tracer Gas Test Plot
Table 1	Proximal DSx Airflow vs. Vacuum ("wc)
Table 2	Distal DSx Airflow vs. Vacuum ("wc)













Diagram 7, Tracer Gas Test Plot



Corrected Values (inches of water, "WC)								
0.9 correction for C/L readings in 4" round duct								
Flow, cfm	dP, collar	dP, 2'	dP, 4'					
0	0	0	0					
4.05	0.246	0.5769	0.886					
7.92	0.7584	2.433	3.653					
13.5 2.801 10.49 14.99								
18.9	6.031	22.08	32.57					

Table 1, Proximal DSx Airflow vs. Vacuum ("wc)

Table 2, Distal DSx Airflow vs. Vacuum ("wc)

Corrected Values (inches of water, "WC)								
0.9 correction for C/L readings in 4" round duct								
Flow, cfm	dP, collar	dP, 2'	dP, 4'					
0	0	0	0					
3.42	0.4568	0.8812	1.401					
5.58	0.9468	2.08	3.16					
9 2.025 5.421 7.776								
18.45	8.222	22.74	33.47					

8 <u>Discrepancies and Alterations:</u>

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 <u>Pertinent Additional Documentation:</u>

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 13-25

TSS/VetEquip, Inc. Project NCO040NPNA-03: Testing the Improved DSx Vented, Warming Table Report 15 August 2004 Page 15 of 25



