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Test Report of Evaluation of Primary Exhaust Ventilation Flow Meters for Double Shell Hydrogen Watch List Tanks

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Abstract: This document reports the results of testing four different flow meters for use in the primary exhaust ventilation ducts of Double Shell Tanks on the hydrogen watch list that do not already have this capability. This currently includes tanks 241-AW-101, 241-AN-103, 241-AN-104, 241-AN-105 and 241-SY-103. The anticipated airflow velocity in these tanks range from 0.25 m/s (50 ft/min) to 1.78 m/s (350 ft/min). Past experiences at Hanford have forced the evaluation and selection of instruments to be used at the low flow and relatively high humidity conditions found in these tanks. Based on the results of this test, a flow meter has been chosen for installation in the primary exhaust ventilation ducts of the above mentioned waste tanks.

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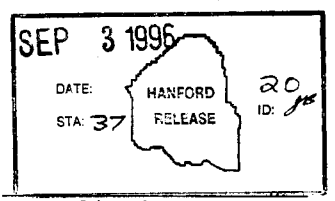

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TEST REPORT OF EVALUATION OF PRIMARY EXHAUST VENTILATION FLOW METERS FOR DOUBLE SHELL HYDROGEN WATCH LIST TANKS

Contents

TEST REPORT OF EVALUATION OF PRIMARY EXHAUST VENTILATION FLOW METERS FOR DOUBLE SHELL HYDROGEN WATCH LIST TANKS

1.0 INTRODUCTION

This document is a report on the results of testing four different flow meters using three different technologies for use in the primary exhaust ventilation ducts of Double Shell Tanks on the hydrogen watch list that do not already have this capability. This currently includes tanks 241-AW-101, 241-AN-103, 241-AN-104, 241-AN-105 and 241-SY-103. The anticipated airflow velocity in these tanks range from 0.25 m/s (50 ft/min) to 1.78 m/s (350 ft/min). Past experiences at Hanford are forcing the evaluation and selection of instruments to be used at the low flow and relatively high humidity conditions found in these tanks.

The objective of the testing was to measure the accuracy, step response and response to high humidity of the four flow meters over the velocity range of 0.066 m/s (13 ft/min) to 2.25 m/s (442 ft/min) [flow range of 4.7E-3 m^3/s (10 cfm) to 0.16 m^3/s (340 cfm) for a 12" duct]. A full scale mock-up of a typical exhaust duct in the valve pits was used for testing because the duct configuration is less than optimum for flow instrumentation. Flow meters generally work best with laminar flow through the duct being used. Typically, the flow meter vendors desire five diameters of straight duct downstream of the flow meter and ten to twenty diameters of straight duct upstream of the flow meter to provide accurate readings. In a typical valve pit arrangement there are only ten diameters of unperturbed duct in which to position the flow element.

Testing was performed by representatives from ICF-KH Analytical Services (5A620) and WHC Equipment Development (8A200) from 5/22/96 to 6/26/96 in the high bay of the 306E building. The procedure used is contained in WHC-SD-WM-TP-441, *Test Plan for Evaluation of Primary Exhaust Ventilation Flow Meters for Double Shell Hydrogen Watch List Tanks*.

2.0 DESCRIPTION OF TEST

All flow meters were tested with manufacturer's factory calibration. Only the zero-cutoff points (set as low as possible) and response times (set as quick as possible) were changed.

A full-scale mockup of the ductwork in a typical tank farm ventilation pit was set up in the 306E Building in the 300 Area. The mockup is schematically shown in Figure 1.

To determine flow meter accuracy a controlled and measured volume of air (4.7E-3 - 0.16 m^3/s [10-340 scfm]) was sent through the ductwork and was measured by the four flow meters tested. A calibrated laminar flow element in an ideal configuration was used as the basis of comparison.

The step response of the flow meters was tested also. The requirement is for a response time of less than ten seconds (measured from 10% to 90% of flow rate change) for a 50% increase or decrease from the nominal flow rate.

The response to humidity was tested by introducing moisture into the airstream with a spray nozzle to maintain a relative humidity range of 50% - 90%. Each flow meter measured a constant flow over a forty-eight hour period to determine the effect of the humidity.

A stability test was performed by holding the flow at a steady rate for 24 hours at ambient temperature and humidity.

The need for additional tests developed as the testing progressed. For example, the effect of probe insertion depth was examined as well as the effect of the butterfly valve position.

2.1 Test Items

The four flow meters that were tested are listed as follows:

- Air Monitor Corporation MASS-tron II and Volu-probe/1. The MASS-tron II is an ultra-low range differential pressure transmitter that is used in conjunction with the Volu-probe/1 airflow traverse probe. The traverse probe measures total pressure and static pressure across the diameter of the duct. The difference of these two pressures is the velocity pressure, which is proportional to air flow. An airstream temperature signal (4-20 mA) is an additional input signal used by the MASS-tron II to calculate and output the actual volumetric flow rate. The specified output of the MASS-tron II is a 4-20 mA signal (0-397 scfm). The standard volumetric flow rate can be calculated if the gas pressure and gas mass density at actual conditions are known.

- Intek, Inc. Rheotherm® Model IIID-IXD-NPT/2I(ADJ)-4/20-ISB. (Rheotherm and Intek are registered trademarks of Intek, Inc.) The Rheotherm® Model IIID is a thermal mass flow meter that measures ambient temperature inside the duct and then heats an adjacent RTD to a set difference above ambient. The air molecules flowing past the heated element take away heat proportional to the velocity of the airflow. The specified output of the Rheotherm® is a 4-20 mA signal proportional to the standard volumetric flow rate (scfm), but is linear only over the 6-20 mA range (45-350 scfm).

- Panametrics Model GP68 General Purpose Flowmeter. The Model GP68 is a transit time ultrasonic flow meter. Two transducers are mounted at a forty-five degree angle across the diameter of the duct. Ultrasonic pulses are sent both upstream and downstream and the difference in pulse transit time is proportional to the airflow velocity. The specified output of the GP68 is a 4-20 mA signal proportional to the standard volumetric flow rate (scfm) and is programmable in the range of 5 to 7000 scfm for a 12" diameter duct. For testing the maximum output was set at 400 scfm.

- Sierra Instruments, Inc. Model 640-FM-L13-E2-PV1-V4-NR. The Model 640 is another thermal mass flow meter. It is similar in operation to the Rheotherm® Model IIID. The specified output of the Model 640 is a 4-20 mA signal proportional to the standard volumetric flow rate, linear over the entire 4-20 mA range (0-300 scfm).

3.0 TEST METHOD AND TEST EQUIPMENT

Testing took place in the high bay of the 306E Laboratory in the 300 Area under ambient temperature and humidity conditions. The high humidity portion of the test required the addition of moisture into the airstream to increase the relative humidity.

3.1 Equipment and Facilities

A full-scale mockup of the ductwork in a typical ventilation pit was required for this testing. See Figures 1, 1a and 1b for design details.

The instruments used for testing are listed below:

- Laminar Flow Element, Meriam Instrument Model 50MC2-4, nominal 400 scfm air flow at 8" wc and 70 degrees F and 29.92" Hg absolute.
- Ashcroft ATE-100 Handheld Pressure Calibrator, Port 1: 0-25 in.H_2O input range. Output via RS-232 port.
- Absolute Pressure Transmitter, Rosemount Model 3051C, 0-30 psia input range, 4-20 mA output.
- RTD, Platinum, 100 Ohm, DIN 385, Gordon Model RFHLOTK100CA200.
- Temperature Indicator/Transmitter, Newport Electronics Model INFU-0010-DC1. Configured for a DIN 385 4-wire 100 ohm RTD.
- Computer, AST Premmia 486/33, with National Instruments Labview Software installed.
- National Instruments data acquisition hardware to match software.
- Power Supply, 120V AC input, 24V DC output, to support pressure instruments, humidity probe and MASS-tron II flow meter.
- Humidity probe, Hy-Cal Model CT-880-C-8-H-(0/100%), 4-20 mA output proportional to 0-100 % relative humidity.

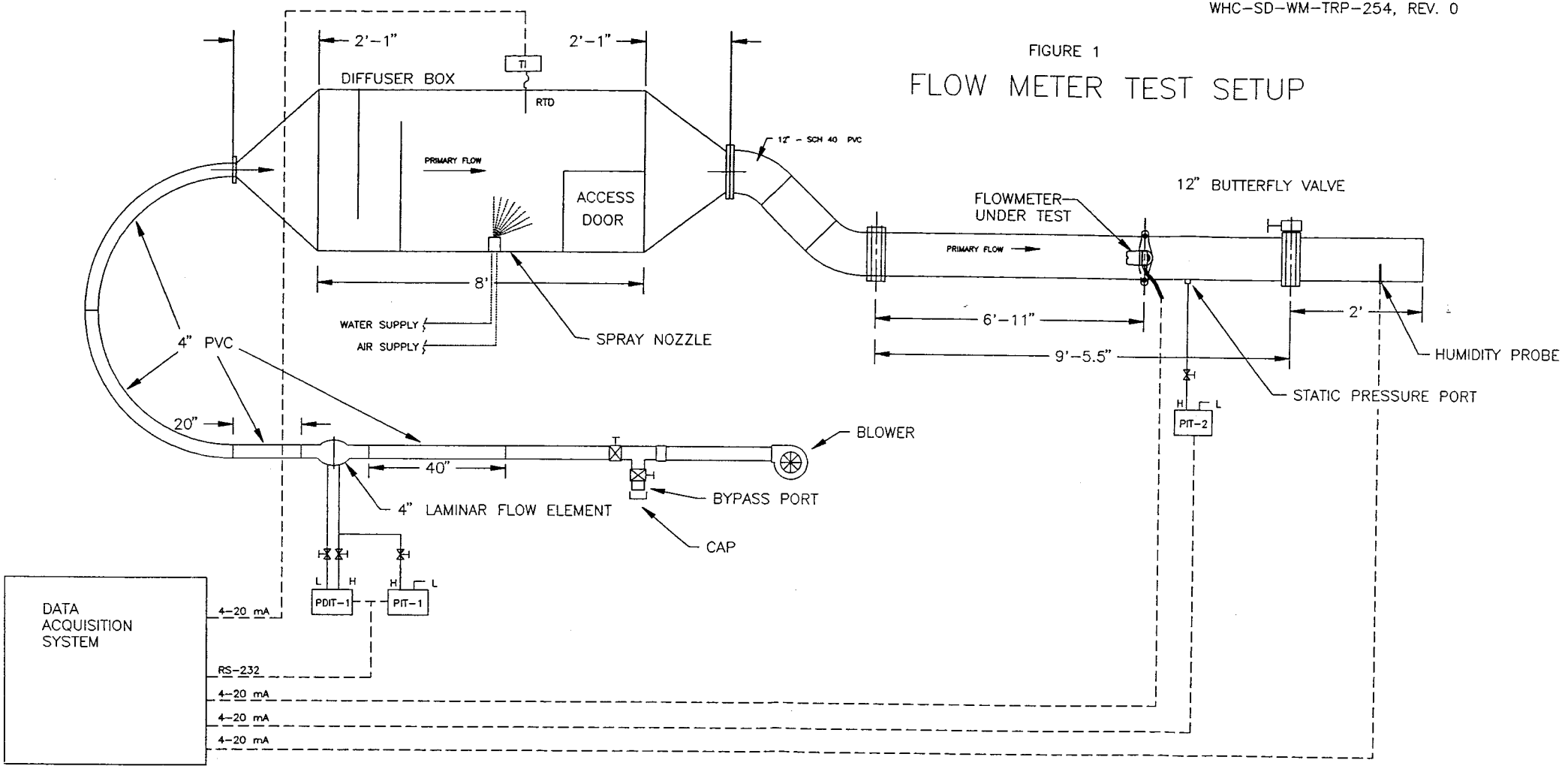
3.2 Data

The test data was collected by the computer as well as written down on the test data sheets or in the test log. All data was processed using Microsoft® Excel Version 5.0. (Microsoft is a registered trademark of Microsoft Corporation in the United Strates and other countries.) In most cases data samples were taken at five second intervals over a thirty second period. Then these six or so samples were averaged to produce a data point for graphing purposes.

The computer data has been stored on a 3.5" floppy disk and can be retrieved and analyzed in the future. Since there is no mechanism in place for Document Control to store magnetic media, both W. E. Willingham Jr. and T. C. Schneider will retain copies of the test data and Excel files on a floppy disk. A CD-ROM may be made of the data for more permanent storage.

FIGURE 1

FLOW METER TEST SETUP



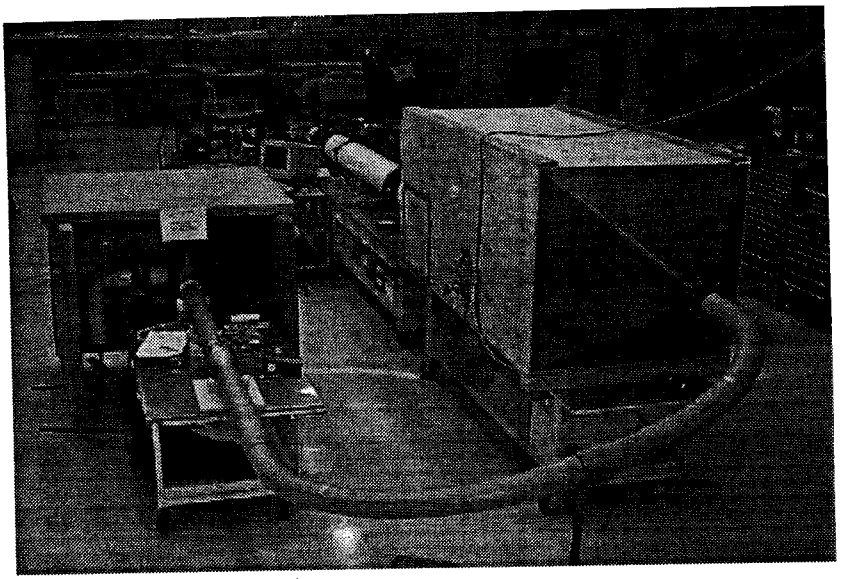


Figure 1a Test Setup in 306E Laboratory

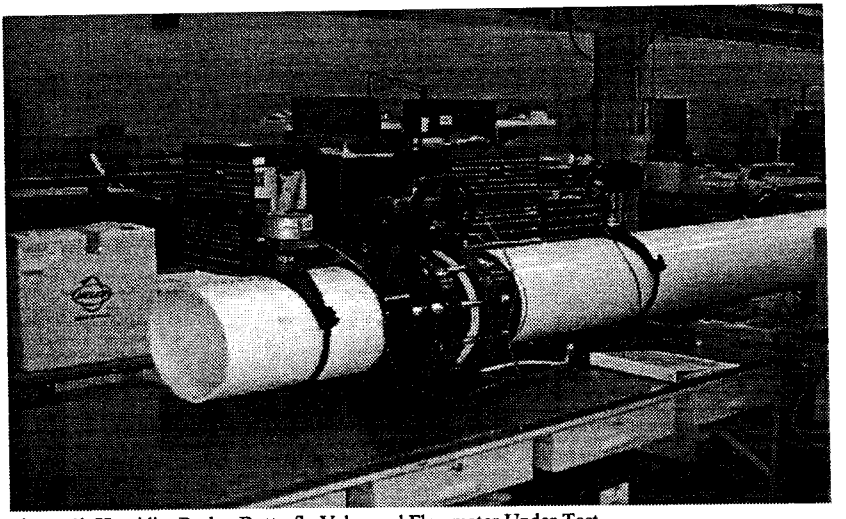


Figure 1b Humidity Probe, Butterfly Valve and Flowmeter Under Test

4.0 TEST RESULTS

4.1 Ambient Tracking Test Summary

For the ambient tracking test, the reference flow was started at 4.7E-3 sm^3/s (10 scfm) and then increased to 0.16 sm^3/s (340 scfm) in a series of steps. At each step the test flow was allowed to settle and then data samples were recorded every five seconds over a thirty second period. This data was averaged to produce the final values used for evaluation purposes. Figures 2 through 5 (Appendix A) show the test velocity and the criteria bounds for the reference velocity (± 0.0762 m/s [15 ft/min]) for the four flow meters. Only the Air Monitor Corporation MASS-tron II stayed within the bounds throughout the required velocity range (0.15 - 2.03 m/s [30 - 400 ft/min]).

4.2 Valve Position Test Summary

For the valve position test the test flow was set at 0.0472 sm^3/s (100 scfm) and then the position of the butterfly valve was varied from full open (90°) to almost closed (10°). Data was recorded at five second intervals for a minimum of thirty seconds at each position after the flow had settled. The test was then repeated with the test flow set at 0.118 sm^3/s (250 scfm). (In the test of the Panametrics GP68 the reference flow was set at 0.0472 sm^3/s and 0.118 sm^3/s (100 and 250 scfm).)

As seen in Figure 6, the amount of valve opening did not significantly affect one flow meter more than the others. No large decrease in flow was noticed until the butterfly valve was at about 45 degrees, or half closed. (The individual flow meter test results are shown in Figures 29-32.)

4.3 Step Response Test Summary

For the step response test the reference flow was set to 0.0472 sm^3/s (100 scfm). Data was recorded at one second intervals while the end of the 12" duct was blocked with cardboard and then opened. The test was then repeated with the reference flow set at 0.118 sm^3/s (250 scfm). In all cases the reference flow decreased by some amount but not as much as the test flow. This was due to the compressibility of the air, the minor leakage in the system and large volume of ductwork between the reference flow meter and the test flow meter.

The Air Monitor Corporation MASS-tron II had a step response time of less than five seconds (Figure 7). The output was under-dampened with some overshoot.

The Intek Rheotherm® had a highly dampened response with no user-accessible adjustments (Figure 8). Its response time ranged from forty to one hundred seconds.

The Panametrics GP68 had a response time of less than ten seconds but it took several seconds to make the step change apparently due to signal processing time (Figure 9). This is more apparent at the higher flow rate but is also evident at the lower flow rates.

The Sierra Model 640 had a response time of about ten seconds (Figure 10).

4.4 24 Hour Stability Test Summary

For the 24 hour stability tests the reference flow was set at 0.076 sm^3/s (160 scfm) and all inputs were recorded at twelve minute intervals over a twenty-four hour period. All flow meters were set at the most sensitive (least dampened) setting. All flow meters performed equally well during this test.

During the Air Monitor Corporation MASS-tron II test the reference flow varied between 0.074 - 0.077 sm^3/s (157 - 163 scfm) while the test flow measured between 0.076 - 0.080 sm^3/s (160 and 170 scfm). See Figure 11.

During the Intek Rheotherm® test the reference flow varied between 0.073 - 0.078 sm^3/s (154 - 166 scfm) while the test flow measured between 0.059 - 0.062 sm^3/s (127 - 131 scfm). See Figure 12.

During the Panametrics GP68 test the reference flow varied between 0.075 - 0.079 sm^3/s (158 - 167 scfm) while the test flow measured between 0.063 - 0.070 sm^3/s (134 and 148 scfm). See Figure 13.

During the Sierra Model 640 test the reference flow varied between 0.073 - 0.077 sm^3/s (155 - 163 scfm) while the test flow measured between 0.079 - 0.087 sm^3/s (168 - 184 scfm). See Figure 14.

4.5 48 Hour Humidity Test Summary

For the forty-eight hour humidity tests the reference flow was set at 0.076 sm^3/s (160 scfm) and then pressurized air and water were injected through a spray nozzle into the upstream end of the 12" duct. This kept the relative humidity around 90%, depending on the ambient humidity conditions. Data was collected at twelve minute intervals over a forty-eight hour period. See Figures 15 through 18.

It appears that the two thermal mass flow meters collected condensation on their sensors which made the test flows show a full upscale value. When the water droplet eventually fell off the sensors the process repeated itself. The ultrasonic flow meter and the pitot-tube flow meter were not so much affected by the humidity. The two thermal mass flow meters were retested for twenty-four hours with the probes mounted in a 4 o'clock position in attempt to minimize condensation on the tip of the sensors. As seen in Figures 19 and 20, this did not solve the problem as the output signals still increased to the full upscale value after a period of time.

4.6 Other Tests

4.6.1 Insertion Depth Test

Insertion depth tests were performed on the two thermal mass flow meters. Marks were made on the bodies of the flow meters such that five insertion depths put the sensor at the center of five circles of equal area. The flow rates at the five different insertion depths were averaged to produce a correction factor. The correction factor (K) can be used to calculate the average flow based on the centerline flow. K should be essentially constant over a flow range of 10:1, but in this case it was not. Tests were run at

0.0472 sm^3/s (100 scfm) and at 0.0944 sm^3/s (200 scfm) that produced different results.

For the Intek Rheotherm® (see Figure 21), the K value at 0.0472 sm^3/s (100 scfm) was 0.8434 while at 0.0944 sm^3/s (200 scfm) the K value was 0.8640. For the Sierra Model 640 (see Figure 22), the K value at 0.0472 sm^3/s (100 scfm) was 0.9146 while at 0.0944 sm^3/s (200 scfm) the K value was 0.8872. This would seem to confirm that the velocity profile is not the ideal fully developed turbulent profile that flow meter manufacturers desire.

4.6.2 Panametrics Parameter Variation Test

For this test two programmable inputs were varied to determine the effect of inaccurate probe distance calculations or measurements. See Figures 23 and 24. The "P" dimension is the transducer face to face distance and the "L" dimension is the axial projection of P in the flow stream. With the flow constant, the programmable values of "P" and "L" were varied over a one inch range. It was found that at a nominal flow rate of 0.066 sm^3/s (140 scfm) that a 0.0254 m (1 inch) increase in "P" increased the apparent flow by 6.1 E-3 sm^3/s (13 scfm). A 0.0254 m (1 inch) increase in "L" decreased the apparent flow by 5.7 E-3 sm^3/s (12 scfm). This indicates that slight errors in measurement of distances while setting up the flow meter would not severely affect the indicated flow rate.

4.7 Installation Assessment

During testing an informal assessment of installation requirements was made. The three insertion-type probes were the easiest to install and set up. The two thermal mass flow meters were mounted in a saddle clamp with a 0.019 m (3/4") compression fitting (Figure 1a). The traverse probe was attached directly to the pipe. The ultrasonic flow meter required that two holes be made in the duct at the correct distance from each other and opposing each other. Two angled spool pieces were clamped around the pipe on opposite sides to give a 45° angled path across the pipe (Figure 1b).

4.8 Cost Considerations

The as-purchased costs for the flow meters were as follows:

- Sierra Instruments $1877
- Intek Rheotherm® $4639
- Panametrics GP68 $5775
- Air Monitor Corporation MASS-tron II $2100
  Air Monitor Corporation Volu-probe I $ 700
  RTD and Temperature Transmitter $ 300
  $3100

On top of procurement costs, installation costs must be considered. The Panametrics GP68 installation would be the most labor intensive due to the two holes required in the duct and the precision needed in locating the holes.

FIGURE 1c – INSERTION-TYPE FLOW METER MOUNTING

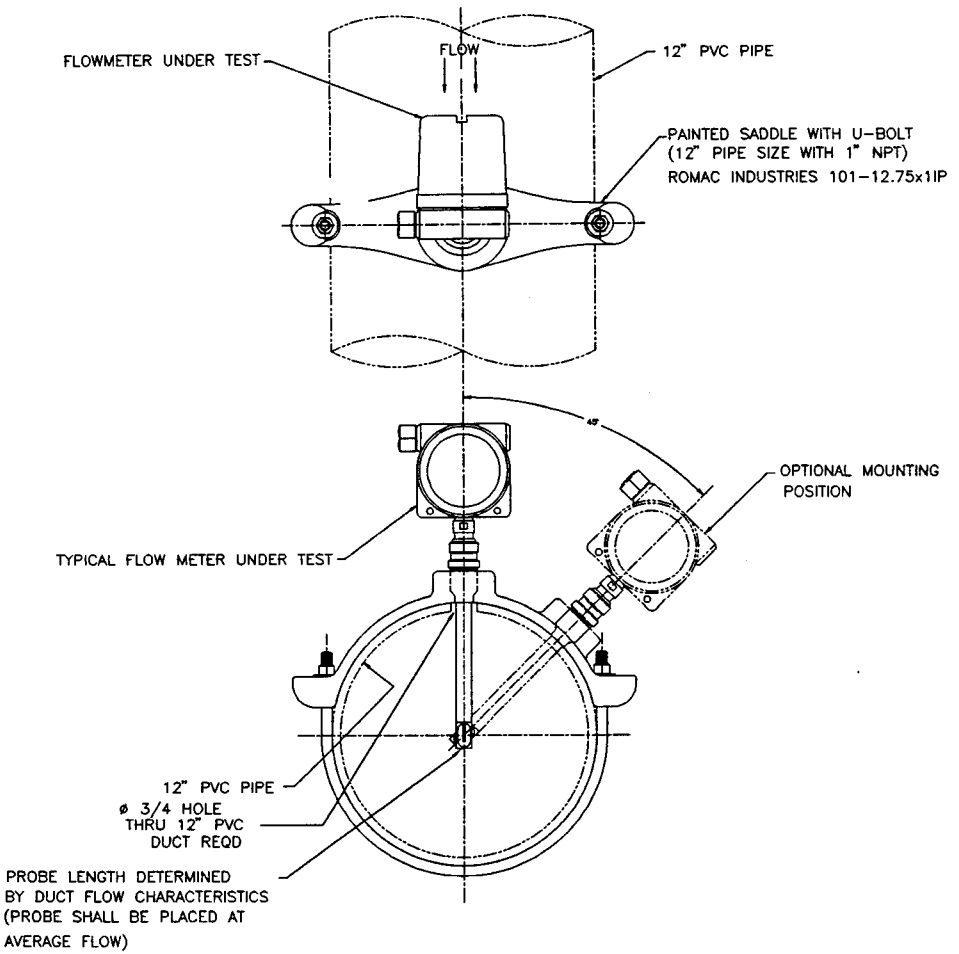
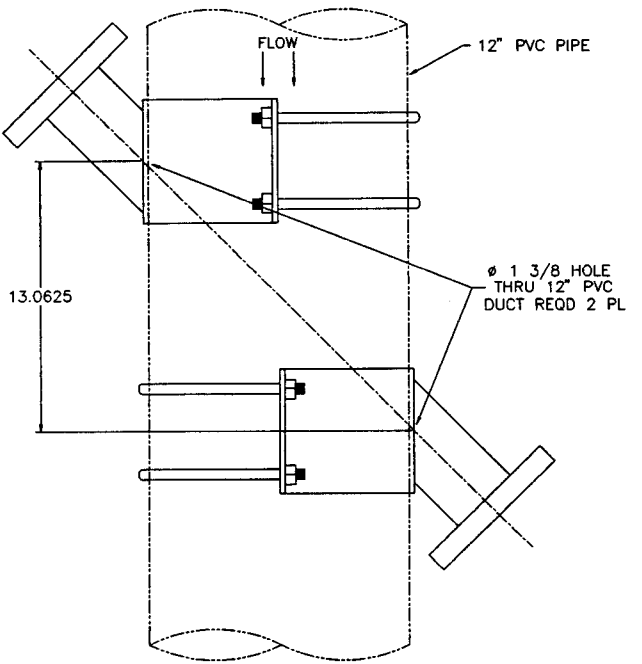


FIGURE 1d – ULTRASONIC FLOW METER MOUNTING



INSTALLATION DETAIL FOR PANAMETRICS ULTRASONIC FLOW METER TRANSDUCERS

The other three flow meters require only one hole be cut and the location is not as critical.

