AP42 Section:	11.7
Reference:	21
Title:	Report To American Standard On Stack Particulate Samples Collected At Tiffin, OH (Test Date August 19, 1992), Affiliated Environmental Services, Inc., Sandusky, OH, August 24, 1992.

R AP-42 Section 11.7
Reference 21
Report Sect. 4
Reference 19

affiliated Environmental services, inc.

American Standard Corp.
Attn: Mr. Dave Kiesel
324 Forth Ave.
Tiffin, OH 44883

REPORT TO AMERICAN STANDARD

ON

STACK PARTICULATE SAMPLES
COLLECTED AT
TIFFIN, OH

SUBMITTED BY

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

DATE OF TESTING: 8-19-92

DATE OF REPORT: 8-24-92

Joe Gillingham
FIELD TEST SUPERVISOR

Don Dauch
MANAGER, AIR SAMPLING DIVISION

RECEIVED

OCT 20 1992

OHIO E.P.A.
N.W.D.O.

3606 Venice Road • Sandusky, Ohio 44870 • (419) 627-1976 • FAX

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INTRODUCTION

This report contains the results of stack particulate emissions testing performed by Affiliated Environmental Services, Inc. for American Standard, Tiffin, OH. Testing was performed on 8-19-92. This is a Basin and Urinal spray line with 2 spray booths. The exhaust air is cleaned by a wet scrubber and air is vented out a 30" diameter stack. Production was monitored by American Standard personnel.

DESCRIPTION OF TEST

All tests were performed in accordance with EPA methods 1,2,3,4, and 5 as described in the federal register. A 20 point sampling set was selected due to the port locations. Each point was sampled for 3 minutes for a total time of a 60 minute test. The equipment used for testing consisted of a Fyrite Gas Analyzer and a RAC Stack Train Sampler (EPA type). A RAC type "S" pitot and heated stainless steel sampling probe was used with the sampling train. All equipment was calibrated in the lab prior to the test. The calculations for the stack sampling parameters were performed on a computer. A description of the method 1-5 test follows on the next few pages.

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

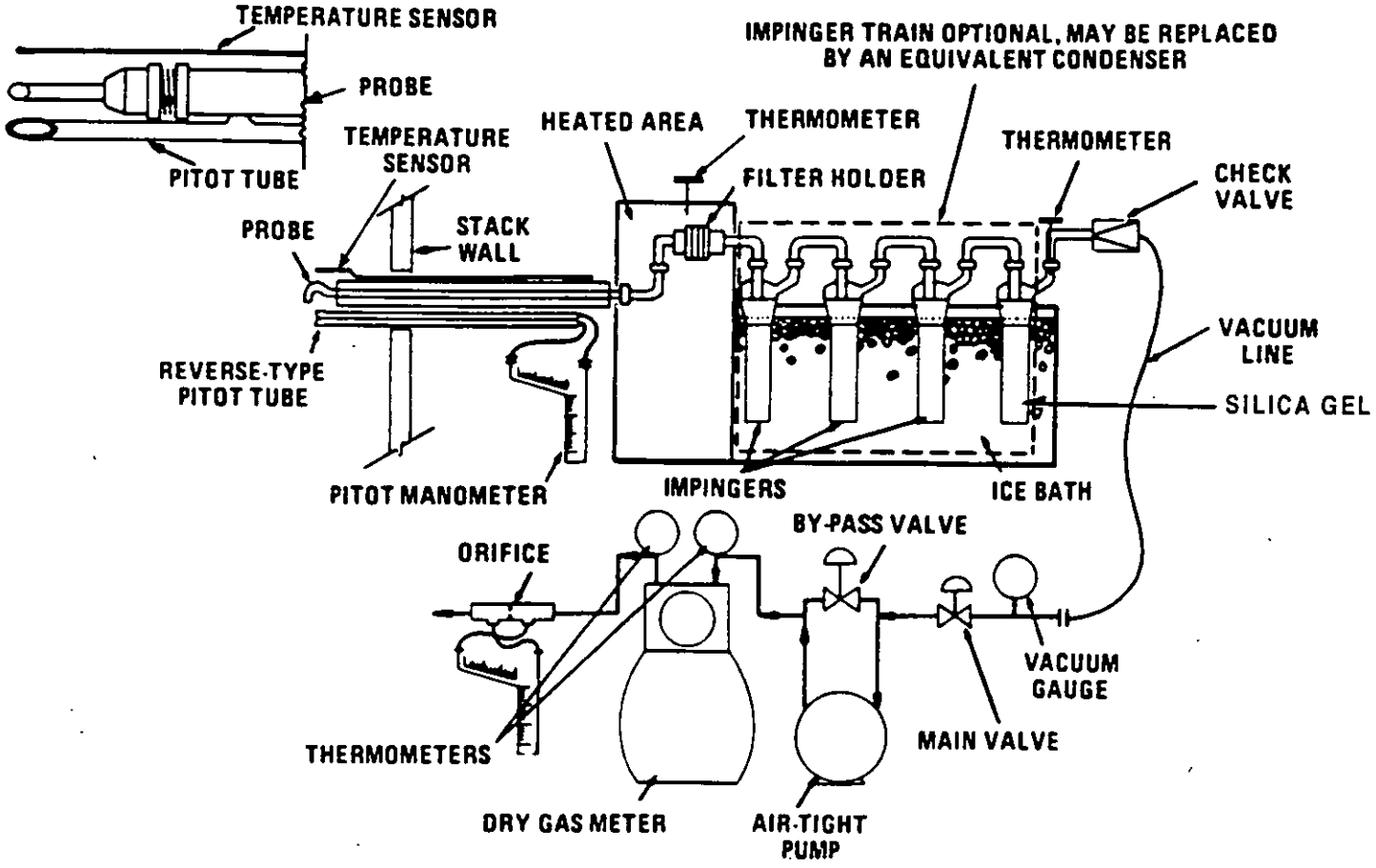
Determination of Moisture Content.

