Background Report Reference

AP-42 Section Number: 12.15

Background Chapter: 4

Reference Number: 14

Title: Source Sampling Report for Johnson Controls, Inc., Winston-Salem, NC

Environmental Testing

1985

C (D) (2) lacked content explanation

EVALUATOR E Bowen EVALUATION DATE 8/6/92

METHOD 12: SECONDARY EMISSIONS TEST REPORT EVALUATION

STATE: NC FACILITY: Johnson Controls TEST DATE: 10-4-85

PROCESS(ES) TESTED: plate stacking, strap casting, & heat sealing assembly

SAMPLING DURATION 3
must have at least 3 runs, each ≥ 1 hour duration, with sampling ≥ 2 minutes at each traverse point, and total sampling volume ≥ 30 dscf

PRODUCTION RATE N/A
is process or production rate during testing representative of normal rates

CONTROL DEVICE(S) 3
are devices described, and their efficiencies given

None

METHOD 1 1
are calculations accurate, and is figure provided

METHODS 2,3 1
are data and calculations included for gas velocity, cyclonic flow, and molecular weight determination, and is source of barometric pressure noted

METHOD 4 —
are data and calculations included for moisture content determination, and is moisture content realistic (< saturation)

wet bulb/dry bulb

FIELD DATA —
is field data on standard forms, and does raw data correspond with printout

ISOKINETICS 3
within 100±10% for all runs

SAMPLING TEMPERATURE 2
both probe and filter must be maintained at 248 ± 25°F or other temperature specified in NSPS; temperature exiting last impinger ≤ 68°F

BACK-HALF 3
nitric acid used in first two impingers, silica gel in fourth
Use low metal glass filter okay for lead

EQUIPMENT 3
were a borosilicate glass probe liner and a quartz fiber filter used

CALIBRATION
were both pre- and post-test calibrations performed for:

meter box 3

pitot tube 2

temperature sensor 3

nozzle (3 #) 3

LEAK CHECKS 3
both pre- and post-test

BLANKS 2
were both filter and reagent blanks analyzed, and were any problems addressed

BOILER TESTS —
calculation of F_0 from Orsat accurate

3-Process ?

AP-42 Section: Storage Battery Production (7.15) Ref #: 2

Date: 5/15/92 Rating: C

Firm / Company: Johnson Controls, Inc. (Winston-Salem, NC)

Tested By: Environmental Testing, Inc.

Test Date: 10/4/85

Special Processes: RADCO is high efficiency particulate filters.

3-Process

a - Plate Stacking → RADCO UNIT →
b - Strap Casting → RADCO UNIT →
c - Heat Sealing → RADCO UNIT →

→ Abort Tunnel a stack (Sampling location) → Atmosphere

Test Conditions: Usual ☐ Unusual ☐

Sampling Method: 12

Sampling Location and Velocity methods: 1 & 2

Calibration Information: Yes ☒ No ☐

Results:

Run	% Isokinetic	Emission Rate (lbs/
1	105.9	0.0336
2	105	0.0685
3	104	0.0298
4		
Avg:	104.97	0.04397

Production Data: N/A

Source:

Emission Factors:

environmental testing inc.

THREE PROCESS OPERATION
RADCO

(2)

SOURCE SAMPLING REPORT

FOR

JOHNSON CONTROLS, INC.

Winston-Salem, North Carolina

Performed by:

ENVIRONMENTAL TESTING, INC.

Peter R. Hill
October 1985

10/22/85

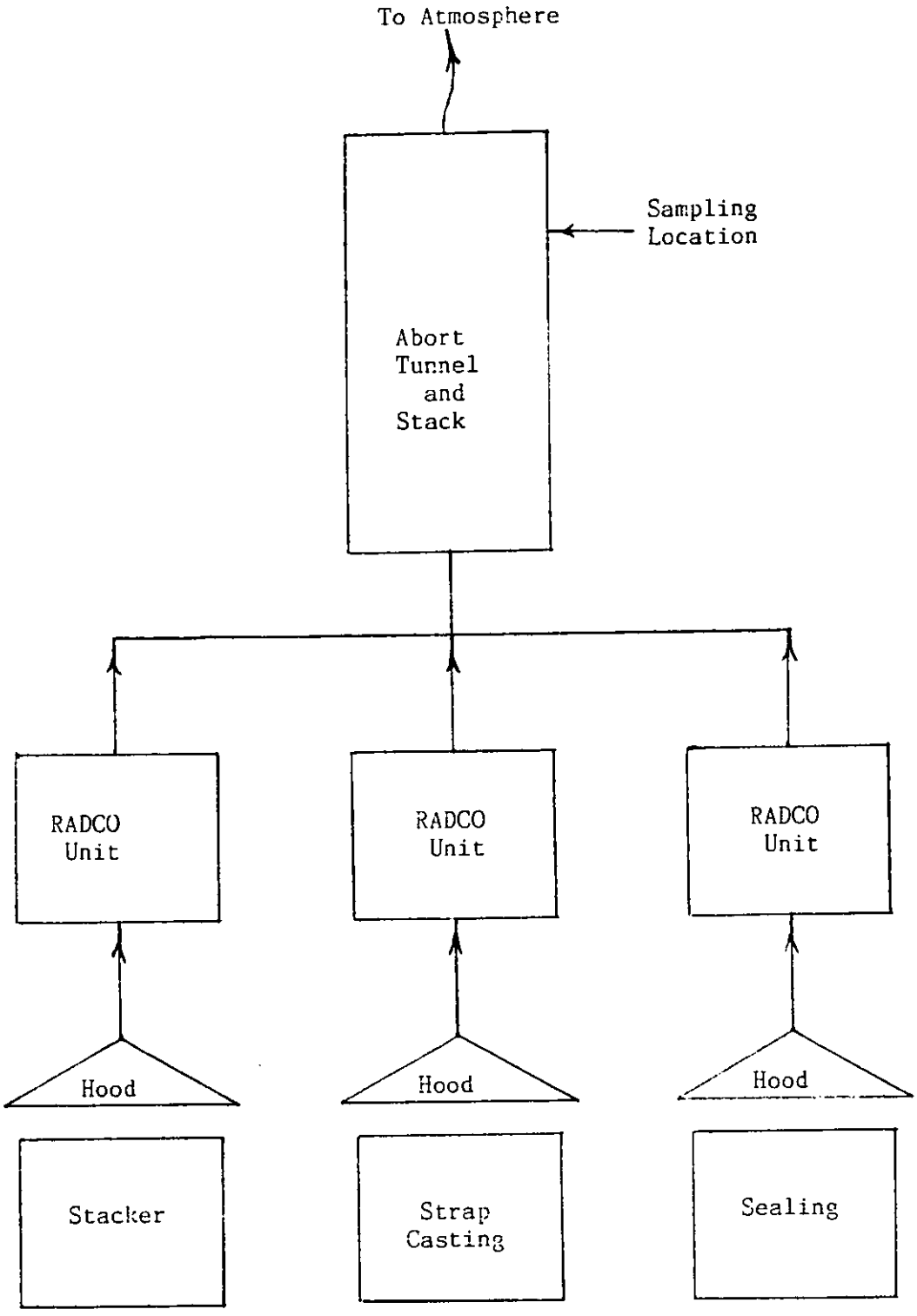
TABLE OF CONTENTS

INTRODUCTION

Source sampling was performed at Johnson Controls, Inc., Winston-Salem, North Carolina, on October 4, 1985, to determine lead emissions from the three process operation facility (plate stacking, strap casting, and heat sealing assembly). Three sampling runs were made at the location shown in Figure 1.

All measurements for stack gas flow rate, lead concentrations and emission rates were made in accordance with the recommendations of the U.S. Environmental Protection Agency and the Forsyth County Department of Environmental Affairs (FDEA). Mr. Kirk Rife, FDEA, was present as an observer.

The following sections of the report treat the summary of results as a description of the processes and their operation, the location of the sampling points, and the sampling and analytical procedures used.



FLOW DIAGRAM

Figure 2

SUMMARY OF RESULTS

Table 1 presents the summary of results of the lead sampling of the three process operation facility (plate stacking, strap casting and heat sealing assembly). The mean lead concentration was less than 0.000135 grains per dry standard cubic foot. The mean emission rate was less than 0.044 pounds per hour.

Based on 40 CFR 60, Subpart KK, "Standards of Performance for Lead-Acid Battery Manufacturing Plants", Section 60.372, Paragraph (a)(3), the three-process operation facility was in compliance with the allowable lead concentration of 0.00044 grains per dry stnadard cubic foot.

TABLE 1 COS RADCOS

Run Number	1	2	3
Date	10/4/85	10/4/85	10/4/85
% Isokinetic	105.9	105.0	104.1
Volume of Gas Sampled, SCF * Dry	35.299	33.761	33.658
Stack Gas Flow Rate, SCFM * Dry	39,023	37,789	38,007
Stack Gas Flow Rate, ACFM	42,421	40,889	41,407
Lead:			
Catch, mg	0.230	0.464	<0.200
Concentration, grains/ SCF * Dry X 10^{-4}	1.003 ✓	2.117 ✓	<0.938 ✓
Emission Rate, lbs/hr X 10-3	0.0336 ✓	0.0685 ✓	<0.0298 ✓

Incorrect ARE 6/27/88

*68°F, 29.92 in.Hg

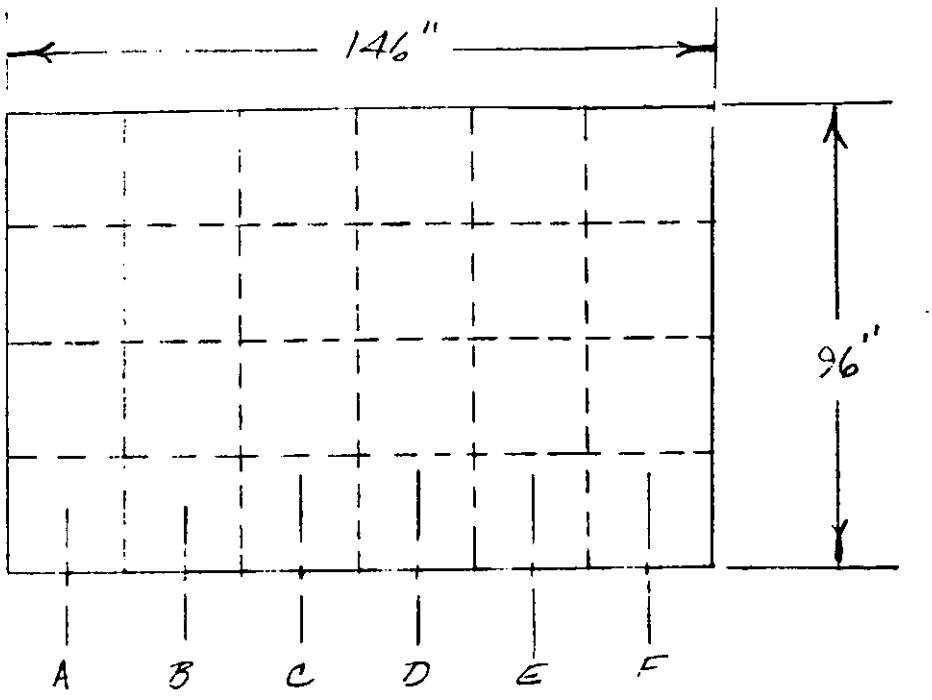
PROCESS DESCRIPTION

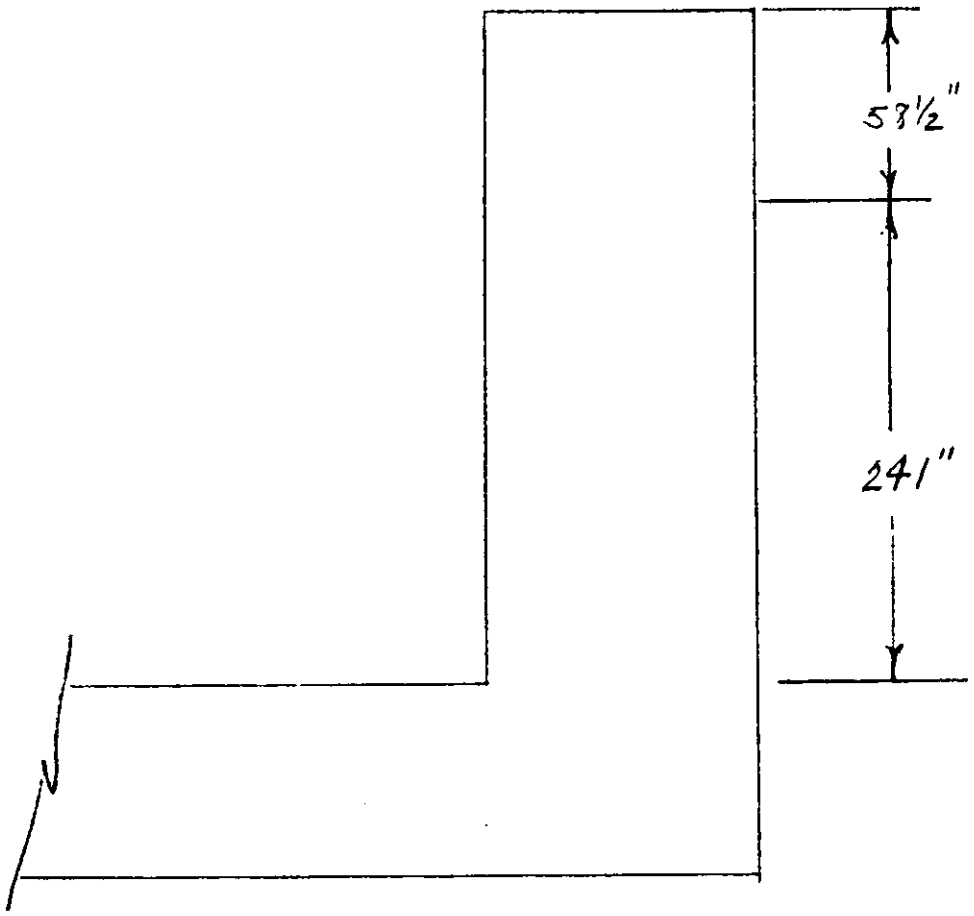
The three-process operation sampled consists of three operations: battery plate stacking, strap casting, and the heat sealing assembly. These operations are hooded and the exhaust air is ducted to high efficiency particulate filters (RADCO units) where the lead is removed and the filtered air is returned to the manufacturing area. Should filter failure occur in the RADCO units, the air is then ducted outside the building through an abort tunnel to the atmosphere. During sampling, all units were exhausted through the abort tunnel.