4.9 Calibration

Calibration of the two thermal mass flow meters must be performed in a calibrated flow stream of controlled gas composition. Calibration of the MASS-tron II is done by applying a calibrated pressure to the input ports. The Panametrics GP68 is not physically calibrated but all flowcell characteristics must be entered prior to use. These parameters include axial dimension, path length, pipe type, pipe inside diameter and gas type. Only the analog output is actually calibrated.

4.10 Deviations, Discrepancies, Exceptions and Anomalies

The flow meters were ordered for use in a 12" Schedule 40 pipe (0.303 m [11.938"] inside diameter). Testing was performed in a PVC 12" pipe with an 0.302 m (11.875") inside diameter. This difference in diameters adds about a 1% error to the displayed flow.

The first anomaly occurred during the 24 hour stability test of the Sierra flow meter when the batteries in the Ashcroft differential pressure transmitter wore out part way through the test. A dc power supply was found for use instead of the batteries and the test was repeated.

A second anomaly occurred when the step response test procedure did not work as anticipated. The bypass port did not allow enough airflow through to change the main (test) flow by fifty percent. Instead, a piece of cardboard with a small hole in it was used to block off the outlet of the 0.305 m (12") duct and thus reduce flow by at least fifty percent.

During the 48 Hour Humidity Test of the Intek Rheotherm® channel 0 of the data acquisition failed. This caused the temperature to apparently increase by twenty degrees F. The temperature signal was moved to another channel and testing of the other flow meters continued. The test was not repeated because the test flow signal had already saturated at the time of failure and remained saturated for the duration of the test. See Figure 16.

After testing was thought to be complete, a leak was discovered in the diffuser box. Speculation is that the humidity testing caused the plywood box to swell and shrink, causing gaps to be formed at the seams. The tracking test was then performed on the Intek flow meter before the box was sealed and again performed after the box was sealed. The flow measured before the box was sealed was the same as was measured when testing started. The measured flow increased by about 1.9E-3 sm^3/s (4 scfm) throughout the range after the box was sealed. While this may have affected some of the test results, the final outcome of testing would not have been changed.

4.11 Retests

During the review of the test results, several questions were brought up. The first question was regarding the step response test and the little change of flow through the reference flow element when the flow past the test flow meter was restricted. The second question was regarding the valve position test and the lack of tracking between the reference and test flow meters. The thought was that blocking the exhaust port could cause some back pressure / turbulence around the test flow meter. For this reason, the test setup was reconfigured such that the fan pulled air through the system (Figure 1e) and the step response and valve position test were repeated using the Air Monitor Corporation MASS-tron II flow meter.

When the reconfigured system was first activated the diffuser box tended to collapse and pulled some of the seams open. The box was then repaired, braced and completely sealed with duct tape. The flow was controlled by throttling the flow downstream of the blower. When the flow was reduced below 100 scfm with the butterfly valve open (>10°), turbulance caused by the fan created erratic readings from the test flow meter. (Controlling flow with the inlet valve caused the diffuser box to tend to collapse.)

As seen in Figures 33 and 34, the reference and test flows tracked closely during the step response and valve position tests. These test results can be compared with Figures 7 and 29, respectively. Based on these test results, the indicated placement of the flow meter (per Figure 1) near the butterfly valve will not be a problem in the field installation.

5.0 CONCLUSIONS AND RECOMMENDATIONS

After completion of all testing, the Air Monitor Corporation MASS-tron II is recommended for use in our application. It tracked the reference flow meter within ± 0.08 m/s (15 ft/min) over the range of 0.15 to 2.03 m/s (30 to 400 ft/min). It was least affected by high humidity. The step response time was less than ten seconds. It is relatively inexpensive and not difficult to install.

All flow meters had merit but the MASS-tron II appears to be the most suitable for our application. The two thermal mass flow meters did not perform well in high humidity conditions and the ultrasonic flow meter is more expensive to procure and install. In fairness to all flow meters, the data from the ambient tracking tests was normalized by multiplying the test velocities by a normalization factor equal to the peak reference velocity divided by the peak test velocity for that flow meter. This data, shown in Figures 25-28, shows that the accuracy performance of all flow meters could be improved by adjusting the gains of the systems.

Note: The installation design must be reviewed by the Flammable Gas Equipment Advisory Board prior to installation of the flowmeters.

6.0 DISPOSITION OF TEST ITEMS

The test mockup will be dismantled and disposed of. The flow meters will be excessed unless an organization on site can use them as spares, etc. The MASS-tron II will be retained for installation design and training purposes.

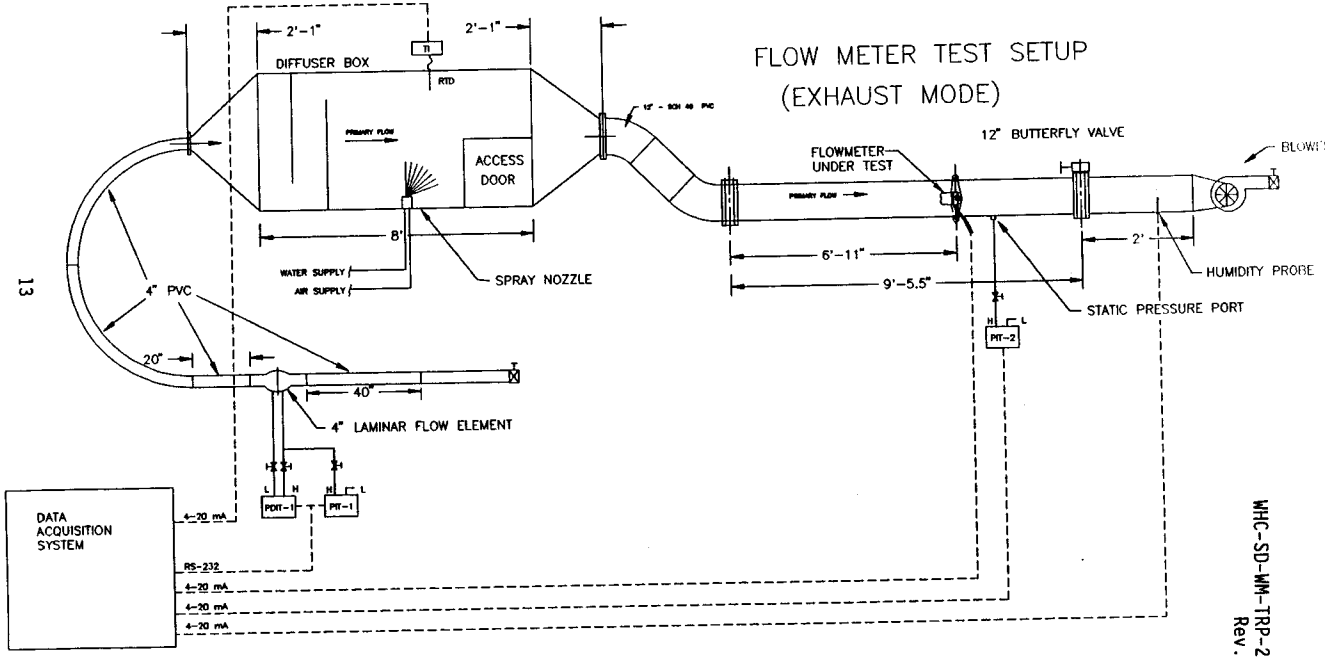

FLOW METER TEST SETUP
(EXHAUST MODE)
2'-1"
2'-1"
DIFFUSER BOX
TI
RTD
PRIMARY FLOW
ACCESS DOOR
8'
WATER SUPPLY
AIR SUPPLY
SPRAY NOZZLE
4" PVC
20"
40"
4" LAMINAR FLOW ELEMENT
FLOWMETER UNDER TEST
12" BUTTERFLY VALVE
BLOWER
6'-11"
9'-5.5"
2'
HUMIDITY PROBE
STATIC PRESSURE PORT
PIT-2
PDIT-1
PIT-1
DATA ACQUISITION SYSTEM
4-20 mA
RS-232
4-20 mA
4-20 mA
4-20 mA

FIGURE 1e

7.0 REFERENCES

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7.2 Westinghouse Hanford Company, WHC-SD-WM-ETP-156, Rev. 0, *Task Plan for Design and Installation of Primary Exhaust Ventilation Flow Monitoring in Double Shell Hydrogen Watch List Tanks*, 9/7/95, Richland, Washington.

7.3 Westinghouse Hanford Company, WHC-SD-WM-CDR-026, Rev. 0, *Engineering Study and Conceptual Design Report for Primary Ventilation Duct Flow Monitoring*, 10/31/95, Richland, Washington.

7.4 Westinghouse Hanford Company, WHC-SD-WM-ETP-178, Rev. 0, *Task Plan for the Selection and Evaluation of Flow Monitoring Instrumentation to be Used on the Primary Exhaust Ventilation in Double Shell Hydrogen Watch List Tanks*, 12/4/95, Richland, Washington.

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APPENDIX A - FIGURES

Air Monitor Corp. MASS-tron II Ambient Tracking Test

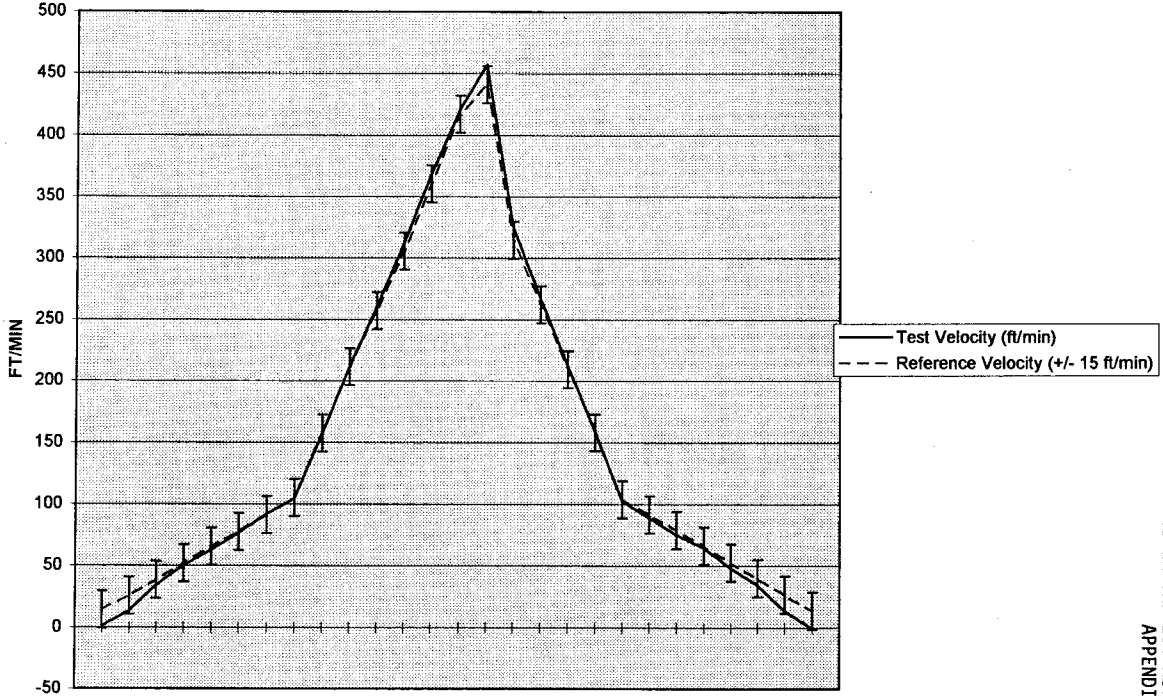


FIGURE 2

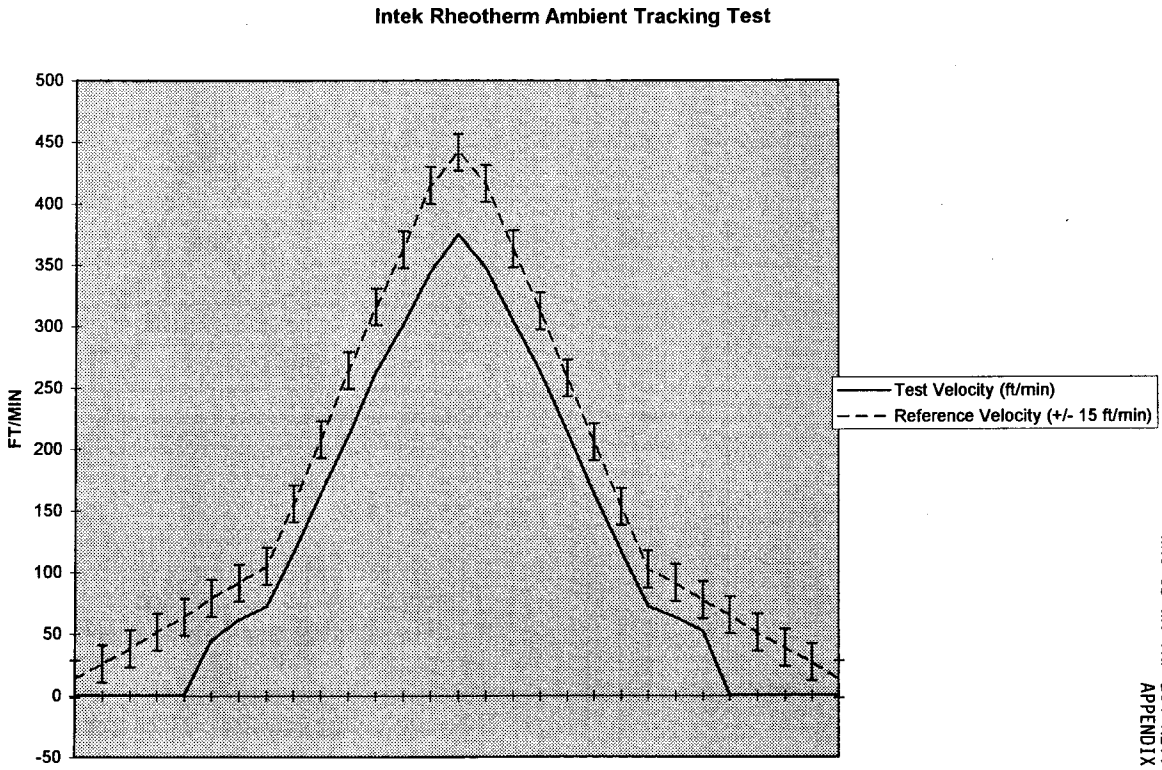

Intek Rheotherm Ambient Tracking Test
FT/MIN
500
450
400
350
300
250
200
150
100
50
0
-50
Test Velocity (ft/min)
Reference Velocity (+/- 15 ft/min)

FIGURE A3

PANA1.XLS

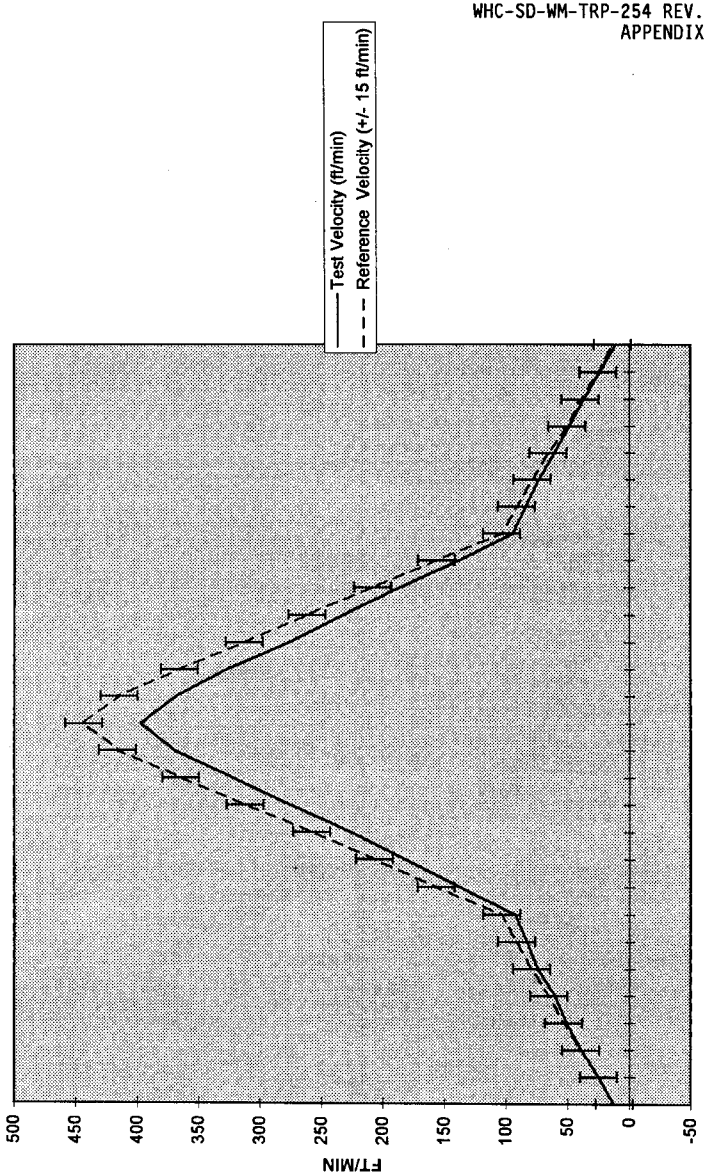


FIGURE A4

SIERRA5.XLS

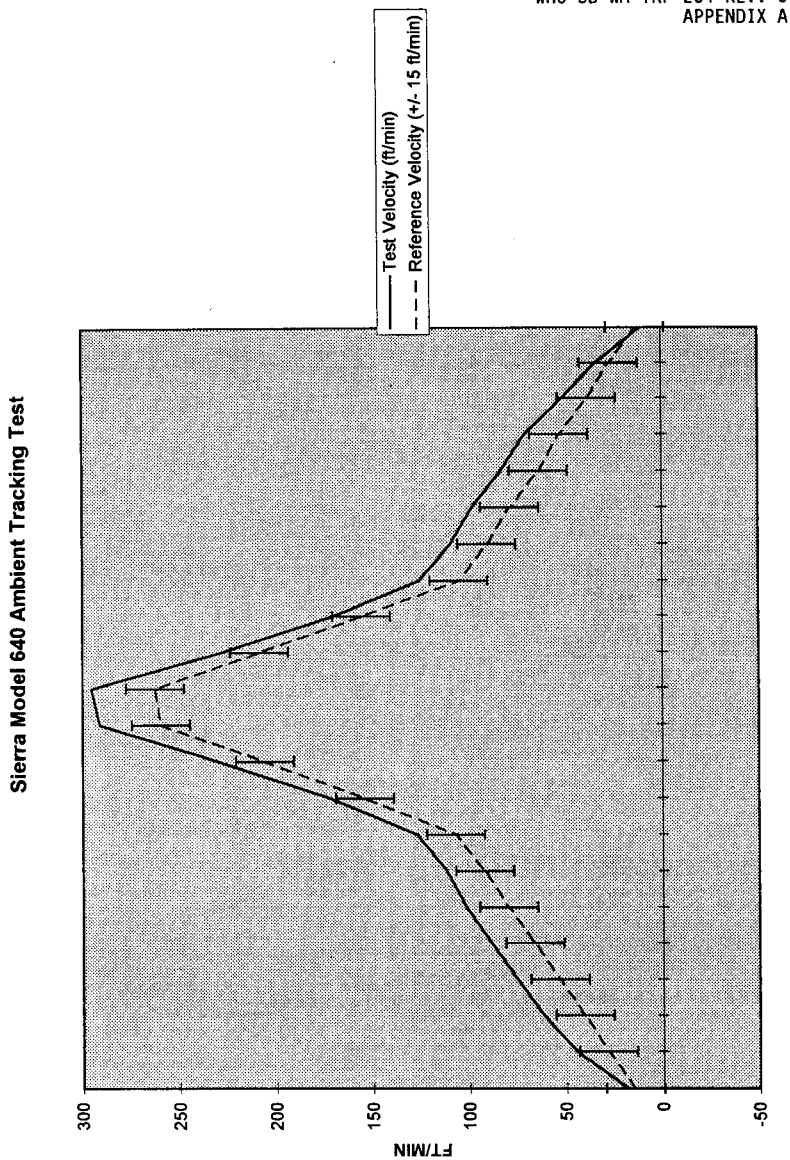


FIGURE A5

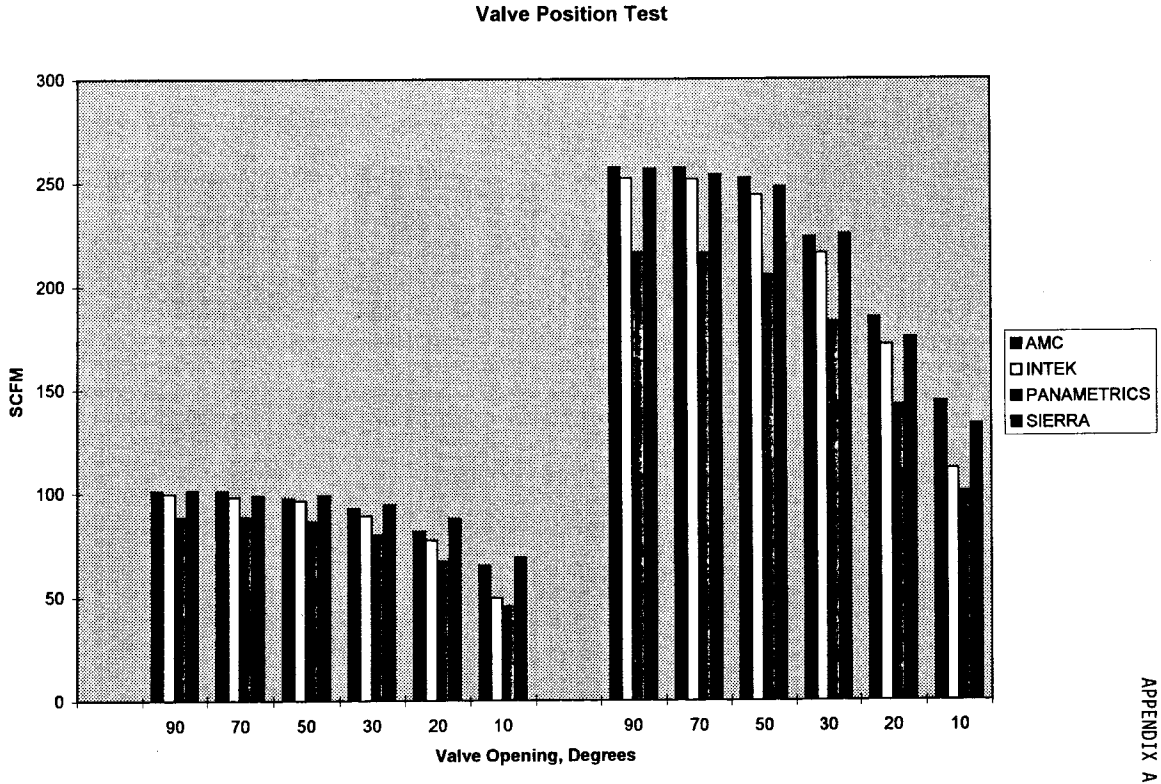
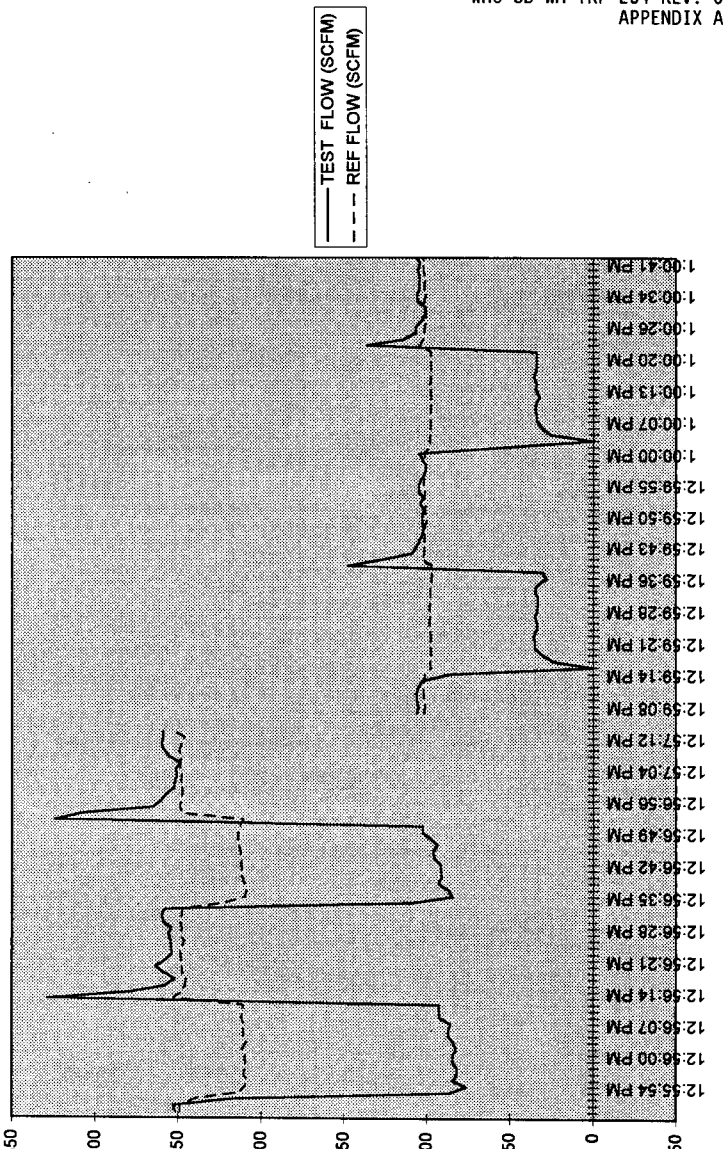