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.

Figure #1

STACK PARTICULATE DATA SHEET

Test No.	gr/dscf(A)	x10^{-6} lbs/dscf(B)	lbs/hr
1	0.0014	0.02002	.11
2	0.0033	0.04737	.26
3	0.0041	0.05929	.34

(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

Test No.	Flow Rate(A)	Temp. °F	Moisture %	CO_2 %	O_2 %	CO %
1	9.402	81	1.8	0.0	21.0	0
2	9.209	80	1.9	0.0	21.0	0
3	9.563	81	1.8	0.0	21.0	0

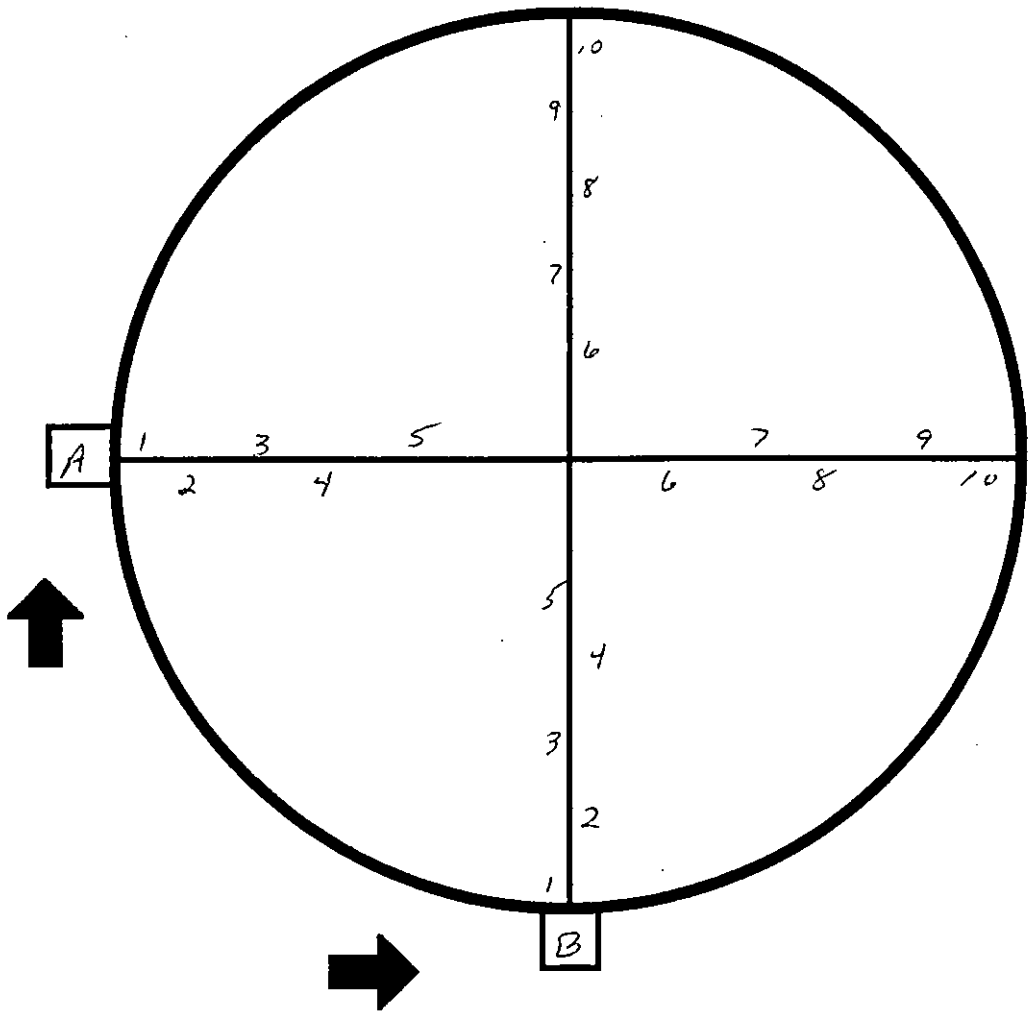
(A) = Dry standard cubic feet per minute at 68°F and 29.92 inches Hg

