Background Report Reference

AP-42 Section Number: 12.15

Background Chapter: 4

Reference Number: 22

Title: Non-Compliance Lead Emission Rate, COS Line #4, Johnson Controls, Inc., Tampa, FL

PACE Laboratories

1988

Not NSPS (10)

TEST REPORT

NON COMPLIANCE LEAD EMISSION RATE

COS Line #4 (S/N 204)
10215 North 30th Street
Tampa, Florida 33687

Test Date: February 15, 1988

Project Number: 280215.403

Report Prepared for:

Johnson Controls, Inc.
P. O. Box 16068
Tampa, Florida 33687

Report Prepared by:

PACE Laboratories, Inc.
5460 Beaumont Center Boulevard
Tampa, Florida 33634

March 31, 1988

TABLE OF CONTENTS

SECTION 1.0

TEST SUMMARY

On Februaray 15, 1988, PACE Laboratories, Inc. conducted NON-COMPLIANCE Lead emissions tests at Johnson Controls, Inc., 10215 North 30th Street, Tampa, Florida. Tests were conducted on the COS Line #4 (S/N 204).

Test team personnel for this test include:

Thomas A. Jackman, Ph.D.	Technical Director
Michael C. Jackman	Team Leader
James E. Franklin	Technician

The results of the Particulate and Lead emissions tests are summarized in the following table.

Date	Operation	Parameter	Actual Emission Rate*
2/15/88	COS #4	Lead	1.93×10^{-4}

* = gr/dscf except for opacity (%)

Respectfully submitted,

PACE Laboratories, Inc.

Timothy M. O'Dell
Project Manager

Thomas A. Jackman, Ph.D.
Director, Florida Division

pace laboratories, inc.

REPORT OF LABORATORY ANALYSIS

Offices:
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa

Source Test Summary

Company Name: Johnson Controls, Inc.

Source Identification: COS Line #4 (S/N 204)

Test Parameter: Lead

Process Weight Rate: UNKNOWN

Test Date: February 15, 1988

RUN NUMBER	1	2	3	Average
SCF	3.6780E+01	3.6405E+01	3.6614E+01	3.6600E+01
ACFM	2.91E+04	2.92E+04	2.92E+04	2.92E+04
WATER, %	1.88E+00	3.13E+00	2.87E+00	2.63E+00
ISOKINETIC, %	9.97E+01	9.99E+01	1.00E+02	1.00E+02
EMISSIONS, GR/DSCF	2.97E-04	1.65E-04	1.18E-04	1.93E-04
EMISSIONS, LB/HR	7.12E-02	3.92E-02	2.81E-02	4.62E-02

EMISSION SUMMARY:

Lead, gr/dscf

Actual: 1.93E-04 ✓

SECTION 2.0

Source Description

SOURCE DESCRIPTION

Johnson Controls, Inc., Globe Battery Division, operates a lead-acid storage battery manufacturing facility at 10215 North 30th Street, Tampa, Florida.

At this location, lead pigs are received, melted and cast to form lead grids. Bulk lead oxide is received from off site and is also produced on site in a ball mill. Lead oxide is mixed with sulfuric acid and is applied as a paste to the lead grids. These grids are then used in the production of lead-acid storage batteries for automotive and marine applications.

COS Line #4 (S/N 204)

The Cast-On-Strap (COS) machine was developed by Globe Union, Inc. to replace gas torches used to weld pre-cast post to cell element lugs. This machine casts the straps and posts and fuses them to the lugs ready for insertion into containers. This produces finished cell elements for through-partition (HV), and over, or conventional post and link intercell connectors.

The Cast-On-Strap machine consists of a separate lead melting furnace (electrically heated) mounted in close proximity to two lead dispensing pots (electrically heated). These two lead dispersing pots are fed lead by automatic mechanical devices from the main lead furnace.

The element loading station, loaded by an operator taking elements produced from the Globe/Reed Stacker, properly aligns and squares up each cell element before processing through succeeding operations. This machine is designed for production of high volume, 12 or 6 volt battery types. Each station and operation of this machine handles six elements simultaneously. When the elements are properly aligned, a set of pick-up clamps mounted on a four position rotating arm assembly transfers the element to a flux station, a casting station, and an unloading station.

The emissions from the COS Line #4 are controlled by an AAF-12-228-4618 Model B baghouse.

SECTION 3.0

Methodology

3.1 GENERAL SAMPLING METHODOLOGY

Sampling methodologies as described in the latest revision of the Florida Department of Environmental Regulation publication Standard Sampling Techniques and Methods of Analysis for the Determination of Air Pollutants from Point Sources and U. S. Environmental Protection Agency Regulations found in 40CFR Part 60 (Standards of Performance for New Stationary Sources) Appendix A, Reference Methods, were used in conducting this test.

