State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL QUALITY
Bureau of Technical Services
CN 411
Trenton, N.J. 08625-0411
(609) 530-4041

January 22, 1992

MEMORANDUM

TO: Scott Hawthorne, Regional Enforcement Officer
Southern Regional Enforcement Office

FROM: Edward Choromanski, Chief
Bureau of Technical Services

SUBJECT: Camden County Energy Recovery Associates
Camden, New Jersey
Stack Emissions Test Program - Monthly Lead Tests
APC Plant ID No. 50617
NJ Stack No. 001
P/CT No. 83668 (Log No. 87-1012)

Stack emission tests were conducted at the above referenced facility on October 18, 1991. The purpose of these tests was to quantify the lead emissions being emitted to the atmosphere from Unit No. 1 (Incinerator Train). The results will be averaged for a twelve month period to verify compliance with the emission standards stated in the permit conditions.

Dan Strochak reviewed the submitted stack test report. His review indicates that the lead emissions were within the allowable emission standards, for each test run. His review indicated that lead emissions were only detected at the outlet during Run No. 1. Runs No. 2 and 3 had lead emissions below the detectable limit of the analytical procedure. However, based on the detection limit, the results would have been below the allowable emission standard. The results are consistent (being below the detection limit) with the previous lead stack test results. The amount and type of material being fed to the incinerator was monitored by personnel of the Division of Solid Waste Management. The results of their inspection are attached.

Final determination of the lead emissions compliance can not be made until the remaining nine months stack data has been completed.

c William O'Sullivan
Don Patterson
Iclal Atay
Chuck DeWeese
Dan Strochak

Attachment

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF ENVIRONMENTAL QUALITY
Bureau of Technical Services
CN 411
Trenton, N.J. 08625-0411
(609) 530-4041

January 14, 1992

MEMORANDUM

To: Edward Choromanski

From: Dan Strochak

Subject: Camden County Resource Recovery Facility
APC I.D. No. 50617
N.J. Stack No. 001
P/CT No. 83668
Log No. 87-1012

On October 18, 1991, monthly lead tests were conducted at the above referenced facility. The tests were for removal efficiency on unit one, and were conducted by Entropy Environmentalists Inc. The results of the tests are as follows.

Contaminant		Run 1	Run 2	Run 3	Allowable
Lead	gr/Dscf	0.0046	0.00639	0.00835	
	gr/Dscf @ 12% CO_2	0.00673	0.00871	0.00114	
	gr/Dscf @ 7% O_2	0.00644	0.00836	0.0108	
	Lb/Hr	1.90	2.43	3.34	
Outlet					
Lead	gr/Dscf	$7.44*10^{-6}$	$<3.45*10^{-6}$	$<3.45*10^{-6}$	
	gr/Dscf @ 12% CO_2	$1.16*10^{-5}$	$<5.18*10^{-6}$	$<5.18*10^{-6}$	
	gr/Dscf @ 7% O_2	$1.08*10^{-5}$	$<4.89*10^{-6}$	$<4.88*10^{6}$	
	Lb/Hr	0.00347	<0.00153	<0.00152	.08
Removal Efficiency %		99.82	99.93	99.95	

Operating Data

Avg. Furnace Temp.(^{o}F)	1109	1115	1170
Economizer Outlet Gas Temp.	442	443	455
Feedwater Pressure psig	1216	1218	1206
Lime Slurry Flow gpm	7.8	7.6	8.9
Lime Slurry ph	6.97	6.99	7.0
Oxygen (%)	9.0	8.99	8.70
Opacity (%)	0.06	0.04	0.03

Technical services calculations of the raw data supplied, indicates substantially the same results. The lead emissions for all three runs were within p/ct 83668 allowables. The amount of waste charged for the day of the tests was 240.75 tons.

CAMDEN COUNTY ENERGY RECOVERY ASSOCIATES
600 MORGAN BOULEVARD, CAMDEN, NEW JERSEY 08104 - PHONE (609) 966-7174

November 22, 1991

Mr. Edward Choromanski, Chief
Department of Environmental Protection
Division of Environmental Quality
Bureau of Technical Services
CN 411
Trenton, N.J. 08625-0414

Subject: Camden County Energy Recovery Associates
APC I.D. 50617
Result of Monthly Stack Testing
October 1991

Dear Mr. Choromanski:

This letter serves to notify you of the results of monthly lead testing which was conducted at this facility on Tuesday October 18, 1991. Attached you will find the results of the subject test which were conducted by Entropy Environmentalist Inc.

Three 2 hour test runs were conducted on Unit 1 ("A" Boiler). Two of the three test runs showed less than detectable concentrations of lead in the stack flue gas and the overall average removal efficiency, based on SDA inlet sampling, was shown to be greater than 99.91%. The average emission rate calculated from the results of the tests was 0.00116 lb/hr or 1.45% of permit limitation of 0.08 lb/hr.

If there are any questions, please contact me at (609) 966-7174.

Sincerely,

Steve Warlick

Steve Warlick
Environmental Coordinator

CC M. Wattis File
B. Studley (OCTPbTest)
M. Cooper (W/Attachment)
C. Clamser

TELECOPY MESSAGE

DATE: 10/10/91 TIME: 1430

PLEASE HAND DELIVER THE FOLLOWING TELECOPY TO:

NAME: ED CADROMANSKI / SUE SLACHATA

COMPANY: NJDEP DEQ TECH SERVICES

TELECOPY NO.: 530-5387

FROM: S. WARLICK

CAMDEN COUNTY ENERGY RECOVERY ASSOCIATES
600 MORGAN BOULEVARD
CAMDEN, NEW JERSEY 08104

TOTAL NUMBER OF PAGES (INCLUDING COVER SHEET) 2

This telecopy message is transmitted from (609) 966-7990 (an automatic machine). Please call (609) 966-7174 if the telecopy you receive is incomplete or illegible.

CAMDEN COUNTY ENERGY RECOVERY ASSOCIATES

600 MORGAN BOULEVARD, CAMDEN, NEW JERSEY 08104 - PHONE (609) 966-7174

October 9, 1991

Mr. Edward Choromanski, Chief
Department of Environmental Protection
Division of Environmental Quality
Bureau of Technical Services
CN 411
Trenton, N.J. 08625-0414

Subject: Camden County Energy Recovery Associates
APC I.D. 50617 - 001
Notice of Monthly Stack Testing
October 18, 1991

Dear Mr. Choromanski:

This letter serves to notify you of scheduled monthly lead testing which will be conducted at this facility on Friday October 18, 1991. Entropy Environmentalist Inc. will be conducting the test. Entropy Plans to be on-site on Thrusday October 17 1991 for set of equipment. Testing will begin on one unit on Friday the 18th.

If there are any questions, please contact me at (609) 966-7174.

Sincerely,

Steve Warlick

Steve Warlick
Environmental Coordinator

CC N. Wattis
B. Studley
M. Cooper
T Byrne
C. Mellon (NJDEP SRO)
File
(MONTHLYTEST)

Process Data 10/18/91

TELECOPY MESSAGE

DATE: JAN 2 1982 TIME: 1600

PLEASE HAND DELIVER THE FOLLOWING TELECOPY TO:

NAME: DAN STROCKAK

COMPANY: DEPE DEQ BUREAU OF TECH SERV

TELECOPY NO.: 530-5387

FROM: DAN STROCKAK

CAMDEN COUNTY ENERGY RECOVERY ASSOCIATES
[illegible]

TOTAL NUMBER OF PAGES (INCLUDING COVER SHEET) 5

This telecopy message is transmitted from [illegible]
or illegible.

DATE OF LOG 18-OCT-91 FRIDAY [illegible] PRINT TIME 00:20:18 19-OCT-91

LOG# 12	HOUR MSW CHRGD	DAILY MSW CHRGD	SHTR OUT FLOW	SHTR OUT FLOW	TOTAL EXPORT POWER	TOTAL EXPORT ENERGY	TG101A OUTPUT POWER	TG101B OUTPUT POWER	TG101A OUTPUT ENERGY	TG101B OUTPUT ENERGY	IN HOUSE 52-F1	IN HOUSE 52-F2	CALC NET EXPORT
	WI	WQI	FI	FQI	JI	JI	JI	JI	JI	JI	JI	JI	JI
TIME	5175A3 Tons	5175A2 Tons	1078 FPH	1078 KLbs	5601 MW	5603 MWH	6104 MW	7104 MW	6106 MWH	7106 MWH	5616 MW	5617 MW	5600 MW
01:00	12.36	12.36	87296.00	24320.00	20.60	27200.000	12.7?	12.16	19072.0	16256.000	2.25	1.90	20.78
02:00	17.28	29.66	89728.00	24416.00	21.60	27200.000	[illegible]	13.20	19104.0	16272.000	2.27	1.91	21.78
03:00	16.69	46.31	89864.00	24512.00	21.44	27232.000	[illegible]	13.31	19104.0	16288.000	2.30	1.91	21.7?
04:00	14.73	61.06	91264.00	24608.00	21.19	27264.000	12.61	13.06	19104.0	16304.000	2.29	1.91	21.47
05:00	14.30	75.38	90496.00	24704.00	20.94	27264.000	12.61	12.78	19136.0	16304.000	2.28	1.91	21.22
06:00	11.84	87.26	85120.00	24768.00	20.59	27296.000	12.58	12.48	1913?.0	16320.000	2.27	1.92	20.88
07:00	14.42	101.?3	87936.00	24864.00	19.81	27328.000	[illegible]	11.4?	19168.0	16336.000	2.26	1.91	20.06
08:00	18.00	119.43	84096.00	24960.00	19.69	27328.000	12.7?	11.41	19168.0	16352.000	2.25	1.90	20.00
09:00	15.66	135.09	74880.00	25024.00	18.03	27360.000	11.6?	10.7?	19168.0	16352.000	2.25	1.87	[illegible]
10:00	7.79	142.75	89600.00	26120.00	18.91	27360.000	10.41	12.89	19200.0	16368.000	2.26	1.78	19.25
11:00	13.91	156.75	86784.00	25184.00	19.47	27392.000	10.42	13.41	19200.0	16384.000	2.26	1.77	19.81
12:00	14.42	171.00	83192.00	25280.00	19.12	27424.000	10.47	13.06	19200.0	16384.000	2.23	1.78	19.47
13:00	9.70	180.?5	87424.00	25376.00	19.30	27424.000	[illegible]	[illegible]	[illegible]	[illegible]	2.23	1.79	[illegible]
14:00	12.84	193.??	86784.00	25472.00	18.58	27456.000	[illegible]	[illegible]	[illegible]	[illegible]	2.23	1.78	[illegible]
15:00	15.67	209.25	96016.00	25536.00	18.46	27456.000	[illegible]	[illegible]	[illegible]	[illegible]	2.26	1.78	[illegible]
16:00	10.48	218.73	87680.00	25632.00							2.25	1.79	18.44
17:00	13.02	232.75	87424.00	25728.00	18.53	27520.000	10.08	12.77	19264.0	16448.000	2.24	1.75	18.84
18:00	18.66	251.25	85248.00	25792.00	20.78	27520.000	10.0?	15.11	19264.0	16480.000	2.25	1.79	21.16
19:00	[illegible]	[illegible]	[illegible]	25888.00	20.48	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.26	1.79	[illegible]
20:00	15.06	278.50	81280.00	25984.00	[illegible]	27552.000	[illegible]	[illegible]	[illegible]	[illegible]	2.27	1.77	[illegible]
21:00	14.00	292.50	[illegible]	26080.00	20.72	[illegible]	[illegible]	[illegible]	[illegible]	16512.000	2.24	1.79	[illegible]
22:00	8.76	301.50	85760.00	26144.00	20.34	27616.000	10.11	14.64	19328.0	16544.000	2.24	1.79	20.72
23:00	18.91	320.50	79872.00	26240.00	18.69	27616.000	10.06	12.95	19328.0	16544.000	2.20	1.79	19.03
24:00	4.77	325.00	70144.00	26304.00	15.11	27648.000	10.00	9.27	19328.0	16544.000	2.20	1.71	15.36
MAX	18.9?		91264.00		21.6?		12.7?	[illegible]			2.30	1.92	21.78
AVG	13.1?		85952.00		18.8?		[illegible]	[illegible]			2.25	1.82	19.89
MIN	4.7?		70144.00		15.1?		10.0?	9.2?			2.20	1.71	15.36
SUM	314.8?		2062846.		451.4?		258.1?	294.4?			54.06	43.74	477.27

LOG#	AVG FURN TEMP	ECON Outlet Gas Temp	A.TEMP SPRAY FLOW	FEED-WATER FLOW	FEED-WATER PRESS	FEED-WATER TEMP	OUTLET STEAM FLOW	OUTLET STEAM PRESS	OUTLET STEAM TEMP	ECON OUTLET GAS OXYGEN	AIR FUEL GAS FLOW	LIME MSW CHRGD	DAILY MSW CHRGD	HOUR MSW CHRGD	LIME SLRY FLOW	LIME SLRY PH
TIME	TIC 1102 DegF	TIC 1110 DegF	FI 1510 PPH	FIC 1009 PPH	PI 5050 PSIG	TI 5126 DegF	FI 1078 PPH	PI 1017 PSIG	TI 1122 DegF	AIC 1116 Pct	FIC 1150 Pct	MQI 5175A Tons	MQI 5175A2 Tons	MQI 5175A1 Tons	FI 1305 GPM	AI 9026 pH
01:00	1118.	441.0	527.00	69760.	1220	304.5	65792.	662.0	757.0	8.73	315.00	3124.000	9.33	9.33	7.49	6.98
02:00	1112.	440.5	522.00	69632.	1220	304.5	64576.	661.0	752.0	8.72	316.00	3132.000	16.75	7.43	7.52	6.98
03:00	1102.	440.0	580.00	66432.	1220	304.5	63504.	660.0	753.0	8.59	316.00	3140.000	26.75	9.98	7.54	6.98
04:00	1090.	439.5	871.00	67328.	1216	304.0	63976.	664.0	757.0	9.02	315.50	3152.000	37.69	10.96	7.41	6.98
05:00	1112.	442.0	1070.0	70656.	1216	305.0	65792.	670.0	755.0	8.63	316.00	3156.000	42.94	6.21	8.39	6.96
06:00	1086.	440.5	667.00	64320.	1218	304.5	59968.	669.0	751.0	9.60	317.00	3172.000	55.88	12.94	8.06	6.97
07:00	1070.	436.0	536.00	65920.	1220	305.0	60032.	668.0	751.0	9.36	317.50	3180.000	65.13	9.31	7.47	6.97
08:00	1092.	441.0	740.00	66688.	1216	304.5	61248.	671.0	755.0	9.28	317.50	3188.000	72.75	7.65	7.46	6.96
09:00	1090.	442.5	666.00	63808.	1218	304.5	61184.	668.0	754.0	9.20	317.50	3196.000	80.00	7.29	7.47	6.96
10:00	1134.	440.5	813.00	76928.	1212	304.5	69632.	664.0	752.0	8.11	315.00	3204.000	90.38	10.33	7.82	6.96
11:00	1160.	444.0	1268.0	83456.	1210	304.5	79232.	677.0	756.0	8.52	314.00	3220.000	103.50	13.20	8.20	6.96
12:00	1108.	441.0	841.00	79808.	1216	304.5	68736.	676.0	752.0	9.03	314.00	3226.000	112.25	8.75	7.62	6.96
13:00	1092.	444.0	751.00	70912.	1220	304.5	67840.	662.0	752.0	9.53	311.00	3236.000	120.13	7.86	7.94	6.98
14:00	1092.	440.0	609.00	66816.	1220	304.5	65216.	670.0	751.0	9.58	314.50	3244.000	129.75	9.48	8.56	6.99
15:00	1102.	446.5	941.00	71552.	1216	304.0	66944.	671.0	750.0	9.55	314.50	3256.000	141.75	11.98	7.63	6.99
16:00	1126.	443.5	1110.0	72960.	1218	304.5	70272.	662.0	747.0	8.80	316.00	3264.000	150.75	9.09	7.56	6.99
17:00	1140.	440.5	1162.0	75776.	1218	304.5	69760.	677.0	756.0	8.61	316.00	3272.000	157.25	6.58	7.50	6.99
18:00	1114.	441.0	1104.0	70656.	1216	304.5	66688.	671.0	752.0	9.06	315.50	3280.000	166.80	9.67	7.70	7.00
19:00	1170.	453.0	1194.0	81664.	1212	304.5	79616.	667.0	757.0	8.56	312.00	3288.000	174.25	7.80	8.36	7.00
20:00	1202.	459.5	1314.0	92544.	1198	304.5	88576.	672.0	755.0	8.31	308.50	3304.000	188.50	14.16	10.67	6.99
21:00	1194.	459.5	1222.0	91136.	1190	304.0	88032.	668.0	754.0	8.84	305.00	3316.000	201.60	13.16	9.26	6.99
22:00	1212.	469.5	1250.0	94336.	1194	304.5	92032.	669.0	753.0	8.03	306.00	3328.000	212.75	11.19	10.48	6.99
23:00	1202.	471.0	1110.0	93312.	1194	304.5	89728.	668.0	754.0	8.73	306.50	3344.000	227.75	15.06	9.00	7.00
24:00	1202.	466.0	1062.0	91520.	1192	304.0	87936.	667.0	754.0	8.47	306.50	3356.000	240.75	12.98	8.56	7.00
MAX	1212.	471.0	1314.0	94336.	1220	305.0	92032.	677.0	756.0	9.58	317.50			15.06	10.67	7.00
AVG	1129.	447.2	912.92	75488.	1212	304.4	71421.	668.0	754.3	8.86	313.25			10.03	8.15	6.96
MIN	1082.	436.0	522.00	63808.	1192	304.0	59968.	657.0	751.0	8.03	306.00			6.21	7.41	6.95

LOG 12

TIME	STK OPACY AI 1190 Pct	STK NOX AI 1191 PPM	STK CO AI 1192 PPM	STK HCL AI 1193 PPM	STK SO2 AI 1194 PPM	ECON OUT SO2 AI 1505 PPM	STK NMHC AI 1196 PPM	STK O2 AI 1198 Pct	STK H2O AI 1196 Pct	TOTAL AIR FLOW FI 1029A PPH	OFIRE AIR FLOW FI 1029B PPH	UGRATE AIR FLOW FI 1029C PPH	AUX MIXBOX AIRFLO FI 1032 PPH	AIRHTR OUT TEMP TI 1033 DegF	AIRHTR INLET TEMP TI 1042 DegF
01:00	0.04	187.0	2.29	1.90	0.62	219.60	-1.64	12.11	17.66	136704.0	36800.00	92288.00	7800.000	316.0	80.88
02:00	0.04	184.0	2.02	1.91	1.17	219.60	-1.64	12.05	17.44	134144.0	36544.00	89856.00	7792.000	316.0	80.88
03:00	0.05	187.5	8.98	2.12	5.48	399.00	-1.63	12.16	19.41	134408.0	36480.00	89984.00	7800.000	316.0	81.25
04:00	0.07	194.5	4.71	1.79	1.40	628.00	-1.62	12.34	17.81	139008.0	37184.00	93952.00	7668.000	315.5	79.13
05:00	0.07	133.5	44.06	-4.41	15.06	387.50	-1.43	12.27	11.42	134656.0	36928.00	90112.00	7792.000	316.0	77.50
06:00	0.03	189.5	11.05	1.64	5.36	310.50	-1.65	12.59	16.59	133632.0	36672.00	89216.00	7800.000	317.0	76.75
07:00	0.04	185.0	4.19	1.73	2.74	358.50	-1.65	12.41	17.04	132352.0	36672.00	87936.00	7800.000	317.5	74.38
08:00	0.04	200.5	5.62	2.57	1.75	301.00	-1.65	12.33	17.53	132608.0	36736.00	88064.00	7808.000	317.5	75.75
09:00	0.03	193.2	6.29	2.34	1.69	246.25	-1.66	12.36	17.09	132608.0	36672.00	88192.00	7792.000	317.5	75.38
10:00	0.07	195.5	2.31	2.20	-0.67	761.00	-1.63	11.46	18.91	143616.0	40320.00	95488.00	7792.000	315.0	75.38
11:00	0.06	216.0	4.44	2.49	0.42	669.00	-1.64	11.59	17.66	162304.0	50304.00	104064.0	7800.000	310.0	73.13
12:00	0.10	196.7	2.42	2.64	-2.60	923.00	-1.62	12.05	[illegible]	148224.0	42304.00	98048.00	7800.000	314.0	72.75
13:00	0.07	[illegible]	4.06	3.52	[illegible]	746.00	-1.63	12.44	16.84	151040.0	[illegible]	[illegible]	7800.000	311.0	71.25
14:00	0.06	185.8	6.36	3.41	[illegible]	936.00	-1.63	12.41	16.64	[illegible]	38592.00	96000.00	7792.000	314.5	72.25
15:00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	864.00	-1.63	12.38	[illegible]	[illegible]	[illegible]	[illegible]	7808.000	314.5	[illegible]
16:00	0.03	191.7	4.73	1.34	6.39	393.00	-1.66	11.77	17.41	146944.0	42048.00	97024.00	7800.000	316.0	74.38
17:00	0.03	185.7	2.27	1.60	6.75	220.50	-1.65	11.67	18.22	149504.0	42944.00	98816.00	7800.000	315.0	74.63
18:00	0.02	191.5	[illegible]	1.84	12.97	216.50	-1.66	12.05	17.63	144432.0	41280.00	97408.00	7792.000	315.5	76.50
19:00	0.02	205.2	[illegible]	1.98	[illegible]	221.20	-1.60	11.62	[illegible]	[illegible]	[illegible]	[illegible]	7800.000	312.0	[illegible]
20:00	0.02	206.0	[illegible]	2.08	14.84	222.50	-1.65	11.23	[illegible]	[illegible]	[illegible]	[illegible]	7800.000	308.5	76.00
21:00	0.04	204.5	[illegible]	[illegible]	[illegible]	624.00	-1.64	11.77	[illegible]	[illegible]	[illegible]	[illegible]	7792.000	[illegible]	[illegible]
22:00	0.06	1176.	20.66	19.78	75.13	862.00	-1.62	13.45	19.44	187648.0	63168.00	116736.0	7800.000	306.0	77.13
23:00	0.08	209.7	6.67	0.03	7.25	1006.0	-1.60	11.77	18.53	192000.0	65280.00	119040.0	7800.000	306.5	77.88
24:00	0.09	206.2	7.81	[illegible]	[illegible]	922.00	-1.60	11.64	[illegible]	195328.0	67072.00	120576.0	7800.000	306.5	78.50
MAX	0.10	1176.	44.06	19.78	75.13	1006.0	-1.43	13.45	19.44	[illegible]	[illegible]	[illegible]	7808.000	317.6	81.26
AVG	0.05	234.1	[illegible]	2.50	[illegible]	[illegible]	-1.63	12.07	17.66	[illegible]	[illegible]	[illegible]	[illegible]	313.2	76.13
MIN	0.02	133.5	1.87	-4.41	-2.60	216.60	-1.66	11.23	11.42	132352.0	36480.00	87936.00	7792.000	305.0	71.26

LOG#

7	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
00:00	9.5	7.9	9.0	9.4	9.1	9.9	8.5	8.6	10.6	9.1	8.9	9.3	9.1	9.4	10.1	9.3	8.0	8.1	9.5	7.6	7.7	9.0	8.4	8.4
00:01	9.2	7.9	8.9	9.9	9.4	9.7	8.3	8.6	10.2	9.1	8.3	8.8	8.9	9.3	10.1	9.3	7.9	8.5	9.5	7.4	7.5	9.1	8.2	8.2
00:02	9.0	8.1	8.8	9.8	9.2	9.3	8.8	8.9	9.6	9.1	8.7	9.0	9.4	9.5	10.4	9.3	7.9	8.7	9.5	7.4	7.1	8.9	8.1	8.5
00:03	8.9	8.6	8.6	8.9	8.9	9.4	8.8	9.1	9.0	9.1	9.4	9.2	9.9	9.5	10.0	8.9	8.0	8.9	9.3	7.4	7.5	8.7	8.7	8.7
00:04	8.9	8.8	8.4	8.8	9.2	9.7	8.8	9.5	9.6	9.1	9.5	9.3	9.9	9.6	10.1	8.9	8.2	9.0	9.0	7.7	7.7	8.6	8.9	8.1
00:05	9.1	8.5	8.5	9.0	9.6	10.2	9.0	9.6	9.6	9.1	9.8	9.3	9.9	9.6	9.9	9.1	8.3	8.6	8.9	7.7	7.6	8.1	9.1	8.1
00:06	9.4	8.3	8.8	8.9	9.4	10.3	8.9	9.4	9.4	8.5	9.7	9.5	10.0	9.4	10.0	9.2	8.2	8.4	8.7	7.5	8.0	7.8	9.3	7.9
00:07	9.4	9.0	9.0	9.1	9.2	10.4	8.8	9.2	9.4	8.5	9.6	9.2	9.9	9.3	10.2	9.0	8.3	8.3	8.9	7.6	8.6	7.4	9.3	8.2
00:08	9.2	8.8	8.9	8.9	8.9	10.4	8.9	9.3	9.5	8.5	9.3	9.8	9.6	9.1	10.8	8.8	8.4	7.8	9.0	8.0	8.7	7.6	9.0	8.2
00:09	9.3	8.8	8.7	9.2	8.3	10.3	9.0	9.5	9.6	8.4	9.2	9.4	9.2	9.0	11.0	8.9	8.7	7.6	8.6	8.3	8.8	7.5	9.4	8.0
00:10	9.3	9.0	8.4	9.4	8.2	10.0	8.9	9.6	9.7	8.2	9.0	9.5	10.0	9.4	11.1	9.0	8.8	7.7	8.7	8.1	8.9	7.1	9.8	7.9
00:11	9.1	8.5	8.3	9.4	7.9	10.0	9.1	9.0	9.7	8.0	8.9	9.6	10.1	9.5	11.1	9.0	8.7	7.6	8.6	8.2	9.0	7.5	9.5	7.9
00:12	9.0	8.1	8.5	9.0	7.7	9.9	9.3	8.8	9.7	8.1	8.5	9.1	9.7	9.6	11.0	8.8	8.3	8.0	8.9	8.1	9.4	7.8	9.5	8.5
00:13	8.7	8.3	8.4	8.6	8.0	9.7	9.7	9.1	9.4	8.4	8.3	9.2	9.7	9.6	11.0	9.1	8.5	8.4	8.9	8.1	9.2	8.2	9.6	8.8
00:14	8.9	8.7	8.3	8.3	8.5	10.0	9.8	9.2	9.0	8.5	8.6	9.2	9.1	8.7	10.0	9.1	8.6	8.0	8.7	8.3	9.6	8.4	9.6	9.0
00:15	9.0	8.9	8.0	8.4	8.4	10.6	10.0	9.8	9.3	8.7	7.8	9.8	8.8	9.5	10.7	9.4	8.7	8.7	8.5	8.2	9.9	8.7	9.5	9.2
00:16	9.1	9.0	8.0	8.9	8.4	10.2	9.9	9.1	8.9	8.5	7.5	9.5	[illegible]	[illegible]	10.6	[illegible]	[illegible]	[illegible]	8.3	8.4	10.3	[illegible]	9.6	[illegible]
00:17	8.9	8.7	7.8	8.7	8.7	10.1	9.8	8.7	8.8	8.7	7.4	9.5	8.8	9.7	10.5	9.4	8.7	8.6	8.5	8.8	10.4	7.9	9.5	9.1
00:18	9.0	9.0	7.5	8.7	8.5	9.3	10.0	8.7	9.3	8.7	7.5	9.7	9.2	9.8	10.4	9.3	9.3	8.7	8.4	9.2	10.2	8.0	9.5	9.1
00:19	9.0	8.7	7.4	8.2	8.3	10.6	10.1	9.0	9.5	8.3	7.7	9.9	9.3	9.5	10.5	9.4	9.4	8.7	8.5	9.1	9.8	8.3	9.5	9.3
00:20	[illegible]	8.0	7.7	[illegible]	8.2	10.6	9.8	8.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.1	10.0	8.6	9.4	[illegible]
00:21	8.4	8.2	7.0	10.0	7.4	10.8	9.5	8.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.1	9.8	[illegible]	[illegible]	[illegible]
00:22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.1	[illegible]	[illegible]	[illegible]	[illegible]
00:23	8.2	8.4	7.0	8.1	8.2	10.9	9.7	8.0	9.1	8.3	7.7	9.5	10.8	9.9	10.8	9.1	9.4	8.3	8.6	9.1	9.5	8.9	9.3	9.2
00:24	8.1	8.8	6.8	8.6	8.3	10.7	9.8	7.9	9.2	7.8	8.0	9.0	10.7	9.9	10.5	9.0	9.3	8.5	8.6	9.0	9.9	9.0	9.4	8.8
00:25	8.0	9.2	7.1	8.8	8.2	10.9	9.3	7.5	9.2	7.4	8.1	8.0	10.7	9.2	10.1	9.5	8.8	8.6	9.0	8.7	10.2	8.8	9.2	8.8
00:26	8.1	9.6	7.2	9.0	8.5	10.8	9.6	7.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.6	9.4	[illegible]	[illegible]	[illegible]
00:27	8.1	9.3	7.4	9.0	8.7	10.6	9.7	7.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.7	8.8	[illegible]	[illegible]	[illegible]
00:28	[illegible]	8.9	7.7	9.2	8.9	10.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.6	8.8	[illegible]	[illegible]	[illegible]
00:29	8.1	9.0	7.5	9.1	8.8	10.6	10.1	7.5	8.9	7.4	8.5	8.1	10.1	9.8	9.3	9.3	9.1	9.5	7.6	9.3	8.7	8.6	9.7	9.1
00:30	8.3	8.9	7.6	8.6	8.3	10.0	10.3	7.4	8.7	7.7	8.5	8.3	10.1	10.1	9.2	9.1	9.3	9.8	7.8	9.4	9.1	8.6	10.0	9.1
00:31	8.4	8.8	7.2	9.1	8.3	9.8	9.9	7.7	8.5	7.6	8.7	9.0	9.5	10.3	8.9	9.0	9.4	9.7	7.9	9.1	9.1	8.3	9.9	8.8
00:32	8.6	8.8	7.2	9.0	7.7	9.4	9.8	8.0	10.7	7.7	8.4	7.9	9.0	10.1	9.0	8.7	8.8	9.7	8.5	9.0	9.2	8.0	9.6	9.4
00:33	8.6	9.3	7.6	8.8	7.7	9.5	10.0	8.4	8.9	7.7	8.0	7.9	8.6	10.2	8.7	8.8	8.9	9.8	8.9	8.8	9.3	7.7	9.9	9.4
00:34	8.8	9.4	7.9	9.1	7.6	9.8	9.9	8.7	8.6	7.7	8.0	7.8	8.7	10.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.5	9.1	7.6	8.9	9.2
00:35	8.7	9.4	8.4	8.8	7.8	9.3	9.8	9.1	8.8	7.3	8.0	7.8	8.8	9.8	8.8	9.0	8.5	9.5	9.1	7.6	9.1	8.0	8.7	9.1
00:36	8.7	9.4	8.8	9.2	8.1	9.5	9.6	9.4	9.1	6.9	8.5	7.8	8.5	9.6	8.9	9.3	8.5	9.5	9.0	7.0	9.4	7.9	8.7	8.7
00:37	8.7	9.5	9.1	9.0	8.3	9.8	9.7	9.4	9.3	7.0	8.7	8.0	8.7	10.0	8.8	9.5	8.4	9.6	8.7	7.3	9.0	8.0	8.9	8.4
00:38	9.0	8.8	7.6	9.2	8.7	8.8	9.3	9.4	9.3	7.1	8.7	8.1	8.4	9.9	8.6	9.1	8.6	9.7	8.8	7.0	9.0	8.0	8.8	8.3
00:39	8.9	8.7	9.8	9.2	9.1	9.2	9.0	10.0	9.4	7.1	8.4	8.4	8.7	9.5	8.7	8.3	8.7	9.6	8.4	7.1	8.9	7.7	8.5	8.1
00:40	9.1	8.1	10.0	9.3	8.6	8.7	8.9	10.4	9.3	7.3	8.7	8.9	8.8	[illegible]	[illegible]	7.9	8.6	9.6	8.5	7.0	8.9	8.0	8.5	7.8
00:41	9.3	8.0	9.8	9.3	8.4	8.8	9.0	10.0	9.3	7.4	8.9	9.0	9.0	8.9	8.4	7.8	8.5	9.9	8.9	7.7	8.9	8.2	8.0	7.8
00:42	9.2	8.2	10.0	9.2	8.3	9.1	9.1	10.1	9.1	7.5	8.7	9.0	9.2	9.1	8.0	7.6	8.5	10.3	9.0	6.7	8.7	8.0	7.8	7.7
00:43	8.9	8.6	9.3	9.2	8.4	9.2	9.2	10.1	8.7	7.7	8.7	9.0	9.4	9.0	7.9	8.0	8.8	10.2	8.9	9.0	8.4	7.7	7.5	7.5
00:44	8.7	8.6	9.6	9.2	8.6	8.9	9.4	9.8	8.3	7.5	8.9	8.9	9.7	9.3	8.4	8.2	8.8	10.3	8.4	9.1	8.3	7.6	7.6	7.4
00:45	8.7	8.6	9.1	9.6	8.7	8.5	9.0	10.0	8.7	7.9	9.2	8.4	9.6	9.6	8.3	8.3	8.6	10.0	8.3	9.3	8.5	7.1	7.6	7.9
00:46	8.9	8.8	9.1	9.1	8.7	8.0	8.7	10.6	9.2	7.4	8.2	8.3	9.9	9.4	8.2	8.4	8.7	9.8	8.7	9.1	8.6	6.9	7.4	8.0
00:47	8.9	8.8	8.7	9.5	8.5	7.8	6.7	10.7	9.1	7.2	8.2	8.6	9.8	9.0	8.4	8.3	8.6	9.6	8.9	8.7	8.4	6.8	7.3	8.2
00:48	8.6	8.3	8.9	9.8	8.8	7.8	9.2	10.6	9.1	7.5	8.0	8.9	9.7	9.3	8.4	7.9	8.7	9.7	8.4	8.5	8.1	7.1	7.1	8.2
00:49	7.9	8.5	9.7	10.1	8.9	8.2	9.3	10.4	9.1	7.5	8.4	9.2	9.8	9.6	8.5	7.5	8.8	9.7	8.3	8.4	8.3	7.3	7.4	7.7
00:50	8.2	8.2	9.4	10.0	8.7	8.1	9.3	10.6	9.1	7.6	8.1	9.6	9.7	9.8	8.6	7.6	8.7	9.8	8.4	8.5	8.3	7.2	7.6	7.6
00:51	8.5	8.3	9.4	9.3	9.0	8.1	9.3	10.9	9.1	7.6	8.1	9.6	9.7	9.7	8.6	7.9	8.6	9.5	8.0	8.2	8.2	7.1	7.6	7.9
00:52	8.7	8.4	10.1	8.8	9.5	7.9	9.3	10.8	9.1	8.6	8.1	9.7	[illegible]	[illegible]	9.0	8.2	8.5	9.6	7.5	7.9	8.1	7.3	7.5	8.0
00:53	8.4	8.7	10.3	9.0	9.4	8.1	9.5	11.0	9.1	8.8	8.1	9.8	9.8	9.9	9.2	8.4	8.3	9.8	7.5	8.1	8.0	7.5	7.4	8.3
00:54	8.3	9.0	10.6	9.0	9.1	8.3	9.3	10.9	9.1	9.3	8.0	10.1	9.6	9.8	8.5	8.4	7.9	9.7	7.6	8.0	8.4	7.3	7.7	8.6
00:55	8.2	9.3	10.0	9.2	9.3	8.3	9.0	10.9	9.1	9.3	8.2	10.5	9.4	9.7	8.4	8.4	8.0	9.5	7.5	8.3	8.8	7.4	8.2	8.5
00:56	8.5	9.3	10.1	9.3	9.5	8.3	9.1	11.0	9.1	9.7	8.8	10.0	9.4	9.5	8.4	8.3	8.3	9.4	7.4	8.3	9.1	7.7	8.4	8.0
00:57	8.6	9.2	10.1	9.2	9.5	8.3	9.3	10.9	9.1	9.4	9.0	9.6	9.9	8.3	8.7	8.5	8.4	9.2	7.3	8.3	8.6	8.4	8.6	7.6
00:58	8.2	9.5	9.8	8.8	9.8	8.2	9.0	10.9	9.1	9.1	9.2	9.6	[illegible]	[illegible]	9.0	8.2	8.4	9.4	7.5	8.3	9.6	[illegible]	8.6	7.6
00:59	7.9	9.4	9.3	9.1	10.0	8.2	8.8	10.6	9.1	9.0	9.3	9.3	9.5	9.8	9.4	8.0	7.9	9.7	7.7	8.1	8.7	8.3	8.6	7.7

CAMDEN COUNTY ENERGY RECOVERY ASSOCIATES

600 MORGAN BOULEVARD, CAMDEN, NEW JERSEY 08104 - PHONE (609) 966-7174

November 25, 1991

Mr. Edward Choromanski, Chief
Department of Environmental Protection
Division of Environmental Quality
Bureau of Technical Services
CN 411
Trenton, N.J. 08625-0414

Subject: Camden County Energy Recovery Associates
APC I.D. 50617
Result of Monthly Stack Testing
October 1991

Dear Mr. Choromanski:

In my November 22, 1991 transmittal letter for the subject report I neglected to include the certification statement signed by Mr. Bruce Studley. Attached you will find the original certification statement.