Valve Position Test
SCFM
300
250
200
150
100
50
0
90
70
50
30
20
10
90
70
50
30
20
10
Valve Opening, Degrees
AMC
INTEK
PANAMETRICS
SIERRA

FIGURE A6



AMC3.XLS

FIGURE A7

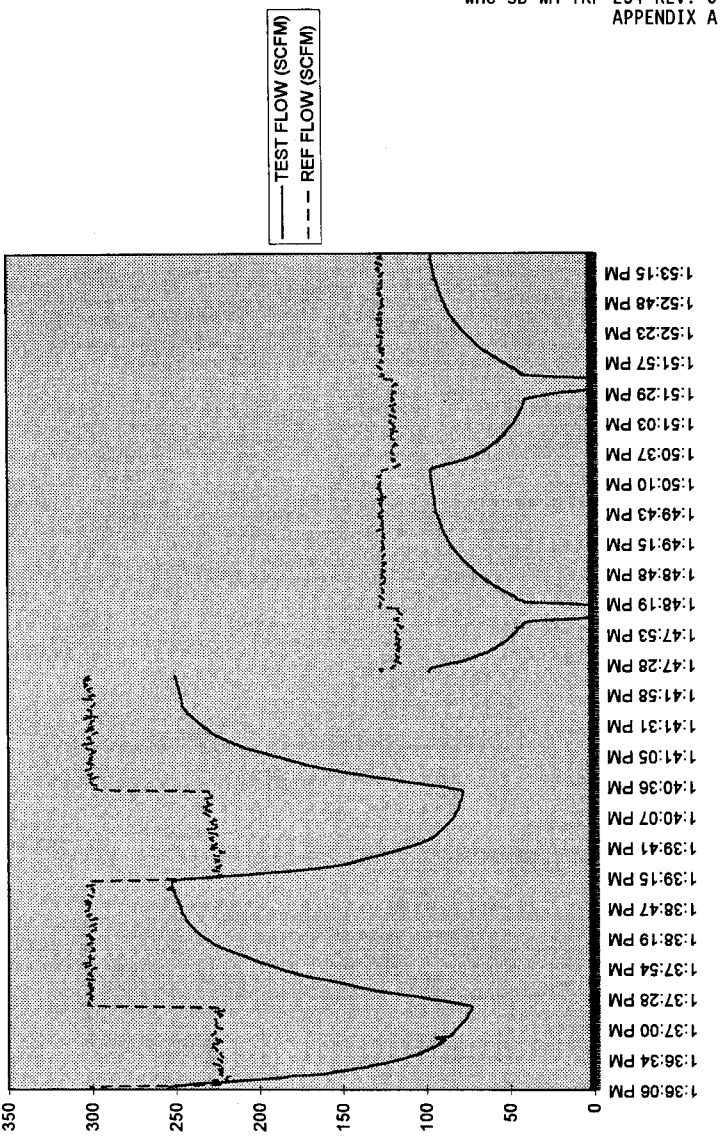
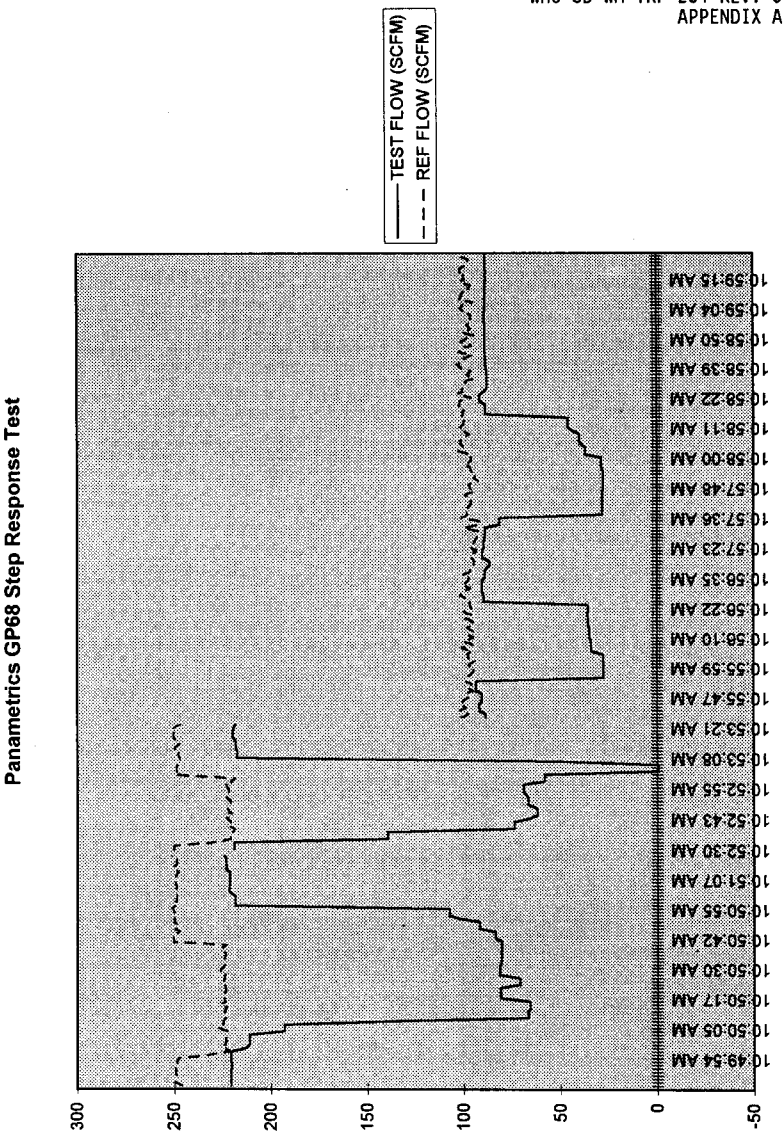

Intek Rheotherm Step Response Test
INTEK4.XLS
TEST FLOW (SCFM)
REF FLOW (SCFM)
SCFM
350
300
250
200
150
100
50
0
1:36:06 PM
1:36:34 PM
1:37:00 PM
1:37:28 PM
1:37:54 PM
1:38:19 PM
1:38:47 PM
1:39:15 PM
1:39:41 PM
1:40:07 PM
1:40:36 PM
1:41:05 PM
1:41:31 PM
1:41:58 PM
1:47:28 PM
1:47:53 PM
1:48:19 PM
1:48:48 PM
1:49:15 PM
1:49:43 PM
1:50:10 PM
1:50:37 PM
1:51:03 PM
1:51:29 PM
1:51:57 PM
1:52:23 PM
1:52:48 PM
1:53:15 PM

FIGURE 8

PANA3.XLS



FIGUREA9

Sierra Instruments Model 640 Step Response Test

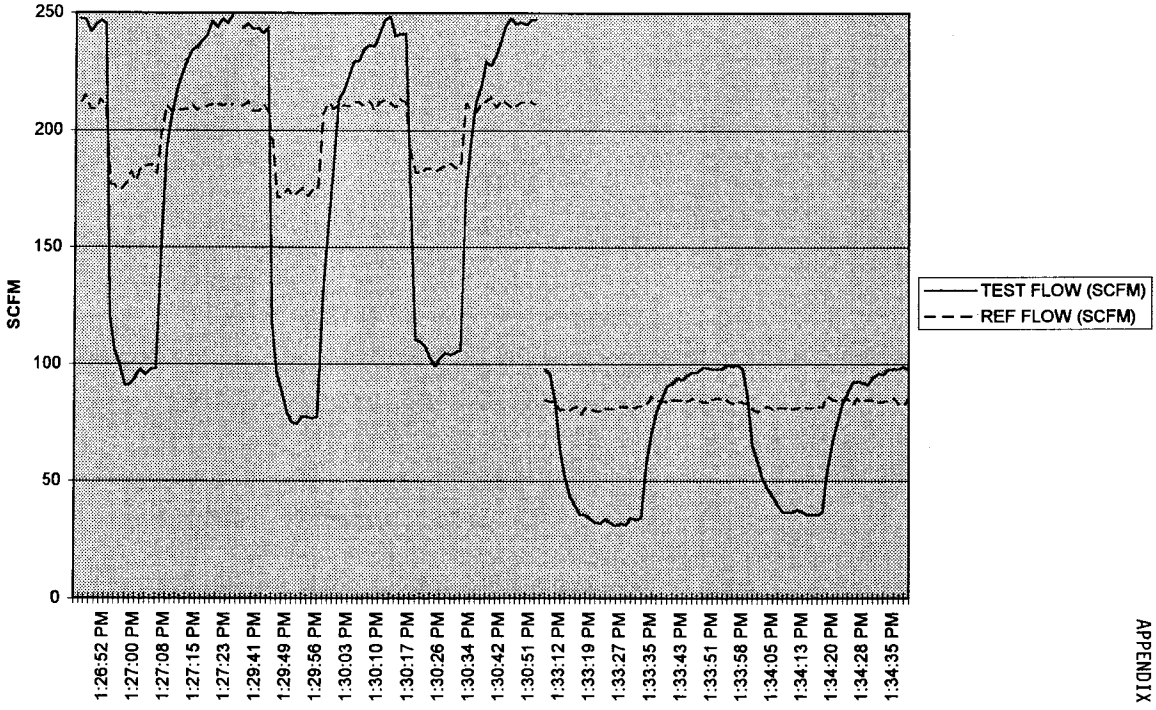


FIGURE A.0

AMC4.XLS

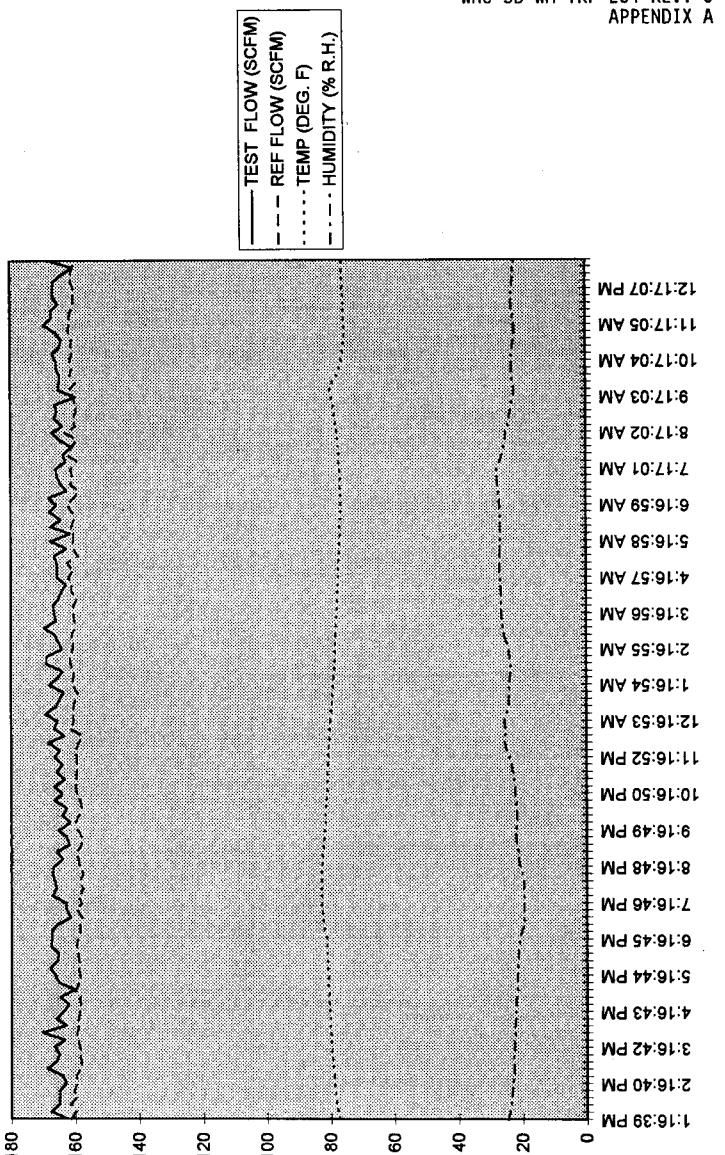
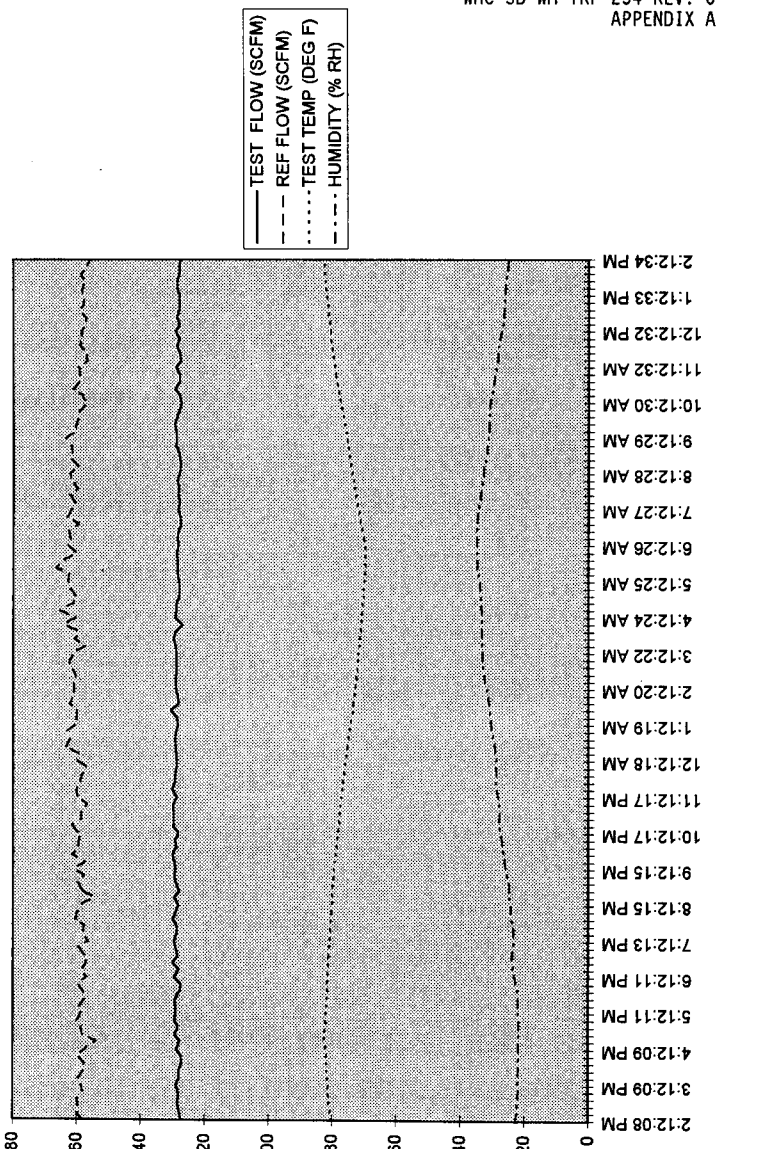