LOCATION OF SAMPLING POINTS

The dimensions of the stack and the location of the sampling points are shown in Figure 2. The sampling points were numbered as noted and lead sampling was performed at each point. Twenty four points were sampled for a period of $2\frac{1}{2}$ minutes each which yielded a total test time of 60 minutes.

The number of sampling points was determined by the distance of the sampling points from disturbances in the air flow as described in Method 1, Federal Register, Volume 48, Number 191, 30 September, 1983.





LOCATION OF SAMPLING POINTS

Figure 2

SAMPLING AND ANALYTICAL PROCEDURES

All sampling and analytical procedures used were those recommended by the U.S. Environmental Protection Agency and the Forsyth County Department of Environmental Affairs. Complete details are found in Appendix E which is a copy of the Federal Register, Volume 41, Number 160, 18 August 1977; Volume 48, Number 191, 30 September 1983; and Volume 47, Number 74, 16 April 1982.

Sample point locations and velocity measurements were made by Methods 1 and 2. The stack gas composition was determined by Method 3. On the first run the stack gases were proved to air. This was expected as there were no combustion sources in the process. Method 12 was used for lead determination.

APPENDICES

W/S 605

SUMMARY OF LEAD RESULTS APPENDIX A

JOHNSON CONTROLS - ABORT TUNNEL

RUN NUMBER		1	2	3
DATE		10/04/85	10/04/85	10/04/85
DN	SAMPLE NOZZLE DIA., IN	0.505	0.504	0.504
TT	NET TIME OF TEST, MIN	60	60	60
PB	BAROMETRIC PRESSURE, IN HG	29.11	29.11	29.11
PM	AVERAGE ORIFICE PRESSURE DROP, IN H2O	1.3338	1.2121	1.2675
VM	VOLUME OF DRY GAS SAMPLED CU FT AT METER CONDITIONS	36.97	35.78	36.11
TM	AVERAGE GAS METER TEMP DEGREES	78.17	85.88	92.67
VMSTD	VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS*, SCF	35.299	33.761	33.653
VW	TOTAL H20 COLLECTED IN IMPINGERS + SILICA GEL, ML	21.5	15.8	17.8
VMV	VOLUME OF WATER VAPOR AT STANDARD CONDITIONS*, SCF	1.012	0.744	0.838
PMV	PERCENT MOISTURE BY VOL	2.788	2.156	2.433
MD	MOLE FRACTION DRY GAS	0.9721	0.9784	0.9757
PCO2	PERCENT CO2 BY VOL., DRY	0.00	0.00	0.00
PO2	PERCENT O2 BY VOL., DRY	20.90	20.90	20.90
PCO	PERCENT CO BY VOL., DRY	0.00	0.00	0.00
PN2	PERCENT N2 BY VOL., DRY	79.10	79.10	79.10
MWD	MOLECULAR WT-DRY STK GAS	28.836	28.836	28.836
MW	MOLECULAR WT-STK GAS	28.534	28.602	28.573
CP	PITOT TUBE COEFFICIENT	0.84	0.84	0.84
DPS	AVERAGE VELOCITY HEAD OF STACK GAS, IN H20	0.1246	0.1202	0.1214
TS	AVERAGE STACK TEMPERATURE	82.63	83.63	83.83

PSI	STATIC PRES OF STK GAS IN HG	-0.0007	-0.0007	-0.0007
PS	STACK PRESSURE, ABSOLUTE	29.1093	29.1093	29.1093
VS	AV STK GAS VELOCITY, FPM	434.06	418.38	423.69
AS	STACK AREA , IN SQRD	14016	14016	14016
QS	STK FLOW RATE, DRY, STD COND.	39023.3	37738.7	38006.6
QSW	STK FLOW RATE, WET, STD COND.	40142.6	38621.3	38953.1
QA	ACTUAL STK FLOW RATE	42420.8	40888.6	41407.2
PERI	PERCENT ISOKINETIC	105.89	105.00	104.08
FMF	LEAD, MG, FRONT	0.230	0.464	<0.200
CAN	LEAD, GR/DSCF PARTIAL	1.003E-4	2.117E-4	<9.151E-5
CAM	LEAD, GR/WSCF PARTIAL	1.032E-4	2.163E-4	<9.379E-5
CAT	LEAD, GR/ACF PARTIAL	9.131E-5	1.956E-4	<8.399E-5
CAW	LEAD, LB/HR PARTIAL	0.0336	0.0685	<0.0298
FNP	NET SAMPLING POINTS	24	24	24

*68 DEG F. 29.92 IN HG

PARTICULATE - LEAD CALCULATIONS TEST 1

JOHNSON CONTROLS - ABORT TUNNEL

VOLUME OF DRY GAS SAMPLED AT STD. CONDITIONS

$$VMSTD = \frac{17.64 * VM * (PB + PM / 13.6)}{TM + 460} = 35.299$$

VOLUME OF WATER VAPOR AT STD. CONDITIONS

$VMV = .04709 * VW =$ 1.012

PERCENT MOISTURE IN STACK GAS

$$PMV = \frac{100 * VMV}{VMSTD + VMV} = 2.788$$

MOLE FRACTION OF DRY STACK GAS

$$MD = \frac{100 - PMV}{100} = 0.9721$$

AVERAGE MOLECULAR WEIGHT OF DRY STACK GAS

$MWD = .44 * PCO2 + .32 * PO2 + .28 *(PN2+PCO) =$ 28.836

MOLECULAR WEIGHT OF STACK GAS

$MW = MWD * MD + 18 * (1-MD) =$ 28.534

STACK GAS VELOCITY AT STACK CONDITIONS

$VS = 5129.4 * CP * DPS * SQRT(TS + 460)/(PS * MW) =$ 434.06

STACK GAS VOLUMETRIC FLOW AT STD. CONDITIONS, DRY

$$QS = \frac{.123 * VS * AS * PS * MD}{TS + 460} = 39023.3$$

STACK GAS VOLUMETRIC FLOW AT STACK CONDITIONS

$$QA = \frac{QS * (TS + 460)}{17.64 * PS * MD} = 42420.8$$

PERCENT ISOKINETIC

$$PERI = \frac{1039 * (TS + 460) * VMSTD}{VS * TT * PS * MD * DN * DN} = 105.89$$

LEAD LOADING -- PROBE, CYCLONE, FILTER
(AT STANDARD CONDITIONS)

$CAN = .0154 * FMF/VMSTD =$ 1.003 E-4

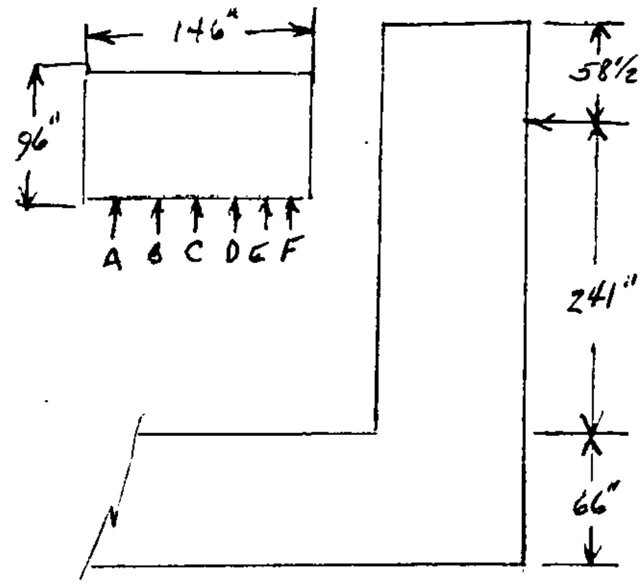
LEAD LOADING -- PROBE, CYCLONE, FILTER
(AT STACK CONDITIONS)

$$CAT = \frac{17.64 * CAN * PS * MD}{TS + 460} = 9.231\ E\text{-}5$$

LEAD LB/HR -- PROBE, CYCLONE, FILTER
(AT STACK CONDITIONS)

$$CAW = .00857 * CAN * QS = 0.0336$$

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS



Plant Johnson Controls

Date 10/1/85

Sampling location Abort Tunnel #49

Inside of far wall to outside of nipple (X) 96" x 146"

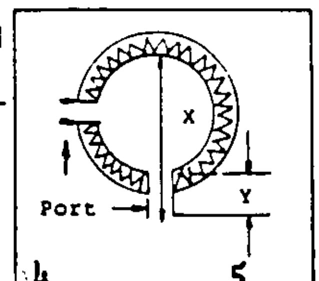
Inside of near wall to outside of nipple (nipple length) (Y) 0

Stack I.D. (X-Y) 96"

Nearest upstream disturbance 0.51 dd

Nearest downstream disturbance 2.08 dd

Calculated by PRH



SCHEMATIC OF SAMPLING LOCATION

1 TRAVERSE POINT NUMBER	2 FRACTION OF STACK I.D.	3 STACK I.D.	4 PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	5 NIPPLE LENGTH	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1		96"	12	0	12
2		↓	36	↓	36
3		↓	60	↓	60
4		↓	84	↓	84

Plant and city	Run date
Johnson Controls	1 10 / 1 : 14 / 8 15

Sampling location	Clock time
Ex. air	

Run number	Operator	Amb. temp., °F	Bar. press., in. Hg	Static press., in. H_2O
1	PRH	70°	29.11	-0.011

Molecular wt.	Stack inside dimension, in. Diam. or side 1	Stack inside dimension, in. side 2	Pitot tube (Cp)
	9 6"	1 4 6"	0.84

$\Delta H@$ 1.92
$Y = 1.00$
$T_m = 90$
$P_s/P_m = 1$
$D_b = 81$
$W_c = .69$
$\Delta = 12$
2% H_2O
$C = 1.15$
.024

Field data

Traverse point number	Position, in.	Velocity head (Δp_s), in. H_2O	Stack temp., °F	Cyclonic flow determination: Δp_s at 0° reference	Cyclonic flow determination: Angle (α) which yields a null Δp
A 1	12	.05	91		
2	36	.03			
3	60	.01			
4	84	.02			
B 1		.04			
2		.02			
3		.01			
4		.02			
C 1		.04			
2		.01			
3		.01			
4		.02			
D 1		.03			
2		.01			
3		.005			
4		.015			
E 1		.02			
2		.01			
3		.005			
4		.015			
F 1		.020			
2		.01			
3		.01			
4		.015		Average angle (α)[a]	—
		.0185			

[a] Average of (α) must be < 10 degrees to be acceptable.

Figure 1.7. Method 2 gas velocity and volume data form.