LOCATION OF SAMPLING POINTS DURING PARTICULATE EMISSIONS TESTING

Distance A= 1 d.iA

30" diameter Stack

Distance B= 3 d.iA



Sample Point #	Distance from Inside of Stack Wall (inches)	Sample Point #	Distance from Inside of Stack Wall (inches)
1	1.0"	6	19.7"
2	2.5"	7	23.2"
3	4.4"	8	25.6"
4	6.8"	9	27.5"
5	10.3"	10	29.0"

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.

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 collectec

PLANT NAME: American Standard

SOURCE I.D.: R-005 DATE: 8-19-92

STACK PARTICULATE SAMPLE LABORATORY DATA SHEET

Run # 1 Lab Analysis by: Don David

Date: 8-20-92 - 8-21-92

	FINAL WEIGHT mg	INITIAL WEIGHT mg	NET WEIGHT GAIN mg
Filter	616.5	614.9	1.6
Probe wash	102,574.2	102,572.2	2.0
Impingers	106,666.9	106,663.4	3.5

SILICA	IMPINGER
Final Weight = 550	Final Volume = 210
Initial Weight = 555	Initial Volume = 200
Total Gain 5gm	Total Gain 10ml

Total gain mg	7.1
Filter & Wash mg	3.6
- Acetone blank mg	-.15
Net Particulate Weight mg	3.45

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

PLANT NAME: American Standard

SOURCE I.D.: R-005 DATE: 8-19-92

STACK PARTICULATE SAMPLE LABORATORY DATA SHEET

Run # 2 Lab Analysis by: Don Dausch

Date: 8-20 - 8-21-92

	FINAL WEIGHT mg	INITIAL WEIGHT mg	NET WEIGHT GAIN mg
Filter	625.2	621.1	4.1
Probe wash	104,482.6	104,478.6	4.0
Impingers	107,816.2	107,812.4	3.8

SILICA	IMPINGER
Final Weight = 555	Final Volume = 210
Initial Weight = 550	Initial Volume = 200
Total Gain 5g	Total Gain 10ml

Total gain mg	11.9
Filter & Wash mg	8.1
- Acetone blank mg	- .15
Net Particulate Weight mg	7.95

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

PLANT NAME: American Standard

SOURCE I.D.: R-005 DATE: 8-19-92

STACK PARTICULATE SAMPLE LABORATORY DATA SHEET

Run # 3 Lab Analysis by: Don Daniels

Date: 8-20 - 8-21-92

	FINAL WEIGHT mg	INITIAL WEIGHT mg	NET WEIGHT GAIN mg
Filter	628.4	621.2	7.2
Probe wash	102,838.3	102,835.1	3.2
Impingers	107,242.4	107,234.6	7.8

SILICA	IMPINGER
Final Weight = 555	Final Volume = 210
Initial Weight = 550	Initial Volume = 200
Total Gain 5gm	Total Gain 10ml

Total gain mg	18.2
Filter & Wash mg	10.4
- Acetone blank mg	-.15
Net Particulate Weight mg	10.25