If there are any questions, please contact me at (609) 966-7174.

Sincerely,

Steve Warlick

Steve Warlick
Environmental Coordinator

CC N. Wattis File
B. Studley (OCTPbCERT)
M. Cooper (W/Attachment)
C. Clamser

CAMDEN COUNTY ENERGY RECOVERY ASSOCIATES

PERRYVILLE CORPORATE PARK • CLINTON, NEW JERSEY 08809-4000 • PHONE 201-730-4000

GENERAL PARTNERS
CAMDEN COUNTY ENERGY RECOVERY CORP.
FOSTER WHEELER CAMDEN COUNTY, INC.

CAMDEN RESOURCE RECOVERY FACILITY

I certify under penalty of law that the information provided in this document is true, accurate and complete. I am aware that there are significant civil and criminal penalties, including fines or imprisonment or both, for submitting false, inaccurate or incomplete information.

B. C. Studley

Bruce C. Studley, P.E.
Vice President, Plant Operations
Foster Wheeler Power Systems, Inc.

NOVEMBER 23, 1991
(Date)

REPORT CERTIFICATION

SUBMITTAL DATE
November 6, 1991

The project was carried out under my direction and supervision. To the best of my knowledge, the data presented in this report is accurate and complete.

Signature Allan F. Lowe

Allan F. Lowe
Project Manager

FOSTER WHEELER POWER SYSTEMS

FINAL REPORT DISTRIBUTION LIST

Revision No.	Date of Revision	Number of Copies	Mailed To
0	11/06/91	3	S. Warlick - CCERA
0	11/06/91	1	B. Studley - FW

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LIST OF TABLES AND FIGURES

INTRODUCTION

1.1 Background. Foster Wheeler Enviresponse, Inc. has conducted a testing program to quantify lead emissions from Unit No. 1 of the Camden County Resource Recovery facility in Camden, New Jersey.

The facility consists of three mass-fired municipal refuse burning furnaces which produce electricity for sale to a local utility company. Each of the mass-fired boilers is equipped with a spray dryer adsorber (SDA) for acid gas removal, an electrostatic precipitator (ESP) for the control of suspended particulate emissions.

1.2 Outline of Test Program. This report covers stationary source sampling performed on October 18, 1991 at the Unit No. 1 SDA inlet and stack. Table 1-1 is a test log which presents the sampling locations, sampling parameters, sampling methods, test dates, and run numbers.

1.3 Test Participants. Table 1-2 lists the personnel involved in the test program.

TABLE 1-1

TEST LOG

Sampling Location	Sampling Parameter	Sampling Method	Test Date	Run Numbers 1	2	3
SDA Inlet	CO_2, O_2	EPA 3	10/18	1-I-M3-1	1-I-M3-2	1-I-M3-3
	Lead	EPA MMTL	10/18	1-I-MMTL-1	1-I-MMTL-2	1-I-MMTL-3
Stack	CO_2, O_2	EPA 3	10/18	1-S-M3-1	1-S-M3-2	1-S-M3-3
	Lead	EPA MMTL	10/18	1-S-MMTL-1	1-S-MMTL-2	1-S-MMTL-3

TABLE 1-2

TEST PARTICIPANTS

Foster Wheeler Enviresponse, Inc.	Bruce C. Studley Test Coordinator
Camden County Energy Recovery Associates	Steven B. Warlick Test Coordinator
New Jersey State Department of Environmental Protection	Frederick Ballay Test Observer
Entropy Environmentalists Inc	Allan F. Lowe Project Manager
	Leslie C. Murray Project Supervisor
	Sean G. Daley Sampling Team Leader
	William E. Morgan Sampling Team Leader
	Patrick F. Daley Engineering Technician
	Reginald F. Holt Engineering Technician
	Lauren A. Sherwood Laboratory Technician

SUMMARY OF RESULTS

Table 2-1 presents the emissions results for lead which has a specific emissions limits of 0.08 lb/hr stated in the permit. Tables 2-2 and 2-3 are run-by-run tests summaries; refer to the "List of Tables and Figures" on page iii of the "Table of Contents" for a cross-reference. Detailed test results are presented in Appendix A; field and analytical data is provided in Appendix B.

TABLE 2-1
LEAD EMISSION RATES, CONCENTRATIONS, AND REMOVAL EFFICIENCIES

	Repetition 1	Repetition 2	Repetition 3	Average
SDA Inlet				
Concentration, gr/DSCF	0.00460	0.00639	0.00835	0.00645
Concentration, gr/DSCF@12%CO_2	0.00673	0.00871	0.00114	0.00895
Concentration, gr/DSCF@7%O_2	0.00644	0.00836	0.00108	0.00853
Emission Rate, lb/hr	1.90	2.43	3.34	2.56
Stack				
Concentration, gr/DSCF	7.44E-06	ND (<3.45E-06)	ND (<3.45E-06)	2.48E-06
Concentration, gr/DSCF@12%CO_2	1.16E-05	ND (<5.18E-06)	ND (<5.18E-06)	3.87E-06
Concentration, gr/DSCF@7%O_2	1.08E-05	ND (<4.89E-06)	ND (<4.88E-06)	3.60E-06
Emission Rate, lb/hr	0.00347	ND (< 0.00153)	ND (< 0.00152)	0.00116
Removal Efficiency, %*	99.82	> 99.93	> 99.95	> 99.91

*Calculated using lb/hr.

TABLE 2-2

Lead Tests Summary

Unit No. 1 SDA Inlet

	1-I-MMTL-1	1-I-MMTL-2	1-I-MMTL-3	Average
Run Date	10/18/91	10/18/91	10/18/91	
Run Start Time	0820	1500	1845	
Run Finish Time	1355	1734	2055	
Test Train Parameters:				
Volume Of Dry Gas Sample, SCF *	71.817	68.258	67.491	
Percent Isokinetic:	96.1	95.8	98.2	
Flue Gas Parameters:				
CO_2, Percent By Volume, Dry	8.2	8.8	8.8	8.6
O_2, Percent By Volume, Dry	11.0	10.3	10.2	10.5
Temperature, °F	438	421	426	428
Air Flow Rate, Dry SCFM *	48,267	44,362	46,747	46,459
Air Flow Rate, Wet ACFM	94,296	84,641	91,576	90,171
Lead:				
Concentration, grains/DSCF *	0.00460	0.00639	0.00835	0.00645
Concentration, gr/DSCF @ 12% CO2	0.00673	0.00871	0.0114	0.00895
Concentration, gr/DSCF @ 7% O2	0.00644	0.00836	0.0108	0.00853
Emission Rate, lb/hr	1.90	2.43	3.34	2.56

* 70° F (21° C) -- 29.92 Inches of Mercury (Hg)

TABLE 2-3

Lead Tests Summary

Unit No. 1 Stack

	1-S-MMTL-1	1-S-MMTL-2	1-S-MMTL-3	Average
Run Date	10/18/91	10/18/91	10/18/91	
Run Start Time	0820	1500	1845	
Run Finish Time	1355	1734	2055	
Test Train Parameters:				
Volume Of Dry Gas Sample, SCF *	91.328	89.343	89.392	
Percent Isokinetic:	96.6	99.7	100.1	
Flue Gas Parameters:				
CO_2, Percent By Volume, Dry	7.7	8.0	8.0	7.9
O_2, Percent By Volume, Dry	11.4	11.1	11.1	11.2
Temperature, °F	275	278	277	277
Air Flow Rate, Dry SCFM *	54,374	51,547	51,402	52,441
Air Flow Rate, Wet ACFM	89,635	86,092	86,833	87,520
Lead:				
Concentration, grains/DSCF *	7.44E-006	ND	ND	2.48E-006
Concentration, gr/DSCF @ 12% CO2	1.16E-005	ND	ND	3.87E-006
Concentration, gr/DSCF @ 7% O2	1.08E-005	ND	ND	3.60E-006
Emission Rate, lb/hr	0.00347	ND	ND	0.00116

* 70° F (21° C) -- 29.92 Inches of Mercury (Hg)

ND Not detected used as zero (0)

PROCESS DESCRIPTION AND OPERATION

3.1 General. The Camden County Resource Recovery Facility in Camden, New Jersey operates three mass-fired municipal refuse burning furnaces which produce electricity for sale to a local utility company. Each of the mass-fired boilers is equipped with a Spray Dryer Absorber (SDA) for acid gas removal. The SDA is followed by an Electrostatic Precipitator (ESP) for the control of suspended particulate emissions. Each ESP is followed by an induced draft fan which directs the flue gas to a reinforced concrete stack. The facility has continuous emissions monitors for CO, SO_2, and O_2 at the SDA inlet and for SO_2, NO_x, O_2, and opacity in the stack. A microprocessor-based data acquisition system receives data from the monitoring system and is equipped with a printer which provides hard copies of emission values.

Bottom ash from the combustion grates and collected flyash are collected in a "semi-dry" conveying system. Sufficient moisture is added to the combined ash or "residue" to suppress dusting. A vibrating conveyor discharges residue from each boiler to an enclosed common ash storage area. A clam shell loader transfers the material to a vibrating conveyor and trommel screen separator. Oversize material is reclaimed as ferrous residue. Material passing through the screen is landfilled by truck.

3.2 Source Air Flow. Figure 3-1 is an air flow schematic which shows the passage of flue gases exhausted from the boilers.

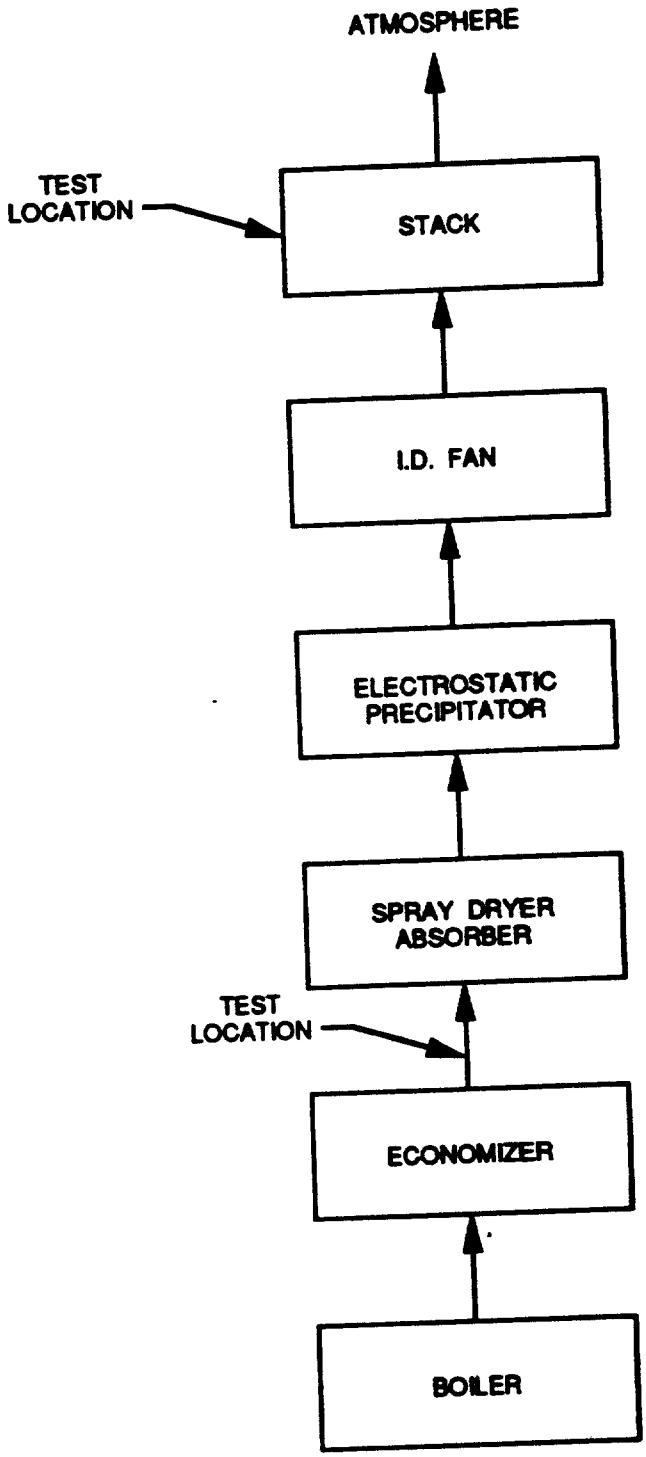


FIGURE 3-1. UNIT NOS. 1, 2, AND 3 AIR FLOW SCHEMATIC.

SAMPLING AND ANALYTICAL PROCEDURES

4.1 General. All sampling and analytical procedures were those recommended by the United States Environmental Protection Agency and the New Jersey State Department of Environmental Protection. This section provides brief descriptions of the sampling and analytical procedures. Detailed descriptions of the procedures are provided in Appendix D.

4.2 Sampling Points. The number and location of the sampling points were determined according to the procedures outlined in EPA Method 1. As shown in Figure 4-1, the SDA inlet cross sections were divided into 24 equal areas with 12 sampling points on each of two traverse axes. As shown in Figure 4-2, the stack cross sections were divided into 12 equal areas with six sampling points on each of two traverse axes.

4.3 Volumetric Air Flow Rates

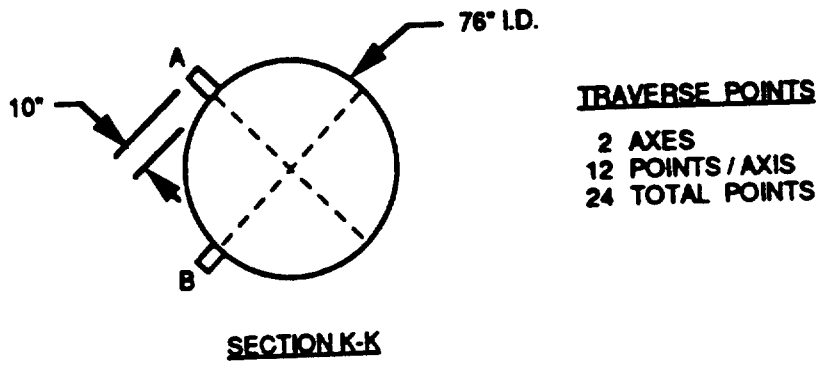
4.3.1 Flue Gas Velocity. The flue gas velocity and volumetric flow rate were determined according to the procedures outlined in EPA Method 2. Velocity head measurements (delta P) were made using Type S Pitot tubes conforming to the geometric specifications outlined in EPA Method 2. Accordingly, each has been assigned a coefficient of 0.84. Differential pressures were measured with Magnehelic gauges of appropriate range. Flue gas temperatures were measured with chromel-alumel thermocouples equipped with hand-held digital readouts.

4.3.2 Flue Gas Composition. Flue gas samples were collected using the multipoint, integrated sampling technique outlined in EPA Method 3.

Sample Collection. A stainless steel probe and a peristaltic pump delivering 500 to 750 mL/min of flue gas were used to fill a Tedlar bag. Moisture was removed by means of a knockout jar located prior to the pump. Sampling was of the same duration (except purges following port changes) as the pollutant emissions runs.

Sample Analysis. Analysis for carbon dioxide and oxygen was performed using an Orsat apparatus. The analytical results were used to determine the flue gas composition, molecular weight, excess air, and emissions correction factor.

(continued on page 4-4)



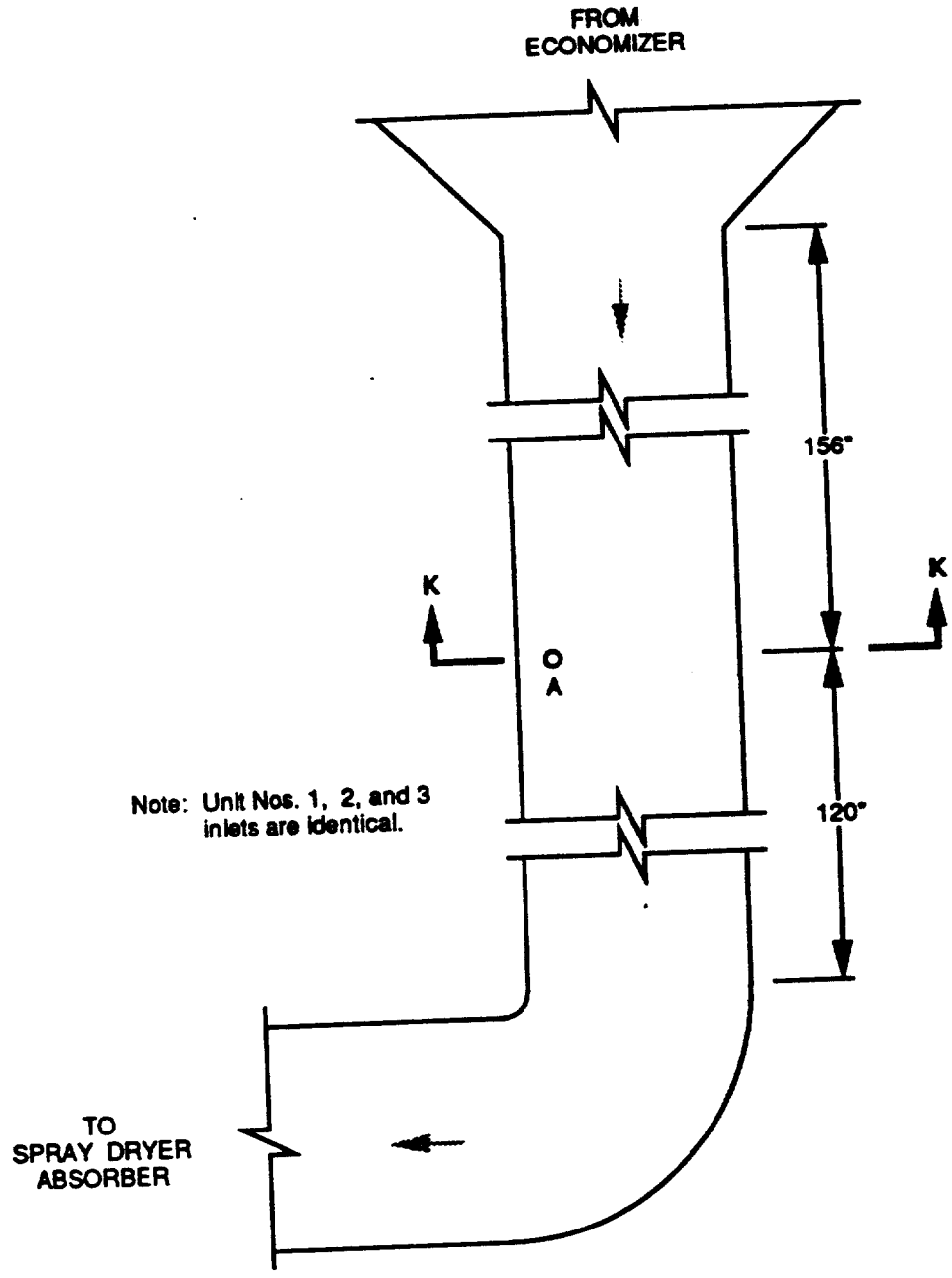
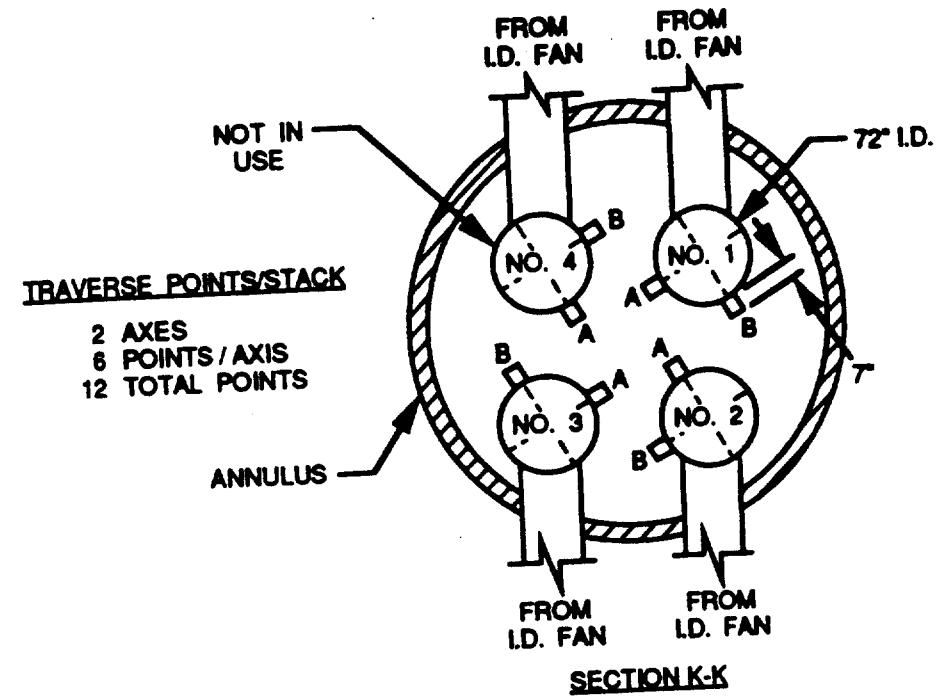
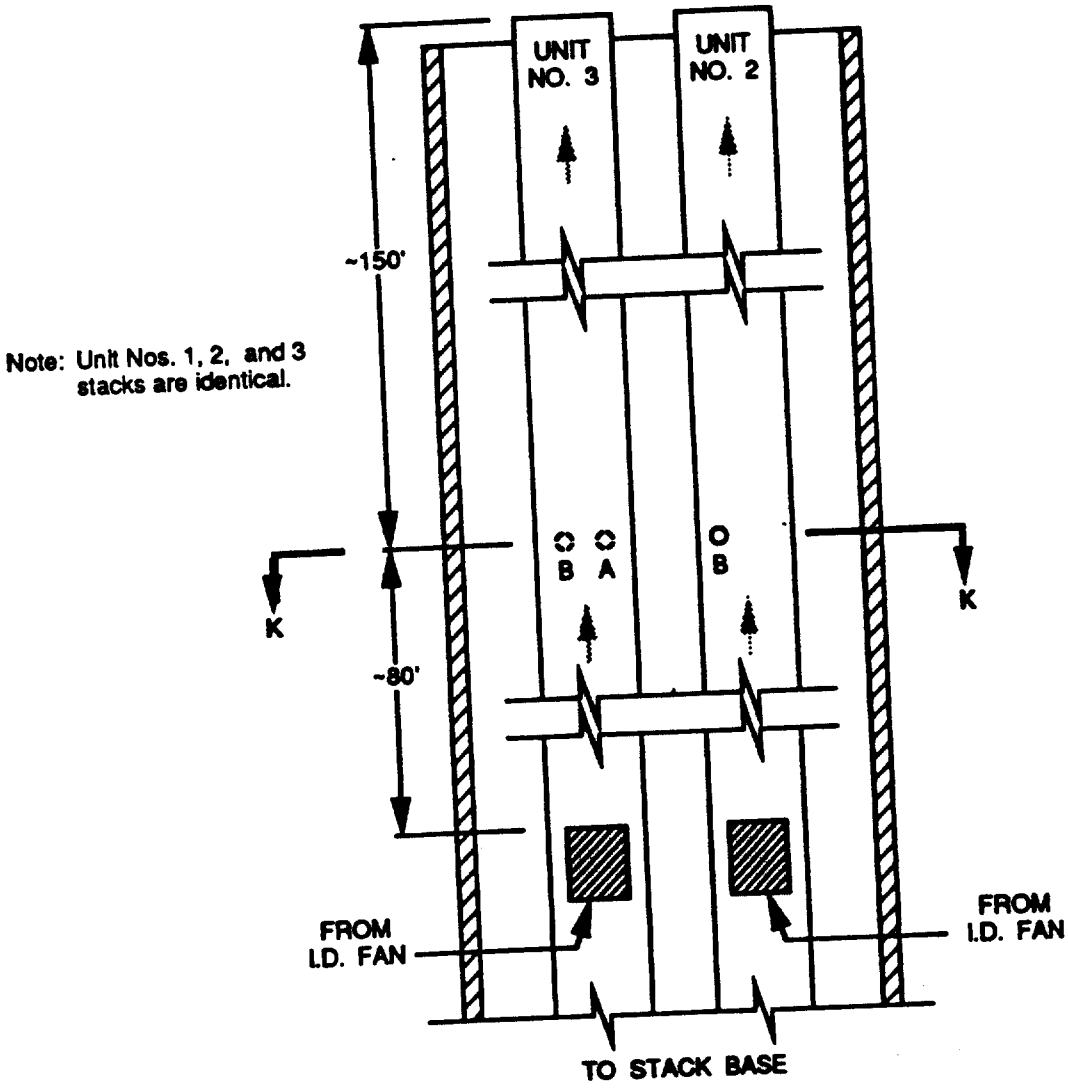


FIGURE 4-1. UNIT NOS. 1, 2, AND 3 SDA INLETS TEST LOCATION.





Note: Unit Nos. 1, 2, and 3 stacks are identical.

FIGURE 4-2. UNIT NOS. 1, 2, AND 3 STACKS TEST LOCATIONS.

4.3.3 Flue Gas Moisture Content. The moisture content was determined in conjunction with the sampling method discussed in the following section.

4.4 Emissions Determinations. Samples were withdrawn isokinetically from the source using an EPA Draft Multi-Metal sampling train.

Sample Collection. The sampling train consisted of a glass nozzle, a heated glass probe with a Type S Pitot tube attached, a filter, four chilled impingers, and a metering console. The particulate sample was collected on a Pallflex 2500QAT-UP quartz filter maintained at a temperature of 248°F ± 25°F. The first impinger remained empty, the second and third impingers each contained 100 mL of 5% nitric acid (HNO_3)/10% hydrogen peroxide (H_2O_2), and the fourth contained preweighed silica gel. Each run was a minimum of two hours in duration with a minimum sample volume of 60 dry standard cubic feet. At the SDA inlet, each of the 24 points was sampled for five minutes, resulting in net run times of 120 minutes. At the stack, each of the 12 points was sampled for 10 minutes, resulting in net run times of 120 minutes.

Sample Recovery. A Teflon spatula and Teflon coated tweezers were used to remove the filter from the filter holder and place it in a 250 mL glass jar. The reagents were returned to the original bottles, weighed, the weights recorded on the labels, and the liquid levels marked. The silica gel was returned to the original container, weighed, and the weight recorded on the label. The volume of water vapor condensed in the impingers and the volume of water vapor collected in the silica gel were summed and entered into moisture content calculations.

The nozzle, probe, and fronthalf of the filter holder were rinsed with 100 mL of acetone into a 500 mL jar followed by rinsing with 100 mL of 0.1N HNO_3 into a second 500 mL jar. A Teflon probe brush was used for cleaning the probe.

The backhalf of the filter holder and the first, second, and third impingers were rinsed with 100 mL of 0.1N HNO_3 into the 1000 mL jar containing the HNO_3/H_2O_2 reagent.

Sample Analyses. For the metals analyses, the fronthalf acetone and HNO_3 rinses were evaporated to near dryness in a Teflon beaker. The filter, loose particulate, 3 mL of concentrated HNO_3, and 5 mL of concentrated HF were added to the beaker. The sample was digested on a hotplate until brown fumes were evident, indicating the destruction of organic matter. After the addition of concentrated HNO_3, the reagent and impinger rinses were evaporated to near dryness in a Teflon beaker on a hotplate. After cooling, 3 mL of concentrated HNO_3 and 5 mL of concentrated HF were added to the beaker and the sample was fumed on a hotplate to destroy organic residue.

The prepared filter and HNO_3/H_2O_2 reagent samples were combined, brought to a final volume of 100 mL with 10% HNO_3, and analyzed for all metals with a Perkin Elmer 3030 atomic absorption analyzer using the appropriate SW-846 methods. Duplicate lead analyses were performed for approximately 30% of the emissions samples.

4.5 Equipment Calibration. Pertinent calibration data are provided in Appendix C.

4.6 Analytical Laboratory. Oxford Laboratory was the laboratory which performed lead analyses for this test program.

QUALITY ASSURANCE/QUALITY CONTROL

5.1 General. Entropy Environmentalists Inc. (EEI) is committed to the continued implementation of a Quality Assurance Program to assure the quality of sampling and analytical procedures of environmental measurement data. The Quality Assurance measures taken during this test project equals or exceeds the minimum QA/QC recommendations as set forth by the U.S. Environmental Protection Agency (EPA) for a particular method.

The following sections outline the QA program implemented by EEI to justify the validity of test procedures. As applicable, the QA system for the various test programs addresses the following areas:

- Preventive Maintenance & Equipment Calibration
- QA Sample Processing
- Analytical Instrument Calibration
- Blanks and Spiked Samples
- Internal/External System Checks
- Data Reduction & Validation
- QA/QC Summary

5.2 Preventive Maintenance and Equipment Calibration. An effective preventive maintenance program decreases downtime and thus increases data completeness and quality. Pretest and posttest equipment calibrations are conducted in a manner and at a frequency which meets or exceeds U.S. EPA specifications.

Each item transported to the field is inspected to detect equipment problems which may originate during periods of storage. All equipment returning from the field is cleaned, repaired, reconditioned, and recalibrated as necessary. Routine maintenance on equipment (dry gas meters, pumps, Magnehelics, manometers, pitot tubes, and nozzles) is carried out periodically for leaks, corrosion, dents, or any other damage. Table 5-1 shows the activities for equipment calibration.