A B C D E F
0 0 0 0 0 0

12:00 Lunch

METHOD 5 PARTICULATE FIELD DATA

Plant Johnson Controls
Run No. 1
Location ~~AIR~~ ABERT TURBEL
Date 10/4/85
Operator PRH - FLH
Sample Box No. 4
Meter Box No. 1965
Filter No. 4
Probe No. 4
Pitot Tube Cp 0.84

Very Important — Fill In All Blanks
Leak Checks: Beg. @ 15" 0.006
End @ 6" 0.003
Pitot Tube: (+) 20.1 @ 4.1 "H2O
(-) 20.1 @ 4.1 "H2O
Static Pressure: -0.01 "H2O
Start: 0926
Finish: 1100
Observer K. Rice Agency

Bar. Press. "Hg 29.11
Meter Box ΔH@ 1.92 Y = 1.00
Assumed Tm, °F 90
Dry Bulb, °F 81
Wet Bulb, °F 69
Db - Wb, °F 12
Assumed Moisture % 2%
Ps/Pm 1.00
C Factor 1.15

Ambient Temp., °F 64
Heater Box Setting, °F 250°
Probe Tip Dia., in. 0.0505
Probe Length 8' steel
Probe Heater Setting 80%
Average Δp 0.0185 Δp 0.824
Average ΔH — ΔH Ref
Process Weight —
Steam Load —
Steam Pressure —

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in H_2O	Orifice Manometer (ΔH) in H_2O Desired	Orifice Manometer (ΔH) in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum in Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F	% CO_2	% O_2
A 1	0	357.50	0.05	3.70	3.70	66	66	4.5	240	52	82		
2	2½	360.15	.03	2.30	2.30	70	67	3.0	240	46	82		
3	5	362.27	.02	1.55	1.55	73	68	2.5	240	42	82		
4	7½	363.99	.015	1.15	1.15	75	68	2.0	250	48	82		
B 1	10/0	365.54	.045	3.35	3.35	75	69	4.0	255	50	82		
2	2½	368.03	.02	1.55	1.55	80	70	2.5	260	50	82		
3	5	369.71	.005	0.40	0.40	80	71	1.0	260	51	82		
4	7½	370.68	.015	1.15	1.15	80	72	1.5	260	44	82		
C 1	10/0	372.14	.04	3.00	3.00	80	73	4.0	265	52	82		
2	2½	374.47	.01	0.76	0.76	83	75	1.5	265	48	83		
3	5	375.73	.005	0.40	0.40	83	75	1.0	265	47	83		
4	7½	376.68	.02	1.55	1.55	84	76	2.0	265	47	83		
D 1	10/0	378.34	.03	2.30	2.30	78	78	3.0	230	46	83		
2	2½	380.38	.005	0.40	0.40	81	78	1.0	235	45	83		
3	5	381.39	.005	0.40	0.40	81	79	1.0	235	41	83		
4	7½	382.35	.01	0.76	0.76	82	79	1.0	240	42	83		
E 1	10/0	383.61	.02	1.55	1.55	82	80	2.0	250	55	82		
2	2½	385.37	.01	0.76	0.76	85	80	2.5	255	43	83		
3	5	386.67	.005	0.40	0.40	85	80	1.0	255	42	84		
4	7½	387.60	.01	0.76	0.76	86	81	1.0	265	43	83		
F 1	10/0	388.89	.015	1.15	1.15	85	82	2.0	260	50	83		
2	2½	390.37	.01	0.76	0.76	87	82	1.5	265	43	83		
3	5	391.64	.01	0.76	0.76	88	83	1.5	260	43	83		
4	7½	392.90	.015	1.15	1.15	88	83	2.0	255	44	83		
	10	394.37	Avg 1.32										

< stopped for break 10:00

METHOD 5 PARTICULATE FIELD DATA

Plant Johnson Controls
Run No. 2
Location ABCET TUNNEL #44
Date 10/7/84
Operator PRB - FLH
Sample Box No. 5
Meter Box No. 1965
Filter No. 5
Probe No. 5
Pitot Tube Cp 0.84

Very Important — Fill In All Blanks
Leak Checks: Beg. @ 15" 0.005
End @ 7" 0.004
Pitot Tube: (+) 60.1 @ 4.4 "H_2O
(-) 60.1 @ 4.4 "H_2O
Static Pressure: -0.01 "H_2O
Start: 1115
Finish: 1250
Observer K. Rife Agency

Bar. Press. "Hg 29.11
Meter Box ΔH@ 1.92 Y = 1.00
Assumed Tm, °F 90
Dry Bulb, °F 81
Wet Bulb, °F 69
Db - Wb, °F 12
Assumed Moisture % 2%
Ps/Pm 1.00
C Factor 1.15

Ambient Temp., °F 68
Heater Box Setting, °F 250°
Probe Tip Dia., in. 0.504
Probe Length 8' steel
Probe Heater Setting 80%
Average Δp 0.0135 Δp 0.24
Average ΔH — ΔH Ref
Process Weight —
Steam Load —
Steam Pressure —

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in H_2O	Orifice Manometer (ΔH) in H_2O Desired	Orifice Manometer (ΔH) in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum in Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F	% CO_2	% O_2
A 1	0	394.90	0.04	3.00	3.00	83	81	4.0	260	60	83		
2	2½	397.27	0.03	2.30	2.30	87	83	3.0	270	52	83		
3	5	399.39	0.02	1.55	1.55	89	84	2.0	250	50	83		
4	7½	401.21	0.015	1.15	1.15	90	84	1.5	260	55	83		
B 1	10/0	402.72	0.030	2.30	2.30	89	84	3.0	260	54	83		
2	2½	404.84	0.015	1.15	1.15	91	84	1.5	275	52	83		
3	5	406.35	0.005	0.40	0.40	91	85	1.0	255	54	83		
4	7½	407.34	0.01	0.76	0.76	90	86	1.0	245	49	83		
C 1	10/0	408.46	0.03	2.30	2.30	90	86	3.5	260	54	83		
2	2½	410.68	0.01	0.76	0.76	90	86	1.0	270	49	83		
3	5	412.00	0.005	0.40	0.40	90	86	1.0	250	51	83		
4	7½	413.00	0.015	1.15	1.15	90	86	1.5	250	48	83		
D 1	10/0	414.47	0.03	2.30	2.30	90	86	3.5	240	55	83		
2	2½	416.59	0.01	0.76	0.76	91	87	1.0	240	45	84		
3	5	417.86	0.005	0.40	0.40	91	87	1.0	245	44	84		
4	7½	418.78	0.025	1.90	1.90	92	88	2.0	260	44	84		
E 1	10/0	420.52	0.01	0.76	0.76	80	80	1.5	260	51	85		
2	2½	421.73	0.01	0.76	0.76	80	81	1.0	265	41	85		
3	5	422.97	0.005	0.40	0.40	81	82	1.0	265	40	85		
4	7½	425.92	0.01	0.76	0.76	83	82	1.0	250	41	84		
F 1	10/0	425.16	0.02	1.55	1.55	84	82	2.0	250	56	83		
2	2½	426.91	0.01	0.76	0.76	86	82	1.5	260	45	85		
3	5	428.17	0.01	0.76	0.76	87	83	1.0	250	45	85		
4	7½	429.41	0.01	0.76	0.76	88	84	1.0	250	46	84		
	10	430.68	Avg 1.21										

Stopped for Lunch

METHOD 5 PARTICULATE FIELD DATA

Plant Johnson Controls
Run No. 3
Location ABORT TUNNEL #49
Date 10/9/85
Operator PRH - ELR
Sample Box No. 6
Meter Box No. 1765
Filter No. 6
Probe No. 6
Pitot Tube Cp 0.84

Very Important — Fill In All Blanks
Leak Checks: Beg. @ 15" 0.008
End @ 12" 0.004
Pitot Tube: (6) <0.1 @ 4.3 "H2O
(5) <0.1 @ 4.3 "H2O
Static Pressure: -0.01 "H2O
Start: 1315
Finish: 1430
Observer K. Rite Agency

Bar. Press. "Hg 29.11
Meter Box ΔH@ 1.84 Y = 1.00
Assumed Tm, °F 90
Dry Bulb, °F 81
Wet Bulb, °F 69
Db - Wb, °F 12
Assumed Moisture % 2%
Ps/Pm 1.00
C Factor 1.15

Ambient Temp., °F 68
Heater Box Setting, °F 250
Probe Tip Dia., in. 0.504
Probe Length 8' steel
Probe Heater Setting 80%
Average Δp 0.0185 Δp 0.024
Average ΔH — ΔH Ref
Process Weight —
Steam Load —
Steam Pressure —

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in H_2O	Orifice Manometer (ΔH) in H_2O Desired	Orifice Manometer (ΔH) in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum in Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F	% CO_2	% O_2
A 1	0	431.50	0.045	3.30	3.30	87	85	10.0	250	55	84		
2	2½	433.82	0.03	2.30	2.30	92	86	7.0	240	55	85		
3	5	435.93	0.025	1.90	1.90	94	88	6.0	230	55	85		
4	7½	437.94	0.020	1.55	1.55	96	88	5.0	235	58	85		
B 1	10/0	439.62	0.045	3.30	3.30	94	87	10.0	255	59	85		
2	2½	441.94	0.015	1.15	1.15	97	88	4.0	260	54	87		
3	5	443.60	0.005	0.40	0.40	97	89	1.5	250	51	87		
4	7½	444.57	0.015	1.15	1.15	97	89	4.0	260	50	86		
C 1	10/0	446.08	0.04	3.00	3.00	96	89	10.0	260	55	85		
2	2½	448.37	0.005	0.40	0.40	98	90	2.0	270	51	86		
3	5	449.41	0.005	0.40	0.40	97	90	2.0	250	52	87		
4	7½	450.35	0.015	1.15	1.15	96	90	4.0	260	50	86		
D 1	10/0	451.84	0.02	1.55	1.55	96	91	5.0	275	55	86		
2	2½	453.63	0.005	0.40	0.40	96	92	1.0	240	51	87		
3	5	454.58	0.005	0.40	0.40	96	92	1.0	260	49	86		
4	7½	455.49	0.015	1.15	1.15	96	92	3.5	245	49	86		
E 1	10/0	456.98	0.015	1.15	1.15	94	91	3.5	255	56	85		
2	2½	458.64	0.005	0.40	0.40	95	91	3.5	260	50	86		
3	5	459.49	0.005	0.40	0.40	95	92	1.5	250	50	86		
4	7½	460.49	0.015	1.15	1.15	96	92	4.0	270	48	86		
F 1	10/0	461.96	0.015	1.15	1.15	95	92	4.0	270	55	86		
2	2½	463.52	0.01	0.76	0.76	96	92	2.5	255	51	86		
3	5	464.81	0.010	0.76	0.76	96	92	2.5	270	52	86		
4	7½	466.09	0.015	~~1.15~~ 1.15	~~0.76~~ 1.15	96	92	3.5	240	53	86		
	10	467.61	Avg	1.27									

ORSAT ANALYSIS AND DRY MOLECULAR WEIGHT DETERMINATION - METHOD 3

RUN NO. 1

PLANT Johnson Controls

DATE 10/7/85

SAMPLING TIME (24 - hr clock) 926

SAMPLE TYPE (BAG, CONTINOUS, INTEGRATED)

AMBIENT TEMPERATURE 65°

OPERATOR Paul

PUMP LEAK CHECK @ 10" - LEAKFREE ? ✓

OXYGEN CHECK % 20.9

ORSAT LEAK CHECK @ 4 MIN.

PIPET LEVELS - LEAKFREE ? ✓

BURET 21.1 - 21.1 = <0.2 ml ? ✓

WATER _____ ml SILICA GEL 10 % SPENT

WATER DESCRIPTION Clean

Gas \ Run	1		2		3		Average Net Volume	Multiplier	Molecular Weight of Stack Gas-Dry Basis, M_d lb/lb mole
	Actual Reading	Net	Actual Reading	Net	Actual Reading	Net			
CO_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44/100	0.00
O_2 (Net is actual O_2 reading minus Actual CO_2)	20.9	20.9	20.9	20.9	20.9	20.9	20.9	32/100	6.688
CO (net is actual CO reading minus actual O_2)	20.9	0.0	20.9	0.0	20.9	0.0	0.0	28/100	0.00
N_2 (Net is 100 minus actual CO	—	79.1	—	79.1	—	79.1	79.1	28/100	22.148
								Total	28.836

Method 3

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant Johnson Controls Sample Date 10/4/85

Sample Location Abert tunnel #49 Recovery Date 10/5/85

Run No. 1 Sample Box No. 4 Probe No. 4

Filter No.(s) 4 Recovered By PRH

MOISTURE RECOVERY

Impingers Cont. No.(s) 5-1 Silica Gel Cont. No.(s) 5-1

Final volume (wt) 214 ml(g) Final wt. 207.5 g

Initial volume (wt) 200 ml(g) Initial wt. 200.0 g

Net volume (wt) 14 ml(g) Net wt. 7.5 g

Description of water Clear Silica gel % spent 10

Total Moisture 21.5 g

PARTICULATE RECOVERY

Filter Cont. No.(s) 4 Sealed ✓ By PRH

Description of Particulate on filter NONE

Probe Rinse Cont. No. — Liquid level marked —

Acetone Blank Cont. No. — Liquid level marked — Vol. —

Impinger Water Cont. No. — Liquid level marked —

— Blank Cont. No. — Liquid level marked —

ACETONE WASH BLANK, mg — Conc. — mg/mg

CONTAINER NUMBER	WEIGHT OF ~~PARTICULATE~~ LEAD COLLECTED, mg		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
4	Lead (mg)	0.232 mg	AA
TOTAL			
		Less acetone blank	
		Weight of ~~particulate~~ LEAD matter	0.232 mg

Additional Notes and Comments:

LABORATORY CUSTODY

Received by PRH Date 10/5/85

Remarks

Stored and Locked ✓

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant Johnson Controls Sample Date 10/4/85

Sample Location Abort Tunnel # 49 Recovery Date 10/5/85

Run No. 2 Sample Box No. 5 Probe No. 5

Filter No.(s) 5 Recovered By PRH

MOISTURE RECOVERY

Impingers Cont. No.(s) 5-2 Silica Gel Cont. No.(s) 5-2

Final volume (wt) 208 ml(g) Final wt. 207.8 g

Initial volume (wt) 200 ml(g) Initial wt. 200.0 g

Net volume (wt) 8 ml(g) Net wt. 7.8 g

Description of water Clear Silica gel % spent 15

Total Moisture 15.8 g

PARTICULATE RECOVERY

Filter Cont. No.(s) 5 Sealed ✓ By PRH

Description of Particulate on filter NONE

Probe Rinse Cont. No. — Liquid level marked —

Acetone Blank Cont. No. — Liquid level marked — Vol. —

Impinger Water Cont. No. — Liquid level marked —

— Blank Cont. No. — Liquid level marked —

ACETONE WASH BLANK, mg — Conc. — mg/mg

CONTAINER NUMBER	WEIGHT OF ~~PARTICULATE~~ LEAD COLLECTED, mg		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
5	Lead (mg)	0.464	by AA
TOTAL			
		Less acetone blank	
		Weight of ~~particulate~~ LEAD matter	0.464 mg

Additional Notes and Comments:

LABORATORY CUSTODY

Received by PRH Date 10/5/85

Remarks

Stored and Locked ✓

PARTICULATE SAMPLE RECOVERY AND INTEGRITY SHEET

Plant Johnson Controls Sample Date 10/4/85

Sample Location Adit Tunnel Recovery Date 10/5/85

Run No. 3 Sample Box No. 6 Probe No. 6

Filter No.(s) 6 Recovered By PAH

MOISTURE RECOVERY

Impingers Cont. No.(s) 5-3 Silica Gel Cont. No.(s) 5-3

Final volume (wt) 208 ml(g) Final wt. 209.8 g

Initial volume (wt) 200 ml(g) Initial wt. 200.0 g

Net volume (wt) 8 ml(g) Net wt. 9.8 g

Description of water Clear Silica gel % spent 15

Total Moisture 17.8 g

PARTICULATE RECOVERY

Filter Cont. No.(s) 6 Sealed ✓ By PAH

Description of Particulate on filter NONE

Probe Rinse Cont. No. — Liquid level marked —

Acetone Blank Cont. No. — Liquid level marked — Vol. —

Impinger Water Cont. No. — Liquid level marked —

— Blank Cont. No. — Liquid level marked —

ACETONE WASH BLANK, mg — Conc. — mg/mg

CONTAINER NUMBER	WEIGHT OF ~~PARTICULATE~~ LEAD COLLECTED, mg		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
6	LEAD (mg)	<0.200	by AA
TOTAL			
		Less acetone blank	
		Weight of ~~particulate~~ LEAD matter	<0.200 mg

Additional Notes and Comments:

LABORATORY CUSTODY

Received by PAH Date 10/5/85

Remarks

Stored and Locked ✓

TEST PARTICIPANTS

Peter R. Hill	Chemist Environmental Testing, Inc.
Larson Harsey	Environmental Scientist Environmental Testing, Inc.

those required by standards of performance for new sources.

