Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

AP-42 Section Number: 9.9.4

Reference Number: 14

Title: Stack Particulate Samples Collected at Verhoff Alfalfa, Ottawa, OH

Affiliated Environmental Services, Inc.

Affiliated Environmental Services, Inc.

June 1995

AP-42 Section 9.9.4
Reference 14
Report Sect. ____
Reference ____

affiliated Environmental services, inc.

Verhoff Alfalfa
Attn: Mr. Don Verhoff
1188 Sugar Mill Dr.
Ottawa, OH 45875
(419) 523 - 4767

REPORT TO VERHOFF ALFALFA

ON

STACK PARTICULATE SAMPLES
COLLECTED AT
OTTAWA, OH

SUBMITTED BY

AFFILIATED ENVIRONMENTAL SERVICES, INC.
3606 VENICE RD.
SANDUSKY, OH 44870

DATE OF TESTING: 6-22-95

DATE OF REPORT: 6-28-95

DON DAUCH
FIELD TEST SUPERVISOR

DON DAUCH
MANAGER, AIR SAMPLING DIVISION

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INTRODUCTION

This report contains the results of stack particulate emissions testing performed by Affiliated Environmental Services, Inc. for Verhoff Alfalfa, Ottawa, OH. The system tested was the exhaust from the bay dryer. Hay is fed from a hopper into a drum to be dried. The air from this process is routed to a cyclone and out a 30x30 inch square stack. This was a three repetition test following EPA Methods 1-5. Testing was on 6-22-95 by Don Dauch and Brad Pean of AES. Production during testing was monitored by Verhoff personnel and can be found in the Appendix. This test was witnessed by Mr. Tom Sattler of the OEPA.

STACK PARTICULATE DATA SUMMARY

Run No.	gr/dscf(A)	x10^{-6} lbs/dscf(B)	lbs/hr
1	0.0556	7.9648	10.67
2	0.0474	6.7824	9.2
3	0.0460	6.5903	8.39

(A) = Grains per dry standard cubic feet at 68°F and 29.92 inches Hg

(B) = Pounds per dry standard cubic feet at 68°F and 29.92 inches Hg

STACK GAS DATA SUMMARY

Run No.	Flow Rate(A)	Temp. °F	Moisture %	CO_2 %	O_2 %	CO %
1	22,326	187	13.7	0.0	21.0	0
2	22,609	181	14.2	0.0	21.0	0
3	21,214	188	20.7	0.0	21.0	0

(A) = Dry standard cubic feet per minute at 68°F and 29.92 inches Hg

DESCRIPTION OF PARTICULATE TEST

Particulate samples were collected following EPA Methods 1-5. Sample port locations were located over 2 diameters down from the exit of the stack (distance A) and up 3 1/2 diameters from the nearest disturbance (distance B). The stack is a 30"x30" square. A 20 point sampling set was selected due to the port locations as outlined in EPA Method 1. Each point was sampled for 3 minutes for a total of a 60 minute test. Three one hour test repetitions were performed. The equipment used for testing consisted of an Orsat Gas Analyzer and a Graseby Nutech Model 2010 Train Stack Sampler (EPA type). A RAC type "S" pitot and heated sampling probe was used with the sampling train. All equipment was calibrated in the laboratory prior to the test. The sampling nozzle and the pitot tubes were measured on the day of the test. All calibrations can be found in the appendix. The dust laden gases are passed through a heated stainless steel probe and a heated glass cyclone separator followed by a four inch filter holder containing Whatman type 934AH fiberglass filter media. The gases leaving the filter were collected in a series of three impingers packed in ice. The first and third impingers were the modified Greenburg-Smith type and the second one was a standard Greenburg-Smith type. The first and second impingers contained 100 ml of distilled water while the third one was used as a dry trap. After leaving the dry trap, the gases passed through a fourth impinger containing about 550 grams of silica gel desiccant to remove any remaining water vapor. The dry gas then passed through the hose portion of the umbilical cord to a Graseby Nutech Model 2010 "Stack Sampler" module. In the module the gas was moved through the system by a leakless air pump to a Rockwell 175-S dry test meter. The dry test meter exhausted to a

calibrated orifice to measure the flow rate of the gases passing through the sampling apparatus. A type "S" pitot tube was attached to the sheath of the heated probe and nozzle. The orifice pressure taps and the pitot tube were connected to a Dwyer dual 10 inch combination inclined-well type manometer. One half of the manometer measured the orifice differential pressure (ˆH) and the other half measured the flue gas velocity head (ˆP). The temperature of the flue gas was measured by a type "K" thermocouple connected to a Fuji PYZ7 thermometer readout. The CO_2 and O_2 levels were sampled with a Bach Fyrite System. One Fyrite was done for each test run.

PARTICULATE TEST PROCEDURES

The probe, filter and glass ware were assembled and leak tested in our lab before transporting to the job site. Three sets of equipment were used. At the job site a preliminary pitot traverse was performed to select the proper nozzle size. The nozzles were measured with an inside vernier caliber. The impingers were filled with distilled water and the silica impinger was connected just prior to elevating the probe into position. After leak testing the apparatus the probe was inserted at the first sample point to start the test. The apparatus was leak tested after the test was completed at a vacuum exceeding that encountered during the test. The moisture content was determined from the amount of condensate collected in the impingers and the difference of the tare and gross weight of the silica impinger. The silica impinger was weighed on a Baxter Scientific Lab Balance to the nearest one tenth of a gram. The filter media was dried in an oven then desiccated at room temperature for 24 hours before tare and gross weighing on a Mettler H30 Analytical Balance. The probe liner, nozzle, cyclone and front half of the filter holder were washed with acetone and brush after testing and evaporated to dryness on a steam bath in 250 ml beakers. The beakers were dried and tare weighed prior to sample evaporation and gross weighed after allowing the samples to desiccate for 24 hours. These weights were accomplished with the Mettler Balance. The contents of the impingers were measured in a 100 ml graduate and poured into a 250 ml beaker. The impingers and graduate were washed with distilled water and brush with the washings added to the beaker. The beakers were placed in a desiccator to cool and dry for at least 24 hours before weighing. The tare and gross weights were accomplished in the same manner as the probe washings. The weight of the material collected in the impingers was not used in the calculations to obtain the weight of the particulate catch.

METHOD 1

Sample and Velocity Traverses for Stationary Sources.

The location of the sampling site and traverse points are determined based on stack diameters and length of the stack.

METHOD 2

Determination of Stack Gas Velocity and Volumetric Flow Rate.