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As-Received Mod	el#:_ADM-8	50 0		Converte	ed to Model #				
PO#:		_ Customer E	qpt ID#:	C	alibration Du	e Date: 06/	2004 QACo	de:951	10CFR21:
This instrument has Program and calibra specifications. Calibrat (twice the calculated to the item calibrat Recalibration Proc	been calibrated tion procedures pration accuracy d uncertainty). T ed. For limita edure for AirDa	I using Calibration meet the required is certified when his report shall n tions on use, se ata Multimeters	n Standards wi ments for 10Cl meters are us ot be reproduce shortridge 1 SIP-CP02 R	hich are traceabl FR50 Appendix E ed with property fi ed, except in full, Instruments, Inc evision: 23	e to NIST (National Content of NIST (National Content of NIST) (National Co	onal Institute of ANSI/NCSL Z54 issories only. Al tten approval of anual for the u 2	Standards and 1 40-1-1994; MIL-3 I Uncertainties a Shortridge Instr ise of AirData 1	Technology). STD 45662A a are expressed i ruments, inc. i Multimeters.	Quality Assurance nd manufacturers in expanded terms Results relate only Procedure used:
Calibration Technic	cian(s):	Handle	h 1	. Inula	uei	-	Calibrati	on Date: 06	105/2003
Calibration Approv	ed by:	5	1	- area and a second	Title	Chan n		on bate.	(7.2003
AS-R	aceived By	- Lu	SE	URI Test Du	nue:	Geroer,	- XX IL	Date :	-2-2003
Date	25/29/03 Rt	5/ 9	6 Dat	06/05/05R	h 4	£% D	Test	By Rh N 0	ey.
Ambie	ent Temperatur	0	'F Ami	bient Temperatu	re	7.*F Ar	mbient Tempera	ture	^*F
Baron Withir	spec (VES) N	25:43_in H	g Ban	ometric Pressure	28.28 in	Hg Ba	arometric Press	ure	in Hg
			4850	ILLITE PRESSU	/ NU DE TEST (in Li	w W	ithin spec YE	S NO	
	TEST ME	TER TOLERANO	E = ± 2.0 % ±	.1 in Hg AS-I	RECEIVED TE	ST WITHIN SPI	EC (TES) NO) N/A	
Pressure Standard:	Heise #02-R	S/N: 41741/4	2451 Cali	bration Date: 04	/21/03 Ca	alibration Due D	ate: 04/2004	As-Revo	Test 2 Test 3
Pressure Standard: I	Heise #04-R	S/N: 41743/4	2453 Cali	bration Date: 05/	05/03 Ca	alibration Due D	ate: 05/2004	As-Rcvd	Test 2 Test 3
Pressure Standard: Pressure Standard:	Heise #06-R	S/N: 41742/4 S/N: 42186/4	2452 Cali 3328 Cali	bration Date: 12/ bration Date: 03/	04/02 Ca	alibration Due D	ate: 06/2003	As-Rovd	CTest 2 Test 3
Pressure Standard:	Heise #10-R	S/N: 42203/4	3352 Cali	bration Date: 04/	07/03 Ca	alibration Due D	ate: 10/2003	As-Rovd	Test 2 Test 3
Pressure Standard: I Heise Model PPM-2	Heise #12-R	S/N: 43166/4	731 Cali	bration Date: 11/	01/02 Ca	alibration Due D	ate: 05/2003	As-Rovd	Test 2 Test 3
Anorey Set Dt	Migaby	Dresser Industri	es Rate	ed Accuracy: 0.0	05% fs (0.0305	in Hg) F	Range: 0-61 in H	lg Und	certainty: < 0.0358
14.0	Standard	Test Meter	% Diff	Standard	Test Meter	% Diff	Standard	Test Meter	r % Diff
28.4	28.42	19.3	05	20 20	19.7	1.17		100	
40.0	40.63	40.5	5.32	41 22	424	107			
Pressure Standard: I Pressure	Heise #01-L Heise #01-R Heise #02-L Heise #03-R Heise #03-R Heise #05-L Heise #05-L Heise #05-L Heise #05-L Heise #08-L Heise #09-L Heise #09-L Heise #10-L Heise #11-L Heise #11-L Heise #11-L Heise #11-L Heise #12-L Standards: Hi -L, 09-L, 11-L	S/N: 41739/4 S/N: 41739/4 S/N: 41739/4 S/N: 41738/42 S/N: 41738/42 S/N: 41743/42 S/N: 41740/42 S/N: 41740/42 S/N: 41740/42 S/N: 41740/42 S/N: 41740/42 S/N: 41740/42 S/N: 41740/42 S/N: 42185/42 S/N: 42185/44 S/N: 42202/43 S/N: 42202/43 S/N: 42202/43 S/N: 42202/43 S/N: 