Finally, States are free under Section 116 of the Act to establish even more stringent emission limits than those established under Section 111 or those necessary to attain or maintain the NAAQS under Section 110. Accordingly, new sources may in some cases be subject to limitations more stringent than EPA's standards of performance under Section 111, and prospective owners and operators of new sources should be aware of this possibility in planning for such facilities.

The regulation will be reviewed 4 years from the date of promulgation as required by the Clean Air Act. This review will include an assessment of such factors as the need for integration with other programs, the existence of alternative methods, enforceability, improvements in emission control technology, and reporting requirements. The reporting requirements in the regulation will be reviewed as required under EPA's sunset policy for reporting requirements in regulations.

Under Executive Order 12291, EPA must judge whether a regulation is "Major" and therefore subject to the requirement of a Regulatory Impact Analysis. This regulation is not Major because: (1) The national annualized compliance costs, including capital charges resulting from the standards total less than $100 million; (2) the standards do not cause a major increase in prices or production costs; and (3) the standards do not cause significant adverse effects on domestic competition, employment, investment, productivity, innovation or competition in foreign markets. This regulation was submitted to the Office of Management and Budget (OMB) for review as required by Executive Order 12291.

Section 317 of the Clean Air Act requires the Administrator to prepare an economic impact assessment for any new source standard of performance promulgated under Section 111(b) of the Act. An economic impact assessment was prepared for the promulgated regulations and for other regulatory alternatives. All aspects of the assessment were considered in the formulation of the promulgated standards to insure that the standards would represent the best system of emission reduction considering costs. The economic impact assessment is included in the background information document.

List of Subjects in 40 CFR Part 60

Air pollution control, Aluminum, Ammonium sulfate plants, Cement industry, Coal, Copper, Electric power-plants, Glass and glass products, Grains, Intergovernmental relations, Iron, Lead, Metals, Motor vehicles, Nitric acid plants, Paper and paper products industry, Petroleum, Phosphate, Sewage disposal, Steel, Sulfuric acid plants, Waste treatment and disposal, Zinc.

Dated: April 9, 1982.

Note.—The regulation does not involve a "collection of information" as defined under the Paperwork Reduction Act of 1980. Therefore, the provisions of the Paperwork Reduction Act applicable to collections of information do not apply to this regulation.

Anne M. Gorsuch,
Administrator.

PART 60—STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES

40 CFR Part 60 is amended by adding a new Subpart KK and by adding a new reference method to Appendix A as follows:

1. A new subpart is added as follows:

Subpart KK—Standards of Performance for Lead-Acid Battery Manufacturing Plants

Sec.

Authority: Sec. 111, 301(a) of the Clean Air Act as amended (42 U.S.C. 7411, 7601(a)), and additional authority as noted below.

Subpart KK—Standards of Performance for Lead-Acid Battery Manufacturing Plants

§ 60.370 Applicability and designation of affected facility.

(a) The provisions of this subpart are applicable to the affected facilities listed in paragraph (b) of this section at any lead-acid battery manufacturing plant that produces or has the design capacity to produce in one day (24 hours) batteries containing an amount of lead equal to or greater than 5.9 Mg (6.5 tons).

(b) The provisions of this subpart are applicable to the following affected facilities used in the manufacture of lead-acid storage batteries:

(1) Grid casting facility.
(2) Paste mixing facility.
(3) Three-process operation facility.
(4) Lead oxide manufacturing facility.
(5) Lead reclamation facility.
(6) Other lead-emitting operations.

(c) Any facility under paragraph (b) of this section the construction or modification of which is commenced after January 14, 1980, is subject to the requirements of this subpart.

§ 60.371 Definitions.

As used in this subpart, all terms not defined herein shall have the meaning given them in the Act and in Subpart A of this part.

(a) "Grid casting facility" means the facility which includes all lead melting pots and machines used for casting the grid used in battery manufacturing.

(b) "Lead-acid battery manufacturing plant" means any plant that produces a storage battery using lead and lead compounds for the plates and sulfuric acid for the electrolyte.

(c) "Lead oxide manufacturing facility" means a facility that produces lead oxide from lead, including product recovery.

(d) "Lead reclamation facility" means the facility that remelts lead scrap and casts it into lead ingots for use in the battery manufacturing process, and which is not a furnace affected under Subpart L of this part.

(e) "Other lead-emitting operation" means any lead-acid battery manufacturing plant operation from which lead emissions are collected and ducted to the atmosphere and which is not part of a grid casting, lead oxide manufacturing, lead reclamation, paste mixing, or three-process operation facility, or a furnace affected under Subpart L of this part.

(f) "Paste mixing facility" means the facility including lead oxide storage, conveying, weighing, metering, and charging operations; paste blending, handling, and cooling operations; and plate pasting, takeoff, cooling, and drying operations.

(g) "Three-process operation facility" means the facility including those processes involved with plate stacking, burning or strap casting, and assembly of elements into the battery case.

§ 60.372 Standards for lead.

(a) On and after the date on which the performance test required to be conducted by § 60.8 is completed, no owner or operator subject to the provisions of this subpart shall cause to be discharged into the atmosphere:

(1) From any grid casting facility any gases that contain lead in excess of 0.40 milligram of lead per dry standard cubic meter of exhaust (0.000176 gr/dscf).

(2) From any paste mixing facility any gases that contain in excess of 1.00 milligram of lead per dry standard cubic meter of exhaust (0.00044 gr/dscf).

(3) From any three-process operation facility any gases that contain in excess of 1.00 milligram of lead per dry

...dard cubic meter of exhaust (0.00044 ... ;

...From any lead oxide ... facturing facility any gases that co...ain in excess of 5.0 milligrams of lead per kilogram of lead feed (0.010 lb/ton).

(5) From any lead reclamation facility any gases that contain in excess of 4.50 milligrams of lead per dry standard cubic meter of exhaust (0.00198 gr/dscf).

(6) From any other lead-emitting operation any gases that contain in excess of 1.00 milligram per dry standard cubic meter of exhaust (0.00044 gr/dscf).

(7) From any affected facility other than a lead reclamation facility any gases with greater than 0 percent opacity (measured according to Method 9 and rounded to the nearest whole percentage).

(8) From any lead reclamation facility any gases with greater than 5 percent opacity (measured according to Method 9 and rounded to the nearest whole percentage).

(b) When two or more facilities at the same plant (except the lead oxide manufacturing facility) are ducted to a common control device, an equivalent standard for the total exhaust from the ...nmonly controlled facilities shall be ...ermined as follows:

$$S_e = \sum_{a=1}^{N} S_a(Q_{sd_a}/Q_{sd_T})$$

Where:

S_e = is the equivalent standard for the total exhaust stream.

S_a = is the actual standard for each exhaust stream ducted to the control device.

N = is the total number of exhaust streams ducted to the control device.

Q_{sd_a} = is the dry standard volumetric flow rate of the effluent gas stream from each facility ducted to the control device.

Q_{sd_T} = is the total dry standard volumetric flow rate of all effluent gas streams ducted to the control device.

§ 60.373 Monitoring of emissions and operations.

The owner or operator of any lead-acid battery manufacturing facility subject to the provisions of this subpart and controlled by a scrubbing system(s) shall install, calibrate, maintain, and operate a monitoring device(s) that measures and records the pressure drop across the scrubbing system(s) at least ...nce every 15 minutes. The monitoring ...vice shall have an accuracy of ±5 ...cent over its operating range.

(Sec. 114 of the Clean Air Act as amended (42 U.S.C. 7414))

§ 60.374 Test methods and procedures.

(a) Reference methods in Appendix A of this part, except as provided under § 60.8(b), shall be used to determine compliance according to § 60.8 as follows:

(1) Method 12 for the measurement of lead concentrations.

(2) Method 1 for sample and velocity traverses.

(3) Method 2 for velocity and volumetric flow rate, and

(4) Method 4 for stack gas moisture.

(b) For Method 12, the sampling time for each run shall be at least 60 minutes and the sampling rate shall be at least 0.85 dscm/h (0.53 dscf/min), except that shorter sampling times, when necessitated by process variables or other factors, may be approved by the Administrator.

(c) When different operations in a three-process operation facility are ducted to separate control devices, the lead emission concentration from the facility shall be determined using the equation:

$$C_{PbT} = \sum_{a=1}^{N} (C_{Pb_a} Q_{sd_a}/Q_{sd_T})$$

Where:

C_{PbT} = is the facility emission concentration for the entire facility.

N = is the number of control devices to which separate operations in the facility are ducted.

C_{Pb_a} = is the emission concentration from each control device.

Q_{sd_a} = is the dry standards volumetric flow rate of the effluent gas stream from each control device.

Q_{sd_T} = is the total dry standard volumetric flow rate from all of the control devices.

(d) For lead oxide manufacturing facilities, the average lead feed rate to a facility, expressed in kilograms per hour, shall be determined for each test run as follows:

(1) Calculate the total amount of lead charged to the facility during the run by multiplying the number of lead pigs (ingots) charged during the run by the average mass of a pig in kilograms or by another suitable method.

(2) Divide the total amount of lead charged to the facility during the run by the duration of the run in hours.

(e) Lead emissions from lead oxide manufacturing facilities, expressed in milligrams per kilogram of lead charged, shall be determined using the following equation:

$$E_{Pb} = C_{Pb} Q_{sd}/F$$

Where:

E_{Pb} = is the lead emission rate from the facility in milligrams per kilogram of lead charged.

C_{Pb} = is the concentration of lead in the exhaust stream in milligrams per dry standard cubic meter as determined according to paragraph (e)(1) of this section.

Q_{sd} = is the dry standard volumetric flow rate in dry standard cubic meters per hour as determined according to paragraph (e)(3) of this section.

F = is the lead feed rate to the facility in kilograms per hour as determined according to paragraph (d) of this section.

(Sec. 114 of the Clean Air Act as amended (42 U.S.C. 7414))

2. Appendix A to Part 60 is amended by adding new Reference Method 12 as follows:

Appendix A—Reference Methods

* * * * *

Method 12. Determination of Inorganic Lead Emissions From Stationary Sources

1. *Applicability and Principle.*

1.1 Applicability. This method applies to the determination of inorganic lead (Pb) emissions from specified stationary sources only.

1.2 Principle. Particulate and gaseous Pb emissions are withdrawn isokinetically from the source and collected on a filter and in dilute nitric acid. The collected samples are digested in acid solution and analyzed by atomic absorption spectrometry using an air acetylene flame.

2. *Range, Sensitivity, Precision, and Interferences.*

2.1 Range. For a minimum analytical accuracy of ±10 percent, the lower limit of the range is 100 μg. The upper limit can be considerably extended by dilution.

2.2 Analytical Sensitivity. Typical sensitivities for a 1-percent change in absorption (0.0044 absorbance units) are 0.2 and 0.5 μg Pb/ml for the 217.0 and 283.3 nm lines, respectively.

2.3 Precision. The within-laboratory precision, as measured by the coefficient of variation ranges from 0.2 to 9.5 percent relative to a run-mean concentration. These values were based on tests conducted at a gray iron foundry, a lead storage battery manufacturing plant, a secondary lead smelter, and a lead recovery furnace of an alkyl lead manufacturing plant. The concentrations encountered during these tests ranged from 0.61 to 123.3 mg Pb/m³.

2.4 Interferences. Sample matrix effects may interfere with the analysis for Pb by flame atomic absorption. If this interference is suspected, the analyst may confirm the presence of these matrix effects and frequently eliminate the interference by using the Method of Standard Additions.

High concentrations of copper may interfere with the analysis of Pb at 217.0 nm. This interference can be avoided by analyzing the samples at 283.3 nm.