FIGURE A1



INTEK5.XLS

FIGURE A12

PANA4.XLS

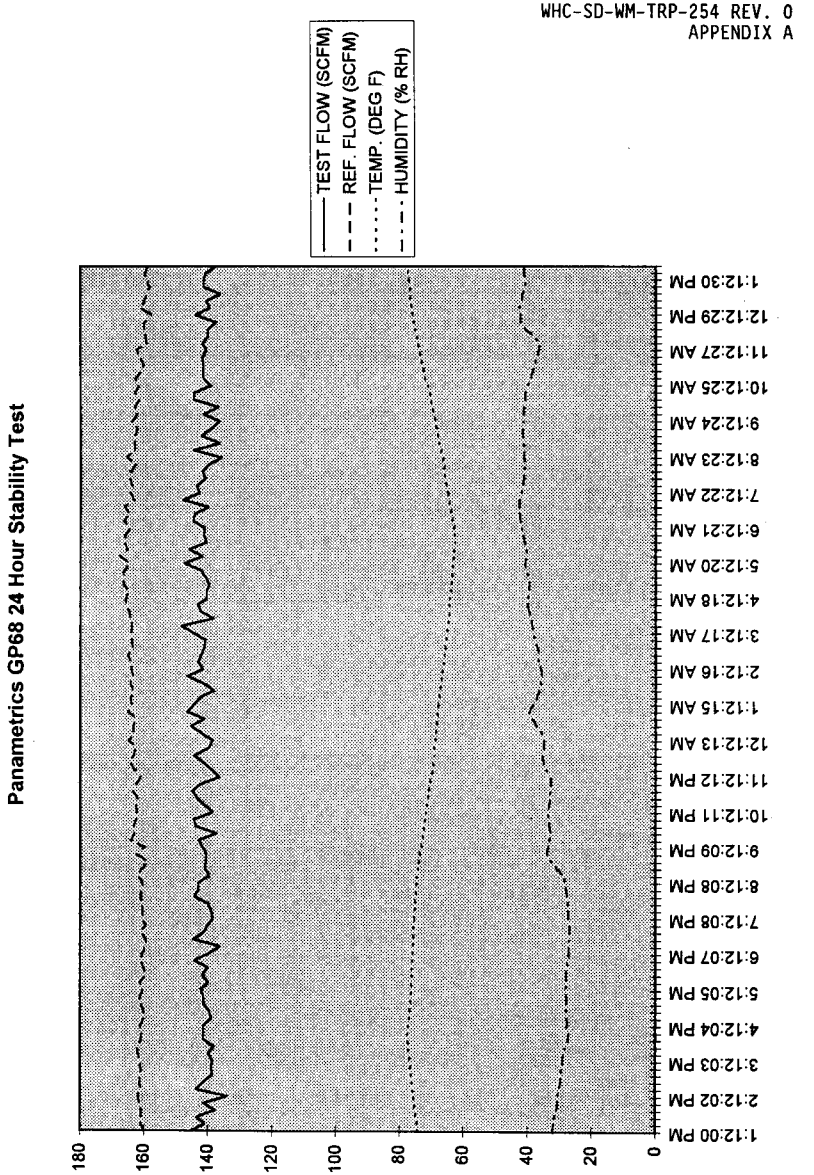


FIGURE A-13

SIERRA4.XLS

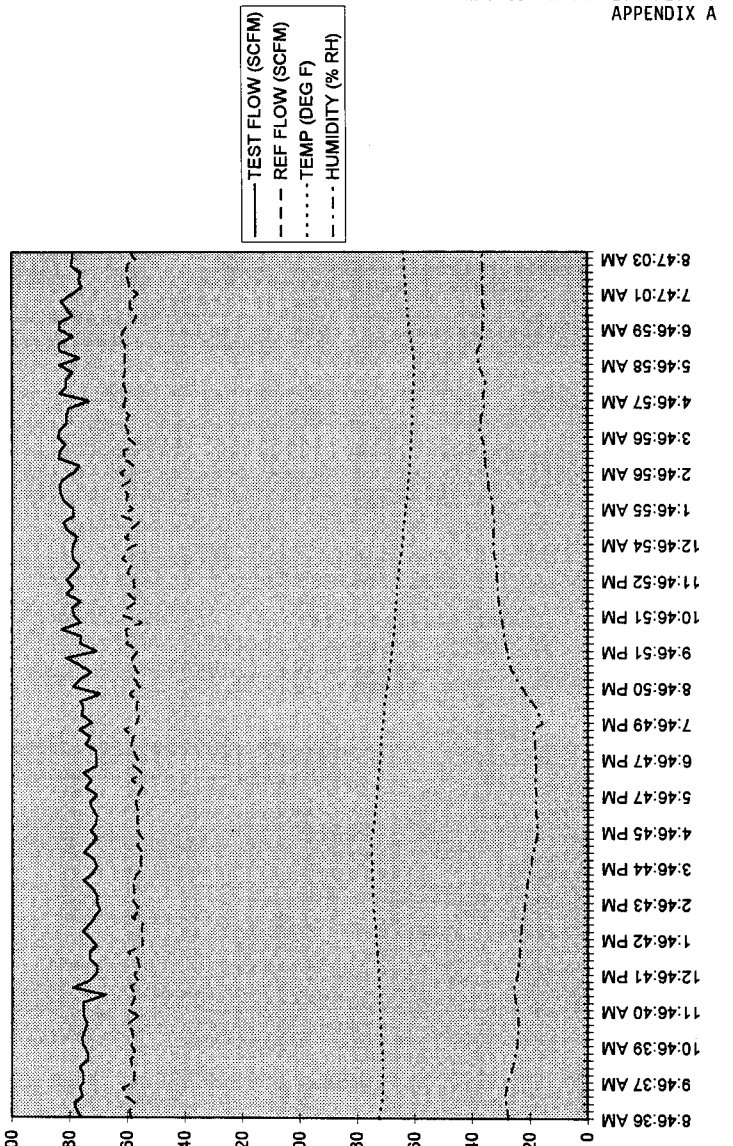


FIGURE A1-4

Air Monitor Corporation MASS-tron II 48 Hour Humidity Test

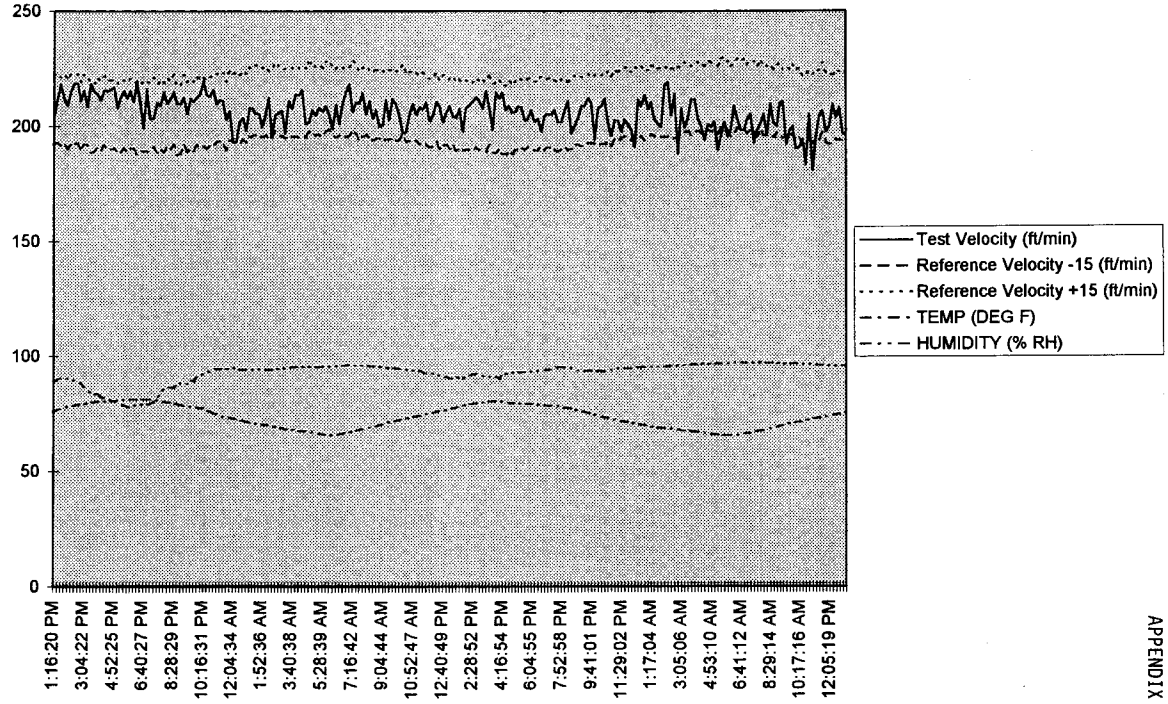


FIGURE A5

INTEK6.XLS

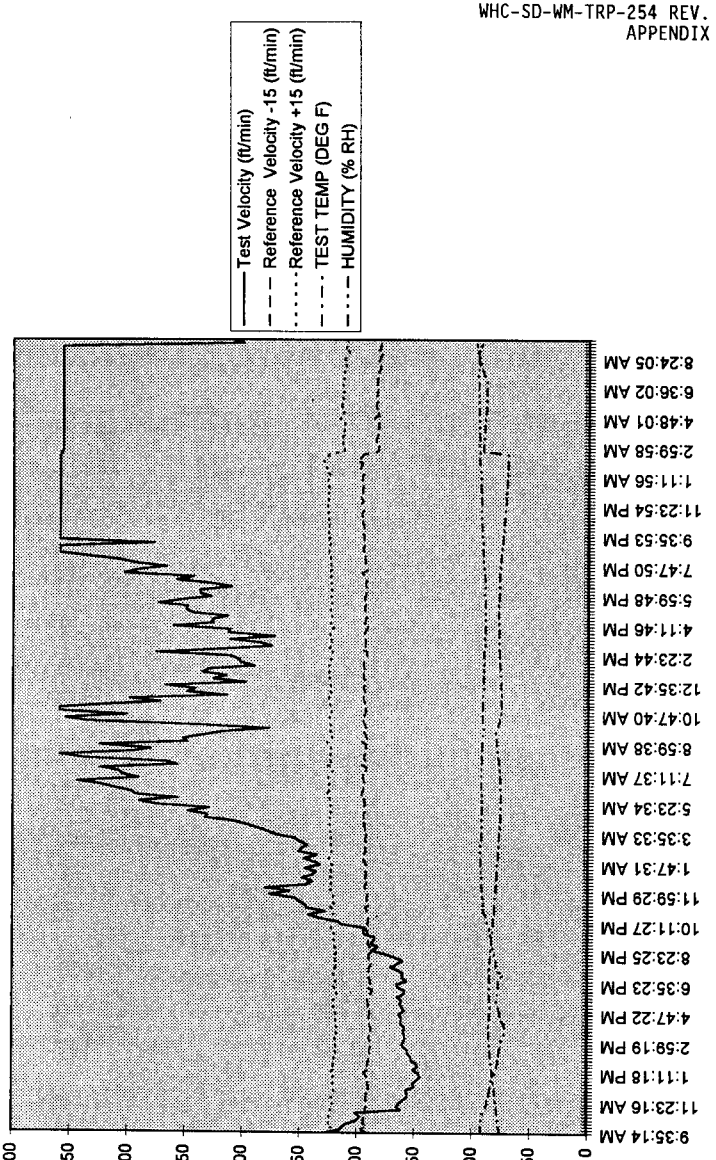


FIGURE A16

PANA6.XLS

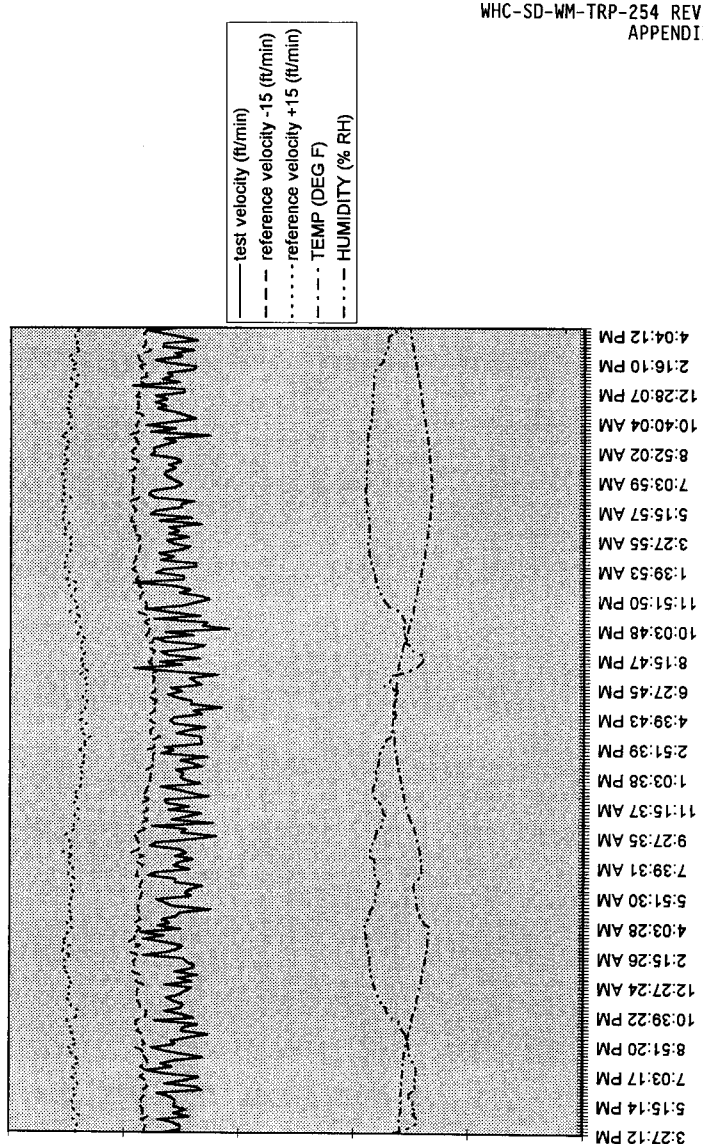


FIGURE A17

Sierra Model 640 48 Hour Humidity Test

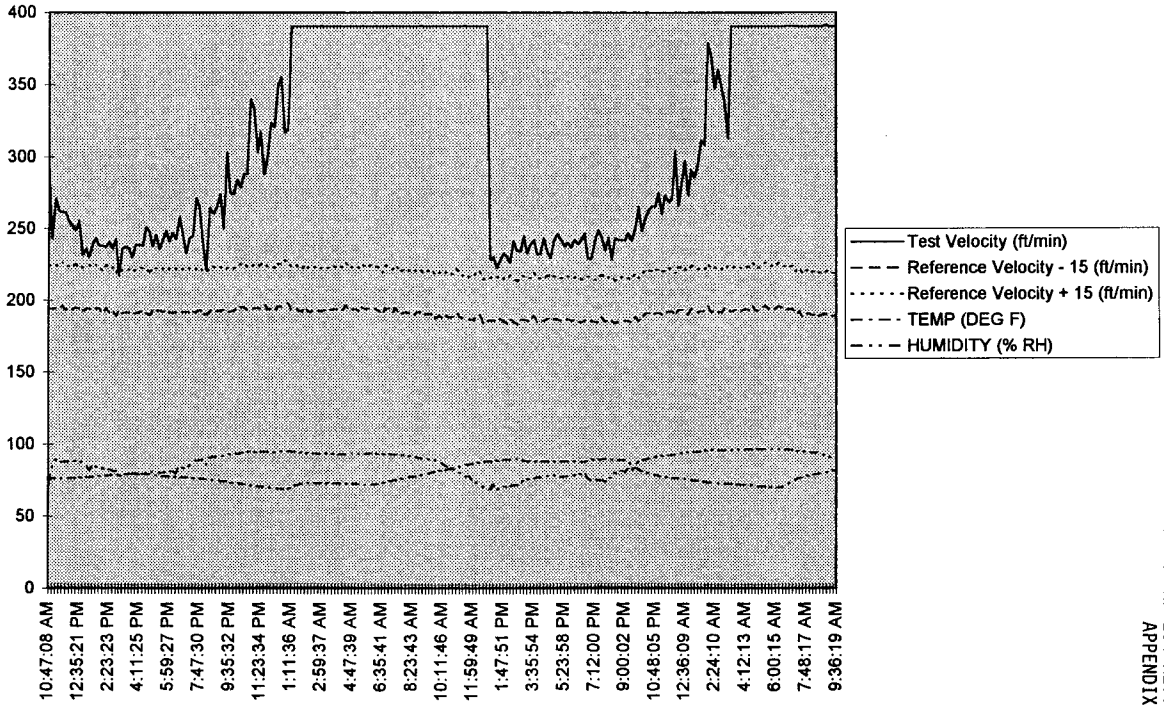


FIGURE A18

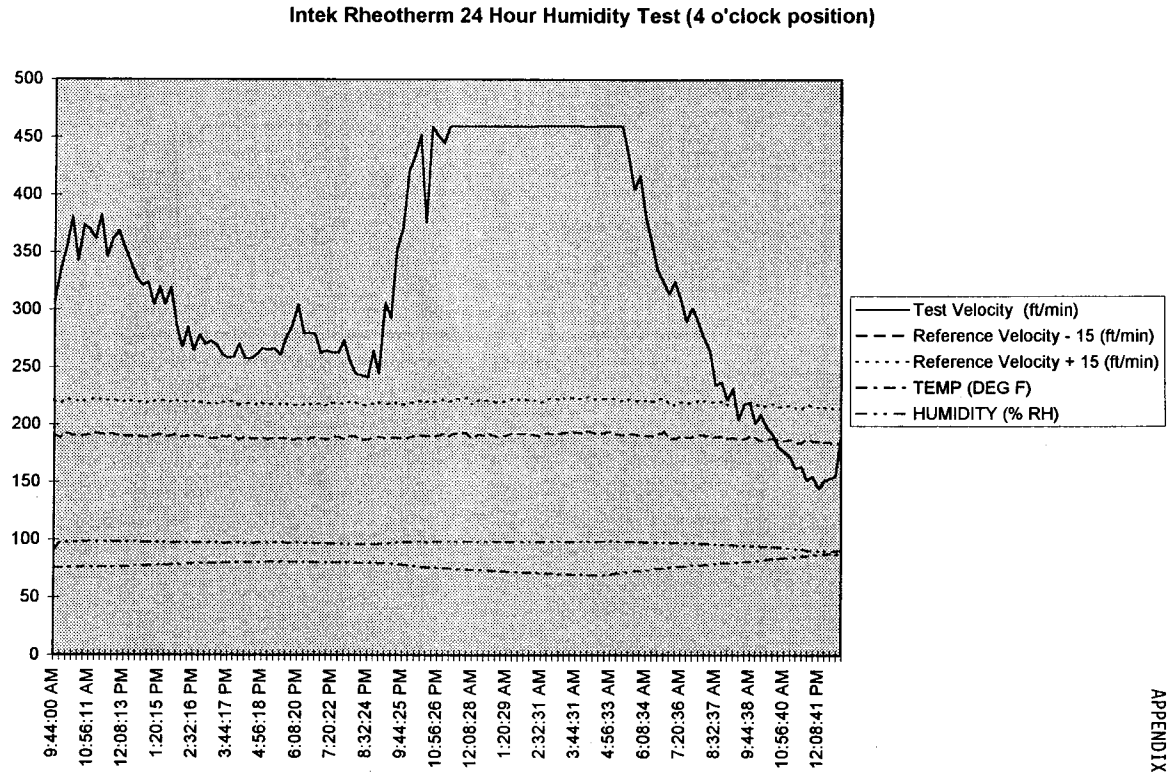

Intek Rheotherm 24 Hour Humidity Test (4 o'clock position)
500
450
400
350
300
250
200
150
100
50
0
9:44:00 AM
10:56:11 AM
12:08:13 PM
1:20:15 PM
2:32:16 PM
3:44:17 PM
4:56:18 PM
6:08:20 PM
7:20:22 PM
8:32:24 PM
9:44:25 PM
10:56:26 PM
12:08:28 AM
1:20:29 AM
2:32:31 AM
3:44:31 AM
4:56:33 AM
6:08:34 AM
7:20:36 AM
8:32:37 AM
9:44:38 AM
10:56:40 AM
12:08:41 PM
Test Velocity (ft/min)
Reference Velocity - 15 (ft/min)
Reference Velocity + 15 (ft/min)
TEMP (DEG F)
HUMIDITY (% RH)

FIGURE 19

SIERRA9.XLS

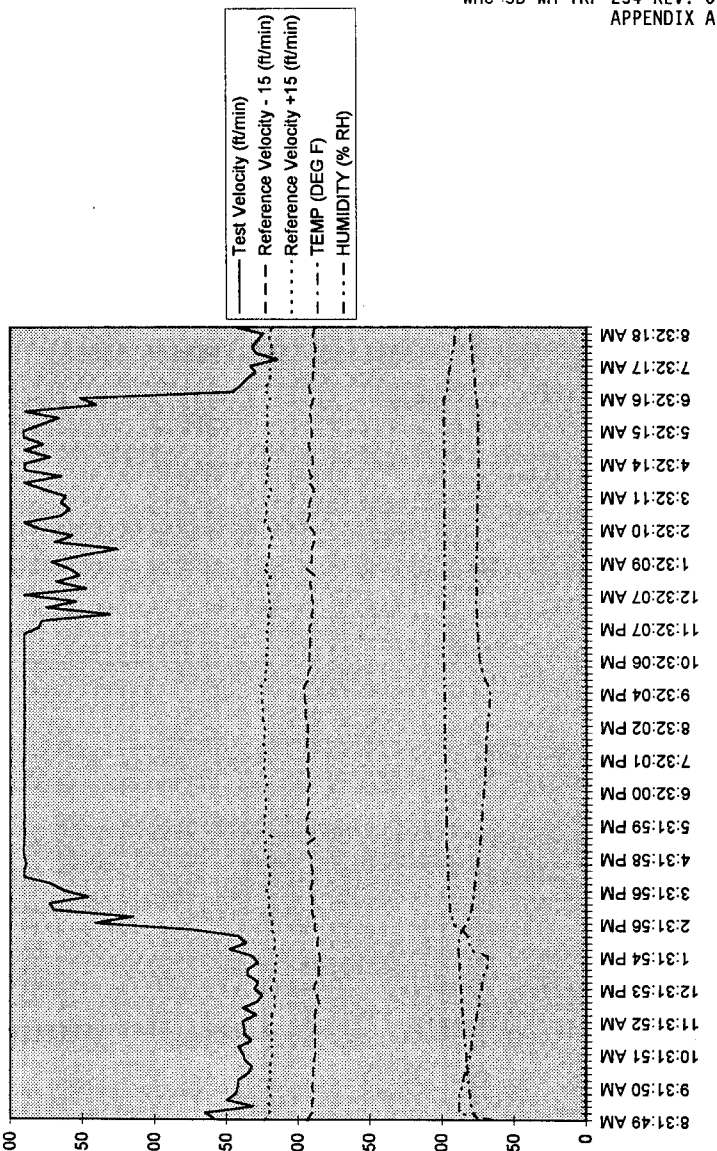


FIGURE A20

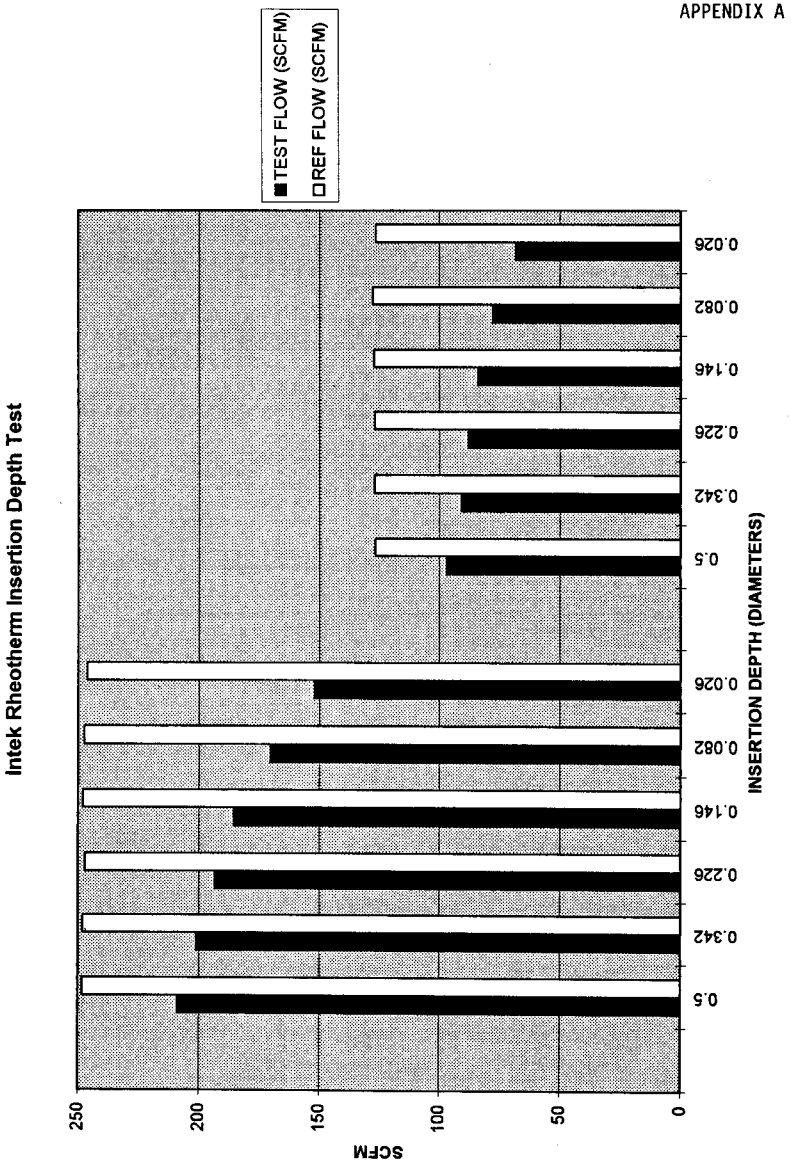
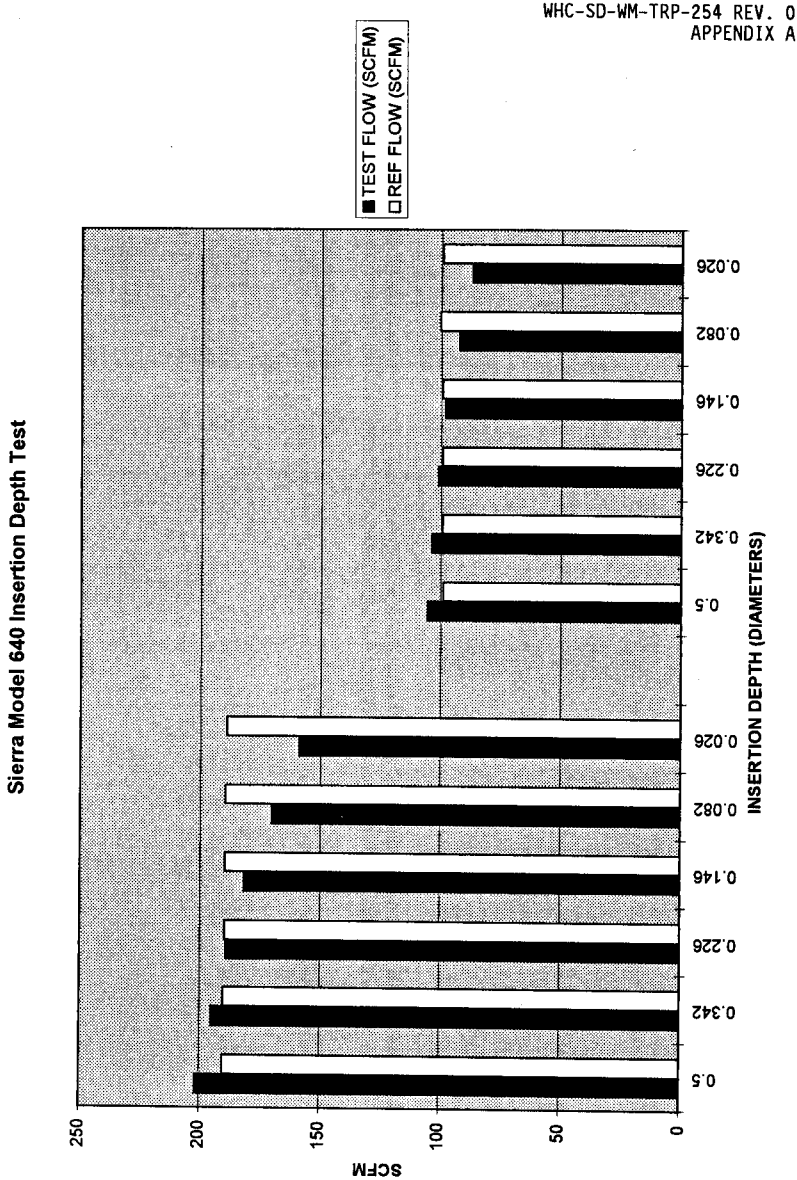

INTEK2.XLS
Intek Rheotherm Insertion Depth Test
TEST FLOW (SCFM)
REF FLOW (SCFM)
SCFM
0
50
100
150
200
250
INSERTION DEPTH (DIAMETERS)
0.5
0.342
0.226
0.146
0.082
0.026
0.5
0.342
0.226
0.146
0.082
0.026

FIGURE A21



SIERRA1.XLS

FIGURE A22

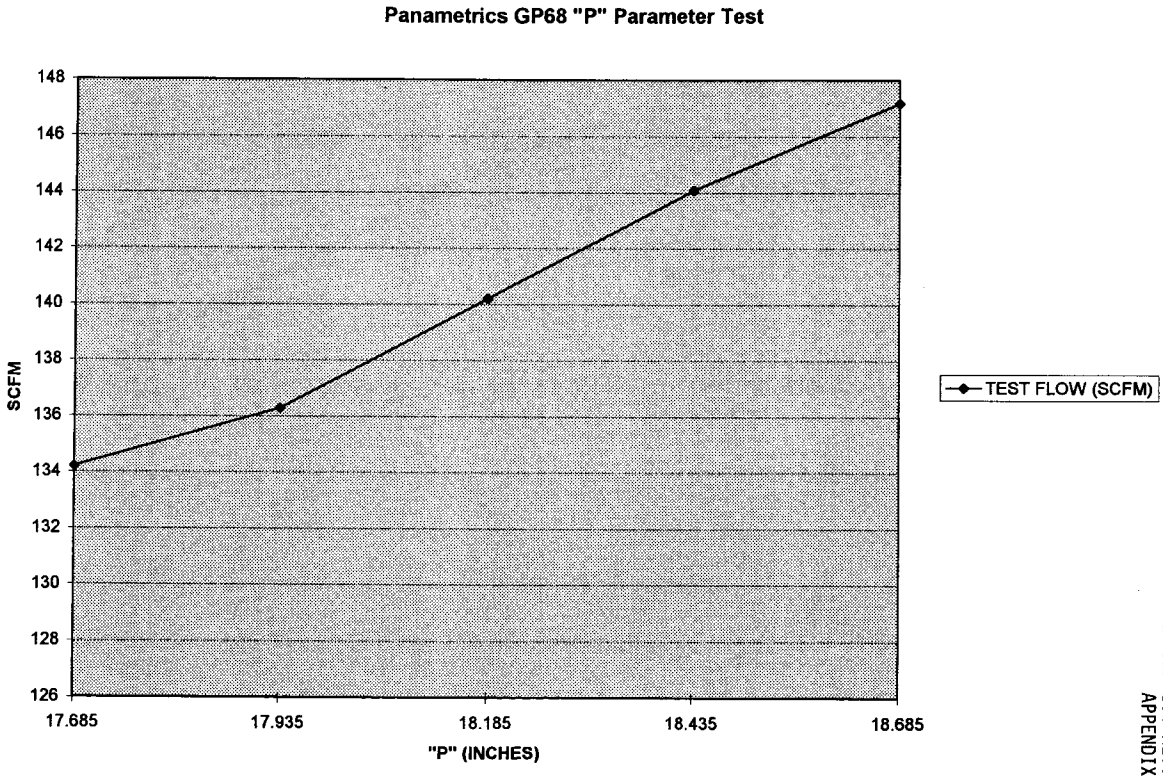

Panametrics GP68 "P" Parameter Test
148
146
144
142
140
138
136
134
132
130
128
126
SCFM
17.685
17.935
18.185
18.435
18.685
"P" (INCHES)
TEST FLOW (SCFM)

FIGURE 23

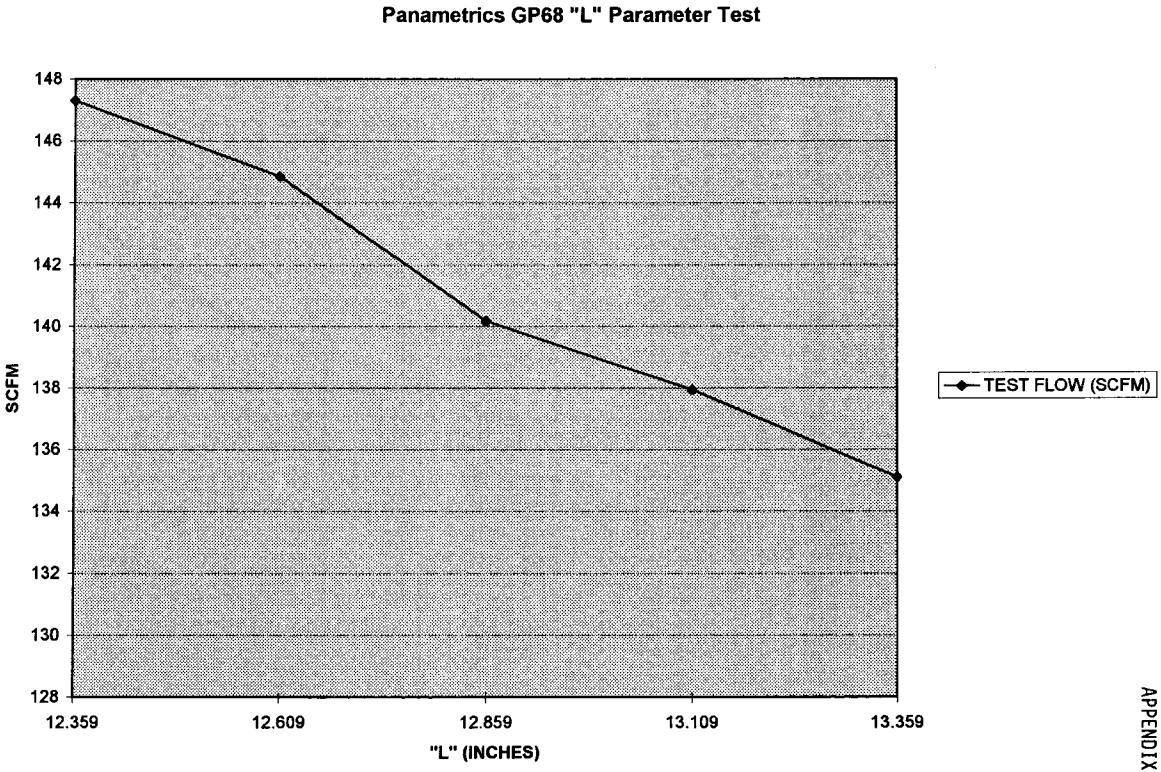

Panametrics GP68 "L" Parameter Test
148
146
144
142
140
138
136
134
132
130
128
SCFM
12.359
12.609
12.859
13.109
13.359
"L" (INCHES)
TEST FLOW (SCFM)

