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COMPLIANCE EMISSION TESTING
FOR
HCA NORTH PARK HOSPITAL
HIXSON, TENNESSEE
FEBRUARY 16, 1988

Submitted By:

AIR SYSTEMS TESTING, INC.
P.O. Box 6278
Marietta, GA 30065
(404) 426-0447

BRUCE LAWRIE

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INTRODUCTION

On Tuesday, February 16, 1988, Air Systems Testing, Inc. (AST), of Marietta, Georgia, performed compliance emission testing on the Simonds Model 750B pathological waste incinerator located at the HCA North Park Hospital, Hixson, Tennessee. The testing was performed to determine if particulate and opacity emission levels were within the allowable rates defined by the Chattanooga-Hamilton County Air Pollution Control Bureau and per the incinerator permit number 4850-50200101-01. Testing was also perfromed for HCl and Cl_2 emissions, although there is presently no emission limits for those pollutants. AST field test personnel were Bruce Lawrie and Tom Soulsby. Opacity data was taken by Tom Yaroch.

AST would like to thank Mr. Teddy Burns and his associates at the North Park Hospital, Mr. Bob Ashworth and Mr. Mike Cooper, both with Simonds Manufacturing Company, for their assistance and cooperation throughout the testing program. We would also like to thank Mr. Jim Weyler with the Chattanooga Air Pollution Control Bureau for his review of the test procedures and incinerator operation.

SUMMARY OF TEST RESULTS

Particulates:

The summary of the results of the testing can be found below and on the following page. Below is shown the results of each of the three test repetitions and the total of the three (which is used to determine compliance with the applicable regulations). The results are shown in pounds of particulate emissions based on three, one hour test repetitions. The allowable emission rate is based upon 0.1 pounds of emissions per 100 pounds of incinerator charge. On the day it was tested, the incinerator was charged with 323 pounds of waste.

Test No.	Particulate Emission Rate (pounds)	Allowable Emission Rate (pounds)
1	0.020	
2	0.029	
3	0.025	
TOTAL:	0.074	0.323

Thus, from the above table, the Simonds Model 750B incinerator located at the HCA North Park Hospital, Hixson, Tennessee is within allowable standards for particulate emissions.

Opacity:

Opacity emissions were determined during each particulate test. All readings were zero. Thus, the incinerator is also with allowable standards for opacity emissions.

:

SUMMARY OF TEST RESULTS
North Park Hospital

	Test #1	Test #2	Test #3
Volume @ Meter (Vm):	35.086	35.447	33.487
Sqrt Delta P:	0.304	0.305	0.282
Sampling Time (min):	60	60	60
Barometric Pressure (Pb):	29.30	29.30	29.30
Delta H (H):	1.23	1.27	1.11
Volume in Impingers (mls):	99.0	88.5	93.5
Static Pressure (in. wc.):	0.0	0.0	0.0
Stack Pressure (Ps):	29.30	29.30	29.30
Stack Temperature (Ts):	1448	1507	1407
Meter Coefficient (Y):	1.008	1.008	1.008
Pitot Coefficient (Cp):	0.84	0.84	0.84
Meter Temperature (Tm):	500	512	516
Area Stack (As):	0.60	0.60	0.60
Area Nozzle (An):	0.001124	0.001104	0.001124
Percent CO2 (%):	3.4	3.0	2.8
Percent O2 (%):	15.8	16.3	16.4
Percent N2 (%):	80.8	80.7	80.8
Milligrams:	17.0	24.1	20.2
Molecular Weight Dry (Md):	29.18	29.13	29.10
Volume Water (Vwstd):	4.66	4.17	4.40
Volume Gas Sampled (Vmstd):	36.67	36.18	33.90
Stack Gas Moisture (%):	11.3	10.3	11.5
Molecular Weight Wet (Ms):	27.92	27.98	27.83
Volume Gas Sampled (Vma):	115.75	117.60	104.24
Stack Gas Velocity, (Vs):	29.05	29.69	26.60
Volumetric Flowrate (Qs):	331	329	312
Volumetric Flowrate (Qa):	1,046	1,069	958
Grainloading, gr/dscf (cs):	0.0072	0.0103	0.0092
Grainloading, gr/ACF (csi):	0.0023	0.0032	0.0030
Grainloading @ 12% CO2:	0.0252	0.0411	0.0394
Grainloading @ 12% CO2 - Fuel:	0.1010	0.1602	0.1622
Emission Rate, #/Hour (E):	0.020	0.029	0.025
HCl Concentration, PPM:	323.8	534.0	275.8
HCl Emission Rate, #/Hour:	0.618	1.012	0.495
Cl2 Concentration, PPM:	1.7	2.5	1.6
Cl2 Emission Rate, #/Hour:	0.006	0.009	0.006
Percent Isokinetic Sampling:	98.55	99.71	96.90

E.P.A. TEST PROCEDURES

The testing procedures followed during the program were according to methods 1, 2, 3, 5, and 9 for location of sampling points; measuring of stack gas velocity and volumetric flow rate; determination of CO_2, O_2, and dry molecular weight; determination of particulate matter concentrations; and determination of opacity emissions. These methods can be found in the *Code of Federal Regulations*, Title 40, Parts 53-60, revised as of July 1, 1986.

Method 1, determination of number and location of sampling points, was used to calculate the location of the six points used on each traverse. The exact location of each point, along with the distance of the upstream and downstream disturbances, can be found in detail in Appendix C.

EPA Method 2 was used to calculate the stack gas velocity and volumetric flow rate. The S-type pitot tube on the pitot-probe assembly was fabricated according to design criteria in Method 2 that allows a pitot coefficient of 0.84 to be used in the calculations. The pre-test and post-test measurements on each pitot-probe assembly can be found in Appendix E. Stack gas temperatures used in the velocity calculations were obtained with a type "K" thermocouple and Omega digital thermometer. Leak checks were performed on the pitot-manometer assembly after each test and showed no leak.

Method 3 was used to determine dry molecular weight, including CO_2 and O_2 concentrations. The sampling train used to collect the gas samples consisted of 1/4" stainless steel tubing attached to the sample probe, 1/4" polyethylene tubing, vacuum gauge, peristaltic pump, and 44 liter sample bag. The samples were analyzed after the testing with an orsat analyzer. Leak checks on the sampling train and the orsat analyzer were performed before and after each test according to procedures outlined in Method 3.

Method 5, Determination of Particulate Matter from Stationary Sources, was used to determine particulate emission concentrations. The sampling train consisted of a 1/2" diameter calibrated nozzle and liner, both manufactured from quartz, glass fiber filter and filter holder, five impingers, umbilical cord, pump, and control console. Filter box, impinger outlet, and dry gas meter temperatures were monitored throughout the test with bimetallic thermometers. The dry gas meter in the control console was calibrated against a Rockwell S-415 test meter that had been standardized with a Rockwell #1464 Bell Prover. The S-415 meter had a calibration cofficient (Y) of 0.999.

EPA Method 9 was used to determine the opacity of emissions during the testing. The readings were taken by Tom Yaroch. Mr. Yaroch was certified on October 21, 1988 by representatives of the Georgia Department of Natural Resources. A copy of his certification is included in Appendix E.

Sampling Procedures

The sampling area for the testing was located on scaffolding around the incinerator exhaust stack. A four foot monorail system was used on each of the two test ports to support the probe - ice bath - filter box assembly. The schematic of the incinerator and sampling location can be found in Appendix C.

Prior to each test, the sampling train was assembled for testing. 100 milliliters (ml) of distilled water was placed in each of the first two impingers, 100 ml of 5% sodium hydroxide (NaOH) was placed in impingers three and four, and 200.0 grams (g) of silica gel was placed in impinger number five. The probe was secured in the sampling box, the filter holder assembly was installed, and the system was ready for pre-test leak checks.

After each test, leak checks were performed on the sampling train, Method 3 train, and each side of the pitot tubes. In each of the three test repetitions, all leak checks were within the allowable limitations. Next, the train was disassembled. The filter holder was removed and sealed to prevent loss of particulate matter. The probe and nozzle were cleaned with reagent grade acetone, with all sample exposed surfaces brushed and rinsed until all particulate matter was removed. This rinse was saved in a 500 ml polyethylene bottle. Next, the contents of each of the first four impingers were measured separately with a graduated cylinder, and the silica gel was returned to its container and sealed. The contents of the first two impingers and rinse of those impingers were saved in one bottle, while the contents of impingers three and four (and the rinse of those two impingers) were saved in another sample bottle.

APPENDIX A
LABORATORY RESULTS

PARTICULATE LABORATORY DATA SHEET

Test No.: 1 Source: NORTH PARK HOSPITAL

Acetone Blank: Volume: 100 ml. Net Wt.: 0.0001 g.

Acetone Density: 0.785 g/ml. Residue: 0.0013 g/ml.

Filter

Filter No.: 114

Final Weight:	0.3989 g.	0.3991 g.	AVG: 0.3990 g.
Tare Weight:	0.3909 g.	0.3913 g.	AVG: 0.3911 g.
Net Weight:			AVG: 0.0079 g.

Probe Wash

Probe Wash Beaker No.: 2 Volume: 125 ml.

Final Weight:	127.7133 g.	127.7135 g.	AVG: 127.7134 g.
Tare Weight:	127.7042 g.	127.7042 g.	AVG: 127.7042 g.
Net Weight:			AVG: 0.0092 g.

Less Acetone Blank Residue: 0.0001 g.

TOTAL PARTICULATE MATTER COLLECTED: 0.0170 g.

PARTICULATE LABORATORY DATA SHEET

Test No.: 2 Source: North Park Hospital

Acetone Blank: Volume: 100 ml. Net Wt.: 0.0001 g.

Acetone Density: 0.785 g/ml. Residue: 0.0013 mg/ml.

Filter

Filter No.: 115

Final Weight:	0.4051 g.	0.4056 g.	AVG: 0.4054 g.
Tare Weight:	0.3936 g.	0.3932 g.	AVG: 0.3934 g.
Net Weight:			AVG: 0.0120 g.

Probe Wash

Probe Wash Beaker No.: 6 Volume: 110 ml.

Final Weight:	127.9433 g.	127.9430 g.	AVG: 127.9432 g.
Tare Weight:	127.9308 g.	127.9311 g.	AVG: 127.9310 g.
Net Weight:			AVG: 0.0122 g.

Less Acetone Blank Residue: 0.0001 g.

TOTAL PARTICULATE MATTER COLLECTED: 0.0241 g.

PARTICULATE LABORATORY DATA SHEET

Test No.: 3 Source: NORTH PARK HOSPITAL

Acetone Blank: Volume: 100 ml. Net Wt.: 0.0001 g.

Acetone Density: 0.785 g/ml. Residue: 0.0013 mg/ml.

Filter

Filter No.: 116

Final Weight:	0.4025 g.	0.4028 g.	AVG: 0.4027 g.
Tare Weight:	0.3927 g.	0.3930 g.	AVG: 0.3929 g.
Net Weight:			AVG: 0.0088 g.

Probe Wash

Probe Wash Beaker No.: 3 Volume: 100 ml.

Final Weight:	128.6261 g.	128.6260 g.	AVG: 128.6261 g.
Tare Weight:	128.6148 g.	128.6144 g.	AVG: 128.6146 g.
Net Weight:			AVG: 0.0115 g.

Less Acetone Blank Residue: 0.0001 g.

TOTAL PARTICULATE MATTER COLLECTED: 0.0202 g.

MOISTURE LABORATORY DATA

IMPINGERS 1, 2, 3, & 4:

Test No.	Final	Tare	Net
1	488	400	88 g.
2	479	400	79 g.
3	485	400	85 g.

IMPINGER NO. 5 (Silica Gel):

Test No.	Final	Tare	Net
1	211.0	200.0	11.0 g.
2	209.5	200.0	9.5 g.
3	208.5	200.0	8.5 g.

MOISTURE SUMMARY:

Test No.	Imp. 1-4	Imp. 5	TOTAL
1	88	11.0	99.0 g.
2	79	9.5	88.5 g.
3	85	8.5	93.5 g.

APPLIED TECHNICAL SERVICES, INCORPORATED

Main Office
1190 Atlanta Industrial Drive
Marietta, Georgia 30066
(404) 423-1400
Fax # 424-6415

Branch Office
1218 Donaldson Road
Greenville, S.C. 29605
(803) 299-0525

CERTIFIED TEST REPORT

REF. C8-2941 DATE February 24, 1988

CHEMICAL ANALYSIS

CUSTOMER Air Systems Testing, Inc., P. O. Box 6278, Marietta, Georgia 30065

Attention: Bruce Lawrie

ORDER NO Verbal PART NO/NAME North Park Hospital Samples

MATERIAL DESIGNATION Absorbing solutions

SPECIAL REQUIREMENT N/A

LAB COMMENT Procedure Supplied by AST, Inc.