3. *Apparatus.*

3.1 Sampling Train. A schematic of the sampling train is shown in Figure 12-1; it is similar to the Method 5 train. The sampling train consists of the following components:

3.1.1 Probe Nozzle, Probe Liner, Pitot Tube, Differential Pressure Gauge, Filter Holder, Filter Heating System, Metering System, Barometer, and Gas Density Determination Equipment. Same as Method 5, Sections 2.1.1 to 2.1.8 and 2.1.8 to 2.1.10, respectively.

3.1.2 Impingers. Four impingers connected in series with leak-free ground glass fittings or any similar leak-free noncontaminating fittings. For the first, third, and fourth impingers, use the Greenburg Smith design, modified by replacing the tip with a 1.3 cm (½ in.) ID glass tube extending to about 1.3 cm (½ in.) from the bottom of the flask. For the second impinger, use the Greenburg-Smith design with the standard tip. Place a thermometer, capable of measuring temperature to within 1°C (2°F) at the outlet of the fourth impinger for monitoring purposes.

BILLING CODE 6560-50-M

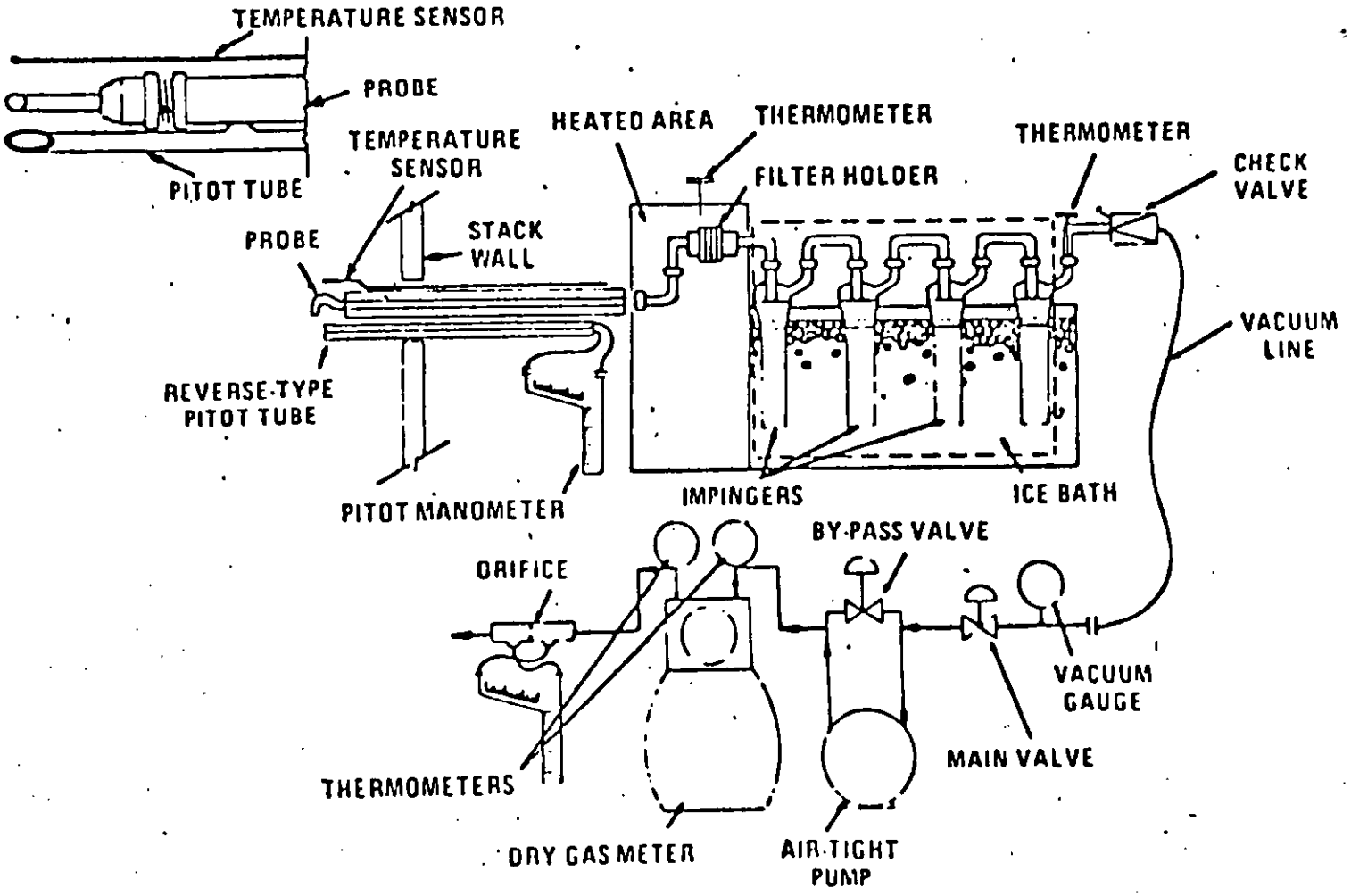


Figure 12-1. Inorganic lead sampling train.

BILLING CODE 6560-50-C

3.2 Sample Recovery. The following items are needed:

3.2.1 Probe-Liner and Probe-Nozzle Brushes, Plastic Storage [illegible] and Funnel and Rubber [illegible]. Same as Method 5, Sections 2.2.1, 2.2.6, and 2.2.7, respectively.

3.2.2 Wash Bottles. Glass (2).

3.2.3 Sample Storage Containers. Chemically resistant, borosilicate glass bottles, for 0.1 nitric acid (HNO_3) impinger and probe solutions and washes, 1000-ml. Use screw-cap liners that are either rubber-backed Teflon* or leak-free and resistant to chemical attack by 0.1 N HNO_3. (Narrow mouth glass bottles have been found to be less prone to leakage.)

3.2.4 Graduated Cylinder and/or Balance. To measure condensed water to within 2 ml or 1 g. Use a graduated cylinder that has a minimum capacity of 500 ml, and subdivisions no greater than 5 ml. (Most laboratory balances are capable of weighing to the nearest 0.5 g or less.)

3.2.5 Funnel. Glass, to aid in sample recovery.

3.3 Analysis. The following equipment is needed:

3.3.1 Atomic Absorption Spectrophotometer. With lead hollow cathode lamp and burner for air/acetylene flame.

3.3.2 Hot Plate.

3.3.3 Erlenmeyer Flasks. 125-ml, 24/40 S.

3.3.4 Membrane Filters. Millipore SCWP0 4700 or equivalent.

3.3.5 Filtration Apparatus. Millipore vacuum filtration unit, or equivalent, for use with the above membrane filter.

3.3.6 Volumetric Flasks. 100-ml, 250-ml, 1000-ml.

4. *Reagents.*

4.1 Sampling. The reagents used in sampling are as follows:

4.1.1 Filter. Gelman Spectro Grade, Reeve Angel 934 AH, MSA 1106 BH, all with lot assay for Pb, or other high-purity glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (≤0.05 percent penetration) on 0.3 micron dioctyl phthalate smoke particles. Conduct the filter efficiency test using ASTM Standard Method D 2986–71 or use test data from the supplier's quality control program.

4.1.2 Silica Gel, Crushed Ice, and [illegible] Grease. Same as *Method 5, Section* 3.1.2, 3.1.4, and 3.1.5, respectively.

4.1.3 Water. Deionized distilled, to conform to ASTM Specification D 1193–74, Type 3. If high concentrations of organic matter are not expected to be present, the analyst may delete the potassium permanganate test for oxidizable organic matter.

4.1.4 Nitric Acid, 0.1 N. Dilute 6.5 ml of concentrated HNO_3 to 1 liter with deionized distilled water. (It may be desirable to run blanks before field use to eliminate a high blank on test samples.)

4.2 Pretest Preparation. 6 N HNO_3 is needed. Dilute 390 ml of concentrated HNO_3 to 1 liter with deionized distilled water.

*Mention of trade names or specific products does not constitute endorsement by the U.S. Environmental Protection Agency.

4.3 Sample Recovery. 0.1 N HNO_3 (same as 4.1.4 above) is needed for sample recovery.

4.4 Analysis. The following reagents are needed for analysis (use ACS reagent grade chemicals or equivalent, unless otherwise specified):

4.4.1 Water. Same as 4.1.3 above.

4.4.2 Nitric Acid, Concentrated.

4.4.3 Nitric Acid, 50 percent (V/V). Dilute 500 ml of concentrated HNO_3 to 1 liter with deionized distilled water.

4.4.4 Stock Lead Standard Solution, 1000 µg Pb/ml. Dissolve 0.1598 g of lead nitrate [$Pb(NO_3)_2$] in about 80 ml of deionized distilled water, add 2 ml concentrated HNO_3, and dilute to 100 ml with deionized distilled water.

4.4.5 Working Lead Standards. Pipet 0.0, 1.0, 2.0, 3.0, 4.0, and 5.0 ml of the stock lead standard solution (4.4.4) into 250-ml volumetric flasks. Add 5 ml of concentrated HNO_3 to each flask and dilute to volume with deionized distilled water. These working standards contain 0.0, 4.0, 8.0, 12.0, 16.0, and 20.0 µg Pb/ml, respectively. Prepare, as needed, additional standards at other concentrations in a similar manner.

4.4.6 Air. Suitable quality for atomic absorption analysis.

4.4.7 Acetylene. Suitable quality for atomic absorption analysis.

4.4.8 Hydrogen Peroxide, 3 percent (V/V). Dilute 10 ml of 30 percent H_2O_2 to 100 ml with deionized distilled water.

5. *Procedure.*

5.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers should be trained and experienced with the test procedures.

5.1.1 Pretest Preparation. Follow the same general procedure given in Method 5, Section 4.1.1, except the filter need not be weighed.

5.1.2 Preliminary Determinations. Follow the same general procedure given in Method 5, Section 4.1.2.

5.1.3 Preparation of Collection Train. Follow the same general procedure given in Method 5, Section 4.1.3, except place 100 ml of 0.1 HNO_3 in each of the first two impingers, leave the third impinger empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fourth impinger. Set up the train as shown in Figure 12–1.

5.1.4 Leak-Check Procedures. Follow the general leak-check procedures given in Method 5, Sections 4.1.4.1 (Pretest Leak-Check), 4.1.4.2 (Leak-Checks During the Sample Run), and 4.1.4.3 (Post-Test Leak-Check).

5.1.5 Sampling Train Operation. Follow the same general procedure given in Method 5, Section 4.1.5. For each run, record the data required on a data sheet such as the one shown in EPA Method 5, Figure 5–2.

5.1.6 Calculation of Percent Isokinetic. Same as Method 5, Section 4.1.6.

5.2 *Sample Recovery.* Begin proper cleanup procedure as soon as the probe is removed from the stack at the end of the sampling period.

Allow the probe to cool. When it can be safely handled, wipe off all external particulate matter near the tip of the probe nozzle and place a cap over it. Do not cap off the probe tip tightly while the sampling train is cooling down as this would create a vacuum in the filter holder, thus drawing liquid from the impingers into the filter.

Before moving the sampling train to the cleanup site, remove the probe from the sapling train, wipe off the silicone grease, and cap the open outlet of the probe. Be careful not to lose any condensate that might be present. Wipe off the silicone grease from the glassware inlet where the probe was fastened and cap the inlet. Remove the umbilical cord from the last impinger and cap the impinger. The tester may use ground-glass stoppers, plastic caps, or serum caps to close these openings.

Transfer the probe and filter-impinger assembly to a cleanup area, which is clean and protected from the wind so that the chances of contaminating or losing the sample are minimized.

Inspect the train prior to and during disassembly and note any abnormal conditions. Treat the samples as follows:

5.2.1 *Container No. 1* (Filter). Carefully remove the filter from the filter holder and place it in its identified petri dish container. If it is necessary to fold the filter, do so such that the sample-exposed side is inside the fold. Carefully transfer to the petri dish any visible sample matter and/or filter fibers that adhere to the filter holder gasket by using a dry Nylon bristle brush and/or a sharp-edged blade. Seal the container.

5.2.2 *Container No. 2* (Probe). Taking care that dust on the outside of the probe or other exterior surfaces does not get into the sample, quantitatively recover sample matter or any condensate from the probe nozzle, probe fitting, probe liner, and front half of the filter holder by washing these components with 0.1 N HNO_3 and placing the wash into a glass sample storage container. Measure and record (to the nearest 2-ml) the total amount of 0.1 N HNO_3 used for each rinse. Perform the 0.1 N HNO_3 rinses as follows:

Carefully remove the probe nozzle and rinse the inside surfaces with 0.1 N HNO_3 from a wash bottle while brushing with a stainless steel, Nylon-bristle brush. Brush until the 0.1 N HNO_3 rinse shows no visible particles, then make a final rinse of the inside surface.

Brush and rinse with 0.1 N HNO_3 the inside parts of the Swagelok fitting in a similar way until no visible particles remain.

Rinse the probe liner with 0.1 N HNO_3. While rotating the probe so that all inside surfaces will be rinsed with 0.1 N HNO_3, tilt the probe and squirt 0.1 N HNO_3 into its upper end. Let the 0.1 N HNO_3 drain from the lower end into the sample container. The tester may use a glass funnel to aid in transferring liquid washes to the container. Follow the rinse with a probe brush. Hold the probe in an inclined position, squirt 0.1 N HNO_3 into the upper end of the probe as the probe brush is being pushed with a twisting action through the probe; hold the sample container underneath the lower end of the probe and catch any 0.1 N HNO_3 and sample matter that is brushed from the probe. Run the brush through the probe three times or more until no visible sample matter is carried out with the 0.1 N HNO_3 and none remains on the probe liner on visual inspection. With

stainless steel or other metal probes, run the brush through in the above prescribed manner at least six times, since metal probes have small crevices in which sample matter can be entrapped. Rinse the brush with 0.1 N HNO_3, and quantitatively collect these washings in the sample container. After the brushing make a final rinse of the probe as described above.