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

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

PLANT NAME: American Standard stack R005

DATE OF TEST: 8-19-92

STACK SAMPLING PARAMETERS

TEST RUN NUMBER 1

MINUTES OF TEST	60
VOLUME OF GAS COLLECTED cubic feet	39.801
METER CALIBRATION FACTOR Y	1
BAROMETRIC PRESSURE	30.1
PRESSURE DIFFERENTIAL ACROSS ORIFICE DELTA H	1.42
METER TEMPERATURE (+460)	558
STACK STATIC PRESSURE (HG)	.006
STACK TEMPERATURE (+460)	541
AVERAGE SQUARE ROOT OF VELOCITY HEAD	.582
VOLUME OF IMPINGER WATER COLLECTED ml	10
WEIGHT OF SILICA COLLECTED gms	5
AREA OF SAMPLING NOZZLE square feet	.0003409
PITOT TUBE COEFFICIENT	.84
AREA OF STACK square feet	4.909
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	38.004
VOLUME OF WATER VAPOR cubic feet	.707
PERCENT MOISTURE IN STACK GAS	1.8
DRY GAS MOLECULAR WEIGHT	28.84
STACK GAS MOLECULAR WEIGHT	28.645
VELOCITY OF STACK GAS feet per second	33.099
FLOW RATE OF STACK GAS DSCFH	564092
FLOW RATE OF STACK GAS DSCFM	9402
ISOKINICITY %	97.1
WEIGHT GAIN OF IMPINGERS mg	3.5
WEIGHT GAIN OF FILTER mg	1.6
WEIGHT GAIN OF PROBE WASH mg	2
PARTICULATES COLLECTED POUNDS/HOUR	.11
PARTICULATES COLLECTED GRAINS/DSCF	.0014
PARTICULATES COLLECTED POUNDS/DSCF	2.002E-07

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

PLANT NAME: American Standard stack R005

DATE OF TEST: 8-19-92

STACK SAMPLING PARAMETERS

TEST RUN NUMBER 2

MINUTES OF TEST	60
VOLUME OF GAS COLLECTED cubic feet	39.038
METER CALIBRATION FACTOR Y	1
BAROMETRIC PRESSURE	30.1
PRESSURE DIFFERENTIAL ACROSS ORIFICE DELTA H	1.35
METER TEMPERATURE (+460)	562
STACK STATIC PRESSURE (HG)	.006
STACK TEMPERATURE (+460)	540
AVERAGE SQUARE ROOT OF VELOCITY HEAD	.57
VOLUME OF IMPINGER WATER COLLECTED ml	10
WEIGHT OF SILICA COLLECTED gms	5
AREA OF SAMPLING NOZZLE square feet	.0003436
PITOT TUBE COEFFICIENT	.84
AREA OF STACK square feet	4.909
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	37.004
VOLUME OF WATER VAPOR cubic feet	.707
PERCENT MOISTURE IN STACK GAS	1.9
DRY GAS MOLECULAR WEIGHT	28.84
STACK GAS MOLECULAR WEIGHT	28.634
VELOCITY OF STACK GAS feet per second	32.393
FLOW RATE OF STACK GAS DSCFH	552519
FLOW RATE OF STACK GAS DSCFM	9209
ISOKINICITY %	95.7
WEIGHT GAIN OF IMPINGERS mg	3.8
WEIGHT GAIN OF FILTER mg	4.1
WEIGHT GAIN OF PROBE WASH mg	4
PARTICULATES COLLECTED POUNDS/HOUR	.26
PARTICULATES COLLECTED GRAINS/DSCF	.0033
PARTICULATES COLLECTED POUNDS/DSCF	4.737E-07