42202/43 S/N: 42105/44 S/N: 43165/44 S/N: 43165/44 S/N: 43165/44 S/N: 43165/44 S/N: 43165/44 S/N: 43165/44 S/N: 43165/44 S/N: 43165/44	2449 Calii 2446 Calii 2454 Calii 2448 Calii 2448 Calii 2448 Calii 2448 Calii 2448 Calii 2456 Calii 2455 Calii 329 Calii 351 Calii 353 Calii 730 Caliit 730 Caliit Manufa Manufa I Manufa Curacy: > 0.0 Curacy: > 0.0	variation Date: 04/ paration Date: 04/ paration Date: 04/ paration Date: 04/ paration Date: 05/ paration Date: 05/ paration Date: 05/ paration Date: 05/ paration Date: 03/ paration Date: 04// paration Date:	22/03 Ca 22/03 Ca 22/03 Ca 09/03 Ca 09/03 Ca 09/03 Ca 06/02 Ca 08/02 Ca 08/02 Ca 18/03 Ca 18/03 Ca 18/03 Ca 18/03 Ca 09/03 Ca 00/02 Ca 00/02 Ca 00/03 Ca 00/02 Ca 00/02 Ca 00/03 Ca 00/02 Ca 00/03 Ca 00/02 Ca 00/03 Ca 00/03 Ca 00/02 Ca	Ilibration Due D Ilibration Due D	ate: 04/2004 ate: 04/2004 ate: 05/2004 ate: 05/2004 ate: 05/2004 ate: 05/2003 ate: 06/2003 ate: 06/2003 ate: 09/2003 ate: 09/2003 ate: 09/2003 ate: 10/2003 ate: 10/2003 ate: 10/2003 ate: 05/2003 ate: 05/2003 ate: 05/2003 ate: 05/2003 ate: 05/2003 ate: 05/2003 ate: 05/2003	As-Rovd As-Rov	Test 2 Test 3 Test 2 Test 3 <td< td=""></td<>
02-L. 04-L. 06-L. 08	7-R, 09-R, 11-F -L, 10-L, 12-L	Rated A Rated A Test Meter	ccuracy: > 0.0 ccuracy: > 0.0 % Diff	6% fs (0.003 in 6% fs (0.03 in w Standard	wc) c) Test Meter	Range: 0. Range: 0.	.0-5.0 in wc .0-50.0 in wc	Uncert Uncert	tainty: < 0.00348 tainty: < 0.0346
Approx Set Pt	Standard				. 0527	7.19		reat wordt	70 011
Approx Set Pt .0500	Standard	.0536	19	.0529 1					
Approx Set Pt .0500 .1250	Standard • 0537 • 1254	.0536	19	.0528	. 1259	-16			
Approx Set Pt .0500 .1250 .2250	Standard • 0537 • 1254 • 2252	.0536 .1251 .2248	19 24 04	.0328 ,1261 .2298	22.96	-16 -09			
Approx Set Pt .0500 .1250 .2250 .2700	Standard • 0537 • 1254 • 2252 • 2212	.0536 .1251 .2248 .2724	19 24 04 .44	.0328 ,1261 .2298 ,2710	· 1259 2296 27/8	-16 -09 -30			
Approx Set Pt .0500 .1250 .2250 .2700 2.000	Standard • 0537 • 1254 • 2252 • 2262 • 2712 2.032	.0536 .1251 .2248 .2724 2.041	19 24 04 .44 .44	.0328 .1261 .2298 .2710 2.003	- 1259 2296 2718 2-010	-16 -09 .30 .35		- AM	
Approx Set Pt .0500 .1250 .2250 .2700 2.000 3.600	Standard • 0537 • 1254 • 2252 • 2712 2.032 3.619	.0536 .1251 .2248 .2724 2.041 3.638	19 54 04 .44 .44 .44 .44	.0328 ,/26/ .2298 ,27/0 2.003 3,622	· 12.59 22.96 27/8 2.0/0 3631	/6 09 30 35 25		- MA	
Approx Set Pt .0500 .1250 .2250 .2700 2.000 3.600 4.400	Standard • 0537 • 1254 • 2252 • 2712 2 032 3 - 619 4448	.0536 .1251 .2248 .2724 2.041 3.638 4.479	19 24 04 .44 .44 .44 .53 .70	.0328 .1261 .2298 .2710 2.003 3.622 4.408	- 1259 2296 27/8 2-0/0 3631 4.423	/6 09 30 35 25 34		- MA	
Approx Set Pt .0500 .1250 .2250 .2700 2.000 3.600 4.400 27.00	Standard • 0537 • 1254 • 2252 • 2252 • 2712 2 032 3 - 619 - 4448 27.35	.0536 .1251 .2248 .2724 2.041 3.638 4.477 2.750	19 24 04 .44 .44 .53 .70 .55	.0528 ./26/ .2298 .27/0 2.003 3.622 4.408 22./4	· /2.59 2296 27/8 2.0/0 363/ 94923 27.29	-/6 -09 .30 .35 .25 .25 .34 .55		MA	
Approx Set Pt .0500 .1250 .2250 .2700 2.000 3.600 4.400 27.00 50.00	Standard • 0537 • 1254 • 2262 • 2262 • 2032 3-619 4-448 22,35 50,25	.0536 .1251 .2248 .2724 2.041 3.638 4.479 2.750 5241	19 54 04 .44 .44 .53 .70 .55 .32	.0328 .1261 .2298 .2710 2.003 3.622 4.408 12.14 49.10	- 12.59 22.96 2.7/8 2.0/0 3.631 4.423 27.29 49.11	-/6 -09 .30 .35 .25 .35 .34 .55 .02		Ma	