The test was conducted using a Lear Siegler Model PM100 Manual Stack Sampler.

Gas stream velocity is measured using a Type S pitot tube. Differential pressures for velocity determinations and in maintaining the proper orifice pressure are measured using a five inch incline manometer. The probe nozzle, probe liner, and pitot tubes are all constructed of type 316 stainless steel.

A Whatman EMS 2000 glass fiber filter is supported in a borosilicate glass heated filter holder for particulate collection. During a test run, the temperature of the filter assembly is maintained at 248 $\pm$ 25°F. The condenser train consists of four impingers connected in series. The first, third, and fourth impingers are of the modified Greenburg-Smith type while the second impinger is of standard design. In all testing situations, the fourth impinger contains a known weight of silica gel (typically 200g). The contents of the first and second impingers depends on the nature of the test being conducted. The third impinger is usually empty. The condenser system is immersed in an ice bath to maintain the gas exit temperature at or below 68°F during all sampling runs.

A leak check is performed before and after each run by blocking the nozzle and drawing the appropriate vacuum. All leakages are below 0.02 CFM at a vacuum exceeding the maximum vacuum encountered during the test cycle.

Prior to the first run, a velocity traverse was performed and appropriate calculations were made to determine the most suitable test conditions. The moisture content used for these calculations is based on the results of previous test on the same or similar sources.

At the end of each test run, the volume of water collected in the first, second, and third impingers was measured. Where appropriate, the contents of the impingers is transferred to a container for laboratory analysis. The silica gel desiccant in the fourth impinger is transferred to a tared bottle for transfer to the laboratory. The filter assembly is removed intact and transferred to the laboratory for filter removal. All components in the front half of the sample train (probe nozzle, probe liner, transfer lines) are rinsed with acetone or appropriate solution

when specified by a particular methodology and the washings saved for further analysis. A fresh filter is installed and the train assembled for the next run.

3.2 SPECIFIC SAMPLING METHODOLOGY

COS Line #4 (S/N 204)

Two (2) sampling ports are installed in a 48 inch diameter circular duct. The ports are positioned at 90° angles and are located 0.75 duct diameters from the closest downstream disturbance and 5.5 duct diameters from the closest upstream flow disturbance.

During each test run, 24 points are sampled along two (2) traverses. Each point was sampled for three (3) minutes.

3.3 ANALYTICAL METHODOLOGY

Lead Methodology

The analytical methodology employed is described below.

The filter and probe wash residue were retained for lead analysis. The volume of the impinger catch was reduced to approximately ten (10) milliliters. The probe wash residue and the particulate filter (cut in strips) and the impinger wash was taken to dryness. The dried residue of each sample was digested with 1:1 nitric acid and 3% hydrogen peroxide. The solutions were filtered and the filtrate diluted to 250 ml. A blank containing 0.1 N nitric acid and a blank filter was treated similarly.

The solutions generated above were analyzed for lead content by atomic absorption spectrophotometry using the Method of Standard Additions. The analysis was performed on an Instrumentation Laboratories Model 251 Atomic Absorption Spectrophotometer at the analytical wavelength for lead (217.0 nm).

3.4 STACK SAMPLING EQUIPMENT DESCRIPTION

a. Nozzle

Stainless steel, type 316, with a 0.225 inch diameter orifice as measure on site with a vernier caliper.

b. Probe

Five (5) foot type 316 stainless steel with a heater type 316 stainless steel liner.

c. Thermocouple

Chromel-Alumel K-type

d. Pitot Tube

Five foot type 316 stainless steel Strauschribe type.

e. Sample Collection Assembly

Contains separate hot and cold modules. The hot box houses the filter holder and is designed to maintain a temperature of 248±25°F. This temperature is monitored periodically during each test run. The cold box module houses the impinger train and ice bath. Impingers one, three, and four are modified Greenburg-Smith and the second is of standard design.

f. Lear Siegler Control Unit

This unit contains a diaphragm vacuum pump, dry gas meter, digital pyrometer, temperature controllers, and dual Dwyer Inclined Manometers (five inch).

3.5 LABORATORY PREPARATION

a. Glassware

Washed and dried prior to each stack test.

b. Filters

Oven dried at 105°C to constant weight (four hours minimum) and weighed to the nearest 0.5 mg. Tared filters are stored in a desiccator until used in a test.

c. Silica Gel

Dried at 250°F for two hours and stored in air tight containers until used.

d. Control Unit

Check operation of all systems.