TEST RESULTS

	COMPOSITION									
IDENTIFICATION	Equation 5.52 Numerator			Equation 5.54 Numerator						
ALLOY OR SPEC REQ (1)	C_{Cl_2}			C_{HCl}						
Test 1	62			11,874						
Test 2	89			19,322						
Test 3	54			9,352						
				**** LAST ITEM ****						

(1)

Patricia L. DuBose
Notary Public, Cobb County Georgia
My Commission Expires Jan. 29, 1992

Prepared by [signature] W. M. Katter Chemist

Approved by [signature] P. E. Rogers Manager

APPLIED TECHNICAL SERVICES, INC

LAB DATA SHEET

TEST: HCL + Cl_2 ATS JOB NO.: C8 2941

P/N: See Below DATE: 2/23/88

CUSTOMER: AST

CPR—)

SPECIFICATION: TEST PROCEDURE: Supplied by Ai Tech

TEST EQUIPMENT: TYPE N/A S/N N/A

CAL. NaOH 0.1N Purchased • Thiosulfate (N) = 0.115 — standardized against pure Cu

(EXAMPLE HARDNESS - TEST BLOCK CAL., TEST READING)

TEST RESULTS:

Sample	Test	Total Vol. (ml)	ml titrant	Alliquot vol. (ml)	Numerator Equation 5.5.4
Parkridge 1	HCL	290	0.15	25 ml	146
Parkridge 2	HCL	315	7.55	25 ml	7972
Parkridge 3	HCL	310	11.90	25 ml	12,365
Parkridge 4	HCL	330	10.40	25 ml	11,504
North Park 1	HCL	325	10.90	25 ml	11,874
North Park 2	HCL	315	18.30	25 ml	19,322
North Park 3	HCL	310	9.0	25 ml	9352

					Numerator Equation 5.5.2
Parkridge 1	Cl_2	270	0.30	25 ml	136
Parkridge 2	Cl_2	235	0.40	25 ml	157
Parkridge 3	Cl_2	265	0.40	25 ml	178
Parkridge 4	Cl_2	295	0.20	25 ml	99
North Park 1	Cl_2	245	0.15	25 ml	62
North Park 2	Cl_2	265	0.20	25 ml	89
North Park 3	Cl_2	215	0.15	25 ml	54

Cu (g)	ml Thiosulfate
.350	

WITNESSED BY [signature] PREPARED BY [signature] DATE 2/23/88

APPROVED BY ______ DATE ______

CHAIN OF CUSTODY FORM

Plant: HCA N. Park Hospital Source: Incinerator

Date Sampled: 2/16/88 Run No.: 1-3

SAMPLE RECOVERY

Container No.	Description (if filter, give filter No.)
As marked	Filter #'s 114, 115, 116
As marked	Probewash tests 1, 2, 3 & Acetone blank
As marked	Imp 1 & 2 catch for HCl - Cl_2
As marked	Imp 3 & 4 catch for HCl - Cl_2

Person Engaged in Sample Recovery:

Signature & Title: [signature]

Recovery Location: North Park Hospital

Date & Time of Recovery: 2/16/88

Sample Recipient, upon Recovery, if not Recovery person:

Signature: ________

Date & Time of Receipt: ________

Sample Storage: ________

Laboratory Person Receiving Sample:

Signature & Title: JBL for Me. 5 Samples - [signature] for HCl - Cl_2 samples

Date & Time of Receipt: 2/16/88 for M5 Samples - 2/19/88 for HCl - Cl_2 samples

Sample Storage: ________

SAMPLE ANALYSIS

Beaker Number	Method of Analysis	Date and Time
~~HCL+Cl Analysis~~	~~Titration~~	~~2/19/88~~
2, 6, 7 (Tests 1-3)	Gravimetric	Tare: 2/14-15/88
1 (Blank)	"	Final: 2/23/88

FILTERS

Container No.	Filter No.	Filter Analysis & Analysis Signature	Date
As marked	114	JOL	Tare: 2/14/88
As marked	115	JOL	Final: 2/19/88
As marked	116	JOL	

APPENDIX B
FIELD DATA SHEETS & CALCULATIONS

Particulate Test Calculations

Company: North Park Hospital   Source: Incinerator   Test No.: 1
Date: February 16, 1988   Test Team: Bruce Lawrie / Tom Soulsby
Nozzle Diameter: 0.454 in.   Nozzle Area (Sq.Ft.): 0.001124
Console No.: 1   Meter Calibration: 1.008   Km: 0.685
Stack Diameter: 10.5 in.   Stack Area: 0.60 Sq.Ft.
Assumed Moisture: 11.3%   Stack Static Pressure: 0.0 " w.c.
Stack Temperature: 1200 oF   Meter Temperature: 31 oF
Pressures: Barometric: 29.30 in. Hg.   Stack: 29.30 in. Hg.
Probe No.: 3' #2   Filter/Impinger Box No.: 1   Cp = 0.84
Orsat/Fyrite: % CO2 = 3.4   %O2 = 15.8   %N2 = 80.8
Molecular Weight of Gas: Dry: 29.18   Wet: 27.91
K Factor: 12.16   Minutes/Point: 5.0   Number of Points: 12
Mls: 99.0   Mg Particulates: 17.0

Vm	^P	Sqrt ^P	^H	Ts	Tm	Tm	I*
498.561	0.11	0.332	1.30	1203	31	31	103.8
501.64	0.11	0.332	1.30	1200	34	31	100.4
504.63	0.11	0.332	1.30	1199	39	31	99.2
507.60	0.10	0.316	1.20	1050	43	32	97.4
510.53	0.07	0.265	1.30	630	45	33	93.6
513.31	0.06	0.245	1.10	600	48	34	104.2
516.23	0.11	0.332	1.30	1110	41	35	99.4
519.31	0.12	0.346	1.50	1175	48	35	97.8
522.43	0.12	0.346	1.50	1165	52	37	98.1
525.59	0.09	0.300	1.10	1075	53	39	101.0
528.50	0.08	0.283	1.00	800	54	40	89.9
531.20	0.05	0.224	0.85	650	54	40	96.7
533.647 Final							

AVERAGES

35.086		0.304	1.23	988		40	
				1448		500	

CALCULATIONS

Volume of Water Vapor Collected (cubic feet):	4.66
Dry gas volume through meter (cubic feet):	36.671
Stack gas moisture content by volume:	11.3%
Stack gas wet molecular weight:	27.92
Actual stack gas volume sampled (cubic feet):	115.75
Stack gas velocity (feet per second):	29.08
Stack gas volumetric flow rate (dscf/minute):	332
Stack gas volumetric flow rate (ACF/minute):	1049
Particulate concentration (grains/dscf):	0.0072
Particulate concentration (grains/ACF):	0.0023
Emission rate (pounds per hour):	0.020
Isokinetic sampling rate (percent):	98.58

I* - Point by point isokinetic rate

Particulate Test Calculations

Company: North Park Hospital Source: Incinerator Test No.: 2
Date: February 16, 1988 Test Team: Bruce Lawrie / Tom Soulsby
Nozzle Diameter: 0.450 in. Nozzle Area (Sq.Ft.): 0.001104
Console No.: 1 Meter Calibration: 1.008 Km: 0.685
Stack Diameter: 10.5 in. Stack Area: 0.60 Sq.Ft.
Assumed Moisture: 10.3% Stack Static Pressure: 0.0 " w.c.
Stack Temperature: 1200 oF Meter Temperature: 31 oF
Pressures: Barometric: 29.30 in. Hg. Stack: 29.30 in. Hg.
Probe No.: 3' #2 Filter/Impinger Box No.: 1 Cp = 0.84
Orsat/Fyrite: % CO2 = 3.0 %O2 = 16.3 %N2 = 80.7
Molecular Weight of Gas: Dry: 29.13 Wet: 27.99
K Factor: 11.95 Minutes/Point: 5.0 Number of Points: 12
Mls: 88.5 Mg Particulates: 24.1

Vm	^P	Sqrt ^P	^H	Ts	Tm	Tm	I*
533.861	0.12	0.346	1.50	1250	46	43	100.1
536.98	0.13	0.361	1.60	1215	52	43	97.1
540.18	0.13	0.361	1.60	1155	56	44	93.4
543.33	0.10	0.316	1.30	1100	58	42	102.6
546.42	0.07	0.265	0.90	1000	60	46	98.8
549.01	0.05	0.224	0.90	600	61	46	95.7
551.50	0.10	0.316	1.30	1115	54	48	103.6
554.61	0.11	0.332	1.50	1235	58	48	101.5
557.70	0.10	0.316	1.30	1135	60	48	101.6
560.75	0.10	0.316	1.30	1060	61	48	99.8
563.82	0.07	0.265	1.10	900	62	49	109.2
566.80	0.06	0.245	0.95	800	62	50	95.4
569.308 Final							

AVERAGES

35.447		0.305	1.27	1047		52	
				1507		512	

CALCULATIONS

Volume of Water Vapor Collected (cubic feet):	4.17
Dry gas volume through meter (cubic feet):	36.193
Stack gas moisture content by volume:	10.3%
Stack gas wet molecular weight:	27.98
Actual stack gas volume sampled (cubic feet):	117.63
Stack gas velocity (feet per second):	29.71
Stack gas volumetric flow rate (dscf/minute):	330
Stack gas volumetric flow rate (ACF/minute):	1072
Particulate concentration (grains/dscf):	0.0103
Particulate concentration (grains/ACF):	0.0032
Emission rate (pounds per hour):	0.029
Isokinetic sampling rate (percent):	99.80

I* - Point by point isokinetic rate

Particulate Test Calculations

Company: North Park Hospital Source: Incinerator Test No.: 3
Date: February 16, 1988 Test Team: Bruce Lawrie / Tom Soulsby
Nozzle Diameter: 0.454 in. Nozzle Area (Sq.Ft.): 0.001124
Console No.: 1 Meter Calibration: 1.008 Km: 0.685
Stack Diameter: 10.5 in. Stack Area: 0.60 Sq.Ft.
Assumed Moisture: 11.5% Stack Static Pressure: 0.0 " w.c.
Stack Temperature: 1200 oF Meter Temperature: 31 oF
Pressures: Barometric: 29.30 in. Hg. Stack: 29.30 in. Hg.
Probe No.: 3' #2 Filter/Impinger Box No.: 1 Cp = 0.84
Orsat/Fyrite: % CO2 = 2.8 %O2 = 16.4 %N2 = 80.8
Molecular Weight of Gas: Dry: 29.10 Wet: 27.83
K Factor: 12.11 Minutes/Point: 5.0 Number of Points: 12
Mls: 93.5 Mg Particulates: 20.2

Vm	^P	Sqrt ^P	^H	Ts	Tm	Tm	I*
569.834	0.11	0.332	1.50	1085	50	49	98.0
572.96	0.10	0.316	1.30	1103	55	49	99.3
575.98	0.11	0.332	1.50	1070	58	49	99.0
579.18	0.08	0.283	1.00	961	61	50	97.8
581.99	0.06	0.245	0.90	865	62	50	96.5
584.48	0.04	0.200	0.60	800	64	51	100.5
586.66	0.10	0.316	1.30	1030	61	51	96.8
589.70	0.10	0.316	1.30	1123	62	52	100.0
592.75	0.10	0.316	1.30	1090	64	52	
	0.08	0.283	1.00	970	65	53	
598.64	0.06	0.245	0.90	670	66	53	89.2
601.15	0.04	0.200	0.70	600	66	54	91.4
603.321 Final							

AVERAGES

Vm	^P	Sqrt ^P	^H	Ts	Tm	Tm	I*
33.487		0.282	1.11	947		56	
				1407		516	

CALCULATIONS

Volume of Water Vapor Collected (cubic feet):	4.40
Dry gas volume through meter (cubic feet):	33.896
Stack gas moisture content by volume:	11.5%
Stack gas wet molecular weight:	27.83
Actual stack gas volume sampled (cubic feet):	104.23
Stack gas velocity (feet per second):	26.60
Stack gas volumetric flow rate (dscf/minute):	312
Stack gas volumetric flow rate (ACF/minute):	960
Particulate concentration (grains/dscf):	0.0092
Particulate concentration (grains/ACF):	0.0030
Emission rate (pounds per hour):	0.025
Isokinetic sampling rate (percent):	97.02

I* - Point by point isokinetic rate

PARTICULATE TEST FIELD DATA

Company: N. Park Hospital Source: Incinerator Test No.: 1
Date: FEB 16, 1988 Test Team: Lawrie / Soulsby / Yarosh
Nozzle Diameter: 0.454 in. Nozzle Area (Sq.Ft.): 0.001124
Console No.: 1 Meter Calibration: 1.008
Stack Diameter: 10.5 in. Stack Area: 0.60 Sq. Ft.
Assumed Moisture: 10 % Stack Static Pressure: ______ " w.c.
Stack Temperature: ______ oF Meter Temperature: ______ oF
Pressures: Barometric: 29.3 in. Hg. Stack: 29.3 in. Hg.
Probe No.: 3' #2 Filter/Impinger Box No.: 1 Cp = 0.84
Orsat/Fyrite: % CO2 = ______ %O2 = ______ %N2 = ______
Molecular Weight of Gas: Dry: ______ Wet: ______
K Factor: 12.4 Minutes/Point: 5.0
Time Start: 10:01 Time End: 11:05

[signature]

Point	Meter Volume	△P	△H Desire	△H Actual	Temperatures Stack	Box	Imp	Meter In	Meter Out	Vacuum
1	498.561	0.11	1.3	1.3	1203	250	35	31	31	5
2	501.64	0.11	1.3	1.3	1200	260	36	34	31	5
3	504.63	0.11	1.3	1.3	1199	252	40	39	31	5
4	507.60	0.10	1.2	1.2	1050	262	40	43	32	5
5	510.53	0.07	~~0.85~~ 1.3	~~0.85~~ 1.3	~~1130~~ 620	255	43	45	33	6
6	513.41	0.06	1.1	1.1	600	255	46	48	34	5
	STOP-	CHANGE	PORTS							
1	516.23	0.11	1.3	1.3	1110	250	45	41	35	6
2	519.31	0.12	1.5	1.5	1175	265	45	48	35	6
3	522.43	0.12	1.5	1.5	1165	245	47	52	37	6
4	525.59	0.09	1.1	1.1	1075	270	48	53	39	5
5	528.50	0.08	1.0	1.0	800	245	47	54	40	5
6	531.20	0.05	0.85	0.85	650	255	48	54	40	
	533.647									

	Primary	°F		Secondary		°F
1	350	1	600	1	1850	1	1860
2	500	2	600	2	1875	2	1850
3	550	3	615	3	1850	3	1810
4	540	4	655	4	1875	4	1750
5	550	5	650	5	1850	5	1800
6	590	6	650	6	1840	6	1850

Comments: Post Test Leak check @ 6"Hg – 0.000 CFM
Pitots static 3.3 / 2.0 } ok / 15. Sec
Method 3 ok

Gas Meter:
11:05 End: 39300
10:01 Start: ~~34100~~ 33900
64 min 540

Imp 1 & 2 + 76
Imp 3 & 4 + 12
S. Gel 11.0
Net · TOTAL: 99.0 g.