Velocities are measured with a type "S" pitot tube. Temperatures are measured with thermocouples.

METHOD 3

Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight.

A gas sample is extracted by using a bag simultaneously with the particulate tests. Analyses are performed using an Orsat and/or Fyrite Analyzer.

METHOD 4

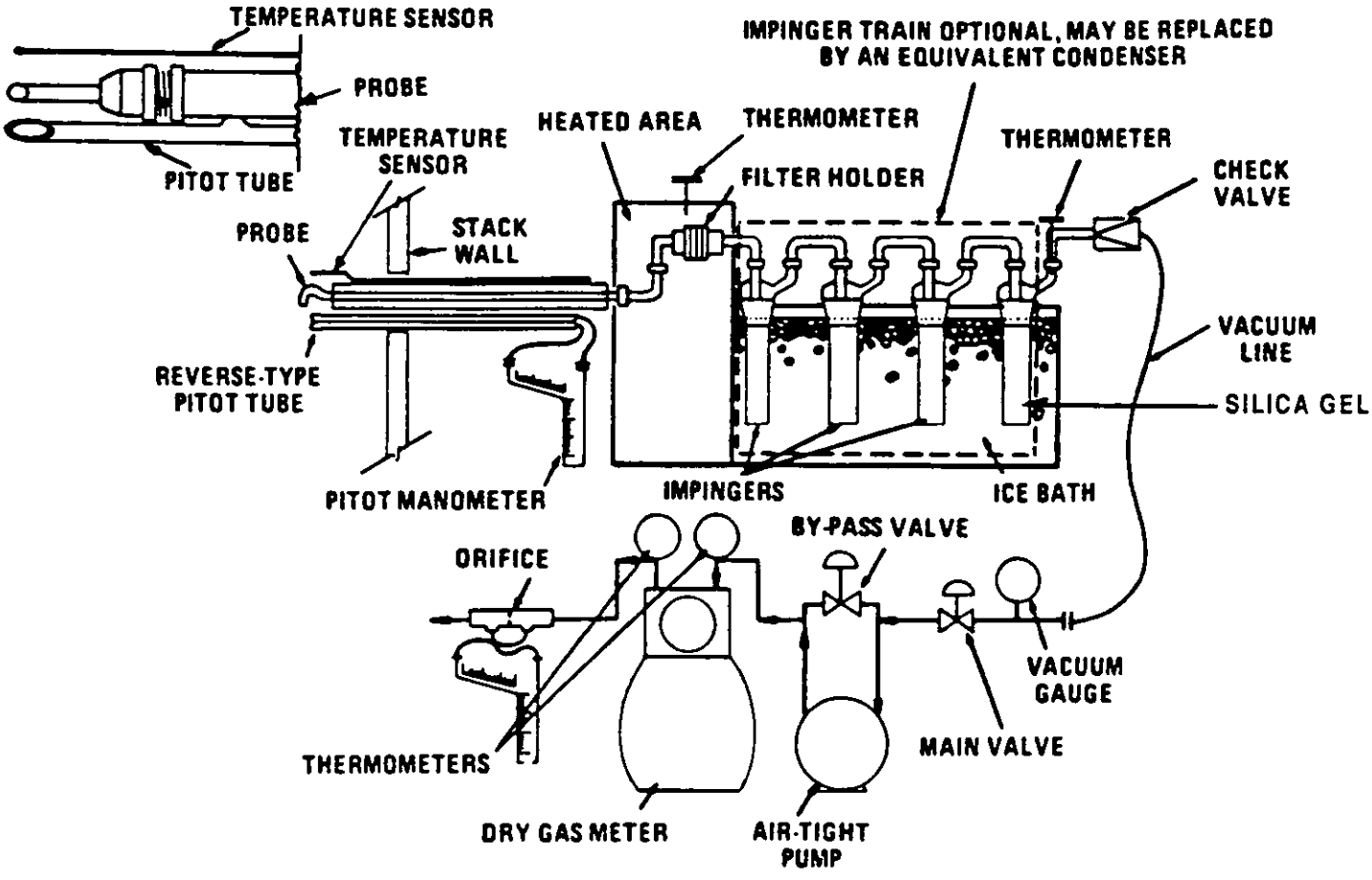
Determination of Moisture Content.

A gas sample is extracted at a constant rate from the source. Moisture is determined either volumetrically or gravimetrically.

METHOD 5

Determination of Particulate Emissions from Stationary Sources.

Particulate matter is withdrawn isokinetically from the source and collected on a glass fiber filter maintained at 248 ± 25° F. A schematic of the sampling train is shown in Figure 1.



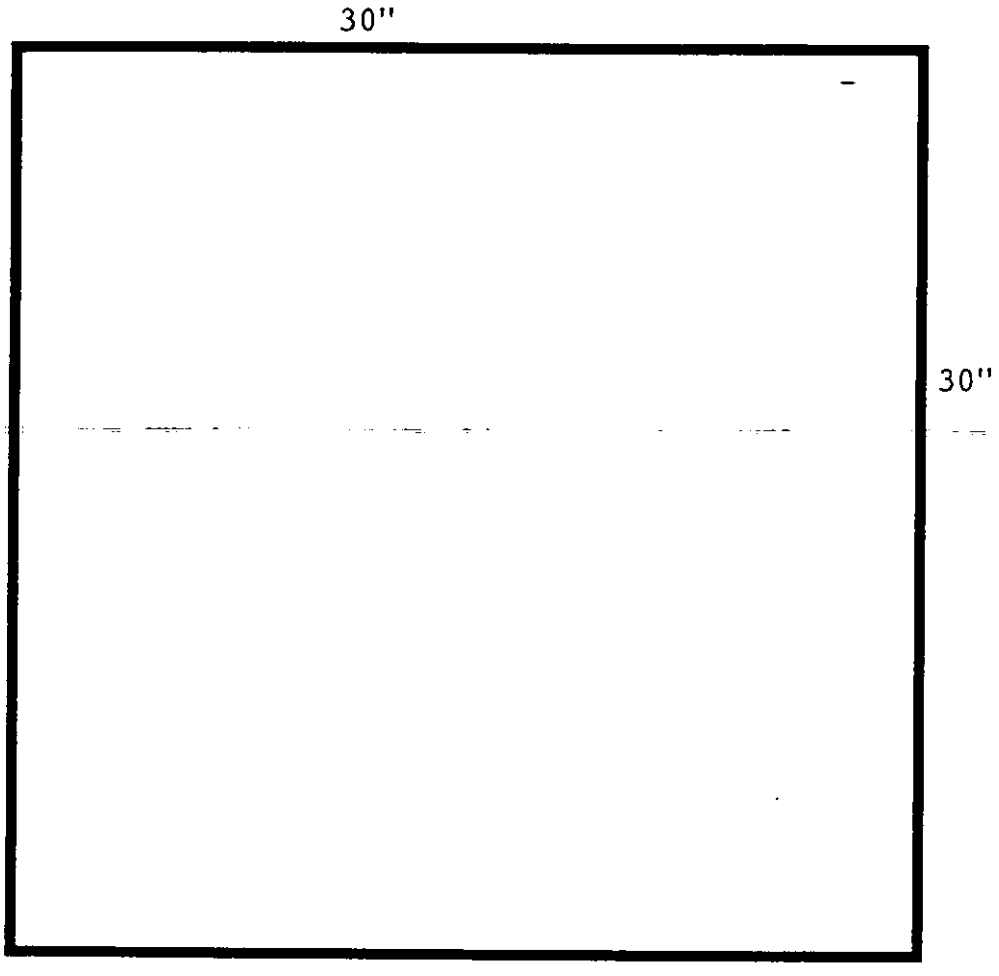
Particulate-sampling train.