TABLE 5-1

IN-HOUSE EQUIPMENT CALIBRATION

Apparatus	Calibration Method And Frequency	Specifications	Corrective Action
Type S Pitot Tubes	Standards contained in EPA Method 2. Visual inspection prior to shipment to test site and again prior to each day of testing.	Coefficient of 0.84 ± 0.02	Refurbish or recalibrate.

(continued next page)

TABLE 5-1 (continued)

IN-HOUSE EQUIPMENT CALIBRATION

Apparatus	Calibration Method And Frequency	Specifications	Corrective Action
Manometers	Leak checked before and after each field use.		Adjust or replace.
Magnehelic Gauges	Initially calibrated over full range.	0-10" water column	
	After each field use, checked against inclined manometer at average settings encountered during testing.	Within ± 5%	Repair and Recalibrate.
Thermometers -Impinger -Dry Gas Meter -Filter Box	After purchase and prior to each field use, using ASTM mercury-in-glass thermometer.	Imp = ± 2°F DGM = ± 5.4°F FB = ± 5.4°F	Adjust, determine correction factor, or reject.
Thermocouple/ Potentiometer	After purchase. 3-point (ice bath, boiling water, and hot oil) using ASTM mercury-in-glass thermometer.	± 1.5% of absolute temperature.	Adjust, determine correction factor, or reject.
	Before and after each field use, compared to ASTM mercury-in-glass thermometer at ambient conditions.		
Dry Gas Meter and Orifice	Full calibration (every 6 months) over wide range of orifice settings to obtain calibration factor (isokinetic meterbox).	DGM = ± 0.02 from avg.coeff. for each run. Ori. = ± 0.15" H20 over delta H range of 0.4" to 4.0"	Adjust or replace.
	10-minute quick calibration before sending to test site and again prior to each day of field use (isokinetic).	± 3% of full. ± 5% of full.	Use if no backup. Do not use.
	Posttest (at average delta H and highest vacuum encoun-) tered during testing) to determine if meter gamma has changed (isokinetic).	± 5% of full calibration. Gamma (initial or recalibration) that yields the lowest sample volume for the testing is used for calculations.	Recalibrate or replace.
	Full calibration w/spirometer before/after each field use (nonisokinetic meterbox).	± 5% of pretest, .02 from average coeff. from each run	Recalibrate.
Dry Gas Meter Transfer Standard	Annual calibrations conducted in triplicate using EPA wet test meter. Calibrations conducted at 7 flow rates from 0.25 to 1.40 cfm.	± 2% of average factor for each calibration run.	Adjust and recalibrate.
Barometer	Before and after each field use against an aneroid barometer.	± 0.1" mercury.	Adjust to agree.
	Reference barometer adjusted for elevation differences.		
Probe Nozzle	Average of 5 I.D. measurements using a micrometer. Visual inspection before and after each field use.	Difference between high and low measurement ≤ 0.004"	Repair and recalibrate.

5.3 Sample Processing. Entropy employs systems which ensure the integrity of an environmental sample from the time of acquisition, through analysis, and ultimately to proper disposal. These systems are necessary to allow valid

conclusions to be drawn from analytical results separated in time and space fromthe sampling operation. In addition, these systems recognize that samples are occasionally of value even after analytical results have been reported.

Samples are collected, transported, and stored in clean containers which are constructed of materials inert to the analytical matrix. Containers are used which allow air tight seals. When necessary, containers are employed which prevent photochemical reactions. All sample containers are labeled with the following information:

- Unique source identifier
- Sample run identifier
- Analyte identifier
- Sample matrix identifier
- Sample analyst identifier

Additional information relating to the sample is recorded on the data sheet for the sampling run that afforded the subject sample. Accordingly, the sampling data sheet contains all the information listed above, plus the date and time the sample was acquired and supplemental information such as observations pertinent to the quality of the sample. For condensed samples, e.g., samples in liquid media, the sample levels are marked on the outside of the container; this mark is used to indicate sample loss, and as such, may serve as a reference in adjusting results accordingly.

For transport from the field to the laboratory, samples are stored in sealed containers and secured in a fashion which minimizes movement and thus prevents breakage of containers. Containers used for transporting glass are packed with foam. Samples which reqiuire chilling are kept cold until analyzed

Samples remain in the custody of the sampler, from acquisition until conveyance to the sample custodian. All custody transfers are signed for and documented on a record of custody form, which remains with the sample until turned over to the custodian.

Analytical data are identified in a manner identical to that of the sampling data. Accordingly, all data generated from the analysis of samples are documented with the following information:

- Source identifier
- Sample run identifier
- Analyte identifier
- Sample matrix identifier
- Analyst identifier
- Analysis date

Portions of samples remaining after analysis are returned to their original

sample containers. These samples are stored in designated storage areas until their destruction is authorized.

5.4 Instrument Calibration. Instrument calibration is one of the most important functions in generating precise and accurate quality data. A listing of major in-house instrumentation and the corresponding Quality Assurance program is given in Table 5-2.

All of the contract laboratories involved in the analytical testing for the test program maintained rigorous QA programs for instrument calibration.

TABLE 5-2

IN-HOUSE INSTRUMENT CALIBRATION

Apparatus	Calibration Method And Frequency	Corrective Specifications	Action
Analytical & Top Loading Balance	Daily and monthly checks with a series of class S weights.	± 1 mg of class S weights.	Adjust or repair.
	Balance serviced annually by a qualified service representative and checked with a series of NBS weights.		
Gas Chromatograph	3-point calibration curve at the expected range.		
	Duplicate injection of the sample until ± 5% variation is achieved.		
	Calibration repeated at the end of each test series.		
HPLC/Ion Chromatograph	Calibrations conducted at the beginning, after the first injection, and after the second injection.		
Fisher Accument 925 pH/Selective Ion Meter	5- point calibration prior to analyzing the samples for the specific ions.		

5.5 Blanks and Spikes. Field blanks, method blanks, trip blanks, lab-proof blanks and filter blanks are obtained, digested and analyzed when applicable. The blanks reflect the background contamination obtained from the various sources during the sampling and analysis. Thus, data adjustment or correction can be made accordingly.

In most cases, it is not necessary to digest and analyze the method blanks, reagent blanks or the lab-proof blanks unless the field blank shows a high level of contamination. If a high level of contamination is present, it is imperative to individually analyze the above blanks to help determine the cause of contamination.

Spiked samples are used to check on the performance of a routine analysis or the recovery efficiency of a method. During spiking, a known amount of stock solutions of the substance of interest is added to the sample prior to sample extraction, digestion, and analysis.

5.6 Internal/External System Audit Checks. System and performance audits are routine elements of all Entropy QA/QC programs.

Internal Systems Audit: The following sampling equipment checks were conducted prior to sample collection.

- All sampling equipment was thoroughly checked to ensure clean and operable components.
- Equipment was inspected for possible damage from shipment.
- The oil manometers or Magnehelic gauges were leveled and zeroed.
- The temperature measurement systems were checked for damage and operability by measuring the ambient temperature.

Performance Audits: Performance audits of the laboratory are conducted prior to the processing of any compliance samples for analysis. Audit materials typically include samples available from the EPA prior to new source testing. Also, samples of known concentration are specially prepared in-house or obtained from the EPA for Internal QA checks.

External Sytems Audits: Entropy is subject to a system audit each time a test is conducted for any Air Pollution Control agency. This procedure entails an EPA observer on-site to do qualitative evaluation of performance to demonstrate compliance with the applicable regulations.

5.7 Data Reduction and Validation. The test team leader is responsible for reviewing and validating data as they are acquired. Each team leader has extensive knowledge of sampling methodology and the characteristics of the process being measured and is capable of evaluating the accuracy, representativeness, and completeness of raw data on-site, where action to replace inadequate data can be taken immediately.

Data obtained during calibrations and test runs are recorded on standardized forms which are checked twice for completeness and accuracy by the QA Director or his designated representative. Data reduction and consistency are achieved by using the standardized forms and using Entropy's in-house computer facilities.

5.8 QA/QC Summary. All chemicals used were American Chemical Society (ACS), High Purity Liquid Chromatography (HPLC), or pesticide grade. The deionized, distilled water utilized met or exceeded the American Society for Testing and Materials (ASTM) specifications for Type-I reagent water. Pretest and posttest leak checks were conducted on each sampling train.

EPA MMTL. Field blanks were prepared at the SDA inlet and stack. The field blanks were analyzed for lead with none detected.

Matrix spikes were conducted on samples 1-I MMTL-3 amd 1-S-MMTL-3. The samples were analyzed with 100% recovery for both.

Duplicate analyses were conducted on samples 1-I-MMTL-2 and 1-S-MMTL-2. Refer to Table 5-3 for the results.

TABLE 5-3

LEAD DUPLICATE ANALYSES RESULTS

	Duplicate Analyses		
	First Analysis	Second Analysis	Relative %* Difference
MICROGRAMS CATCH			
SDA Inlet Samples			
Run 1-I-MMTL-2	27,900	28,600	2.5
Stack Samples			
Run 1-S-MMTL-2	< 20.0	< 20.0	NA

*Not applicable if one or both results are below the detection limit.

APPENDIX A.1

A. TEST RESULTS

1. SDA Inlet

FIELD DATA AND RESULTS TABULATION

PLANT: Camden County Resource Recovery Facility, Camden, NJ

LOCATION: Unit No. 1 SDA Inlet

RUN #	DATE	OPERATOR
1-I-MMTL-1	10/18/91	Reginald F. Holt
1-I-MMTL-2	10/18/91	Reginald F. Holt
1-I-MMTL-3	10/18/91	Reginald F. Holt

		1-I-MMTL-1	1-I-MMTL-2	1-I-MMTL-3
	Run Start Time	0820	1500	1845
	Run Finish Time	1355	1734	2055
	Net Traversing Points	24	24	24
Theta	Net Run Time, Minutes	120.00	120.00	120.00
Dia	Nozzle Diameter, Inches	0.273	0.278	0.266
Cp	Pitot Tube Coefficient	0.840	0.840	0.840
Y	Dry Gas Meter Calibration Factor	0.9823	0.9823	0.9823
Pbar	Barometric Pressure, Inches Hg	30.00	30.00	30.00
Delta-H	Avg. Pressure Differential of Orifice Meter, Inches H_2O	1.31	1.20	1.15
Vm	Volume Of Metered Gas Sample, Dry ACF	76.117	73.326	72.097
tm	Dry Gas Meter Temperature, Degrees F	95	102	99
Vmstd	Volume Of Metered Gas Sample, Dry SCF*	71.817	68.258	67.491
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, ml	229.5	209.5	241.5
Vwstd	Volume of Water Vapor, SCF*	10.843	9.899	11.410
$\%H_2O$	Moisture Content, Percent by Volume	13.1	12.7	14.5
Mfd	Dry Mole Fraction	0.869	0.873	0.855
$\%CO_2$	Carbon Dioxide, Percent By Volume, Dry	8.2	8.8	8.8
$\%O_2$	Oxygen, Percent By Volume, Dry	11.0	10.3	10.2
Md	Gas Molecular Weight, lb/lb-Mole, Dry	29.75	29.82	29.82
Ms	Gas Molecular Weight, lb/lb-Mole, Wet	28.21	28.32	28.11
Pg	Flue Gas Static Pressure, Inches H_2O	-2.00	-1.95	-2.05
Ps	Absolute Flue Gas Pressure, Inches Hg	29.85	29.86	29.85
ts	Flue Gas Temperature, Degrees F	438	421	426
Delta-p	Average Velocity Head, Inches H_2O	0.4528	0.3731	0.4310
vs	Flue Gas Velocity, Feet/Second	49.89	44.78	48.45
A	Stack/Duct Area, Square Inches	4,536	4,536	4,536
Qsd	Volumetric Air Flow Rate, Dry SCFM*	48,267	44,362	46,747
Qaw	Volumetric Air Flow Rate, Wet ACFM	94,296	84,641	91,576
%I	Isokinetic Sampling Rate, Percent	96.1	95.8	98.2

(Continued next pag

* 70° F (21° C) -- 29.92 Inches of Mercury (Hg)

FIELD DATA AND RESULTS TABULATION
(Continued)

PLANT: Camden County Resource Recovery Facility, Camden, NJ

		1-I-MMTL-1	1-I-MMTL-2	1-I-MMTL-3
	Lead			
fwt	Formula Weight, lb/lb-Mole	207.19	207.19	207.19
ug	Catch Weight, Micrograms	21400	28250	36500
ug/DSCM	Concentration, ug/DSCM *	10,522	14,614	19,097
ug@12%CO2	Concentration, ug/DSCM @ 12% CO2	15,398	19,928	26,041
ug@7%O2	Concentration, ug/DSCM @ 7% O2	14,731	19,121	24,755
gr/DSCF	Concentration, grains/DSCF *	0.00460	0.00639	0.00835
gr@12%CO2	Concentration, gr/DSCF @ 12% CO2	0.00673	0.00871	0.0114
gr@7%O2	Concentration, gr/DSCF @ 7% O2	0.00644	0.00836	0.0108
lb/hr	Emission Rate, lb/hr	1.90	2.43	3.34

* 70° F (21° C) -- 29.92 Inches of Mercury (Hg)

APPENDIX A.2

A. TEST RESULTS

2. Stack

FIELD DATA AND RESULTS TABULATION

PLANT: Camden County Resource Recovery Facility, Camden, NJ

LOCATION: Unit No. 1 Stack

RUN #	DATE	OPERATOR
1-S-MMTL-1	10/18/91	James E. Daley
1-S-MMTL-2	10/18/91	James E. Daley
1-S-MMTL-3	10/18/91	James E. Daley

		1-S-MMTL-1	1-S-MMTL-2	1-S-MMTL-3
	Run Start Time	0820	1500	1845
	Run Finish Time	1355	1734	2055
	Net Traversing Points	24	24	24
Theta	Net Run Time, Minutes	120.00	120.00	120.00
Dia	Nozzle Diameter, Inches	0.274	0.274	0.274
Cp	Pitot Tube Coefficient	0.840	0.840	0.840
Y	Dry Gas Meter Calibration Factor	1.0095	1.0095	1.0095
Pbar	Barometric Pressure, Inches Hg	29.90	29.90	29.90
Delta-H	Avg. Pressure Differential of Orifice Meter, Inches H_2O	1.98	1.82	1.88
Vm	Volume Of Metered Gas Sample, Dry ACF	93.313	91.743	92.994
tm	Dry Gas Meter Temperature, Degrees F	89	92	99
Vmstd	Volume Of Metered Gas Sample, Dry SCF*	91.328	89.343	89.392
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, ml	361.0	372.5	404.0
Vwstd	Volume of Water Vapor, SCF*	17.057	17.600	19.088
$\%H_2O$	Moisture Content, Percent by Volume	15.7	16.5	17.6
Mfd	Dry Mole Fraction	0.843	0.835	0.824
$\%CO_2$	Carbon Dioxide, Percent By Volume, Dry	7.7	8.0	8.0
$\%O_2$	Oxygen, Percent By Volume, Dry	11.4	11.1	11.1
Md	Gas Molecular Weight, lb/lb-Mole, Dry	29.69	29.72	29.72
Ms	Gas Molecular Weight, lb/lb-Mole, Wet	27.85	27.79	27.66
Pg	Flue Gas Static Pressure, Inches H_2O	-0.32	-0.31	-0.32
Ps	Absolute Flue Gas Pressure, Inches Hg	29.88	29.88	29.88
ts	Flue Gas Temperature, Degrees F	275	278	277
Delta-p	Average Velocity Head, Inches H_2O	0.6127	0.5616	0.5699
vs	Flue Gas Velocity, Feet/Second	52.84	50.75	51.19
A	Stack/Duct Area, Square Inches	4,072	4,072	4,072
Qsd	Volumetric Air Flow Rate, Dry SCFM*	54,374	51,547	51,402
Qaw	Volumetric Air Flow Rate, Wet ACFM	89,635	86,092	86,833
%I	Isokinetic Sampling Rate, Percent	96.6	99.7	100.1

* 70° F (21° C) -- 29.92 Inches of Mercury (Hg)

(Continued next page)

FIELD DATA AND RESULTS TABULATION
(Continued)

PLANT: Camden County Resource Recovery Facility, Camden, NJ

		1-S-MMTL-1		1-S-MMTL-2		1-S-MMTL-3
	Lead					
fwt	Formula Weight, lb/lb-Mole	207.19		207.19		207.19
ug	Catch Weight, Micrograms	44	<	20	<	20
ug/DSCM	Concentration, ug/DSCM *	17.0	<	7.90	<	7.90
ug@12%CO2	Concentration, ug/DSCM @ 12% CO2	26.5	<	11.9	<	11.9
ug@7%O2	Concentration, ug/DSCM @ 7% O2	24.8	<	11.2	<	11.2
gr/DSCF	Concentration, grains/DSCF *	7.44E-006	<	3.45E-006	<	3.45E-006
gr@12%CO2	Concentration, gr/DSCF @ 12% CO2	1.16E-005	<	5.18E-006	<	5.18E-006
gr@7%O2	Concentration, gr/DSCF @ 7% O2	1.08E-005	<	4.89E-006	<	4.88E-006
lb/hr	Emission Rate, lb/hr	0.00347	<	0.00153	<	0.00152

* 70° F (21° C) -- 29.92 Inches of Mercury (Hg)
< Indicates the value is below the detection limit.

APPENDIX A.3

A. TEST RESULTS

3. Example Calculations

NOTE

The example values shown in these calculations have been rounded for presentation purposes. Any hand calculations conducted using these example values may produce slightly different results than those presented.

EXAMPLE TEST CALCULATIONS RUN 1-S-MMTL-1

Unit No. 1 Stack

VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS

$$Vmstd = Y * Vm * \frac{Pbar + (Delta\ H/13.6)}{(460 + tm)} * \frac{460 + tstd}{Pstd}$$

$$Vmstd = 1.0095 * 93.313 * \frac{29.90 + (1.980/13.6)}{(460 + 89)} * \frac{460 + 70}{29.92} = 91.328\ DSCF$$

VOLUME OF WATER VAPOR AT STANDARD CONDITIONS

$$Vwstd = 0.04707 * Vlc * (460 + tstd)/528$$

$$Vwstd = 0.04707 * 361.0 * (460 + 70)/528 = 17.057\ SCF$$

PERCENT MOISTURE, BY VOLUME, AS MEASURED IN FLUE GAS

$$\%H_2O = 100 * Vwstd / (Vwstd + Vmstd)$$

$$\%H_2O = \frac{17.057}{17.057 + 91.328} * 100 = 15.7\ \%$$

ABSOLUTE FLUE GAS PRESSURE

$$Ps = Pbar + (Pg / 13.6)$$

$$Ps = 29.90 + (-0.32/13.6) = 29.88\ inches\ Hg$$

DRY MOLE FRACTION OF FLUE GAS

$$Mfd = 1 - \%H_2O / 100$$

$$Mfd = 1 - 15.7/100 = 0.843$$

DRY MOLECULAR WEIGHT OF FLUE GAS

$$Md = (\%CO_2/100 * 44) + (\%O_2/100 * 32) + ((100 - \%CO_2 - \%O_2)/100 * 28)$$

$$Md = (7.7/100 * 44) + (11.4/100 * 32) + ((100 - 7.7 - 11.4)/100 * 28)$$

$$Md = 29.69\ lb/lb\text{-}Mole$$

WET MOLECULAR WEIGHT OF FLUE GAS

$$Ms = (Md * Mfd) + (0.18 * \%H_2O)$$

$$Ms = (29.69 * 0.843) + (0.18 * 15.7) = 27.85\ lb/lb\text{-}Mole$$

AVERAGE FLUE GAS VELOCITY [Note: (Delta p)avg is square of average square root]

$$vs = 85.49 * Cp * \left[\frac{(\text{Delta P})avg * (460 + ts)}{Ps * Ms} \right]^{\frac{1}{2}}$$

$$vs = 85.49 * 0.840 * \left[\frac{0.6127 * (460 + 275)}{29.88 * 27.85} \right]^{\frac{1}{2}} = 52.84 \text{ ft/sec}$$

DRY VOLUMETRIC FLUE GAS FLOW RATE AT STANDARD CONDITIONS

$$Qsd = \frac{60}{144} * Mfd * vs * A * \frac{460 + tstd}{460 + ts} * \frac{Ps}{Pstd}$$

$$Qsd = \frac{60}{144} * 0.843 * 52.84 * 4,071.5 * \frac{460 + 70}{460 + 275} * \frac{29.88}{29.92}$$

Qsd = 54,374 DSCFM

WET VOLUMETRIC FLUE GAS FLOW RATE AT ACTUAL CONDITIONS

Qaw = 60 / 144 * vs * A

Qaw = 60 / 144 * 52.84 * 4,071.5 = 89,635 ACFM

PERCENT ISOKINETIC OF SAMPLING RATE

$$\%I = \frac{Pstd}{460 + tstd} * \frac{100}{60} * \frac{(ts + 460) * Vmstd}{Ps * vs * Mfd * Theta * (\pi * (NozzleDia/2)^2/144)}$$

$$\%I = \frac{29.92}{460 + 70} * \frac{100}{60} * \frac{(275 + 460) * 91.328}{29.88 * 52.84 * 0.843 * 120.00 * (\pi * (0.274/2)^2/144)}$$

%I = 96.6 %

CONCENTRATION, MICROGRAMS PER DRY STANDARD CUBIC METER, LEAD

$$ug/DSCM = \frac{(ug / 10^6)}{Vmstd * 0.02832} * 10^6$$

$$ug/DSCM = \frac{(44.0/10^6)}{91.328 * 0.02832} * 10^6 = 17.0 \text{ ug/DSCM}$$

CONCENTRATION, MICROGRAMS PER DSCM CORRECTED TO 12% CO_2, LEAD

ugDSCM@12% = ug/DSCM * (12 / $\%CO_2$)

ugDSCM@12% = 17.0 * (12 / 7.7) = 26.5 ug/DSCM @ 12% CO_2

CONCENTRATION, MICROGRAMS PER DSCM CORRECTED TO 7% O_2, LEAD

$$ugDSCM@7\% = ug/DSCM * \frac{21.0 - 7}{21.0 - \%O_2}$$

$$ugDSCM@7\% = 17.0 * \frac{21.0 - 7}{21.0 - 11.4} = 24.8 \text{ ug/DSCM @ 7\% } O_2$$

CONCENTRATION, GRAINS PER DRY STANDARD CUBIC FOOT, LEAD

$$gr/DSCF = \frac{7,000}{453.592} * \frac{(ug / 10^6)}{Vmstd}$$

$$gr/DSCF = \frac{7,000}{453.592} * \frac{(44.0/10^6)}{91.328} = 7.44E\text{-}006 \text{ gr/DSCF}$$

CONCENTRATION, GRAINS PER DSCF CORRECTED TO 12% CO_2, LEAD

$$gr@12\% = gr/DSCF * (12 / \%CO_2)$$

$$gr@12\% = 7.44E\text{-}006 * (12 / 7.7) = 1.16E\text{-}005 \text{ gr/DSCF @ 12\% } CO_2$$

CONCENTRATION, GRAINS PER DSCF CORRECTED TO 7% O_2, LEAD

$$gr@7\% = gr/DSCF * \frac{21.0 - 7}{21.0 - \%O_2}$$

$$gr@7\% = 7.44E\text{-}006 * \frac{21.0 - 7}{21.0 - 11.4} = 1.08E\text{-}005 \text{ gr/DSCF @ 7\% } O_2$$

EMISSION RATE, POUNDS PER HOUR, LEAD

$$lb/hr = \frac{60}{453.592} * \frac{(ug / 10^6)}{Vmstd} * Qsd$$

$$lb/hr = \frac{60}{453.592} * \frac{(44.0/10^6)}{91.328} * 54,374 = 0.00347 \text{ lb/hr}$$

APPENDIX B.1

B. FIELD AND ANALYTICAL DATA

1. SDA Inlet

METHOD 3 (ORSAT) FIELD DATA

Plant Name/Address Camden — Job No. 1055

Sampling Location Unit 1 SDA Inlet — Fuel Type [redacted]

Run/Sample No. 1-I-M3-1 — Leak √ ✓ — Date 10-18-91 — Operator JCM

Time of Sample Collection	Time of Analysis	CO_2 Reading (A)	O_2 Reading (B)	CO Reading (C)	% O_2 (B-A)	% CO (C-B)	% N_2 (100-C)
0820	1520	8.0	19.2	—	11.0	—	[redacted]
↓	1540	8.1	19.1	—	11.0	—	
1355	1550	8.2	19.2	—	11.0	—	
	Avg.	8.2		Avg.	11.0	—	80.8

Orsat I.D. 1 — Tedlar Bag I.D. 48 — F_o _____

Run/Sample No. 1-I-M3-2 — Leak √ ✓ — Date 10-18 — Operator JCM

Time of Sample Collection	Time of Analysis	CO_2 Reading (A)	O_2 Reading (B)	CO Reading (C)	% O_2 (B-A)	% CO (C-B)	% N_2 (100-C)
1500	1930	8.8	19.1	—	10.3	—	[redacted]
↓	1940	8.8	19.0	—	10.2	—	
1734	1850	8.8	19.1	—	10.3	—	
	Avg.	8.8		Avg.	10.3	—	80.9

Orsat I.D. 1 — Tedlar Bag I.D. 6 — F_o _____

Run/Sample No. 1-I-M3-3 — Leak √ ✓ — Date 10-18 — Operator JCM

Time of Sample Collection	Time of Analysis	CO_2 Reading (A)	O_2 Reading (B)	CO Reading (C)	% O_2 (B-A)	% CO (C-B)	% N_2 (100-C)
1845	2125	8.8	19.0	—	10.2		[redacted]
↓	2135	8.8	19.0	—	10.2		
2085	2145	8.8	19.0	—	10.2		
	Avg.	8.8		Avg.	10.2		81.0

Orsat I.D. 1 — Tedlar Bag I.D. 65 — F_o _____

(For field check of fuel type, refer to page 2)

FIELD DATA - METHOD(S) MM TL

RUN NO. 1-I-MMTL-2

PLANT Foster Wheeler - Camden Co. - RRF JOB NO. 10535-1 DATE 10-18-91

CITY/STATE Camden, New Jersey TIME START 1500

SAMPLING LOC. Unit 1 - Inlet TIME FINISH 1734

BAROMETRIC PRESSURE, IN. HG 30.0 STATIC PRESSURE, IN. H_2O -1.95 OPERATOR RFH

LEAK CHECK, VACUUM IN. HG 15 / 7 / 15 / 17 / ___ / ___ ASST(S) WEM

LEAK RATE, CUBIC FEET/MIN. 0.002 / 0.002 / 0003 / 0.003 / ___ / ___

EQUIPMENT CHECKS*
- ✓ PITOT, PRETEST
- ✓ PITOT, POSTTEST
- ✓ NOZZLE, PRE/POST
- ✓ TC 84 °F PRE
- ✓ TC 88 °F POST
- ✓ ORSAT SYSTEM

EQUIPMENT I.D. NUMBERS

REAGENT BOX M111 METER BOX A1-23 Y 0.9823

PITOT S-12 Cp .84 NOZ'L GL/23 DIA. 0.278

TC READOUT F-1 TC PROBE R94 UMBILICAL U90

SAMPL'G BOX 74 ORSAT PUMP 5 TEDLAR BAG 6

LEAK CHECKS

	B	E
	842.59	842.68
	865.327	865.487

FILTER/XAD	TARE WT.
#1 Q1033	0.5179
#2 Q1034	0.5260

NOMOGRAPH DATA (RFH 10-18-91)

DELTA H@	1.827	1.827
METER TEMP	80	110
EST. XH_2O	13	15
C FACTOR	0.880	0.864
STACK TEMP	425	425
REF DELTA P	0.569	0.573
K FACTOR	3.269	3.212

PYRITES

Part A 9.5%

Part B 9 %

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H_2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H_2O ACTUAL	ORIFICE SETTING IN. H_2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	GAS TEMPERATURES °F IMPING. EXIT	GAS TEMPERATURES °F PROBE OR COND EXIT**	✓
1	A-1	0/ON	806.390	0.23	94	420	0.72	0.72	2	251	57	NA	
2	2	5	808.78	0.33	94	420	1.04	1.04	2	250	56		
3	3	10	811.64	0.37	95	422	1.16	1.16	2	250	55		
4	4	15	814.70	0.36	97	434	1.12	1.12	3	251	55		
5	5	20	817.65	0.36	98	434	1.12	1.12	3	251	54		
6	6	25	820.63	0.37	100	432	1.16	1.16	4	252	54		
7	7	30	823.68	0.38	101	430	1.20	1.20	4	253	53		
8	8	35	826.78	0.46	102	432	1.45	1.45	5	254	54		
9	9	40	830.11	0.44	103	425	1.40	1.40	6	255	54		
10	10	45	833.47	0.36	104	412	1.16	1.16	6	255	55		
11	11	50	836.57	0.34	105	412	1.10	1.10	6	256	55		
12	12	55	839.55	0.35	105	412	1.13	1.13	7	255	56		
13	B-1	60/0	842.59	0.21	103	415	0.67	0.67	7	256	56		
14	2	5	844.84	0.28	102	414	0.90	0.90	7	255	56		
15	3	10	847.50	0.37	102	413	1.19	1.19	8	256	55		
16	4	15	850.55	0.37	103	450	1.14	1.14	8	257	54		
17	5	20	853.18	0.37	104	447	1.15	1.15	9	258	54		
18	6	25	856.20	0.41	105	447	1.28	1.28	10	258	55		
19	7	30	859.39	0.46	106	428	1.46	1.46	12	257	54		
20	8	35	862.78	0.60	108	407	1.96	1.96	17	257	54		
21	9	40	866.75	0.43	104	407	1.39	1.39	3	255	55		
22	10	45	870.12	0.42	106	400	1.38	1.38	4	253	57		
23	11	50	873.46	0.42	108	400	1.38	1.38	5	252	58		
24	12	55	876.80	0.36	109	399	1.19	1.19	5	250	58		↓
25		60/OFF	879.896										

* FILTER EXIT for NJ Method 1. FILTER BOX for all others.

** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

120	73.326	0.3731	102.42	421.29	1.20
Min. (Θ)	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH

ENTROPY

FIELD DATA - METHOD(S) MM TL

PLANT Foster Wheeler - Camden Co. - RRF — RUN NO. 1-I-MMTL-1 — 14

CITY/STATE Camden, New Jersey — JOB NO. 10535-1 — DATE 10-18-91

SAMPLING LOC. Unit 1 - Inlet — TIME START 0820

BAROMETRIC PRESSURE, IN. HG 30.0 — STATIC PRESSURE, IN. H_2O -2.0 — TIME FINISH 1355

LEAK CHECK, VACUUM IN. HG 15 | 9 | 14 | 14 — OPERATOR RFH

LEAK RATE, CUBIC FEET/MIN. 0.001 | 0.003 | 0.003 | 0.003 — ASST(S) WEM

EQUIPMENT CHECKS*

- ✓ PITOT, PRETEST
- ✓ PITOT, POSTTEST
- ✓ NOZZLE, PRE/POST
- ✓ TC 69 °F PRE
- ✓ TC 84 °F POST
- ✓ ORSAT SYSTEM

EQUIPMENT I.D. NUMBERS

REAGENT BOX M111 — METER BOX N-23 — Y 0.9823

PITOT 8-9 — C_p .84 — NOZZLE GL88 — DIA. 0.273

TC READOUT F-1 — TC PROBE R271 — UMBILICAL U490

SAMPL'G BOX 6.3 — ORSAT PUMP 5 — TEDLAR BAG 48

NOMOGRAPH DATA

DELTA H@ 1.827

METER TEMP 83

EST. $\%H_2O$ 15

C FACTOR 0.823

STACK TEMP 425

REF DELTA P 0.647

K FACTOR 2.846

LEAK CHECKS

B	768.084	B	
E	768.170	E	
B	789.420	B	
E	789.574	E	
B		B	
E		E	

FYRITES

Point A 9%

Point B 9.5%

	FILTER/XAD	TARE WT.
# 1.	Q1028	0.5089
# 2.	Q1020	0.5210

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H_2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H_2O ACTUAL	ORIFICE SETTING IN. H_2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	GAS TEMPERATURES °F IMPING. EXIT	GAS TEMPERATURES °F PROBE OR COND EXIT**	✓
1	A-1	0/ON	729.668	0.24	77	420	0.68	0.68	2	240	58	N/A	
2	2	5	732.01	0.42	82	420	1.20	1.20	2	240	56		
3	3	10	734.96	0.44	85	422	1.26	1.26	3	245	55		
4	4	15	738.04	0.50	87	439	1.41	1.41	4	246	55		
5	5	20	741.30	0.50	89	446	1.41	1.41	5	248	54		
6	6	25	744.58	0.60	91	455	1.68	1.68	6	250	55		
7	7	30	748.12	0.58	93	454	1.63	1.63	7	249	56		
8	8	35	751.55	0.50	92	438	1.43	1.43	7	248	55		
9	9	40	754.88	0.49	94	432	1.41	1.41	7	247	54		
10	10	45	758.17	0.47	97	427	1.37	1.37	8	247	55		
11	11	50	761.46	0.49	98	428	1.43	1.43	9	248	56		
12	12	55	764.78	0.47	99	431	1.37	1.37	9	248	57		
13	B-1	60/0	768.084	0.27	94	419	0.79	0.79	6	250	55		
14	2	5	770.64	0.43	96	420	1.26	1.26	9	249	56		
15	3	10	773.78	0.47	98	466	1.31	1.31	9	249	56		
16	4	15	776.97	0.34	100	466	0.95	0.95	9	248	55		
17	5	20	779.81	0.48	100	464	1.35	1.35	11	248	54		
18	6	25	783.00	0.49	101	463	1.38	1.38	12	249	55		
19	7	30	786.29	0.55	102	446	1.58	1.58	14	250	54		
20	8	35	789.91	0.50	99	446	1.43	1.43	3	250	54		
21	9	40	793.31	0.49	102	473	1.37	1.37	3	248	55		
22	10	45	796.62	0.36	102	411	1.08	1.08	3	249	54		
23	11	50	799.57	0.46	101	408	1.38	1.38	4	250	53		
24	12	55	802.83	0.43	102	408	1.29	1.29	5	250	53		
25		60/OFF	806.025										

* FILTER EXIT for NJ Method 1. FILTER BOX for all others.

** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

120	31.117	0.4528	95.04	437.58	1.31
Min. (Θ)	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH

ENTROPY

FIELD DATA - METHOD(S) MM TL

PLANT Foster Wheeler - Camden Co. - RRF
CITY/STATE Camden, New Jersey
SAMPLING LOC. Unit 1 - Inlet
BAROMETRIC PRESSURE, IN. HG 30.0
LEAK CHECK, VACUUM IN. HG 15 15 15
LEAK RATE, CUBIC FEET/MIN. 0.004 0.002 0.004

RUN NO. 1-I-MMTL-3
JOB NO. 10535-1
DATE 10-18-91
TIME START 1845
TIME FINISH 2055
STATIC PRESSURE, IN. H_2O -2.05
OPERATOR RFH
ASST(S) WEM

EQUIPMENT CHECKS*
- ✓ PITOT, PRETEST
- ✓ PITOT, POSTTEST
- ✓ NOZZLE, PRE/POST
- ✓ TC 88 °F PRE
- ✓ TC 86 °F POST
- ✓ ORSAT SYSTEM

EQUIPMENT I.D. NUMBERS
REAGENT BOX M111 METER BOX N-23 Y 0.9823
PITOT 84 C_p .84 NOZ'L GL87 DIA. 0.266
TC READOUT F-1 TC PROBE R271 UMBILICAL U90
SAMPL'G BOX 53 ORSAT PUMP 5 TEDLAR BAG 65

NOMOGRAPH DATA
DELTA HG 1.827
METER TEMP 110
EST. %H_2O 15
C FACTOR 0.864
STACK TEMP 425
REF DELTA P 0.683
K FACTOR 2.692

LEAK CHECKS
B 914.982 E 915.128

FYRITES
Port A 9.5%
Port B 9.5%

FILTER/XAD	TARE WT.
Q1032	0.5183

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H_2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H_2O ACTUAL	ORIFICE SETTING IN. H_2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	GAS TEMPERATURES °F IMPING. EXIT	GAS TEMPERATURES °F PROBE OR COND EXIT**	✓
1	A-1	0/ON	880.147	0.30	90	420	0.79	0.79	2	258	62	NA	
2	2	5	882.64	0.39	91	420	1.02	1.02	2	257	60		
3	3	10	885.47	0.43	92	430	1.12	1.12	3	255	58		
4	4	15	888.43	0.41	94	434	1.06	1.06	3	252	54		
5	5	20	891.30	0.40	95	438	1.03	1.03	4	250	52		
6	6	25	894.08	0.39	96	434	1.02	1.02	5	248	50		
7	7	30	896.92	0.42	98	430	1.10	1.10	6	245	48		
8	8	35	899.89	0.47	99	423	1.25	1.25	7	246	50		
9	9	40	903.01	0.39	100	411	1.05	1.05	7	248	50		
10	10	45	905.91	0.47	100	420	1.25	1.25	8	250	48		
11	11	50	909.05	0.40	101	420	1.07	1.07	8	248	47		
12	12	55	912.99	0.40	101	414	1.07	1.07	8	246	47		
13	B-1	60/0	914.982	0.44	97	420	1.17	1.17	7	248	49		
14	2	5	918.16	0.38	100	420	1.01	1.01	8	250	50		
15	3	10	921.01	0.38	100	460	0.97	0.97	8	248	51		
16	4	15	923.81	0.45	101	461	1.15	1.15	9	246	52		
17	5	20	926.80	0.47	101	458	1.20	1.20	10	245	53		
18	6	25	929.90	0.55	102	460	1.41	1.41	11	247	52		
19	7	30	933.19	0.61	103	448	1.58	1.58	12	248	52		
20	8	35	936.68	0.55	104	416	1.48	1.48	14	248	53		
21	9	40	940.11	0.47	104	404	1.28	1.28	13	249	53		
22	10	45	943.33	0.45	104	399	1.24	1.24	14	250	53		
23	11	50	946.47	0.41	104	394	1.13	1.13	13	251	52		
24	12	55	949.52	0.37	104	390	1.03	1.03	13	250	52		
25		60/OFF	952.390										

* FILTER EXIT for NJ Method 1. FILTER BOX for all others

** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser

120	72.097	0.4310	99.21	426	1.15
Min. (Θ)	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH

ENTROPY

MOISTURE SAMPLING LABORATORY RESULTS

Plant Name:CAMDEN COUNTY ENERGY RECOVERY ASSOCIATES EEI Ref# 10535

Sampling Location: UNIT #1 SDA INLET

Date Received: 10/29/91 Date Analyzed:10/18/91 Reagent Box(es): M111

Run Number	1-I-MMTL-1	1-I-MMTL-2	1-I-MMTL-3
Run Date	10/18/91	10/18/91	10/18/91

ANALYSIS OF MOISTURE CATCH

Reagent 1 (H2O)			
Final Weight, g.	478.5	456.5	494.0
Tared Weight, g.	269.0	267.0	270.0
Water Catch,g.	209.5	189.5	224.0
Reagent 2 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch,g.	0.0	0.0	0.0
Reagent 3 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch,g.	0.0	0.0	0.0
CONDENSED WATER, g.	209.5	189.5	224.0
Silica Gel:			
Final Weight, g.	220.0	220.0	217.5
Tared Weight, g.	200.0	200.0	200.0
ADSORBED WATER, g.	20.0	20.0	17.5
TOTAL WATER COLLECTED, g.	229.5	209.5	241.5

MOISTURE SAMPLING LABORATORY RESULTS

Plant Name:CAMDEN COUNTY ENERGY RECOVERY ASSOCIATES EEI Ref# 10535

Sampling Location: UNIT #1 INLET AND STACK

Date Received: 10/29/91 Date Analyzed: 10/18/91 Reagent Box(es): M136

Run Number	1-S-MMTL-FB	1-I-MMTL-FB
Run Date	10/18/91	10/18/91

ANALYSIS OF MOISTURE CATCH

Reagent 1 (H20)		
Final Weight, g.	270.5	270.5
Tared Weight, g.	271.0	271.0
Water Catch,g.	-0.5	-0.5
Reagent 2 ( )		
Final Weight, g.		
Tared Weight, g.		
Water Catch,g.	0.0	0.0
Reagent 3 ( )		
Final Weight, g.		
Tared Weight, g.		
Water Catch,g.	0.0	0.0
CONDENSED WATER, g.	-0.5	-0.5
Silica Gel:		
Final Weight, g.		
Tared Weight, g.		
ADSORBED WATER, g.	0.0	0.0
TOTAL WATER COLLECTED, g.	-0.5	-0.5

OL # 91W3667

pg 1 of 2

SAMPLE SUBMISSION FORM
Oxford Laboratory

19

Suomitted By | Date Submitted 10-22-91 | Date Requested 11-5-91

Company Name Entropy | Attention Rick Lehman

Address | State | Zip Code

Telephone | Received By

No. of Samples & Identification: Purchase Order# 1781-10535

1.	1-S-mm TL-1	(7)	1-I-mm TL-1
2.	2	(8)	2
3.	2 Duplicate	(9)	2 Duplicate
4.	3	(10)	3
5.	3 Spike	(11)	3 Spike
6.	RB	(12)	RB

Analyses Requested and Special Instructions: DL - 20 ug

Custody →

Results:	(1)	(2)	(3)	(4)	(5)	(6)
Lead Total ug/g	44.0	< 20.0	< 20.0	< 20.0	100%	< 20.0
		$\bar{X}$ = 23250				
	(7)	(8)	(9)	(10)	(11)	(12)
Lead	21400	27900	28600	36500	100%	< 20.0

OL # 9103647

pg 20

SAMPLE SUBMISSION FORM
Oxford Laboratory

Submitted By _____ Date Submitted 10-25-91 Date Requested _____

Company Name Entropy Attention _____

Address _____ State _____ Zip Code _____

Telephone _____ Received By _____

No. of Samples & Identification: Purchase Order# _____

(13) Blanks

(4) Mixed Code

3.

4.

5.

6.

Analyses Requested and Special Instructions:

Results:	(13)	(4)	3	4	5	6
ad Total g	< 20.0	SW846-7420				

A.A. SUMMARY REPORT

C ENTROPY
P.O.#/PROJECT #:1781-10535
ANALYST: KEN SMITH
DATE: 10/28/91

X MT. STDS
CONC STDS
.100 INST LIMIT
1 SPK LEVEL
1.00 MAX ALIQUOT
F.V. .1 M.D.L.

SAMPLE I.D.	EL	MEAN ABS	ug/ml CONC	SAMPLE ALIQUOT	X DILUTION	TOTAL ug ANALYZED	% REC OR <	SPIKE LEVEL
3667-01	Pb	.0025571	.22	1	200	44.0		
3667-02	Pb	.0002185	.02	1	200 <		20.0	
3667-03	Pb	.0007468	.07	1	200 <		20.0	
3667-04	Pb	.0003522	.03	1	200 <		20.0	
3667-05-804SPK	Pb	.0114054	1	1	400	400	100	1
3667-06	Pb	.0008137	.07	1	200 <		20.0	
3667-07	Pb	.0623239	5.34	1	4000	21360		
3667-08	Pb	.0819021	6.97	1	4000	27880		
3667-09	Pb	.0840422	7.14	1	4000	28560		
3667-10	Pb	.1084626	9.13	1	4000	36520		
3667-11-810SPK	Pb	.1147851	9.63	1	4000	38520	100	.5
3667-12	Pb	.0009497	.08	1	200 <		20.0	
3667-13	Pb	-.000018	0	1	200 <		20.0	
AS Position 3	Pb	.0466448	4.03	0	0			
AS Position 3	Pb	.0465021	4.01	0	0			
AS Position 3	Pb	.0464375	4.01	0	0			
AS Position 3	Pb	.0459738	3.97	0	0			
B.	Pb	-.000375	-.03	0	0			
Blank	Pb	-.000183	-.02	0	0			
Blank	Pb	.0006576	.06	0	0			
Blank	Pb	-.000609	-.05	0	0			
B.L.=	Pb	.0009497	.08	0	0			
BLI BLK	Pb	.0004436	.04	0	0			
PE KNOWN	Pb	.0124019	1.09	1	1	1.09		
Std 1=.50ug/ml	Pb	.0055868	.51	0	0			
Std 2=4.0ug/ml	Pb	.0476413	4.26	0	0			
Std 3=10.0ug/ml	Pb	.1181336	8.99	0	0			
Std Blank	Pb	-.000051	0	0	0			

RECORD OF CUSTODY, CONTAINER NO. M111

22

Container Type (check) ✓ Reagent Box __ Cooler __ Other (specify) _____

Plant Name/Address CCERA

Job No. 10535 Sampling Method MMTL-Pb (EPA, NIOSH, etc.)

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
638	10-10	9.15	S	Bobby L Bell Jr.	
	10-9	1:15	B	[signature]	Chas Lam
1536	10-11		S	[signature]	
	10-21 TAS		B	[signature]	Chas Lam-in shop
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

* S = Sealed By; B = Broken By ** Use "REMARKS" Section if more space needed.

Received by Sample Custodian

DR P. A — Signature

10-21-91 — Date

9:50 — Time

Seal Intact? Yes ✓ No __

As Applicable:
All liquid levels at mark (check)? __ YES __ NO (Estimate loss if not at mark; describe in "REMARKS")

As Applicable:
TUBE SAMPLES put in freezer by _____ Date _____ Time _____

CONDENSATE SAMPLES put in refrige. by _____ Date _____ Time _____

REMARKS _____

L-0023 rev. 9-91

ENTROPY

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. M111 Assembly Date 10/9/91 Assembled By dlk R3

Plant Name/address CCSEA Job No. 10535

Sampling Loc. Unit 1 Inlet Method MMTL/Ab

Individual Tare Of Reagent 200 (Ml)(gm) Of 5% HNO_3 / 10% H_2O_2

Individual Tare Of Reagent _____ (Ml)(gm) Of _____

Individual Tare Of Reagent _____ (Ml)(gm) Of _____

Individual Tare Of Sil. Gel ~200 Gm _____ other (specify)

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
1-I-MMTL/Ab-1	10-18	N/A		✓	JHS	10-18	50	✓	JHS
1-I-MMTL/Ab-2	10-18	N/A		✓	JHS	10-18	50	✓	JHS
1-I-MMTL/Ab-3	10-18	N/A		✓	JHS	10-18	55	✓	JHS

Filter Appearance* grey-black
2 filters - manganese particulate

Reagents Appearance*
Clear

Filter Appearance* "
2 filters - "

Reagents Appearance*
Clear

Filter Appearance* "
1 filter - "

Reagents Appearance*
Clear

Filter Appearance*

Reagents Appearance*

* Use "REMARKS" section if needed.

@ All liquid levels at mark? (check) YES ___ NO ___ (estimate loss if not at mark; use "REMARKS" section).

REMARKS _____

Custodian DR Pat Date 10-21-91 Time 9:50

Q-1002 rev. 10-91

ENTROPY

.266

687

RECORD OF CUSTODY, CONTAINER NO. M136

Container Type (check) ✓ Reagent Box __ Cooler __ Other (specify) _____

Plant Name/Address CCERA; Canoga, N.J.

Job No. 10585 Sampling Method MMTC/PD (EPA, NIOSH, etc.)

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
647	10-16	9:15	S	Billy L. Bell Jr.	
	10-18	8:25	B	[signature]	Change Blanks
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

* S = Sealed By; B = Broken By ** Use "REMARKS" Section if more space needed.

Received by Sample Custodian

[signature] Signature

10-21-91 Date

9:45 Time

Seal Intact? Yes ✓ No __

As Applicable:
All liquid levels at mark (check)? __ YES __ NO (Estimate loss if not at mark; describe in "REMARKS")

As Applicable:
TUBE SAMPLES put in freezer by _____ Date _____ Time _____

CONDENSATE SAMPLES put in refrige. by _____ Date _____ Time _____

REMARKS _____

ENTROPY

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. M136 Assembly Date 10/9/91 Assembled By dlk

Plant Name/address CCERA Job No. 10535

Sampling Loc. UNIT 1 STACK OUTLET Method MM5L/M5

Individual Tare Of Reagent 200 (Ml) ~~(gm)~~ Of 5% HNO_3 / 10% H_2O_2

Individual Tare Of Reagent _____ (Ml)(gm) Of _____

Individual Tare Of Reagent _____ (Ml)(gm) Of _____

Individual Tare Of Sil. Gel ~200 Gm _____ other (specify)

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
1-S-MM5L-FB	10-15			✓	[illegible]	10-15	0	—	[illegible]
1-I-MM5L-FB	10-15			✓	[illegible]	10-15	0	—	[illegible]
BLANKS	10-15								

Filter Appearance* Clean

Reagents Appearance* Clean

Filter Appearance* Clean

Reagents Appearance* Clean

Filter Appearance*

Reagents Appearance*

Filter Appearance*

Reagents Appearance*

* Use "REMARKS" section if needed.

@ All liquid levels at mark? (check) YES ___ NO ___ (estimate loss if not at mark; use "REMARKS" section).

REMARKS _____

Custodian DRA Date 10-21-91 Time 9:40

ENTROPY

ENTROPY
Environmentalists, Inc.

P.O. Box 12291
Research Triangle Park
North Carolina 27709-2291
919-781-3550 FAX 919-787-8442

REQUEST FOR ANALYSIS

PO#: 1781-10535

Customer Name: Camden Co. RRF
Camden, NJ

Laboratory: OLI

Date Transmitted: 10/21/91

Results Due By: 11/05/91

Sample Matrix: MMTL

Analysis: Analyze for Pb by MMTL method. [detection limit = 20μg]

Sample #	Sample ID	Components/Comments
1	1-S-MMTL-1	-FH,-BH,-F,-R
2	1-S-MMTL-2	-FH,-BH,-F,-R
3	1-S-MMTL-2	duplicate analysis
4	1-S-MMTL-3	-FH,-BH,-F,-R
5	1-S-MMTL-3	matrix spike
6	1-S-MMTL-FB	-FH,-BH,-F,-R
7	1-I-MMTL-1	-FH,-BH,-F,-R
8	1-I-MMTL-2	-FH,-BH,-F,-R
9	1-I-MMTL-2	duplicate analysis
10	1-I-MMTL-3	-FH,-BH,-F,-R
11	1-I-MMTL-3	matrix spike
12	1-I-MMTL-FB	-FH,-BH,-F,-R
13	Blanks	HNO3/H2O2, 0.1N HNO3, filter

Submitted By:

APPENDIX B.2

B. FIELD AND ANALYTICAL DATA

2. Stack

METHOD 3 (ORSAT) FIELD DATA

Plant Name/Address Camden Job No. 16578

Sampling Location Unit 1 Stack Fuel Type _____

Run/Sample No. 1-S-M3-1 Leak √ ✓ Date 10-19-91 Operator [illegible]

Time of Sample Collection	Time of Analysis	CO_2 Reading (A)	O_2 Reading (B)	CO Reading (C)	% O_2 (B-A)	% CO (C-B)	% N_2 (100-C)
0820	1600	7.7	19.1		11.4		[redacted]
↓	1610	7.7	19.1		11.4		
1355	1620	7.7	19.1		11.4		
	Avg.	7.7		Avg.	11.4		80.9

Orsat I.D. 1 Tedlar Bag I.D. 21 F_o _____

Run/Sample No. 1-S-M3-2 Leak √ ✓ Date 9-18 Operator [illegible]

Time of Sample Collection	Time of Analysis	CO_2 Reading (A)	O_2 Reading (B)	CO Reading (C)	% O_2 (B-A)	% CO (C-B)	% N_2 (100-C)
1500	1900	8.0	19.1		11.1		[redacted]
↓	1910	8.0	19.1		11.1		
1734	1920	8.0	19.0		11.0		
	Avg.	8.0		Avg.	11.1		80.9

Orsat I.D. 1 Tedlar Bag I.D. 60 F_o _____

Run/Sample No. _____ Leak √ ___ Date _____ Operator _____

Time of Sample Collection	Time of Analysis	CO_2 Reading (A)	O_2 Reading (B)	CO Reading (C)	% O_2 (B-A)	% CO (C-B)	% N_2 (100-C)
1845	2155	8.0	19.1		11.1		[redacted]
↓	2205	8.0	19.0		11.0		
2055	2215	8.0	19.1		11.1		
	Avg.	8.0		Avg.	11.1		80.9

Orsat I.D. 1 Tedlar Bag I.D. 50 F_o _____

(For field check of fuel type, refer to page 2)

ENTROPY

FIELD DATA - METHOD(S) MM5

RUN NO. 1-S-MM5-29

PLANT FOSTER WHEELER CAMDEN CO. JOB NO. 10635 DATE 10/18/91

CITY/STATE CAMDEN NJ TIME START 0820

SAMPLING LOC. UNIT #1 STACK TIME FINISH 1355

BAROMETRIC PRESSURE, IN. HG 29.9 STATIC PRESSURE, IN. H_2O -.32 OPERATOR JED

LEAK CHECK, VACUUM IN. HG 15 15 15 15 ASST(S) SGD

LEAK RATE, CUBIC FEET/MIN. 0.000 0.000 0.000 0.002

EQUIPMENT CHECKS*
- ✓ PITOT, PRETEST
- ✓ PITOT, POSTTEST
- ✓ NOZZLE, PRE/POST
- ✓ TC 78 °F PRE
- ✓ TC 276 °F POST
- ✓ ORSAT SYSTEM

EQUIPMENT I.D. NUMBERS

REAGENT BOX M114 METER BOX N-27 Y 1.0095
PITOT S-15 C_p .84 NOZ'L GL-692 DIA. .274
TC READOUT E-23 TC PROBE B-187 UMBILICAL U-68
SAMPL'G BOX 53 ORSAT PUMP 3416 TEDLAR BAG 21

FILTER/XAD	TARE WT.
Q1035	.5276

NOMOGRAPH DATA

DELTA H@	1.778		
METER TEMP	85		
EST. $\%H_2O$	18%		
C FACTOR	0.761		
STACK TEMP	270		
REF DELTA P	0.568		
K FACTOR	3.237		

LEAK CHECKS

B ~~15"/000~~		B	
E		E	
B 682.428		B	
E 682.830		E	
B 703.917		B	
E 704.026		E	

FYRITES

6.5		
7		
7		

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H_2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H_2O ACTUAL	ORIFICE SETTING IN. H_2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	GAS TEMPERATURES °F IMPING. EXIT	GAS TEMPERATURES °F PROBE OR COND EXIT**	✓
1	A-1	0	656.525	.61	68	270	1.92	1.91	6	250	52	N/A	
2		5	660.19	.64	74	274	2.01	2.01	6	250	50		
3	2	10	663.07	.65	80	274	2.07	2.07	8	250	52		
4		15	667.91	.62	85	273	1.99	1.99	10	255	50		
5	3	20	671.72	.60	88	274	1.94	1.94	12	255	48		
6		25	675.52	.60	92	275	1.95	1.95	13	255	48		
7	4	30	679.42	.68	94	277	2.21	2.21	15	250	48		1
8		35	684.79	.64	88	275	2.06	2.06	10	250	52		
9	5	40	687.85	.62	90	275	2.01	2.01	10	250	50		
10		45	691.79	.64	92	276	2.09	2.09	10	250	50		
11	6	50	695.75	.65	92	276	2.11	2.11	8	250	48		
12		55	699.83	.66	92	276	2.14	2.14	8	250	48		
13	B-1	60/0	703.917	.57	88	277	1.93	1.83	4	250	52		2
14		5	707.85	.62	90	278	2.00	2.00	4	250	50		
15	2	10	711.75	.58	92	278	1.93	1.88	4	250	48		
16		15	715.61	.52	94	278	1.69	1.69	4	250	48		
17	3	20	719.31	.52	94	277	1.69	1.69	4	250	48		
18		25	722.98	.55	94	276	1.79	1.79	4	250	50		
19	4	30	726.74	.62	94	274	2.02	2.02	4	255	50		
20		35	730.68	.60	92	~~274~~	1.95	1.95	4	255	50		
21	5	40	734.60	.62	90	272	2.01	2.01	4	255	50		
22		45	738.76	.65	92	273	2.12	2.12	4	255	52		
23	6	50	742.41	.62	90	275	2.01	2.01	4	260	50		
24		~~55~~	746.38	.64	90	276	2.07	2.07	4	260	50		
25		60/~~min~~	750.349										

0826 STOP
1120 START

1148 STOP
1205 START

PORT CHANGE
1231 STOP
1240 START

1314 STOP
1321 START

1333 STOP
1340 START

* FILTER EXIT for NJ Method 1. FILTER BOX for all others.

** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

120	~~92.824~~ 93.813	.6127	89	275	1.9008
Min. (Θ)	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH

F-1112 (Page 1) 9-91

ENTROPY

FIELD DATA - METHOD(S) MM7L

PLANT FOSTER WHEELER CAMDEN CO. RUN NO. 1-S-MM7L-2
CITY/STATE CAMDEN NJ JOB NO. 10535 DATE 10-18-94
SAMPLING LOC. UNIT #1 STACK TIME START 1500
BAROMETRIC PRESSURE, IN. HG 29.9 STATIC PRESSURE, IN. H_2O -.31 TIME FINISH 1734
LEAK CHECK, VACUUM IN. HG 15 15 OPERATOR JED
LEAK RATE, CUBIC FEET/MIN. .001 .002 ASST(S) SGD

EQUIPMENT CHECKS*
- ✓ PITOT, PRETEST
- ✓ PITOT, POSTTEST
- ✓ NOZZLE, PRE/POST
- ✓ TC 81 °F PRE
- ✓ TC 252 °F POST
- ✓ ORSAT SYSTEM

EQUIPMENT I.D. NUMBERS
REAGENT BOX M114 METER BOX N-27 Y 1.0095
PITOT 9-16 C_p .84 NOZ'L S6643 DIA. .274
TC READOUT F-23 TC PROBE R-315 UMBILICAL U-68
SAMPL'G BOX 62 ORSAT PUMP 34 TEDLAR BAG 68

LEAK CHECKS
B ___ B ___ / E ___ E ___ ; B ___ B ___ / E ___ E ___ ; B ___ B ___ / E ___ E ___

FILTER/XAD	TARE WT.
Q1031	.5346

NOMOGRAPH DATA

DELTA H@	1.778
METER TEMP	85
EST. $\%H_2O$	18
C FACTOR	.761
STACK TEMP	270
REF DELTA P	.568
K FACTOR	3.237

FYRITES
7 7 ___ ; 7.5 ___ ___ ; 7 ___ ___

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H_2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H_2O ACTUAL	ORIFICE SETTING IN. H_2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	✓
1	B-1	0	750.50	.65	85	281	2.08	2.08	4	250	56	N/A	
2		5	754.53	.52	94	275	1.67	1.67	3	250	56		
3	2	10	758.11	.53	86	275	1.71	1.71	3	252	56		
4		15	761.77	.52	87	276	1.68	1.68	3	252	54		
5	3	20	765.40	.48	89	277	1.55	1.55	3	254	54		
6		25	768.93	.45	90	277	1.46	1.46	3	254	54		
7	4	30	772.39	.49	90	277	1.59	1.59	3	252	52		
8		35	775.97	.53	90	277	1.72	1.72	3	252	52		
9	5	40	779.68	.54	91	277	1.75	1.75	3	252	54		
10		45	783.42	.57	91	278	1.85	1.85	3	254	54		
11	6	50	787.25	.57	92	278	1.85	1.85	4	254	54		
12		55	791.09	.55	92	279	1.78	1.78	4	255	54		
13	A-1	60/0	794.867	.58	91	278	1.88	1.88	3	252	56		
14		5	798.67	.55	92	281	1.78	1.78	3	252	54		
15	2	10	802.50	.57	94	281	1.85	1.85	3	250	54		
16		15	806.32	.56	94	280	1.82	1.82	3	250	55		
17	3	20	810.12	.53	95	279	1.73	1.73	3	250	55		
18		25	813.89	.55	96	278	1.80	1.80	3	254	52		
19	4	30	817.72	.58	95	278	1.89	1.89	4	254	52		
20		35	821.66	.63	95	278	2.05	2.05	4	252	54		
21	5	40	825.72	.62	92	280	2.00	2.00	4	252	54		
22		45	829.73	.65	94	280	2.11	2.11	4	254	55		
23	6	50	833.93	.64	95	281	2.08	2.08	4	254	55		
24		55	838.07	.65	96	282	2.11	2.11	4	254	55		
25		60/END	824.243										

* FILTER EXIT for NJ Method 1. FILTER BOX for all others.

** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

120	91.743	.5616	91.5	278.5	1.8246
Min. (Θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH

ENTROPY

FIELD DATA - METHOD(S) MM5

RUN NO. 1-5-MM5-3

PLANT FOSTER WHEELER CAMDEN CO. JOB NO. 10535 DATE 10/18/91

CITY/STATE CAMDEN N.J. TIME START 1545

SAMPLING LOC. UNIT #1 STACK TIME FINISH 2055

BAROMETRIC PRESSURE, IN. HG 29.9 STATIC PRESSURE, IN. H_2O -.32 OPERATOR JEP

LEAK CHECK, VACUUM IN. HG 15 5 7 ASST(S) SGD

LEAK RATE, CUBIC FEET/MIN. .000 .000 .000

EQUIPMENT CHECKS*
- ✓ PITOT, PRETEST
- ✓ PITOT, POSTTEST
- ✓ NOZZLE, PRE/POST
- ✓ TC 84 °F PRE
- ✓ TC 274 °F POST
- ✓ ORSAT SYSTEM

EQUIPMENT I.D. NUMBERS

REAGENT BOX M114 METER BOX N-27 Y 1.0095

PITOT S-19 opt 23 cp .84 NOZ'L GL-643 DIA. .274

TC READOUT E-23 TC PROBE R-134 UMBILICAL U-68

SAMPL'G BOX 30 ORSAT PUMP 16 TEDLAR BAG 50

NOMOGRAPH DATA

DELTA HG	1.776
METER TEMP	85
EST. $\%H_2O$	18
C FACTOR	.761
STACK TEMP	275
REF DELTA P	0.572
K FACTOR	3.215

LEAK CHECKS

B 887.571	B	B	B
E 887.638	E	E	E
B	B	B	B
E	E	E	E
B	B	B	B
E	E	E	E

FYRITES

7.5 7

7

7

FILTER/XAD	TARE WT.
G 1029	.5185

908.24

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H_2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H_2O ACTUAL	ORIFICE SETTING IN. H_2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	✓
1	A-1	0	842.415	.52	84	275	1.67	1.67	4	255	56	N/A	
2		5	846.08	.55	90	277	1.78	1.78	4	255	55		✓
3	2	10	849.78	.59	92	277	1.92	1.92	4	254	54		
4		15	853.68	.55	94	278	1.79	1.79	4	254	54		
5	3	20	857.47	.54	96	277	1.77	1.77	4	252	52		
6		25	861.24	.51	96	277	1.67	1.67	4	252	52		
7	4	30	864.90	.50	96	276	1.64	1.64	4	252	52		
8		35	868.56	.52	97	275	1.71	1.71	4	250	53		
9	5	40	872.27	.57	98	275	1.88	1.88	4	252	53		
10		45	876.18	.59	100	276	1.95	1.95	5	252	54		
11	6	50	880.12	.56	100	277	1.84	1.84	5	252	54		
12		55	883.92	.50	101	277	1.65	1.65	4	254	52		
13	B-1	60/0	887.571	.67	99	278	2.20	2.20	5	252	55		
14		5	891.65	.70	100	279	2.30	2.30	6	254	53		
15	2	10	896.13	.60	102	279	1.98	1.98	5	254	53		
16		15	900.11	.63	102	278	2.08	2.08	5	254	52		
17	3	20	904.14	.63	103	277	2.09	2.09	5	252	52		
18		25	908.24	.61	104	277	2.02	2.02	5	252	52		
19	4	30	912.27	.66	104	276	2.19	2.19	5	250	54		
20		35	916.42	.60	104	277	1.99	1.99	5	250	54		
21	5	40	920.41	.53	104	277	1.76	1.76	5	252	56		
22		45	924.19	.54	102	276	1.79	1.79	5	252	55		
23	6	50	927.98	.52	102	275	1.72	1.72	5	252	54		
24		55	931.74	.52	101	275	1.72	1.72	5	250	54		
25		60/off	935.476										

* FILTER EXIT for NJ Method 1. FILTER BOX for all others.

** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

120	93.061	.5699	99.8	276.7	1.8796
Min. (θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH

92.194

ENTROPY

MOISTURE SAMPLING LABORATORY RESULTS

Plant Name:CAMDEN COUNTY ENERGY RECOVERY ASSOCIATES EEI Ref# 10535

Sampling Location: UNIT #1 STACK

Date Received: 10/29/91 Date Analyzed:10/18/91 Reagent Box(es): M114

Run Number	1-S-MMTL-1	1-S-MMTL-2	1-S-MMTL-3
Run Date	10/18/91	10/18/91	10/18/91
ANALYSIS OF MOISTURE CATCH			
Reagent 1 (5%HNO3/10%H2O2)			
Final Weight, g.	609.5	618.0	632.5
Tared Weight, g.	266.5	265.0	265.5
Water Catch,g.	343.0	353.0	367.0
Reagent 2 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch,g.	0.0	0.0	0.0
Reagent 3 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch,g.	0.0	0.0	0.0
CONDENSED WATER, g.	343.0	353.0	367.0
Silica Gel:			
Final Weight, g.	218.0	224.0	239.0
Tared Weight, g.	200.0	204.5	202.0
ADSORBED WATER, g.	18.0	19.5	37.0
TOTAL WATER COLLECTED, g.	361.0	372.5	404.0

MOISTURE SAMPLING LABORATORY RESULTS

Plant Name:CAMDEN COUNTY ENERGY RECOVERY ASSOCIATES EEI Ref# 10535

Sampling Location: UNIT #1 INLET AND STACK

Date Received: 10/29/91 Date Analyzed: 10/18/91 Reagent Box(es): M136

Run Number	1-S-MMTL-FB	1-I-MMTL-FB
Run Date	10/18/91	10/18/91

ANALYSIS OF MOISTURE CATCH

Reagent 1 (H2O)		
Final Weight, g.	270.5	270.5
Tared Weight, g.	271.0	271.0
Water Catch,g.	-0.5	-0.5
Reagent 2 ( )		
Final Weight, g.		
Tared Weight, g.		
Water Catch,g.	0.0	0.0
Reagent 3 ( )		
Final Weight, g.		
Tared Weight, g.		
Water Catch,g.	0.0	0.0
CONDENSED WATER, g.	-0.5	-0.5
Silica Gel:		
Final Weight, g.		
Tared Weight, g.		
ADSORBED WATER, g.	0.0	0.0
TOTAL WATER COLLECTED, g.	-0.5	-0.5

OL # 910366

pg 1 of 2 of 4

SAMPLE SUBMISSION FORM
Oxford Laboratory

Submitted By | Date Submitted 10-22-91 | Date Requested 11-5-91

Company Name Entropy | Attention Rick Sullivan

Address | State | Zip Code

Telephone | Received By

No. of Samples & Identification: Purchase Order# 1781-10535

1.	1-S-mm TL-1	(7)	1-I-mm TL-1
2.	2	(8)	2
3.	2 Duplicate	(9)	2 Duplicate
4.	3	(10)	3
5.	3 Spike	(11)	3 Spike
6.	FB	(12)	FB

Analyses Requested and Special Instructions: DL - 20 ug/g

Custody →

Results:	(1)	(2)	(3)	(4)	(5)	(6)
Lead Total ug/g	44.0	< 20.0	< 20.0	< 20.0	100%	< 20.0
			$\bar{X}$ = 28250			
	(7)	(8)	(9)	(10)	(11)	(12)
Lead	21400	27900	28600	36500	100%	< 20.0

OL # 9110367

Pg 2 of 2

35

SAMPLE SUBMISSION FORM
Oxford Laboratory

Submitted By .Date Submitted 10-22-91 Date Requested

Company Name Entropy Attention

Address State Zip Code

Telephone Received By

No. of Samples & Identification: Purchase Order#

(13) Blanks

(4) Mixed Code

3.