It is recommended that two people clean the probe to minimize loss of sample. Between sampling runs, keep brushes clean and protected from contamination.

After insuring that all joints are wiped clean of silicone grease, brush and rinse with 0.1 N HNO_3 the inside of the front half of the filter holder. Brush and rinse each surface three times or more, if needed, to remove visible sample matter. Make a final rinse of the brush and filter holder. After all 0.1 N HNO_3 washings and sample matter are collected in the sample container, tighten the lid on the sample container so that the fluid will not leak out when it is shipped to the laboratory. Mark the height of the fluid level to determine whether leakage occurs during transport. Label the container to clearly identify its contents.

5.2.3 *Container No. 3* (Silica Gel). Check the color of the indicating silica gel to determine if it has been completely spent and make a notation of its condition. Transfer the silica gel from the fourth impinger to the original container and seal. The tester may use a funnel to pour the silica gel and a rubber policeman to remove the silica gel from the impinger. It is not necessary to remove the small amount of particles that may adhere to the walls and are difficult to remove. Since the gain in weight is to be used for moisture calculations, do not use any water or other liquids to transfer the silica gel. If a balance is available in the field, the tester may follow procedure for Container No. 3 under Section 5.4 (Analysis).

5.2.4 *Container No. 4* (Impingers). Due to the large quantity of liquid involved, the tester may place the impinger solutions in several containers. Clean each of the first three impingers and connecting glassware in the following manner:

1. Wipe the impinger ball joints free of silicone grease and cap the joints.

2. Rotate and agitate each impinger, so that the impinger contents might serve as a rinse solution.

3. Transfer the contents of the impingers to a 500 ml graduated cylinder. Remove the outlet ball joint cap and drain the contents through this opening. Do not separate the impinger parts (inner and outer tubes) while transferring their contents to the cylinder. Measure the liquid volume to within ± 2 mL. Alternatively, determine the weight of the liquid to within ± 0.5 g. Record in the log the volume or weight of the liquid present, along with a notation of any color or film observed in the impinger catch. The liquid volume or weight is needed, along with the silica gel data, to calculate the stack gas moisture content (see Method 5, Figure 5-3).

4. Transfer the contents to Container No. 4.

5. Note: In steps 5 and 6 below, measure and record the total amount of 0.1 N HNO_3 used for rinsing. Pour approximately 30 ml of 0.1 N HNO_3 into each of the first three impingers and agitate the impingers. Drain the 0.1 N HNO_3 through the outlet arm of each impinger into Container No. 4. Repeat this operation a second time; inspect the impingers for any abnormal conditions.

6. Wipe the ball joints of the glassware connecting the impingers free of silicone grease and rinse each piece of glassware twice with 0.1 N HNO_3; transfer this rinse into Container No. 4. (*Do not rinse or brush the glass-fritted filter support.*) Mark the height of the fluid level to determine whether leakage occurs during transport. Label the container to clearly identify its contents.

5.2.5 *Blanks. Save 200 ml of the 0.1 N* HNO_3 used for sampling and cleanup as a blank. Take the solution directly from the bottle being used and place into a glass sample container labeled "0.1 N HNO_3 blank."

5.3 Sample Preparation.

5.3.1 *Container No. 1* (Filter). Cut the filter into strips and transfer the strips and all loose particulate matter into a 125-ml Erlenmeyer flask. Rinse the petri dish with 10 ml of 50 percent HNO_3 to insure a quantitative transfer and add to the flask. (Note: If the total volume required in Section 5.3.3 is expected to exceed 80 ml, use a 250-ml Erlenmeyer flask in place of the 125-ml flask.)

5.3.2 *Containers No. 2 and No. 4* (Probe and Impingers). (Check the liquid level in Containers No. 2 and/or No. 4 and confirm as to whether or not leakage occurred during transport; note observation on the analysis sheet. If a noticeable amount of leakage had occurred, either void the sample or take steps, subject to the approval of the Administrator, to adjust the final results.) Combine the contents of Containers No. 2 and No. 4 and take to dryness on a hot plate.

5.3.3 Sample Extraction for lead. Based on the approximate stack gas particulate concentration and the total volume of stack gas sampled, estimate the total weight of particulate sample collected. Then transfer the residue from Containers No. 2 and No. 4 to the 125-ml Erlenmeyer flask that contains the filter using rubber policeman and 10 ml of 50 percent HNO_3 for every 100 mg of sample collected in the train or a minimum of 30 ml of 50 percent HNO_3, whichever is larger.

Place the Erlenmeyer flask on a hot plate and heat with periodic stirring for 30 min at a temperature just below boiling. If the sample volume falls below 15 ml, add more 50 percent HNO_3. Add 10 ml of 3 percent H_2O_2, and continue heating for 10 min. Add 50 ml of hot (80°C) deionized distilled water and heat for 20 min. Remove the flask from the hot plate and allow to cool. Filter the sample through a Millipore membrane filter or equivalent and transfer the filtrate to a 250-ml volumetric flask. Dilute to volume with deionized distilled water.

5.3.4 *Filter Blank. Determine a filter* blank using two filters from each lot of filters used in the sampling train. Cut each filter into strips and place each filter in a separate 125-ml Erlenmeyer flask. Add 15 ml of 50 percent HNO_3, and treat as described in Section 5.3.3 using 10 ml of 3 percent H_2O_2 and 50 ml of hot, deionized distilled water. Filter and dilute to a total volume of 100 ml using deionized distilled water.

5.3.5 0.1 N HNO_3 Blank. Take the entire 200 ml of 0.1 N HNO_3 to dryness on a steam bath, add 15 ml of 50 percent HNO_3, and treat as described in Section 5.3.3 using 10 ml of 3 percent H_2O_2 and 50 ml of hot, deionized distilled water. Dilute to a total volume of 100 ml using deionized distilled water.

5.4 Analysis.

5.4.1 Lead Determination. Calibrate the spectrophotometer as described in Section 6.2 and determine the absorbance for each source sample, the filter blank, and 0.1 N HNO_3 blank. Analyze each sample three times in this manner. Make appropriate dilutions, as required, to bring all sample Pb concentrations into the linear absorbance range of the spectrophotometer.

If the Pb concentration of a sample is at the low end of the calibration curve and high accuracy is required, the sample can be taken to dryness on a hot plate and the residue dissolved in the appropriate volume of water to bring it into the optimum range of the calibration curve.

5.4.2 Mandatory Check for Matrix Effects on the Lead Results. The analysis for Pb by atomic absorption is sensitive to the chemical compositon and to the physical properties (viscosity, pH) of the sample (matrix effects). Since the Pb procedure described here will be applied to many different sources, many sample matrices will be encountered. Thus, check (mandatory) at least one sample from each source using the Method of Additions to ascertain that the chemical composition and physical properties of the sample did not cause erroneous analytical results.

Three acceptable "Method of Additions" procedures are described in the General Procedure Section of the Perkin Elmer Corporation Manual (see Citation 9.1). If the results of the Method of Additions procedure on the source sample do not agree within 5 percent of the value obtained by the conventional atomic absorption analysis, then the tester must reanalyze all samples from the source using the Method of Additions procedure.

5.4.3 *Container No. 3* (Silica Gel) The tester may conduct this step in the field. Weigh the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g; record this weight.

6. *Calibration.*

Maintain a laboratory log of all calibrations.

6.1 Sampling Train Calibration. Calibrate the sampling train components according to the indicated sections of Method 5: Probe Nozzle (Section 5.1); Pitot Tube (Section 5.2); Metering System (Section 5.3); Probe Heater (Section 5.4); Temperature Gauges (Section 6.5); Leak-Check of the Metering System (Section 5.6); and Barometer (Section 5.7).

6.2 Spectrophotometer. Measure the absorbance of the standard solutions using the instrument settings recommended by the spectrophotometer manufacturer. Repeat until good agreement (±3 percent) is obtained between two consecutive readings. Plot the absorbance (y-axis) versus concentration in μg Pb/ml (x-axis). Draw or compute a straight line through the linear portion of the curve. Do not force the calibration curve through zero, but if the curve does not pass through the origin or at least lie closer to the origin than ±0.003

absorbance units, check for incorrectly prepared standards and for curvature in the calibration curve.

[illegible] determine stability of the calibration curve, run a blank and a standard after every [illegible] samples and recalibrate, as necessary.

Calculations.

7.1 Dry Gas Volume. Using the data from this test, calculate $V_{m(std)}$, the total volume of dry gas metered corrected to standard conditions (20°C and 760 mm Hg), by using Equation 5-1 of Method 5. If necessary, adjust $V_{m(std)}$ for leakages as outlined in Section 6.3 of Method 5. See the field data sheet for the average dry gas meter temperature and average orifice pressure drop.

7.2 Volume of Water Vapor and Moisture Content. Using data obtained in this test and Equations 5-2 and 5-3 of Method 5, calculate the volume of water vapor $V_{w(std)}$ and the moisture content B_{ws} of the stack gas.

7.3 Total Lead in Source Sample. For each source sample correct the average absorbance for the contribution of the filter blank and the 0.1 N HNO_3 blank. Use the calibration curve and this corrected absorbance to determine the µg Pb concentration in the sample aspirated into the spectrophotometer. Calculate the total Pb content C'_m (in µg) in the original source sample; correct for all the dilutions that were made to bring the Pb concentration of the sample into the linear range of the spectrophotometer.

7.4 Lead Concentration. Calculate the stack gas Pb concentration C_m in mg/dscm as follows:

$$C_m = K \frac{C'_m}{V_{m(std)}}$$

Where:

K = 0.001 mg/µg for metric units.

= 2.205 lb/µg for English units.

7.5 Isokinetic Variation and Acceptable Results. Same as Method 5, Sections 6.11 and 6.12, respectively. To calculate v_s, the average stack gas velocity, use Equation 2-9 of Method 2 and the data from this field test.

8. *Alternative Test Methods for Inorganic Lead.*

8.1 Simultaneous Determination of Particulate and Lead Emissions. The tester may use Method 5 to simultaneously determine Pb provided that (1) he uses acetone to remove particulate from the probe and inside of the filter holder as specified by Method 5, (2) he uses 0.1 N HNO_3 in the impingers, (3) he uses a glass fiber filter with a low Pb background, and (4) he treats and analyzes the entire train contents, including the impingers, for Pb as described in Section 5 of this method.

8.2 Filter Location. The tester may use a filter between the third and fourth impinger provided that he includes the filter in the analysis for Pb.

8.3 In-stack Filter. The tester may use an in-stack filter provided that (1) he uses a glass lined probe and at least two impingers, each containing 100 ml of 0.1 N HNO_3, after the in-stack filter and (2) he recovers and analyzes the probe and impinger contents for Pb. Recover sample from the nozzle with acetone if a particulate analysis is to be made.

9. *Bibliography*

9.1 Perkin Elmer Corporation. Analytical Methods for Atomic Absorption Spectrophotometry. Norwalk, Connecticut. September 1976.

9.2 American Society for Testing and Materials. Annual Book of ASTM Standards. *Part 31: Water*, Atmospheric Analysis. Philadelphia, Pa. 1974. p. 40–42.

9.3 Klein, R. and C. Hach. Standard Additions—Uses and Limitations in Spectrophotometric Analysis. *Amer. Lab.* 9:21–27. 1977.

9.4 Mitchell, W.J. and M.R. Midgett. Determining Inorganic and Alkyl Lead Emissions from Stationary Sources. U.S. Environmental Protection Agency, Emission Monitoring and Support Laboratory, Research Triangle Park, N.C. (Presented at National APCA Meeting, Houston, June 26, 1978).

9.5 Same as Method 5, Citations 2 to 5 and 7 of Section 7.

* * * * *

[Secs. 111, 114, and 301(a) of the Clean Air Act as amended (42 U.S.C. 7411, 7414, and 7601(a))]

[FR Doc. 82-31681 Filed 4-15-82; 8:45 am]

BILLING CODE 6560-50-M

For Samples

$\mu g/l \div 4 = \mu g/250\ ml$

$= \mu g$ / Filter, sample

For Blanks

$\mu g/l \div 10 = \mu g/100\ ml$

$= \mu g$ / Filter Blk or μg / HNO_3 blank

CALIBRATION INFORMATION

NOZZLES

Each new set of nozzles purchased by ETI are first machined and calibrated before being put into field use. Thereafter, whenever it becomes apparent that a nozzel has been damaged, it is again machined and recalibrated. A set of three is matched to within 0.002 inches (Difference between high and low readings).

PITOT TUBES

All pitot tubes used by ETI whether separate or attached to a sampling probe were made by ETI personnel. Prior to being put into field use, they are calibrated. In general, if a type "S" pitot tube is constructed properly, and not positioned too closely to the probe nozzle or any other obstruction, it will have a Cp of 0.83 - 0.87. As long as the pitot tube is not damaged its calibration should not change. All ETI pitot tubes are made to have a Cp of 0.84. If a pitot tube does not initially have a Cp of 0.84, it is altered until a reading of 0.84 is obtained.

DRY GAS METER AND ORIFICE METER

Meter box calibrations are checked periodically according to their usage. If a large difference is noted between calibrations, the meter box is sent back to the manufacturer to be rechecked.