3.6 SAMPLE RECOVER EQUIPMENT

a. Probe Brush

b. Water Wash Bottles

c. Sample Storage Bottles

d. Graduated Cylinder

e. Desiccator

f. Analytical Balances

   1. Mettler EL

   2. Mettler H1Ow

g. Filters

   Whatman EMS 2000 borosilicate glass fiber filters (10.16 cm diameter)

h. Silica Gel

   Indicating type, 6-16 mesh, dried at 350°F immediately before test.

i. Acetone, ACS Reagent Grade

j. Nitric Acid, ACS, Reagent Grade

k. Water, Deionized

l. Ice

SECTION 4.0

Test Data and Calculations

Source Testing Nomenclature and Dimensions

ACFM	=	Actual ft^3/min
A_n	=	Probe nozzle tip area, ft^2
A_s	=	Area of stack, ft^2
B_{ws}	=	Proportion of water vapor in gas stream by volume, dimensionless
C_p	=	Pitot Coefficient
Delta H	=	Average pressure differential across the orifice meter
I	=	Percent of Isokinetic sampling
M_d	=	Molecular weight of stack gas, dry basis
M_s	=	Molecular weight of stack gas, wet basis
$(\text{Delta p})^{1/2}$	=	Square root of velocity head, inches of H_2O
P_b	=	Barometric pressure, inches of Hg
P_s	=	Absolute stack pressure, inches of Hg
Q_{std}	=	Dry volumetric stack gas flow rate corrected to standard conditions
θ	=	Sampling time, minutes
SCF	=	V_m (standard)
SCFM	=	Q_{std}
T_m	=	Absolute meter temperature
T_s	=	Absolute stack temperature
V_f	=	Final volume of condenser water, ml
V_i	=	Initial volume, if any, of condenser water
V_m	=	Volume of total sample metered under actual conditions, ft^3
$V_m(std)$	=	Dry gas volume measured by the dry gas meter, corrected to standard conditions (dscf)
V_s	=	Gas stream velocity, ft/sec.

$V_{wc}(std)$	=	Volume of water vapor condensed corrected to standard conditions, scf.
Y	=	Dry gas meter calibration factor

EQUATIONS

Water Vapor Volume of Moisture Condensate

$$V_{wc}(std) = 0.047\ (V_t - V_i)$$

Moisture in Gas Stream

$$B_{ws} = \frac{V_{wc}(std)}{V_{wc}(std) + V_m\ (std)}$$

Wet Molecular Weight of Gas

$$M_s = M_d\ (1-B_{ws}) + B_{ws}$$

Gas Stream Velocity

$$V_s = 85.49\ (C_p)\ (\text{Delta P})^{1/2} \left(\frac{T_s}{P_s M_s}\right)_{avg}^{1/2}$$

Sample Gas Volume Corrected to Std. Conditions

$$V_m(std) = \frac{17.64\ V_m Y\ (P_b + \text{Delta H}/13.6)}{T_m}$$

% Isokinetic

$$I = 0.09450\ \frac{T_s V_m(std)}{P_s V_s A_n \theta\ (1-B_{ws})}$$

Stack Volumetric Flow Rate (ACFM)

$$ACFM = A_s \times V_s \times 60$$

Stack Volumetric Flow Rate (SCFM) corrected to std. cdts.

$$Q_{sd} = 60\ (1-B_{ws}) V_s A_s \left(\frac{528}{T_s}\right) \left(\frac{P_s}{29.92}\right)$$

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EPA Method 5 Field Data Sheet

Project Johnson Controls
Sample Location COS #4 Meth 12
Date 2-15-88 Test 2 Run 1
Operators Jackman Franklin

Train No. _____
C Factor _____
ΔP_R 0.70
Nozzle No. _____ D_n _____

Pitot Tube No. _____ Cp _____
Bar. Pres. _____ Ins. Hg
Static Pres. _____ Ins. H_2O
Estimated MC _____ %