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

PLANT NAME: American Standard stack R005

DATE OF TEST: 8-19-92

STACK SAMPLING PARAMETERS

TEST RUN NUMBER 3

MINUTES OF TEST	60
VOLUME OF GAS COLLECTED cubic feet	40.496
METER CALIBRATION FACTOR Y	1
BAROMETRIC PRESSURE	30.1
PRESSURE DIFFERENTIAL ACROSS ORIFICE DELTA H	1.44
METER TEMPERATURE (+460)	566
STACK STATIC PRESSURE (HG)	.006
STACK TEMPERATURE (+460)	541
AVERAGE SQUARE ROOT OF VELOCITY HEAD	.592
VOLUME OF IMPINGER WATER COLLECTED ml	10
WEIGHT OF SILICA COLLECTED gms	5
AREA OF SAMPLING NOZZLE square feet	.0003409
PITOT TUBE COEFFICIENT	.84
AREA OF STACK square feet	4.909
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	38.123
VOLUME OF WATER VAPOR cubic feet	.707
PERCENT MOISTURE IN STACK GAS	1.8
DRY GAS MOLECULAR WEIGHT	28.84
STACK GAS MOLECULAR WEIGHT	28.645
VELOCITY OF STACK GAS feet per second	33.668
FLOW RATE OF STACK GAS DSCFH	573789
FLOW RATE OF STACK GAS DSCFM	9563
ISOKINICITY %	95.8
WEIGHT GAIN OF IMPINGERS mg	7.8
WEIGHT GAIN OF FILTER mg	7.2
WEIGHT GAIN OF PROBE WASH mg	3.2
PARTICULATES COLLECTED POUNDS/HOUR	.34
PARTICULATES COLLECTED GRAINS/DSCF	.0041
PARTICULATES COLLECTED POUNDS/DSCF	5.929E-07

(Method 5)

Location: American Standard
Stack: R-005
Operator: Joe Gillingham
Date: 8-19-92
Run Number: 1
Pitot Tube Coeff.: .84 /#
Area of Stack: 30" dia AREA = 4.909

Ambient Temp.: 60°
Barometric Pres.: 30.10
Assumed Moisture %: 3%
Heater Box Setting: 248
Probe Length & No.: 3' SS /#
Nozzle Diameter & No.: 1/4 .250 /# AREA .0003409
Probe Heater Setting: 248

0.0 % CO_2 21.0 % O_2

Additional Information:

START / STOP

A 8:19 – 8:49

B 8:50 – 9:20

Base Unit # 4

STATIC PRESSURE "H2O (Ps) .08 = "Hg. .0059

LEAK CHECK "Hg Initial .006 At 10" Final .006 At 10"

PITOT LEAK CHECK Initial OK Final OK

10 MIN. CHECK Final Initial

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
A1	0 – 3	81	.20	.447	.320	964.935	94	88	243	259	4.5	44
2	3 – 6	81	.27	.520	1.10	966.3	94	88	245	252	5.0	44
3	6 – 9	80	.27	.520	1.10	968.1	96	88	247	255	5.0	44
4	9 – 12	80	.27	.520	1.10	969.9	98	88	250	260	5.0	46
5	12 – 15	81	.29	.539	1.20	971.1	100	88	251	262	5.5	46
6	15 – 18	82	.36	.600	1.50	973.5	102	88	247	261	6.0	46
7	18 – 21	80	.38	.616	1.60	975.6	106	88	245	258	6.0	46
8	21 – 24	80	.40	.632	1.70	977.7	108	88	245	255	6.5	46
9	24 – 27	81	.42	.648	1.70	979.9	110	90	243	252	6.5	46
10	27 – 30	82	.38	.616	1.60	982.0	110	90	240	250	6.0	46
1B		81	.36	.600	1.50	984.2	106	90	244	250	6.0	48
2		81	.38	.616	1.60	986.2	108	90	249	248	6.0	48
3		82	.38	.616	1.60	988.3	110	90	251	245	6.0	48
4		82	.40	.632	1.70	990.4	110	90	258	253	6.5	48
5		81	.40	.632	1.70	992.6	110	90	257	250	6.5	48
6		81	.38	.616	1.60	994.8	112	92	260	250	6.0	50
7		81	.36	.600	1.50	997.0	112	92	258	253	6.0	50
8		80	.35	.592	1.40	999.0	112	92	261	256	6.0	50
9		80	.33	.574	1.30	1001.1	112	92	263	255	6.0	50
10		80	.25	.500	1.00	1002.9	112	92	259	254	5.5	50
						1004.736						
total		1617		11.636	28.32		avg.106	avg.90				
Avg.		81		.582	1.42	39.801	Avg %	558				

541

A.E. SERVICES, INC.

(Method 5)

0.0 %CO_2 21.0 %O_2

Location	AMERICAN STANDARD	Ambient Temp.	62°	Additional Information:	
Stack	R-005	Barometric Pres.	30.10	START	STOP
Operator	JOE GILLINGHAM	Assumed Moisture %	3%		
Date	8-19-92	Heater Box Setting	248 ± 25°	A 9:25	- 9:55
Run Number	2	Probe Length & No.	3' GLASS /#		
Pitot Tube Coeff.	.84 /#	Nozzle Diameter & No.	1/4 .257 /# AERA 0005436	B 9:56	- 10:26
Area of Stack	30" DIA AREA = 4.909	Probe Heater Setting	248 ± 25°		
				Base Unit #	4