4.

5.

6.

Analyses Requested and Special Instructions:

Results:	(13)	(4)	3	4	5	6
add Totals	< 20.0	SW846 7420				

A.A. SUMMARY REPORT

% MT. STDS
CONC STDS
.100 INST LIMIT
1 SPK LEVEL
1.00 MAX ALIQUOT
.1 M.D.L.

[: ENTROPY
P.u.s/PROJECT #:1781-10535
ANALYST: KEN SMITH
DATE: 10/28/91

SAMPLE I.D.	EL	MEAN ABS	ug/ml CONC	SAMPLE ALIQUOT	F.V. / DILUTION	TOTAL ug ANSWER	% REC OR <	SPIKE LEVEL
3667-01	Pb	.0025571	.22	1	200	44.0		
3667-02	Pb	.0002185	.02	1	200 <		20.0	
3667-03	Pb	.0007468	.07	1	200 <		20.0	
3667-04	Pb	.0003522	.03	1	200 <		20.0	
3667-05-#04SPK	Pb	.0114054	1	1	400	400	100	1
3667-06	Pb	.0008137	.07	1	200 <		20.0	
3667-07	Pb	.0623239	5.34	1	4000	21360		
3667-08	Pb	.0819021	6.97	1	4000	27880		
3667-09	Pb	.0840422	7.14	1	4000	28560		
3667-10	Pb	.1084626	9.13	1	4000	36520		
3667-11-#10SPK	Pb	.1147851	9.63	1	4000	38520	100	.5
3667-12	Pb	.0009497	.08	1	200 <		20.0	
3667-13	Pb	-.000018	0	1	200 <		20.0	
AG Position 3	Pb	.0466448	4.03	0	0			
AG Position 3	Pb	.0465021	4.01	0	0			
AG Position 3	Pb	.0464375	4.01	0	0			
AG Position 3	Pb	.0459738	3.97	0	0			
[	Pb	-.000375	-.03	0	0			
Blank	Pb	-.000183	-.02	0	0			
Blank	Pb	.0006576	.06	0	0			
Blank	Pb	-.000609	-.05	0	0			
D.L.=	Pb	.0009497	.08	0	0			
OLI BLK	Pb	.0004436	.04	0	0			
PE KNOWN	Pb	.0124019	1.09	1	1	1.09		
Std 1=.50ug/ml	Pb	.0055868	.51	0	0			
Std 2=4.0ug/ml	Pb	.0476413	4.26	0	0			
Std 3=10.0ug/ml	Pb	.1181336	8.99	0	0			
Std Blank	Pb	-.000051	0	0	0			

RECORD OF CUSTODY, CONTAINER NO. M114

Container Type (check) ✓ Reagent Box __Cooler __Other (specify) _____

Plant Name/Address CCRA

Job No. 10535 Sampling Method MMTL-Pb (EPA, NIOSH, etc.)

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
395	10-10	9:15	S	Robyl Bly.	
	10-17	1:10	B	[signature]	Change Lanes
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

* S = Sealed By; B = Broken By ** Use "REMARKS" Section if more space needed.

Received by Sample Custodian

[signature] 10-21-91 9:50 Seal Intact? Yes ✓ No__

Signature Date Time

As Applicable:
All liquid levels at mark (check)? __ YES __ NO (Estimate loss if not at mark; describe in "REMARKS")

As Applicable:
TUBE SAMPLES put in freezer by _____ Date _____ Time _____

CONDENSATE SAMPLES put in refrige. by _____ Date _____ Time _____

REMARKS DF

L-0023 rev. 9-91

ENTROPY

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. M114 Assembly Date 10/9/91 Assembled By dlk

Plant Name/address CCGPA, CAMDEN, NJ Job No. 10535

Sampling Loc. STACK - UNIT 1 Method MMTL-PO

Individual Tare Of Reagent 200 (Ml) (~~gm~~) Of 5% HNO_3 / 10% H_2O_2

Individual Tare Of Reagent _____ (Ml) (gm) Of _____

Individual Tare Of Reagent _____ (Ml) (gm) Of _____

Individual Tare Of Sil. Gel ~200 Gm _____ other (specify)

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
1-S-MMTL-1	10-15	N/A		✓	[illegible]	10-15	50	[illegible]	✓
1-S-MMTL-2	10-15	N/A		✓	[illegible]	10-17	45	[illegible]	✓
1-S-MMTL-3	10-15			✓	[illegible]	10-17	45	[illegible]	✓

Filter Appearance* Clean - 3

Reagents Appearance* Clear

Filter Appearance* Clean

Reagents Appearance* Clear

Filter Appearance* Clean

Reagents Appearance* Clear

Filter Appearance* _____

Reagents Appearance* _____

* Use "REMARKS" section if needed.

@ All liquid levels at mark? (check) YES ___ NO ___ (estimate loss if not at mark; use "REMARKS" section).

REMARKS _____

Custodian DR PSA Date 10-21-91 Time 9:50

ENTROPY

RECORD OF CUSTODY, CONTAINER NO. M136

Container Type (check) ✓ Reagent Box __ Cooler __ Other (specify) _____

Plant Name/Address CDERA; Cayce, S.C.

Job No. 10585 Sampling Method MMTC/MB (EPA, NIOSH, etc.)

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
649	10-10	9:15	S	Bobby L. Bell Jr.	
	10-15	8:20	B	Bobby L. Bell Jr.	Change Blanks
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

* S = Sealed By; B = Broken By ** Use "REMARKS" Section if more space needed.

Received by Sample Custodian

DR P.A. Signature

10-21-91 Date

9:45 Time

Seal Intact? Yes ✓ No __

As Applicable:
All liquid levels at mark (check)? __ YES __ NO (Estimate loss if not at mark; describe in "REMARKS")

As Applicable:
TUBE SAMPLES put in freezer by _____ Date _____ Time _____

CONDENSATE SAMPLES put in refrige. by _____ Date _____ Time _____

REMARKS _____

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. M136 Assembly Date 10/9/91 Assembled By dlk

Plant Name/address CLEAT Job No. 10535

Sampling Loc. UNIT 1 STACK OUTLET Method MM5L/M26

Individual Tare Of Reagent 200 (Ml) ~~(gm)~~ Of 5% HNO_3 / 10% H_2O_2

Individual Tare Of Reagent _____ (Ml)(gm) Of _____

Individual Tare Of Reagent _____ (Ml)(gm) Of _____

Individual Tare Of Sil. Gel ~200 Gm _____ other (specify)

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
1-S-MM5L-FB	10-18			✓	JHS	10-18	0	—	JHS
1-I-MM5L-FB	10-18			✓	JHS	10-18	0	—	JHS
DEADWT BLANKS	10-18								

Filter Appearance* Clean

Reagents Appearance* Clean

Filter Appearance* Clean

Reagents Appearance* Clean

Filter Appearance*

Reagents Appearance*

Filter Appearance*

Reagents Appearance*

* Use "REMARKS" section if needed.

@ All liquid levels at mark? (check) YES ___ NO ___ (estimate loss if not at mark; use "REMARKS" section).

REMARKS _____

Custodian DLR Date 10-21-91 Time 9:40

ENTROPY

ENTROPY
Environmentalists, Inc.

P.O. Box 12291
Research Triangle Park
North Carolina 27709-2291
919-781-3550 FAX 919-787-8442

REQUEST FOR ANALYSIS

PO#: 1781-10535

Customer Name: Camden Co. RRF
Camden, NJ

Laboratory: OLI

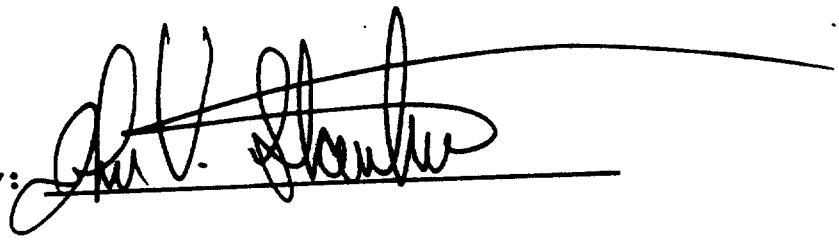
Date Transmitted: 10/21/91

Results Due By: 11/05/91

Sample Matrix: MMTL

Analysis: Analyze for Pb by MMTL method. [detection limit = 20μg]

Sample #	Sample ID	Components/Comments
1	1-S-MMTL-1	-FH,-BH,-F,-R
2	1-S-MMTL-2	-FH,-BH,-F,-R
3	1-S-MMTL-2	duplicate analysis
4	1-S-MMTL-3	-FH,-BH,-F,-R
5	1-S-MMTL-3	matrix spike
6	1-S-MMTL-FB	-FH,-BH,-F,-R
7	1-I-MMTL-1	-FH,-BH,-F,-R
8	1-I-MMTL-2	-FH,-BH,-F,-R
9	1-I-MMTL-2	duplicate analysis
10	1-I-MMTL-3	-FH,-BH,-F,-R
11	1-I-MMTL-3	matrix spike
12	1-I-MMTL-FB	-FH,-BH,-F,-R
13	Blanks	HNO3/H2O2, 0.1N HNO3, filter

Submitted By: 

APPENDIX C

CALIBRATION DATA

SAMPLING EQUIPMENT AUDIT

Plant Name Foster Wheeler Enviresponse, Inc. CAMDEN CO.-RRF Job No. 10535-1

City/State Camden, New Jersey Auditor(s) RFH + WEM

Test Loc. Inlet - Unit 1 Date 10-17-91

BAROMETER
Entropy In-House Ref. Barometer 29.6 "Hg vs Field Barometer 29.7 "Hg

Date Compared 10-17-91 Dev. 0.1 "Hg (Max. Allowable Dev.: ± 0.1 "Hg)

Ref. Therm. Initial Ambient Temp., °F 71

	Allowable Deviation From Ambient	Ambient Temperature, °F					Audit OK (√)
THERMOMETERS *							
Dry Gas Meter	± 5.4 °F	74	(Meterbox No. N-23)				✓
Impinger Exit	± 2.0 °F	70	—	—	—	—	—
Filter Box	± 5.4 °F	72	—	—	—	—	—

* Adjust thermometer until acceptable. If it cannot be adjusted, use as backup. If no backup, record ambient temperature indicated by unadjusted thermometer and label with correction factor (indicate):

THERMOCOUPLES Allowable Deviation from Ambient: ± 8.0°F* (± 2.0°F)**

TC No./ °F	√ OK	TC No./ °F	√ OK	TC No./ °F	√ OK	TC No./ °F	√ OK	TC No./ °F	√ OK
R271 / 70	✓	/	—	/	—	/	—	/	—

* ± 8.0 °F = ± 1.5% of ambient absolute temperature.
** (± 2.0 °F if used in saturated or water droplet-laden gas stream.)

ISOKINETIC METERBOX I.D. N-23 Gamma (Y) 0.9823 ΔH@ 1.827

As Applicable (check): Zero Magnehelics? ✓ Zero/Level Manometer? NA

Barometric Pressure (P_{bar}) 29.5 Auditor RFH Date 10-17-91

Dry Gas Meter Reading (Cubic Ft.)	Meter Temperature (°F)	Lower and Upper Limits for Audit Gamma
Final 729.402	Final 78	0.96 * Y = 0.943008
Initial 721.784	Initial 74	1.04 * Y = 1.021592

Dry Gas Volume Metered (Cubic Ft.)	Average Meter Temp. (°F)	Run Time (Base = 10)	
		(Minutes)	(Seconds)
Vm = 7.618	Tm = 76	10	0

$$Y_c = \frac{[\text{Min.} + (\text{Sec.} / 60)]}{Vm} * \left[\frac{0.0319\ (Tm + 460)}{P_{bar}}\right]^{1/2}$$

$$Y_c = \frac{[10 + (0 / 60)]}{7.618} * \left[\frac{0.0319\ (76 + 460)}{29.5}\right]^{1/2} = \underset{\text{Audit Gamma}}{0.9993687}$$

Audit Gamma Acceptable (between lower & upper limits)? (√) ✓ Yes ___ No

F-1113 9-91

ENTROPY

SAMPLING EQUIPMENT CHECKLIST

Plant Name/Address FOSTER WHEELER CAMDEN CO. Job No. 10535

Sampling Location UNIT #1 STACK Team Leader SGD

BAROMETER CHECK

Date	Entropy In-House Reference Barometer	Field Barometer	Check OK?*
10-16-91	29.8	29.8	✓

* ± 0.1" Mercury

THERMOMETERS AND THERMOCOUPLE CHECK

Date 10-18-91 | Reference Thermometer Ambient Temperature, °F 78°F

	Ambient Temperature, °F	Acceptance Range, °F	Check OK?
Thermometers Impinger Exit	78°F	± 2.0	✓
Filter Box	78°F	± 5.4	✓
Dry Gas Meter	77°F	± 5.4	✓

Adjust thermometer until acceptable. If it cannot be adjusted, use as back-up. If no backup, record ambient temp. indicated by unadjusted thermometer.

Thermocouple	78°F	± 8.0* (± 2.0)**	✓

* ± 1.5% of Absolute Temperature.

** Acceptance range is ± 2.0°F if used in saturated or water droplet-laden gas stream.

PITOT AND NOZZLE CHECK

Pitot No.	Visual Check	Nozzle No.	Visual Check
S-15	✓	GL-692	✓
S-19	✓	GL-643	✓

Dry Gas Meter Identification: 1017057 Calibration by: WLS

Date: 1-15-91 Barometric Pressure (P_b): 29.58 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

Approx. Flow Rate (Q) cfm	Spirometer		Dry Gas Meter		Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	Gas Volume (V_s) ft^3	Temp. (t_s) °F	Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F					
	2.5956	77.0	2.549	70.5	-0.40	10	0.2522	1.0070 ~~1.0066~~	
	2.6047	77.0	2.526	72.0	-0.40	10	0.2531	1.0226	
	2.5592	77.0	2.462	73.0	-0.40	10	0.2487	1.0328	
	4.4080	77.0	4.339	74.0	-0.62	11	0.3894	1.0118	
	4.0619	77.0	3.973	74.0	-0.62	10	0.3947	1.0182	
	3.9799	77.0	3.953	75.0	-0.62	10	0.3867	1.0046	
	4.8178	77.0	4.800	75.0	-0.80	10	0.4681	1.0020	
	4.8634	77.0	4.770	75.0	-0.80	10	0.4726	1.0178	
	4.8634	77.0	4.794	76.0	-0.80	10	0.4726	1.0146	
	7.8142	77.0	7.711	76.0	-1.70	10	0.7693	1.0158	
	7.7596	77.0	7.693	76.0	-1.70	10	0.7540	1.0111	
	7.7140	77.0	7.684	76.0	-1.70	10	0.7496	1.0063	
	10.0000	77.0	9.979	76.0	-2.10	10	0.9717	1.0055	
	9.8725	77.0	9.850	76.0	-2.10	10	0.9593	1.0057	
	9.8178	77.0	9.845	76.0	-2.10	10	0.9540	1.0006	
	11.5392	77.0	11.591	76.0	-3.40	10	1.1212	1.0021	

$$Y_{ds} = \frac{(V_s)\ (t_{ds} + 460)\ (P_b)}{(V_{ds})\ (t_s + 460)\ (P_b + (\ p\ /\ 13.6))}$$

$$Q = (17.64)\ \frac{(P_b)\ (V_s)}{(t_s + 460)\ (9)}$$

Dry Gas Meter Identification: 1017057 Calibration by: WLS

Date: 1-15-91 Barometric Pressure (P_b): 29.58 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

Approx. Flow Rate (Q) cfm	Spirometer		Dry Gas Meter		Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	Gas Volume (V_s) ft^3	Temp. (t_s) °F	Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F					
	11.5118	77.0	11.592	76.0	- 3.40	10	1.1186	0.9997	
	11.5027	77.0	11.606	76.0	- 3.40	10	1.1177	0.9977	
	12.7413	77.0	12.871	76.0	- 4.40	10	1.2380	0.9990	
	12.6867	77.0	12.805	76.0	- 4.40	10	1.2327	0.9999	
	12.6685	77.0	12.784	76.0	- 4.40	10	1.2310	1.0001	

$\bar{Y}_{ds}$ = 1.0083

$$Y_{ds} = \frac{(V_s)\,(t_{ds} + 460)\,(P_b)}{(V_{ds})\,(t_s + 460)\,(P_b + (p / 13.6))}$$

$$Q = (17.64)\,\frac{(P_b)\,(V_s)}{(t_s + 460)\,(9)}$$

Dry Gas Meter Identification: 1054682 Calibration by: WLS

(Page 1 of 2)

Date: 7-18-90 Barometric Pressure (P_b): 30.04 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

Approx. Flow Rate (Q) cfm	Spirometer		Dry Gas Meter		Pressure (Δp) in. H_2O	Time (θ) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	Gas Volume (V_s) ft^3	Temp. (t_s) °F	Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F					
	2.6230	79	2.602	80	0.51	10	0.2579	1.0089	1.0087
	2.6503	79	2.579	80	0.51	10	0.2606	1.0283	1.0283
	2.6503	79	2.563	80	0.51	10	0.2606	1.0347	1.0347
	4.0802	79	3.989	80	0.91	10	0.4011	1.0225	1.0285
	4.0528	79	3.922	80	0.91	10	0.3984	1.0330	1.0330
	4.0164	79	3.915	80	0.91	10	0.3949	1.0255	1.0255
	4.8452	79	4.696	81	1.40	10	0.4763	1.0321	1.0320
	4.8452	79	4.669	81	1.40	10	0.4763	1.0380	1.0380
	4.7996	79	4.645	81	1.40	10	0.4719	1.0336	1.0335
	7.9235	79	7.802	81	2.60	10	0.7790	1.0129	1.0129
	7.8780	79	7.880	81	2.60	10	0.7745	0.9971	0.9971
	7.9508	79	7.922	81	2.60	10	0.7817	1.0010	1.0010
	10.146	79	10.184	82	4.40	10	0.9975	0.9911	0.9911
	10.164	79	10.224	82	4.40	10	0.9993	0.9890	0.9890
	10.127	79	10.213	82	4.40	10	0.9956	0.9865	0.9865
	11.676	79	11.874	83	5.50	10	1.1479	0.9775	0.9774

$$Y_{ds} = \frac{(V_s)\ (t_{ds} + 460)\ (P_b)}{(V_{ds})\ (t_s + 460)\ (P_b + (p / 13.6))}$$

$$Q = (17.64)\ \frac{(P_b)\ (V_s)}{(t_s + 460)\ (\theta)}$$

Dry Gas Meter Identification: 1054682 Calibration by: WLS

(Page 2 of 2)

Date: 7-18-90 Barometric Pressure (P_b): 30.04 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

Approx. Flow Rate (Q) cfm	Spirometer		Dry Gas Meter		Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	Gas Volume (V_s) ft^3	Temp. (t_s) °F	Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F					
	11.612	79	11.807	83	5.50	10	1.1416	0.9776	0.9776
	11.594	79	11.833	83	5.50	10	1.1398	0.9740	0.9739
	12.796	82	13.133	84	6.50	10	1.2510	0.9626	0.9626
	12.805	82	13.122	84	6.50	10	1.2519	0.9641	0.9641
	12.787	82	13.095	84	6.50	10	1.2502	0.9647	0.9647

$Y_{ds} = 1.0026$

$$Y_{ds} = \frac{(V_s)\,(t_{ds} + 460)\,(P_b)}{(V_{ds})\,(t_s + 460)\,(P_b + (\Delta p / 13.6))}$$

$$Q = (17.64)\,\frac{(P_b)\,(V_s)}{(t_s + 460)\,(9)}$$

Dry Gas Meter Identification: 1054682 Calibration by: WLS

Date: 8-14-91 Barometric Pressure (P_b): 29.82 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

	Spirometer		Dry Gas Meter							
	Gas Volume (V_s) ft^3	Temp. (t_s) °F	Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F	Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q)	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	2.76	75	2.808	74	-.26	10	.23	.9874	NA
	2.75		2.783	74	-.26		.23	.9869	
	2.76		2.788	74	-.26		.23	.9845	
	4.098		4.172	76	-.74		.55	.9859	
	4.089		4.149	76	-.74		.55	.9892	
	4.089		4.139	76	-.74		.55	.9916	
	4.927		4.988	76	-.60		.80	.9911	
	5.009		5.039	76	-.60		.80	.9974	
	4.964		5.024	76	-.60		.80	.9914	
	8.097		8.161	77	-1.4		2.10	1.0040	
	8.078		8.183	77	-1.4		2.10	.9970	
	7.987		8.110	77	-1.4		2.10	.9919	
	10.383		10.507	77	-2.1		3.45	.9971	
	10.300		10.423	77	-2.1		3.45	.9971	
	10.300		10.426	77	-2.1		3.45	.9968	
	12.523		12.685	78	-3.2		4.30	1.0007	

$$Y_{ds} = \frac{(V_s)\ (t_{ds} + 460)\ (P_b)}{(V_{ds})\ (t_s + 460)\ (P_b + (\ p\ /\ 13.6))}$$

Dry Gas Meter Identification: 1054682 Calibration by: WLS

Date: 8-14-91 Barometric Pressure (P_b): 29.82 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

*Date: _____ *Barometric Pressure (P_b): _____ in. Hg

	Spirometer		Dry Gas Meter						
	Gas Volume (V_s) ft³	Temp. (t_s) °F	Gas Volume (V_{ds}) ft³	Temp. (t_{ds}) °F	Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q)	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	12.259	75	12.456	78	- 2.9	10	4.70	.9968	NA
	12.077	↓	12.277	78	- 2.9	↓	4.70	.9964	↓
	13.661		13.895	78	- 3.6		5.80	.9975	
	13.682		13.894	78	- 3.6		5.80	.9969	
	13.452	↓	13.712	78	- 3.6	↓	5.80	.9954	↓

Y_{ds} = .9940

$$Y_{ds} = \frac{(V_s)\ (t_{ds} + 460)\ (P_b)}{(V_{ds})\ (t_s + 460)\ (P_b + (\ p\ /\ 13.6))}$$

ISOKINETIC METERBOX FULLTEST CALIBRATION

Meterbox No. N23

Calibrated By MBC/SWS

Date 9-13-91

Barometric Pressure (P_b) 29.58 (In. Hg)

Date _____*

Barometric Pressure (P_b) _____ (In. Hg)*

Standard Meter No. 10170577

Standard Meter Coefficient 1.0083

STANDARD METER			METERBOX METERING SYSTEM				
Gas Volume (V_{ds}) cf	Temp. (t_{ds}) °F	Time (θ) Min.	Orifice Setting (ΔH) In. H2O	Gas Volume (V_d) cf	Temp. (t_d) °F	Coeff. (Y_d)	$\Delta H\theta$ In. H_2O
4.679	78	12	0.5	4.901	86	.9757	1.838
6.193	78	16	0.5	6.518	88	.9746	1.858
7.794	77		2.0	8.152	91	.9843	1.816
7.811	↓	↓	2.0	8.210	95	.9830	1.802
12.007			4.8	12.512	93	.9882	1.824
12.042	↓	↓	4.8	12.459	91	.9882	1.826
					Average	.9823	1.827

1. Coefficient range: 0.97-1.03.
2. Coefficient tolerance: for individual runs, ± 0.02 from average.
3. $\Delta H\theta$ range: 1.6-2.0.
4. $\Delta H\theta$ tolerance: ≤ 0.15 In. H_2O over ΔH range of 0.4 In.-4.0 In.

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + (\Delta H / 13.6))}$$

$$\Delta H\theta = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

ISOKINETIC METERBOX POSTTEST CALIBRATION

METERBOX NO. N27

Date 11-5-91 Calibrated By MBC/SWS Job Number 10535

Barometric Pressure (P_b) 29.79 (In. Hg) Meterbox Vacuum 15 (In. Hg)

Standard Meter No. 1054682 Standard Meter Coefficient .9940

STANDARD METER			METERBOX METERING SYSTEM				
Gas Volume (V_{ds}) cf	Temp. (t_{ds}) °F	Time (Θ) Min.	Orifice Setting (ΔH) In. H2O	Gas Volume (V_d) cf	Temp. (t_d) °F	Coeff. (Y_d)	ΔH@ In. H_2O
7.714	70	10	1.9	7.968	88	.9904	1.763
7.707	↓	↓	↓	8.061	99	.9977	1.731
7.722	↓	↓	↓	8.104	101	.9979	1.718
					Average	.9953	1.737

Fulltest Y_d 1.0095 Date 5-8-91 % Dev. 1.4 Allowed Dev.: ± 5%

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + \{\Delta H / 13.6\})}$$

$$\Delta H@ = \frac{0.0319 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \Theta}{Y_{ds} * V_{ds}} \right]^2$$

ISOKINETIC METERBOX FULLTEST CALIBRATION

Meterbox No. N27

Calibrated By MBC/KWS

Date 5-8-91

Barometric Pressure (P_b) 29.9 (In. Hg)

Date _____*

Barometric Pressure (P_b) _____ (In. Hg)*

Standard Meter No. 1054682

Standard Meter Coefficient 1.0026

STANDARD METER			METERBOX METERING SYSTEM				
Gas Volume (V_{ds}) cf	Temp. (t_{ds}) °F	Time (θ) Min.	Orifice Setting (ΔH) In. H2O	Gas Volume (V_d) cf	Temp. (t_d) °F	Coeff. (Y_d)	$\Delta H@$ In. H_2O
3.965	72	10	0.5	4.071	86	1.0010	1.739
3.958	↓	10	0.5	4.070	88	1.0031	1.739
15.604		20	2.0	15.901	92	1.0159	1.722
7.711		10	2.0	7.962	96	1.0098	1.806
11.948		10	4.8	12.294	99	1.0119	1.796
11.861	↓	10	4.8	12.232	102	1.0150	1.812
					Average	1.0095	1.778

1. Coefficient range: 0.97-1.03.
2. Coefficient tolerance: for individual runs, ± 0.02 from average.
3. $\Delta H@$ range: 1.6-2.0.
4. $\Delta H@$ tolerance: ≤ 0.15 In. H_2O over ΔH range of 0.4 In.-4.0 In.

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + (\Delta H / 13.6))}$$

$$\Delta H@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

ISOKINETIC METERBOX POSTTEST CALIBRATION

METERBOX NO. N23

Date 11-5-91 Calibrated By MBC/GWS Job Number 10535

Barometric Pressure (P_b) 29.26 (In. Hg) Meterbox Vacuum 17 (In. Hg)

Standard Meter No. 1054682 Standard Meter Coefficient .9940

STANDARD METER			METERBOX METERING SYSTEM				
Gas Volume (V_{ds}) cf	Temp. (t_{ds}) °F	Time (θ) Min.	Orifice Setting (ΔH) In. H2O	Gas Volume (V_d) cf	Temp. (t_d) °F	Coeff. (Y_d)	ΔH@ In. H_2O
6.813	70	11	1.2	7.146	84	.9698	1.741
6.177	↓	10	↓	6.546	88	.9670	1.738
6.140	↓	10	↓	6.519	91	.9704	1.749
					Average	.9691	1.743

Fulltest Y_d .9823 Date 9-13-91 % Dev. 1.4 Allowed Dev.: ± 5%

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + (\Delta H / 13.6))}$$

$$\Delta H@ = \frac{0.0319 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}} \right]^2$$

ON-SITE DRY GAS METER AUDIT

Plant Name FOSTER WHEELER CAMDEN CO. Job Number 10535

Date 10/17/91 Meter Box Identification Number N-27

Time 1420 Fulltest Gamma (Y) 1.0095 $\Delta H_@$ 1.778

Auditor SGD Barometric Pressure (P_{bar}) 29.4 In. Hg

As Applicable:

Zero Magnehelics? (check) ✓

Zero/Level Manometer? (check) NA

Dry Gas Meter Reading (ft^3)	Meter Temperature (°F)	Upper and Lower Limits for Audit Gamma
Initial 648.218	Initial 76	0.96 * Y = .96912
Final 655.726	Final 76	1.04 * Y = 1.04988

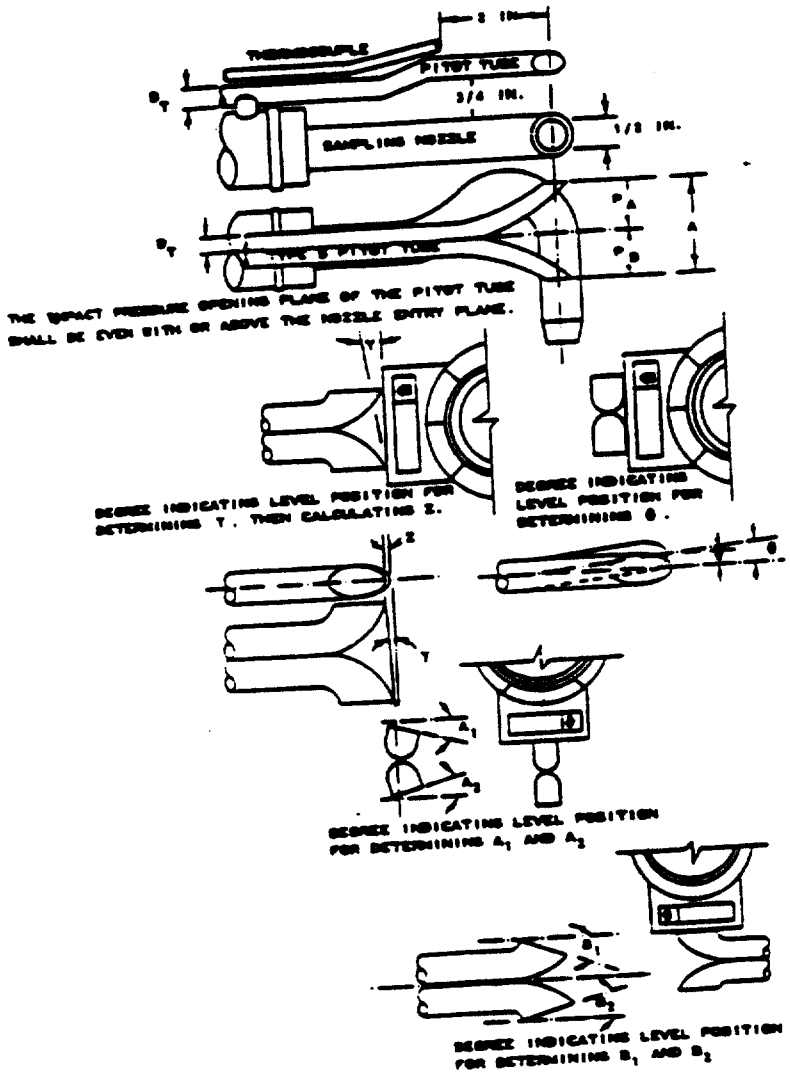
Dry Gas Volume Metered (ft^3)	Average Meter Temperature (°F)	Run Time (Base = 10)	
		(Min.)	(Sec.)
Vm = 7.508	Tm = 76	10	0

$$Y_c = \frac{[\text{Min.} + (\text{Sec.} / 60)]}{Vm} * \left[\frac{0.0319\ (Tm + 460)}{P_{bar}}\right]^{0.5}$$

$$Y_c = \frac{[10 + (0 / 60)]}{7.508} * \left[\frac{0.0319\ (76 + 460)}{29.4}\right]^{0.5} = \frac{1.01573}{\text{Calculated Audit Y}}$$

Audit Gamma Within Acceptable Limits? Yes ✓ No ___

PITOT TUBE INSPECTION DATA SHEET



level?	Yes
obstructions?	None
damaged?	None
$-10^\circ < \alpha_1 < +10^\circ$	1
$-10^\circ < \alpha_2 < +10^\circ$	1
$-5^\circ < \beta_1 < +5^\circ$	2
$-5^\circ < \beta_2 < +5^\circ$	1
γ	0
θ	0
A	1.040
$1.05\ D_t < P_a < 1.5\ D_t$	.531
$1.05\ D_t < P_b < 1.5\ D_t$	.509
$3/16" < D_t < 3/8"$	.375
$A \tan \gamma < 0.125"$	0
$A \tan \theta < 0.03125"$	0
$P_a = P_b \pm 0.063"$	Yes

Comments: _____

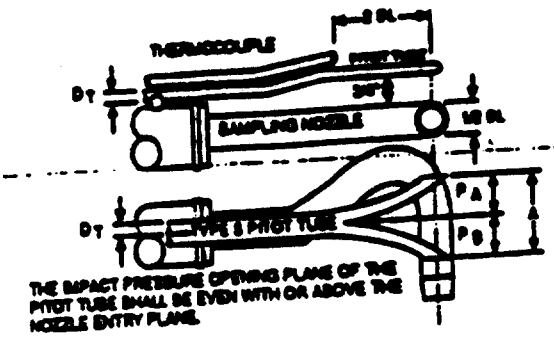
I certify that pitot tube/probe number 8-9 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube calibration factor of 0.84.