Leak Check:
Pretest: 0.000 @ 15 Ins. Hg
Post-test: 0.000 @ 15 Ins. Hg

Point Number	Time ΔT	Meter Vol. V_m cu. ft.	Velocity Head-ΔP Ins. H_2O	√ΔP	ORIFICE ΔH		Vacuum Ins. Hg	Stack Temp. °F	Sampling Train Temperatures -- °F					Clock Time	
									Filter	Probe	Imp. Out	M/In	M/Out		
	(2½)	(300/182)													
1	2.5	301.4	0.30	~~0.77~~ 0.55	0.77		0	73	232	230	55	83	68	0915	
2	~~5~~	302.7	0.32	~~0.57~~ 0.57	0.83		0	74	234	230	53	85	68	0917	
3	7.5	304.2	0.39	0.62	1.01		0	77	232	230	54	85	68	0920	
4	10	305.5	0.43	0.66	1.11		0	78	230	230	55	86	68	0922	
5	12.5	306.9	0.46	0.68	1.20		0	78	230	230	55	88	69	0925	
6	15	308.4	0.46	0.68	1.20		0	78	230	230	56	89	69	0927	
7	17.5	310.0	0.54	0.73	1.41		0	79	232	230	55	90	70	0930	
8	20	311.7	0.56	0.75	1.48		0	79	232	234	55	91	71	0932	
9	22.5	313.4	0.58	0.76	1.51		0	79	230	230	55	92	72	0935	
10	25	315.0	0.60	0.77	1.55		0	79	230	233	54	93	72	0937	
11	27.5	316.7	0.57	0.75	1.50		0	80	232	233	55	92	72	0940	
12	30	318.4	0.555	0.74	1.42		0	80	233	232	55	92	73	0942	
13	32.5	319.6	0.28	0.53	0.72		0	77	230	230	57	87	73	0947	
14	35	321.0	0.39	0.62	1.01		0	79	231	232	56	89	73	0950	
15	37.5	322.4	0.39	0.62	1.01		0	79	232	233	56	91	74	0952	
16	40	323.7	0.36	0.60	0.94		0	79	232	234	56	91	74	0955	
17	42.5	325.2	0.48	0.70	1.25		0	80	230	230	56	91	73	0957	
18	45	326.8	0.50	0.71	1.31		0	80	230	232	57	91	74	1000	
19	47.5	328.4	0.52	0.72	1.38		0	80	231	233	57	91	74	1002	
20	50	330.0	0.53	0.73	1.39		0	80	232	234	56	92	75	1005	
21	52.5	331.7	0.53	0.73	1.39		0	81	230	232	57	93	75	1007	
22	55	333.3	0.53	0.73	1.39		0	81	231	232	57	93	75	1010	
23	57.5	335.0	0.55	0.74	1.42		0	81	232	232	57	93	75	1012	
24	60	336.593	0.51	0.71	1.31		0	81	232	232	56	93	75	1015	

θ = 60 V_m = 36.411 $\overline{\sqrt{\Delta P}}$ = 068 ΔH = 1.23 T_s = 79 T_m = 81

Samples Recovered: Filter Number _____ ; ☐ Probe Wash ; ☐ Wet Catch ; ☐ _____

Gas Sampling Data:

Box No. _____
Bag No. _____
Bag Vol. _____ Liters

Bag Material _____
Leak Check _____ cc @ 15" Hg
Post Test O_2 Reading _____ %
320 P No. _____

Moisture Recovery Data:

Impinger No.	1	2	3	4	Desiccant	Total
Final Vol.	102	47	0		218.8	
Initial Vol.	100	100	0		213.1	
Difference	62	-53	0		5.7	15

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EPA Method 5 Field Data Sheet

Project _____ Train No. _____ Pitot Tube No. _____ C_p _____ Leak Check:
Sample Location COS4 Meth 12 C Factor _____ Bar. Pres. _____ Ins. Hg Pretest: 0.000 @ 15 Ins. Hg
Date 2-15-88 Test 2 Run 2 ΔP_R 0.70 Static Pres. _____ Ins. H_2O Post-test: 0.000 @ 15 Ins. Hg
Operators Jackman Franklin Nozzle No. _____ D_n _____ Estimated MC _____ %