7855 East Redfield Road Scottsdale, Arizona 85260 (480) 991-6744 • Fax (480) 443-1267 • www.shortridge.com • info@shortridge.com

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AIRDATA MULTIMETER CERTIFICATE OF RECALIBRATION

S/N: 197783 Order #: 203 139 6

LOW VELOCITY CONFIRMATION % ± 7 FPM AS-RECEIVED TEST WITHIN SPEC TEST METER TOLERANCE = ± 3.0% ± 7 FPM

Velocity Standard: AirData Multimeter Velocity Standard: AirData Multimeter Velocity Standard: AirData Multimeter Velocity Standard: AirData Multimeter Rated Accuracy: Velocity ± 2.0 % ± 3 fpm	S/N: M96455 S/N: M96099 S/N: M98326 S/N: M99420 Uncertainty: <2	Calibration Date: 11/08/02 Calibration Date: 09/26/02 Calibration Date: 10/29/02 Calibration Date: 09/26/02 .25 fpm at 100 fpm; <2.5 fpm at 50	Calibration Due Date: 11/2003 Calibration Due Date: 09/2003 Calibration Due Date: 10/2003 Calibration Due Date: 09/2003 00 fpm	As-Rovd Test 2 As-Rovd Test 2 As-Rovd Test 2 As-Rovd Test 2) Test 3 Test 3 Test 3 Test 3
			and the second sec	Test Motor	Diff

	Approx Set Point	Standard	Test Meler	Diff	Standard	Test Meter	Diff	Standard	44	
ſ	100	123.7	122	-67	11S.Y	116			74	
١	500	615.7	514	-1.7	534.8	539	- 8	1		

ADM-870/870C and ADM-860/860C AirData Multimeters are read in AirFoll Mode. ADM-850 Multimeters are read in Pitot Tube Mode. Uncertainties shown for Low Velocity Confirmation represent Uncertainty of the Transfer Standard Meter exposed to the pressure source only.

TEMPERATURE TEST - AIRDATA MULTIMETER (* F) TEST METER TOLERANCE = ± 0.2* F AS-RECEIVED TEST WITHIN SPEC (YES) NO N/A

RTD Simulator Temperature Difference Test Meter Difference Test Meter Difference Equivalent Set Point Test Meter . z 3J, 8 -1 35.60 35.7 . 2 95.2 0 95.0 95.00 154.5 . 1 -.1 154.3 154.40

TEMPERATURE TEST OF CUSTOMER'S TEMPROBE TEMPROBE TOLERANCE = ± 0.3" F AS-RECEIVED TEST WITHIN SPEC (ES) NO N/A

Thermometer S/N 92143/Thermistor Thermometer S/N 8A089/Thermistor Thermometer S/N 92142/Thermistor Thermometer S/N 8B104/Thermistor Above Temperature Standards: Rated Acc	S/N 871513 S/N 881708 S/N 850104 S/N 871507 uracy: 0.023° F/0	Calibration Date: 04/04/01 Calibration Date: 10/05/02 Calibration Date: 02/09/01 Calibration Date: 11/05/02 .018° F Combined Uncerta	Cal Due Date: 06/2003 Cal Due Date: 10/2004 Cal Due Date: 05/2003 Cal Due Date: 11/2004 ainty: < 0.025° F	Set Point: 35° F 95° F 155° F Set Point: 35° F 95° F 55° F Set Point: 35° F 95° F 55° F Set Point: 35° F 95° F 155° F
Temperature Standard AirData Multimeter Temperature Standard AirData Multimeter Above Temperature Standards: Rated Acc Total combined Uncertainty for TemProbe	S/N: M00136 S/N: M96100 auracy: 0.03° F testing : < 0.028	Calibration Date: 03/31/03 Calibration Date: 05/14/03 Uncertainty: < 0.023° F 5	Cal Due Date: 03/2004 Cal Due Date: 05/2004	Set Point 35° F 95° F 155° F Set Point: 35° F 95° F 155° F