FIGURE A24

Air Monitor Corporation MASS-tron II Normalized Tracking Test

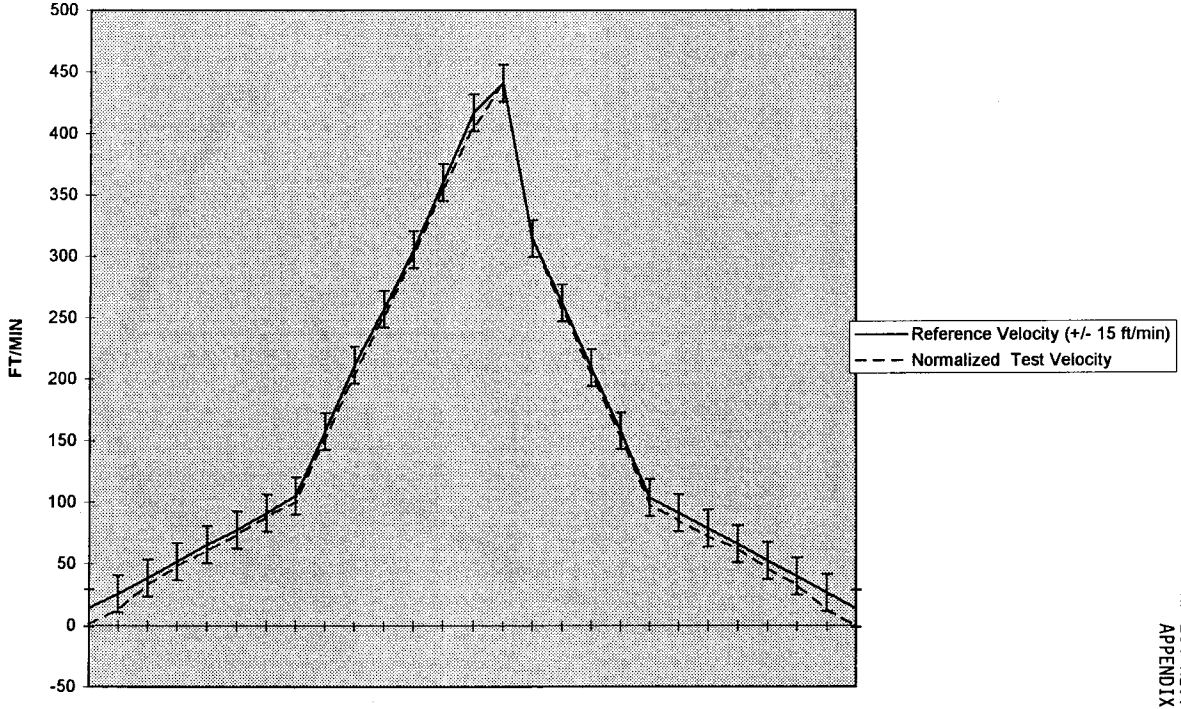


FIGURE A-25

Intek Rheotherm Normalized Tracking Test

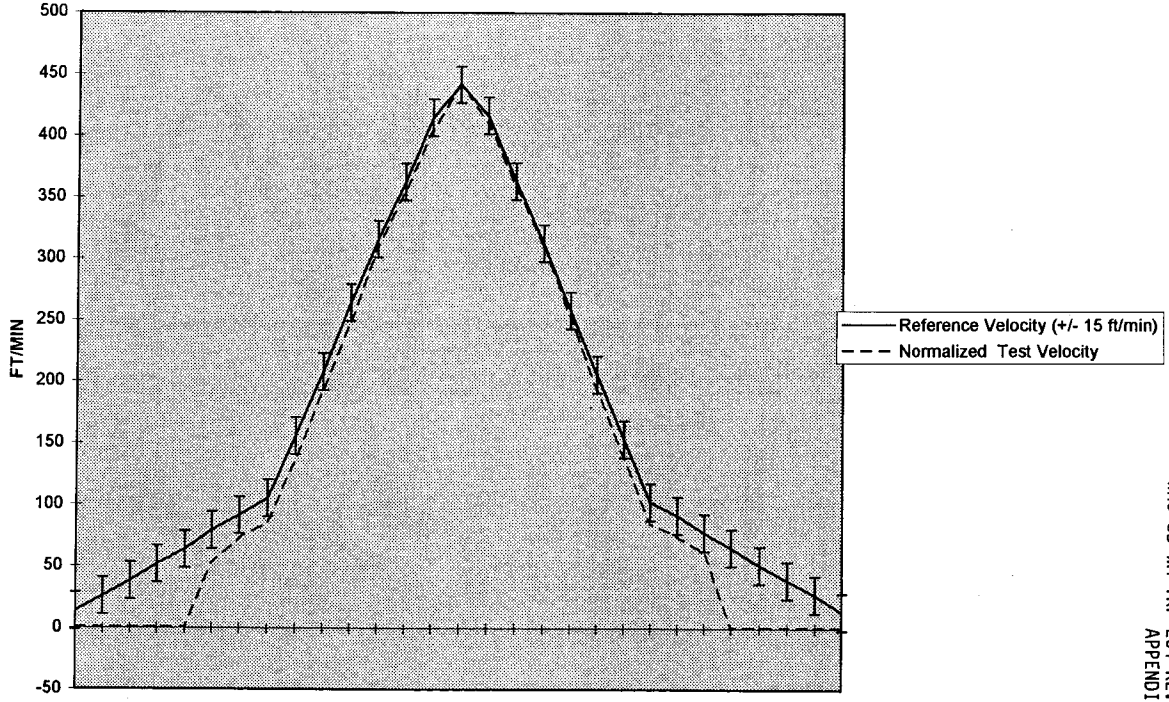


FIGURE A26

Panametrics GP68 Normalized Tracking Test

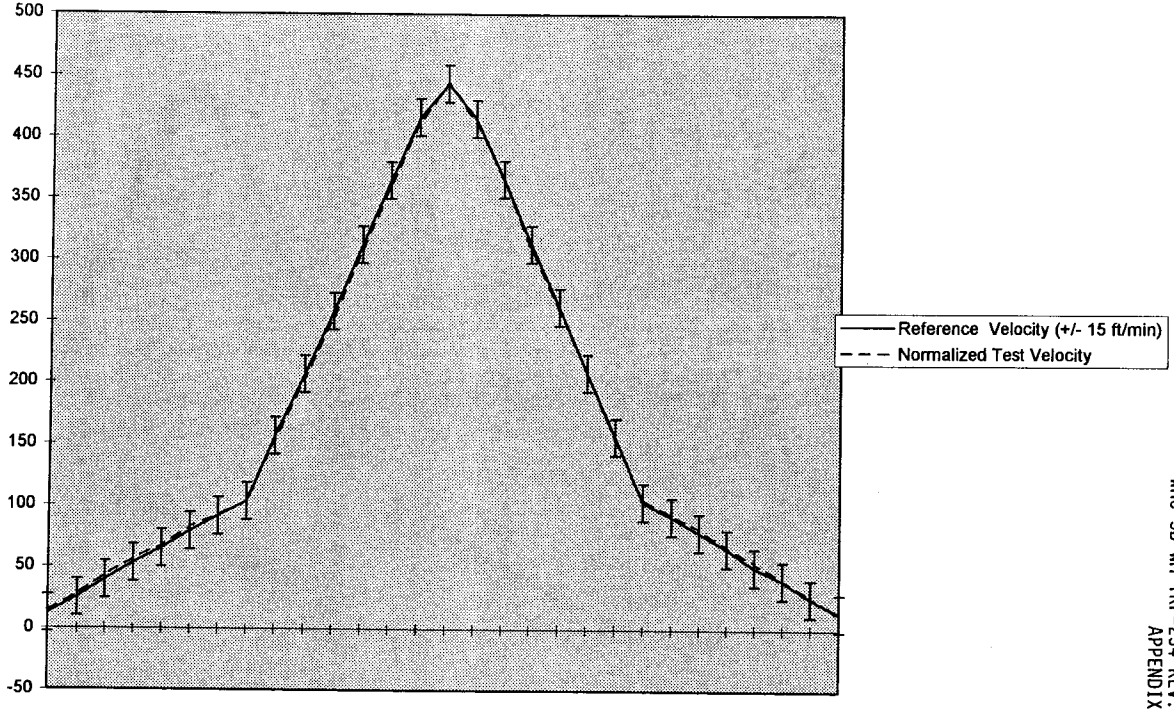


FIGURE A27

SIERRA5.XLS

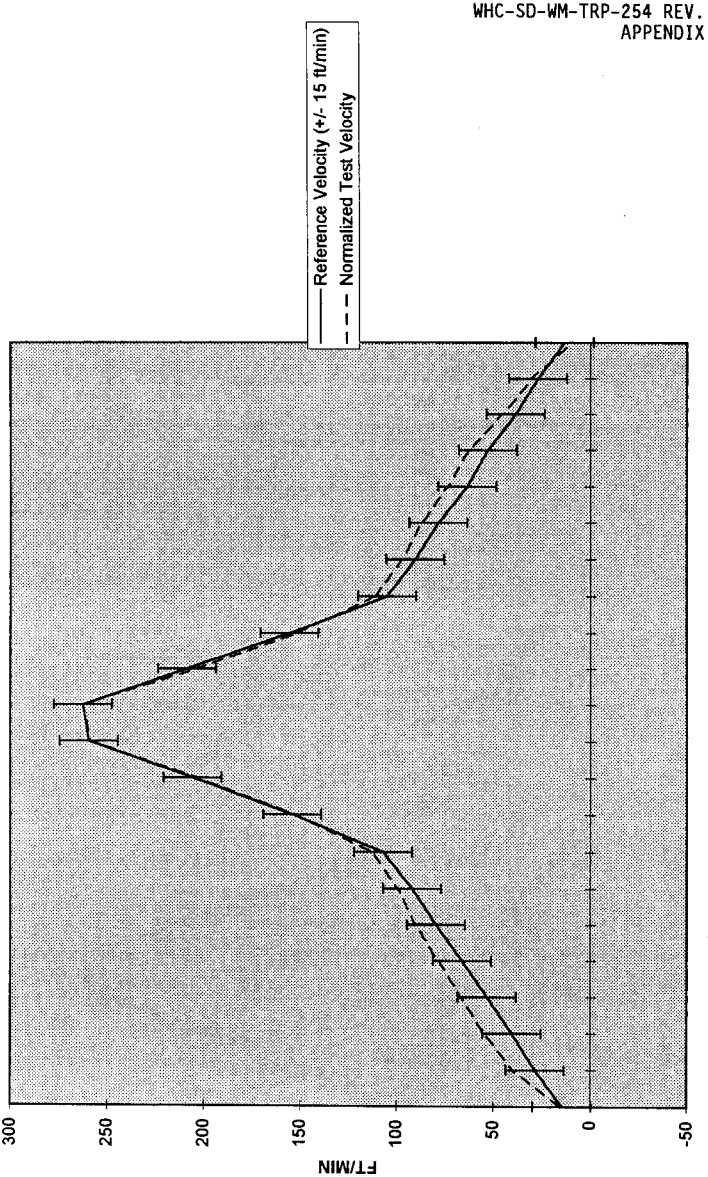


FIGURE A28

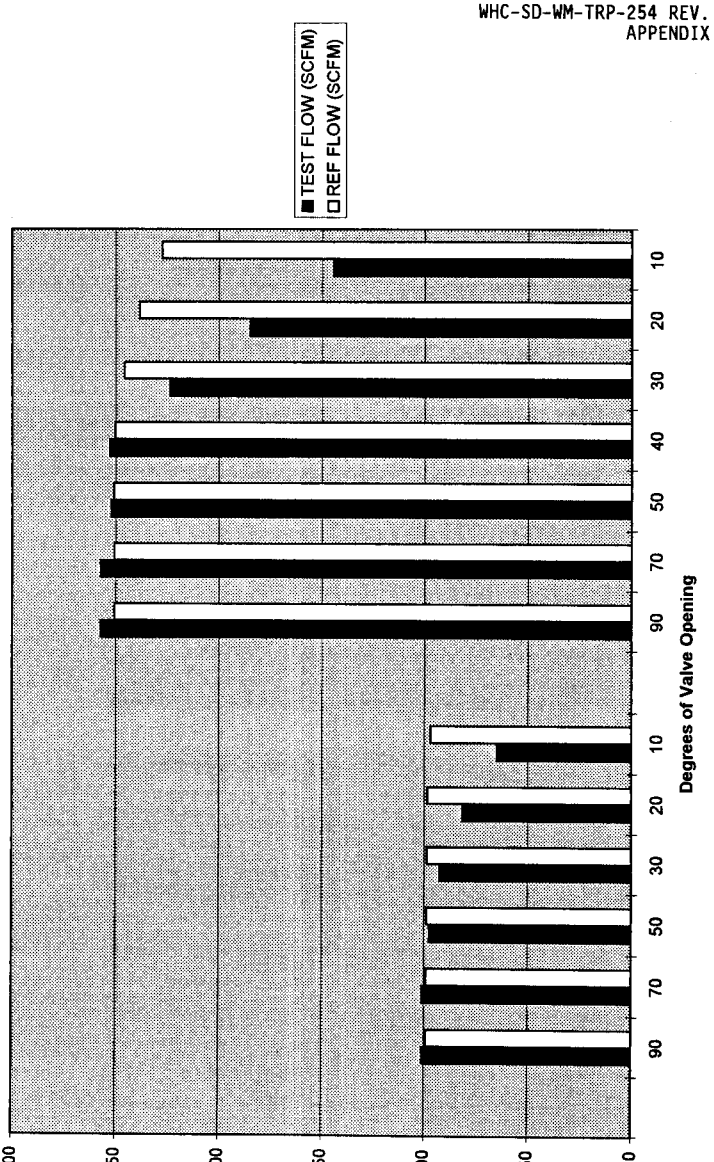

AMC2.XLS
Air Monitor Corporation MASS-tron II Valve Position Test
TEST FLOW (SCFM)
REF FLOW (SCFM)
300
250
200
150
100
50
0
10
20
30
40
50
70
90
10
20
30
50
70
90
Degrees of Valve Opening

FIGURE A-29

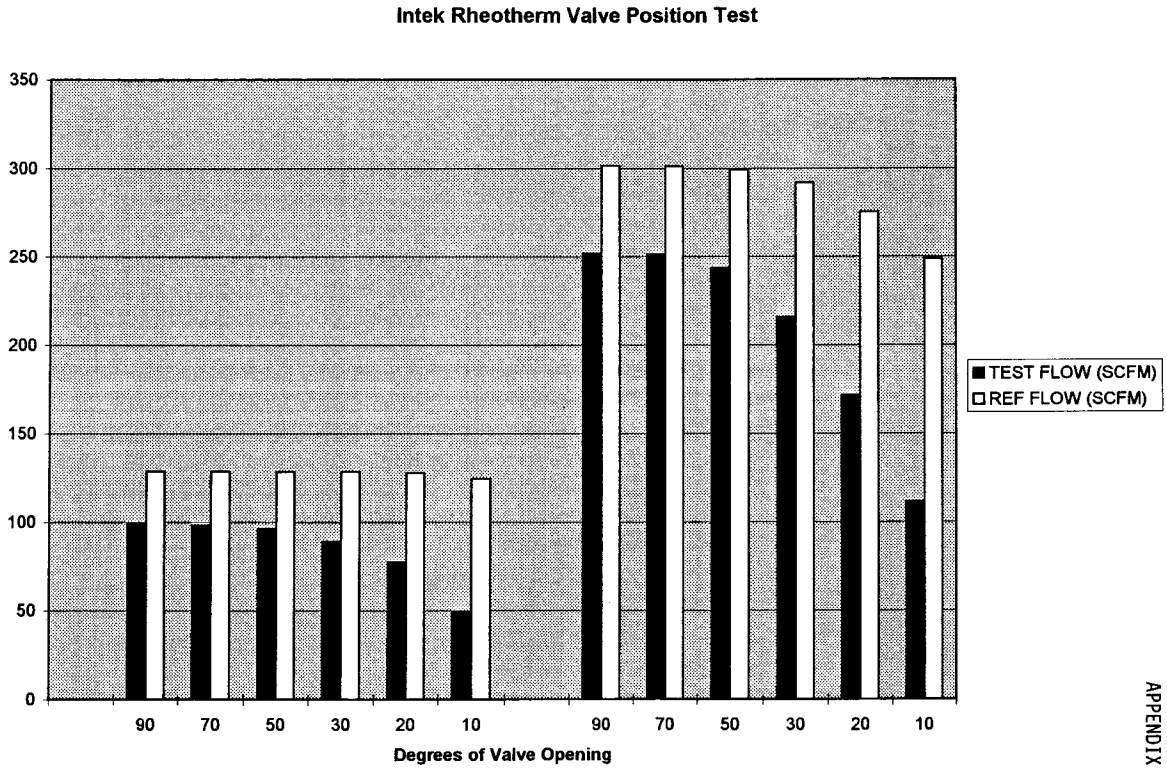
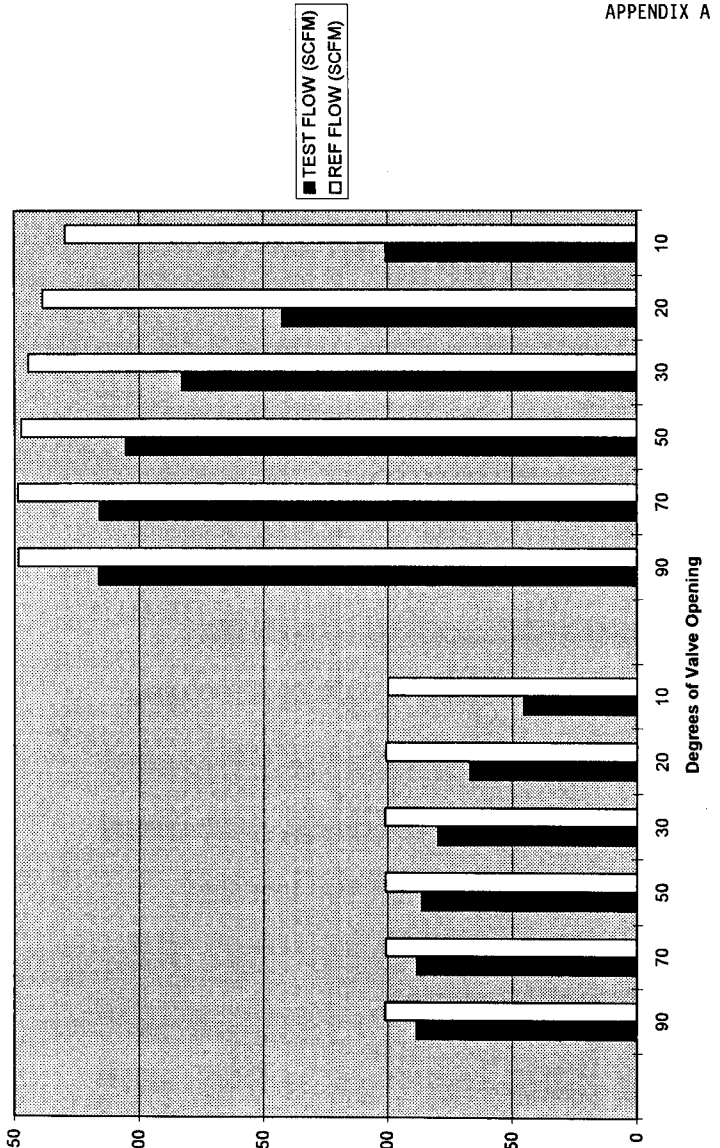

Intek Rheotherm Valve Position Test
350
300
250
200
150
100
50
0
90
70
50
30
20
10
90
70
50
30
20
10
Degrees of Valve Opening
TEST FLOW (SCFM)
REF FLOW (SCFM)

FIGURE A30



PANA2.XLS

FIGURE A1

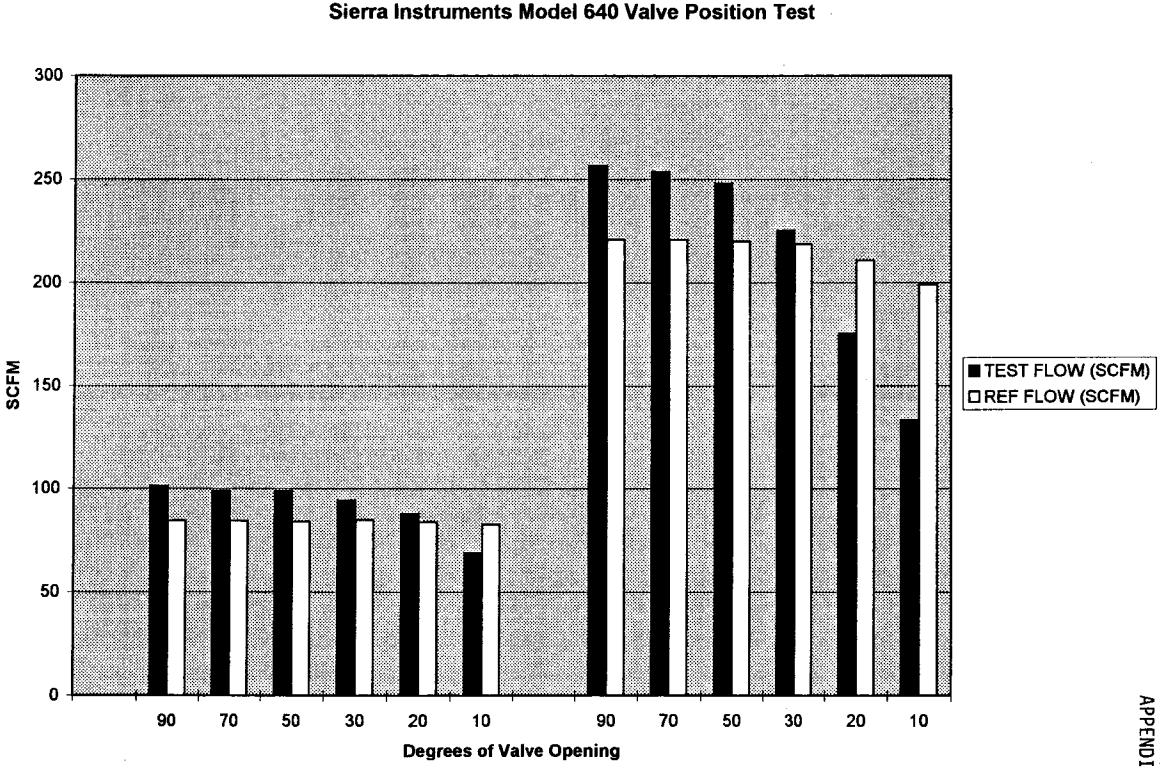

Sierra Instruments Model 640 Valve Position Test
SCFM
300
250
200
150
100
50
0
90
70
50
30
20
10
90
70
50
30
20
10
Degrees of Valve Opening
TEST FLOW (SCFM)
REF FLOW (SCFM)

FIGURE A-32

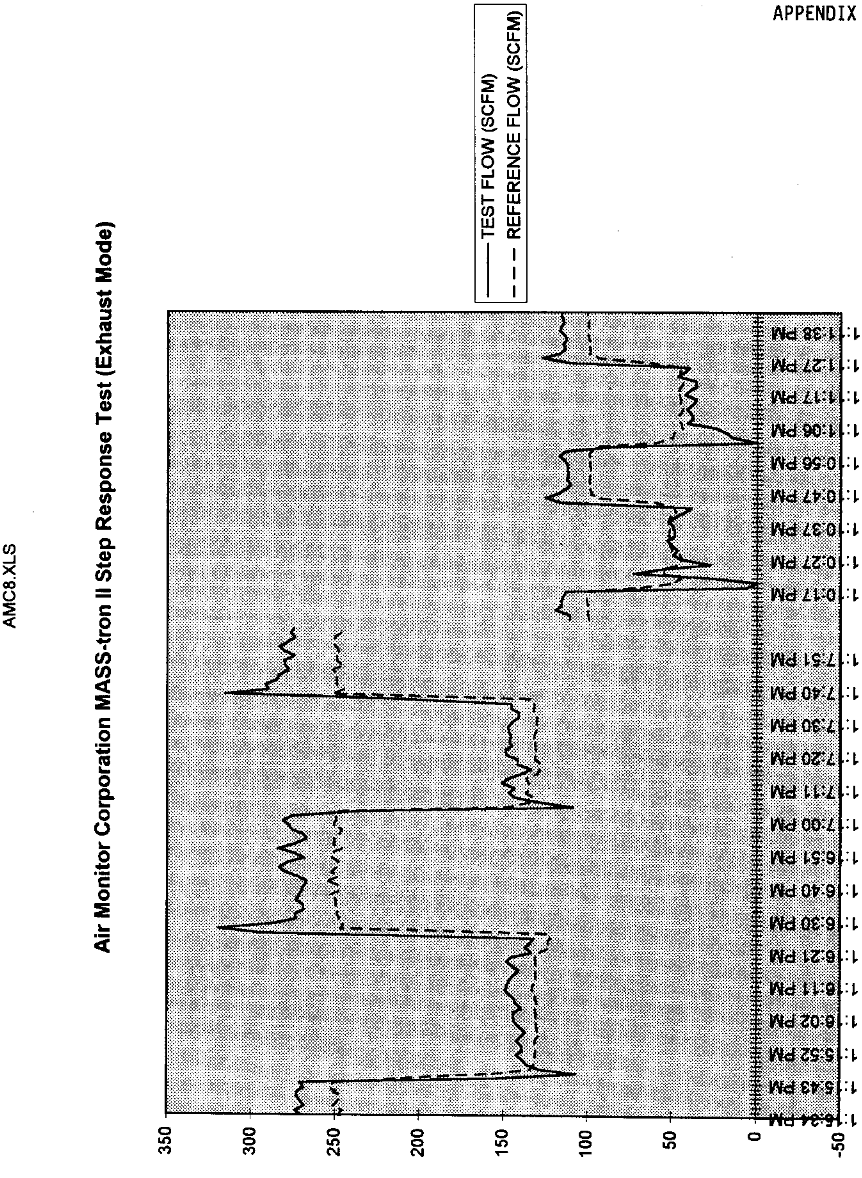

AMC8.XLS
Air Monitor Corporation MASS-tron II Step Response Test (Exhaust Mode)
TEST FLOW (SCFM)
REFERENCE FLOW (SCFM)
350
300
250
200
150
100
50
0
-50