LOCATION OF SAMPLING POINTS DURING PARTICULATE EMISSIONS TESTING

Distance A= >2 diameters

Distance B= 3.5 diameters

30"x30"



Sample Point #	Distance from Inside of Stack Wall (inches)	Sample Point #	Distance from Inside of Stack Wall (inches)
1	3.0"	Ports	3.8"
2	9.0"		11.3"
3	15.0"		18.8"
4	21.0"		26.3"
5	27.0"		

FORMULAS USED IN CALCULATIONS

Gas Volume Sampled - Standard cubic feet = Vmc

$$17.64 \times (Vm) \times (Y) \times \left(\frac{Pbar + \frac{\Delta H}{13.6}}{Tm} \right)$$

Volume of Water Vapor - Standard cubic feet =Vwc

$$Vlc \times \left(\frac{PH20}{MH20} \right) \times \left(\frac{RTstd}{Pstd} \right) = (0.0471 \text{ ft/ml}) \times Vlc$$

Stack Moisture Content - Bws

$$Bws = \frac{Vwc}{Vwc + Vmc}$$

Dry Molecular Weight - Md

$$Md = 0.44 \times (\%CO2) + 0.32 \times (\%02) + 0.28 \times (\%CO+N2)$$

Stack Gas Molecular Weight - Ms

$$Ms = 18 \times (Bws) + Md \times (1-Bws)$$

Average Stack Velocity - Vs

$$Vs = 85.48 \times (Cp) \times \sqrt{(\Delta P)} \times \sqrt{\frac{Ts + 460}{Ps \times Ms}}$$

Stack Gas Volumetric Flow Rate - SCFH

$$3600 \times (1-Bws) \times Vs \times A \times \left(\frac{Tstd}{Ts} \right) \times \left(\frac{Ps}{Pstd} \right)$$

Isokinicity %

$$\frac{TS \times (1.667) \times (Vwc + Vmc)}{(min.) \times (17.64) \times Ps \times Vs \times Atip}$$

Stack Particulate Concentration - Pounds/hour

$$2.205 \times 10^{-6} \left(\frac{Mn}{Vm\ std} \right) \times SCFH$$

Grains/standard cu ft

$$0.0154 \left(\frac{Mn}{Vm\ std} \right)$$

Y = Calibration factor of sampling train

Pbar = Barometric pressure

R Tstd = 460 + 68 = 528

Pstd = 29.92 in Hg

Cp = Pitot tube coefficient

Ps = Stack static pressure + Pbar

A = Area of stack - sq ft

min = Minutes of test

Atip = Area of sampling nozzle sq ft

Mn = Weight gain of filter + probe wash

Vlc = Volume of liquid and silica collected

VOLUME OF GAS SAMPLED AT STANDARD CONDITIONS

$$Vm\ (std) = Vm \bullet 17.64 \bullet \frac{Pbar + \frac{\hat{}H}{13.6}}{Tm} \bullet Y$$

Vm (std)	=	Volume of gas collected , corrected to standard conditions, cuft
Vm	=	volume of gas sampled at meter box, cuft
17.64	=	standard temperature, 528 Rankine / std pressure, 29.92
Tm	=	Average dry gas meter temperature, + 460 Rankine
Pbar	=	Barometric pressure, inches of mercury (Hg)
^H	=	Average pressure differential across orifice
13.6	=	Specific gravity of mercury
Y	=	Calibration factor of meter box
Run Number		1

$$Vm\ (std) = 40.285 \bullet 17.64 \bullet \frac{29.95 + \frac{1.52}{13.6}}{544} \bullet 1$$

Vm (std) = 39.270

VOLUME OF WATER VAPOR COLLECTED AT STANDARD CONDITIONS

$$Vw(std) = Vlc \bullet \frac{P\ H2O}{M\ H2O} \bullet \frac{R\ Tstd}{Pstd} = K2 \bullet Vlc$$

Vlc = volume of water and silica collected

P H2O = density of water, 0.002201 lb/ml

M H2O = molecular weight of water , 18.01b/lb-mole

R = ideal gas constant, 21.85 in. Hg-ft3/R-lb-mole

Tstd = standard absolute temperature, 528 R

Pstd = standard absolute pressure, 29.92 in. Hg

k2 = 0.0471 ft3 / ml

RUN NUMBER 1

Vw(std) = 125 + 7 • 0.0471

Vw scf = 6.217

STACK MOISTURE CONTENT

$$Bws = \frac{Vw(std)}{Vm(std) + Vw(std)}$$

Bws = water vapor in the gas stream, proportion

Vw(std) = volume of water vapor in the gas sample, scf

Vm(std) = volume of gas sampled at meter box, scf

RUN NUMBER 1

$$Bws = \frac{6.217}{39.27 + 6.217}$$

Bws = 0.137

DETERMINATION OF DRY MOLECULAR WEIGHT OF STACK GAS

$$Md = 0.44\ (\%CO2) + 0.32\ (\%O2) + 0.28\ (\%N2 + \%CO)$$

Md = dry molecular weight, lb / lb-mole

0.44 = molecular weight of CO2 divided by 100

0.32 = molecular weight of O2 divided by 100

0.28 = molecular weight of N2 or CO divided by 100

CO2, O2, N2, and CO are in percent by volume, dry basis

RUN NUMBER 1

$$Md = .44 * 0 + .32 \bullet 21 + .28 \bullet 79$$

$$Md = 28.840$$

DETERMINATION OF STACK GAS MOLECULAR WEIGHT

$$Ms = Md \bullet (1 - Bws) + M\ H2O \bullet (Bws)$$

Ms = molecular weight of gas, wet basis, lb / lb-mole

M H2O = molecular weight of water, 18 lb / lb-mole

RUN NUMBER 1

$$Ms = 28.84 \bullet (1 - .137) + 18 \bullet .137$$

$$Ms = 27.355$$

AVERAGE GAS STACK VELOCITY, ft/sec

$$Vs = 85.49 \bullet Cp \bullet \hat{}P * \text{sq rt} \frac{Ts + 460}{Ps * Ms}$$