	Set Point	Standard	TemProbe	Diff	TemProbe	Diff	TemProbe	Diff	TemProbe	Un	Temptope	Un	Tente loce	
	35.0	35.0	34.8	7.2					L					
	95.0	95.0	94.9	-1					P/A					
	155.0	155.0	155.0	0								-	HOF	
1										аррно	VED FUR	CLILIN	000	

NOTES:

IUN 0 9 2003 FOR TSS, INC.

BY www.techsafety.com

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TSS EQ	1254						Eve	n+#M	031381
Customer ID: (3)	2460	AIRDAT	MOLTIME	IER GERTIF	ICATE OF R	ECALIBRAI	ION	C/NI-	m9/2/9
Customer: TECI	HNICAL SAT	FETY SEA	VICES IN	6. City: 1	BERKELE	~	State:	Order #	P 07 22 27
As-Received Mode	el#: ADM-	860		Converte	d to Model #:			01001 #.	NOD 22 -7
PO#:	-	Customer Ed	apt ID#:	c	alibration Due	Date: 08/20	04 QA Cod	le: 95 10	CFR21:
This instrument has	been calibrated	using Calibratio	n Standards whi	ich are traceable	to NIST (Natio	nal Institute of S	tandarde and T	actinologia) Ou	ality Accurance
Program and calibrat	ion procedures	meet the require	ments for 10CF	R50 Appendix B	ANSI/N45.2; A	NSI/NCSL Z54	0-1-1994; MIL-S	TD 45662A and	manufacturer's
(twice the calculated	uncertainty). Th	is report shall n	of be reproduce	d, except in full,	without the write	sories only. All en approval of 5	Uncertainties ar Shortridge Instru	e expressed in ments. Inc. Re	expanded terms suits relate only
to the item calibrate Recalibration Proce	d. For limitation	ons on use, se	e Shortridge In	struments, Inc.	Instruction Ma	nual for the us	e of AirData M	ultimeters. Pr	ocedure used:
Calibration Technic		A. A.	SIF-CFUZ Re	VISION: 23 L	ated: 12/09/02				
Calibration rechnic	an(s).	uanon	0 8	. Anno	melen	- /	Calibratio	n Date: OF	29/2003
Calibration Approve	ed by:	gay	Baisle	1	Title:(a ma	1.	Date : 09/0	12/2003
AS-Re	ceived By	50 1	70-1	Teşt By	£1	- 2	mal, Test B	y_ 4/	_
Date <u>o</u> Ambie	s/22/03 Rh		6 Date	0P/28/03 R	h	% Da	18 08/29/63	Rh	2%
Barom	etric Pressure	28.40 in H	Baro	metric Pressure	18.44 in	Ho Ba	pient Temperat	ure 28.74	- Ha
Within	spec (YES) NO	O NA	With	in spec (YES)NO	Wi	thin spec YES	5) NO	
	TEOTMET		ABSO	LUTE PRESSU	RE TEST (in Hg)		/	
Deserver Oles dest	IESI MEI	ER TOLERANC	$E = \pm 2.0 \% \pm .$	1 in Hg AS-F	RECEIVED TES	ST WITHIN SPE	C (YES NO	N/A	
Pressure Standard: I Pressure Standard: I	Heise #02-K Heise #04-R	S/N: 41741/4 S/N: 41743/4	2451 Calib 2453 Calib	ration Date: 04/	21/03 Ca	libration Due Da	te: 04/2004	As-Rovo	Test 2 Test 3
Pressure Standard:	Heise #06-R	S/N: 41742/4	2452 Calib	ration Date: 12/	04/02 Ca	libration Due Da	ite: 11/2003	As-Rovd	Test 2 Test 3
Pressure Standard: I	Heise #08-R	S/N: 42186/4	3328 Calib	vation Date: 03/	14/03 Ca	libration Due Da	ate: 09/2003	As-Rcvd	Test 2 Test 3
Pressure Standard; I	Heise #10-R	S/N: 42203/4 S/N: 43412/4	3352 Calib 5043 Calib	ration Date: 04/	07/03 Ca /18/03 Ca	libration Due Da libration Due Da	tte: 10/2003	As-Rovd As-Rovd	Test 2 Test 3 Test 2 Test 3
Heise Model PPM-2	Mfgd by I	Dresser Industri	es Rate	d Accuracy: 0.0	05% fs (0.0305	in Hg) Ri	ange: 0-61 in Ho	Unce	tainty: < 0.0358
Approx Set Pt	Standard	Test Meter	% Diff	Standard	Test Meter	% Diff	Standard	Test Meter	% Diff
14.0	14.88	15.0	. 81	14.32.	14.4	.56	14.38	14.4	.14
28.4	28.39	28.5	.39	28.44	28.6	.56	28.34	28.4	,21
40.0	40.60	40.6	1 e	42.48	42.6	.28	42.25	42.2	/2
			DIFFER	ENTIAL PRESS	URE TEST (in	wc)			
	TEST METE	R TOLERANCE	$= \pm 2.0 \% \pm 0.0$	001 in wc AS	-RECEIVED TE	ST WITHIN SP	EC (YES) NO	D N/A	
Pressure Standard: I	Heise #01-L	S/N: 41739/4	2449 Calib	ration Date: 04	/22/03 Ca	libration Due Da	ate: 04/2004	As-Revie	est 2 Test 3
Pressure Standard: I Pressure Standard: I	Heise #01-R Heise #02.I	S/N: 41739/4 S/N: 41741/4	2446 Calib 2454 Calib	ration Date: 04	/22/03 Ca	libration Due Da	ate: 04/2004	As-Rove	est 2 Test 3
Pressure Standard:	Heise #03-L	S/N: 41738/4	2448 Calib	ration Date: 05	09/03 Ca	libration Due Da	ate: 05/2004	As-Rovd 1	est 2 Test 3
Pressure Standard: I	Heise #03-R	S/N: 41738/4	2445 Calib	pration Date: 05	09/03 Ca	libration Due Da	ate: 05/2004	As-Rovd 1	est 2 Test 3
Pressure Standard: I Pressure Standard: I	Heise #04-L Heise #05-L	S/N: 41/43/4 S/N: 41740/4	2456 Calib 2450 Calib	ration Date: 05 ration Date: 12	/13/03 Ca /06/02 Ca	libration Due Da libration Due Da	ate: 05/2004	As-Rovd a	est 2 Test 3
Pressure Standard:	Heise #05-R	S/N: 41740/4	2447 Calib	ration Date: 12	/08/02 Ca	libration Due Da	ate: 11/2003	As-Rovd	est2 Test3
Pressure Standard: I	Heise #06-L	S/N: 41742/4	2455 Calib	ration Date: 12	06/02 Ca	libration Due Da	ate: 11/2003	As-Rovd a	TESL2 (Tesl3)
Pressure Standard: I	Heise #07-L	S/N: 42185/4	2186 Calib 3326 Calib	ration Date: 03/ pration Date: 03/	/18/03 Ca	libration Due Da	ate: 09/2003	As-Rovd	est 2 Test 3 est 2 Test 3
Pressure Standard: I	Heise #08-L	S/N: 42186/4	3329 Calib	ration Date: 03	/18/03 Ca	libration Due Da	ate: 09/2003	As-Rovd	lest 2 Test 3
Pressure Standard: I Pressure Standard: I	Heise #09-L Heise #09-D	S/N: 42202/4	3351 Calib	pration Date: 04	/09/03 Ca	libration Due Da	ate: 10/2003	As-Rovd 1	Test 2 Test 3
Pressure Standard: I	Heise #10-L	S/N: 42203/4	3353 Calib	ration Date: 04	/09/03 Ca	libration Due Da	ate: 10/2003	As-Rovd 1	est 2 Test 3
Pressure Standard: I	Heise #13-L	S/N: 43415/4	5041 Calib	ration Date: 06	18/03 Ca	libration Due Da	ate: 12/2003	As-Rovd	est 2 Test 3
Pressure Standard: I Pressure Standard: I	Heise #13-R Heise #14-I	S/N: 43415/4 S/N: 43412/4	5039 Calib 5045 Calib	ration Date: 06	/18/03 Ca	libration Due Da	ate: 12/2003	As-Rovd 1	Test 2 Test 3
Differential Pressure	Standards: He	ise Model PPM	11 Manufa	ctured by Dress	ser Industries		10. 12/2003	79-110-10	6612 16815
#01-L, 03-L, 05-L, 07 #01-D 03-D 05-D 0	-L, 09-L, 11-L	Rated	Accuracy: > 0.0	7% fs (0.00017	5 in wc)	Range: 0.	.0-0.25 in wc	Uncerta	inty: < 0.00035
#02-L, 04-L, 06-L, 08	3-L, 10-L, 12-L	Rated	Accuracy: > 0.0	6% fs (0.03 in w	wc)	Range: 0	.0-50.0 in wc	Uncerta	anty: < 0.00346
Approx Set Pt	Standard	Test Meter	% Diff	Standard	Test Meter	% Diff	Standard	Test Meter	% Diff
.0500	.0563	. 0560	-53	.0.528	,0524	76	.0536	-0336	0
.1250	.1266	. 1260	+ 47	. 1237	.1228	773	,1251	, 1254	,24
.2250	.2245	.2254	49	. 22.47	.2229	-80	-2274	. 2277	.13
.2700	.2712	.2702	37	-2746	,2736	736	.2738	.2738	0
2.000	2-028	2020	39	2.030	2.018	7.59	2.024	2.022	-10
3.600	3.620	3.595	- 69	3.654	3.633	- 63	3.666	3.667	.03
4.400	4.414	4.427	. 29	4.430	4.419	725	4.461	4.470	.20
27.00	27.33	27.25	- 29	27.7.8	27.68	7.2.2	27.37	27.37	
Overance	50.11	99.82	-58	49.7/	47.93	.56	77.62	79.96	732
e torange				~	~			~	
			01						