FIGURE A33

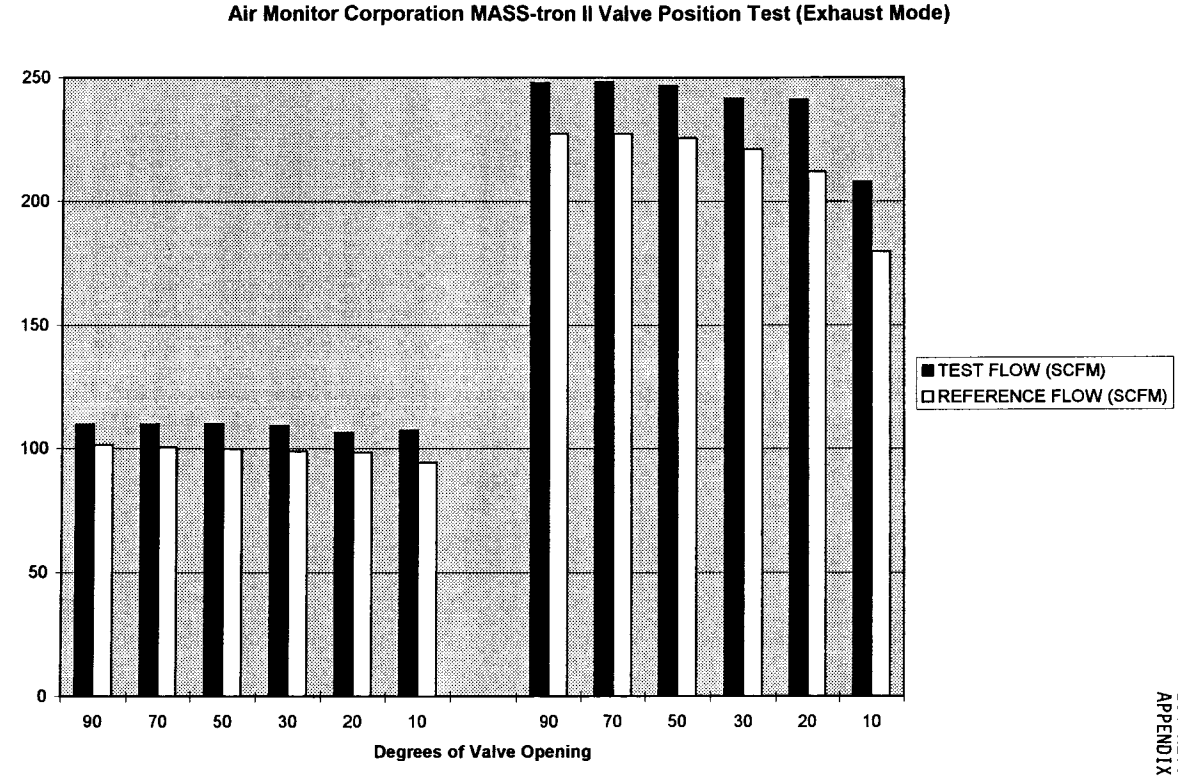

Air Monitor Corporation MASS-tron II Valve Position Test (Exhaust Mode)
250
200
150
100
50
0
90
70
50
30
20
10
90
70
50
30
20
10
Degrees of Valve Opening
TEST FLOW (SCFM)
REFERENCE FLOW (SCFM)

FIGURE A34

APPENDIX B - TEST DATA SHEETS

TEST EQUIPMENT DATA SHEET

- Laminar Flow Element, Meriam Instrument Model 50MC2-4, nominal 400 scfm air flow at 8" wc and 70 degrees F and 29.92" Hg abs.

Serial Number 757200-K1
Factory Calibration: 2-7-96

- Ashcroft ATE-100 Handheld Pressure Calibrator, Port 1: 0-25 in.H_2O input range, ~~Port 2: 0-30 psia input range.~~ failed, see sheet 2

Serial Number AQS-1 (cal) , AQS-1717
Calibration: 179-13-01-001 , 10/12/95 due 10/12/96

- Absolute Pressure Transmitter, Rosemount Model 3051C, 0-30 psia input range, 4-20 mA output. (USED FOR TEST PRESSURE)

Serial Number 0266492
Calibration: 355-80-02-055 , 5/6/91 due 5/6/97

- Humidity Probe CT-880-C-H-8-(0/100%)

Model Number Hy-Cal Serial Number 954330
Calibration: 817-80-01-009, 11/16/95 due 11/16/96

- RTD, Platinum, 100 Ohm, Gordon Model RFHLOTK100CA200

- Temperature Indicator/Transmitter, Newport Electronics Model INFU-0010-DC1

Serial Number 5251213
Calibration: 355-35-03-009 , 5/3/96 due 5/3/97

- Computer, IBM PC/XT/AT, Model Number AST Premmia 4/33

Serial Number 501127-007 Property Number WC51776

- Data acquisition software

Model Number LabVIEW Version 3.1 Serial Number 32750870

- Power Supply, 120V AC input, 24V DC output.

Model Number Acopian VA24MT210 Serial Number N/A

Test Performer William E. Willingham Jr. Date 5/15/96
Test Director Jeffrey S Pitts Date 5/15/96

FLOW METER TEST DATA SHEET - AMBIENT, PAGE A

Flow Meter Manufacturer Air Monitor Corporation

Model Number Mass-tran II Serial Number B11024

Ambient Temperature 69 °F Ambient Humidity 31%

Flow Meter mounting location, orientation standard

Butterfly Valve Position 90° (wide open)

Probe insertion depth N/A

Data File Name AMC1.LOG 5/29/96

Nominal Air Flow (SCFM) ± 5	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (_____)	Calculated Flow Meter Air Flow (SCFM)
10	10	70	0.206	14.55	14.51	Varies	
20	20	70	0.370	14.55	14.51	Varies	
30	29	70	0.547	14.56	14.51	~25	
40	40	70	0.752	14.57	14.50	38	
50	50	71	0.945	14.57	14.52	50	
60	60	71	1.111	14.58	14.51	60	
70	70	71	1.320	14.59	14.51	70	
80	80	8172	1.1164	14.60	14.51	80	
120	120	72	2.270	14.63	14.50	120	
160	160	72	2.459	14.66	14.50	163	
200	~200	73	3.678	14.68	14.51	203	
240	~240	74	4.421	14.73	14.52	240	
280	~280	75	5.341	14.76	14.51	~280	
320	~320	75	6.067	14.81	14.51	~325	
340	340	76	6.431	14.83	14.50	~345	
320	~320	76	6.131	14.80	14.51	~330	
280	~280	76	5.339	14.77	14.51	~285	

Test Performer William E Wellington Date 5/29/96

Test Director Jeffrey S Pittman Date 5/29/96

FLOW METER TEST DATA SHEET - AMBIENT, PAGE B

Flow Meter Manufacturer Air Monitor Corporation

Model Number MASS-tron II Serial Number B11024

Ambient Temperature 69°F Ambient Humidity 31%

Flow Meter mounting location, orientation standard

Butterfly Valve Position 90° (wide open)

Probe insertion depth N/A

Data File Name AMC1.606 5/24/96

Nominal Air Flow (SCFM) ± 5	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
240	~240	76	4.666	14.73	14.50	~250	
200	~200	76	3.830	14.69	14.50	208	
160	~160	76	3.050	14.66	14.51	~165	
120	~121	76	2.311	14.62	14.50	~122	
80	80	76	1.520	14.60	14.50	78	
70	70	76	1.330	14.59	14.50	66	
60	61	76	1.156	14.58	14.50	55	
50	51	76	0.968	14.57	14.50	51	
40	40	76	0.771	14.56	14.50	~36	
30	30	76	0.582	14.56	14.50	~25	
20	20	75	0.380	14.55	14.50	varies	
10	10	75	0.198	14.54	14.50	varies	

COMMENTS: Square Root Lockdown in MASS-tron II set at 0% (vs. 10%) gets unstable below 40 scfm.

Test Performer William E. Willyard Jr Date 5/29/96

Test Director Jeffrey A Pitts Date 5/29/96

5/29/96 Air Monitor Cap Test

Butterfly Valve Position

FILE = AMC2.LOG, 5 second intervals for 30 seconds

FLOW SET AT ~100 SCFM

VALVE POSITION	FLOW METER FLOW
90°	100
70°	100
50°	100
30°	90
20°	82
10°	~68

FLOW SET AT ~250 SCFM

VALVE POSITION	FLOW METER FLOW
90°	~255
70°	~255
40°	
50°	~250/255
30°	222
20°	~182
10°	~143

William E. Willingham 5/29/96

Jeffrey J. Potter 5/29/96

BEST AVAILABLE COPY

5/24/96 Air Monitor Corp - MASS-tron II
Step Response Test - Modified
FILENAME: AMC3.LOG, 1 second intervals

1. FLOW SET AT ~250 scfm
2. END OF 12" PIPE BLOCKED W/CARDBOARD
3. FLOW DECREASES TO ~100 scfm
4. RELEASE FLOW
5. REPEAT

HUMIDITY ~ 28%, TEMP ≈ 74°F

6. REPEAT ABOVE WITH FLOW SET AT ~100 scfm

W K Wellington 5/29/96
Jeffrey G Pitts 5/29/96

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FLOW METER STABILITY TEST DATA SHEET

Flow Meter Manufacturer Air Monitor Corporation

Model Number MASS-two II Serial Number B11024

Ambient Temperature 75 °F Ambient Humidity 27%

Flow Meter mounting location, orientation standard

Butterfly Valve Position 90° (wide open)

Probe insertion depth N/A

Data File Name AMC4.LOG 5/29/96

	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
START							
~13:00	160	75.7	3.045	14.65	14.49	~165	
END							
13:10	160	76.1	3.051	14.65	14.49	~162	

Comments: Started Test ~1:05 p.m. 5/29/96
Stopped Test ~1:10 p.m. 5/30/96

Test Performer William E Wilkerson Date 5/30/96

Test Director Jeffrey S Pitts Date 5/30/96

FLOW METER TEST DATA SHEET - HIGH HUMIDITY

Flow Meter Manufacturer Air Monitor Corporation

Model Number MASS-tron II Serial Number B11024

Ambient Temperature 72°F Ambient Humidity ——

Flow Meter mounting location, orientation standard

Butterfly Valve Position 90° (wide open)

Probe insertion depth N/A

Data File Name AMC5.LOG started 6/12/96

	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
START	~160	72.0	3.035	14.656	14.51	~161	
24 hrs	~160	77.2	3.069	14.637	14.48	~152	
END	~160	75.4	3.041	14.684	14.53	~149	

Comments: Water Pressure Set At = 7.5 psi } not calibrated
Air Pressure Set At = 18 psi }
started taking data prior to humidity introduction.
12 minute sampling interval
started at 1:00 p.m. 6/12/96.
stopped at 1:05 p.m. 6/14/96

Test Performer Walter E Wallfinger Date 6/14/96

Test Director Jeffrey A Pitts Date 6/14/96

AMC PROBE

7/18/96 VALVE POSITION TEST ⊥ to Butterfly Valve

FILE = AMC6.LOG, 5sec intervals for 305 records

FLOW SET AT 100 scfm (test) (ref)

VALVE POSITION	FLOW (test)
90°	~104
70°	~106
50°	~104
30°	~98
20°	~86
10°	~72

FLOW SET AT 250 scfm (ref)

VALVE POSITION	FLOW (test)
90°	~260
70°	~260
50°	~257
30°	~232
20°	~200
10°	~160

William E. Wellington 7/18/96

Jeffrey A. Pitts 7/10/96

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FLOW METER TEST DATA SHEET - AMBIENT, PAGE A

Flow Meter Manufacturer Intek

Model Number 1111D-1XD-NPT/2I(ADJ)-4/20-358 Serial Number 96003-1

Ambient Temperature 76°F Ambient Humidity 29%

Flow Meter mounting location, orientation standard

Butterfly Valve Position 90° (wide open)

Probe insertion depth centered in pipe

Data File Name INTEK1.LOG 5/22/96

Nominal Air Flow (SCFM) ± 5	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
10	10.5	73.9	0.198	14.53	14.49	0.38	
20	19.7	73.7	0.374	14.54	14.49	0.38	
30	29.3	73.6	0.558	14.54	14.48	0.37	
40	39.5	73.4	0.739	14.55	14.49	0.38	
50	49	73.6	0.924	14.56	14.49	0.38	
60	60	73.6	1.154	14.57	14.49	40.4 ①	
70	70	74.1	1.333	14.58	14.50	47	
80	81	74.4	1.527	14.58	14.49	55	
120	120	74.8	2.284	14.62	14.49	89	
160	159	75.8	3.057	14.65	14.50	125	
200	~200	76.4	3.852	14.69	14.49	162	
240	~242	77.0	4.660	14.73	14.50	201	
280	~280	77.6	5.351	14.76	14.49	233	
320	~320	78.1	6.072	14.80	14.49	264	
340	~340	78.4	6.526	14.82	14.50	289	
320	~320	78.5	6.096	14.80	14.49	269	
280	~280	78.5	5.325	14.76	14.49	233	

Test Performer William E Wilkerson Jr. Date 5/22/96

Test Director Jeffrey S Pitts Date 5/22/96

FLOW METER TEST DATA SHEET - AMBIENT, PAGE B

Flow Meter Manufacturer Intek

Model Number 1111D - I1D - NPT/2I(ADJ) - 4/20 - IS8 Serial Number 96003-1

Ambient Temperature 75°F Ambient Humidity 28%

Flow Meter mounting location, orientation standard

Butterfly Valve Position 90° (wide open)

Probe insertion depth centered in pipe

Data File Name INTEK1.LOG

Nominal Air Flow (SCFM) ± 5	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (_____)	Calculated Flow Meter Air Flow (SCFM)
240	241	78.5	4.640	14.73	14.49	203	
200	200	78.5	3.821	14.69	14.49	165	
160	~160	78.2	3.028	14.65	14.49	127	
120	~120	77.9	2.289	14.62	14.49	90	
80	79	77.7	1.517	14.59	14.50	56	
70	70	77.8	1.370	14.58	14.49	48	
60	60	77.7	1.129	14.57	14.49	40	
50	50	77.6	0.962	14.56	14.49	0.34	
40	40	77.5	0.756	14.56	14.49	0.34	
30	30	77.4	0.574	14.55	14.50	0.35	
20	21	77.3	0.399	14.54	14.49	0.34	
10	10	77.1	0.142	14.54	14.49	0.35	

COMMENTS: Data Samples = 5 second intervals for 30 seconds.
Flow meter seems to have long (slow) response time.
① Output dropped slowly after taking data.

Test Performer William E Walkup Jr. Date 5/22/96

Test Director Jeffrey S Pitt Date 5/22/96

5/22/96 Set up Intek Rheotherm flow meter output previously set at 0-350 scfm

TEST METER: INTEK, FILENAME: INTEK2.LOG

INSERTION DEPTH TEST

SET FLOW AT ~210 SCFM PER INTEK

BUTTERFLY VALVE WIDE OPEN

CENTERLINE FLOW	=	208 scfm
.342 dia	=	200 scfm
.226 dia	=	193 scfm
.146 dia	=	184 scfm
.082 dia	=	170 scfm
.026 dia	=	152 scfm

Jeffrey S. Smith 5/22/96

5 second intervals for 1 minute

SET FLOW AT ~100 scfm per INTEK

centerline	=	97 scfm
.342	=	91 scfm
.226	=	88 scfm
.146	=	84 scfm
.082	=	76 scfm
.026	=	69 scfm

William E Willingham Jr. 5/22/96

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5/23/96 VALVE POSITION TEST

FILE = INTEK3.LOG , 5 second intervals for 30 seconds

FLOW SET AT ~100 SCFM

BUTTERFLY VALVE POSITION	FLOW METER FLOW
90°	99
70°	98
50°	96
30°	88
20°	77
10°	49

FLOW SET AT ~250 SCFM

VALVE POSITION	FLOW METER FLOW
90°	252
70°	251
50°	243
30°	216
20°	172
10°	111

Test Performer : [signature] for 5/23/96
[signature] 5/23/96

BEST AVAILABLE COPY

5/23/96 INTEK FLOWMETER

STEP RESPONSE TEST – MODIFIED

1. FLOW SET AT ~250 SCFM
2. END OF 12" DUCT BLOCKED WITH CARDBOARD
3. FLOW DECREASES TO ~ 125 SCFM
4. FLOW UNBLOCKED
5. DATA FILE = INTEK4.LOG, 1 SECOND INTERVALS

REPEATED ABOVE TEST AT ~100 SCFM

Test Performed: W. E. Fulton Jr. 5/23/96

Jeffrey A. Fulton 5/23/96

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FLOW METER STABILITY TEST DATA SHEET

Flow Meter Manufacturer INTEK

Model Number 111D-IXD-NPT/2I(ADJ)-4/20-ISB Serial Number 96003-1

Ambient Temperature 72°F Ambient Humidity 23 %

Flow Meter mounting location, orientation STANDARD

Butterfly Valve Position 90°(WIDE OPEN)

Probe insertion depth CENTERED IN PIPE

Data File Name INTEK5.LOG 5/23/96

	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
START	~160	80.4	3.041	14.760	14.60	128.7	
1400							
END							

Comments:

Test Performer William E. Williamson Jr. Date 5/24/96

Test Director Jeffrey A. Pitts Date 5/24/96

FLOW METER TEST DATA SHEET - HIGH HUMIDITY

Flow Meter Manufacturer Intek

Model Number RheoTherm IID-IXD-NPT/2I (ADJ)-4/20-ISB Serial Number 96003-1

Ambient Temperature 65°F Ambient Humidity 39.0 %

Flow Meter mounting location, orientation standard, centered

Butterfly Valve Position 90° wide open

Probe insertion depth centered in pipe

Data File Name ~~INTEK6.LOG~~

	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
START	~160	72	3.042	14.69	14.53	~135	
24 hrs	~160	75.5	3.028	14.745	14.59	~245	
END	~150	77	3.066	14.743	14.41	~205	

Comments:

Started 6/17/96 ~~0900 hrs.~~ 0920 hrs.

water pressure ~ 7.5 psi

air pressure ~ 18 psi

Question (VI test flow vs. local readout?)

Note: 9:35 a.m. 6/19/96 indicated temperature on VI = 98.0 vs 77 on local readout

Stopped 6/19/96 ~9:40 a.m.

changed from input channel 0 to input channel 5 on input board.

Test Performer William E Wilkerson Jr. Date 6/19/96

Test Director Jeffrey S Rikli Date 6/19/96

FLOW METER TEST DATA SHEET - HIGH HUMIDITY

Flow Meter Manufacturer Intek

Model Number IIID-IxD-NPT/II(ADJ)-4/20-ISB Serial Number 96003-1

Ambient Temperature 72°F Ambient Humidity 38%

Flow Meter mounting location, orientation 3:30 o'clock

Butterfly Valve Position 90° wide open

Probe insertion depth centered in duct

Data File Name INTEK7.LOG

	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
START							
24 hrs							
END	~154	85.1	3.014	14.54	14.38	473	

Comments: 24 hour test at different orientation.
Started ~ 1:20 a.m. 6/25/96
Stopped ~ 1:00 p.m. 6/26/96

Test Performer Walter E Willyard Date 6/26/96

Test Director Jeffrey S Pitcher Date 6/26/96

FLOW METER TEST DATA SHEET - AMBIENT, PAGE A

Flow Meter Manufacturer Intek

Model Number IIID-IXD-NPT/22(ADJ)-4/20-ISB Serial Number 96003-1

Ambient Temperature 70°F Ambient Humidity 48% rh

Flow Meter mounting location, orientation 4 o'clock position

Butterfly Valve Position 90° (wide open)

Probe insertion depth centered in duct

Data File Name INTEK8.LOG 7/16/96

Nominal Air Flow (SCFM) ± 5	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (_____)	Calculated Flow Meter Air Flow (SCFM)
10	~4	71	0.186	14.462	14.42	-0.48	
20	~20	71	0.381	14.470	14.42	-0.48	
30	~30	71	0.555	14.475	14.41	-0.50	
40	~40	71	0.750	14.488	14.42	-0.51	
50	~50	72	0.928	14.488	14.42	-0.54	
60	~60	73	1.118	14.498	14.42	~33 (unstable)	
70	~70	73	1.341	14.510	14.42	~46	
80	~80	73	1.558	14.517	14.42	~56	
120	~120	74	2.278	14.545	14.42	~88	
160	~160	76	3.094	14.585	14.42	~128	
200	~200	76	3.760	14.615	14.42	~161	
240	~240	77	4.571	14.652	14.42	~200	
280	~280	78	5.425	14.688	14.42	~233	
320	~320	78	6.187	14.734	14.42	~268	
340	~340	78	6.524	14.754	14.42	~288	
320	~320	78	6.188	14.726	14.42	~266	
280	~280	78	5.346	14.699	14.42	~234	

Test Performer William E. Butterbaugh Date 7/16/96

Test Director Jeffrey S. Pitts Date 7/16/96

FLOW METER TEST DATA SHEET - AMBIENT, PAGE B

Flow Meter Manufacturer Intek

Model Number IIID-IXD-NPT/2I(ADJ)-4/20-ISB Serial Number 96003-1

Ambient Temperature 70°F Ambient Humidity 48% r.h.

Flow Meter mounting location, orientation 4 o'clock

Butterfly Valve Position 90° (wide open)

Probe insertion depth centered in duct

Data File Name INTEK8.LOG

7/16/96

Nominal Air Flow (SCFM) ± 5	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
240	~240	79	4.580	14.654	14.42	~202	
200	~200	79	3.874	14.617	14.42	~168	
160	~160	79	3.137	14.585	14.42	~131	
120	~120	79	2.326	14.549	14.42	~93	
80	~80	79	1.572	14.513	14.42	~59	
70	~70	79	1.355	14.503	14.42	~50	
60	~60	79	1.147	14.499	14.42	~42	
50	~50	79	0.989	14.494	14.42	-.60	
40	~40	79	0.795	14.480	14.42	-.61	
30	~30	79	0.593	14.475	14.42	-.60	
20	~20	79	0.372	14.466	14.42	-.58	
10	~10	78	0.193	14.467	14.42	-.58	

COMMENTS: This test is a repeat of an earlier test to see if any leakage in the system has developed over the course of testing.

Test Performer William E. Witherspoon Jr. Date 7/16/96

Test Director Jeffrey V. Pitts Date 7/16/96

FLOW METER TEST DATA SHEET - AMBIENT, PAGE A

Flow Meter Manufacturer Intek

Model Number IIID-IXD-NPT/2I(ADJ)-4/20-ISB Serial Number 96003-1

Ambient Temperature 74.4°F Ambient Humidity 40.1 % r.h.

Flow Meter mounting location, orientation 40'clock position

Butterfly Valve Position 90° (wide open)

Probe insertion depth centered in duct

Data File Name INTEKA.LOG 7/17/96

Nominal Air Flow (SCFM) ± 5	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
10	~10	76.4	0.143	14.425	14.38	-0.54	
20	~20	76.6	0.393	14.437	14.38	-0.54	
30	~29	76.8	0.555	14.442	14.38	-0.53	
40	~41	77.0	0.787	14.450	14.38	-0.54	
50	~50	77.5	0.965	14.455	14.38	-0.56	
60	~60	77.9	1.149	14.467	14.38	~41	
70	~70	78.4	1.352	14.469	14.38	~48	
80	~80	79.0	1.554	14.478	14.38	~56	
120	~120	79.6	2.320	14.510	14.38	~91	
160	~160	80.0	3.127	14.546	14.38	~130	
200	~200	80.3	3.871	14.577	14.38	~168	
240	~240	80.3	4.695	14.612	14.38	~206	
280	~280	80.0	5.456	14.652	14.38	~240	
320	~320	79.7	6.266	14.700	14.38	~275	
340	~340	79.6	6.697	14.720	14.38	~294	
320	~320	79.4	6.229	14.668	14.38	~273	
280	~282	79.2	5.520	14.660	14.38	~244	

Test Performer William E Wallingford Jr. Date 7/17/96

Test Director Jeffrey S Litton Date 7/17/96

FLOW METER TEST DATA SHEET - AMBIENT, PAGE B

Flow Meter Manufacturer Intek

Model Number IIID-IXD-NPT/2I(ADJ)-4/20-ISB Serial Number 96003-1

Ambient Temperature 74.4 °F Ambient Humidity 40.1 % r.h

Flow Meter mounting location, orientation 4 o'clock

Butterfly Valve Position 90° (wide open)

Probe insertion depth centered in duct

Data File Name INTEK9.LOG 7/17/96

Nominal Air Flow (SCFM) ± 5	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
240	~240	79.2	4.648	14.619	14.37	~210	
200	~200	79.3	3.830	14.572	14.38	~190	
160	~160	79.3	3.050	14.541	14.37	~182	
120	~120	79.4	2.322	14.511	14.37	~96	
80	~80	79.6	1.535	14.479	14.38	~59	
70	~70	79.6	1.363	14.466	14.38	~52	
60	~60	79.5	1.128	14.461	14.38	~43	
50	~50	79.6	0.967	14.459	14.38	−0.54	
40	~40	79.5	0.781	14.454	14.37	−0.55	
30	~30	79.5	0.580	14.442	14.38	−0.55	
20	~20	79.3	0.373	14.436	14.38	−0.57	
10	~10	79.1	0.179	14.425	14.38	−0.54	

COMMENTS: This is a repeat of the tracking test after the leaks in the diffuser box were sealed.