Point Number	Time ΔT	Meter Vol. V_m cu. ft.	Velocity Head-ΔP Ins. H_2O	$\sqrt{\Delta P}$	ORIFICE ΔH		Vacuum Ins. Hg	Stack Temp. °F	Sampling Train Temperatures – °F					Clock Time	
									Filter	Probe	Imp. Out	M/In	M/Out		
	(2.5)	(337.568)													
1	2.5	338.7	0.28	0.53	0.72		0	79	236	232	60	85	76	1042	
2	5	340.0	0.30	0.55	0.77		0	80	236	232	59	93	77	1045	
3	7.5	341.3	0.38	0.62	0.98		0	80	232	230	59	93	77	1047	
4	10	342.7	0.42	0.65	1.10		0	82	230	231	60	94	77	1050	
5	12.5	344.2	0.46	0.68	1.20		0	82	231	233	59	94	77	1052	
6	15	345.7	0.46	0.68	1.20		0	82	230	230	59	94	78	1055	
7	17.5	347.2	0.53	0.73	1.39		0	83	232	231	59	94	78	1057	
8	20	348.9	0.53	0.73	1.39		0	83	232	231	60	95	78	1100	
9	22.5	350.5	0.56	0.75	1.45		0	83	232	231	60	95	79	1102	
10	25	352.3	0.56	0.75	1.45		0	83	233	230	60	95	79	1105	
11	27.5	354.0	0.56	0.75	1.45		0	83	230	232	60	96	79	1107	
12	30	355.5	0.56	0.75	1.45		0	83	231	230	60	95	79	1110	
13	32.5	356.9	0.30	0.55	0.77		0	77	235	231	58	84	73	1130	
14	35	358.2	0.37	0.61	0.96		0	79	232	232	58	82	64	1132	
15	37.5	359.6	0.42	0.65	1.10		0	80	234	240	58	93	74	1135	
16	40	361.1	0.46	0.68	1.20		0	81	232	233	58	94	74	1137	
17	42.5	362.6	0.50	0.71	1.30		0	81	231	233	58	94	75	1140	
18	45	364.2	0.50	0.71	1.30		0	81	233	230	58	95	76	1142	
19	47.5	365.8	0.54	0.73	1.41		0	81	230	233	59	96	75	1145	
20	50	367.5	0.54	0.73	1.41		0	81	233	232	60	97	75	1147	
21	52.5	369.0	0.54	0.73	1.41		0	80	235	230	61	97	75	1150	
22	55	370.7	0.52	0.72	1.35		0	81	232	230	62	98	76	1152	
23	57.5	372.3	0.52	0.72	1.35		0	82	230	230	62	98	76	1155	
24	60	373.875	0.47	0.68	1.21		0	82	231	230	62	99	76	1157	

θ = 60 V_m = 36.307 $\sqrt{\Delta p_i}$ = 0.68 ΔH = 1.22 T_s = 81 T_m = 85

Samples Recovered: Filter Number _____ ; ☐ Probe Wash ; ☐ Wet Catch ; ☐ _____

Gas Sampling Data:

Box No. _____
Bag No. _____
Bag Vol. _____ Liters

Bag Material _____
Leak Check _____ cc @ 15" Hg
Post Test O_2 Reading _____ %
320 P No. _____

Moisture Recovery Data:

Impinger No.	1	2	3	4	Desiccant	Total
Final Vol.	107	110	1		22.2	
Initial Vol.	100	100	100		21.3	
Difference	7	10	1		0.9	25

Laboratories, inc.

EPA Method 5 Field Data Sheet

Project COS #4 Johnson Controls
Sample Location COS #4 Meth 12
Date 2-15-88 Test 2 Run 3
Operators Jackman, Franklin

Train No. _____
C Factor _____
ΔP_R 0.70
Nozzle No. _____ Dn _____

Pitot Tube No. _____ Cp _____
Bar. Pres. _____ Ins. Hg
Static Pres. _____ Ins. H_2O
Estimated MC _____ %