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07/14/03

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		AIRDATA I	MULTIMET	TER CERTI	FICATE C	F R	ECALIBRAT	ION			
									S/N:_	MAIN	7
									01001 #	K05 22	-/
	TEST METE	R TOLERANCE	LOW = ± 3.0% ± 7	FPM AS	RECEIVED	ION TEST	WITHIN SPE	C (YES) NO	N/A		
Velocity Standard: Air	Data Multimeter	S/N: M964	155 Cali	bration Date: 1	1/08/02	Cal	ibration Due D	ate: 11/2003	As-Rev	Test 2	Test 3
Velocity Standard: Air	Data Multimeter	S/N: M960	099 Cali	bration Date: 0	9/26/02	Cal	ibration Due D	ate: 09/2003	As-Rov	d Test2	Test 3
Velocity Standard: Air	Data Multimeter	S/N: M994	120 Cali	bration Date: 0	9/26/02	Cal	ibration Due D	ate: 10/2003 ate: 09/2003	As-Rov	d Test2	Test 3
Rated Accuracy: Velo	city ± 2.0 % ± 3	fpm Uncertain	nty: <2.25 fpm	n at 100 fpm; •	2.5 fpm at 5	500 fp	m				
Anner Cat Dalas	Character at	-	-								
Approx Set Point	Standard	Test Meter	- Nit	Standard	Test	Meter	Diff	Standard	Test M	eter D	- ne
500	129.1	121	-3.7	106.4	109	<u> </u>	- 2. y	123.2	+ 2	-9.	2
500	525.5	522	-3.5	998.4	99	Y	-4.6	550.9	55	0 -	۲
ADM-870/870C and A Low Velocity Confirma	DM-860/860C A ation represent L	irData Multimete Incertainty of the	rs are read in Transfer Sta	AirFoil Mode. ndard Meterie	ADM-850 i posed to th	Multim e pres	eters are read	In Pitot Tube M	lode. Unce	ertainties sho	own for
-											
		т	EMPERATUR	E TEST - AIR	DATA MUL	TIMET	'ER (° F)	~			
	TEST	METER TOLERA	NCE = ± 0.2	F AS-REC	EIVED TES	T WIT	HIN SPEC	ES NO NI	A		
RTD Simulator: S/N 2	49 Calibratio	on Date: 01/24/20	02 Calib	ration Due Dat	e: 01/2004	As	Revo Test 2	Test 3 Set	Point 35.6	5 95° F	154.4° F
RTD Simulator: S/N 2 RTD Simulator: S/N 2	50 Calibratio 53 Calibratio	on Date: 01/24/20	02 Calib	ration Due Dat	8: 01/2004	A	Revel Test 2	Test 8 Set	Point: 35.6 Point: 35.6	°F <u>95°</u> Đ	154.4° F
RTD Simulator: S/N 2	54 Calibrati	on Date: 03/28/20	02 Calib	ration Due Dal	e: 03/2004	As	-Rovd Test 2	Test 3 Set	Point: 35.6	°F 95°F	154.4° F
RTD Simulator: S/N 2	56 Calibrati	on Date: 03/28/20	02 Calib	ration Due Dat	e: 03/2004	As	-Rovd Test 2	Test 3 Set	Point: 35.6	°F 95°F	154.4° F
RTD Simulator: S/N 2 RTD Simulators Mode	57 Calibration RTD-1000/500	n Date: 03/28/20 Rated Accura	02 Calib	f setting R	e: 03/2004	AS In 11	-Rovd Test 2	Test 3 Set	Point: 35.6	°F 95°F	154.4° F
				i coung i i				onoordanity.	on ppin		
RTD Simulator T Equivalent S	emperature et Point	Test Meter	Diff	erence	Test Mete	ar	Difference	Test	Meter	Differen	ce
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95	00	95.1	1.1		951		. /		0	σ	
154	40	154.2	2		154 6	_		- 73	4.4	0	
		1-1-1-2			151.1						
		т	MPERATUR	E TEST OF C		S TEA	PROBE				
	TEMP	ROBE TOLERAN	VCE = ± 0.3*	F AS-RECI	EIVED TES	WIT	HIN SPEC	ES NO N/A	\		
Thermometer S/N 921	43/Thermistor	S/N 8715	13 Calib	ration Date: 04	/04/01	С	al Due Date: 0	6/2003	Set Point:	35°F 95°F	155° F
Thermometer S/N 8A	089/Thermistor	S/N 88170	08 Calib	ration Date: 05	/27/03	c	al Due Date: 0	5/2005	Set Point:	35° F 95° F	(155)F
Thermometer S/N 921	42/Thermistor	S/N 85010	04 Calib	ration Date: 07	/02/03	C	al Due Date: 0	7/2005	Set Point:	35° D95° F	155° F
Above Temperature S	tandards: Rated	5/N 8/150 Accuracy: 0.023	3° F/0.018° F	Combi	ned Uncerta	Gi ainty:	al Due Date: 1 < 0.025° F	1/2004	Set Point:	35" F QO' F	J100" F
Temperature Clauder				and an and a second					0		ARCA F
Temperature Standar	d AirData Multim	eter S/N: M00 eter S/N: M96	136 Calib 100 Calib	ration Date: 0 ration Date: 0	3/31/03 5/14/03	C C	al Due Date: 0 al Due Date: 0	3/2004 5/2004	Set Point:	35° F 95° F	155° F
Above Temperature S	tandards: Rated	Accuracy: 0.03	F Uncert	ainty: < 0.023°	F						
Total combined Unce	tainty for TemP	robe testing : < 0	.039° F								
Approx											
Set Point Standard	TemProbe	Diff TemP	robe Diff	TemProbe		TemP	hope Diff	TemProbe	<u> 1 10</u>	amProbe	Dif
35.0	- 349	/		-	╂						
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			Shor	ridge Inst	ruments	Inc			sisately	CONS	
		7855	East Redf	ield Road S	cottsdale	, Ariz	ona 85260				
	(480) 99	1-6744 • Fax	(480) 443	-1267 • w	w.shortri	dge.o	com • info@	gshortridge.	com		
ADM Receibration Spec	Rev20/04/15/03			2 0	2						07/14/03
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TSS/VetEquip, Inc. Project NCO040NPNA-03: Testing the Improved DSx Vented, Warming Table Report 15 August 2004 Page 23 of 25