Test Performer William E. Willingham Jr. Date 7/17/96

Test Director Jeffrey A. Pitts Date 7/17/96

FLOW METER TEST DATA SHEET - AMBIENT, PAGE A

Flow Meter Manufacturer PANAMETRICS

Model Number GP68-22-2001-0 Serial Number 165

Ambient Temperature 75°F Ambient Humidity 52%

Flow Meter mounting location, orientation standard location, P= 18.185" L= 12.859"

Butterfly Valve Position 90° (wide open)

Probe insertion depth N/A RESPONSE TIME STATISTICS

Data File Name PANA1.LOG 6/3/96

Nominal Air Flow (SCFM) ± 5	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
10	10	77	0.183	14.531	14.48	10	
20	19	~~77~~ 78	0.363	14.537	14.49	19	
30	30	77	0.583	14.546	14.49	30	
40	41	77	0.788	14.553	14.48	39	
50	50	77	0.951	14.563	14.49	46	
60	61	77	1.162	14.570	14.49	57	
70	71	77	1.351	14.572	14.49	64	
80	80	78	1.523	14.585	14.49	71	
120	120	78	2.307	14.616	14.49	106	
160	160	79	3.078	14.646	14.49	140	
200	200	79	3.812	14.685	14.48	175	
240	240	80	4.621	14.729	14.49	212	
280	280	81	5.424	14.763	14.48	250	
320	320	81	6.174	14.801	14.49	287	
340	~340	82	6.564	14.816	14.48	305	
320	320	82	6.197	14.799	14.49	284	
280	280	82	5.451	14.751	14.48	253	

Test Performer William E. Willingham Date 6/3/96

Test Director Jeffrey A Pitts Date 6/3/96

FLOW METER TEST DATA SHEET - AMBIENT, PAGE B

Flow Meter Manufacturer PANAMETRICS

Model Number GP68-22-2001-0 Serial Number 165

Ambient Temperature 75°F Ambient Humidity 52%

Flow Meter mounting location, orientation standard location

Butterfly Valve Position 90° (w.r.t. open)

Probe insertion depth N/A

Data File Name PANA1.LOG

6/3/96

Nominal Air Flow (SCFM) ± 5	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
240	240	82	4.656	14.720	14.48	211	
200	200	82	3.898	14.681	14.49	176	
160	160	82	3.116	14.647	14.48	143	
120	120	82	2.324	14.607	14.48	108	
80	80	81	1.549	14.578	14.48	73	
70	70	81	1.363	14.569	14.49	64	
60	61	81	1.177	14.562	14.48	57	
50	50	81	0.982	14.552	14.49	46	
40	39	81	0.758	14.542	14.48	38	
30	30	81	0.594	14.536	14.48	28	
20	20	81	0.375	14.521	14.48	19	
10	10	81	0.201	14.522	14.49	8	

COMMENTS:

Test Performer William E Willingham Jr. Date 6/3/96

Test Director Jeffrey S Pitt Date 6/3/96

6/4/96 PANAMETRICS FLOW METER

VALVE POSITION TEST

FILE: PANA2.LOG, 5 second intervals for 30 seconds

FLOW SET AT ~ 100 SCFM

VALVE POSITION	FLOW METER FLOW
90°	89
70°	88
50°	~~88~~ 86 zero
30°	80
20°	67
10°	44

FLOW SET AT ~ 250 SCFM

VALVE POSITION	FLOW METER FLOW
90°	220
70°	216
50°	205
30°	183
20°	142
10°	102

William E Willingham 6/4/96

Jeffrey A Plath 6/4/96

BEST AVAILABLE COPY

6/4/96 PANAMETRICS FLOW METER
STEP RESPONSE TEST - MODIFIED
FILENAME: PANA3.LOG, 1 SECOND INTERVALS

1 { FLOW SET AT 250 SCFM (REF)
RESPONSE TIME SET AT "STATISTICS"

2 { FLOW SET AT 250 SCFM (REF)
RESPONSE TIME SET AT "1 SEC"

3 { FLOW SET AT 100 SCFM (REF)
RESPONSE TIME SET AT "1 SEC"

4 { FLOW SET AT 100 SCFM (REF)
RESPONSE TIME SET AT "STATISTICS"

William E Wellington 6/4/96
Jeffrey A Pitts 6/4/96

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6/4/96 PANAMETRICS FLOW METER

24 HOUR STABILITY TEST

FILENAME = PANA4.LOG

720 SECOND SAMPLING INTERVAL (12 MINUTES)

STARTED ~11:10 a.m.

STOPPED ~11:10 a.m. 6/5/96

NO DATA WAS FOUND IN FILE

J Williamson 6/5/96

Jeffrey S Pitts 6/5/96

BEST AVAILABLE COPY

FLOW METER STABILITY TEST DATA SHEET

Flow Meter Manufacturer PANAMETRICS

Model Number GP68-22-2001-0 Serial Number 165

Ambient Temperature 68°F Ambient Humidity 42%

Flow Meter mounting location, orientation STANDARD

Butterfly Valve Position 90° WIDE OPEN

Probe insertion depth N/A

Data File Name PANA4.LOG 6/4/96

	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
START							
11:10	160	74.7	3.024	14.690	14.53	140	
END							
11:10	162	71.3	3.022	14.755	14.60	141	

Comments:

PANAMETRICS RESPONSE TIME SET AT "1 SEC".

6/5/96 Only one data point was stored on disk. Test restarted on 6/5/96 Same file name.

START:

~~12:20~~ 1:12 pm	164	70.8°F	3.009	14.753	14.60	140.77
1:45 pm 6/4/96	160	77.9°F	3.018	14.698	14.54	137.76

Test Performer William E Wallingford Jr Date 6/5/96

Test Director Jeffrey S Path Date 6/5/96

6/5/96 PANAMETRICS FLOW METER

PARAMETER CHANGE TEST

FILENAME: PANA5.LOG, 5 second interval for 30 seconds

1. Ref flow set at ~160 scfm
   a. Axial Dimension (L) = 12.859" (P=18.185")
   b. L = 13.109"
   c. L = 13.359"
   d. L = 12.609"
   e L = 12.359"

2. a Path Length (P) = 18.185" (L = 12.859")
   b. P = 18.435"
   c. P = 18.685"
   d. P = 17.935"
   e. P = 17.685"

3. Back to Normal

6/6/96 Data not stored on PANA5.LOG (operator error)
Test redone with above settings.

William E Wallace 6/6/96
Jeffrey S Pitts 6/6/96

BEST AVAILABLE COPY

FLOW METER TEST DATA SHEET - HIGH HUMIDITY

Flow Meter Manufacturer PANAMETRICS

Model Number GP68-22-2001-0 Serial Number 165

Ambient Temperature 72°F Ambient Humidity ~ 40%

Flow Meter mounting location, orientation standard

Butterfly Valve Position 90° (wide open)

Probe insertion depth N/A

Data File Name PANA6.LOG (12 minute sampling interval)

	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
START	160	79	3.032	14.687	14.52	137	
24 hrs							
END							

Comments:

Started 3:15 p.m. 6/6/96 with ~ 88% r.h.

Water pressure set at: 7.5 psi } not calibrated

air pressure set at: 18 psi }

(Humidity still dropping as test started.)

Test Stopped 6/8/96 ~4:30 p.m. Everything looks okay!

Test Performer William E Wallingford Date 6/8/96

Test Director Jeffrey A Pitt Date 6/8/96

Test LOG 5/15/96

Test meter = SIERRA

purpose: determine K for average flow where

$Q_s = K V_s A$, $K = V_{s,c} / V_s$

set flow at ~210 scfm per sierra

temp = 81.6°F, humidity = 27.7 %

FILENAME = SIERRA1.LOG, ~~incorrectly entered data~~

5 second intervals for 1 minute

data point 1 = probe at center of pipe, F ≅ 201 scfm

data point 2 = dia x 0.342, F ≅ 195 scfm

data point 3 = dia x 0.226, F ≅ 186 scfm

data point 4 = dia x 0.146, F ≅ 180 scfm

data point 5 = dia x .082, F ≅ 165 scfm

data point 6 = dia x .026, F ≅ 160 scfm

butterfly valve wide open

William E Willingham 5/15/96

Jeffrey S Pitts 5/15/96

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5/15/96

Test Meter = SIERRA

purpose = determine K at lower flow rate

FILENAME = SIERRA2.LOG

TEMP = 84.3 °F , HUMIDITY = 24.9 %

Data Point 1 = center of pipe , F = 108 scfm

2 = .342 DIA , F = 102 scfm

3 = .226 DIA , F = 102 scfm

4 = .146 DIA , F = 102 scfm

5 = .082 DIA , F = 90 scfm

6 = .026 DIA , F = 85 scfm

William E Willingham 5/15/96

Jeffrey A Smith 5/15/96

BEST AVAILABLE COPY

FLOW METER STABILITY TEST DATA SHEET

Flow Meter Manufacturer Sierra

Model Number 640-FM-L13-E2-PV1-V4-NR Serial Number 25730

Ambient Temperature ~80°F Ambient Humidity 23%

Flow Meter mounting location, orientation standard

Butterfly Valve Position 90° (wide open)

Probe insertion depth centered in pipe

Data File Name SIERRA3.LOG

	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
START							
11:00	~162	80.5	3.19	14.5	14.4	170	
END							

Comments:

Started test 11:00 a.m. 5/16/96
data sampling every 12 minutes.
Batteries in Ashcroft ran out ~8:00 p.m. 5/16/96
will red. test

Test Performer William E Willhite Jr Date 5/17/96

Test Director Jeffrey A Pitchford Date 5/17/96

FLOW METER STABILITY TEST DATA SHEET

Flow Meter Manufacturer SIERRA

Model Number 640-FM-L13-E2-PV1-V4-NR Serial Number 25730

Ambient Temperature 68°F Ambient Humidity 28%

Flow Meter mounting location, orientation normal

Butterfly Valve Position 90° (wide open)

Probe insertion depth centered in duct

Data File Name SIERRA4.LOG

	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
START							
08:30	159	72.3	2.9	14.7	14.6	170	
END							
0904	157	64.0	2.9	14.5	14.4	177	

Comments: 5/20/96 started
5/21/96 stopped

Test Performer William E Willshire Jr. Date 5/21/96

Test Director Jeffrey D Smith Date 5/21/96

FLOW METER TEST DATA SHEET - AMBIENT, PAGE A

Flow Meter Manufacturer SIERRA

Model Number 640-FM-L13-E2-PV1-V4-NR Serial Number 25730

Ambient Temperature 62°F Ambient Humidity 44%

Flow Meter mounting location, orientation standard

Butterfly Valve Position 90° (wide open)

Probe insertion depth centered in duct

Data File Name SIERRA5.LOG 5/21/96

Nominal Air Flow (SCFM) ± 5	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (scfm)	Calculated Flow Meter Air Flow (SCFM)
10	11	62.0	0.208	14.44	14.40	12	
20	22	62.0	0.401	14.44	14.39	35	
30	31	62.0	0.570	14.45	14.39	47	
40	41	62.1	0.751	14.46	14.40	58	
50	51	62.2	0.925	14.47	14.40	67	
60	61	62.4	1.111	14.48	14.41	78	
70	71	62.4	1.300	14.48	14.41	87	
80	82	62.6	1.500	14.49	14.40	98	
120	120	62.8	2.202	14.52	14.40	131	
160	158	63.2	2.910	14.56	14.41	180	
200	200	63.9	3.653	14.59	14.40	220	
240	240	64.4	4.421	14.62	14.41	285	
280							
320						off	
340						scale	
320						300	cfm
280						limit	

Test Performer William E Wallace Jr Date 5/21/96

Test Director Jeffrey A Pitts Date 5/21/96

FLOW METER TEST DATA SHEET - AMBIENT, PAGE B

Flow Meter Manufacturer SIERRA

Model Number 640-FM-L13-E2-PV1-V4-NR Serial Number 25730

Ambient Temperature 62°F Ambient Humidity 44%

Flow Meter mounting location, orientation standard

Butterfly Valve Position 90° (wide open)

Probe insertion depth centered in duct

Data File Name SIERRA5.LOG 5/21/96

Nominal Air Flow (SCFM) ± 5	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (SCFM)	Calculated Flow Meter Air Flow (SCFM)
240							SEE PAGE A
200	202	64.6	3.734	14.59	14.40	230	
160	160	64.6	2.970	14.55	14.40	175	
120	119	64.6	2.208	14.52	14.40	132	
80	81	64.6	1.498	14.49	14.40	94	
70	69	64.5	1.264	14.48	14.41	83	
60	60	64.5	1.104	14.48	14.39	74	
50	49	64.4	0.892	14.47	14.40	63	
40	40	64.4	0.750	14.46	14.40	55	
30	30	64.3	0.541	14.45	14.40	40	
20	21	64.2	0.387	14.45	14.40	27	
10	10	64.1	0.190	14.44	14.41	8	

COMMENTS: 5 second sampling interval over 30 seconds at each point
SIERRA flowmeter is only programmed for the 0-300 scfm range.

Test Performer William S Willingham Date 5/21/96

Test Director Jeffrey A Leith Date 5/21/96

5/21/96 SIERRA FLOWMETER

STEP RESPONSE TEST – MODIFIED

1. FLOW SET AT ~250 SCFM
2. END OF 12" PIPE BLOCKED W/ CARDBOARD
3. FLOW DECREASE TO ~125 SCFM
4. DATA TAKEN IN FILE SIERRA6.LOG
   TEMP = 64.3°F, H = 45.9%
5. REPEATED TEST TWICE
6. FLOW SET AT ~100 SCFM
7. REPEATED ABOVE TEST

NOTE: FLOW BLOCKED, THEN OPENED AS QUICKLY AS POSSIBLE.

TEST PERFORMER: W & W Williamson 5/21/96
Jeffrey A Smith 5/21/96

BEST AVAILABLE COPY

5/21/96 VALVE POSITION TEST

FILE = SIERRA7.LOG, 5 sec interval for 30 sec

FLOW SET AT ~100 SCFM, centered in duct

BUTTERFLY VALVE POSITION	FLOW METER FLOW
90° (wide open)	~100
70°	~100
50°	~99
30°	~96
20°	~90
10°	~70

FLOW SET AT ~250 SCFM

BUTTERFLY VALVE POSITION	FLOW METER FLOW
90°	~250
70°	~250
50°	~248
30°	~227
20°	~180
10°	~133

TEST PERFORMER : W E Willingham Jr. 5/21/96

TEST DIRECTOR : Jeffrey A Pitts 5/21/96

BEST AVAILABLE COPY

FLOW METER TEST DATA SHEET - HIGH HUMIDITY

Flow Meter Manufacturer Sierra

Model Number 640-FM-L13-E2-PV1-V4-NR Serial Number 25730

Ambient Temperature 74 Ambient Humidity 28%

Flow Meter mounting location, orientation standard

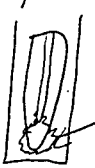
Butterfly Valve Position 90° wide open

Probe insertion depth centered in duct

Data File Name SIE.12A8.LOG

	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
START	~160	75.5	3.054	14.738	14.58	~170	
24 hrs	~155	85.5	3.077	14.606	14.45	300	
END	~157	81.5	3.063	14.623	14.46	300	

Comments: Started 6/19/96, 10:45 a.m.
first data = 10 second intervals during start up
air pressure set at 18 psi } not calibrated
water pressure set at 7.5 psi }



Water would condense and form a bridge between the RTD and the protective cover.
Test flow dropped from 300 scfm to ~130 scfm when water was removed.

Test Performer William E. Wallingford Date 6/21/96

Test Director Jeffrey S. Pitts Date 6/21/96

FLOW METER TEST DATA SHEET - HIGH HUMIDITY

Flow Meter Manufacturer SIERRA

Model Number 640-FM-L13-E2-PR1-V4-NR Serial Number 25730

Ambient Temperature 71°F Ambient Humidity 41%

Flow Meter mounting location, orientation ~~4' ditch~~ 3:30 o'clock 2KN

Butterfly Valve Position 10° wide open

Probe insertion depth centered in duct

Data File Name SIERRA9.LOG

	Reference Air Flow (SCFM)	Airstream Temp. (° F)	Reference Diff. Pressure (in. H_2O)	Reference Static Pressure (psia)	Flow Meter Static Pressure (psia)	Flow Meter Output (____)	Calculated Flow Meter Air Flow (SCFM)
START	~160	73	3.040	14.62	14.46	~175	
24 hrs							
END							

Comments: 24 hour test at different orientation.
Started 6/24/96 8:30 a.m.
Stopped 6/25/96 8:45 a.m.
readings ~ same as when started.

Test Performer Walter E Wallace Jr Date 6/25/96

Test Director Jeffry A Pitts Date 6/25/96

Valve Position Test - Exhaust Mode

AMC MASS-tron II 8/19/96

FILENAME = AMC7.LOG 5second intervals for 30seconds

PROBE IS HORIZONTAL, ORIGINAL DISTANCE

START WITH TEST FLOW @ 250 scfm

VALVE POSITION	TEST FLOW	REF FLOW
90°	~250	~226
70°	~245	~226
50°	~250	~226
30°	~250	~222
20°	~240	~212
10°	~207	~180

TEST FLOW @ 100 scfm

VALVE POSITION	TEST FLOW	REF FLOW
90°	~110	~100
70°	~110	~100
50°	~110	~100
30°	~110	~100
20°	~110	~98
10°	~106	~94

William E. Fellingham 8/19/96

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Step Response Test - Exhaust Mode

AMC - MASS-tro. II 8/19/96

FILENAME AMC8.LOG , 1second sample rate

CALCULATED (REFERENCE)
FLOW SET AT 100 SCFM

BUTTERFLY valve set at ~10° open

will block outlet flow with cardboard w. th orifice.

REFERENCE FLOW SET AT ~250 scfm

BUTTERFLY VALVE WIDE OPEN

will block outlet flow with cardboard orifice.

William E. Wellington 8/19/96
Jeffrey S. Smith 8/21/96

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APPENDIX C - DATA FILE INDEX

The following is a list of the ASCII text data files and the corresponding Microsoft® Excel Version 5.0 spreadsheet files used to process the data.

AMC1.LOG/.XLS Air Monitor Corporation MASS-tron II Ambient Tracking Test

AMC2.LOG/.XLS Air Monitor Corporation MASS-tron II Valve Position Test

AMC3.LOG/.XLS Air Monitor Corporation MASS-tron II Step Response Test

AMC4.LOG/.XLS Air Monitor Corporation MASS-tron II 24 Hour Stability Test

AMC5.LOG/.XLS Air Monitor Corporation MASS-tron II 48 Hour Humidity Test

AMC6.LOG/.XLS Air Monitor Corporation MASS-tron II Valve Position Test (Horizontal Position)

AMC7.LOG/.XLS Air Monitor Corporation MASS-tron II Valve Position Test (Exhaust Mode)

AMC8.LOG/.XLS Air Monitor Corporation MASS-tron II Step Response Test (Exhaust Mode)

INTEK1.LOG/.XLS Intek Rheotherm® Ambient Tracking Test

INTEK2.LOG/.XLS Intek Rheotherm® Insertion Depth Test

INTEK3.LOG/.XLS Intek Rheotherm® Valve Position Test

INTEK4.LOG/.XLS Intek Rheotherm® Step Response Test

INTEK5.LOG/.XLS Intek Rheotherm® 24 Hour Stability Test

INTEK6.LOG/.XLS Intek Rheotherm® 48 Hour Humidity Test

INTEK7.LOG/.XLS Intek Rheotherm® 24 Hour Humidity Test (4 o'clock position)

INTEK8.LOG/.XLS Intek Rheotherm® Ambient Tracking Test (before fixing leak)

INTEK9.LOG/.XLS Intek Rheotherm® Ambient Tracking Test (after fixing leak)

PANA1.LOG/.XLS Panametrics GP68 Ambient Tracking Test

PANA2.LOG/.XLS Panametrics GP68 Valve Position Test

PANA3.LOG/.XLS Panametrics GP68 Step Response Test

PANA4.LOG/.XLS Panametrics GP68 24 Hour Stability Test

PANA5.LOG/.XLS Panametrics GP68 Dimensional Parameter Change Test

PANA6.LOG/.XLS Panametrics GP68 48 Hour Humidity Test

SIERRA1.LOG/.XLS Sierra Model 640 K Value Test at 210 SCFM

SIERRA2.LOG/.XLS	Sierra Model 640 K Value Test at 100 SCFM
SIERRA3.LOG/.XLS	Sierra Model 640 24 Hour Stability Test
SIERRA4.LOG/.XLS	Sierra Model 640 24 Hour Stability Test
SIERRA5.LOG/.XLS	Sierra Model 640 Ambient Tracking Test
SIERRA6.LOG/.XLS	Sierra Model 640 Step Response Test
SIERRA7.LOG/.XLS	Sierra Model 640 Valve Position Test
SIERRA8.LOG/.XLS	Sierra Model 640 48 Hour Humidity Test
SIERRA9.LOG/.XLS	Sierra Model 640 24 Hour Humidity Test (4 o'clock position)

APPENDIX D - CALIBRATION DATA SHEETS

WESTINGHOUSE STANDARDS LABORATORY PHYSICAL AND ELECTRICAL REPORT

CUSTODIAN/ADDRESS: SCHNEIDER TC L6-37	STANDARDS CODE NUMBER: 355-35-03-009			NEW: ✓ MODIFY: ✓	REFERENCE NUMBER: 400598
				ORGANIZATION CODE: W75240	WORK ORDER: N2169
INSTRUMENT: INDICATOR TEMP NEWPORT INFU-0010DC1	SERIAL NUMBER: 5251213	PROPERTY NUMBER: N/A	RECALL STATUS: 1 ACTIVE, 2 NONRECALL, 3 SUSPENDED, 4 DELETED, 5 PM, 6 NONDATA MATE: 1	RECALL CYCLE: 360	TOLERANCE HISTORY
	ROOM: N/A BUILDING: 306E	SERVICE DEPARTMENT: 24		DATE RECEIVED: 960501	TOLERANCE AS RECEIVED: 1 IN, 2 OUT, 3 NA, 4 FAILED
SENDER: W)WILLINGHAM 69835	COMMENTS: PM 5-3-96			SHIPPING DAY: WE	
INSTRUMENT SPECIFICATIONS: SEE MANUAL BELOW				TRAINING HOURS	
				CALIBRATION HOURS: 2.5	
STANDARD(S) USED IN CALIBRATION TRACEABLE TO NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY OR NATIONALLY RECOGNIZED STANDARDS — 4:1 RATIO Y ☐ N ☑ RSS				REPAIR HOURS	
002-6302-012 EXPIRATION DATE: 7-23-96			EXPIRATION DATE	OTHER HOURS: 2.42	
002-6322-021 EXPIRATION DATE: 4-1-97				MATERIALS	
002-4508-029 EXPIRATION DATE: 5-8-96				TOTAL CHARGE = ($125 x SUM OF HOURS) + MATERIALS	
REMARKS: WRTE PROCEDURAL ; DATA REP				DATE CALIBRATED: 5-3-96	DATE DUE: 5-3-97
PROCEDURE NUMBER: WHC-4-TEMPINFU 5-3-96 WHC-4-NEWPORT-INFU-010 REV.0				AMBIENT TEMPERATURE =	

APPROVED BY: 5-3-96	CALIBRATED BY: WA DIGLAS 30	Hanford Operations and Engineering Contractor for the United States Department of Energy	Westinghouse Hanford Company Subsidiary of Westinghouse Electric Corporation P.O. Box 1970, Richland, WA 99352	PAGE 1 OF 1

RUSH

PROCEDURE NAME - [illegible]	STANDARDS CODE NUMBER	REFERENCE NUMBER
WHC-4-NEWPORT-INPU-0102Rv0	355-35-63-059	400558

DATA SHEET

Nom °F	STD Ω	AS FOUND INDICATION	AS FOUND	FINAL	MANUFACTURER SPECIFICATION
-97.6	71.53	-97.44			± .3°F
-49.0	82.29	-48.85			
+32.0	100.0	32.00			
68	107.79	67.91			
86	111.67	85.99			
STD ADC					
4 mA	106.08	59.99			
8 mA	108.23	69.93			
12 mA	110.38	79.98			
16 mA	~~112.53~~ 111.54	89.95			
20 mA	114.67	99.98			
Nom °F					
320	161.04	320.00			
500	197.69	499.79			
950	284.22	949.72			
1310	348.22	N/A			
1490	378.48	↓			
					↓