Leak Check:
Pretest: 0.000 @ 15 Ins. Hg
Post-test: 0.000 @ 15 Ins. Hg

Point Number	Time ΔT	Meter Vol. V_m cu. ft.	Velocity Head–ΔP Ins. H_2O	√ΔP	ORIFICE ΔH		Vacuum Ins. Hg	Stack Temp. °F	Sampling Train Temperatures – °F					Clock Time	
									Filter	Probe	Imp. Out	M/In	M/Out		
	(2.5)	(374.647)													
1	2.5	375.8	0.26	0.51	0.67		0	74	231	230	63	82	75	1220	
2	5	377.1	0.36	0.60	0.93		0	78	232	231	60	95	75	1222	
3	7.5	378.5	0.38	0.62	0.98		0	80	231	232	59	97	75	1225	
4	10	380.0	0.43	0.65	1.11		0	81	230	232	59	98	76	1227	
5	12.5	381.4	0.45	0.67	1.18		0	81	231	235	60	99	76	1230	
6	15	382.9	0.50	0.71	1.30		0	82	232	233	60	99	76	1232	
7	17.5	384.6	0.51	0.71	1.31		0	82	235	235	59	99	76	1235	
8	20	386.2	0.56	0.75	1.47		0	82	233	235	59	99	76	1237	
9	22.5	387.9	0.56	0.75	1.47		0	82	231	232	60	99	76	1240	
10	25	389.6	0.56	0.75	1.47		0	82	232	230	59	99	76	1242	
11	27.5	391.3	0.59	0.77	1.52		0	82	233	230	60	99	76	1245	
12	30	392.8	0.51	0.71	1.38		0	82	230	231	60	99	76	1247	
13	32.5	394.1	0.28	0.53	0.72		0	78	231	230	61	91	76	1250	
14	35	395.7	0.36	0.60	0.93		0	80	232	232	60	96	76	1252	
15	37.5	396.9	0.43	0.65	1.11		0	81	230	231	60	98	76	1255	
16	40	398.3	0.45	0.67	1.18		0	82	232	232	60	99	76	1257	
17	42.5	400.0	0.50	0.71	1.30		0	82	234	234	60	99	77	1300	
18	45	401.5	0.50	0.71	1.30		0	82	231	232	60	99	77	1302	
19	47.5	403.0	0.51	0.71	1.31		0	82	232	235	60	99	77	1305	
20	50	404.6	0.53	0.73	1.39		0	82	234	232	61	99	77	1307	
21	52.5	406.4	0.54	0.73	1.41		0	82	231	231	62	100	77	1310	
22	55	408.2	0.54	0.73	1.41		0	82	232	230	62	100	77	1312	
23	57.5	409.6	0.51	0.71	1.31		0	83	231	230	63	100	77	1315	
24	60	411.296	0.51	0.71	1.31		0	83	232	230	63	100	77	1318	

Θ = 60 V_m = 36.649 $\overline{\sqrt{\Delta P}}$ = 0.68 ΔH = 1.22 $\overline{T_s}$ = 81 $\overline{T_m}$ = 87

Samples Recovered: Filter Number _____ ; ☐ Probe Wash ; ☐ Wet Catch ; ☐ _____

Gas Sampling Data:

Box No. _____
Bag No. _____
Bag Vol. _____ Liters

Bag Material _____
Leak Check _____ cc @ 15" Hg
Post Test O_2 Reading _____ %
320 P No. _____

Moisture Recovery Data:

Impinger No.	1	2	3	4	Desiccant	Total
Final Vol.	111	103	1		221.3	
Initial Vol.	100	100	0		213.2	
Difference	11	3	1		8.1	23

pace laboratories, inc.

Offices:
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa

REPORT OF LABORATORY ANALYSIS

Source Test Data Summation

Company Name:	Johnson Controls, Inc.
Source Identification:	COS Line #4 (S/N 204)
Source Test For:	Lead
Test Date:	February 15, 1988

	RUN NUMBER	1	2	3
V(w)	Volume of moisture collected, ml	1.50E+01	2.50E+01	2.30E+01
T(m)	Average Meter Temperature, °F	81	85	87
V(m)	Actual Sample Volume, cu. ft.	3.6411E+01	3.6307E+01	3.6649E+01
GC	Dry Gas Meter Coefficient	1.03E+00	1.03E+00	1.03E+00
P(b)	Barometric Pressure, inches Hg	29.90	29.90	29.90
P(m)	Pressure across orifice, in Hg	1.23	1.22	1.22
A(s)	Stack Diameter, inches	48.0	48.0	48.0
A(n)	Probe Nozzle Diameter, inches	0.225	0.225	0.225
T(s)	Stack Temperature, ave °F	79	81	81
mg	Weight of Lead, mg	0.71	0.39	0.28
t	Sampling Time, min.	60	60	60
√dP	Velocity Head, √(ave), in. water	0.680	0.680	0.680
P(s)	Stack Pressure, Ave inches Hg	29.93	29.93	29.93

CALCULATIONS

RUN NUMBER	1	2	3
SCF Sampled	3.6780E+01	3.6405E+01	3.6614E+01
Water, %	1.9	3.1	2.9
Gas Molecular Weight	28.76	28.62	28.65
Gas Stream Velocity	3.86E+01	3.88E+01	3.88E+01
ACFM	2.91E+04	2.92E+04	2.92E+04
SCFM	2.80E+04	2.77E+04	2.77E+04
Isokinetic, %	100	100	100
Emissions, gr/dscf	2.97E-04	1.65E-04	1.18E-04
Emissions, lb/hr	7.12E-02	3.92E-02	2.81E-02

APPENDIX A

Calibration Data

NOZZLE DIAMETER CALIBRATION DATA

Client: Johnson Controls, Inc.
Source I.D.: COS Line #4 (S/N 204)
Test Date: February 15, 1988
Computed By: Michael C. Jackman

	Nozzle Diameter						
DATE	1	2	3	4	5	6	Average
2/15/88	0.226	0.224	0.225	0.225	0.225	0.224	0.225