.506 / none
8.44 / min

PARTICULATE TEST FIELD DATA

Company: N Park Hospital Source: Incinerator Test No.: 2
Date: Feb 16, 1988 Test Team: ______
Nozzle Diameter: ______ in. Nozzle Area (Sq.Ft.): ______
Console No.: ___ Meter Calibration: ______
Stack Diameter: ______ in. Stack Area: ______ Sq. Ft.
Assumed Moisture: ______ % Stack Static Pressure: ______ " w.c.
Stack Temperature: ______ oF Meter Temperature: ______ oF
Pressures: Barometric: 29.3 in. Hg. Stack: 29.3 in. Hg.
Probe No.: 3' #3 Filter/Impinger Box No.: 1 Cp = 0.84
Orsat/Fyrite: % CO2 = ______ %O2 = ______ %N2 = ______
Molecular Weight of Gas: Dry: ______ Wet: ______
K Factor: ______ Minutes/Point: 5.0
Time Start: 11:23 Time End: ______

JB Lam

Point	Meter Volume	△P	△H Desire	△H Actual	TEMPERATURES Stack	Box	Imp	Meter In	Meter Out	Vacuum
1	533.861	0.12	1.5	1.5	1250	245	46	46	43	5
2	536.98	0.13	1.6	1.6	1215	245	45	52	43	5
3	540.18	0.13	1.6	1.6	1155	250	48	56	44	5
4	543.33	0.10	1.3	1.3	1100	255	52	58	42	5
5	546.42	0.07	0.90	0.90	1000	248	56	60	46	4
6	549.01	0.05	0.90	0.90	600	265	62	61	46	4
	STOP-	CHANGE	PORTS							
1	551.50	0.10	1.3	1.3	1115	250	58	54	48	5
2	554.61	0.11	1.5	1.5	1235	255	60	58	48	5
3	57.70	0.10	1.3	1.3	1135	252	59	60	48	5
4	60.75	0.10	1.3	1.3	1060	265	58	61	48	5
5	63.82	0.08	1.1	1.1	900	265	57	62	49	5
6	66.80	0.06	0.95	0.95	800	245	56	62	50	4
	569.308									

	Primary			Secondary	
1)	515	1) 610	1	1800	1) 1900
2)	550	2) 680	2	1850	2) 1800
3)	540	3) 650	3	1840	3) 1800
4)	550	4) 670	4	1850	4) 1825
5)	560	5) 610	5	1875	5) 1850
6	550	6) 600	6	1800	6) 1850

Comments: Post test leak check @ 6" Hg = 0.008 CFM 12:29 45700

Pitots Total 5.6" / Static 6.0") NO LEAK 11:23 START 41000

N. GAS 7.34/MIN

Method 3 @ 10" → NO LEAK

TEST 3
IMP 1 & 2: 73
IMP 3 & 4: 12
S GEL: 8.5 g

TEST 2
IMP 1 & 2 = 67.0
IMP 3 & 4 = 12
S. GEL = 9.5 g

PARTICULATE TEST FIELD DATA

Company: N. PARK HOSPITAL Source: Incinerator Test No.: 3
Date: FEB 16, 1983 Test Team: LAWRIE / SOWLSBY / YAROCH
Nozzle Diameter: 0.454 in. Nozzle Area (Sq.Ft.):
Console No.: 1 Meter Calibration: 1.008
Stack Diameter: 10.5 in. Stack Area: 0.60 Sq. Ft.
Assumed Moisture: 10 % Stack Static Pressure: 0.0 " w.c.
Stack Temperature: oF Meter Temperature: oF
Pressures: Barometric: 29.3 in. Hg. Stack: 29.3 in. Hg.
Probe No.: Filter/Impinger Box No.: Cp = 0.84
Orsat/Fyrite: % CO2 = %O2 = %N2 =
Molecular Weight of Gas: Dry: Wet:
K Factor: Minutes/Point: 5.0
Time Start: 12:44 Time End: 1:40

JBLam

Point	Meter Volume	ΔP	ΔH Desire	ΔH Actual	Temperatures Stack	Box	Imp	Meter In	Meter Out	Vacuum
1	569.834	0.11	1.5	1.5	1085	250	42	50	49	4
2	572.96	0.10	1.3	1.3	1103	240	40	55	49	4
3	575.98	0.11	1.5	1.5	1070	260	40	58	49	5
4	579.18	0.08	1.0	1.0	961	242	42	61	50	4
5	581.99	0.06	0.90	0.90	865	240	43	62	50	3
6	584.48	0.04	0.60	0.60	800	250	44	64	51	2
	STOP - CHANGE	PORTS								
1	586.66	0.10	1.3	1.3	1030	260	46	61	51	4
2	89.70	0.10	1.3	1.3	1123	240	47	62	52	4
3	92.75	0.10	1.3	1.3	1090	265	49	64	52	5
4		0.08	1.0	1.0	970	245	51	65	53	4
5	98.64	0.06	0.90	0.90	670	250	52	66	53	4
6	601.15	0.04	0.70	0.70	600	255	53	66	54	3
END:	603.321									

°F

	Primary			Secondary	
1	450	456	1	1810	180
2	410	440	2	1890	1780
3	400	490	3	1890	1900
4	400	500	4	1800	1850
5	410	500	5	1800	1750
6	423	510	6	1800	1750

Comments: Post test leak check @ 5.0" Hg :
Method 3 @ 10.5" Hg = OK
Pitots Static @ 7.1"
total @ 5.2" } OK

D.G.M.
12:46 START 46900
1:48 END 51000
410
6.61/min

AIR SYSTEMS TESTING, INC.
ORSAT ANALYSIS

Source: N. Park Hospital   Date: 2/16/83

Pre-test leak Check: OK   Post-test Leak Check: OK

TEST NO: 1 JBD

Component	Run #1	Run #2	Run #3	Average %
% CO_2	3.4, 3.4	3.4, 3.4		3.4
% O_2	19.0, 19.1, 19.2, 19.2	19.2. 19.2		19.2 / 15.8
% CO				
% N_2				

TEST NO: 2 JBD

Component	Run #1	Run #2	Run #3	Average %
% CO_2	2.9 2.9	3.0 3.0	3.0, 3.0	3.0
% O_2	19.2 19.2	19.3, 19.3	19.4, 19.4	19.3 / 16.3
% CO				
% N_2				

TEST NO: 3 JBD

Component	Run #1	Run #2	Run #3	Average %
% CO_2	2.8, 2.8	2.8, 2.8		2.8
% O_2	19.2 19.2	19.2 19.2		19.2 / 16.4
% CO				
% N_2				

SAMPLE CALCULATIONS
TEST # 1

1) VOLUME OF WATER VAPOR COLLECTED (ft^3)

$$V_{WSTD} = 0.04707 * V_{lc}$$

$$V_{WSTD} = 0.04707 * 99.0$$

$$V_{WSTD} = 4.66 \ ft^3$$

2) DRY GAS VOLUME THROUGH METER (ft^3)

$$V_{mSTD} = 17.64 * V_m * Y * [(P_{BAR} + (\Delta H/13.6))/T_m]$$

$$V_{mSTD} = 17.64 * 35.086 * 1.008 * [(29.3 + (1.23/13.6))/500]$$

$$V_{mSTD} = 36.67 \ ft^3$$

3) MOISTURE CONTENT (% by VOLUME)

$$B_{ws} = \frac{V_{WSTD}}{(V_{WSTD} + V_{mSTD})} * 100$$

$$B_{ws} = \frac{4.66}{(4.66 + 36.67)} \times 100$$

$$B_{ws} = 11.3\ \%$$

4) STACK GAS SAMPLED (ft^3)

$$V_{mA} = [V_{mSTD} * T_s * P_{STD}] / [(1 - B_{ws}) * T_{STD} * P_s]$$

$$V_{mA} = [36.67 * 1448 * 29.92] / [0.887 * 528 * 29.3]$$

$$V_{mA} = 115.75$$

4) STACK GAS VELOCITY (ft/SECOND)

$$V_s = K_p * C_p * \sqrt{\Delta P} * \sqrt{\frac{T_s}{(P_s * M_s)}}$$

$$V_s = 85.49 * 0.84 * 0.304 * \sqrt{\frac{1448}{(29.3 * 27.92)}}$$

$$V_s = 29.05 \text{ ft/second}$$

5) STACK GAS FLOW RATE ACTUAL ft³/MINUTE

$$Q_A = V_s * A_s * 60$$

$$Q_A = 29.05 * 0.60 \times 60$$

$$Q_A = 1{,}046 \text{ ft}^3\text{/minute}$$

6) STACK GAS FLOW RATE DRY STANDARD ft³/MINUTE

$$Q_s = 60 * (1 - B_{ws}) * V_s * A_s * \left(\frac{T_{STD}}{T_s}\right) * \left(\frac{P_s}{P_{STD}}\right)$$

$$Q_s = 60 * (0.887) * 29.05 * 0.60 * \left(\frac{528}{1448}\right) * \left(\frac{29.3}{29.92}\right)$$

$$Q_s = 331 \text{ ft}^3\text{/minute}$$

7) GRAINLOADING (gr/dscf)

$$C_s = 0.01543 * \left(\frac{M_n}{V_{mSTD}}\right)$$

$$C_s = 0.01543 * \left(\frac{17.0}{36.67}\right)$$

$$C_s = 0.0072 \text{ gr/dscf}$$

8) GRAINLOADING @ 12% CO_2 (gr/dscf @ 12% CO_2)

$$C_{s_{12}} = C_s * \left(\frac{12}{\% CO_2}\right)$$

$$C_{s_{12}} = 0.0072 * \left(\frac{12}{3.4}\right)$$

$$C_{s_{12}} = 0.0252$$

9) GRAINLOADING @ 12% CO_2 without AUXILIARY FUEL

$$C_{s_F} = C_s * \frac{0.12}{\left(\frac{ft^3 CO_2 - ft^3 CO_2 \text{ fuel}}{dscf}\right)}$$

$$C_{s_F} = 0.0072 \frac{0.12}{\frac{11.25 - 8.44}{331}}$$

$$C_{s_F} = 0.1018 \text{ gr/dscf}$$

10) EMISSION RATE (POUNDS/HOUR)

$$E = 60 * Q_s * \left(\frac{C_s}{7000}\right)$$

$$E = 60 * 331 * \left(\frac{0.0072}{7000}\right)$$

$$E = 0.020 \text{ pounds/Hour}$$

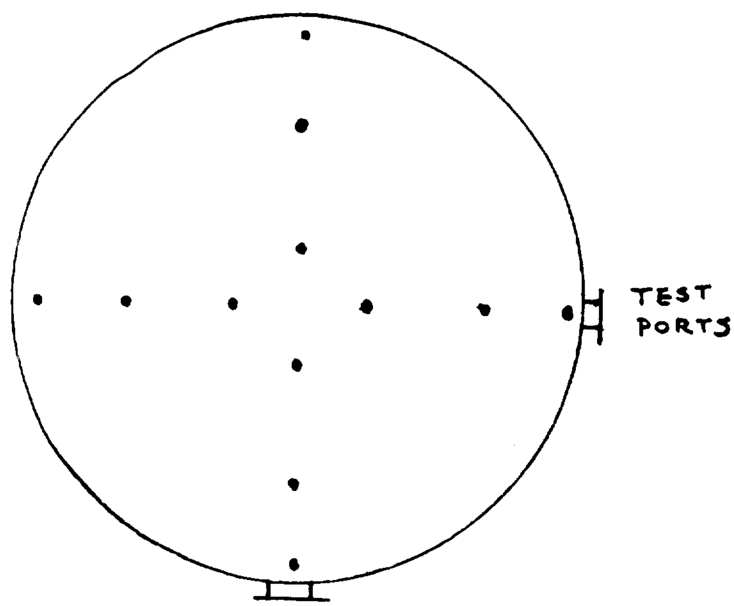
11) DETERMINATION OF ISOKINETIC SAMPLING RATE

$$I = \frac{T_s((0.00267 * V_{lc}) + ((V_m * Y / T_m) * (P_{BAR} + (\Delta H / 13.6))))}{0.599 * \theta * V_s * P_s * A_n}$$

$$I = \frac{1448((0.00267 \times 99) + ((35.09 * 1.008/500) * (29.3 + (1.23/13.6))))}{0.599 * 60 * 29.05 * 29.3 * 0.001124}$$

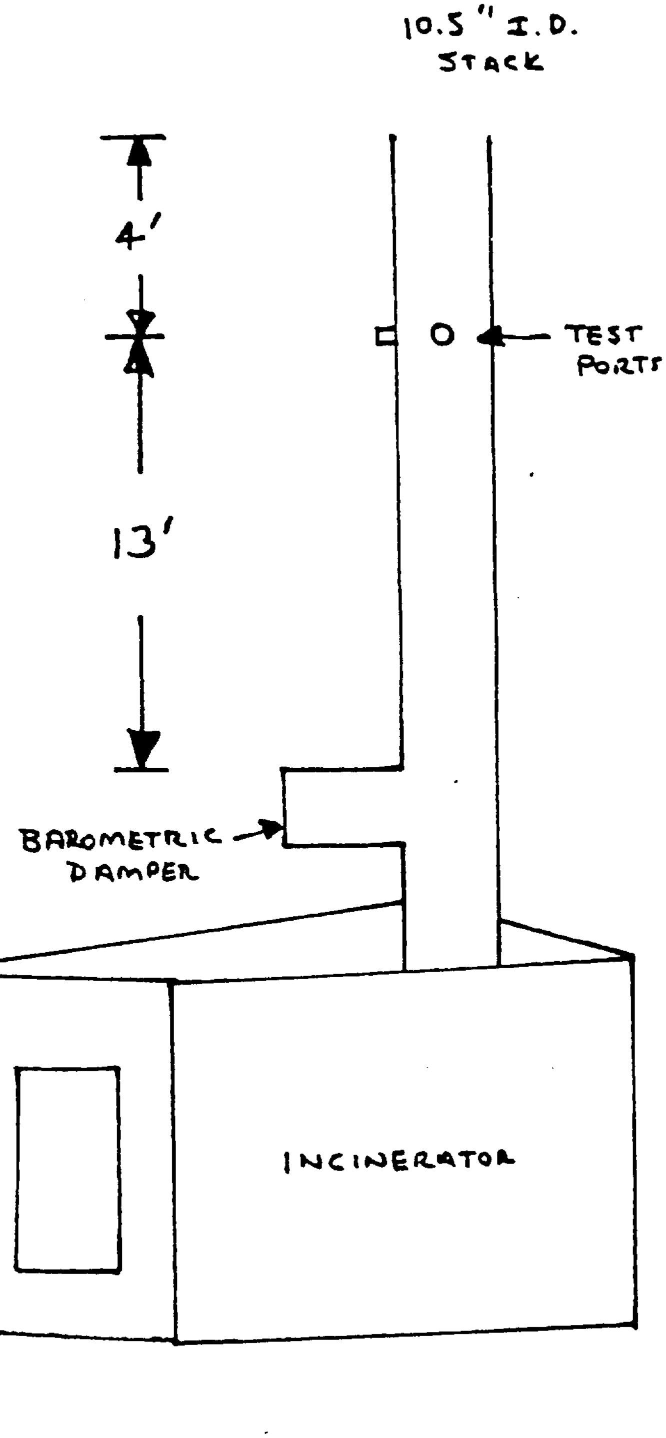
APPENDIX C
SCHEMATIC OF SAMPLING LOCATION

Sampling Point Location
for
Incinerator Exhaust



10.5 inch Diameter

Sampling Point	Distance From Stack Wall (Inches)
1	0.5
2	1.5
3	3.1
4	7.4
5	9.0
6	10.0



10.5" I.D.
STACK
4'
13'
TEST
PORTS
BAROMETRIC
DAMPER
INCINERATOR

APPENDIX D
INCINERATOR DATA

PROCESS DESCRIPTION

The Simonds Model 750B natural gas fired pathological waste incinerator located at the North Park Hospital is charged once per day of operation. On the day of the test, it was charged with 323 pounds of waste. The waste was of typical hospital waste that is burned in the incinerator. The untreated exhaust from the incinerator passes through a 10.5 inch (inside diameter) stack and out into the atmosphere.