APPROVED BY	CALIBRATED BY	Page
D.R. Nelson 5-3-96	WHC CALIBRATED 30	2 of 2

WESTINGHOUSE STANDARDS LABORATORY PHYSICAL AND ELECTRICAL REPORT

CUSTODIAN/ADDRESS: SCHNEIDER TC L6-37	STANDARDS CODE NUMBER: 355-80-02-055			NEW ✓ / MODIFY	REFERENCE NUMBER: 400604
				ORGANIZATION CODE: W75240	WORK ORDER: N2169
INSTRUMENT: PRESSURE TRANSMITTER ROSEMOUNT 3051C 0-30 PSIA	SERIAL NUMBER: 0266492	PROPERTY NUMBER: N/A	RECALL STATUS (1 ACTIVE, 2 NONRECALL, 3 SUSPENDED, 4 DELETED, 5 PM, 6 NONDATA M&TE): 1	RECALL CYCLE: 360	TOLERANCE HISTORY
	ROOM: N/A / BUILDING: 306E	SERVICE DEPARTMENT: 5		DATE RECEIVED: 960501	TOLERANCE AS RECEIVED (1 IN, 2 OUT, 3 NA, 4 FAILED)
SENDER: W)WILLINGHAM 36256	COMMENTS			SHIPPING DAY: WE	

INSTRUMENT SPECIFICATIONS: MFG. SPECS +/- .2% FS

STANDARD(S) USED IN CALIBRATION TRACEABLE TO NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY OR NATIONALLY RECOGNIZED STANDARDS — 4:1 RATIO Y ☒ N ☐

Standard	EXPIRATION DATE
002-35-40-008	6-14-96
002-45-08-047	2-27-97

TRAINING HOURS	
CALIBRATION HOURS	2.0
REPAIR HOURS	
OTHER HOURS	*4
MATERIALS	
TOTAL CHARGE = ($125 x SUM OF HOURS) + MATERIALS	
DATE CALIBRATED	5/6/96
DATE DUE	5/6/97
AMBIENT TEMPERATURE =	23°C

REMARKS: (WP-216)

PROCEDURE NUMBER: WHC-5-RMT-3051CA REV.3 30PSIA

APPROVED BY: 5-6-96 D. J. Nelson

CALIBRATED BY: [stamp] STD LAB 21

Hanford Operations and Engineering Contractor for the United States Department of Energy — Westinghouse Hanford Company, a subsidiary of Westinghouse Electric Corporation, Box 1970, Richland, WA 99352

RUSH

1 OF 2

PROCEDURE NAME 216	STANDARDS CODE NUMBER	REFERENCE NUMBER
WHC-5-RMT-3051CA REV.3 30PSIA	355-80.02-055	400604

DATA SHEET

TEST POINTS		AS FOUND		FINAL		TOLERANCE	
MA	PSIA	MA	PSIA	MA	PSIA	MA	PSIA
4	0	3.979	-.0223			+/-.032	+/-.06
8	7.5	7.972	7.464				
12	15.0	11.971	14.96				
16	22.5	15.968	22.46				
20	30.0	19.968	29.56				

Same

APPROVED BY	CALIBRATED BY	WHC STD Lab 21	Page
5-6-96 Q.R. Nelson			2 of 2

WESTINGHOUSE STANDARDS LABORATORY PHYSICAL AND ELECTRICAL REPORT

CUSTODIAN/ADDRESS: SCHNEIDER TC L6-37	STANDARDS CODE NUMBER: 355-80-02-056	NEW / MODIFY	REFERENCE NUMBER: 400762
		ORGANIZATION CODE: W75240	WORK ORDER: N2169
INSTRUMENT: PRESSURE TRANSMITTER ROSEMOUNT 3051C 0-30 PSIA	SERIAL NUMBER: 163720	PROPERTY NUMBER: N/A	RECALL STATUS: 1 (1 ACTIVE, 2 NONRECALL, 3 SUSPENDED, 4 DELETED, 5 FM, 6 NONDATA M&TE)
	ROOM: N/A BUILDING: 306E	SERVICE DEPARTMENT: 9	RECALL CYCLE: 360
		DATE RECEIVED: 960508	TOLERANCE AS RECEIVED: 1 IN, 2 OUT, 3 PD, 4 FAILED
SENDER: W)WILLINGHAM 36256	COMMENTS:	SHIPPING DAY: WE	TOLERANCE HISTORY

INSTRUMENT SPECIFICATIONS: MFG. SPECS. +/- .2% FS

TRAINING HOURS

CALIBRATION HOURS: 2.0

REPAIR HOURS

OTHER HOURS

ENG/ADMIN HOURS

MATERIALS

TOTAL CHARGE = (5.25 x SUM OF HOURS) + MATERIALS

STANDARD(S) USED IN CALIBRATION TRACEABLE TO NATIONAL OR NATIONALLY RECOGNIZED STANDARDS (NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY)

4:1 RATIO	EXPIRATION DATE
Y [X] N [ ]	
002-35-40-008	6-14-96
002-45-08-047	2-27-97

REMARKS: (WP-216)

DATE CALIBRATED: 5/10/96 DATE DUE: 5/10/97

PROCEDURE NUMBER: WHC-5-RMT-3051CA REV.3 30PSIA

AMBIENT TEMPERATURE = 23C

APPROVED BY: D.R. Nelson 5-10-96 CALIBRATED BY: WHC STD LAB 21

Hanford Operations and Engineering Contractor for the United States Department of Energy

Westinghouse Hanford Company Subsidiary of Westinghouse Electric Corporation P.O. Box 1970, Richland, WA 99352

PAGE 1 OF 2

CUSTOMER COPY

PROCEDURE NAME 216	STANDARDS CODE NUMBER	REFERENCE NUMBER
WHC-5-RMT-3051CA REV.3 30PSIA	355-80-02-056	400762

DATA SHEET

TEST POINTS		AS FOUND		FINAL		TOLERANCE	
MA	PSIA	MA	PSIA	MA	PSIA	MA	PSIA
4	0	3.996	.0039	Same		+/-.032	+/-.06
8	7.5	8.000	7.511				
12	15.0	12.001	15.01				
16	22.5	16.001	22.51				
20	30.0	20.004	30.02				

APPROVED BY		CALIBRATED BY	WHC STD 146 21	Page
D.L. Nelson	5-10-96			2 of 2

WESTINGHOUSE STANDARDS LABORATORY PHYSICAL AND ELECTRICAL REPORT

Field	Value
CUSTODIAN/ADDRESS	BARNES GA, H5-09
STANDARDS CODE NUMBER	179-13-01-001
NEW / MODIFY	✓ / ✓
REFERENCE NUMBER	394743
ORGANIZATION CODE	W75220
WORK ORDER	N2841
INSTRUMENT	PRESSURE CALIBRATOR ASHCROFT ATE-100 0-25 IN/H2O/0-30 PSIA
SERIAL NUMBER	AOS-1713
PROPERTY NUMBER	N/A
RECALL STATUS (1 ACTIVE, 2 NONRECALL, 3 SUSPENDED, 4 DELETED, 5 PM, 6 NONDATA M&TE)	1
RECALL CYCLE	360
TOLERANCE HISTORY	
ROOM	N/A
BUILDING	ETC-1
SERVICE DEPARTMENT	5
DATE RECEIVED	951011
TOLERANCE AS RECEIVED (1 IN, 2 OUT, 3 NA, 4 FAILED)	3 NA
SENDER	G BARNES 6-2241
COMMENTS	2ND MODULE #AOS-2263
SHIPPING DAY	MO

INSTRUMENT SPECIFICATIONS
0-30 PSIA ±.05% F.S.
0-25 IN H2O ±.06% F.S.

STANDARD(S) USED IN CALIBRATION TRACEABLE TO NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY OR NATIONALLY RECOGNIZED STANDARDS — 4:1 RATIO Y ☐ N ☒

Standard	Expiration Date
002-14-01-025	1-26-96
002-77-01-005	6-5-96
002-80-02-005	4-25-96

TRAINING HOURS	
CALIBRATION HOURS	5.0
REPAIR HOURS	
OTHER HOURS	
MATERIALS	
TOTAL CHARGE = ($120 x SUM OF HOURS) + MATERIALS	
DATE CALIBRATED	10-12-95
DATE DUE	10-12-96
AMBIENT TEMPERATURE =	23.1C

REMARKS
MODULE TO BE ADJUSTED MUST BE IN LEFT ~~HAND SOCKET~~ SIDE OF CALIBRATOR 10-12-95
USED 255 NO AF. TAKEN ON IN H2O DUE TO LEARNING CAL

PROCEDURE NUMBER: VM-5-Ashcroft-ATE100

0-30 PSIA

TEST POINTS PSIA	AF. PSIA	FINAL PSIA	TOL. PSIA
0	0.006	0.001	±.05
6	6.027	6.012	↓
12	12.030	12.013	↓
18	18.028	18.003	↓
24	24.032	24.002	↓
30	30.042	30.008	↓

0-50 mA

TEST POINTS mA	AS FOUND mA	FINAL mA	TOL. mA
10	9.999	SAME	±.025
20	20.002	↓	↓
30	30.00	↓	↓
40	40.00	↓	↓
50	49.99	↓	↓

0-25 IN H2O

TEST POINTS IN H2O	AF(FOUND) IN H2O	FINAL IN H2O	TOL ±.015
5	NA	5.002	↓
10	↓	10.003	↓
15	↓	15.005	↓
20	↓	20.011	↓
25	↓	25.002	↓

0-30 VOLTS

TEST POINTS VOLTS	AS FOUND VOLTS	FINAL VOLTS	TOL VOLTS
6	5.999	SAME	±.03
12	12.00	↓	↓
18	18.00	↓	↓
24	23.99	↓	↓
30	29.99	↓	↓

APPROVED BY: D. J. Nelson 10-13-95
CALIBRATED BY: [stamp: WHC STD LAB 46]

Hanford Operations and Engineering Contractor for the United States Department of Energy — Westinghouse Hanford Company, Subsidiary of Westinghouse Electric Corporation, Box 1970, Richland, WA 99352

PAGE 1 OF 1

Meriam Instrument
a Scott Fetzer company

FILE NO. 040FB:001-17

LETTER OF CERTIFICATION
LAMINAR FLOW ELEMENT

CUSTOMER NAME: WESTINGHOUSE HANFORD

CUSTOMER ORDER NUMBER: MBJ-VDV-478063

MERIAM ORDER NUMBER: 757200

Meriam Instrument certifies that the completed LFE unit has been calibrated and correlated at several points of flow rate using a Meriam Standard, which is controlled per the calibration system requirements of MIL-STD-45662A and traceable to the National Institute of Standards & Technology. The collective uncertainty of the measurement standards has a 1:1 ratio to the acceptable tolerance for the flow rate being calibrated.

The total rss uncertainty of the completed laminar flow unit is +/- .86 % of reading.

MODEL NO.: 50MC2-4 SERIAL NO.: 757200-K1

FLOW CURVE/TABLE NO.: 26862

DATE OF CALIBRATION 02-07-1996 BY GEORGE ROBOTKAY

FLOW STANDARD SERIAL NO.	DATE OF LAST CAL	DATE OF NEXT CAL
68-9606	APRIL 1995	APRIL 1996

NIST Traceability Nos. 737/228509, 215451, 202491, 184984, 213426, 199114, 203537

The LFE unit listed hereon has been successfully calibrated in accordance with Meriam Instrument Procedure A-33558 rev B.

Karen M Cooper 2/8/96
QUALITY ASSURANCE INSPECTOR
MERIAM INSTRUMENT

Greg Kloppel KMC 2/8/96
GREG KLOPPEL
QUALITY ASSURANCE MANAGER
MERIAM INSTRUMENT

Standard
LAMINAR.BAS VER 1.26 NOVEMBER 1995

CALIBRATION DATE 02-07-1996 PLOT NUMBER 116

LAMINAR MODEL # 50MC2-4 WORKING MASTER SERIAL # 68-9606

SERIAL # 757200-K1 MASTER MASTER SERIAL # 66-8606-2

CURVE # 26862 JOB # 757200

uut = Unit Under Test

DATA AS INPUT FROM DATA SHEET mas = Master

RH %	Tuut DEG F	Tmas DEG F	PSuut PSIA	PSmas PSIA	DPuut In H2O	DPmas In H2O
16.6	68.6	69.6	14.345	14.316	1.009	1.061
16.6	68.7	69.6	14.342	14.273	2.014	2.134
16.6	68.8	69.6	14.334	14.229	3.022	3.226
16.6	69.0	69.7	14.327	14.180	4.028	4.332
16.6	69.2	69.7	14.319	14.132	5.036	5.449
16.6	69.5	69.7	14.305	14.078	6.024	6.575
16.6	69.7	69.8	14.292	14.023	7.034	7.744
16.6	69.9	69.8	14.278	13.967	7.994	8.866

Master LFE coefficients

A1 = 9.46020E+03
B1 = -2.73395E+07
C1 = -1.27140E+11

REDUCED DATA, BASED ON MASTER LFE COEFFICIENTS:

DATA POINT	DP uut InH2O@4C	FLOW IN ACFM BASED ON MASTER	CFM* (DATA) BASED ON MASTER	CFM* (CURVE) B*DP+C*DP^2	PERCENT ERROR**
1	1.009	54.652706	54.543381	54.559998	0.03
2	2.014	108.816788	108.614526	108.611681	-0.00
3	3.022	162.897992	162.624035	162.543097	-0.05
4	4.028	216.485642	216.167520	216.076750	-0.04
5	5.036	269.480673	269.151390	269.436844	0.11
6	6.024	321.781332	321.535990	321.442139	-0.03
7	7.034	374.669687	374.489886	374.335974	-0.04
8	7.994	424.279641	424.210830	424.331075	0.03

*CFM = ACFM x (Flowing viscosity in Micropoise / 181.87)

** PERCENT ERROR = ((CURVE-DATA) / DATA) * 100

A Least Squares Fit of the CFM(DATA) yields the following formula and LFE uut coefficients used to generate the CFM(CURVE) values:

CFM(CURVE) = (B x DP) + (C x DP^2) Where B = 5.42091E+01
C = -1.41293E-01

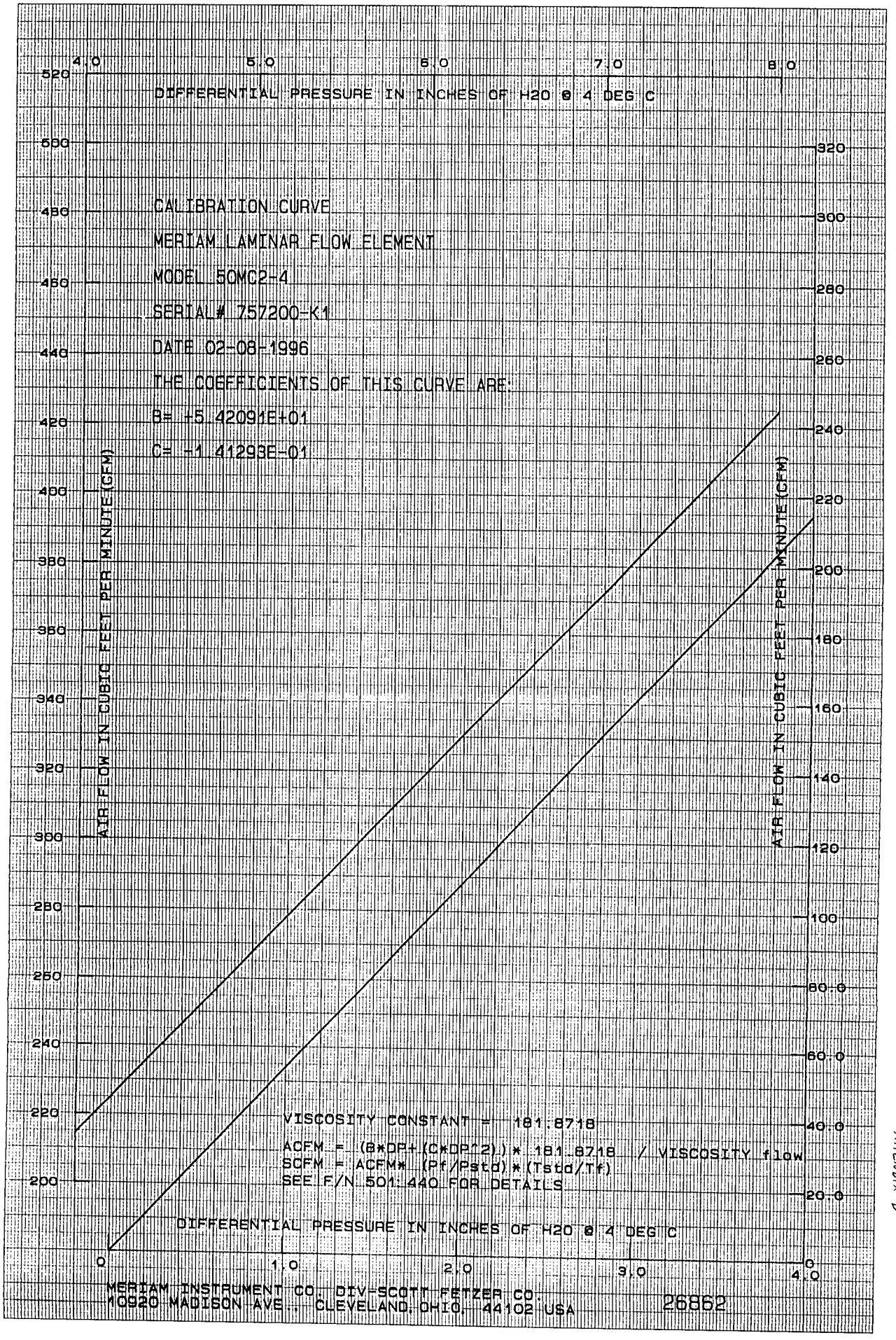
A Flow of 424.629974 CFM produces a UUT DP of 8.00 In H2O

TERMINAL NON-LINEARITY = 1.080 %
INDEPENDENT NON-LINEARITY = 0.328 %
FOR DETAILS SEE FILE NO. 501:440

PRINTOUT DATE :02-08-1996

Filename : 75720001.100

GRAPHIC CONTROLS CORPORATION Buffalo, New York Printed in U.S.A. SQUARE 10 X 10 TO THE CENTIMETER BS 8114-GT



AIR MONITOR CORPORATION
1050 Hopper Avenue • Santa Rosa, CA 95403

MAIL TO: Corporate Offices
P.O. Box 6358
Santa Rosa, CA 95406
Tel: (707) 544-2706
Fax: (707) 526-9970

AMC W.O. No. 26616

CERTIFICATE OF CALIBRATION

Air Monitor Corporation hereby certifies that this instrument meets or exceeds all published specifications and has been calibrated using standards whose accuracies are traceable to the National Institute of Standards and Technology within the limitations of the Institute's calibration services, or have been derived from acceptable values of natural physical constants, or have been derived by the ratio type of self-calibration techniques.

Qty.	Description	Serial Number
1	MASS-tron II Span: 0 to 0.0200 IN w.c. Temperature Input/Range: RTD, 0 to 200°F Display Line #1: 0 to 0.0200 IN w.c. Display Line #2: 0 to 511 AFPM Display Line #3: 0 to 397 ACFM Display Line #4: 24.00 to 32.00 IN Hg Output #1 (Transmitter, ACFM): 4.0 to 20.0 mADC Output #2 (Temperature, °F): 4.0 to 20.0 mADC Output #3 (Absolute Pressure, IN Hg): 4.0 to 20.0 mADC Power: 24 VDC	B11024

David M. Bullick — Calibrated By — Date: 3/15/96

David Silsbe — Quality Assurance Manager — Date: 3-18-96

TABLE II

INTEK RHEOTHERM

ORIGINAL CALIBRATION DATA FOR FUNCTIONAL TEST

Unit Serial Number - 96003-1

I	II	III	IV	V
Test Point TP15	Log Output (nonlinear) VDC	Linear Output 4-20 mA	Rheotherm Instrument Display (option) SCFM	Flow Rate 40-350 SCFM
-8.865	0.336	5.872	040	40.4
-7.779	2.861	7.157	068	69.4
-6.877	4.972	9.014	109	109.1
-6.412	6.053	10.384	139	138.8
-5.937	7.159	12.179	178	178.5
-5.649	7.843	13.550	208	208.2
-5.314	8.620	15.441	250	247.9
-5.124	9.062	16.692	278	277.6
-4.885	9.631	18.497	318	317.28
-4.733	9.975	19.722	345	347.0

An offset between data in columns I and II may appear if the instrument has undergone field calibration.

INTEK RHEOTHERM
OUTPUT CURVE

Serial no. 96003-1 Tag no.

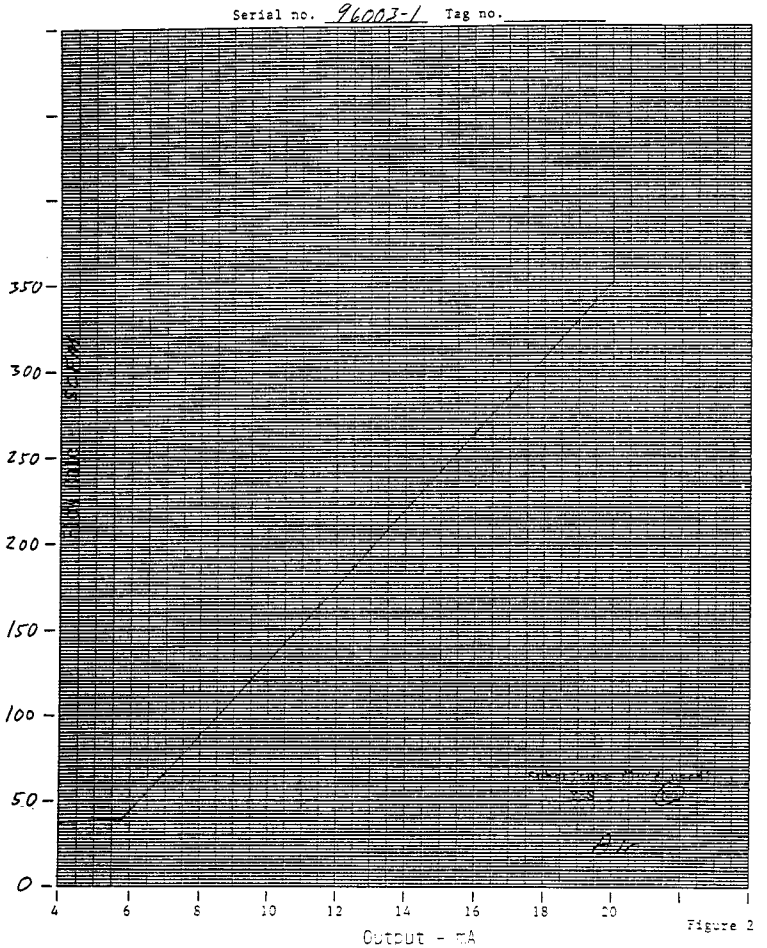


Figure 2

-18-

BEST AVAILABLE COPY

SIERRA INSTRUMENTS, INC.
5 HARRIS COURT, BUILDING L
MONTEREY, CA 93940 USA
800-866-0200 · 408-373-0200
FAX 408-373-4402

Certificate of Calibration

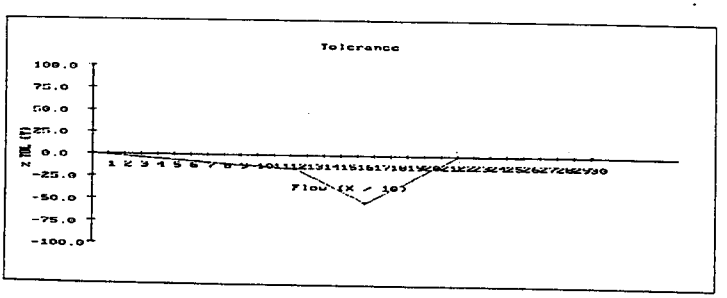
No. 3787345359010O1-25730

Calibration Date: 02/06/96
Calibration Due Date: 02/06/97

Order Data	Application Data	Reference Data
Cust: WESTINGHOUSE HANFORD	Gas: AIR	Ref. Temp: 70°F
PO#: 3787345359010O1	Temp: 90°F	Amb. Temp: 74.7°F
Tag#: N/A	Press: 0-6" H20	Ref. Press: 29.92 In Hg
Serial#: 25730	Line Size: 12" SCH 40	Amb. Press: 30.06 In Hg
Sales Order#: 15324	Flow Range: 300.00	Cal Method: Laser Doppler
Model#: 640-FM-L13-E2-PS-V4-NR	Output: 4-20mA	Asset#: 0388
	Units: SCFM	Accuracy: ±1% FS+.5% R

Calibration Data

Actual Flow	Linear Output	Indicated Flow	% Tolerance	Tolerance Band Min	Tolerance Band Max
0.00	4.000	0.00	0.00%	0.00	3.00
122.82	10.520	122.25	-15.77%	119.21	126.43
165.54	12.720	163.50	-53.30%	161.71	169.37
218.83	15.670	218.81	-0.43%	214.74	222.92
300.00	20.000	300.00	0.00%	295.50	304.50



The calibration standards used in this procedure are tracable to NIST or applicable international standards.

This instrument has been calibrated in accordance with the provisions of ANSI/NCSL Z540-1 and ISO/IEC GUIDE 25.

Calibration Technician _____ Q.C. Technician _____

Date FEB. 6, 1996 Date 2/6/96

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	W. E. Willingham Jr.	Date 7/25/96
Project Title/Work Order		EDT No. 615720
Characterization		ECN No.

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
W. E. Willingham Jr.	H6-11	X			
S. K. Farnworth	H5-56	X			
T. C. Schneider	L6-37	X			
D. D. Tate	L6-37	X			
E. A. Smith	B4-40	X			
D. B. Engelman	L6-37	X			
J. W. Lentsch	S7-12	X			
B. J. Hug	L6-35	X			
J. R. Thielges	L6-38	X			
D. G. Panther	L6-39	X			
C. C. Scaief III	R1-56	X			
J. R. Kriskovich	R1-56	X			
R. E. Raymond	S7-12	X			
Central Files	A3-88	X			