SUMMARY OF SAMPLING EQUIPMENT CALIBRATION

Equipment Calibration	Date of Calibration	Place of Calibration	Method of Calibration	Calibration Date
Nozzle	2/15/88	On Site	Vernier Caliper Ave.	See Following
Pitot Tube	2/3/88	PACE	FDER Alt. Method	$C_p = 0.84$
Dry Gas Meter and Orifice	3/1/88	PACE	Wet Test Meter JU	MCF = 1.033
Barometer	----	Tampa Airport	----------	@ 12 noon
Thermocouples	1/88	PACE	Calibrated at ambient and boiling water temperatures against ASTM mercury bulb thermometer	± 5°F
Nomograph Accuracy	1/88	PACE	EPA Pub. "Adjustments in the EPA Nomograph for different Pitot Tube Coeff. and Dry Molecular Weights	± 10%

pace laboratories, inc.
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa

DRY GAS METER AND ORIFICE CALIBRATION

Calibration Date: March 1, 1988
Calibrated by: Michael Jackman

Barometric Pressure: 30.18 in Hg
Calibration Time: 15 min

WET TEST METER					DRY GAS METER							CALIBRATION	
Initial Vol	Final Vol	Vw	dW	Tw °F	Initial Vol	Final Vol	Vm	dH	T in	T out	Tm ave	MCF	dH@
0.000	6.192	6.192	0.30	71.3	722.278	728.281	6.003	0.50	97	71	84.0	1.044	1.638
0.000	7.598	7.598	0.35	71.3	728.281	735.697	7.416	0.75	101	76	88.5	1.044	1.617
0.000	8.509	8.509	0.40	71.2	735.697	744.072	8.375	1.00	104	76	90.0	1.035	1.718
0.000	10.209	10.209	0.40	71.3	744.072	754.207	10.135	1.50	106	77	91.5	1.028	1.788
0.000	11.715	11.715	0.45	71.3	754.207	765.845	11.638	2.00	108	79	93.5	1.028	1.804
0.000	13.221	13.221	0.50	71.5	780.303	793.252	12.949	2.50	99	75	87.0	1.027	1.785
0.000	14.354	14.354	0.50	71.5	807.505	821.799	14.294	3.00	110	79	94.5	1.023	1.803
											AVERAGE	1.033	1.736

dH = Orifice Pressure — inches water
dW = Pressure (-) at Wet Test Meter — inches Hg
Vm = Gas Volume, Dry Gas Meter — cubic feet
Vw = Gas Volume, Wet Test Meter — cubic feet
Tw = Temperature, Wet Test Meter — °F
Tm = Temperature, Dry Gas Meter — °F
t = Calibration Time — minutes
MCF = Meter Correction Factor
dH@ = Standard Orifice Pressure Differential
0.75 CFM dry air @70°F, 29.92 inches Hg