THERMOMETERS, FYRITES, ORSAT, ORSAT, ORSAT BAGS

Each new thermometer, pyrometer and thermocouple purchased by ETI is checked and calibrated before being put into field use. Periodically and according to each piece of equipments use it is again checked and recalibrated.

Fyrites and orsats are checked after each source test. If they do not function properly, each is refilled with fresh solutions and rechecked. Orsat gas sampling bags are leak tested and evacuated after each source test.

Calibration data and test dates are posted on each individual piece of equipment.

LABORATORY EQUIPMENT

ETI has a written quality assurance document that covers calibration and maintenance of laboratory equipment. This includes calibration of the analytical balance daily against Class S weights, and service contracts to maintain traceability to N.B.S. Calibration of thermometers, barometers, stopwatches, and wet test meters are traceable to N.B.S. A copy of our quality assurance document may be obtained by written request.

PRETEST -POSTTEST CALIBRATION CHECKS

(Method 5, Figure 5.1)

Plant Johnson Controls Calibrated by PRH

Meter box number 1965 Date _____

Dry Gas Meter

Pretest calibration factor, Y 1.00 (within ±2%)
Posttest check, Y* 0.984 (within ±5% of pretest)
Recalibration required? _____ yes ✓ no
If yes, recalibration factor, Y _____ (within ±2%)
Lower calibration factor, Y _____ for calculations (pretest or posttest)

Dry Gas Meter Thermometers

Was a pretest temperature correction used? _____ yes ✓ no
If yes, temperature correction _____ (within ±3°C (5.4°F) over range)
Posttest comparison with mercury-in-glass thermometer?* (within ±6°C (10.8°F) at ambient temperature)
Recalibration required? _____ yes ✓ no
Recalibration temperature correction? _____ (within ±3°C (5.4°F) over range)*
If yes, no correction necessary for calculations if meter thermometer temperature is higher; if calibration temperature is higher, add correction to average meter temperature for calculations

Stack Temperature Sensor

Was a pretest temperature correction used? _____ yes ✓ no
If yes, temperature correction _____ °C (°F) (within ±1.5% of readings in K (°R) over range)
Average stack temperature of compliance test, T_s 535 K (°R)
Temperature of reference thermometer or solution for recalibration 535 K (°R)* (within ±10% of T_s)
Temperature of stack thermometer for recalibration 535 K (°R)
Difference between reference and stack thermometer temperatures, ΔT_s 0 K (°R)
Do values agree within ±1.5%?* ✓ yes _____ no
If yes, no correction necessary for calculations
If no, calculations must be done twice--once with the recorded values and once with the average stack temperature corrected to correspond to the reference temperature differential (ΔT_s); both final result values must be reported since there is no way to determine which is correct

(continued)

(continued)

Barometer

Was the pretest field barometer reading correct? ✓ yes ___ no
Posttest comparison?* Δ=0.04 ~~mm~~ (in.) Hg (±2.5 mm (0.1 in.) Hg)
Was calibration required? _____ yes ✓ no
If yes, no correction necessary for calculations when the field barometer has a lower reading; if the mercury-in-glass reading is lower, subtract the difference from the field data readings for the calculation

Nozzle*

Was the nozzle calibrated to the nearest 0.025 mm (0.001 in.)?
✓ yes _____ no

Impinger Thermometer

Was a pretest temperature correction used? _____ yes ✓ no
If yes, temperature correction _____ (within ±3°C (5.4°F) over range)

*Most significant items/parameters to be checked.

POSTTEST DRY GAS METER CALIBRATION DATA FORM (English Units)

Test Number 1 Date 10-5-85 Meter Box number 1965 Plant Johnson Controls Abort Tunnel #49

Barometric pressure, P_b = 29.06 in.Hg. Dry Gas Meter No. 1 Pretest Y 1.00

Orifice manometer setting, (ΔH) in. H_2O	Gas Volume: Wet test meter (V_w), ft.³	Gas Volume: Dry gas meter (V_d), ft.³	Temperature: Wet test meter, (t_w) °F	Temperature: Dry Gas Meter: Inlet (t_{d_i}) °F	Temperature: Dry Gas Meter: Outlet (t_{d_o}) °F	Temperature: Dry Gas Meter: Average (t_d) °F	Time (θ), min.	Vacuum setting, in. Hg.	Y_i	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 4)}$
1.27	10	10.64	72.00	105	96	100.5	16.19	10.0	.98 7	$\frac{10(29.06)(560.5)}{10.64(29.153)(532)}$
1.27	10	10.70	71.95	106	97	101.5	16.20	10.0	.98 3	$\frac{10(29.06)(561.5)}{10.70(29.153)(531.95)}$
	10	10.72	71.90	107	97.5	102.25	16.21	10.0	.98 3	$\frac{10(29.06)(562.25)}{10.72(29.153)(531.9)}$
									Y = 0.984	

V_w = Gas volume passing through the wet test meter, ft.³

V_d = Gas volume passing through the dry gas meter, ft.³

t_w = Temperature of the gas in the wet test meter, ° F

t_{d_i} = Temperature of the inlet gas of the dry gas meter, °F

t_{d_o} = Temperature of the outlet gas of the dry gas meter, °F

t_d = Average temperature of the gas in the dry gas meter, obtained by the average of t_{d_i} and t_{d_o}, °F

H = Pressure differential across orifice, in. H_2O

Y_i = Ratio of accuracy of wet test meter to dry gas meter for each run

Y = Average ratio of accuracy of wet test meter to dry gas meter for all three runs; tolerance = pretest Y ± 0.05Y

P_b = Barometric pressure, in. Hg

θ = Time of calibration run, min.

STAKSAMPLR CALIBRATION SHEET

ENVIRONMENTAL TESTING, INC.	Valves ok
Date 08-19-85	Remarks: Calibrated by RJ
Pump ok visual Inspection ok	Positive leak check @ 4.7" H_2O OK
Pump Oil clean level ok	
Clean Quick Connects ok ; oiled	
Manometers ok levels ok	
Dry Test Meter ok see calibration data	
Thermometers ok calibrated 08-16-85	
Lights ok	
Electrical Check--Amphenol ok	
Variac ok	
Vacuum Gauge ok	
Leak Check at 27" Hg.---Leakage < 0.00	

Calibration--Orifice and Meter

08-19-85 Box No. 1965 P_b 29.163

CF_w	CF_d	T_w	IT_d	OT_d	T_d avg.	Time t
5	5.26	73.5	99.5	97.0	98.25	12.68
5	5.26	73.5	102.5	98.0	100.25	9.25
10	10.53	73.5	105.0	99.0	102.00	15.32
10	10.54	73.5	109.0	99.0	103.00	13.35
10	10.54	73.5	110.0	100.0	105.00	10.98
10	10.48	73.5	111.0	99.5	105.25	9.54

Calculate Y & $\Delta H_@$ as follows:

$$\frac{CF_w P_b (T_d \text{ avg.} + 460)}{P_d (P_b + \frac{\Delta H}{13.6}) (T_w + 460)} = \frac{1.00}{0.997} = 1.00$$

$$\frac{0.0317 \Delta H}{P_b} \cdot \frac{(T_d + 460)}{CF_w} \cdot \left[\frac{(T_d + 460)}{(T_w + 460)} \cdot t \right]^2 = 1.922 = 1.92$$

Tolerances

0.90 - 1.00 - 1.10 Y ± 0.02Y

1.6 - 1.84 - 2.1 $\Delta H_{@1}$ ± 0.15 in.

CALIBRATION CALCULATIONS METER AND PUMP BOX

Date 08-19-85 Box No. 1965

0.0317 (Man. orifice) / P_b (T_d + 460)	$\left[\frac{(T_w + 460)\,t}{CF_w}\right]^2$	Man.	$\Delta H_@$	$\frac{T_w\, CF_w\, P_b\, (T_d \text{ avg.} + 460)}{CF_d \left(P_b + \frac{\text{Man. orifice}}{13.6}\right)(T_w + 460)}$	Man.	Y
0.01585 / 29.183 (98.25 + 460)	$\left[\frac{(73.5 + 460)\,12.68}{5}\right]^2$	.5	1.781	$\frac{5 \text{ X } 29.183\ (98.25 + 460)}{5.26\ (29.183 + 0.0368)\ (73.5 + 460)}$	.5	0.993
0.0317 / 29.183 (100.25 + 460)	$\left[\frac{(73.5 + 460)\,9.25}{5}\right]^2$	1.0	1.889	$\frac{5 \text{ X } 29.183\ (100.25 + 460)}{5.26\ (29.183 + 0.0737)\ (73.5 + 460)}$	1.0	0.996
0.04755 / 29.183 (102.00 + 460)	$\left[\frac{(73.5 + 460)\,15.32}{10}\right]^2$	1.5	1.937	$\frac{10 \text{ X } 29.183\ (102.00 + 460)}{10.53\ (29.183 + 0.1103)\ (73.5 + 460)}$	1.5	0.997
0.06340 / 29.183 (103.00 + 460)	$\left[\frac{(73.5 + 460)\,13.35}{10}\right]^2$	2.0	1.957	$\frac{10 \text{ X } 29.183\ (103.00 + 460)}{10.54\ (29.183 + 0.1471)\ (73.5 + 460)}$	2.0	0.996
0.09510 / 29.183 (105.00 + 460)	$\left[\frac{(73.5 + 460)\,10.98}{10}\right]^2$	3.0	1.979	$\frac{10 \text{ X } 29.183\ (105.00 + 460)}{10.54\ (29.183 + 0.2206)\ (73.5 + 460)}$	3.0	0.997
0.12680 / 29.183 (105.25 + 460)	$\left[\frac{(73.5 + 460)\,9.54}{10}\right]^2$	4.0	1.941	$\frac{10 \text{ X } 29.183\ (105.25 + 460)}{10.48\ (29.183 + 0.2941)\ (73.5 + 460)}$	4.0	1.001

environmental testing inc.

TYPE S PITOT TUBE INSPECTION DATA FORM Date: 8/19/85

Specifications: Calibrator: PRH

1.) Pitot tube assembly must be level.
2.) If pitot tube is damaged explain under comments section.

Probe Length 4 ft. $z = A \sin\gamma$ <0.125 $w = A \sin\theta$ <0.03125

Probe#	α_1 (<10°)	α_2 (<10°)	β_1 (<5°)	β_2 (<5°)	γ°	θ°	A, in.	z, in.	w, in.	P_A, in.	P_B, in.	D_t, in.
1	1.0	1.0	2.0	2.0	0.5	0.5	0.956	0.008	0.008	0.478	0.478	0.377
2	3.0	1.0	2.0	2.0	1.0	0.5	0.911	0.016	0.008	0.456	0.455	0.374
3	0.5	0.5	0.5	2.5	0.5	0.5	0.898	0.008	0.008	0.449	0.449	0.375
4	1.0	3.5	0.5	3.0	1.0	1.0	0.878	0.015	0.015	0.439	0.439	0.375
5	1.5	1.5	2.0	1.0	1.0	0.0	0.874	0.015	0.000	0.437	0.437	0.374
6	1.0	2.5	0.5	0.5	0.5	0.5	0.969	0.008	0.008	0.484	0.485	0.375
Unattached 35"-2	1.5	1.0	0.5	1.0	0.5	1.0	1.199	0.010	0.021	0.600	0.599	0.377
Unattached 36"-1	1.5	1.0	0.5	0.0	1.0	0.5	0.789	0.014	0.007	0.394	0.395	0.376

Probe Length 5 ft. $z = A \sin\gamma$ <0.125 $w = A \sin\theta$ <0.03125

Probe#	α_1 (<10°)	α_2 (<10°)	β_1 (<5°)	β_2 (<5°)	γ°	θ°	A, in.	z, in.	w, in.	P_A, in.	P_B, in.	D_t, in.
1	0.5	0.5	0.5	0.5	3.5	0.5	1.045	0.063	0.009	0.522	0.523	0.375
2	1.0	1.0	0.5	0.0	0.5	0.5	1.044	0.009	0.009	0.522	0.522	0.375
3	3.0	2.0	0.5	0.5	0.5	0.0	1.028	0.009	0.0	0.514	0.514	0.375
4	2.5	2.0	0.5	0.5	2.5	0.5	1.051	0.046	0.009	0.525	0.526	0.375

Probe Length 6 ft. $z = A \sin\gamma$ <0.125 $w = A \sin\theta$ <0.03125

Probe#	α_1 (<10°)	α_2 (<10°)	β_1 (<5°)	β_2 (<5°)	γ°	θ°	A, in.	z, in.	w, in.	P_A, in.	P_B, in.	D_t, in.
1	2.0	2.0	0.0	0.0	1.0	0.5	1.003	0.018	0.009	0.501	0.502	0.375
2	2.0	2.0	0.5	0.5	1.0	0.5	1.025	0.018	0.009	0.513	0.512	0.375
3	2.5	1.5	0.5	0.5	2.0	0.5	1.007	0.035	0.009	0.503	0.504	0.375
4	1.0	0.5	1.0	0.5	0.5	1.0	1.001	0.009	0.017	0.501	0.500	0.375
(AC) Unattached 54"-1	1.0	1.5	0.5	0.5	0.5	0.5	1.009	0.009	0.009	0.504	0.504	0.375
Unattached 66"-2	2.5	2.0	3.0	2.0	0.5	1.0	1.127	0.010	0.020	0.563	0.564	0.378