STATIC PRESSURE "H2O (Ps) .05 = "Hg. .0059

LEAK CHECK "Hg Initial .005 AT 8" Final .006 AT 12"

PITOT LEAK CHECK Initial OK Final OK

10 MIN. CHECK Final Initial

Witnessed by

Pt. #	Time Min.	Stack temp f	Δ P	√ Δ P	Δ H	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
A1	0 - 3	81	.27	.520	1.10	5.303	100	90	243	251	6.0	46
2	3 - 6	81	.29	.539	1.20	7.1	102	90	245	250	6.0	46
3	6 - 9	80	.33	.574	1.30	8.8	104	90	251	258	7.0	40
4	9 - 12	80	.35	.592	1.40	10.7	106	92	254	260	7.5	40
5	12 - 15	80	.35	.592	1.40	12.7	108	92	258	261	7.5	40
6	15 - 18	81	.38	.616	1.60	14.8	110	92	260	260	8.0	40
7	18 - 21	80	.40	.632	1.70	16.8	110	92	234	257	8.5	40
8	21 - 24	80	.38	.616	1.60	18.9	112	92	237	260	8.5	40
9	24 - 27	79	.30	.548	1.20	21.0	112	92	256	258	7.0	42
10	27 - 30	80	.28	.529	1.10	23.0	112	94	257	260	6.5	42
1B		80	.38	.616	1.60	24.9	110	94	261	255	8.5	42
2		80	.40	.632	1.70	26.9	110	94	260	250	9.0	42
3		80	.40	.632	1.70	29.1	112	94	258	253	9.0	46
4		80	.37	.608	1.50	31.3	114	94	255	256	8.5	50
5		81	.36	.600	1.50	33.4	114	94	260	255	8.5	50
6		80	.31	.557	1.30	35.5	116	94	240	250	7.5	50
7		81	.27	.520	1.10	37.5	116	96	240	250	6.5	52
8		81	.25	.500	1.00	39.3	116	96	247	245	6.0	52
9		80	.25	.500	1.00	41.4	116	96	251	248	6.0	52
10		80	.23	.480	.940	42.7	116	96	250	250	6.0	52
						44.341						
total		1605		11.403	26.94		avg. 111	avg 93				
Avg.		80		.570	1.35	39.038	Avg. 102	562				

540

P-17

(Method 5) 0.0 %CO_2 21.0 %O_2

Location: AMERICAN STANDARD
Stack: 12-005
Operator: JOE GILLINGHAM
Date: 8-17-92
Run Number: 3
Pitot Tube Coeff.: .84 /#
Area of Stack: 30" dia AREA = 4.909

Ambient Temp.: 64°
Barometric Pres.: 30.10
Assumed Moisture %: 3%
Heater Box Setting: 248 ± 25°
Probe Length & No.: 3' SS /#
Nozzle Diameter & No.: .250 S/S /# AREA .0003409
Probe Heater Setting: 248 ± 25°

Additional Information:

START	STOP
A 10:33	11:03
B 11:04	11:34

Base Unit # 4

STATIC PRESSURE "H2O (Ps) .08 = "Hg. .0059

LEAK CHECK "Hg Initial .005 At 12" Final .003 At 14"

PITOT LEAK CHECK Initial OK Final OK

10 MIN. CHECK Final Initial

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	0 - 3	82	.38	.616	1.60	44.667	100	94	251	243	6.5	52
2	3 - 6	80	.42	.648	1.70	46.7	106	96	256	242	6.5	52
3	6 - 9	80	.42	.648	1.70	48.8	110	96	256	258	6.5	52
4	9 - 12	81	.40	.632	1.60	51.0	112	96	260	258	6.0	54
5	12 - 15	81	.40	.632	1.60	53.2	114	96	257	260	6.5	54
6	15 - 18	81	.34	.583	1.40	55.5	116	96	261	259	6.0	54
7	18 - 21	81	.28	.529	1.10	57.4	116	96	257	251	5.0	54
8	21 - 24	80	.25	.500	1.00	59.3	116	98	259	243	5.0	54
9	24 - 27	80	.27	.520	1.10	61.0	116	98	260	248	5.5	54
10	27 - 30	80	.27	.520	1.10	62.7	116	98	255	243	5.5	54
1 B		81	.36	.600	1.50	64.5	108	96	250	248	6.5	56
2		81	.40	.632	1.60	66.5	112	96	243	252	6.5	56
3		82	.40	.632	1.60	68.7	114	96	248	257	6.5	56
4		82	.41	.640	1.70	70.8	116	98	240	250	7.0	56
5		80	.40	.632	1.60	73.0	116	98	242	254	6.5	58
6		80	.38	.616	1.60	75.2	118	98	247	258	6.5	58
7		81	.36	.600	1.50	77.3	118	98	250	250	6.0	58
8		81	.35	.592	1.40	79.4	120	100	253	261	6.0	58
9		80	.30	.548	1.20	81.4	120	100	250	260	5.5	58
10		80	.28	.529	1.10	83.3	120	100	250	254	5.0	58
						85.163						
total		1614		11.849	28.7		avg. 114	avg. 97				
Avg.		81		.592	1.44	40.496	Avg. 106	566				