Vs = average stack gas velocity, ft / sec

85.49 = pitot tube constant, ft / sec

Cp = pitot tube coefficient, dimensionless

^P = velocity head of stack gas, avg sq rt

Ts = temperature of stack gas, + 460 (Rankine)

Ps = absolute stack gas pressure, barometric + static

Ms = molecular weight of stack gas, wet basis

RUN NUMBER 1

$$Vs = 85.49 * .84 * 1.323 * \text{sq rt} \frac{647}{29.965 \bullet 27.355}$$

Vs ft/sec = 84.408

STACK GAS VOLUMETRIC FLOW RATE - SCFH

$$3600 \bullet (1 - Bws) \bullet Vs \bullet A \bullet \frac{Tstd}{Ts} \bullet \frac{Ps}{Pstd}$$

3600 = seconds per hour

Bws = water vapor in the gas stream, proportion

A = area of stack in sq ft

Tstd = standard absolute temperature, 528 R

Pstd = standard absolute pressure, 29.92 in. Hg

RUN NUMBER 1

$$3600 \bullet (1 - .137) \bullet 84.408 \bullet 6.25 \bullet \frac{528}{647} \bullet \frac{29.965}{29.92}$$

Q scfh = 1339551

ISOKINICITY %

$$\frac{K4 * Ts \bullet Vm(std)}{Ps \bullet Vs \bullet An * Min \bullet (1-Bws)} = ISOKINICITY$$

K4	=	0.09450 for English units
Ts	=	stack temperature + 460 R
Vm(std)	=	volume of gas collected, scf
Ps	=	stack pressure, inches Hg
Vs	=	stack velocity, ft / sec
An	=	area of the sampling nozzle, cuft
Min	=	minutes of test
Bws	=	water vapor in the gas stream, proportion

RUN NUMBER 1

$$\frac{0.0945 * 647 * 39.27}{29.965 * 84.408 * .0001907 * 60 * .863}$$

ISOKINICITY % = 96.1

STACK PARTICULATE CONCENTRATION

$$2.205 * E\text{-}6 \bullet \frac{Mn}{Vm\ std} \bullet scfh = \text{pounds per hour}$$

$$0.0154 \bullet \frac{Mn}{Vm\ std} = \text{grains per standard cu ft}$$

2.205 • E-6	=	conversion from mg to lbs
Mn	=	weight gain of filter and wash minus bl
scfh	=	standard stack volumetric flow rate
Vm std	=	volume of air sampled at stp
0.0154	=	conversion to grains from mg

RUN NUMBER 1

$$2.205 \bullet E\text{-}6 \bullet \frac{141.85}{39.27} \bullet 1339551$$

Pounds per hour = 10.67

$$0.0154 * \frac{141.85}{39.27}$$

Grains per standard cu ft = 0.0556

QUALITY CONTROL/QUALITY ASSURANCE

All equipment was fully calibrated at our laboratory prior to the test. The sampling nozzles were measured using a vernier caliper. The pitots were measured for proper alignment and dimensions. All thermometers and thermocouples were calibrated against ASTM glass thermometers. The RAC base units are checked in the field by comparison of a 10 minute run at 0.75 cfm (ΔH) to dry gas meter integration and single point check against critical orifice. Blank solutions (acetone, distilled water) are taken and analyzed at the laboratory to see if they are within specifications. A chain of custody was maintained by the field supervisor from the start of the test program to its completion. When the samples were returned to the laboratory they were placed under the control of the laboratory supervisor until analysis is completed.

1 FIELD TEST DATA SHEETS

A.E. SERVICES, INC.

PARTICULATE SAMPLE DATA SHEET
(Method 5)

Location: Verhoff Ottawa
Stack: outlet
Operator: Dave R
Date: 6-22-95
Run Number: 1
Pitot Tube Coeff.: .84 I#
Area of Stack: 30x30 6.25

Ambient Temp.: 75
Barometric Pres.: 29.95
Assumed Moisture %: 15%
Heater Box Setting: 248±25
Probe Length & No.: 3'SS I#
Nozzle Diameter & No. A .187 I#.000/907
Probe Heater Setting: 248±25

Avg. Fyrite Analysis: 0 % CO_2 21.0 % O_2

Additional Information:

	START	STOP
A	8:27	8:42
B	8:47	9:02
C	9:05	9:20
D	9:22	9:37

STATIC PRESSURE "H2O (Ps) _____ = "Hg. 1.015

LEAK CHECK "Hg Initial .005 10" Final .005 9"