APPENDIX E
VISUAL EMISSIONS DATA

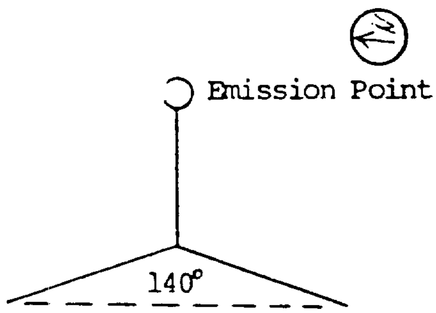
VISIBLE EMISSIONS OBSERVATION FORM

Client: North Park Hospital Source: Incinerator

Control Device: — Test Personnel: Tom Yarech

Date: 2/16/88 Run #: 1 Clock Time: 10:00 - 11:00

Height Of Discharge Pt. 25ft Distance to Source: 50ft



Source Layout Sketch

Ambient Temp. 27

Wind Speed Calm-Light

Wind Direction —

Sky Color Blue

Plume Background Blue

Condensed H2O in Plume —

Detached — Attached —

Comments:

Signature:

Certification Date:

min \ sec	0	15	30	45	min \ sec	0	15	30	45
0	0	0	0	0	30	0	0	0	0
1	0	0	0	0	31	0	0	0	0
2	0	0	0	0	32	0	0	0	0
3	0	0	0	0	33	0	0	0	0
4	0	0	0	0	34	0	0	0	0
5	0	0	0	0	35	0	0	0	0
6	0	0	0	0	36	0	0	0	0
7	0	0	0	0	37	0	0	0	0
8	0	0	0	0	38	0	0	0	0
9	0	0	0	0	39	0	0	0	0
10	0	0	0	0	40	0	0	0	0
11	0	0	0	0	41	0	0	0	0
12	0	0	0	0	42	0	0	0	0
13	0	0	0	0	43	0	0	0	0
14	0	0	0	0	44	0	0	0	0
15	0	0	0	0	45	0	0	0	0
16	0	0	0	0	46	0	0	0	0
17	0	0	0	0	47	0	0	0	0
18	0	0	0	0	48	0	0	0	0
19	0	0	0	0	49	0	0	0	0
20	0	0	0	0	50	0	0	0	0
21	0	0	0	0	51	0	0	0	0
22	0	0	0	0	52	0	0	0	0
23	0	0	0	0	53	0	0	0	0
24	0	0	0	0	54	0	0	0	0
25	0	0	0	0	55	0	0	0	0
26	0	0	0	0	56	0	0	0	0
27	0	0	0	0	57	0	0	0	0
28	0	0	0	0	58	0	0	0	0
29	0	0	0	0	59	0	0	0	0

Total minutes observed: 60

Minutes exceeding 0 % opacity 0

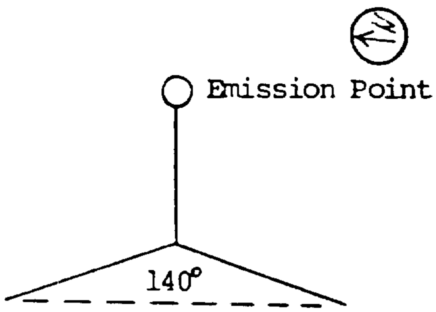
VISIBLE EMISSIONS OBSERVATION FORM

Client: North Park Hospital Source: Incinerator

Control Device: — Test Personnel: Tom Yarock

Date: 2/16/88 Run #: 1 Clock Time: 10:00 - 11:00

Height Of Discharge Pt. 25ft Distance to Source: 50ft



Source Layout Sketch

Ambient Temp. 27

Wind Speed Calm-Light

Wind Direction —

Sky Color Blue

Plume Background Blue

Condensed H2O in Plume —

Detached — Attached —

Comments:

Signature: Tom Yarock

Certification Date:

sec min	0	15	30	45	sec min	0	15	30	45
0	0	0	0	0	30	0	0	0	0
1	0	0	0	0	31	0	0	0	0
2	0	0	0	0	32	0	0	0	0
3	0	0	0	0	33	0	0	0	0
4	0	0	0	0	34	0	0	0	0
5	0	0	0	0	35	0	0	0	0
6	0	0	0	0	36	0	0	0	0
7	0	0	0	0	37	0	0	0	0
8	0	0	0	0	38	0	0	0	0
9	0	0	0	0	39	0	0	0	0
10	0	0	0	0	40	0	0	0	0
11	0	0	0	0	41	0	0	0	0
12	0	0	0	0	42	0	0	0	0
13	0	0	0	0	43	0	0	0	0
14	0	0	0	0	44	0	0	0	0
15	0	0	0	0	45	0	0	0	0
16	0	0	0	0	46	0	0	0	0
17	0	0	0	0	47	0	0	0	0
18	0	0	0	0	48	0	0	0	0
19	0	0	0	0	49	0	0	0	0
20	0	0	0	0	50	0	0	0	0
21	0	0	0	0	51	0	0	0	0
22	0	0	0	0	52	0	0	0	0
23	0	0	0	0	53	0	0	0	0
24	0	0	0	0	54	0	0	0	0
25	0	0	0	0	55	0	0	0	0
26	0	0	0	0	56	0	0	0	0
27	0	0	0	0	57	0	0	0	0
28	0	0	0	0	58	0	0	0	0
29	0	0	0	0	59	0	0	0	0

Total minutes observed: 60

Minutes exceeding 0 % opacity 0

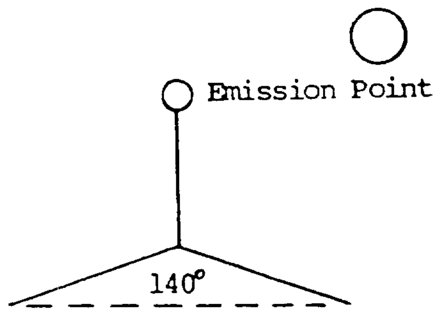
VISIBLE EMISSIONS OBSERVATION FORM

Client: North Park Hospital Source: Incinerator

Control Device: — Test Personnel: Tom Yarock

Date: 2/16/88 Run #: 3 Clock Time: 12 45 -

Height Of Discharge Pt. 25ft Distance to Source: 40ft



Source Layout Sketch

Ambient Temp. 45 °F

Wind Speed Calm

Wind Direction —

Sky Color Blue

Plume Background Blue

Condensed H2O in Plume —

Detached — Attached —

Comments:

Signature: Tom Yarock

Certification Date:

min \ sec	0	15	30	45	min \ sec	0	15	30	45
0	0	0	0	0	30	0	0	0	0
1	0	0	0	0	31	0	0	0	0
2	0	0	0	0	32	0	0	0	0
3	0	0	0	0	33	0	0	0	0
4	0	0	0	0	34	0	0	0	0
5	0	0	0	0	35	0	0	0	0
6	0	0	0	0	36	0	0	0	0
7	0	0	0	0	37	0	0	0	0
8	0	0	0	0	38	0	0	0	0
9	0	0	0	0	39	0	0	0	0
10	0	0	0	0	40	0	0	0	0
11	0	0	0	0	41	0	0	0	0
12	0	0	0	0	42	0	0	0	0
13	0	0	0	0	43	0	0	0	0
14	0	0	0	0	44	0	0	0	0
15	0	0	0	0	45	0	0	0	0
16	0	0	0	0	46	0	0	0	0
17	0	0	0	0	47	0	0	0	0
18	0	0	0	0	48	0	0	0	0
19	0	0	0	0	49	0	0	0	0
20	0	0	0	0	50	0	0	0	0
21	0	0	0	0	51	0	0	0	0
22	0	0	0	0	52	0	0	0	0
23	0	0	0	0	53	0	0	0	0
24	0	0	0	0	54	0	0	0	0
25	0	0	0	0	55	0	0	0	0
26	0	0	0	0	56	0	0	0	0
27	0	0	0	0	57	0	0	0	0
28	0	0	0	0	58	0	0	0	0
29	0	0	0	0	59	0	0	0	0

Total minutes observed: 60

Minutes exceeding 0 % opacity 0

Georgia Department of Natural Resources
205 Butler Street, S.E., Floyd Towers East, Atlanta, Georgia 30334
J. Leonard Ledbetter, Commissioner
Harold F. Reheis, Assistant Director
Environmental Protection Division

November 16, 1987

Thomas M. Yaroch
Knox Consultants
4015 Holcomb Bridge Road
#350 Suite 860
Norcross, GA 30092

Dear Mr. Yaroch:

Please be advised that you have successfully completed the field certification training of the Georgia Visible Emissions Evaluation Certification Course conducted at the Atlanta Civic Center parking lot on October 21-22, 1987.

Your plume evaluations were within the specifications of Federal Reference Method "9" which qualified you as a Visible Emissions Evaluator. Your average error on black and white smoke did not exceed 7.5% opacity and you incurred no single error exceeding 15% opacity during your qualifying run.

This letter serves as your official notice of certification which is valid for six months from the date you qualified (October 21, 1987), subject to the following visual restriction: NONE.

If you desire a copy of your original qualified "field test form" or if we may be of any further assistance, feel free to contact our office.

It is our hope that the end result of your participation in this course will help in promoting cleaner and healthier air.

Yours for cleaner air,

Arthur D. Hollis
Environmental Specialist
Air Protection Branch
Planning & Technical
Support Program

ADH:cl

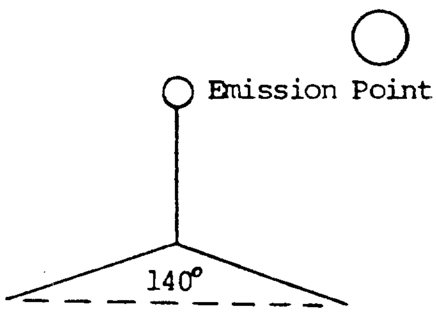
VISIBLE EMISSIONS OBSERVATION FORM

Client: North Park Hospital Source: Incinerator

Control Device: — Test Personnel: Tom Yarock

Date: 2/16/88 Run #: 3 Clock Time: 12 45 -

Height Of Discharge Pt. 25ft Distance to Source: 40ft



Source Layout Sketch

Ambient Temp. 45°F

Wind Speed Calm

Wind Direction —

Sky Color Blue

Plume Background Blue

Condensed H2O in Plume —

Detached — Attached —

Comments:

Signature: Tom Yarock

Certification Date:

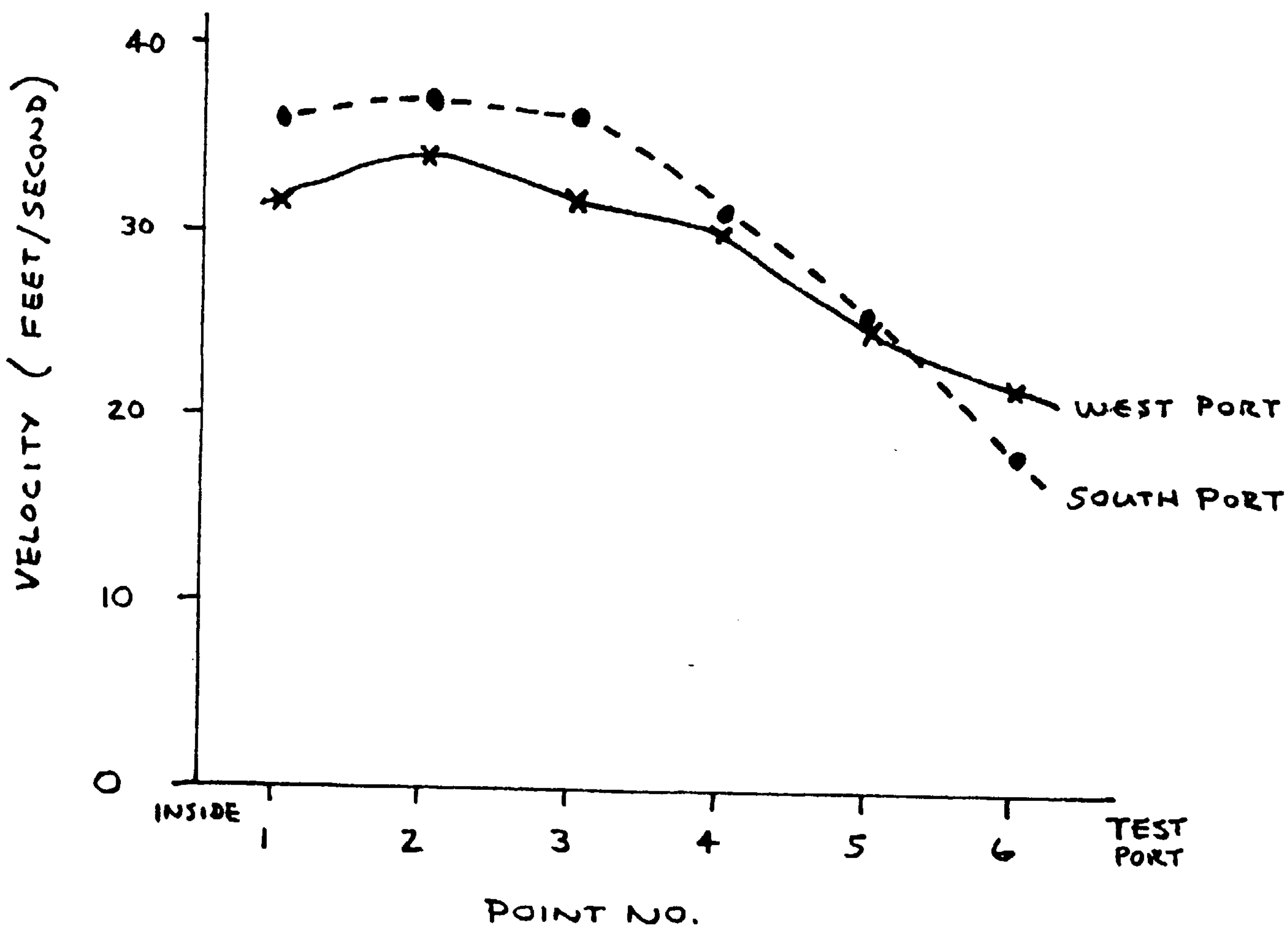
min \ sec	0	15	30	45	min \ sec	0	15	30	45
0	0	0	0	0	30	0	0	0	0
1	0	0	0	0	31	0	0	0	0
2	0	0	0	0	32	0	0	0	0
3	0	0	0	0	33	0	0	0	0
4	0	0	0	0	34	0	0	0	0
5	0	0	0	0	35	0	0	0	0
6	0	0	0	0	36	0	0	0	0
7	0	0	0	0	37	0	0	0	0
8	0	0	0	0	38	0	0	0	0
9	0	0	0	0	39	0	0	0	0
10	0	0	0	0	40	0	0	0	0
11	0	0	0	0	41	0	0	0	0
12	0	0	0	0	42	0	0	0	0
13	0	0	0	0	43	0	0	0	0
14	0	0	0	0	44	0	0	0	0
15	0	0	0	0	45	0	0	0	0
16	0	0	0	0	46	0	0	0	0
17	0	0	0	0	47	0	0	0	0
18	0	0	0	0	48	0	0	0	0
19	0	0	0	0	49	0	0	0	0
20	0	0	0	0	50	0	0	0	0
21	0	0	0	0	51	0	0	0	0
22	0	0	0	0	52	0	0	0	0
23	0	0	0	0	53	0	0	0	0
24	0	0	0	0	54	0	0	0	0
25	0	0	0	0	55	0	0	0	0
26	0	0	0	0	56	0	0	0	0
27	0	0	0	0	57	0	0	0	0
28	0	0	0	0	58	0	0	0	0
29	0	0	0	0	59	0	0	0	0

Total minutes observed: 60

Minutes exceeding 0 % opacity 0

APPENDIX F
VELOCITY PROFILE

VELOCITY PROFILE
TEST #2



APPENDIX G
TURBULENT FLOW DETERMINATION

TURBULENT FLOW DETERMINATION

The formula for determination of the turbulent flow for the secondary chamber is as follows:

$$Re = \frac{V * L * p}{u}$$

When:

Re = Reynolds Number (dimensionless)

V = Flue gas linear velocity (ft/second)

L = Channel diameter (feet)

p = Secondary chamber gas density (lb/ft^3)

u = Secondary chamber gas viscosity (lb/ft*s)

Thus:

$$Re = \frac{25.82 * .912 * .017}{3.17 * 10^{-5}}$$

$$Re = 12,628$$

APPENDIX H
SECONDARY CHAMBER RESIDENCE TIME DETERMINATION

:

SECONDARY CHAMBER RESIDENCE TIME DETERMINATION

The formula for determination of the secondary chamber residence time (in seconds) is as follows:

$$t_r = \frac{V_c}{Q_a * (T_c / T_s)}$$

When:

t_r = flue gas residence time (seconds)

V_c = Volume of secondary chamber ft^3

Q_a = Stack gas flowrate (ACF/second)

T_c = Secondary chamber temperature (^oR)

Ts = Stack temperature (^oR)

Thus:

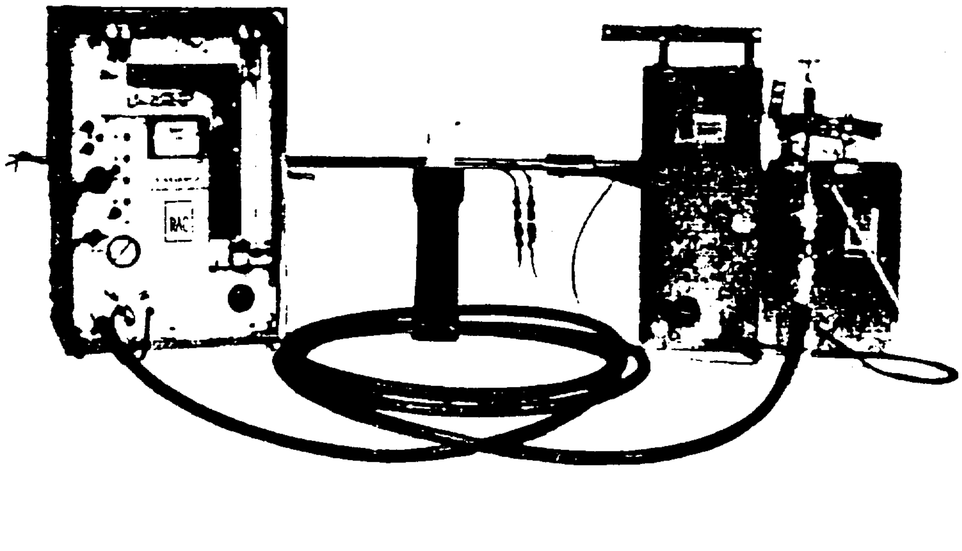
$$t_r = \frac{5.0}{17.07 * (2291/1454)}$$

t_r = 0.19 Seconds

APPENDIX I
TEST EQUIPMENT & CALIBRATION DATA

Reliable Accurate Control

BULLETIN 2343-R3



The RAC Staksamplr system

modular, portable RAC STAKSAMPLR™

this versatile, efficient, field-proven system takes isokinetic samples of process & combustion effluents to EPA sampling standards

• features

- Designed & manufactured to EPA specifications (Federal Register) for sampling the emissions from stationary sources
- First stack sampling system made specifically to EPA design (1969)
- Modular sample case features separate, interchangeable impinger (ice bath) compartment and lightweight aluminum construction
- With glassware installed, complete 2-module sampling case weighs only 32 lbs; detached impinger module weighs only 14 lbs w/glassware
- A series of stack samples can be taken with one set-up (and with minimum downtime) by using several impinger modules equipped with different, preassembled trains
- ASTM & Power Test Code approved
- Ready-to-use, fully portable system
- Easy to install & operate
- Control unit can be located up to 300' from sample collecting unit
- Stainless steel pitobe assembly permits one-point sampling & flow measurements
- Pyrometer unit (optional, P/N 9927-26) takes concurrent stack temperature readings
- Variety of pitobe designs & probe tip sizes available
- Interchangeable 2.5", 3" & 4" dia particulate filters
- Ball-joint connections on glassware assure flexible vacuum-tight assembly, minimize the breakage experienced with solid connections
- Design of glassware connections prevents particle buildup at fitting inlets (if misaligned) & hang-ups if stopcock grease is used
- Nomograph is available to permit fast accurate on-site calculations
- Monorail suspension-guidance system for sample case & pitobe is easy to assemble, provides secure mounting & smooth traverse during sampling
- Integrated umbilical cord available in lengths of 25', 50', 75', 100', 200' and 300'
- Optional accessories enhance system's inherent capabilities & versatility

• application

The RAC Staksamplr System takes accurate, low cost, isokinetic samples of the effluents (particulates, gases, vapors or mists) in the emissions from chemical and combustion processes. This efficient, flexible system samples all gas stream effluents in accordance with **Environmental Protection Agency (EPA) standards**, as specified in the **Federal Register**. Introduced in 1969, the RAC Staksamplr was the *first* system made to the *EPA design* for stationary source sampling apparatus.

Today, the RAC Staksamplr is the most widely used — and most widely copied — system of its type. With hundreds of units now in use around the world, Research Appliance Company has the most extensive in-the-field operating experience of any manufacturer of this kind of equipment. RAC's expertise is reflected in progressive modifications and improvements to the basic design. It also has produced a wide range of accessories that have been developed or adapted to meet specialized stack sampling requirements.

Designed to operate with its sampling probe in a horizontal or vertical position, the versatile RAC Staksamplr can be used in round or rectangular stacks and ducts with flow velocities from 400 to 10,000 fpm and temperatures to approximately 2000°F. (NOTE: If flows below 400 fpm are encountered, measurements can be made by an accessory micromanometer (P/N 994084) that measures velocities down to approx. 65 fpm.)

The RAC Staksamplr collects samples of water vapor (Method 4), particulates (Methods 5 & 17), sulfur dioxide gas (Method 6), sulfuric acid mist, including sulfur trioxide (Method 8), inorganic lead (Method 12), fluorides (Methods 13A & B), mercury (Methods 101 & 102) and beryllium (Methods 103 & 104) all in accordance with EPA Methods as published in the Federal Register.

Engineered for ease of installation and operation, this advanced RAC system meets all accepted standards for stack sampling operations.

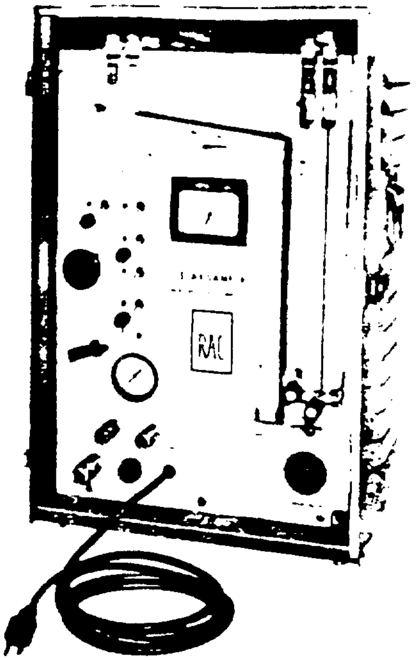


FIGURE 2
Standard Meter Control Case with dual-column inclined-vertical manometer for measuring pressure differentials across sampling orifice (△ H) and pitot (△ P) with ±1% accuracy.

• design

Available as a complete system, RAC Staksamplr is comprised of four major subsystems: (1) a **pitobe assembly** (combination of a heated, lined, stainless steel probe and a detachable pitot tube); (2) an **operating/control console;** (3) a lightweight, modular, **two-piece sample case**; and (4) an integrated, modular **umbilical cord** that connects the sample case and pitobe to the control console. All subsystems are furnished assembled.

To facilitate on-site calculations, a **nomograph** is available with each system. A **monorail suspension-guidance assembly** for the sample case and pitobe also can be furnished as a standard accessory.

Pitobes

RAC pitobes are furnished with three interchangeable sampling nozzles (¼", ⅜" and ½" ID), ball-joint connections, and quick-disconnect couplings. They are available in 3', 5' and 10' effective lengths. The 3' and 5' standard units can be supplied with stainless steel or Pyrex® glass-lined probes, the standard 10' unit has a stainless steel lined probe.

Glass-lined probes can be used for stack temperatures up to 800°F. For higher temperatures, stainless steel or special liners (optional) — or the RAC water-cooled pitobes (optional) — can be used. In addition, the pitot tube can be detached from the probe for quick, easy replacement. It also can be used separate from the probe for *traversing* prior to setting the Staksamplr in position.

Control Console

STANDARD MODEL

The Standard Master Control Console (Meter Control Case) for the RAC Staksamplr contains the system's vacuum pump, inclined-vertical dual-column manometer, totalizing dry gas meter, thermometers, valves, and operating switches in a sturdy, louvered, steel cabinet with a hinged, removable access door. Clear plastic viewports on top of cabinet permit visual readings of two dial-type thermometers located in the inlet and outlet ports of the dry gas meter. This meter measures the volume of air drawn through the system during a sampling period and provides a digital readout of the total volume.

When the system is operating, the dual-column manometer is used to selectively monitor the pressure differentials across the sampling orifice (△ **H**) and the pitot tube (△ **P**). The manometer's vertical scale ranges from 1.1 to 10" water (0.1" minor division) and the inclined scale from 0 to 1.0" water (0.01" minor division). Full scale accuracy is ±1%.

LCD MODEL

Staksamplr LCD is a Lightweight, Compact, Digital stack sampling system that supplies a meter control console equipped with a liquid crystal display (LCD) temperature indicator for Type K Chromel-Alumel thermocouple sensors.

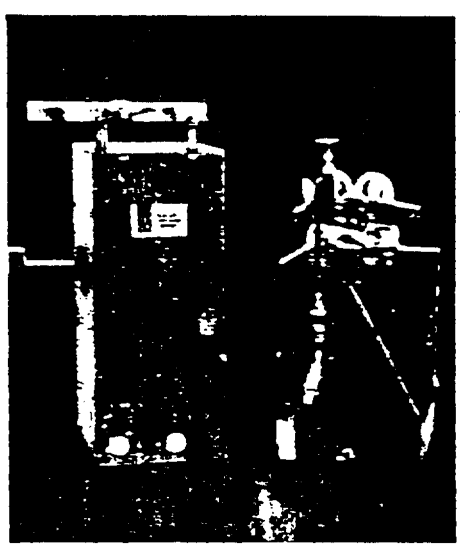


FIGURE 4
Two-module sample case with glassware installed. Door on thermostat-controlled heated compartment provides quicker access to particulate-collecting components. Modules are easily joined or separated by a slip-fit connection.