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APPENDIX

Date 7-3-92

Metering System Identification: #4

Barometric pressure, P_b = 29.8 in. H_g

Calibrated by:

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	
.5	7.726	7.944	74	98	84	91	20
1.0	12.605	13.329	74	114	100	107	23
1.5	12.925	13.856	74	120	104	112	20
2.0	14.667	15.868	74	122	108	115	20

CALCULATIONS

ΔH in. H_2O	Y $\frac{V_w P_b (t_m + 460)}{V_m \left[P_b + \frac{\Delta H}{13.6}\right] (t_w + 460)}$	ΔHθ $\frac{0.0317\ \Delta H}{P_b (t_o + 460)} \left[\frac{(t_w + 460)\ \theta}{V_w}\right]^2$
.5	Y = 1.00	ΔH = 1.87
1.0	Y = 1.00	ΔH = 1.80
1.5	Y = 1.00	ΔH = 1.93
2.0	Y = .99	ΔH = 1.99
Average	Y = 1.00	ΔH = 1.90

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

ΔHθ = 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.

Figure 5.6. Example data sheet for calibration of metering system (English units).

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 7-3-92 Thermocouple number 3'55

Ambient temperature 23 °C Barometric pressure 29.89 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	98	0.5
			1	0.3
3B	ice bath	0.2	98	0.5
			2	0.7
3C			99	0.5
			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 7-3-92 Thermocouple number RAC Meter Boxes

Ambient temperature 23 °C Barometric pressure 29.89 in. Hg

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

other _____

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °C	Thermocouple potentiometer temperature, °C	Temperature difference,[c] %
RAC #	Inlet	outlet		
1	73	74		
2	73	73		
3	74	74		
4	74	73		
6	73	74		

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

[b] Type of calibration system used.

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

NOZZLE CALIBRATION DATA FORM

Date 8-19-92 Calibrated by Joe Tillinghast

Nozzle identification number	Nozzle Diameter[a]			ΔD,[b] mm (in.)	D_{avg}[c]
	D_1, mm (in.)	D_2, mm (in.)	D_3, mm (in.)		
A	.250	.250	.250		.250
B	.251	.250	.251		.251
C	.250	.250	.251		.250

where:

[a] $D_{1,2,3}$ = three different nozzles diameters, mm (in.); each diameter must be within (0.025 mm) 0.001 in.

[b] ΔD = maximum difference between any two diameters, mm (in.), $\Delta D \leq$ (0.10 mm) 0.004 in.

[c] D_{avg} = average of D_1, D_2, and D_3.