Technical Safet	y Services, Inc.	Valid Date Supersedes		04 S 06 D	eptemb Decemb	er 2000 er 1999					
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Document Number INSTRUMENT CALIBRATION RECORD Technical Statey Services, inc. O4 September 2000 Supersedes 06 December 1999 Page 1 of 1 INSTRUMENT CALIBRATION RECORD FACILITY Technical Safety Services, Inc. DB ID NO. C.Q. 36.2 TSS Cal Event <i>WCO</i> 402374 ADDRESS 620 Hearst Avenue MFGR. Dickson INSTRUMENT Calibration Structure CITV, STATE Berkeley, CA. MODEL THDx Instructure Instructure CONTACT Duy Doan BLDG. 620 Hearst Avenue MFGR. Dickson CITV, STATE Berkeley, CA. MODEL THDx Instructure Instructure CONTACT Duy Doan BLDG. 620 Hearst Avenue Instructure Instructure Instructure ONTO STATUS: CEASON FOR SERVICE: FINAL TEST STATUS: Instructure Instructure<											
FACILITY	Technical S	Safety Servi	ces, Inc.	DB ID	NO. F	0 26	L TSS C	al Event		VCAUC	27/
ADDRESS	620 Hearst	Avenue		MFGR.	I	Dickson	0-1.000			000 90	219
CITY, STATE	Berkeley, C	MODE	ιI	HDx							
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PHONE	Duy Doan	BLDG.	6	20 Hearst A	Ave						
THONE	510.845.55	91		RM.	C	alibration	Laboratory				
AS FOUN	D STATUS		FASON FOR	SERVIC	T.			TRAM -	100 - 7		
IN TOLERAN	ICE	SCHE	DULED	SERVIC	15:	BCAL	BRATED	. TEST S	TAT	US:	'AT
OUT OF TOL	ERANCE	O UNSC	HEDULED			0 OUT	OF TOLERA	NCE		CIMITED	and the second
INOPERATIV	D NEW	UNIT				ERATIVE					
UNITS MEASUR	ED	AS FOUN	ND TEST DAT	ΓA:			FINAL	TEST	DATA		
TEST POINTS	STANDARD	INSTRUMENT	DIFFERENCE	TOL (+6)	IN	STANDARD	INSTRUMENT	DIFFERE	NOP		IN
Ambient °C	19.8	19	08	1	VOC	or a donado	1.37 Kongott	DIFFERE	ME	TOL.(+/+)	TOL?
Low °C	2.2	3	0.8	i	yes				2		
Ambient %r	1 50.2	50	0.2	à	1905				γ		
					the second s	A					
STANDARDS U	SED		SERIAL/ID	NUMBE	R	STD. CAL. I	DATE	CA	L. D	UE DATE	
GE 1311DR/N	12 Dew point	er	TSS EO 1	69		10/13/03 4			13/0	4	-
Barometric Pr	essure (30	3 "Ha)	TSS FO I	064		5/7/02			17/04		
	coolie (50	.5 11g)	155 EQ 1	004 577/03			5/1	5///04			
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Duy Doan	. (******)	SALIDIAL	50 DT (310N			CALI	/. /	TE	C	AL DUE D	ATE
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TSS/VetEquip, Inc. Project NCO040NPNA-03: Testing the Improved DSx Vented, Warming Table Report 15 August 2004 Page 24 of 25