$$MCF = [Vw*(Tm+460)*(Pb-dW)]/[Vm*(Tw+460)*(Pb+dH/13.6)]$$

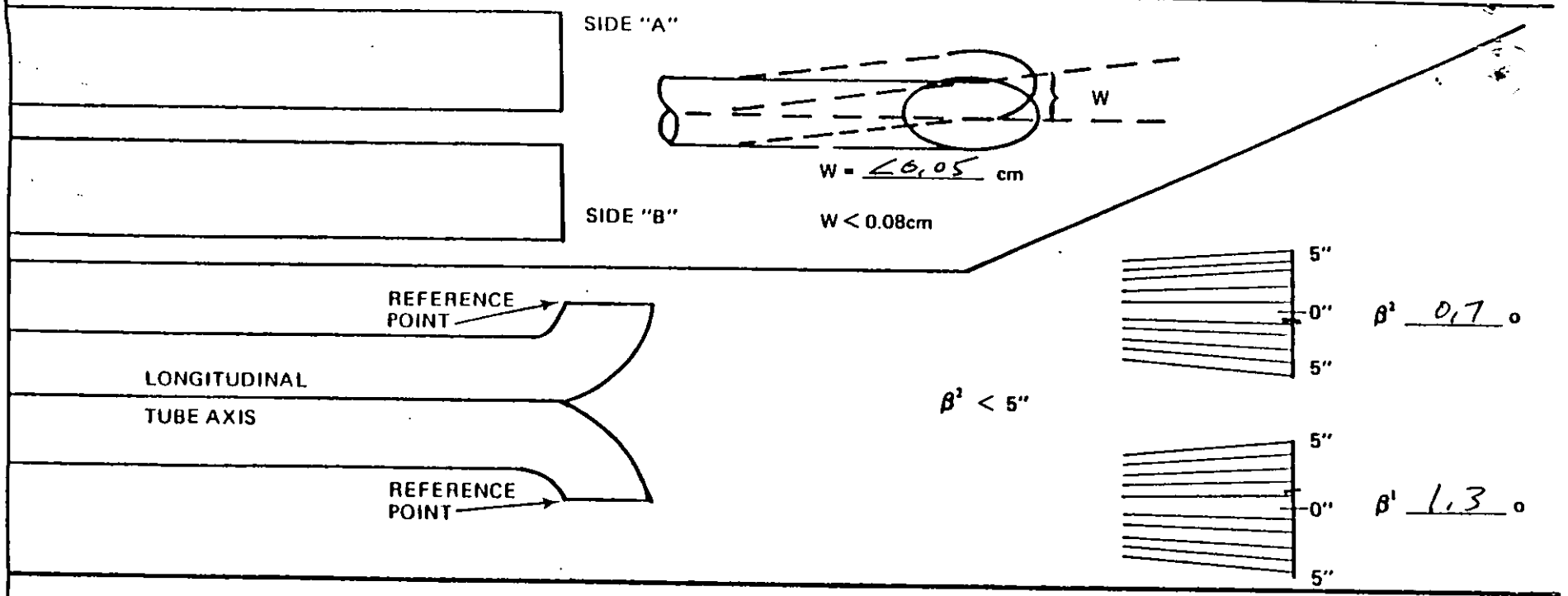
$$dH@ = [(0.0317*dH/(Pb*(Tmout+460))][(Tw+460)*t/Vw]^2$$

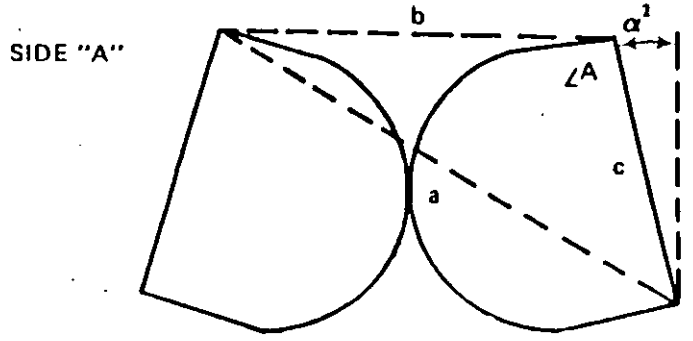
SOURCE SAMPLING PITOT TUBE CALIBRATION

ALIGNMENT MEASUREMENT OF FACE-OPENINGS

DATE: 2/3/88

S/N: 5' pitot tube





a = 1.125 cm

b = 1.075 cm

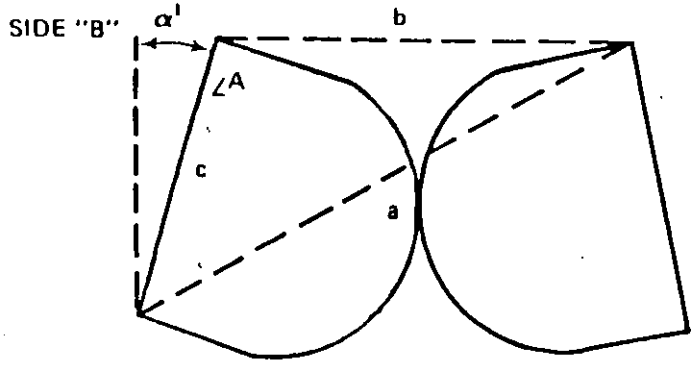
c = 0.460 cm

∠A = 84 °

$\alpha^2 = 180^\circ - (180^\circ - \angle A) + 90^\circ$

$\alpha^2 =$ −6 °

$\alpha^2 < 10^\circ$



a = 1.135 cm

b = 1.075 cm

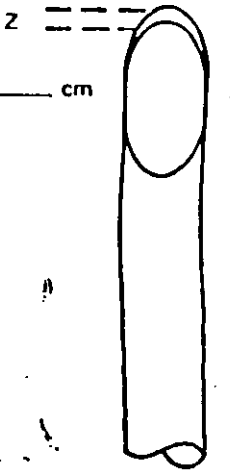
c = 0.490 cm

∠A = 84.1 °

$\alpha^1 = 180^\circ - (180^\circ - \angle A) + 90^\circ$

$\alpha^1 =$ −5.9 °

$\alpha^2 < 10^\circ$



Z = _____ cm

Z < 0.32cm