ANALYTICAL BALANCE CALIBRATION FORM

Balance name Mettler Number H30

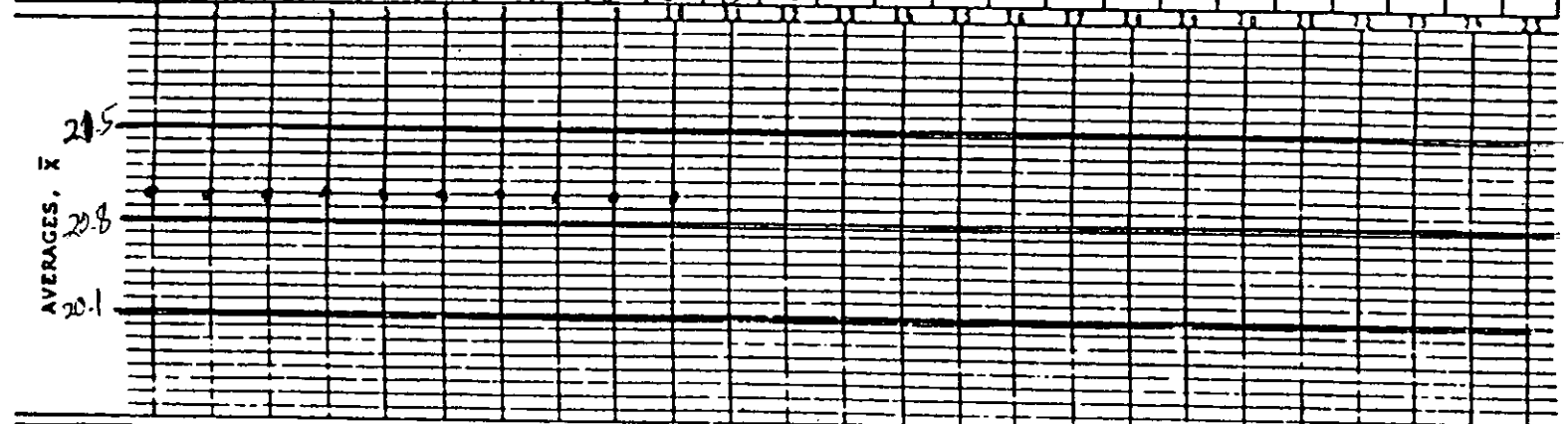
Classification of standard weights NBS

Date	0.2000 g	1.0000 g	10.000 g	50.0000 g	100.0000 g	Analyst
6-9-92	200.0	1.0000			100.0000	
6-11-92	200.0	1.0000			100.0000	
6-12-92	200.0	1.0000			100.0000	T.S.
6-15-92	200.0	1.0000			100.0000	
6-17-92	200.0	1.0000			100.0000	
6-18-92	200.0	1.0000			100.0000	
6-22-92	200.0	1.0000			100.0000	
6-30-92	200.0	1.0000			100.0000	JG
7-7-92	200.0	1.0000			100.0000	
7-13-92	200.0	1.0000			100.0000	JG
7-17-92	200.0	1.0000			100.0000	JG
7-20-92	200.0	1.0000			100.0000	TS
7-28-92	200.0	1.0000			100.0000	TS
8-4-92	200.0	1.0000			100.0000	TS
8-5-92	200.0	1.0000			100.0000	JG
8-6-92	200.0	1.0000			100.0001	
8-7-92	200.0	1.0000			100.0001	
8-10-92	200.0	1.0000			100.0001	
8-13-92	200.0	1.0000			100.0001	
8-19-92	200.0	1.0000			100.0001	
8-20-92	200.0	1.0000			100.0001	
8-21-92	200.0	1.0000			100.0001	JG

$\bar{X}$ AND R CHART

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

DATE														
MEASUREMENT CODE	1													
	2													
	3													
MEASUREMENT RESULT	1	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	
	2	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	
	3	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	
SUM		63.0	63.0	63.0	63.0	63.0	63.0	63.0	63.0	63.0	63.0	63.0	63.0	
AVERAGE $\bar{x}$		21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	
RANGE, R		0	0	0	0	0	0	0	0	0	0	0	0	



Comments (Correct Action, etc.)	6-19-92	6-24-92 new	7-2-92	7-15-92	8-3-92	8-4-92	8-5-92	8-6-92	8-11-92 new	8-17-92	8-20-92	8-21-92																		

TYPE S PITOT TUBE INSPECTION DATA FORM

Pitot tube assembly level? ✓ yes _____ no

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

α_1 = 3 ° (<10°), α_2 = 2 ° (<10°), β_1 = 1 ° (<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 0.551 cm (in.) P_b 0.549 cm (in.)

D_t = 0.375 cm (in.)

Comments: 3' SS A Don Daniel 6-2-92

Adjusted 0.49

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 0.552 cm (in.) P_b 0.545 cm (in.)

D_t = 0.375 cm (in.)

Comments: 3' SS R [illegible] 6-2-02

[illegible] 2 ea

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 = __2__ ° (<5°)

γ = __2__ °, θ = __1__ °, A = __1.10__ cm (in.)

$z = A \sin \gamma$ = __0.038__ cm (in.); <0.32 cm (<1/8 in.),

$w = A \sin \theta$ = __0.010__ cm (in.); <.08 cm (<1/32 in.)

P_A __0.550__ cm (in.) P_b __0.550__ cm (in.)

D_t = __0.375__ cm (in.)

Comments: [illegible]

Calibration required? _____ yes ___✓___ no