Comments: None damaged

Pitot tubes requiring calibration: None

NOZZLE CALIBRATION

Date: 9/11/02

Calibrator: JSM

Set # 1 Brown Box

Nozzle Diameter	D_1, in	D_2, in	D_3, in	D_4, in	D_5, in	ΔD, in	D avg.
3/16" #1	.187	.189	.189	.187	.188	.002	.188
#2	.190	.190	.189	.191	.191	.002	.190
#3	.186	.186	.185	.187	.186	.002	.186
1/4" #1	.250	.250	.251	.251	.250	.001	.250
#2	.253	.252	.251	.252	.251	.002	.252
#3	.251	.251	.251	.251	.251	.000	.251
5/16" #1	.299	.300	.300	.300	.301	.002	.300
2	.301	.301	.301	.302	.302	.001	.301
3	.302	.302	.302	.302	.302	.000	.302
3/8" #1	.376	.374	.376	.376	.376	.002	.376
#2	.377	.376	.377	.376	.377	.001	.377
#3	.376	.377	.376	.375	.377	.002	.376
13/32" #0	.405	.405	.405	.406	.405	.001	.405
1/2" #1	.503	.505	.503	.504	.505	.002	.504
#2	.502	.502	.502	.502	.502	.000	.502
#3	.502	.501	.502	.502	.502	.000	.502
5/8"	.617	.619	.619	.619	.619	.002	.619
3/4"	.782	.782	.783	.782	.781	.002	.782
1"	1.002	1.000	1.002	1.002	1.001	.002	1.002

Set # 2 Blue Box

Nozzle Diameter	D_1, in	D_2, in	D_3, in	D_4, in	D_5, in	ΔD, in	D avg.
3/16" #1	.183	.184	.185	.184	.184	.002	.184
#2	.185	.185	.185	.184	.185	.001	.185
#3	.186	.186	.186	.185	.186	.001	.186
1/4" #1	.251	.252	.253	.252	.251	.002	.252
#2	.253	.253	.254	.253	.253	.001	.253
#3	.253	.252	.252	.252	.253	.001	.252
5/16" #1	.304	.304	.305	.306	.306	.002	.305
#2	.302	.303	.304	.303	.303	.001	.303
#3	.304	.304	.305	.304	.304	.001	.304
3/8" #1	.379	.380	.380	.379	.380	.001	.380
#2	.378	.378	.376	.378	.377	.002	.377
#3	.374	.375	.376	.375	.374	.002	.375
1/2" #1	.498	.498	.499	.497	.499	.002	.498
#2	.498	.498	.499	.499	.499	.001	.499
#3	.498	.497	.498	.496	.498	.002	.497

Where:

$D_{1,2,3,4,5}$ = nozzle diameter measured on a different diameter, in.
Tolerance = measure within 0.001 in.

D = maximum difference in any two measurements, in.
Tolerance = 0.004 in.

D_{avg} = average of D_1, D_2, D_3, D_4, and D_5.

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POST-TEST THERMOMETER CALIBRATION

Client Johnson Controls Date 10-5-85

Location Abort Tunnel Ref Thermometer 22

Thermometer	Reading, °F	Ref. Temp. (Ambient) ° F
Meter box 1965 A	74	74
Meter box 1965 B	74	74
Impinger #1	76	74
Impinger #2	74	74
WB	—	—
DB	—	—
Box #4	74	74
Box #5	75	74
Box #6	75	74
Box	—	—
WB Omega	75	74
DB Omega	75	74
Probe 8' No. 1	75	74
Probe	—	—
Impinger #3	74	74

environmental testing inc.

PRETEST THERMOMETER CALIBRATION

Client Johnson Controls Date 10/2/85

Location Winston - Salem Ref Thermometer #22

Thermometer	Reading, °F	Ref. Temp. (Ambient) ° F
Meter box 1965A	76	78
Meter box 1965B	77	78
Impinger #1	76	78
Impinger #2	75	78
WB #1	77	78
DB #1	78	78
Box #4	77	78
Box #5	79	78
Box #6	76	78
Box	—	—
WB Omega	77	78
WB Omega	78	78
Probe 8' #1	75	75
Probe 8' #2	75	75
Impinger #3	75	78

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 08-16-85 Thermocouple number Below

Ambient temperature 77 °F Barometric pressure 29.24 in. Hg

Calibrator PRJ Reference: mercury-in-glass #22

other

Reference point number[a]		Source[b] (specify)	Reference thermometer temperature, °F	Thermocouple potentiometer temperature, °F	Temperature difference,[c] %
4'-1	a.	0:1 Bath	86	86	0.0
	b.	0:1 Bath	271	269	0.27%
	c.	0:1 Bath	379	376	0.36%
4'-2	a.	0:1 Bath	86	86	0.0
	b.	0:1 Bath	271	272	-0.14%
	c.	0:1 Bath	379	381	-0.24%
5'-1	a.	0:1 Bath	86	86	0.0
	b.	0:1 Bath	271	271	0.0
	c.	0:1 Bath	379	381	-0.24%
5'-2	a.	0:1 Bath	86	86	0.0
	b.	0:1 Bath	271	271	0.0
	c.	0:1 Bath	379	381	-0.24%
6'-1	a.	0:1 Bath	86	86	0.0
	b.	0:1 Bath	271	270	0.14%
	c.	0:1 Bath	380	382	-0.24%
6'-2	a.	0:1 Bath	86	86	0.0
	b.	0:1 Bath	271	271	0.0
	c.	0:1 Bath	380	381	-0.12%
8'-1	a.	0:1 Bath	86	86	0.0
	b.	0:1 Bath	271	270	0.14%
	c.	0:1 Bath	381	381	0.0
8'-2	a.	0:1 Bath	86	86	0.0
	b.	0:1 Bath	271	272	-0.14%
	c.	0:1 Bath	380	380	0.0
8'-3	a.	0:1 Bath	86	86	0.0
	b.	0:1 Bath	271	270	0.14%
	c.	0:1 Bath	380	380	0.0
8'9"	a.	0:1 Bath	86	86	0.0
	b.	0:1 Bath	271	271	0.0
	c.	0:1 Bath	382	381	0.24%
9'7"	a.	0:1 Bath	86	86	0.0
	b.	0:1 Bath	271	272	-0.14%
	c.	0:1 Bath	383	381	0.24%

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

[b] Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °F} + 460) - (\text{test thermom temp, °F} + 460)}{\text{ref temp, °F} + 460}\right] 100 \leq 1.5\%$.

METER BOX TEMPERATURE SENSOR CALIBRATION DATA FORM
TOLERANCE: ± 5.4 F

Date 08-14-85 Thermocouple number N1

Ambient temperature 73 °F Barometric pressure 29.24 in. Hg

Calibrator PEJ-FLH Reference: mercury-in-glass #22

other

Reference point number[a]		Source[b] (specify)	Reference thermometer temperature, °F	Thermocouple potentiometer temperature, °F	Temperature difference,[c] %
1264 A	a.	Oil Bath	42	43	-0.20%
	b.	Oil Bath	73	73	0.0
	c.	Oil Bath	117	116	0.17%
1264 B	a.	Oil Bath	42	42	0.0
	b.	Oil Bath	73	73	0.0
	c.	Oil Bath	117	116	0.17%
1348 A	a.	Oil Bath	42	42	0.0
	b.	Oil Bath	73	73	0.0
	c.	Oil Bath	117	116	0.17%
1348 B	a.	Oil Bath	42	42	0.0
	b.	Oil Bath	73	72	0.19%
	c.	Oil Bath	117	115	0.35%
1401 A	a.	Oil Bath	42	42	0.0
	b.	Oil Bath	73	73	0.0
	c.	Oil Bath	117	117	0.0
1401 B	a.	Oil Bath	42	41	0.0
	b.	Oil Bath	73	73	0.20%
	c.	Oil Bath	117	116	0.17%
1965 A	a.	Oil Bath	42	42	0.0
	b.	Oil Bath	73	71	0.38%
	c.	Oil Bath	117	115	0.35%
1965 B	a.	Oil Bath	42	41	0.20%
	b.	Oil Bath	73	72	0.19%
	c.	Oil Bath	117	115	0.38%

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

[b] Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °F} + 460) - (\text{test thermom temp, °F} + 460)}{\text{ref temp, °F} + 460}\right] 100 \leq 1.5\%$.

WET-BULB & DRY-BULB
TEMPERATURE SENSOR CALIBRATION DATA FORM
TOLERANCE: ± 3 C. (±5.4 F.)

Date 08-16-85 Thermocouple number NA

Ambient temperature 76 F Barometric pressure 29.24 in. Hg

Calibrator PRJ Reference: mercury-in-glass #22

other

Reference point number[a]		Source[b] (specify)	Reference thermometer temperature, F	Thermocouple potentiometer temperature, F	Temperature difference,[c] %
Omegatemp					
D_{b1}	a.	oil Bath	76	76	0.0
	b.	oil Bath	222	223	-0.15%
	c.	oil Bath	275	277	-0.27%
W_{b1}	a	oil Bath	76	76	0.0
	b.	oil Bath	222	222	0.0
	c.	oil Bath	275	275	0.0
D_{b2}	a.	oil Bath	76	76	0.0
	b.	oil Bath	222	222	0.0
	c.	oil Bath	275	275	0.0
W_{b2}	a.	oil Bath	76	76	0.0
	b.	oil Bath	222	224	-0.29%
	c.	oil Bath	275	276	-0.14%
Bimetallic					
D_{b1}	a.	oil Bath	76	76	0.0
	b.	oil Bath	222	221	0.15%
	c.	oil Bath	274	271	0.41%
W_{b1}	a.	oil Bath	76	76	0.0
	b.	oil Bath	222	221	0.15%
	c.	oil Bath	274	270	0.54%
D_{b2}	a.	oil Bath	76	75	0.19%
	b.	oil Bath	222	222	0.0
	c.	oil Bath	274	274	0.0
W_{b2}	a.	oil Bath	76	76	0.0
	b.	oil Bath	222	219	0.44%
	c.	oil Bath	274	269	0.68%

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

[b] Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, F} + 460) - (\text{test thermom temp, F} + 460)}{\text{ref temp, F} + 460}\right] 100 \leq 1.5\%$.

IMPINGER TEMPERATURE SENSOR CALIBRATION DATA FORM

TOLERANCE: ± 2.0 F.

Date 08-14-85 Thermocouple number NA

Ambient temperature 76 °F Barometric pressure 29.24 in. Hg

Calibrator PRJ Reference: mercury-in-glass #22

other

Reference point number[a]		Source[b] (specify)	Reference thermometer temperature, °F	Thermocouple potentiometer temperature, °F	Temperature difference,[c] %
#1	a.	0:1 Bath	76	76	0.0
	b.	0:1 Bath (iced)	54	54	0.0
	c.	0:1 Bath (iced)	36	36	0.0
#2	a.	0:1 Bath	76	76	0.0
	b.	0:1 Bath (iced)	54	55	-0.19%
	c.	0:1 Bath (iced)	36	37	-0.20%
#3	a.	0:1 Bath	76	76	0.0
	b.	0:1 Bath (iced)	54	55	-0.19%
	c.	0:1 Bath (iced)	36	37	-0.20%
#4	a.	0:1 Bath	76	74	0.0
	b.	0:1 Bath (iced)	54	54	0.0
	c.	0:1 Bath (iced)	36	36	0.0
#5	a.	0:1 Bath	76	78	-0.37%
	b.	0:1 Bath (iced)	54	57	-0.58%
	c.	0:1 Bath (iced)	36	38	-0.40%

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

[b] Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °F} + 460) - (\text{test thermom temp, °F} + 460)}{\text{ref temp, °F} + 460}\right] 100 \leq 1.5\%$.

BOX TEMPERATURE SENSOR CALIBRATION DATA FORM
TOLERANCE: ±5.4 F

Date 08-16-85 Thermocouple number NA

Ambient temperature 77 °F Barometric pressure 29.24 in. Hg

Calibrator PRJ Reference: mercury-in-glass #32

other

Reference point number[a]		Source[b] (specify)	Reference thermometer temperature, °F	Thermocouple potentiometer temperature, °F	Temperature difference,[c] %
#1	a.	oil Bath	77	77	0.0
	b.	oil Bath	224	223	0.15%
	c.	oil Bath	275	274	0.14%
#2	a.	oil Bath	77	77	0.0
	b.	oil Bath	224	223	0.15%
	c.	oil Bath	275	269	0.82%
#3	a.	oil Bath	77	77	0.0
	b.	oil Bath	224	220	0.58%
	c	oil Bath	275	274	0.14%
#4	a.	oil Bath	77	77	0.0
	b.	oil Bath	223	221	0.29%
	c.	oil Bath	275	272	0.41%
#5	a.	oil Bath	77	77	0.0
	b.	oil Bath	223	223	0.0
	c.	oil Bath	276	276	0.0
#6	a.	oil Bath	77	77	0.0
	b.	oil Bath	223	222	0.15%
	c.	oil Bath	276	275	0.14%
#7	a.	oil Bath	77	76	0.19%
	b.	oil Bath	223	221	0.29%
	c.	oil Bath	276	271	0.68%
#8	a.	oil Bath	77	74	0.56%
	b.	oil Bath	222	219	0.44%
	c.	oil Bath	276	269	0.95%
Spare	a.	oil Bath	77	77	0.0
	b.	oil Bath	222	222	0.0
	c.	oil Bath	276	276	0.0
Hot Box	a.	oil Bath	77	76	0.19%
	b.	oil Bath	222	218	0.59%
	c.	oil Bath	276	268	1.09%

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

[b] Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °F} + 460) - (\text{test thermom temp, °F} + 460)}{\text{ref temp, °F} + 460}\right] 100 \leq 1.5\%$.