T	95 EQ 1	282			Event# NCC	940114
			Fluke Corporation 6920 Seaway Blvd Everett, WA 98203 (425) 347-6100	n	ISO 90	
		Ce	rtificate of Calib	ration	CalNe	to
	Manufacturer: Model: Description: Serial Number:	Fluke FLUKE-189/CW LOGGING MUL 85090172	'G .TIMETER	APPROVED FOR CLIEN JAN 2 1 2004 BY: <u>0.0</u> FOR TSS www.techssfety.co	IT USE	
	The Fluke Corpor calibrated in acc ISO-9001 control specifications at The measureme traceable to the physical constant	oration, ISO Certif ordance with appl illed and are desig the time of calibra nt standards and United States Nat ts, consensus sta	ication No. U0018, certifies the icable Fluke calibration process gned to certify that the instrum- ation. instruments used during the ional Institute of Standards a undards, or by ratio type mean Temperature: $23^{\circ} C \pm 5^{\circ}$	hat the instrument ide odures. Its calibration ment was within its put calibration of this instr nd Technology (NIST surements. Report Number:	ntified above was processes are blished rument are), natural 1598453-85090172	
	Cell Lead: G	Nov 12, 2004 reg Romig	Humidity: < 80%	Received Condition	on: New Product on: In Tolerance	
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나 이렇게			- 			
			Page 1 of 1			

TSS/VetEquip, Inc. Project NCO040NPNA-03: Testing the Improved DSx Vented, Warming Table Report 15 August 2004 Page 25 of 25

Marker De Cent, friede ministration du contre d'alternation du date: 3, 2, 5, 6, 6, 100 Serial No. 3, 3, 0, 5, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10	EQ	Certificate of Calibration									
Serial No. Strong P Date Childrate: Stop P Net Childrate: Stop P Model No. M-1 M-5 M-30		A.F. BUCK, INC. MINI-BUCK CALIBRAIOKIM									
Model Not M-1 M-5 0 M-30 Applicable Measurement Standards	(Model No.	- N								
Applicable Measurement Standards		Model No. M-1 M-5 0 M-30									
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□ 100ml Burette Kimble 1702/1*100 1219 02/15/2005 Special 17/02/1* □ 1000ml Burette Kimble 17081 0002 10/15/2005 ASTM E542 ☑ 1000ml Burette Kimble 17081 0003 10/15/2005 ASTM E542 ☑ Stopwatch CMS 387-621 0996605 07/17/2004 EL015 □ Stopwatch Fisher 14-649-5 230268455 10/21/2004 FREQ. STD. 104 □ Unable to calibrate as received due to condition of unit. □ Unable to calibrate as received due to condition of unit. ☑ Within specifications of ± 0.5% of the display reading. □ Not in specifications of ± 0.5% of the display reading. □ Not in specification by% High% Low of the display. The instrument listed above has been adjusted to nominal, utilizing a 1,000ml burette, and an electronic digital stop watch, which are traceable to the National Institute of Standards & Technology (NIST). The accuracy of the instruments used to perform calibration is greater than 4 to 1. The A.P. Buck, Inc. Calibration system is in compliance with ANSI Z540-1 and IEC guide 25. Calibration system is in compliance with ANSI Z540-1 and IEC guide 25. Calibration was conducted with A.P. Buck, Inc. Calibration Procedure APB-1 Rev. 6.1 with a constant flow pum		Description MFR. Model Serial # Calibration Due Date N. I. S. T.									
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CD 1000mi Burette Kinible 17061 0003 1015/2003 ASTALES42 Stopwatch CMS 387-621 0996605 07/17/2004 EL015 Stopwatch Fisher 14-649-5 230268455 10/21/2004 FREQ. STD. 104 This instrument as received on 3-19-04 at A.P. Buck, Inc.'s facility was found to be: 10/10/10/10/10/10/10/10/10/10/10/10/10/1		1000ml Burette Kimble 17081 0002 10/15/2005 ASTM E542									
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A.P. BUCK, INC. 7101 Presidents Drive, Suite 110 APR 0 2 2004		This instrument as received on at APP. Buck, inc. stacking was found to be. Unable to calibrate as received due to condition of unit. Within specifications of ± 0.5% of the display reading. Not in specification by% High% Low of the display. The instrument listed above has been adjusted to nominal, utilizing a 1,000ml burette, and an electron digital stop watch, which are traceable to the National Institute of Standards & Technology (NIST). The accuracy of the instruments used to perform calibration is greater than 4 to 1. The A.P. Buck, Inc. Calibration system is in compliance with ANSI Z540-1 and IEC guide 25. Calibration was conducted with A.P. Buck, Inc. Calibration Procedure APB-1 Rev. 6.1 with a constant flop pump using the Bubble-meter method. A.P. Buck, Inc. guarantees the accuracy and repeatability of ± 0.5 for any display reading as described under the instruction manual "Principles of Operation Responsibilities shall in no event, nor for any cause whatsoever, exceed the price charged for the calibration represented by this certification. QA APPROVAL BY: Ohandrika for the calibration APPROVED FOR CLIENT USE A.P. BUCK, INC. 7101 Presidents Drive, Suite 110	nic he nc.								