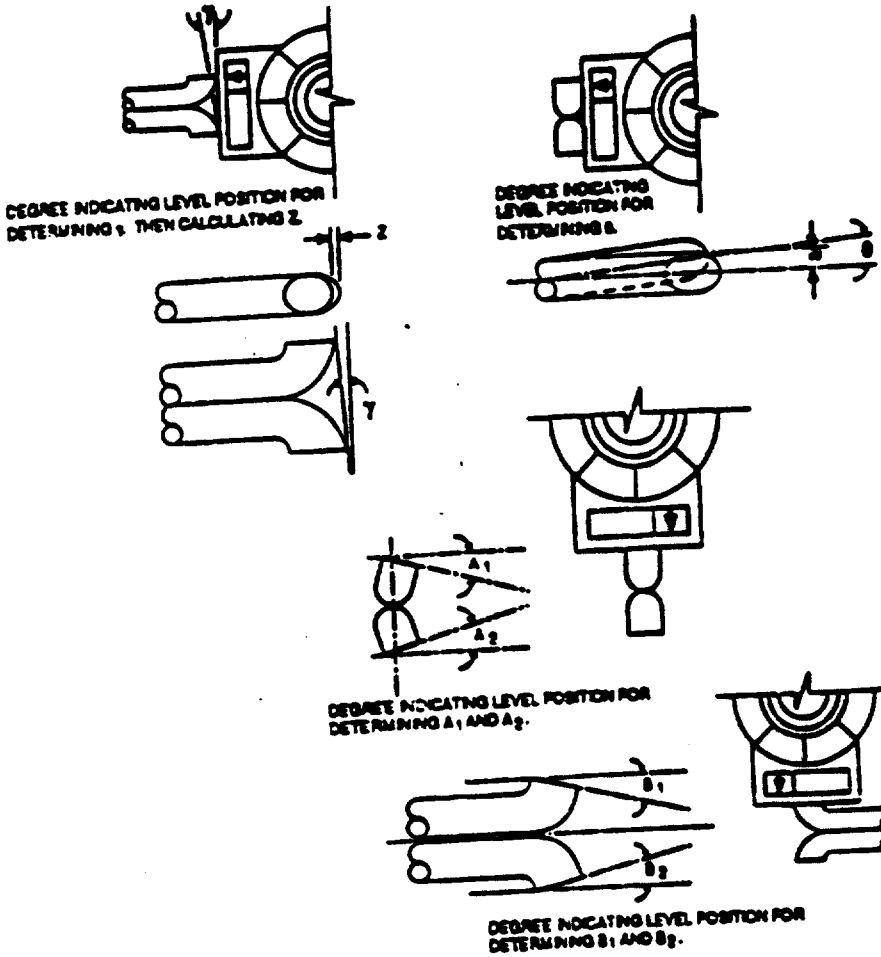
Signature W.D. Shrull

Date 8-2-99

*SEE 40 CFR 60, VOL.42 NO. 160 METHOD 2. VERIFY THE MINIMUM 2 INCH SETBACK OF THE THERMOCOUPLE AND THE MINIMUM 3/4 INCH SEPARATION BETWEEN THE PITOT TUBE AND THE NOZZLE AS SHOWN AT THE TOP OF THIS PAGE.

PITOT TUBE INSPECTION





level?	YES
obstructions?	NONE
damaged?	NONE
$-10° < \alpha_1 < +10°$	0
$-10° < \alpha_2 < +10°$	0
$-5° < \beta 1 < +5°$	0
$-5° < \beta 2 < +5°$	0
γ	0
θ	0
A	.991
$1.05\ D_t < P_a < 1.5\ D_t$	.495
$1.05\ D_t < P_b < 1.5\ D_t$	.496
$3/16" < D_t < 3/8"$	.375
A tan γ < 0.125"	.017
A tan θ < 0.03125"	0
$P_a = P_b \pm 0.063"$	YES .001

See 40 CFR 60, Vol. 42 No. 160 EPA Method 2. Verify the minimum 2-inch setback of the thermocouple and the minimum 3/4-inch separation between the pitot tube and the nozzle as shown at the top of this page.

Comments: Must-fixed NEW

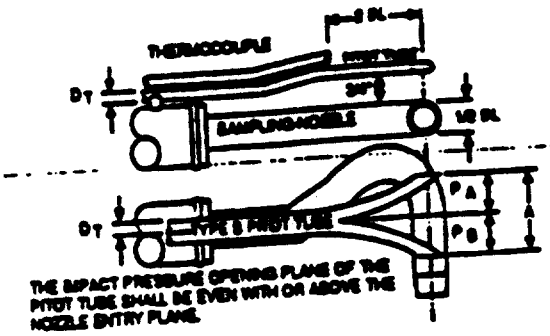
I certify that pitot tube/probe number S-15 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube calibration factor of 0.84.

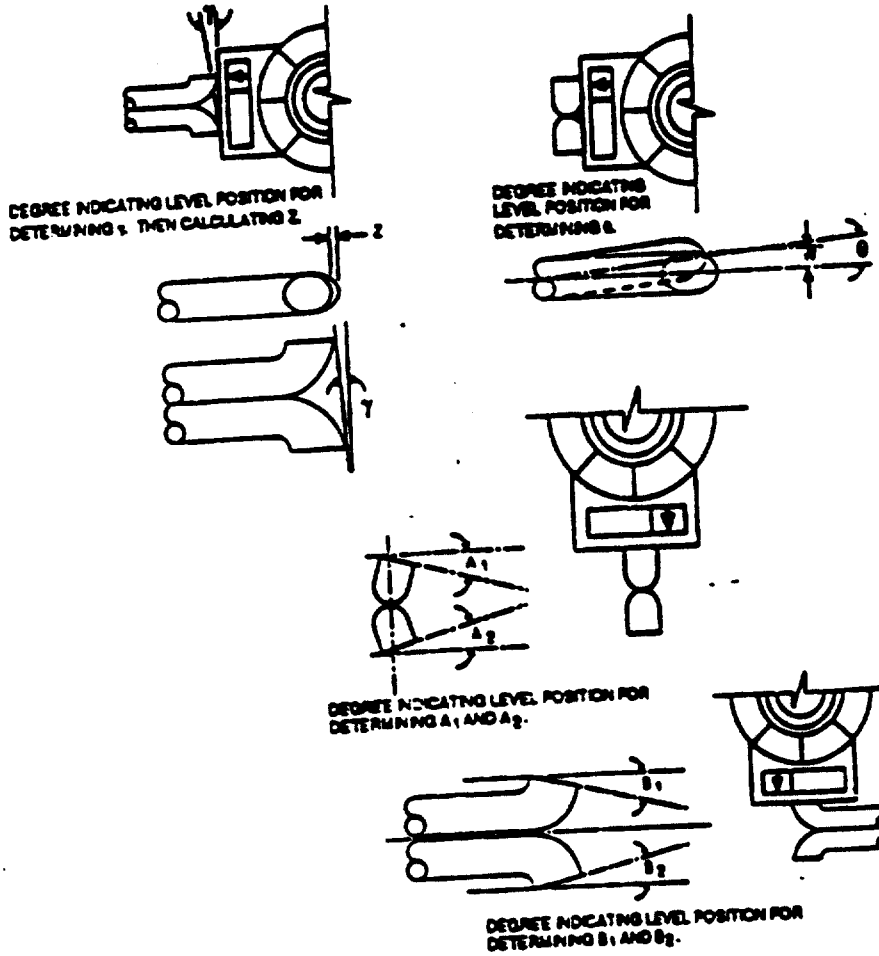
Signature Charles A Lanham

Date 5-2-91

R-0028 rev. 3/90

PITOT TUBE INSPECTION





level?	YES
obstructions?	NONE
damaged?	NONE
$-10° < \alpha_1 < +10°$	0
$-10° < \alpha_2 < +10°$	0
$-5° < \beta 1 < +5°$	0
$-5° < \beta 2 < +5°$	0
γ	1°
θ	0
A	.925
$1.05\ D_t < P_a < 1.5\ D_t$	.462
$1.05\ D_t < P_b < 1.5\ D_t$	.463
$3/16" < D_t < 3/8"$	.375
$A \tan \gamma < 0.125"$	.016
$A \tan \theta < 0.03125"$	0
$P_a = P_b \pm 0.063"$	YES 001

See 40 CFR 60, Vol. 42 No. 160 EPA Method 2. Verify the minimum 2-inch setback of the thermocouple and the minimum 3/4-inch separation between the pitot tube and the nozzle as shown at the top of this page.

Comments: Nut - fixed NEW

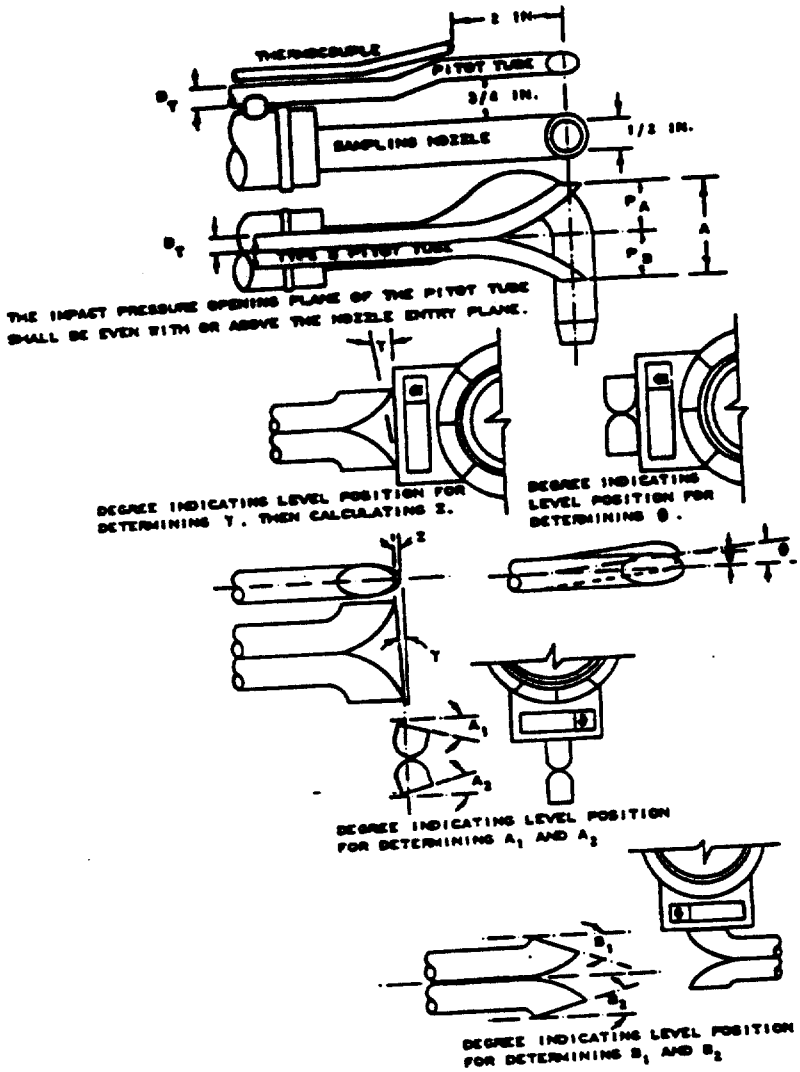
I certify that pitot tube/probe number S-16 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube calibration factor of 0.84.

Signature Chuck Dunham

Date 5-2-91

R-0028 rev. 3/90

PITOT TUBE INSPECTION DATA SHEET



level?	Yes
obstructions?	NONE
damaged?	NONE
$-10^\circ < \alpha_1 < +10^\circ$	0
$-10^\circ < \alpha_2 < +10^\circ$	0
$-5^\circ < \beta_1 < +5^\circ$	1°
$-5^\circ < \beta_2 < +5^\circ$	1°
γ	1°
θ	0
A	.836
$1.05\ D_t < P_a < 1.5\ D_t$	.411
$1.05\ D_t < P_b < 1.5\ D_t$	.425
$3/16" < D_t < 3/8"$	.375
$A \tan \gamma < 0.125"$	.014
$A \tan \theta < 0.03125"$	0
$P_a = P_b \pm 0.063"$	.014

Comments: _____

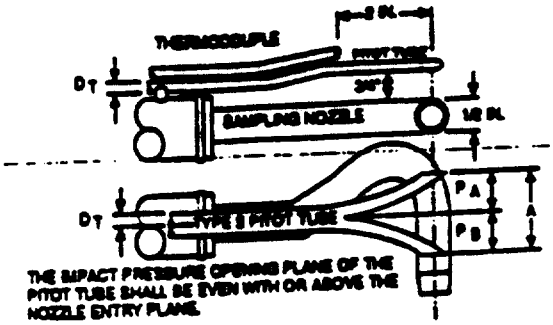
I certify that pitot tube/probe number PPT-61 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube calibration factor of 0.84.

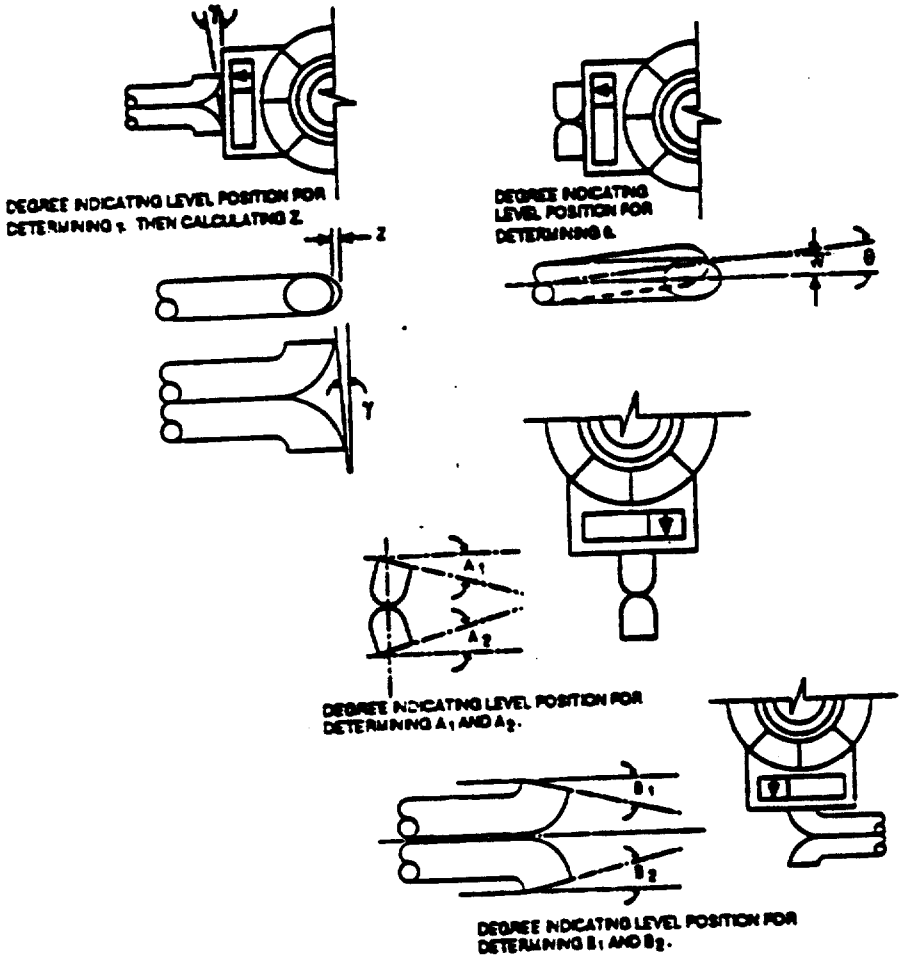
Signature W.L. Shull

Date 3-5-90

±SEE 40 CFR 60, VOL. 42 NO. 160 METHOD 2. VERIFY THE MINIMUM 2 INCH SETBACK OF THE THERMOCOUPLE AND THE MINIMUM 3/4 INCH SEPARATION BETWEEN THE PITOT TUBE AND THE NOZZLE AS SHOWN AT THE TOP OF THIS PAGE.

PITOT TUBE INSPECTION





level?	YES
obstructions?	NONE
damaged?	NONE
$-10° < \alpha_1 < +10°$	0
$-10° < \alpha_2 < +10°$	0
$-5° < B1 < +5°$	0
$-5° < B2 < +5°$	0
γ	0
θ	0
A	1.042
$1.05\ D_t < P_a < 1.5\ D_t$	.521
$1.05\ D_t < P_b < 1.5\ D_t$	.521
$3/16" < D_t < 3/8"$	.375
A tan γ < 0.125"	.016
A tan θ < 0.03125"	0
$P_a = P_b \pm 0.063"$	YES.

See 40 CFR 60, Vol. 42 No. 160 EPA Method 2. Verify the minimum 2-inch setback of the thermocouple and the minimum 3/4-inch separation between the pitot tube and the nozzle as shown at the top of this page.

Comments: _____

I certify that pitot tube/probe number PPT-83 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube calibration factor of 0.84.

Signature Chas Blanton

Date 3-7-91

R-0028 rev. 3/90

NOZZLE NUMBER: GL87

Date	Initials	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
4-14-89	WLS	.268	.265	.267	.264	.266	.266

NOTE: All diameters measured in inches.

ENTROPY ENVIRONMENTALISTS, INC.

NOZZLE NUMBER: GL-88

Date	Initials	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
4.20.89	JJM	.274	.273	.272	.274	.274	.273

NOTE: All diameters measured in inches.

NOZZLE NUMBER: GL-123

Date	Initials	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
7-21-89	WLS	.278	.280	.278	.276	.279	.278

NOTE: All diameters measured in inches.

NOZZLE CALIBRATION

NOZZLE NUMBER GL 643

Date	Calib. By	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
5-14-91	OOP	.273	.273	.274	.274	.274	.274

Note: 1. All diameters measured in inches.
2. Maximum 0.004 inches from lowest to highest diameter.

ENTROPY

NOZZLE CALIBRATION

NOZZLE NUMBER GL-692

Date	Calib. By	Dia. 1	Dia. 2	Dia. 3	Dia. 4	Dia. 5	Average
6-12-91	WLS	.272	.275	.274	.274	.273	.274

Note: 1. All diameters measured in inches.
2. Maximum 0.004 inches from lowest to highest diameter.

ENTROPY

THERMOCOUPLE CALIBRATION

Thermocouple No.: R094

Date: 8/28/90

Calibrated By: RDS/WLS

Barometric Pressure, Inches Hg: 29.51

Ambient Temperature, °F: 72.0

Mercury-In-Glass Thermometer I.D. No.: 7121K

Calibration System Used	Potentiometer I.D. Number	Reference Thermometer Temperature T_o °F	Reference Thermometer Temperature T_c °F	Mean Temperature of Hg Column T_m °F	Thermocouple Thermometer Temperature T_t °F	Temperature Diff., % (Allowable: ≤ 1.5 %)
Ice Bath	F-9	32.0	31.96	72.0	29.4	.52
		32.0	31.96	72.0	29.8	.44
		32.0	31.96	72.0	29.7	.46
Boiling Water	F-9	214.0	215.82	110.0	212.4	.51
		214.0	215.82	110.0	212.6	.48
		214.0	215.82	110.0	212.2	.54
Boiling Oil	F-9	388.0	396.88	120.0	387.0	1.15
		388.0	396.88	120.0	386.6	1.20
		388.0	396.88	120.0	386.6	1.20

$$\text{Corrected Temperature} = T_c = T_o + [(.00009) * (T_o - 20) * (T_o - T_m)]$$

$$\text{Temperature Difference} = \frac{[(T_c + 460) - (T_t + 460)]}{(T_c + 460)} * 100$$

THERMOCOUPLE CALIBRATION

Thermocouple No.: R134

Date: 3/13/90

Calibrated By: TAB

Barometric Pressure, Inches Hg: 29.64

Ambient Temperature, °F: 74.0

Mercury-In-Glass Thermometer I.D. No.: 7121K

Calibration System Used	Potentiometer I.D. Number	Reference Thermometer Temperature T_o °F	Reference Thermometer Temperature T_c °F	Mean Temperature of Hg Column T_m °F	Thermocouple Thermometer Temperature T_t °F	Temperature Diff., % (Allowable: ≤ 1.5 %)
Ice Bath	F24	32.0	31.96	72.0	33.0	-.21
		32.0	31.96	72.0	33.0	-.21
		32.0	31.96	72.0	34.0	-.42
Boiling Water	F24	214.0	215.82	110.0	210.0	.86
		214.0	215.82	110.0	211.0	.71
		214.0	215.82	110.0	211.0	.71
Boiling Oil	F24	382.0	390.54	120.0	380.0	1.24
		384.0	392.65	120.0	383.0	1.13
		386.0	394.76	120.0	386.0	1.03

$$\text{Corrected Temperature} = T_c = T_o + [(.00009) * (T_o - 20) * (T_o - T_m)]$$

$$\text{Temperature Difference} = \frac{[(T_c + 460) - (T_t + 460)]}{(T_c + 460)} * 100$$

THERMOCOUPLE CALIBRATION

Thermocouple No.: R187

Date: 6/08/90

Calibrated By: CCB

Barometric Pressure, Inches Hg: 29.66

Ambient Temperature, °F: 72.0

Mercury-In-Glass Thermometer I.D. No.: 7121K

Calibration System Used	Potentiometer I.D. Number	Reference Thermometer Temperature T_o °F	Reference Thermometer Temperature T_c °F	Mean Temperature of Hg Column T_m °F	Thermocouple Thermometer Temperature T_t °F	Temperature Diff., % (Allowable: ≤ 1.5 %)
Ice Bath	F28	32.0	31.96	72.0	31.6	.07
		32.0	31.96	72.0	31.6	.07
		32.0	31.96	72.0	31.6	.07
Boiling Water	F28	214.0	215.82	110.0	212.6	.48
		214.0	215.82	110.0	212.6	.48
		214.0	215.82	110.0	211.8	.59
Boiling Oil	F28	388.0	396.88	120.0	387.0	1.15
		388.0	396.88	120.0	386.8	1.18
		388.0	396.88	120.0	386.8	1.18

$$\text{Corrected Temperature} = T_c = T_o + [(.00009) * (T_o - 20) * (T_o - T_m)]$$

$$\text{Temperature Difference} = \frac{[(T_c + 460) - (T_t + 460)]}{(T_c + 460)} * 100$$

THERMOCOUPLE CALIBRATION

Thermocouple No.: R315

Date: 5/27/91

Calibrated By: WLS

Barometric Pressure, Inches Hg: 29.74

Ambient Temperature, °F: 71.0

Mercury-In-Glass Thermometer I.D. No.: 7121K

Calibration System Used	Potentiometer I.D. Number	Reference Thermometer Temperature T_o °F	Reference Thermometer Temperature T_c °F	Mean Temperature of Hg Column T_m °F	Thermocouple Thermometer Temperature T_t °F	Temperature Diff., % (Allowable: ≤ 1.5 %)
Ice Bath	P41	32.0	31.96	69.0	32.4	-.09
		32.0	31.96	70.0	33.1	-.23
		32.0	31.96	70.0	33.0	-.21
Boiling Water	P41	212.0	213.80	108.0	211.6	.33
		212.0	213.76	110.0	210.8	.44
		212.0	213.75	111.0	211.4	.35
Boiling Oil	P41	386.0	392.65	184.0	384.8	.92
		388.0	394.66	187.0	383.9	1.26
		388.0	394.62	188.0	384.0	1.24

$$\text{Corrected Temperature} = T_c = T_o + [(.00009) * (T_o - 20) * (T_o - T_m)]$$

$$\text{Temperature Difference} = \frac{[(T_c + 460) - (T_t + 460)]}{(T_c + 460)} * 100$$

APPENDIX D

SAMPLING AND ANALYTICAL PROCEDURES

METHOD 1—SAMPLE AND VELOCITY TRAVERSES FOR STATIONARY SOURCES

1. *Principle and Applicability*

1.1 Principle. To aid in the representative measurement of pollutant emissions and/or total volumetric flow rate from a stationary source, a measurement site where the effluent stream is flowing in a known direction is selected, and the cross-section of the stack is divided into a number of equal areas. A traverse point is then located within each of these equal areas.

1.2 Applicability. This method is applicable to flowing gas streams in ducts, stacks, and flues. The method cannot be used when: (1) flow is cyclonic or swirling (see Section 2.4), (2) a stack is smaller than about 0.30 meter (12 in.) in diameter, or 0.071 m^2 (113 $in.^2$) cross-sectional area, or (3) the measurement site is less than two stack or duct diameters downstream or less than a half diameter upstream from a flow disturbance.

The requirements of this method must be considered before construction of a new facility from which emissions will be measured; failure to do so may require subsequent alterations to the stack or deviation from the standard procedure. Cases involving variants are subject to approval by the Administrator, U.S. Environmental Protection Agency.

2. *Procedure*

2.1 Selection of Measurement Site. Sampling or velocity measurement is performed at a site located at least eight stack or duct diameters downstream and two diameters upstream from any flow disturbance such as a bend, expansion, or contraction in the stack, or from a visible flame. If necessary, an alternative location may be selected, at a position at least two stack or duct diameters downstream and a half diameter upstream from any flow disturbance. For a rectangular cross section, an equivalent diameter (D_e) shall be calculated from the following equation, to determine the upstream and downstream distances:

$$D_e = \frac{2LW}{(L+W)}$$

where L = length and W = width.

An alternative procedure is available for determining the acceptability of a measurement location not meeting the criteria above. This procedure, determination of gas flow angles at the sampling points and comparing the results with acceptability criteria, is described in Section 2.5.

2.2 Determining the Number of Traverse Points.

2.2.1 Particulate Traverses. When the eight- and two-diameter criterion can be met, the minimum number of traverse points shall be: (1) twelve, for circular or rectangular stacks with diameters (or equivalent diameters) greater than 0.61 meter (24 in.); (2) eight, for circular stacks with diameters between 0.30 and 0.61 meter (12-24 in.); (3) nine, for rectangular stacks with equivalent diameters between 0.30 and 0.61 meter (12-24 in.).

When the eight- and two-diameter criterion cannot be met, the minimum number of traverse points is determined from Figure 1-1. Before referring to the figure, however, determine the distances from the chosen measurement site to the nearest upstream and downstream disturbances, and divide each distance by the stack diameter or equivalent diameter, to determine the distance in terms of the number of duct diameters. Then, determine from Figure 1-1 the minimum number of traverse points that corresponds: (1) to the number of duct diameters upstream; and (2) to the number of diameters downstream. Select the higher of the two minimum numbers of traverse points, or a greater value, so that for circular stacks the number is a multiple of 4, and for rectangular stacks, the number is one of those shown in Table 1-1.

TABLE 1-1. CROSS-SECTION LAYOUT FOR RECTANGULAR STACKS

Number of traverse points	Matrix layout
9	3x3
12	4x3
16	4x4
20	5x4
25	5x5
30	6x5
36	6x6
42	7x6
49	7x7

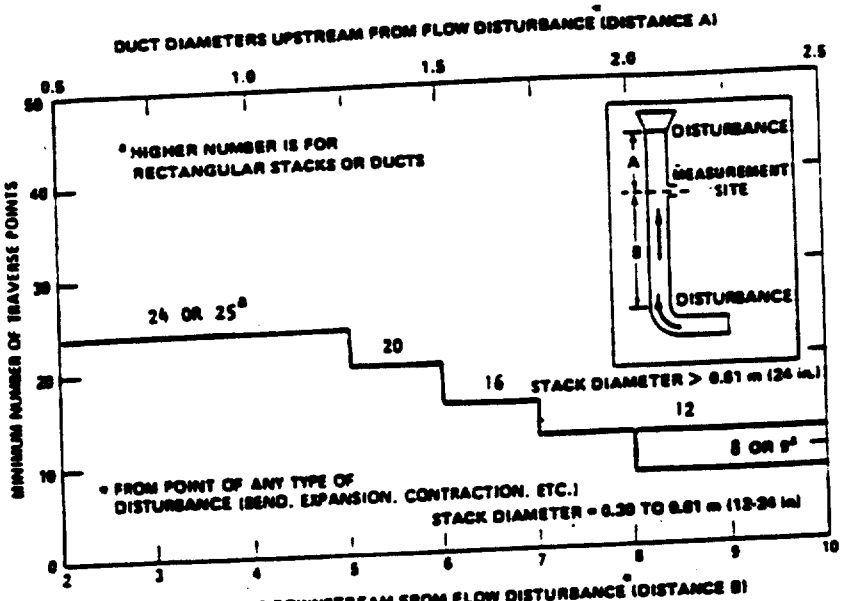


Figure 1-1. Minimum number of traverse points for particulate traverses.

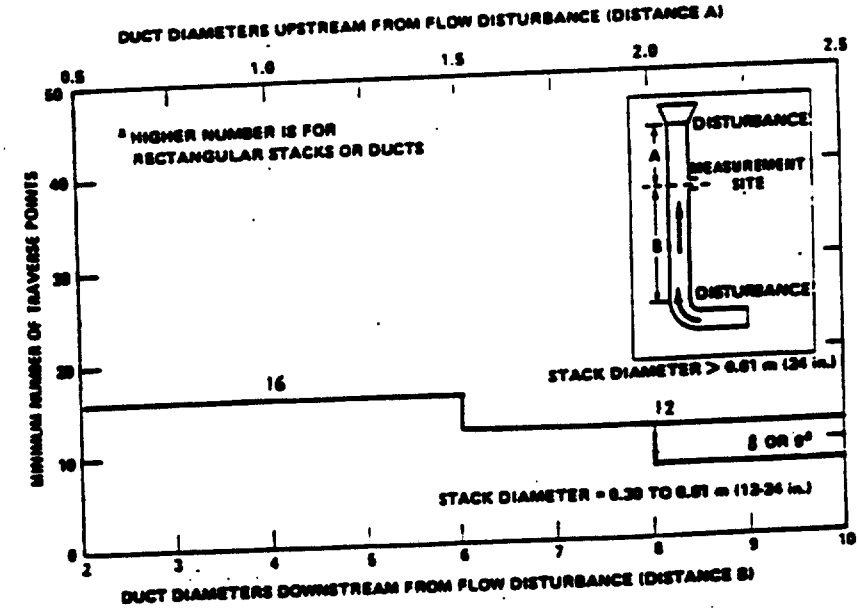


Figure 1-2. Minimum number of traverse points for velocity (nonparticulate) traverses.

2.3.1.2 Stacks With Diameters Equal to or Less Than 0.61 m (24 in.). Follow the procedure in Section 2.3.1.1, noting only that any "adjusted" points should be relocated away from the stack walls to: (1) a distance of 1.3 cm (0.50 in.); or (2) a distance equal to the nozzle inside diameter, whichever is larger.

2.3.2 Rectangular Stacks. Determine the number of traverse points as explained in Sections 2.1 and 2.2 of this method. From Table 1-1, determine the grid configuration. Divide the stack cross-section into as many equal rectangular elemental areas as traverse points, and then locate a traverse point at the centroid of each equal area according to the example in Figure 1-4.

If the tester desires to use more than the minimum number of traverse points, expand the "minimum number of traverse points" matrix (see Table 1-1) by adding the extra traverse points along one or the other or both legs of the matrix; the final matrix need not be balanced. For example, if a 4x3 "minimum number of points" matrix were expanded to 36 points, the final matrix could be 9x4 or 12x3, and would not necessarily have to be 6x6. After constructing the final matrix, divide the stack cross-section into as many equal rectangular, elemental areas as traverse points, and locate a traverse point at the centroid of each equal area.

The situation of traverse points being too close to the stack walls is not expected to arise with rectangular stacks. If this problem should ever arise, the Administrator must be contacted for resolution of the matter.

2.4 Verification of Absence of Cyclonic Flow. In most stationary sources, the direction of stack gas flow is essentially parallel to the stack walls. However, cyclonic flow may exist (1) after such devices as cyclones and inertial demisters following venturi scrubbers, or (2) in stacks having tangential inlets or other duct configurations which tend to induce swirling; in these instances, the presence or absence of cyclonic flow at the sampling location must be determined. The following techniques are acceptable for this determination.

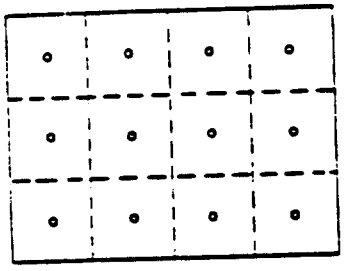


Figure 1-4. Example showing rectangular stack cross section divided into 12 equal areas, with a traverse point at centroid of each area.