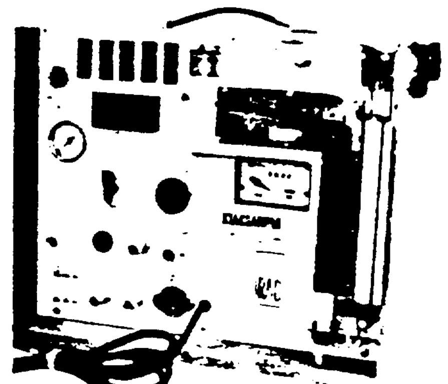


FIGURE 3
LCD Meter Console with liquid crystal display temperature indicator for Type K thermocouple sensors. Circuit breaker switches and external rotary vane pump are standard.

The LCD Meter Console contains the same basic components as the Standard Meter Control Case with the added features of a digital temperature readout indicator, temperature-indicating thermocouples rather than dial thermometers, circuit breaker switches instead of fuses, and an external high capacity rotary vane vacuum pump.

The external pump adds to the compactness of the unit, reduces noise and vibration during sampling periods, and is easily accessible for all service and maintenance work.

The LCD temperature indicator provides accurate digital readings for a minimum 6 different points in the sampling system. Individual temperature readings can easily be obtained for the (1) stack gas,(2) probe liner,(3) sample case heated compartment,(4) outlet of the last impinger,(5) dry gas meter inlet, and (6) dry gas meter outlet. The liquid crystal display readout is equipped with a thermostatically controlled heater to prevent sluggish response in cold weather and a field-selectable slide switch for conversion to either Fahrenheit or Celsius temperature scales. The digital display is easily removed through the front of the console for fast servicing and maintenance and provides glare-free readings even in direct sunlight.

Sample Collecting Case

The RAC Modular Sample Case is a two-module configuration that features a lightweight aluminum construction as well as optimum ease and flexibility of operation. This case contains the system's standard all-glass sampling train (or optional stainless steel impingers-bubblers, P/N 201093-201092), and supports the pitobe in both the normal horizontal and vertical optional (P/N 201015) mounting positions.

A separate **heated compartment** contains the sampling train's particulate-collecting cyclone, flask, and filter,

• options & accessories

Digital Temperature Display

Staksamplr LCD is a complete stack sampling system which provides accurate digital temperature readouts for 6 different points in the system. Thermocouples replace dial thermometers and are used to obtain temperature readings (1) in the stack (2) at the probe liner (3) in sample case heated compartment (4) at outlet of last impinger (5) at dry gas meter inlet, and (6) at dry gas meter outlet. The meter control case is equipped with a liquid crystal display (LCD) temperature indicator and external pump and is compatible with all existing RAC Staksamplrs.

Large Filter Holders

When a high volume of particulate matter is encountered, interchangeable 3" (80 mm, P/N 201012) and 4" (110mm, P/N 201013) glass units can be substituted for 2.5" (64mm, P/N 997065) particle filter in sample case heated compartment. All sizes of RAC filter holders are equipped with a fritted glass disc to support the filter media.

Water-Jacketed Pitobes

These jacketed units use circulating water to withstand stack temps over 800 F; available in 3, 5 & 10' effective lengths.

Stainless Steel Impingers-Bubblers

For applications in which breakage of glassware is a common problem, RAC offers optional stainless steel impingers (P/N 201093) & bubbler units (P/N 201092) with ball-joint connections. These unbreakable all-metal units are interchangeable with the std glassware.

Sectionalized Pitot Tube

Three modular sections provide an S-type pitot with effective lengths of 10' & 15'.

Digital Pocket Pyrometer

Pocket-sized, battery powered thermocouple pyrometer provides stable, accurate temperature readings. Type K thermocouple (supplied separately) attaches to pitobe and provides temperatures over a range of 50 to 1900°F (P/N 992726) or 10° to 1100°C (P/N 992726-1).

Slide Rule Nomograph

Performs presampling and during-sampling isokinetic calculations easily and accurately; handy, standard, slide rule body, very accurate and versatile, no assumptions are necessary; calculates nozzle diameter and isokinetic sampling rate (P/N 201014); optional slide rule (P/N 201127) available if meter moisture content is greater than 2.5% and/or dry molecular weight is not 29 ± 1.

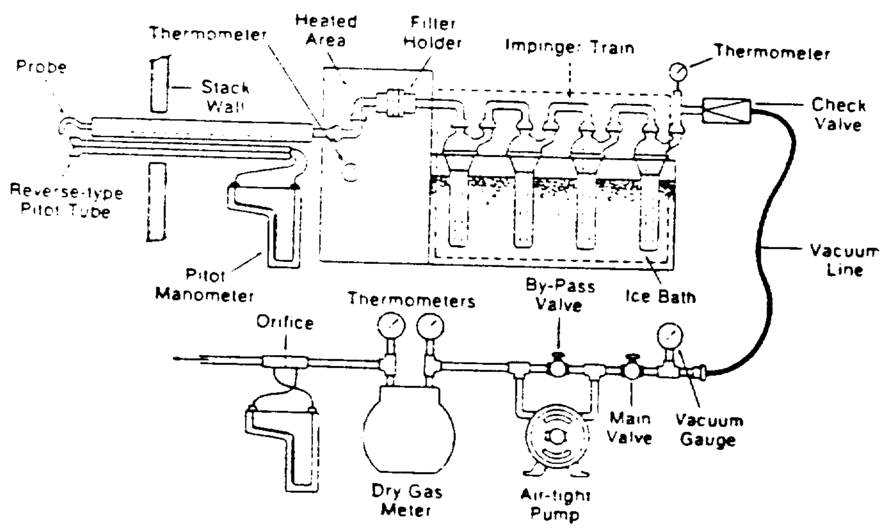
Special Probe Liners

In addition to the standard Pyrex glass and Type 304 stainless steel liners furnished as standard with RAC probes, optional liners made of Teflon, Type 316 stainless steel, quartz, and Inconel also are available on special order. These liners are furnished in standard lengths of 3', 5' or 10' (except for Pyrex glass and quartz) and special lengths can be supplied to order.

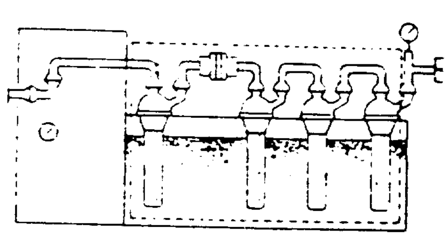
Flexible Sampling Lines

For sampling operations in confined or physically restricted areas, RAC offers flexible, heated, sample-collecting lines that allow the pitobe to be separated from the sample case by distances up to 20' with no loss in sampling efficiency. Available in 5', 10', 15' & 20' lengths, these flexible lines can be used for gas streams with temps up to 300 F (max) and have std ball-joint connections at both ends. A variable voltage device controls temp range in the sample line and prevents burn-out of integral heating wires. Pitot extension lines may be required.

RAC Staksamplr Schematic of EPA Particulate Sampling Train (Method 5)
Same basic configuration used to sample Beryllium & Mercury Vapor
(Federal Register, Vol. 36, Nos 234 [Be, Hg] & 247)



Configuration of Sample Case for sampling SO_2, SO_3 & H_2SO_4 MIST (Method 8)
Heated area is by-passed; particulate filter positioned between 1st & 2nd impingers; all other components same as for particulate sampling
(Federal Register, Vol 36, No 247)



Stack Interface

This instrument adapts the Staksamplr control console for use with the RAC **Stack Gas Train sample case**, which uses midget (30 ml) impingers for sampling moisture *(EPA Method 4)* and SO_2 *(EPA Method 6)* in stacks or ducts; has flowmeter to monitor the low flow rates required, drying tube & connections for sampling pitot & electrical lines (P/N 997503).

Andersen In-Stack Fractionating Sampler

Precision, multi-stage, stainless steel unit collects & automatically classifies particles into 8 sizes (ranging from +20.0 microns down to 0.36 microns dia) according to their aerodynamic characteristics; isokinetic techniques can be used for sampling in stacks with velocities from 100 to 12,000 fpm & temps to 1500 F; adapts to all RAC pitobes (P/N 201037).

Gas Stream Hygrometer

Uses matched (0—220°F) wet-bulb and dry-bulb thermometers to measure percent of water vapor in stack gas streams with temps below 212 F; stainless steel construction (P/N 997517).

Alundum Thimble Filter (in-stack)

Uses 45 x 127mm Alundum (ceramic) thimble of coarse porosity for dry collection of particles entrained in gas streams with temps to 1500 F; glass-fiber and

AST Meter/Orifice Calibration

Console No.: 1 Calibration Date: November 29, 1987

Time (min)	^H	^cm	Gas Volume Calibration Meter Initial	Final	Gas Volume Dry Gas Meter Initial	Final	Tcm	T1	T
13.00	0.55	0.0	74.386	79.693	148.871	154.173	64	65	6
								70	6
10.00	1.0	0.0	79.693	85.205	154.173	159.686	64	70	6
								75	6
8.00	1.5	0.0	85.205	90.528	159.686	165.030	64	74	6
								78	6
7.00	2.0	0.0	90.528	95.862	165.030	170.376	64	76	6
								80	6
8.00	2.5	0.0	95.862	102.667	170.376	177.200	64	78	5
								82	6
7.00	3.0	0.0	102.667	109.225	177.200	183.766	64	79	6
								83	6

Pb = 28.85

H = 0.55	MCF = 1.004	Qm = 0.408	Km = 0.694
H = 1.0	MCF = 1.007	Qm = 0.551	Km = 0.695
H = 1.5	MCF = 1.006	Qm = 0.665	Km = 0.685
H = 2.0	MCF = 1.008	Qm = 0.762	Km = 0.679
H = 2.5	MCF = 1.009	Qm = 0.851	Km = 0.678
H = 3.0	MCF = 1.012	Qm = 0.938	Km = 0.682
AVERAGES:	MCF = 1.008	Qm = 0.696	Km = 0.685

CALCULATIONS

$$\text{MCF} = \frac{(\text{Cm Final} - \text{Cm Initial})\ (\text{Tdgm})\ (\text{Pcm})}{(\text{DGM Final} - \text{DGM Initial})\ (\text{Tcm})\ (\text{Pdgm})}$$

$$\text{Qm} = \frac{\text{DGM Volume}}{\text{Time}} \times \frac{(\text{T2 Avg.} + 460)}{(\text{T1+T2 Avg.} + 460)} \times (\text{MCF})$$

$$\text{Km} = (\text{Qm})\ [\ \text{Sqrt}\ (\text{Pm} * \text{Mm} / \text{Tm} / \text{^H})\ ]$$

AST, Inc.
Post Test Meter Calibration
Console #1

^H	^cm	V1cm	V2cm	V1dgm	V2dgm	Tcm	T1	T2
1.2	0.0	156.487	164.742	851.001	859.295	57	66	56
							75	58
1.2	0.0	164.742	170.828	859.295	865.436	57	74	59
							77	61
1.2	0.0	170.828	183.695	865.436	878.425	57	76	61
Pb =	29.30						80	63