PITOT LEAK CHECK Initial HR 7" Final OK

10 MIN. CHECK Final _____ Initial _____

Witnessed by _____

Base Unit # Gradelog #2
Y = 1.00
ΔH = 1.902

Pt. #	Time Min.	Stack temp f	ΔP	√ΔP	.86 x ΔH	Gas Sample Volume ft	Dry gas temp. inlet °f	Dry gas temp. outlet °f	Probe temp. °f	Box temp. °f	Vac. "Hg	Imp. gas temp. °f
A 1	3	194	1.8	1.342	1.55	519.223	82	76	263	261	3.0	67
2	6	195	1.6	1.265	1.40	21.1	83	77	260	260	3.0	68
3	9	195	1.65	1.285	1.45	23.1	83	77	261	262	3.0	67
4	12	191	1.75	1.323	1.50	25.0	84	78	261	262	3.5	67
5	15	190	1.75	1.323	1.50	27.2	84	78	261	262	3.5	68
B 1		188	1.90	1.328	1.65	529.140	84	80	261	263	4.0	67
2		188	1.90	1.328	1.65	31.2	85	80	263	261	4.0	68
3		188	1.90	1.378	1.65	33.2	86	80	262	264	4.00	67
4		184	2.00	1.414	1.75	35.5	87	81	242	248	4.00	68
5		185	1.90	1.378	1.65	37.3	86	81	232	237	4.0	68
C 1		185	1.70	1.304	1.45	539.575	87	81	232	227	3.5	68
2		186	1.80	1.342	1.55	41.4	87	81	232	232	3.5	68
3		187	1.80	1.342	1.55	43.4	87	81	232	231	3.5	68
4		184	1.85	1.360	1.60	45.6	87	82	232	230	3.5	68
5		184	1.80	1.342	1.55	47.7	89	83	231	230	4.0	69
D 1		183	1.60	1.265	1.40	549.783	89	82	230	231	3.5	69
2		183	1.70	1.304	1.45	51.7	90	83	232	230	3.5	69
3		182	1.65	1.285	1.45	53.7	90	84	232	231	4.0	69
4		181	1.50	1.225	1.30	55.6	91	84	231	231	3.5	69
5		182	1.60	1.225	1.30	57.4	91	84	231	232	3.5	69
						559.508						
total		3735					avg 87	avg 81				
Avg.		187		1.323	1.52	1.285	Avg 84	544				

1.47

A.E. SERVICES, INC.

PARTICULATE SAMPLE DATA SHEET
(Method 5)

Location: Verhoff Ottawa
Stack: outlet
Operator: Dauch
Date: 6-22-95
Run Number: 2
Pitot Tube Coeff.: .84 I#
Area of Stack: 30x30 6.25

Ambient Temp.: 80
Barometric Pres.: 29.95
Assumed Moisture %: 15%
Heater Box Setting: 248±5
Probe Length & No.: 3'ss B I#
Nozzle Diameter & No.: .185 I# .00018466
Probe Heater Setting: 248±25

Avg. Fyrite Analysis: 0 % CO_2 21.0 % O_2

Additional Information:

	START	STOP
A	9[5]8	10:13
B	10:14	10:29
C	10:30	10:45
D	10:46	11:01

STATIC PRESSURE "H2O (Ps) ____ = "Hg. +.015

LEAK CHECK "Hg
Initial .014 10"
Final 011 9"

PITOT LEAK CHECK
Initial ok at 3.5
Final ok

10 MIN. CHECK
Final
Initial

Base Unit # Grasely #2
Y = 1.00
ΔH = 1.902

Witnessed by ____

Pt. #	Time Min.	Stack temp f	ΔP	√ΔP	ΔH	Gas Sample Volume ft	Dry gas temp. inlet °f	Dry gas temp. outlet °f	Probe temp. °f	Box temp. °f	Vac. "Hg	Imp. gas temp. °f
A 1	3	181	1.65	1.28	1.45	559.775	91	86	231	231	3.0	68
2	6	182	1.7	1.30	1.50	61.6	89	86	232	235	3.0	68
3	9	180	1.70	1.30	1.50	64.0	90	87	232	232	3.0	65
4	12	178	1.60	1.26	1.40	65.9	92	87	231	231	3.0	65
5	15	178	1.45	1.20	1.25	67.8	92	87	231	230	3.0	66
B 1		180	1.80	1.34	1.55	569.723	93	87	232	232	3.0	66
2		180	1.90	1.38	1.65	71.7	94	88	232	236	3.0	67
3		179	2.00	1.41	1.75	73.8	95	88	232	230	3.0	68
4		180	2.00	1.41	1.75	76.0	95	89	231	236	3.0	68
5		180	1.90	1.38	1.65	78.2	96	89	231	229	3.0	68
C 1		179	1.90	1.38	1.65	580.406	96	89	232	232	3.5	68
2		180	1.95	1.40	1.70	82.5	97	90	232	232	3.5	68
3		180	2.05	1.43	1.75	84.7	98	90	232	230	3.5	68
4		181	2.05	1.43	1.75	86.8	98	91	232	231	3.5	68
5		180	1.95	1.40	1.70	89.0	99	91	232	230	3.5	68
1 D		181	1.90	1.38	1.65	591.261	98	92	232	230	3.5	68
2		183	1.75	1.32	1.50	93.3	99	92	232	231	3.5	69
3		183	1.65	1.28	1.45	95.4	99	92	232	231	3.5	69
4		183	1.65	1.28	1.45	97.4	100	93	232	232	3.5	69
5		183	1.50	1.22	1.30	99.4	101	93	232	229	3.5	69
						601.419						
total		3610		26.78	31.35		avg. 96	avg. 89				
Avg.		181		1.34	1.57	.644	Avg 93	553				

1041

A.E. SERVICES, INC.

PARTICULATE SAMPLE DATA SHEET
(Method 5)

Location: Verhoff Ottawa
Stack: Dryer Outlet
Operator: D Daub
Date: 6-22-95
Run Number: 3
Pitot Tube Coeff.: .84 I#
Area of Stack: 30 x 30 6.25

Ambient Temp.: 80
Barometric Pres.: 29.95
Assumed Moisture %: 15%
Heater Box Setting: 248±25
Probe Length & No.: 3'SS C I#
Nozzle Diameter & No.: .190 I#.000/1968
Probe Heater Setting: 248±25

Avg. Fyrite Analysis:
0.0 % CO_2 21.0 % O_2

Additional Information:

	START	STOP
A	11:21	11:36
B	11:37	11:52
C	11:53	12:08
D	12:09	12:24

Base Unit # Conarky #2

STATIC PRESSURE "H2O (Ps)
= "Hg. +.015

LEAK CHECK "Hg
Initial .009 9"
Final .032 9"