Level and zero the manometer. Connect a Type S pitot tube to the manometer. Position the Type S pitot tube at each traverse point, in succession, so that the planes of the face openings of the pitot tube are perpendicular to the stack cross-sectional plane; when the Type S pitot tube is in this position, it is at "0° reference." Note the differential pressure (Δp) reading at each traverse point. If a null (zero) pitot reading is obtained at 0° reference at a given traverse point, an acceptable flow condition exists at that point. If the pitot reading is not zero at 0° reference, rotate the pitot tube (up to ±90° yaw angle), until a null reading is obtained. Carefully determine and record the value of the rotation angle (α) to the nearest degree. After the null technique has been applied at each traverse point, calculate the average of the absolute values of α; assign α values of 0° to those points for which no rotation was required, and include these in the overall average. If the average value of α is greater than 20°, the overall flow condition in the stack is unacceptable and alternative methodology, subject to the approval of the Administrator, must be used to perform accurate sample and velocity traverses.

The alternative procedure described in Section 2.5 may be used to determine the rotation angles in lieu of the procedure described above. The limit of acceptability for the average value of α would remain 20°.

2.5 Alternative Measurement Site Selection Procedure. This alternative applies to sources where measurement locations are less than 2 equivalent stack or duct diameters downstream or less than ½ duct diameter upstream from a flow disturbance. The alternative should be limited to ducts larger than 24 in. in diameter where blockage and wall effects are minimal. A directional flow-sensing probe is used to measure pitch and yaw angles of the gas flow at 40 or more traverse points; the resultant angle is calculated and compared with acceptable criteria for mean and standard deviation.

Note.—Both the pitch and yaw angles are measured from a line passing through the traverse point and parallel to the stack axis. The pitch angle is the angle of the gas flow component in the plane that INCLUDES the traverse line and is parallel to the stack axis. The yaw angle is the angle of the gas flow component in the plane PERPENDICULAR to the traverse line at the traverse point and is measured from the line passing through the traverse point and parallel to the stack axis.

2.5.1 Apparatus.

2.5.1.1 Directional Probe. Any directional probe, such as United Sensor Type DA Three-Dimensional Directional Probe, capable of measuring both the pitch and yaw angles of gas flows is acceptable. (Note: Mention of trade name or specific products does not constitute endorsement by the U.S. Environmental Protection Agency.) Assign an identification number to the directional probe, and permanently mark or engrave the number on the body of the probe. The pressure holes of directional probes are susceptible to plugging when used in particulate-laden gas streams. Therefore, a system for cleaning the pressure holes by "back-purging" with pressurized air is required.

2.5.1.2 Differential Pressure Gauges. Inclined manometers, U-tube manometers, or other differential pressure gauges (e.g., magnehelic gauges) that meet the specifications described in Method 2, § 2.2.

Note.—If the differential pressure gauge produces both negative and positive readings, then both negative and positive pressure readings shall be calibrated at a minimum of three points as specified in Method 2, § 2.2.

2.5.2 Traverse Points. Use a minimum of 40 traverse points for circular ducts and 42 points for rectangular ducts for the gas flow angle determinations. Follow § 2.3 and Table 1-1 or 1-2 for the location and layout of the traverse points. If the measurement location is determined to be acceptable according to the criteria in this alternative procedure, use the same traverse point number and location for sampling and velocity measurements.

2.5.3 Measurement Procedure.

2.5.3.1 Prepare the directional probe and differential pressure gauges as recommended by the manufacturer. Capillary tubing or surge tanks may be used to dampen pressure fluctuations. It is recommended, but not required, that a pretest leak check be conducted. To perform a leak check, pressurize or use suction on the impact opening until a reading of at least 7.5 cm (3 in.) H_2O registers on the differential pressure gauge, then plug the impact opening. The pressure of a leak-free system will remain stable for at least 15 seconds.

2.5.3.2 Level and zero the manometers. Since the manometer level and zero may drift because of vibrations and temperature changes, periodically check the level and zero during the traverse.

2.5.3.3 Position the probe at the appropriate locations in the gas stream, and rotate until zero deflection is indicated for the yaw angle pressure gauge. Determine and record the yaw angle. Record the pressure gauge readings for the pitch angle, and determine the pitch angle from the calibration curve. Repeat this procedure for each traverse point. Complete a "back-purge" of the pressure lines and the impact openings prior to measurements of each traverse point.

A post-test check as described in § 2.5.3.1 is required. If the criteria for a leak-free system are not met, repair the equipment, and repeat the flow angle measurements.

2.5.4 Calculate the resultant angle at each traverse point, the average resultant angle, and the standard deviation using the following equations. Complete the calculations retaining at least one extra significant figure beyond that of the acquired data. Round the values after the final calculations.

METHOD 2—DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE (TYPE S PITOT TUBE)

1. *Principle and Applicability*

1.1 Principle. The average gas velocity in a stack is determined from the gas density and from measurement of the average velocity head with a Type S (Stauscheibe or reverse type) pitot tube.

1.2 Applicability. This method is applicable for measurement of the average velocity of a gas stream and for quantifying gas flow.

This procedure is not applicable at measurement sites which fail to meet the criteria of Method 1, Section 2.1. Also, the method cannot be used for direct measurement in cyclonic or swirling gas streams; Section 2.4 of Method 1 shows how to determine cyclonic or swirling flow conditions. When unacceptable conditions exist, alternative procedures, subject to the approval of the Administrator, U.S. Environmental Protection Agency, must be employed to make accurate flow rate determinations; examples of such alternative procedures are: (1) to install straightening vanes; (2) to calculate the total volumetric flow rate stoichiometrically, or (3) to move to another measurement site at which the flow is acceptable.

2. *Apparatus*

Specifications for the apparatus are given below. Any other apparatus that has been demonstrated (subject to approval of the Administrator) to be capable of meeting the specifications will be considered acceptable.

2.1 Type S Pitot Tube. The Type S pitot tube (Figure 2-1) shall be made of metal tubing (e.g. stainless steel). It is recommended that the external tubing diameter (dimension D_t, Figure 2-2b) be between 0.48 and 0.95 centimeters (3/16 and 3/8 inch). There shall be an equal distance from the base of each leg of the pitot tube to its face-opening plane (dimensions P_A and P_B, Figure 2-2b); it is recommended that this distance be between 1.05 and 1.50 times the external tubing diameter. The face openings of the pitot tube shall, preferably, be aligned as shown in Figure 2-2; however, slight misalignments of the openings are permissible (see Figure 2-3).

The Type S pitot tube shall have a known coefficient, determined as outlined in Section 4. An identification number shall be assigned to the pitot tube; this number shall be permanently marked or engraved on the body of the tube.

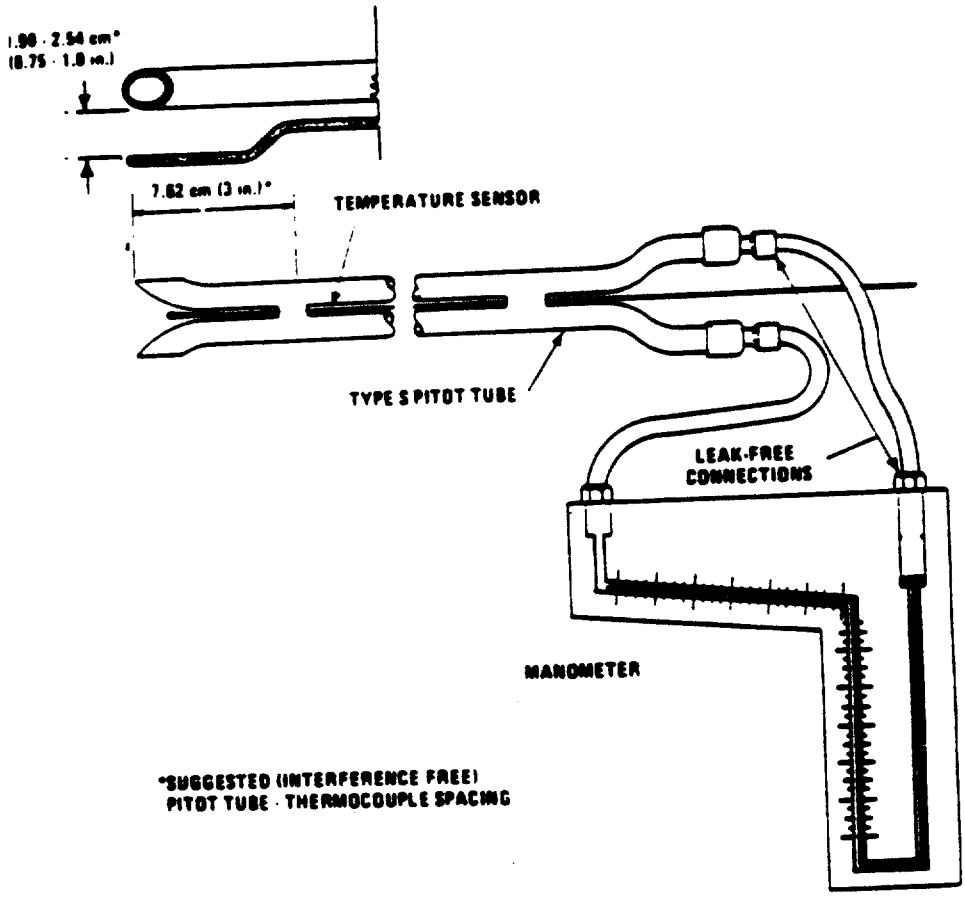


Figure 2-1. Type S pitot tube manometer assembly.

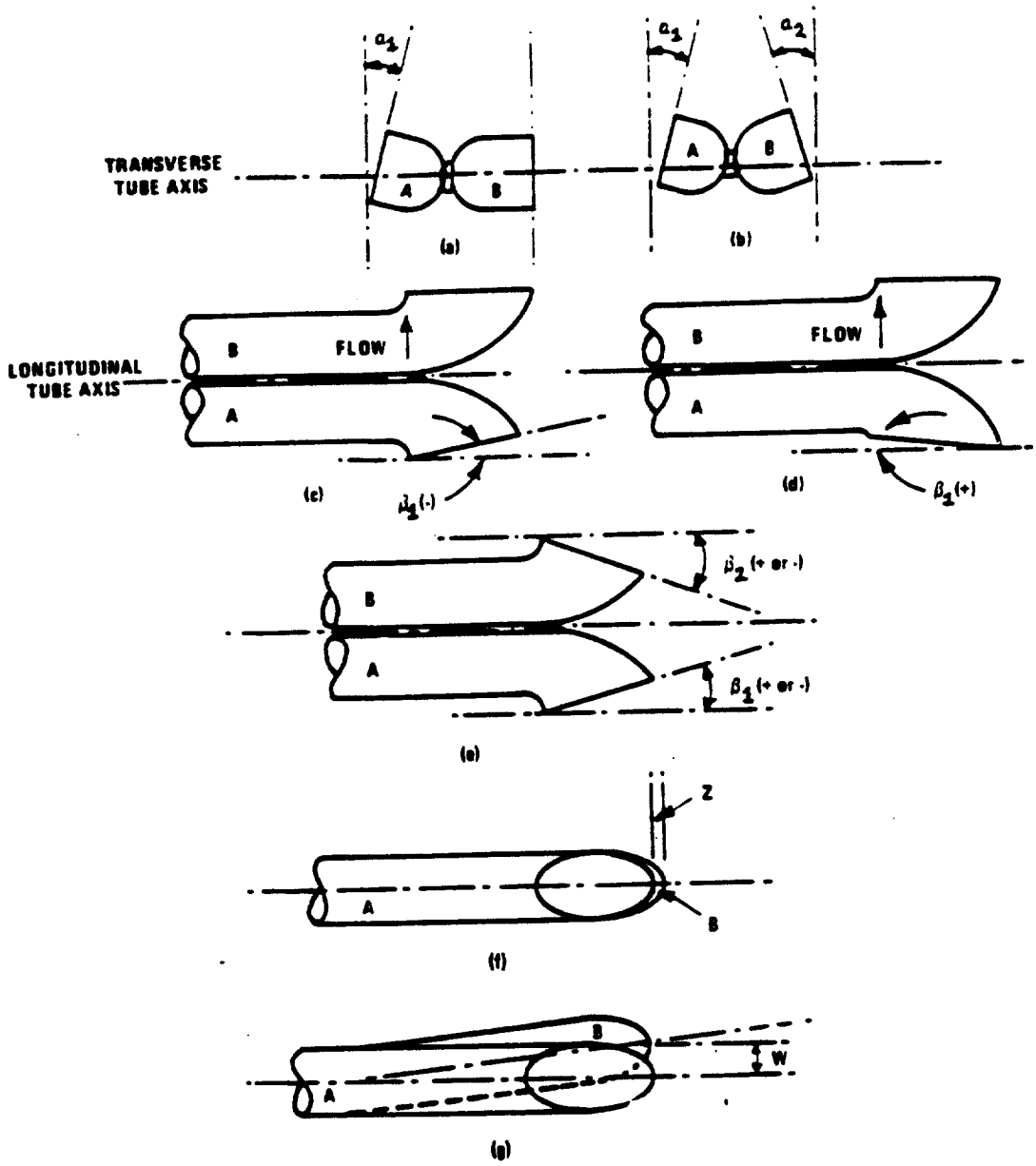


Figure 2-3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect the baseline value of Cp(s) so long as α_1 and α_2 10°, β_1 and β_2 5°, z 0.32 cm (1/8 in.) and w 0.08 cm (1/32 in.) (citation 11 in Bibliography).

A standard pitot tube may be used instead of a Type S, provided that it meets the specifications of Sections 2.7 and 4.2; note, however, that the static and impact pressure holes of standard pitot tubes are susceptible to plugging in particulate-laden gas streams. Therefore, whenever a standard pitot tube is used to perform a traverse, adequate proof must be furnished that the openings of the pitot tube have not plugged up during the traverse period; this can be done by taking a velocity head (Δp) reading at the final traverse point, cleaning out the impact and static holes of the standard pitot tube by "back-purging" with pressurized air, and then taking another Δp reading. If the Δp readings made before and after the air purge are the same (±5 percent), the traverse is acceptable. Otherwise, reject the run. Note that if Δp at the final traverse point is unsuitably low, another point may be selected. If "back-purging" at regular intervals is part of the procedure, then comparative Δp readings shall be

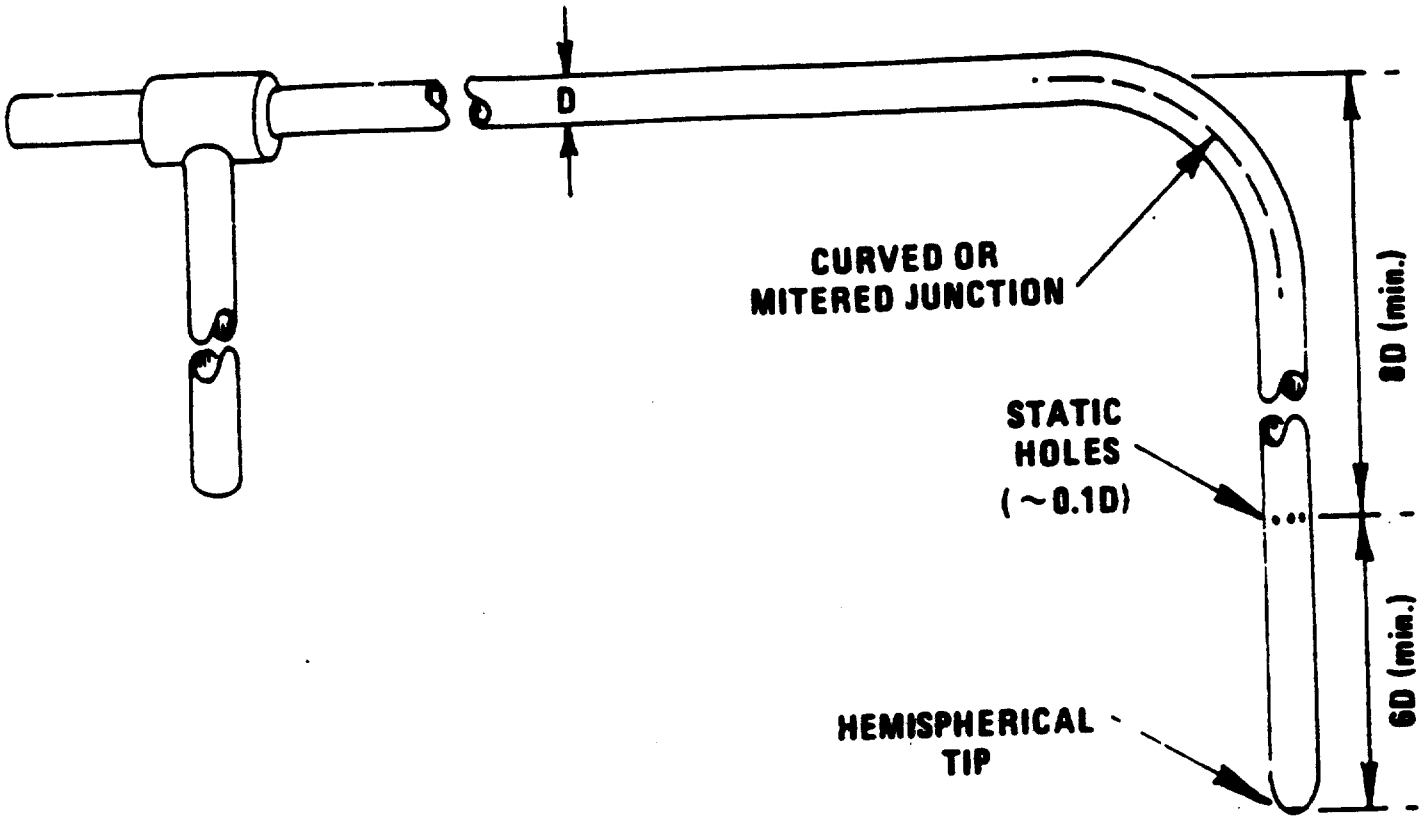


Figure 2-4. Standard pitot tube design specifications.

3. *Procedure*

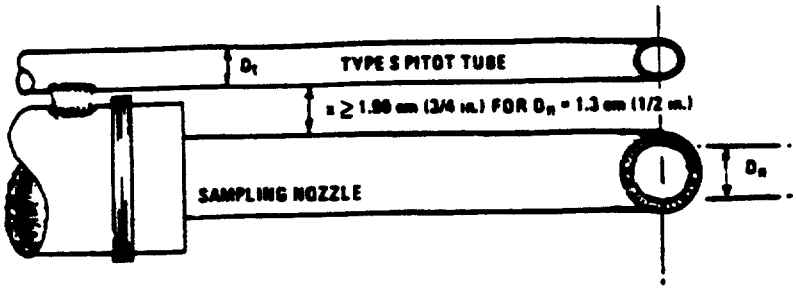
3.1 Set up the apparatus as shown in Figure 2-1. Capillary tubing or surge tanks installed between the manometer and pitot tube may be used to dampen Δp fluctuations. It is recommended, but not required, that a pretest leak-check be conducted, as follows: (1) blow through the pitot impact opening until at least 7.6 cm (3 in.) H_2O velocity pressure registers on the manometer; then, close off the impact opening. The pressure shall remain stable for at least 15 seconds; (2) do the same for the static pressure side, except using suction to obtain the minimum of 7.6 cm (3 in.) H_2O. Other leak-check procedures, subject to the approval of the Administrator may be used.

3.2 Level and zero the manometer. Because the manometer level and zero may drift due to vibrations and temperature changes, make periodic checks during the traverse. Record all necessary data as shown in the example data sheet (Figure 2-5).

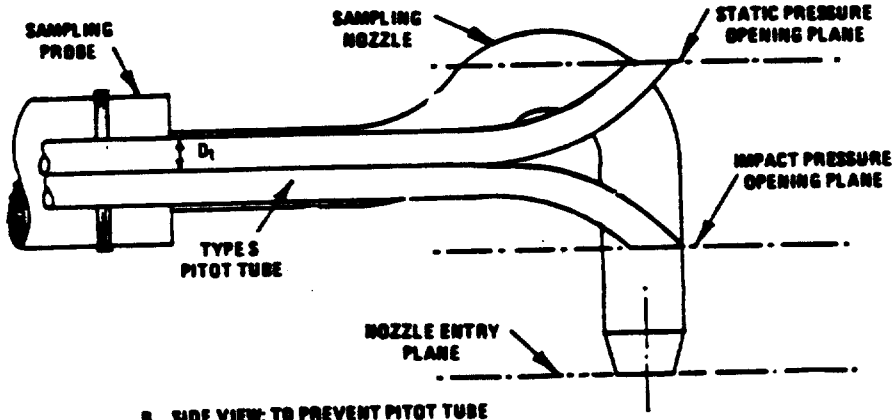
3.3 Measure the velocity head and temperature at the traverse points specified by Method 1. Ensure that the proper differential pressure gauge is being used for the range of Δp values encountered (see Section 2.2). If it is necessary to change to a more sensitive gauge, do so, and remeasure the Δp and temperature readings at each traverse point. Conduct a post-test leak-check (mandatory), as described in Section 3.1 above, to validate the traverse run.

3.4 Measure the static pressure in the stack. One reading is usually adequate.

3.5 Determine the atmospheric pressure.



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.).

4.1.1 Type S Pitot Tube Assemblies. During sample and velocity traverses, the isolated Type S pitot tube is not always used; in many instances, the pitot tube is used in combination with other source-sampling components (thermocouple, sampling probe, nozzle) as part of an "assembly." The presence of other sampling components can sometimes affect the baseline value of the Type S pitot tube coefficient (Citation 9 in Bibliography); therefore an assigned or otherwise known) baseline coefficient value may or may not be valid for a given assembly. The baseline and assembly coefficient values will be identical only when the relative placement of the components in the assembly is such that aerodynamic interference effects are eliminated. Figures 2-6 through 2-8 illustrate interference-free component arrangements for Type S pitot tubes having external tubing diameters between 0.48 and 0.95 cm (3/16 and 3/8 in.). Type S pitot tube assemblies that fail to meet any or all of the specifications of Figures 2-6 through 2-8 shall be calibrated according to the procedure outlined in Sections 4.1.2 through 4.1.5 below, and prior to calibration, the values of the intercomponent spacings (pitot-nozzle, pitot-thermocouple, pitot-probe sheath) shall be measured and recorded.

NOTE: Do not use any Type S pitot tube assembly which is constructed such that the impact pressure opening plane of the pitot tube is below the entry plane of the nozzle (see Figure 2-6b).

4.1.2 Calibration Setup. If the Type S pitot tube is to be calibrated, one leg of the tube shall be permanently marked A, and the other, B. Calibration shall be done in a flow system having the following essential design features:

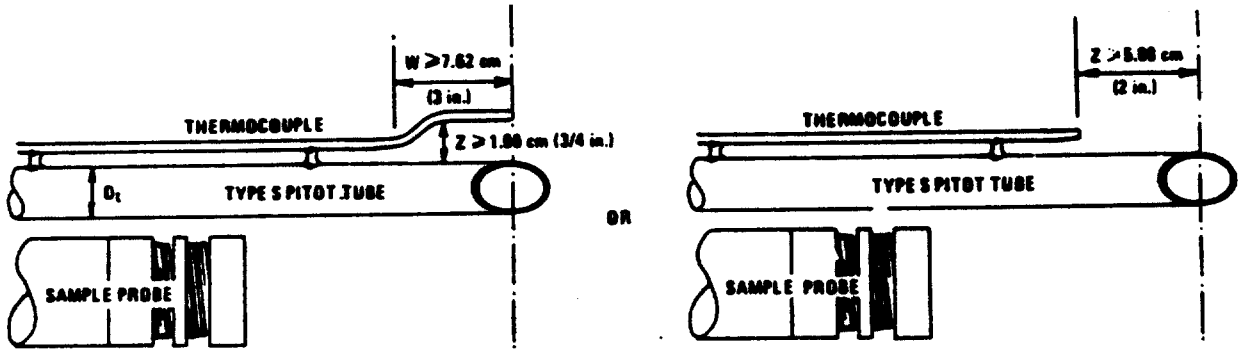


Figure 2-7. Proper thermocouple placement to prevent interference; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

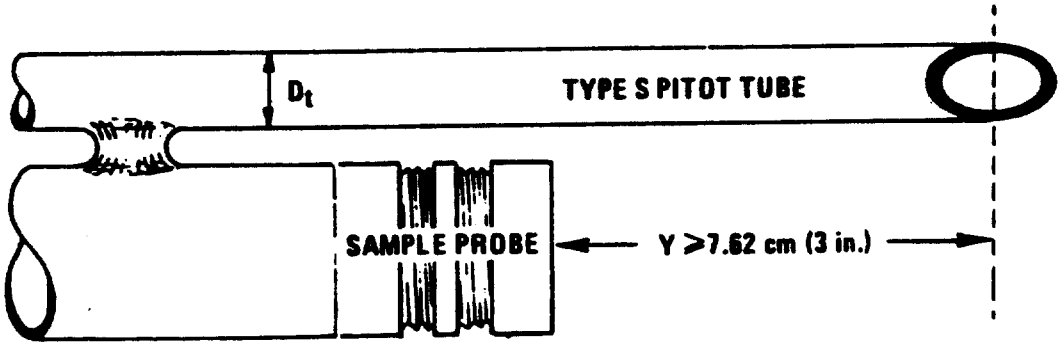


Figure 2-8. Minimum pitot-sample probe separation needed to prevent interference; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

$$C_{p(s)} = C_{p(std)} \sqrt{\frac{\Delta p_{std}}{\Delta p_s}}$$

Equation 2-2

where:

$C_{p(s)}$ = Type S pitot tube coefficient

$C_{p(std)}$ = Standard pitot tube coefficient; use 0.99 if the coefficient is unknown and the tube is designed according to the criteria of Sections 2.7.1 to 2.7.5 of this method.

Δp_{std} = Velocity head measured by the standard pitot tube, cm H_2O (in. H_2O)

Δp_s = Velocity head measured by the Type S pitot tube, cm H_2O (in H_2O)

4.1.4.2 Calculate $\bar{C}_p$ (side A), the mean A-side coefficient, and $\bar{C}_p$ (side B), the mean B-side coefficient; calculate the difference between these two average values.

4.1.4.3 Calculate the deviation of each of the three A-side values of $C_{p(s)}$ from $\bar{C}_p$ (side A), and the deviation of each B-side value of $C_{p(s)}$ from $\bar{C}_p$ (side B). Use the following equation:

$$\text{Deviation} = C_{p(s)} - \bar{C}_p(\text{A or B})$$

Equation 2-3

4.1.4.4 Calculate σ, the average deviation from the mean, for both the A and B sides of the pitot tube. Use the following equation:

$$\sigma\,(\text{side A or B}) = \frac{\sum_{1}^{3} |C_{p(s)} - \bar{C}_p(A \text{ or } B)|}{3}$$

Equation 2-4

4.1.4.5 Use the Type S pitot tube only if the values of σ (side A) and σ (side B) are less than or equal to 0.01 and if the absolute value of the difference between $\bar{C}_p$ (A) and $\bar{C}_p$ (B) is 0.01 or less.

4.1.5 Special considerations.

4.1.5.1 Selection of calibration point.

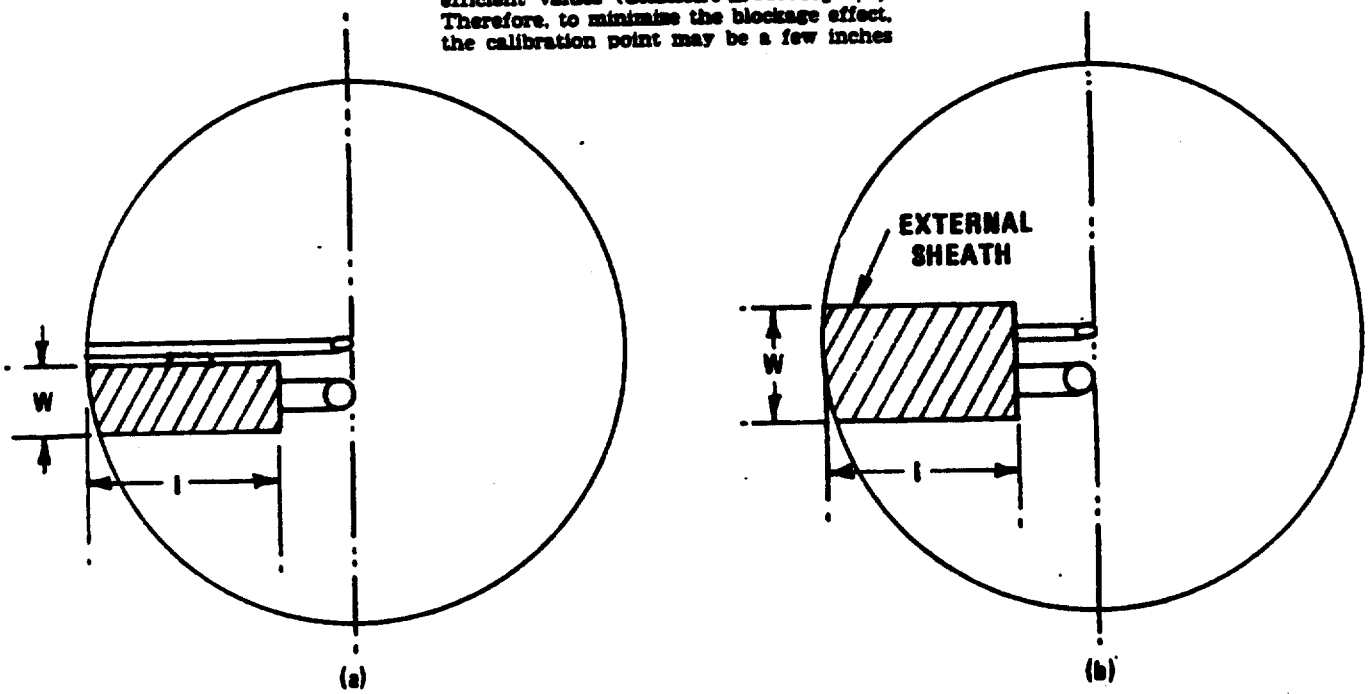
4.1.5.1.1 When an isolated Type S pitot tube is calibrated, select a calibration point at or near the center of the duct, and follow the procedures outlined in Sections 4.1.3 and 4.1.4 above. The Type S pitot coefficients so obtained, i.e., $\bar{C}_p$ (side A) and $\bar{C}_p$ (side B), will be valid, so long as either: (1) the isolated pitot tube is used; or (2) the pitot tube is used with other components (nozzle, thermocouple, sample probe) in an arrangement that is free from aerodynamic interference effects (see Figures 2-6 through 2-8).

4.1.5.1.2 For Type S pitot tube-thermocouple combinations (without sample probe), select a calibration point at or near the center of the duct, and follow the procedures outlined in Sections 4.1.3 and 4.1.4 above. The coefficients so obtained will be valid so long as the pitot tube-thermocouple combination is used by itself or with other components in an interference-free arrangement (Figures 2-6, and 2-8).

4.1.5.1.3 For assemblies with sample probes, the calibration point should be located at or near the center of the duct; however, insertion of a probe sheath into a small duct may cause significant cross-sectional area blockage and yield incorrect coefficient values (Citation 9 in Bibliography). Therefore, to minimize the blockage effect, the calibration point may be a few inches off-center if necessary. The actual blockage effect will be negligible when the theoretical blockage, as determined by a projected-area model of the probe sheath, is 2 percent or less of the duct cross-sectional area for assemblies without external sheaths (Figure 2-10a), and 3 percent or less for assemblies with external sheaths (Figure 2-10b).

4.1.5.2 For those probe assemblies in which pitot tube-nozzle interference is a factor (i.e., those in which the pitot-nozzle separation distance fails to meet the specification illustrated in Figure 2-6a), the value of $C_{p(s)}$ depends upon the amount of free-space between the tube and nozzle, and therefore is a function of nozzle size. In these instances, separate calibrations shall be performed with each of the commonly used nozzle sizes in place. Note that the single-velocity calibration technique is acceptable for this purpose, even though the larger nozzle sizes (>0.635 cm or ¼ in.) are not ordinarily used for isokinetic sampling at velocities around 915 m/min (3,000 ft/min), which is the calibration velocity; note also that it is not necessary to draw an isokinetic sample during calibration (see Citation 19 in Section 6).

4.1.5.3 For a probe assembly constructed such that its pitot tube is always used in the same orientation, only one side of the pitot tube need be calibrated (the side which will face the flow). The pitot tube must still meet the alignment specifications of Figure 2-2 or 2-3, however, and must have an average deviation (σ) value of 0.01 or less (see Section 4.1.4.4).



$$\text{ESTIMATED SHEATH BLOCKAGE (\%)} = \left[\frac{l \times W}{\text{DUCT AREA}}\right] \times 100$$

Figure 2-10. Projected-area models for typical pitot tube assemblies.

Method 3—Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight

1. *Principle and Applicability*

1.1 Principle. A gas sample is extracted from a stack, by one of the following methods: (1) single-point, grab sampling; (2) single-point, integrated sampling; or (3) multi-point, integrated sampling. The gas sample is analyzed for percent carbon dioxide (CO_2), percent oxygen (O_2), and, if necessary, percent carbon monoxide (CO). If a dry molecular weight determination is to be made, either an Orsat or a Fyrite[1] analyzer may be used for the analysis; for excess air or emission rate correction factor determination, an Orsat analyzer must be used.