MCF = 1.005
MCF = 1.009
MCF = 1.012

Average MCF = 1.009

Calibrated by: [signature] Date: 2/25/88

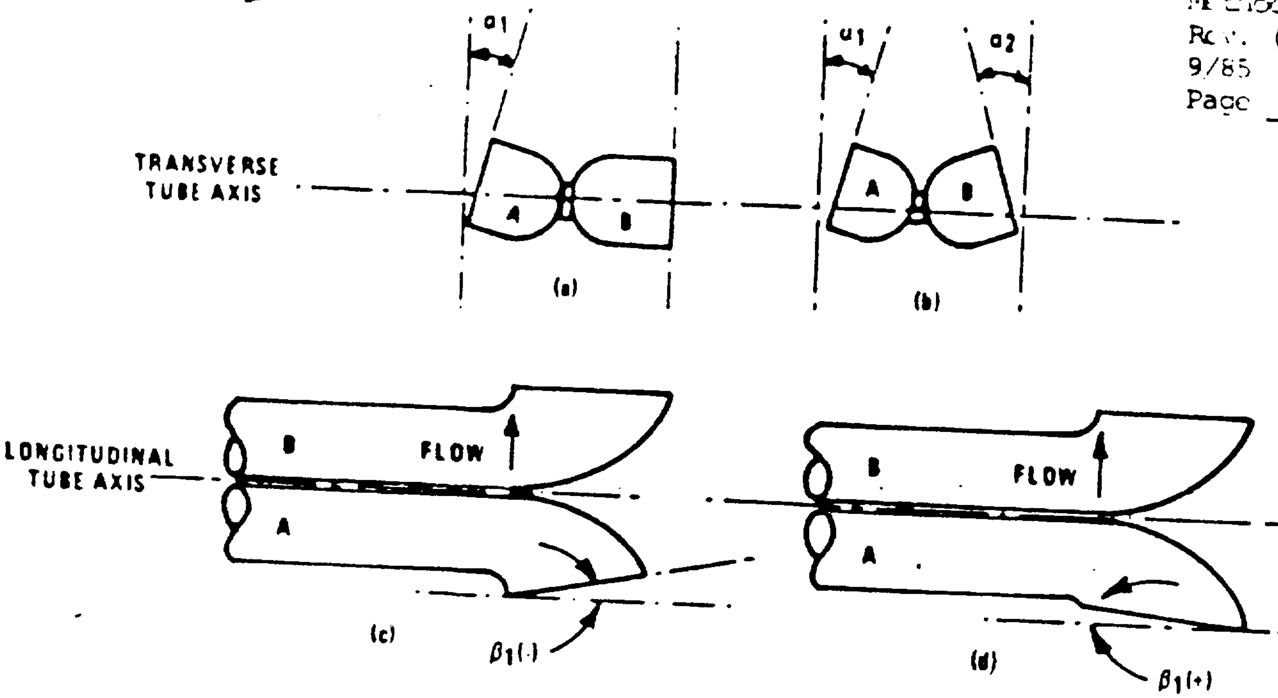
THERMOCOUPLE/THERMOMETER CALIBRATIONS

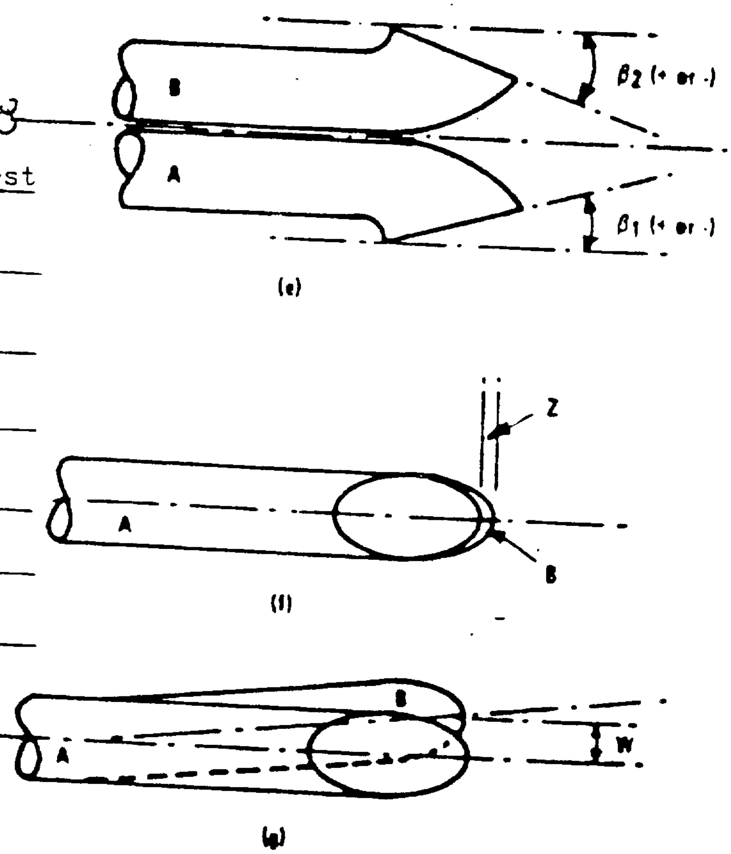
Device	Reading (oF)	ASTM Reference Thermometer (oF)
3' PROBE # 2 STACK T/C*	33°/211°	33°/211°
3' PROBE # 3 STACK T/C*	33°/211°	33°/211°
FILTER BOX THERMOMETER	55°/209°	57°/211°
IMP. OUTLET THERMOMETER	33°/56°	33°/57°
METER INLET	34°/210°	33°/211°
METER OUTLET	34°/210°	33°/211°

* T/C ASSEMBLY INCLUDED OMEGA HH99AK DIGITAL THERMOMETER

DATE: 2/12/88 JCBL

3' # 2 WITH QUARTZ NOZZLE/LINER





Item	2/16/88 Pre-test	2/19/88 Post-test
a_1	0	0
a_2	0	0
B_1	0	0
B_2	0	0
z	0	0
w	0	0
f_L	0.56	0.56"
f_b	0.56	0.56"

Figure 2.3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect the baseline value of $\bar{C}_{p(s)}$ so long as α_1 and $\alpha_2 < 10^{\circ}$, β_1 and $\beta_2 < 5^{\circ}$, $z < 0.32$ cm (1/8 in.) and $w < 0.08$ cm (1/32 in.) (citation 11 in Section 6).

3'#2

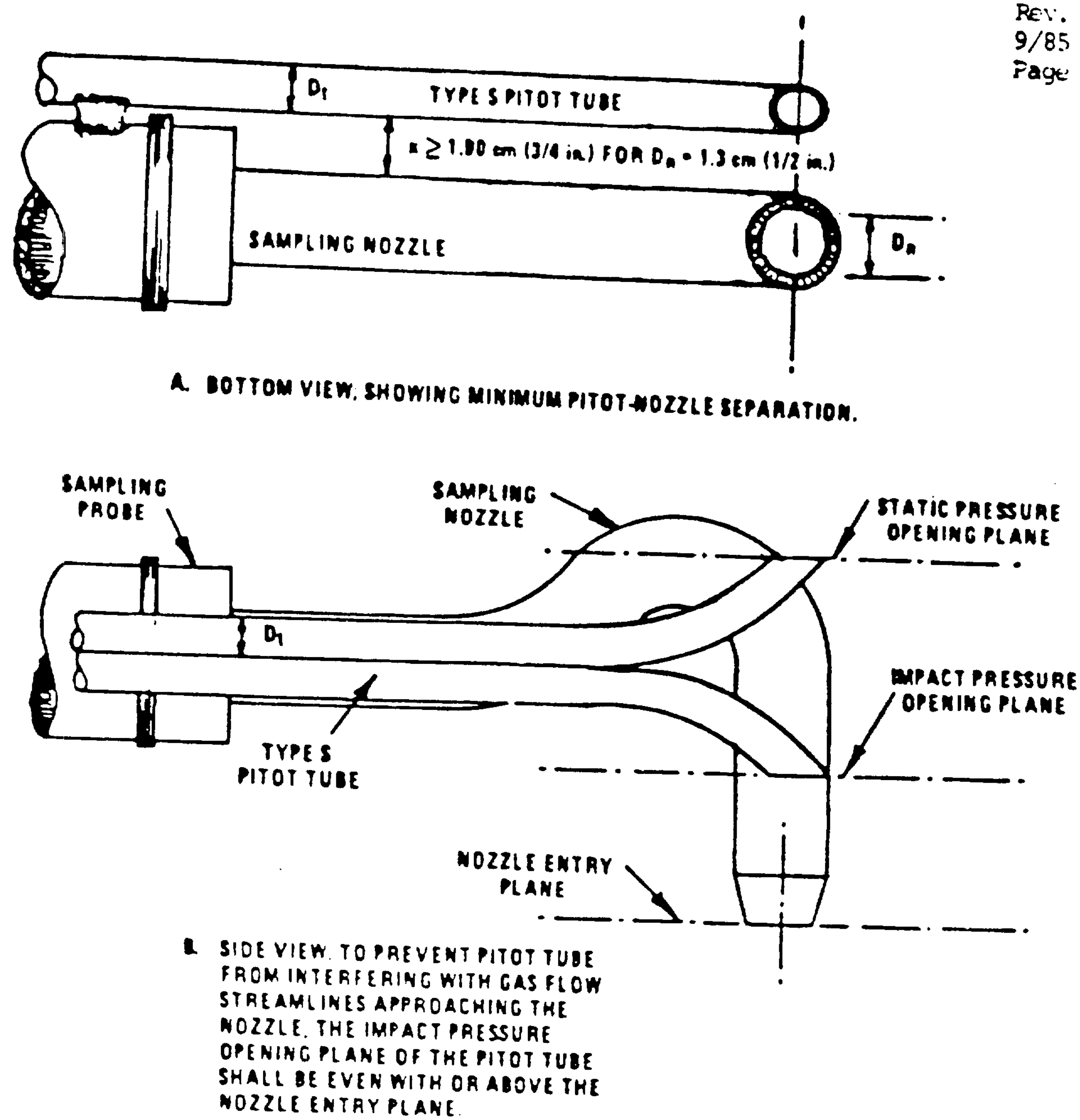


Figure 2-6. Proper pitot tube - sampling nozzle configuration to prevent aerodynamic interference; buttonhook - type nozzle; centers of nozzle and pitot opening aligned; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

Measurement	Pre-test	Post-test
D_t	3/8	3/8
D_n	1/2	
x	0.71	0.71

3' # 2

Pre-test "Z" = 2.0"

Post-test "Z" = 2.0

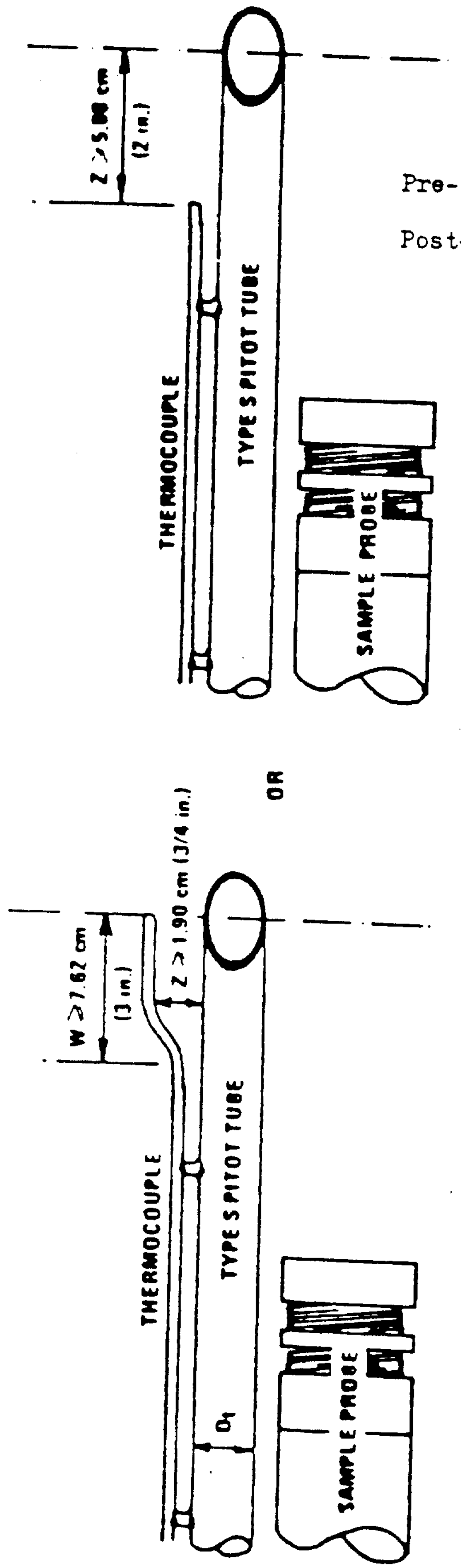
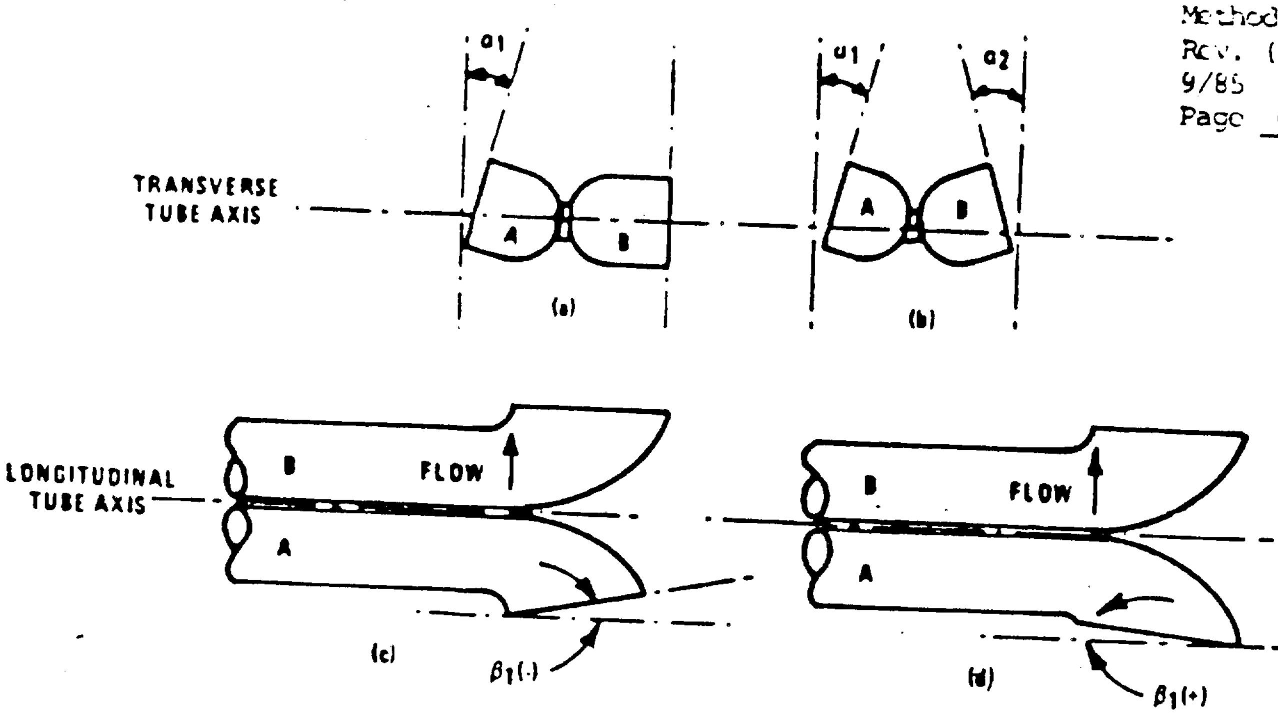
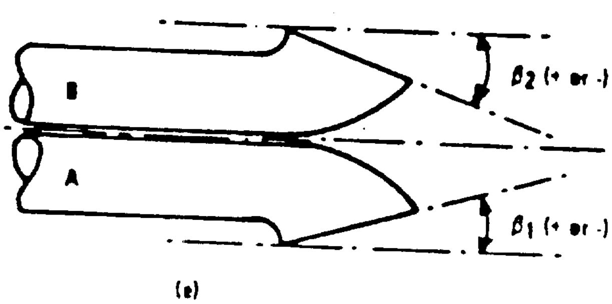


Figure 2.7. Proper thermocouple placement to prevent interference; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