PITOT LEAK CHECK
Initial ok
Final ok

10 MIN. CHECK
Final
Initial

Witnessed by

Pt. #	Time Min.	Stack temp f	ΔP	√ΔP	.90 x ΔH	Gas Sample Volume ft	Dry gas temp. inlet °f	Dry gas temp. outlet °f	Probe temp. °f	Box temp. °f	Vac. "Hg	Imp. gas temp. °f
1 A	3	184	1.90	1.378	1.70	601.882	98	95	240	233	3.5	73
2	6	186	1.80	1.342	1.60	3.9	96	95	234	229	3.5	73
3	9	186	1.70	1.30	1.50	6.1	99	95	229	232	3.5	71
4	12	184	1.75	1.32	1.55	8.1	99	95	232	231	3.5	70
5	15	186	1.60	1.26	1.45	10.2	101	95	232	231	3.5	69
1 B		185	1.90	1.38	1.70	612.287	101	96	235	233	4.0	73
2		186	1.95	1.40	1.75	14.3	102	96	235	230	4.0	70
3		186	2.05	1.43	1.85	16.6	103	96	237	230	4.5	70
4		187	2.05	1.43	1.85	18.8	103	96	232	232	4.5	69
5		186	1.95	1.40	1.75	21.0	104	97	232	331	4.5	68
1 C		188	1.80	1.34	1.60	623.317	104	97	235	232	4.5	69
2		189	1.95	1.40	1.75	25.3	104	96	232	230	4.5	69
3		189	2.00	1.41	1.80	27.6	105	98	232	231	4.50	69
4		190	2.00	1.41	1.80	29.8	105	98	236	231	4.50	68
5		190	1.90	1.38	1.70	31.9	105	98	232	236	5.0	69
1 D		190	1.70	1.30	1.50	634.254	105	99	233	231	4.0	70
2		189	1.75	1.32	1.55	36.5	106	99	234	230	4.0	69
3		189	1.70	1.30	1.50	38.7	106	99	233	232	4.0	70
4		190	1.60	1.26	1.45	40.4	106	100	232	230	4.5	70
5		190	1.50	1.22	1.35	42.3	107	100	232	230	4.5	76
						644.23						
						41.521						
total		3750		26.98	32.7	412.541	avg. 103	avg. 97				
Avg.		188		1.35	1.64	= 72	Avg. 100	560				

1.48

Correct volume = 102.41

2 LABORATORY DATA SHEETS

PLANT NAME: VERHOFF ALFALFA (OTTAWA)

SOURCE I.D.: DRYER outlet DATE: 6-22-95

STACK PARTICULATE SAMPLE LABORATORY DATA SHEET

Run # 1

Lab Analysis by: Joe Tillingham

Date: 6-28-95

	FINAL WEIGHT mg	INITIAL WEIGHT mg	NET WEIGHT GAIN mg
Filter	664.2	575.9	88.3
Probe wash	104615.5	104561.8	53.7
Impingers	101048.8	101043.8	5.0

SILICA	IMPINGER
Final Weight = 557	Final Volume = 325
Initial Weight = 550	Initial Volume = 200
Total Gain 7	Total Gain 125

Total gain mg	147.0
Filter & Wash mg	142.0
- Acetone blank mg	-.15
Net Particulate Weight mg	141.85

Net particulate weight refers to the filter and wash minus the acetone blank.

PLANT NAME: VERHOFF ALFALFA (OTTAWA)

SOURCE I.D.: DRYER outlet DATE: 6-22-95

STACK PARTICULATE SAMPLE LABORATORY DATA SHEET

Run # 2

Lab Analysis by: Lee Tillingham

Date: 6-28-95

	FINAL WEIGHT mg	INITIAL WEIGHT mg	NET WEIGHT GAIN mg
Filter	652.2	573.1	79.1
Probe wash	103151.9	103108.0	43.9
Impingers	107365.1	107359.7	5.4

SILICA	IMPINGER
Final Weight = 560.5	Final Volume = 330
Initial Weight = 550	Initial Volume = 200
Total Gain 10.5	Total Gain 130

Total gain mg	128.4
Filter & Wash mg	123.0
- Acetone blank mg	-.15
Net Particulate Weight mg	122.85

Net particulate weight refers to the filter and wash minus the acetone blank.

PLANT NAME: VERHOFF ALFALFA (OTTAWA)

SOURCE I.D.: DRYER OUTLET DATE: 6-22-95

STACK PARTICULATE SAMPLE LABORATORY DATA SHEET

Run # 3

Lab Analysis by: Joe Gillingham

Date: 6-28-95

	FINAL WEIGHT mg	INITIAL WEIGHT mg	NET WEIGHT GAIN mg
Filter	654.4	574.6	79.8
Probe wash	104953.9	104916.0	37.9
Impingers	104645.2	104641.0	4.2

SILICA	IMPINGER
Final Weight = 558.5	Final Volume = 333
Initial Weight = 550	Initial Volume = 200
Total Gain 8.5	Total Gain 133

Total gain mg	121.9
Filter & Wash mg	117.7
- Acetone blank mg	-.15
Net Particulate Weight mg	117.55

Net particulate weight refers to the filter and wash minus the acetone blank.

3 COMPUTER CALCULATION SHEETS

AFFILIATED ENVIRONMENTAL SERVICES, INC.
3606 VENICE RD.
SANDUSKY, OHIO 44870

PLANT NAME: Verhoff Alfalfa (Ottawa)
SAMPLE LOCATION: Outlet
DATE OF TEST: 6-22-95

STACK SAMPLING PARAMETERS

TEST RUN NUMBER 1

MINUTES OF TEST	60
VOLUME OF GAS COLLECTED cubic feet	40.285
METER CALIBRATION FACTOR Y	1
BAROMETRIC PRESSURE	29.95
PRESSURE DIFFERENTIAL ACROSS ORIFICE delta H	1.52
METER TEMPERATURE (+460)	544
STACK STATIC PRESSURE (Hg)	.015
STACK TEMPERATURE (+460)	647
AVERAGE SQUARE ROOT OF VELOCITY HEAD	1.323
VOLUME OF IMPINGER WATER COLLECTED milliliters	125
WEIGHT OF SILICA COLLECTED grams	7
AREA OF SAMPLING NOZZLE square feet	.0001907
PITOT TUBE COEFFICIENT	.84
AREA OF STACK square feet	6.25
CARBON DIOXIDE (DRY FRACTION)	0
CARBON MONOXIDE (DRY FRACTION)	0
OXYGEN (DRY FRACTION)	21
NITROGEN (DRY FRACTION)	79

STACK PARTICULATE DATA

GAS VOLUME STANDARD CONDITIONS DSCF	39.27
VOLUME OF WATER VAPOR cubic feet	6.217
PERCENT MOISTURE IN STACK GAS	13.7
DRY GAS MOLECULAR WEIGHT	28.84
STACK GAS MOLECULAR WEIGHT	27.355
VELOCITY OF STACK GAS feet per second	84.408
FLOW RATE OF STACK GAS DSCFH	1339551
FLOW RATE OF STACK GAS DSCFM	22326
ISOKINICITY %	96.1
WEIGHT GAIN OF IMPINGERS mg	5
WEIGHT GAIN OF FILTER mg	88.3
WEIGHT GAIN OF PROBE WASH minus blank, mg	53.55
PARTICULATES COLLECTED POUNDS/HOUR	10.67
PARTICULATES COLLECTED GRAINS/DSCF	.0556
PARTICULATES COLLECTED POUNDS/DSCF	7.9648E-06

AFFILIATED ENVIRONMENTAL SERVICES, INC.
3606 VENICE RD.
SANDUSKY, OHIO 44870

PLANT NAME: Verhoff Alfalfa (Ottawa)
SAMPLE LOCATION: Outlet
DATE OF TEST: 6-22-95

STACK SAMPLING PARAMETERS

TEST RUN NUMBER 2

MINUTES OF TEST	60
VOLUME OF GAS COLLECTED cubic feet	41.644
METER CALIBRATION FACTOR Y	1
BAROMETRIC PRESSURE	29.95
PRESSURE DIFFERENTIAL ACROSS ORIFICE delta H	1.57
METER TEMPERATURE (+460)	553
STACK STATIC PRESSURE (Hg)	.015
STACK TEMPERATURE (+460)	641
AVERAGE SQUARE ROOT OF VELOCITY HEAD	1.34
VOLUME OF IMPINGER WATER COLLECTED milliliters	130
WEIGHT OF SILICA COLLECTED grams	10.5
AREA OF SAMPLING NOZZLE square feet	.0001866
PITOT TUBE COEFFICIENT	.84
AREA OF STACK square feet	6.25
CARBON DIOXIDE (DRY FRACTION)	0
CARBON MONOXIDE (DRY FRACTION)	0
OXYGEN (DRY FRACTION)	21
NITROGEN (DRY FRACTION)	79

STACK PARTICULATE DATA

GAS VOLUME STANDARD CONDITIONS DSCF	39.939
VOLUME OF WATER VAPOR cubic feet	6.618
PERCENT MOISTURE IN STACK GAS	14.2
DRY GAS MOLECULAR WEIGHT	28.84
STACK GAS MOLECULAR WEIGHT	27.301
VELOCITY OF STACK GAS feet per second	85.179
FLOW RATE OF STACK GAS DSCFH	1356535
FLOW RATE OF STACK GAS DSCFM	22609
ISOKINICITY %	98.7
WEIGHT GAIN OF IMPINGERS mg	5.4
WEIGHT GAIN OF FILTER mg	79.1
WEIGHT GAIN OF PROBE WASH minus blank, mg	43.75
PARTICULATES COLLECTED POUNDS/HOUR	9.2
PARTICULATES COLLECTED GRAINS/DSCF	.0474
PARTICULATES COLLECTED POUNDS/DSCF	6.7824E-06

AFFILIATED ENVIRONMENTAL SERVICES, INC.
3606 VENICE RD.
SANDUSKY, OHIO 44870

PLANT NAME: Verhoff Alfalfa (Ottawa)
SAMPLE LOCATION: Outlet
DATE OF TEST: 6-22-95

STACK SAMPLING PARAMETERS

TEST RUN NUMBER 3

MINUTES OF TEST	60
VOLUME OF GAS COLLECTED cubic feet	41.521
METER CALIBRATION FACTOR Y	1
BAROMETRIC PRESSURE	29.95
PRESSURE DIFFERENTIAL ACROSS ORIFICE delta H	1.64
METER TEMPERATURE (+460)	560
STACK STATIC PRESSURE (Hg)	.015
STACK TEMPERATURE (+460)	648
AVERAGE SQUARE ROOT OF VELOCITY HEAD	1.35
VOLUME OF IMPINGER WATER COLLECTED milliliters	133
WEIGHT OF SILICA COLLECTED grams	85
AREA OF SAMPLING NOZZLE square feet	.0001968
PITOT TUBE COEFFICIENT	.84
AREA OF STACK square feet	6.25
CARBON DIOXIDE (DRY FRACTION)	0
CARBON MONOXIDE (DRY FRACTION)	0
OXYGEN (DRY FRACTION)	21
NITROGEN (DRY FRACTION)	79

STACK PARTICULATE DATA

GAS VOLUME STANDARD CONDITIONS DSCF	39.33
VOLUME OF WATER VAPOR cubic feet	10.268
PERCENT MOISTURE IN STACK GAS	20.7
DRY GAS MOLECULAR WEIGHT	28.84
STACK GAS MOLECULAR WEIGHT	26.596
VELOCITY OF STACK GAS feet per second	87.418
FLOW RATE OF STACK GAS DSCFH	1272824
FLOW RATE OF STACK GAS DSCFM	21214
ISOKINICITY %	98.2
WEIGHT GAIN OF IMPINGERS mg	4.2
WEIGHT GAIN OF FILTER mg	79.8
WEIGHT GAIN OF PROBE WASH minus blank, mg	37.75
PARTICULATES COLLECTED POUNDS/HOUR	8.39
PARTICULATES COLLECTED GRAINS/DSCF	.046
PARTICULATES COLLECTED POUNDS/DSCF	6.5903E-06

4 CALIBRATION DATA

GRASEBY

CONTROL UNIT CALIBRATION
(English Units)

Date 6-6-95

Metering System Identification: 80875
DGM # 1348744

Barometric pressure, P_b = 28.99 in. Hg

Model Number 2010

Orifice manometer setting ΔH in. H_2O	Spirometer (wet meter) gas volume V_w ft^3	Dry gas meter volume V_m ft^3	Temperatures				Time Θ min
			Spirometer (wet meter) t_w °F	Dry Gas Meter			
				Inlet t_i °F	Outlet t_o °F	Average t_m °F	
1.0	5	5.010	75.0	80	77	78.5	8.84
2.0	5	4.998	76.0	81	77	79.0	6.45
4.0	5	5.002	75.0	84	77	80.5	4.56

Calculations

ΔH in. H_2O	Y	ΔH@
	$\frac{V_w P_b (t_m + 460)}{V_m \left[P_b + \frac{\Delta H}{13.6}\right](t_w + 460)}$	$\frac{0.0317\ \Delta H}{P_b(t_o + 460)} \left[\frac{(t_w + 460)\,\Theta}{V_w}\right]^2$
1.0	1.002	1.823
2.0	1.001	1.945
4.0	1.000	1.938
Average	1.001	1.902

Y = Ratio of reading of wet test meter to dry test meter; tolerance for individual values ±0.02 from average.

ΔH@ = Orifice pressure differential that equates to 0.75 cfm of air @ 68 °F and 29.92 inches of mercury, in. H_2O; tolerance for individual values ±0.20 from average.