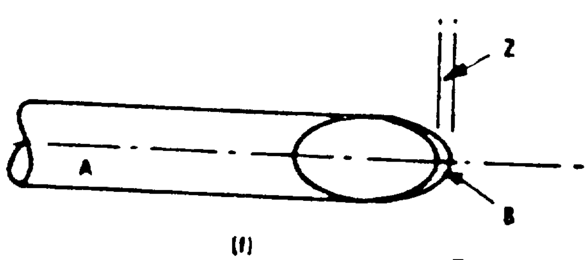
2/16
Nozzle:
0.455
0.453
0.453
0.453

3' #3 (Test 2)





Item	2/16/88 Pre-test	2/19/88 Post-test
a_1	0	0
a_2	0	0
B_1	0	0
B_2	0	0
z	0	0
w	0	0
P_2	0.46	0.46
P_0	0.46	0.46



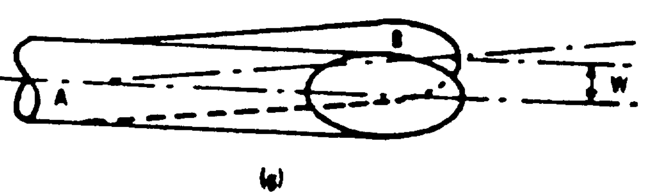
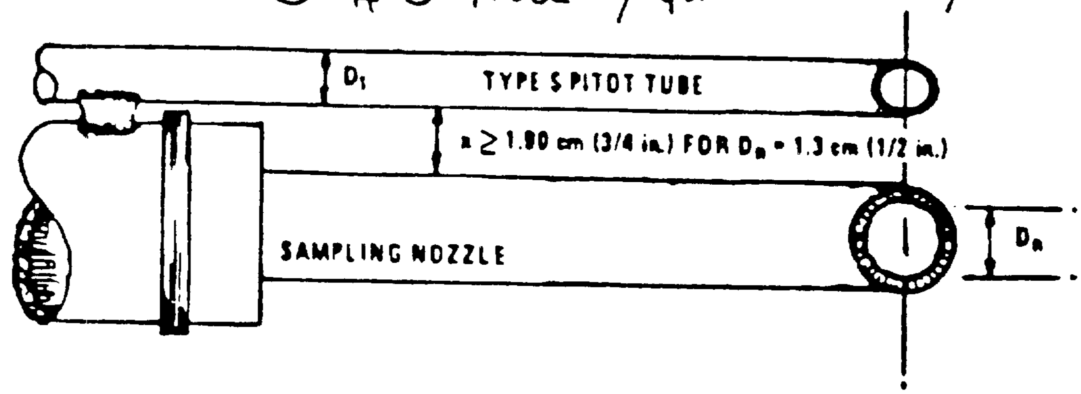
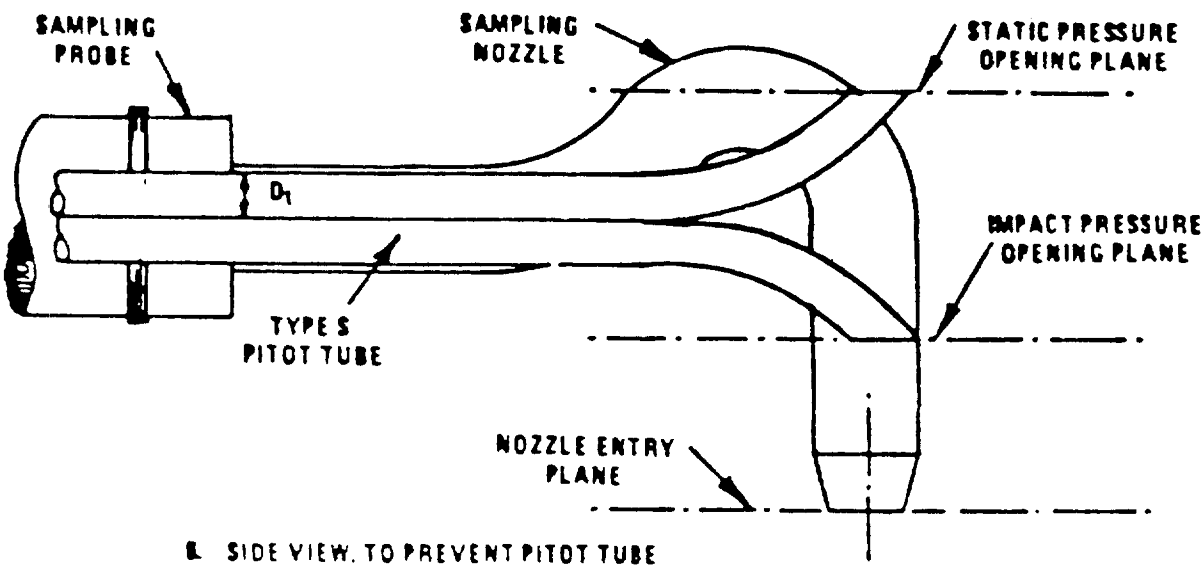


Figure 2.3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect the baseline value of $\bar{C}p(s)$ so long as α_1 and $\alpha_2 < 10°$, β_1 and $\beta_2 < 5°$, $z < 0.32$ cm (1/8 in.) and $w < 0.08$ cm (1/32 in.) (citation 11 in Section 6).

3' #3 Probe w/ QUARTZ NOZZLE/LINER



A. BOTTOM VIEW, SHOWING MINIMUM PITOT-NOZZLE SEPARATION.



B. SIDE VIEW, TO PREVENT PITOT TUBE FROM INTERFERING WITH GAS FLOW STREAMLINES APPROACHING THE NOZZLE, THE IMPACT PRESSURE OPENING PLANE OF THE PITOT TUBE SHALL BE EVEN WITH OR ABOVE THE NOZZLE ENTRY PLANE

Figure 2-6. Proper pitot tube - sampling nozzle configuration to prevent aerodynamic interference; buttonhook - type nozzle; centers of nozzle and pitot opening aligned; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

Measurement	Pre-test	Post-test
D_t	3/8	3/8
D_n	0.450	[redacted] N/A
x	0.72	0.72

3'#3

Pre-test "Z" = 2.1

Post-test "Z" = 2.1"

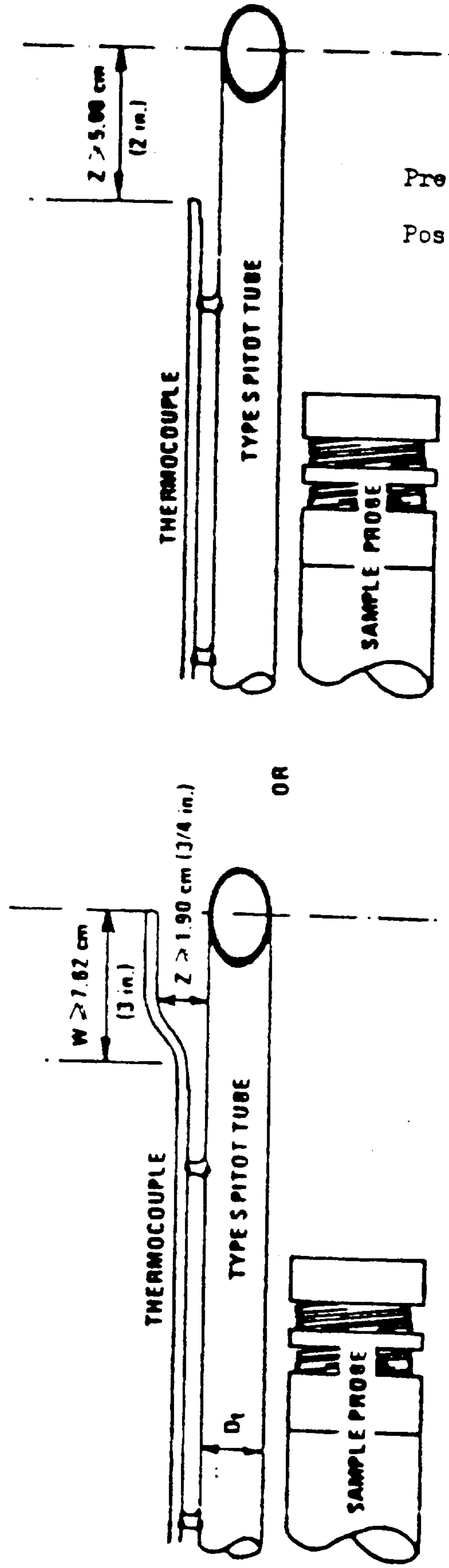


Figure 2.7. Proper thermocouple placement to prevent interference; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

Nozzle: 2/16/88

0.450"
0.450"
0.450"
0.451"

APPENDIX J
HCl - Cl_2 PROCEDURES

5.4.10 CHLORINE AND CHLORINE COMPOUNDS

The following method has been used to a limited extent for analysis of hydrochloric acid, free chlorine, and total chlorides in emissions from chlorination fluxing of molten aluminum alloys.

5.4.10.1 Method Summary

Hydrochloric acid is collected by impingers containing water at ambient temperature. These are followed by impingers containing caustic, cooled in an ice bath, for collection of free chlorine. If only free chlorine is to be determined, collection may be made with potassium iodide solution, analyzing for free liberated iodine by standard iodometric methods. Only traces of free chlorine and hydrochloric acid, respectively, are collected by the distilled water and caustic.

The hydrochloric acid and free chlorine are determined by alkalimetric and iodometric titrations, respectively. Total chlorine is determined as chloride by the Volhard method; other halides, except fluorides, will be included in the analysis. The latter determination is made for checking purposes, as well as for other chlorides that may be present in the sample.

Metal chlorides, if present in more than trace amounts, are removed by a paper thimble preceding the distilled water impingers. The thimble collection is extracted and analyzed by usual chemical procedures for metal and chloride ions. An APCD method uses 8-hydroxyquinoline reagent for analysis of milligram quantities of aluminum and magnesium.

5.4.10.2 Sampling

The absorption train consists of: *(a)* two impingers, each containing 100 ml of distilled water (the contents are later referred to as *solution A*), followed by *(b)* two impingers, each containing 100 ml of 5% sodium hydroxide solution (the contents are later referred to as *solution B*), followed in turn by a ~~dry~~ S.GEL impinger fitted with a thermometer on the inside stem. The first two impingers are held in a water bath at ambient temperature, and the remaining three are placed in an ice bath. A dry gas meter and vacuum pump follow the impingers. Details of assembly, sampling, and recording data are the same as described for other constituents, e.g., ammonia, organic acids, and sulfur dioxide; sampling rates should not exceed 0.5 cfm.

The total volume of each of solutions A and B are measured; the condensate volume, if not negligible, is recorded for later calculation of sampled gas volume. The impingers and tubing for each solution are rinsed with water ~~and each made up to an exact volume~~.

5.4.10.3 Analytical Procedure

To analyze for free chlorine, a few milligrams of solid potassium iodide are added to an aliquot of solution A; if no iodine color develops, the solution is then titrated for determination of free hydrochloric acid as described below. If iodine is liberated, the solution is first titrated to the starch end point with standard 0.1 N sodium thiosulfate solution.

An aliquot of solution B is acidified with sulfuric acid, about one gram of solid potassium iodide added, and the liberated iodine titrated with standard 0.1 N sodium thiosulfate to the starch end point. The quantity of sodium thiosulfate used for each of the above titrations is recorded and expressed as milliequivalents.

For hydrochloric acid, the solution A aliquot from above is titrated with standard 0.1 N sodium hydroxide solution to the methyl red end point. The quantity of standard base used is recorded and expressed as milliequivalents.

In the analysis for total free and combined chlorine, separate aliquots of solution A (made alkaline) and solution B are used. Sufficient 30% hydrogen peroxide is added to each solution to reduce all free chlorine to chloride ion. The total chloride ion content of each is determined by the standard Volhard titration procedure, and expressed as milliequivalents of chloride ion.

5.4.10.4 CALCULATIONS

Calculations of the volume of stack gas sampled are made in the same manner as described for other constituents collected by sampling trains, e.g., ammonia, organic acids, sulfur dioxide. Usually little or no condensate is collected so only Equation 4.9 may be needed.

The concentration and emission rate of free chlorine (as Cl_2) in the sampled gas are calculated using the following relations:

$$c_{Cl} = 419 \frac{(f_1 m_1 + f_2 m_2)}{V_T} \quad , \qquad (5.52)$$

and

$$M_{Cl} = 11.2 \times 10^{-6} c_{Cl} Q \quad , \qquad (5.53)$$

where,

c_{Cl} = concentration of free chlorine, parts per million by volume

m_1, m_2 = milliequivalents of standard sodium thiosulfate used for titration of iodine liberated by aliquots of solutions A and B, respectively

f_1, f_2 = *aliquot factors* for solutions A and B, respectively

V_T = volume of stack gas sampled, standard cubic feet

M_{Cl} = emission rate of free chlorine, pounds per hour

Q = stack gas flow rate, standard cubic feet per minute

The concentration and emission rate of hydrochloric acid (as HCl) in the sampled gas are calculated with the expressions

$$c_{HCl} = 838 \frac{f_1 m_3}{V_T} \quad , \qquad (5.54)$$

and

$$M_{HCl} = 5.76 \times 10^{-6} c_{HCl} Q \quad , \qquad (5.55)$$

where,

c_{HCl} = hydrochloric acid concentration, parts per million by volume

m_3 = milliequivalents of standard sodium hydroxide used for titration of aliquot of solution A

M_{HCl} = emission rate of hydrochloric acid, pounds per hour

f_1, V_T, Q = as defined for Equations 5.52 and 5.53

The milliequivalents of total chloride ion found for solution A should be at least equal to the sum of the milliequivalents of free Cl_2 and HCl found (i.e., $f_1 m_1 + f_1 m_3$). Any greater amount suggests that the difference is due to metal chlorides that may have been collected in the solution.

The milliequivalents of total chloride ion found for solution B should be equal to $f_2 m_2$, the milliequivalents of free Cl_2 found; any slight excess may be attributable to hydrochloric acid that was not absorbed in the distilled water impingers. In this case, the additional acid is added to that calculated from the preceding section.

5.5 STACK GAS WATER VAPOR CONTENT

An average value for water vapor content of the stack gases over the test period is ob-