Calibrated by: MDC

GRASEBY ANDERSEN
500 TECHNOLOGY CT., SMYRNA, GA 30082-5211, USA
TEL: 404 319 9999 FAX: 404 319 0336

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 4-27-95 Thermocouple number 3' SS

Ambient temperature 20 °C Barometric pressure 30.12 in. Hg

Calibrator [illegible] Reference: mercury-in-glass ASTM

other

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
3A	Boiling water	99.9	99	0.2
			1	0.3
	Ice Bath	0.2		
3B			98	0.5
			1	0.3
3C			99	0.2
			2	0.7

[a] Every 30°C (50°F) for each reference point.

[b] Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%$.

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 6-23-95 Thermocouple number Goosenecк

Ambient temperature 30 °C Barometric pressure 29.94 in. Hg

Calibrator D. Dauch Reference: mercury-in-glass ASTM

other

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
goosenecк #1	Boiling water	99.0	98.3	0.19%
	Ice Bath	0.3	0.0	0.1%
goosenecк #2	Boiling water	99.0	98.3	0.19%
	Ice Bath	0.3	0.6	0.11%

[a] Every 30°C (50°F) for each reference point.

[b] Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%$.

$\frac{372 - 371.3}{372}$

$\frac{273 - 273.0}{273}$

ANALYTICAL BALANCE CALIBRATION FORM

-Balance name Mettler Number #30

Classification of standard weights NIST

Date	0.1000 g	1.0000 g	10.000 g	50.0000 g	100.0000 g	Analyst
2-23-95	200.0				100,000.0	
2-24-95	200.0				100,000.0	
3-10-95	200.0				100,000.0	
3-17-95	200.0				100,000.0	on
3-23-95	200.0				100,000.0	on Pauch
4-3-95	200.0				100,000.0	On Pauch
4-7-95	200.0				100.000.0	
4-17-95	200.0				100.000.0	
4-24-95	200.0				100.000.0	
4-28-95	200.0				100.000.0	
5-08-95	200.0				100.000.0	
5-18-95	200.0				100.000.0	
5-23-95	200.0				100.000.0	Pauch
5-30-95	200.0				100,000.0	Pauch
6-6-95	200.0				100,000.0	Pauch
6-15-95	200.0				100,000.0	Pauch
6-23-95	200.0				100,000.0	Pauch
6-26-95	200.0				100,000.0	Pauch
6-25-95	200.0				100,000.0	Pauch

$\bar{X}$ AND R CHART

PROJECT NAME: Fyrite Calibration MEASUREMENT PERFORMED: AIR MEASUREMENT UNITS: Oxygen Percent v/v

DATE							
MEASUREMENT CODE	1						
	2						
	3						
MEASUREMENT RESULT	1	21.0	21.0	21.0	21.0	21.0	
	2	21.0	21.0	21.0	21.0	21.0	
	3	21.0	21.0	21.0	21.0	21.0	
SUM		63	63	63	63	63	
AVERAGE $\bar{X}$		21	21	21	21	21	
RANGE, R		0	0	0	0	0	

AVERAGES, $\bar{X}$: 21.5, 20.8, 20.1 — 20.8

RANGES, R

Comments (Correct Action, etc.)	6-12-95	6-20-95	6-21-95	6-22-95	6-26-95		
	K.I.	V.A.	P.E.	V.A.	G.M.		

TYPE S PITOT TUBE INSPECTION DATA FORM

Pitot tube assembly level? ✓ yes _____ no

Pitot tube openings damaged? _____ yes (explain below) ✓ no

α_1 = 2 ° (<10°), α_2 = 2 ° (<10°), β_1 = 2 ° (<5°),
β_2 = 1 ° (<5°)

γ = 2 °, θ = 1 °, A = 1.10 cm (in.)

z = A sin γ = 0.038 cm (in.); <0.32 cm (<1/8 in.),
w = A sin θ = 0.019 cm (in.); <.08 cm (<1/32 in.)

P_A 0.550 cm (in.) P_b 0.549 cm (in.)

D_t = 0.375 cm (in.)

Comments: 3'ss A 3-20-95
[signature] 5-3-95
0.84 5-31-95 [signature] 6-22-95

Calibration required? _____ yes ✓ no

TYPE S PITOT TUBE INSPECTION DATA FORM

Pitot tube assembly level? ✓ yes _____ no

Pitot tube openings damaged? _____ yes (explain below) ✓ no

α_1 = 2 ° (<10°), α_2 = 2 ° (<10°), β_1 = 1 ° (<5°),
β_2 = 2 ° (<5°)

γ = 1 °, θ = 1 °, A = 1.10 cm (in.)

z = A sin γ = 0.019 cm (in.); <0.32 cm (<1/8 in.),
w = A sin θ = 0.019 cm (in.); <.08 cm (<1/32 in.)

P_A 0.550 cm (in.) P_b 0.55 cm (in.)

D_t = 0.375 cm (in.)

Comments: 3' SS B 5-31-95
Worth Duck 10-22-95
assume 0.84

Calibration required? _____ yes X no

TYPE S PITOT TUBE INSPECTION DATA FORM

Pitot tube assembly level? ✓ yes _____ no

Pitot tube openings damaged? _____ yes (explain below) ✓ no

α_1 = 2 ° (<10°), α_2 = 2 ° (<10°), β_1 = 1 ° (<5°),

β_2 = 1 ° (<5°)

γ = 1 °, θ = 1 °, A = 1.10 cm (in.)

z = A sin γ = 0.019 cm (in.); <0.32 cm (<1/8 in.),

w = A sin θ = 0.019 cm (in.); <.08 cm (<1/32 in.)

P_A 0.55 cm (in.) P_b 0.54 cm (in.)

D_t = 0.376 cm (in.)

Comments: 3 SS C

3-20-95 5-3-95

(a) and (b) 0.84 5-31-95 6-22-95

Calibration required? _____ yes ✓ no

5 PLANT DATA

UERHOFF ALFALFA OTTAWA

6/22/95

TEST #1

WET HAY SCOOPS 15 x 2540# = 38100#

WATER APPROX. 1/2 GAL MIN = 240.0#
SAW DUST SCOOPS 1½ 3150#
DRY PELLETS 83 DUMPS 8300#

TEST #2

WET HAY SCOOPS 14 x 2540# = 35560#

WATER APPROX 1/2 GAL MIN 240.0#
SAW DUST SCOOPS 1½ = 3150#
DRY PELLETS 81 DUMPS 8100#

TEST #3

WET HAY SCOOPS 15 X 2540# = 38100

WATER ½ GAL MIN APPROX 240.0#
SAW DUST SCOOPS 1½ = 3150
DRY PELLETS 82 8200