1.2 Applicability. This method is applicable for determining CO_2 and O_2 concentrations, excess air, and dry molecular weight of a sample from a gas stream of a fossil-fuel combustion process. The method may also be applicable to other processes where it has been determined that compounds other than CO_2, O_2, CO, and nitrogen (N_2) are not present in concentrations sufficient to affect the results.

Other methods, as well as modifications to the procedure described herein, are also applicable for some or all of the above determinations. Examples of specific methods and modifications include: (1) a multi-point sampling method using an Orsat analyzer to analyze individual grab samples obtained at each point; (2) a method using CO_2 or O_2 and stoichiometric calculations to determine dry molecular weight and excess air; (3) assigning a value of 30.0 for dry molecular weight, in lieu of actual measurements, for processes burning natural gas, coal, or oil. These methods and modifications may be used, but are subject to the approval of the Administrator, U.S. Environmental Protection Agency.

2. *Apparatus*

As an alternative to the sampling apparatus and systems described herein, other sampling systems (e.g., liquid displacement) may be used provided such systems are capable of obtaining a representative sample and maintaining a constant sampling rate, and are otherwise capable of yielding acceptable results. Use of such systems is subject to the approval of the Administrator.

2.1 Grab Sampling (Figure 3-1).

2.1.1 Probe. The probe should be made of stainless steel or borosilicate glass tubing and should be equipped with an in-stack or out-stack filter to remove particulate matter (a plug of glass wool is satisfactory for this purpose). Any other materials inert to O_2, CO_2, CO, and N_2, and resistant to temperature at sampling conditions may be used for the probe; examples of such material are aluminum, copper, quartz glass and Teflon.

2.1.2 Pump. A one-way squeeze bulb, or equivalent, is used to transport the gas sample to the analyzer.

2.2 Integrated Sampling (Figure 3-2).

2.2.1 Probe. A probe such as that described in Section 2.1.1 is suitable.

[1]Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

2.2.2 Condenser. An air-cooled or water-cooled condenser, or other condenser that will not remove O_2, CO_2, CO, and N_2, may be used to remove excess moisture which would interfere with the operation of the pump and flow meter.

2.2.3 Valve. A needle valve is used to adjust sample gas flow rate.

2.2.4 Pump. A leak-free, diaphragm-type pump, or equivalent, is used to transport sample gas to the flexible bag. Install a small surge tank between the pump and rate meter to eliminate the pulsation effect of the diaphragm pump on the rotameter.

2.2.5 Rate Meter. The rotameter, or equivalent rate meter, used should be capable of measuring flow rate to within ±2 percent of the selected flow rate. A flow rate range of 500 to 1000 cm^3/min is suggested.

2.2.6 Flexible Bag. Any leak-free plastic (e.g., Tedlar, Mylar, Teflon) or plastic-coated aluminum (e.g., aluminized Mylar) bag, or equivalent, having a capacity consistent with the selected flow rate and time length of the test run, may be used. A capacity in the range of 55 to 90 liters is suggested.

To leak-check the bag, connect it to a water manometer and pressurize the bag to 5 to 10 cm H_2O (2 to 4 in. H_2O). Allow to stand for 10 minutes. Any displacement in the water manometer indicates a leak. An alternative leak-check method is to pressurize the bag to 5 to 10 cm H_2O (2 to 4 in. H_2O) and allow to stand overnight. A deflated bag indicates a leak.

2.2.7 Pressure Gauge. A water-filled U-tube manometer, or equivalent, of about 30 cm (12 in.) is used for the flexible bag leak-check.

2.2.8 Vacuum Gauge. A mercury manometer, or equivalent, of at least 760 mm Hg (30 in. Hg) is used for the sampling train leak-check.

2.3 Analysis. For Orsat and Fyrite analyzer maintenance and operation procedures, follow the instructions recommended by the manufacturer, unless otherwise specified herein.

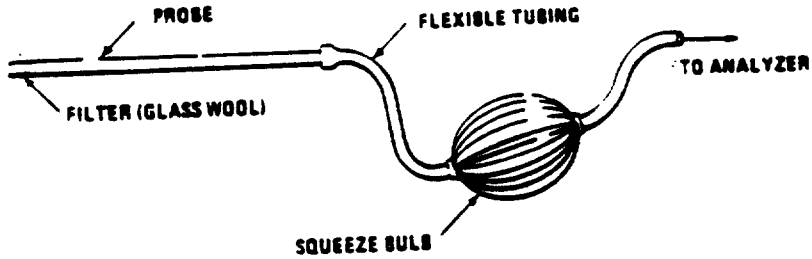


Figure 3-1. Grab sampling train.

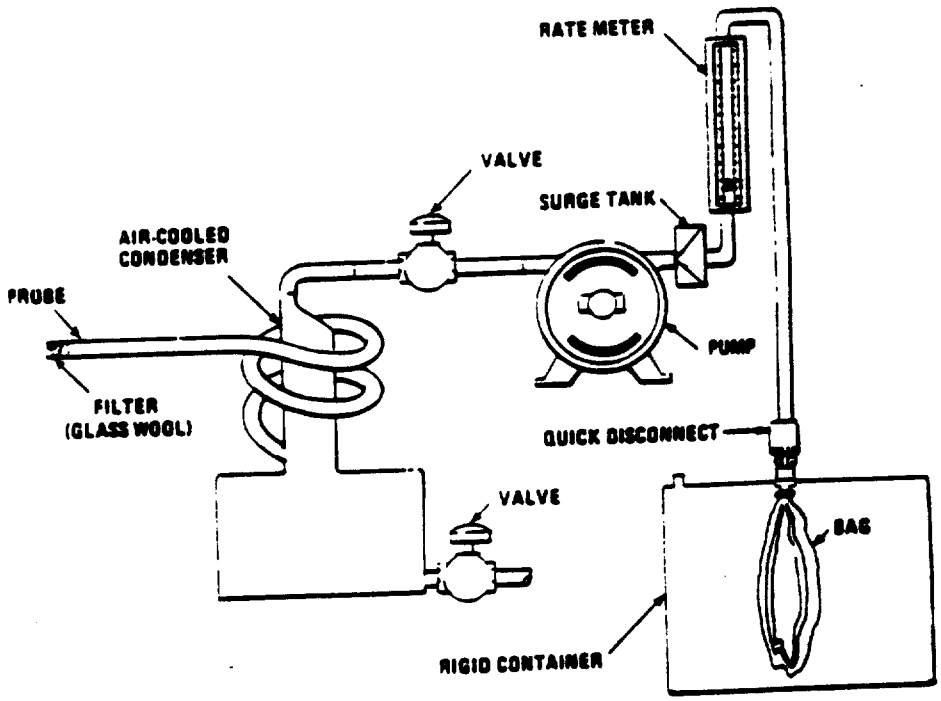


Figure 3-2. Integrated gas-sampling train.

4.2.5 To insure complete absorption of the CO_2, O_2, or if applicable, CO, make repeated passes through each absorbing solution until two consecutive readings are the same. Several passes (three or four) should be make between readings. (If constant readings cannot be obtained after three consecutive readings, replace the absorbing solution.)

4.2.6 Repeat the analysis until the following criteria are met:

4.2.6.1 For percent CO_2, repeat the analytical procedure until the results of any three analyses differ by no more that (a) 0.3 percent by volume when CO_2 is greater than 4.0 percent or (b) 0.2 percent by volume when CO_2 is less than or equal to 4.0 percent. Average the three acceptable values of percent CO_2 and report the results to the nearest 0.1 percent.

4.2.6.2 For percent O_2, repeat the analytical procedure until the results of any three analyses differ by no more than (a) 0.3 percent by volume when O_2 is less than 15.0 percent or (b) 0.2 percent by volume when O_2 is greater than or equal to 15.0 percent. Average the three acceptable values of percent O_2 and report the results to the nearest 0.1 percent.

4.2.6.3 For percent CO, repeat the analytical procedure until the results of any three analyses differ by no more than 0.3 percent. Average the three acceptable values of percent CO and report the results to the nearest 0.1 percent.

4.2.7 After the analysis is completed, leak-check (mandatory) the Orsat analyzer once again, as described in Section 5. For the results of the analysis to be valid, the Orsat analyzer must pass this leak test before an after the analysis.

NOTE: Although in most instances only CO_2 or O_2 is required, it is recommended that both CO_2 and O_2 be measured, and that Section 4.4.1 be used to validate the analytical data.

4.3 Multi-Point, Integrated Sampling and Analytical Procedure.

4.3.1 Both the minimum number of sampling points and the sampling point location shall be as specified in Section 3.3.1 of this method. The use of fewer points than specified is subject to the approval of the Administrator.

4.3.2 Follow the procedures outlined in Sections 4.2.2 through 4.2.7, except for the following: Traverse all sampling points and sample at each point for an equal length of time. Record sampling data as shown in Figure 3-3.

4.4 Quality Control Procedures.

4.4.1 Data Validation When Both CO_2 and O_2 Are Measured. Although in most instances, only CO_2 or O_2 measurement is required, it is recommended that both CO_2 and O_2 be measured to provide a check on the quality of the data. The following quality control procedure is suggested.

NOTE: Since the method for validating the CO_2 and O_2 analyses is based on combustion of organic and fossil fuels and dilution of the gas stream with air, this method does not apply to sources that (1) remove CO_2 or O_2 through processes other than combustion, (2) add O_2 (e.g., oxygen enrichment) and N_2 in proportions different from that of air, (3) add CO_2 (e.g., cement or lime kilns), or (4) have no fuel factor, F_o, values obtainable (e.g., extremely variable waste mixtures). This method validates the measured

for samples collected downstream of most lime or limestone flue-gas desulfurization units as the CO_2 added or removed from the gas stream is not significant in relation to the total CO_2 concentration. The CO_2 concentrations from other types of scrubbers using only water or basic slurry can be significantly affected and would render the F_o check minimally useful.

4.4.1.1 Calculate a fuel factor, F_o, using the following equation:

$$F_o = \frac{20.9 - \%O_2}{\%CO_2}$$

Eq. 3-3

Where:
$\%O_2$ = Percent O_2 by volume (dry basis).
$\%CO_2$ = Percent CO_2 by volume (dry basis).
20.9 = Percent O_2 by volume in ambient air.

If CO is present in quantities measurable by this method, adjust the O_2 and CO_2 values before performing the calculation for F_o as follows:

$$\%CO_2(adj) = \%CO_2 + \%CO$$

$$\%O_2(adj) = \%O_2 - 0.5\ \%CO$$

Where: %CO = Percent CO by volume (dry basis).

4.4.1.2 Compare the calculated F_o factor with the expected F_o values. The following table may be used in establishing acceptable ranges for the expected F_o if the fuel being burned is known. When fuels are burned in combination, calculate the combined fuel F_c and F_o factors (as defined in Method 19) according to the procedure in Method 19 Section 5.2.3. Then calculate the F_o factor as follows:

$$F_o = \frac{0.209\ F_c}{F_c}$$

Eq. 3-4

Fuel type		F_o range
Coal:		
	Anthracite and lignite	1.016–1.130
	Bituminous	1.083–1.230
Oil:		
	Distillate	1.260–1.413
	Residual	1.210–1.370
Gas:		
	Natural	1.600–1.836
	Propane	1.434–1.586
	Butane	1.405–1.583
Wood		1.000–1.120
Wood bark		1.003–1.130

Calculated F_o values beyond the acceptable ranges shown in this table should be investigated before accepting the test results. For example, the strength of the solutions in the gas analyzer and the analyzing technique should be checked by sampling and analyzing a known concentration, such as air; the fuel factor should be reviewed and verified. An acceptability range of ±12 percent is appropriate for the F_o factor of mixed fuels with variable fuel ratios. The level of the emission rate relative to the compliance level should be considered in determining if a retest is appropriate, i.e., if the measured emissions are much lower or much greater than the compliance limit, repetition of the test would not significantly

5. *Leak-Check Procedure for Orsat Analyzers*

Moving an Orsat analyzer frequently causes it to leak. Therefore, an Orsat analyzer should be throughly leak-checked on site before the flue gas sample is introduced into it. The procedure for leak-checking an Orsat analyzer is:

5.1.1 Bring the liquid level in each pipette up to the reference mark on the capillary tubing and then close the pipette stopcock.

5.1.2 Raise the leveling bulb sufficiently to bring the confining liquid meniscus onto the graduated portion of the burette and then close the manifold stopcock.

5.1.3 Record the meniscus position.

5.1.4 Observe the meniscus in the burette and the liquid level in the pipette for movement over the next 4 minutes.

5.1.5 For the Orsat analyzer to pass the leak-check, two conditions must be met.

5.1.5.1 The liquid level in each pipette must not fall below the bottom of the capillary tubing during this 4-minute interval.

5.1.5.2 The meniscus in the burette must not change by more than 0.2 ml during this 4-minute interval.

5.1.6 If the analyzer fails the leak-check procedure, all rubber connections and stopcocks should be checked until the cause of the leak is identified. Leaking stopcocks must be disassembled, cleaned, and regreased. Leaking rubber connections must be replaced. After the analyzer is reassembled, the leak-check procedure must be repeated.

6. *Calculations*

6.1 Nomenclature.

M_d = Dry molecular weight, g/g-mole (lb/lb-mole).
%EA = Percent excess air.
$\%CO_2$ = Percent CO_2 by volume (dry basis).
$\%O_2$ = Percent O_2 by volume (dry basis).
%CO = Percent CO by volume (dry basis).
$\%N_2$ = Percent N_2 by volume (dry basis).
0.264 = Ratio of O_2 to N_2 in air, v/v.
0.280 = Molecular weight of N_2 or CO, divided by 100.
0.320 = Molecular weight of O_2 divided by 100.
0.440 = Molecular weight of CO_2 divided by 100.

6.2 Percent Excess Air. Calculate the percent excess air (if applicable), by substituting the appropriate values of percent O_2, CO, and N_2 (obtained from Section 4.1.3 or 4.2.4) into Equation 3-1.

$$\%EA = \frac{\%O_2 - 0.5\%\ CO}{0.264\%\ N_2 - (\%O_2 - 0.5\ \%\ CO)} \times 100$$

Equation 3-1

NOTE: The equation above assumes that ambient air is used as the source of O_2 and that the fuel does not contain appreciable amounts of N_2 (as do coke oven or blast furnace gases). For those cases when appreciable amounts of N_2 are present (coal, oil, and natural gas do not contain appreciable amounts of N_2) or when oxygen enrichment is used, alternate methods, subject to approval of the Administrator, are required.

6.3 Dry Molecular Weight. Use Equation 3-2 to calculate the dry molecular weight of the stack gas

$$M_d = 0.440(\%CO_2) + 0.320(\%O_2) + 0.280(\%N_2 + \%CO)$$

Equation 3-2

METHODOLOGY FOR THE DETERMINATION OF METALS EMISSIONS IN EXHAUST GASES FROM HAZARDOUS WASTE INCINERATION AND SIMILAR COMBUSTION PROCESSES

1. Applicability and Principle

1.1 Applicability. This method is being developed for applicability for the determination of total chromium (Cr), cadmium (Cd), arsenic (As), nickel (Ni), manganese (Mn), beryllium (Be), copper (Cu), zinc (Zn), lead (Pb), selenium (Se), phosphorus (P), thallium (Tl), silver (Ag), antimony (Sb), barium (Ba), and mercury (Hg) stack emissions from hazardous waste incinerators and similar combustion processes. This method may also be used for the determination of particulate emissions following the procedures and precautions described. Modifications to the sample recovery and analysis procedures described in this protocol for the purpose of determining particulate emissions may potentially impact the front-half mercury determination.

1.2 Principle. The stack sample is withdrawn isokinetically from the source, with particulate emissions collected in the probe and on a heated filter and gaseous emissions collected in a series of chilled impingers containing an aqueous solution of dilute nitric acid combined with dilute hydrogen peroxide in each of two impingers, and acidic potassium permanganate solution in each of two impingers. Sampling train components are recovered and digested in separate front- and back-half fractions. Materials collected in the sampling train are digested with acid solutions to dissolve inorganics and to remove organic constituents that may create analytical interferences. Acid digestion is performed using conventional Parr® Bomb or microwave digestion techniques. The nitric acid and hydrogen peroxide impinger solution, the acidic potassium permanganate impinger solution, the HCl rinse solution, and the probe rinse and digested filter solutions are analyzed for mercury by cold vapor atomic absorption spectroscopy (CVAAS). The nitric acid and hydrogen peroxide solution and the probe rinse and digested filter solutions of the train catches are analyzed for Cr, Cd, Ni, Mn, Be, Cu, Zn, Pb, Se, P, Tl, Ag, Sb, Ba, and As by inductively coupled argon plasma emission spectroscopy (ICAP) or atomic absorption spectroscopy (AAS). Graphite furnace atomic absorption spectroscopy (GFAAS) is used for analysis of antimony, arsenic, cadmium, lead, selenium, and thallium, if these elements require greater analytical

for the following metals: Sb (3 ng/mL), As (1 ng/mL), Be (0.2 ng/mL), Cd (0.2 ng/mL), Cr (1 ng/mL), Pb (1 ng/mL), Se (2 ng/mL), and Tl (1 ng/mL).

Using (1) the procedures described in this method, (2) the analytical detection limits described in the previous paragraph, (3) a volume of 300 mL, Fraction 1, for the front half and 150 mL, Fraction 2A, for the back-half samples, and (4) a stack gas sample volume of 1.25 m^3, the corresponding in-stack method detection limits are presented in Table A-1 and calculated as shown:

$$\frac{A \times B}{C} = D$$

where: A = analytical detection limit, ug/mL.
B = volume of sample prior to aliquot for analysis, mL.
C = stack sample volume, dscm (dsm^3).
D = in-stack detection limit, ug/m^3.

Values in Table A-1 are calculated for the front and back half and/or the total train.

To ensure optimum sensitivity in obtaining the measurements, the concentrations of target metals in the solutions are suggested to be at least ten times the analytical detection limits. Under certain conditions, and with greater care in the analytical procedure, this concentration can be as low as approximately three times the analytical detection limit. In all cases, on at least one sample (run) in the source test and for each metal analyzed, repetitive analyses, method of standard additions (MSA), serial dilution, or matrix spike addition, etc., shall be used to establish the quality of the data.

Actual in-stack method detection limits will be determined based on actual source sampling parameters and analytical results as described above. If required, the method in-stack detection limits can be made more sensitive than those shown in Table A-1 for a specific test by using one or more of the following options:

- A 1-hour sampling run may collect a stack gas sampling volume of about 1.25 m^3. If the sampling time is increased and 5 m^3 are collected, the in-stack method detection limits would be one fourth of the values shown in Table A-1 (this means that with this change, the method is four times more sensitive than a 1-hour run. Larger sample volumes (longer runs) would make it even more sensitive).

- When both of the above two improvements are used on one sample at the same time, the resultant improvements are multiplicative. For example, where stack gas volume is increased by a factor of five and the total liquid sample digested volume of both the front and back halves is reduced by factor of six, the in-stack method detection limit is reduced by a factor of thirty (the method is thirty times more sensitive).
- Conversely, reducing stack gas sample volume and increasing sample liquid volume will increase in-stack detection limits (the method would then be less sensitive). The front-half and back-half samples (Fractions 1A plus and 2A) can be combined proportionally (see Section 1.2 of this methodology) prior to analysis. The resultant liquid volume (excluding the mercury fractions, which must be analyzed separately) is recorded. Combining the sample as described does not allow determination (whether front or back half) of where in the train the sample was captured. The in-stack method detection limit then becomes a single value for all metals except mercury, for which the contribution of the mercury fractions must be considered.
- The above discussion assumes no blank correction. Blank corrections are discussed later in this method.

2.3 Precision. The precisions (relative standard deviation) for each metal detected in a method development test at a sewage sludge incinerator, are as follows: Sb (12.7%), As (13.5%), Ba (20.6%), Cd (11.5%), Cr (11.2%), Cu (11.5%), Pb (11.6%), P (14.6%), Se (15.3%), Tl (12.3%), and Zn (11.8%). The precision for nickel was 7.7% for another test conducted at a source simulator. Beryllium, manganese and silver were not detected in the tests; however, based on the analytical sensitivity of the ICAP for these metals, it is assumed that their precisions should be similar to those for the other metals, when detected at similar levels.

2.4 Interferences. Iron can be a spectral interference during the analysis of arsenic, chromium, and cadmium by ICAP. Aluminum can be a spectral interference during the analysis of arsenic and lead by ICAP. Generally, these interferences can be reduced by diluting the sample, but this increases the method detection limit (in-stack detection limit). Refer to EPA Method 6010 (SW-846) or the other analytical methods used for details on potential interferences for this method. The analyst must eliminate or reduce

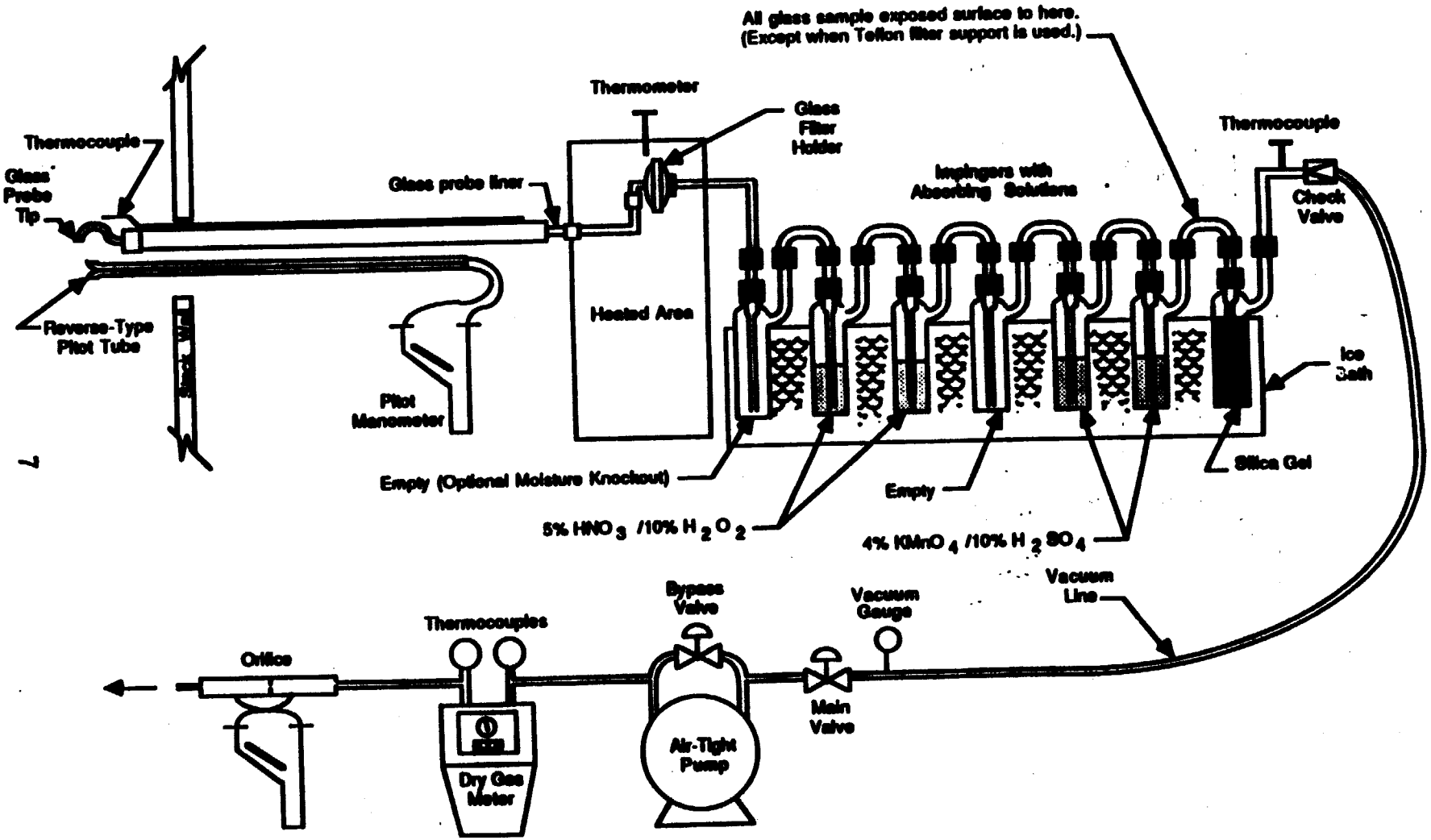


Figure A-1. Schematic of multiple metals sampling train configuration.

3.3.1 Volumetric Flasks, 100-mL, 250-mL, and 1000-mL. For preparation of standards and sample dilution.

3.3.2 Graduated Cylinders. For preparation of reagents.

3.3.3 Parr® Bombs or Microwave Pressure Relief Vessels with Capping Station (CEM Corporation model or equivalent).

3.3.4 Beakers and Watchglasses. 250-mL beakers for sample digestion with watchglasses to cover the tops.

3.3.5 Ring Stands and Clamps. For securing equipment such as filtration apparatus.

3.3.6 Filter Funnels. For holding filter paper.

3.3.7 Whatman 541 Filter Paper (or equivalent). For filtration of digested samples.

3.3.8 Disposable Pasteur Pipets and Bulbs.

3.3.9 Volumetric Pipets.

3.3.10 Analytical Balance. Accurate to within 0.1 mg.

3.3.11 Microwave or Conventional Oven. For heating samples at fixed power levels or temperatures.

3.3.12 Hot Plates.

3.3.13 Atomic Absorption Spectrometer (AAS). Equipped with a background corrector.

3.3.13.1 Graphite Furnace Attachment. With antimony, arsenic, cadmium, lead, selenium, thallium, and hollow cathode lamps (HCLs) or electrodeless discharge lamps (EDLs). Same as EPA SW-846 Methods 7041 (antimony), 7060 (arsenic), 7131 (cadmium), 7421 (lead), 7740 (selenium), and 7841 (thallium).

3.3.13.2 Cold Vapor Mercury Attachment. With a mercury HCL or EDL. The equipment needed for the cold vapor mercury attachment includes an air recirculation pump, a quartz cell, an aerator apparatus, and a heat lamp or desiccator tube. The heat lamp should be capable of raising the ambient temperature at the quartz cell by 10°C such that no condensation forms on the wall of the quartz cell. Same as EPA Method 7470.

3.3.14 Inductively Coupled Argon Plasma Spectrometer. With either a direct or sequential reader and an alumina torch. Same as EPA Method 6010.

4. Reagents

The complexity of this methodology is such that to obtain reliable results, the testers (including analysts) should be experienced and knowledgeable in

of water, and then add carefully with stirring 333 mL of 30 percent H_2O_2. Dilute to volume with water. Mix well. The reagent shall contain less than 2 ng/mL of each target metal.

4.2.2 Acidic Potassium Permanganate ($KMnO_4$) Absorbing Solution, 4 Percent $KMnO_4$ (W/V), 10 Percent H_2SO_4 (V/V). Prepare fresh daily. Mix carefully, with stirring, 100 mL of concentrated H_2SO_4 into 800 mL of water, and add water with stirring to make a volume of 1 L: this solution is 10 percent H_2SO_4 (V/V). Dissolve, with stirring, 40 g of $KMnO_4$ into 10 percent H_2SO_4 (V/V) and add 10 percent H_2SO_4 (V/V) with stirring to make a volume of 1 L: this is the acidic potassium permanganate absorbing solution. Prepare and store in glass bottles to prevent degradation. The reagent shall contain less than 2 ng/mL of Hg.

Precaution: To prevent autocatalytic decomposition of the permanganate solution, filter the solution through Whatman 541 filter paper. Also, due to the potential reaction of the potassium permanganate with the acid, there may be pressure buildup in the sample storage bottle; these bottles shall not be fully filled and shall be vented both to relieve potential excess pressure and prevent explosion due to pressure buildup. Venting is required, but should not allow contamination of the sample; a No. 70-72 hole drilled in the container cap and Teflon liner has been used.

4.2.3 Nitric Acid, 0.1 N. Add with stirring 6.3 mL of concentrated HNO_3 (70 percent) to a flask containing approximately 900 mL of water. Dilute to 1000 mL with water. Mix well. The reagent shall contain less than 2 ng/mL of each target metal.

4.2.4 Hydrochloric Acid (HCl), 8 N. Make the desired volume of 8N HCl in the following proportions. Carefully add with stirring, 690 mL of concentrated HCl to a flask containing 250 mL of water. Dilute to 1000 mL with water. Mix well. The reagent shall contain less than 2 ng/mL of Hg.

4.3 Glassware Cleaning Reagents.

4.3.1 Nitric Acid, Concentrated. Fisher ACS grade or equivalent.

4.3.2 Water. To conform to ASTM Specifications D1193-77, Type II.

4.3.3 Nitric Acid, 10 Percent (V/V). Add with stirring 500 mL of concentrated HNO_3 to a flask containing approximately 4000 mL of water. Dilute to 5000 mL with water. Mix well. Reagent shall contain less than 2 ng/mL of each target metal.

4.4.31 AAS Grade Al Standard, 1000 ug/mL.

4.4.32 AAS Grade Fe Standard, 1000 ug/mL.

4.4.33 The metals standards may also be made from solid chemicals as described in EPA Method 200.7. EPA SW-846 Method 7470 or Standard Methods for the Analysis of Water and Wastewater, 15th Edition, Method 303F should be referred to for additional information on mercury standards.

4.4.34 Mercury Standards and Quality Control Samples. Prepare fresh weekly a 10 ug/mL intermediate mercury standard by adding 5 mL of 1000 ug/mL mercury stock solution to a 500-mL volumetric flask; dilute with stirring to 500 mL by first carefully adding 20 mL of 15 percent HNO_3 and then adding water to the 500-mL volume. Mix well. Prepare a 200 ng/mL working mercury standard solution fresh daily: add 5 mL of the 10 ug/mL intermediate standard to a 250-mL volumetric flask and dilute to 250 mL with 5 mL of 4 percent $KMnO_4$, 5 mL of 15 percent HNO_3, and then water. Mix well. At least six separate aliquots of the working mercury standard solution should be used to prepare the standard curve. These aliquots should contain 0.0, 1.0, 2.0, 3.0, 4.0, and 5.0 mL of the working standard solution containing 0, 200, 400, 600, 800, and 1000 ng mercury, respectively. Quality control samples should be prepared by making a separate 10 ug/mL standard and diluting until in the range of the calibration.

4.4.35 ICAP Standards and Quality Control Samples. Calibration standards for ICAP analysis can be combined into four different mixed standard solutions as shown below.

MIXED STANDARD SOLUTIONS FOR ICAP ANALYSIS

Solution	Elements
I	As, Be, Cd, Mn, Pb, Se, Zn
II	Ba, Cu, Fe
III	Al, Cr, Ni
IV	Ag, P, Sb, Tl

Prepare these standards by combining and diluting the appropriate volumes of the 1000 ug/mL solutions with 5 percent nitric acid. A minimum of one standard and a blank can be used to form each calibration curve. However, a separate quality control sample spiked with known amounts of the target metals in quantities in the midrange of the calibration curve should be prepared. Suggested standard levels are 25 ug/mL for AL, Cr and Pb, 15 ug/mL for Fe, and 10 ug/mL for the remaining elements. Standards containing less than 1 ug/mL of

Method 5, Section 4.1.1, except that, unless particulate emissions are to be determined, the filter need not be desiccated or weighed. All sampling train glassware should first be rinsed with hot tap water and then washed in hot soapy water. Next, glassware should be rinsed three times with tap water, followed by three additional rinses with water. All glassware should then be soaked in a 10 percent (V/V) nitric acid solution for a minimum of 4 hours, rinsed three times with water, rinsed a final time with acetone, and allowed to air dry. All glassware openings where contamination can occur should be covered until the sampling train is assembled for sampling.

5.1.2 Preliminary Determinations. Same as Method 5, Section 4.1.2.

5.1.3 Preparation of Sampling Train. Follow the same general procedures given in Method 5, Section 4.1.3, except place 100 mL of the nitric acid/hydrogen peroxide solution (Section 4.2.1) in each of the two HNO_3/H_2O_2 impingers as shown in Figure A-1 (normally the second and third impingers), place 100 mL of the acidic potassium permanganate absorbing solution (Section 4.2.2) in each of the two permanganate impingers as shown in Figure A-1, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the last impinger. Alternatively, the silica gel may be weighed directly in the impinger just prior to train assembly.

Several options are available to the tester based on the sampling requirements and conditions. The use of an empty first impinger can be eliminated if the moisture to be collected in the impingers will be less than approximately 100 mL. If necessary, use as applicable to this methodology the procedure described in Section 7.1.1 of EPA Method 101A, 40 CFR Part 61, Appendix B, to maintain the desired color in the last permanganate impinger.

Retain for reagent blanks volumes of the nitric acid/hydrogen peroxide solution per Section 5.2.9 of this method and of the acidic potassium permanganate solution per Section 5.2.10. These reagent blanks should be labeled and analyzed as described in Section 7. Set up the sampling train as shown in Figure A-1, or if mercury analysis is not to be performed in the train, then it should be modified by removing the three impingers which are the two permanganate impingers and the impinger preceding the permanganate impingers. If necessary to ensure leak-free sampling train connections, Teflon tape or other non-contaminating material should be used instead of silicone grease to prevent contamination.

stirring into Container No. 1.A. Analyze the HCl rinse separately by carefully diluting with stirring the contents of Container No. 1.A. to 500 mL with deionized distilled water. Filter (if necessary) through Whatman 40 filter paper, and then analyze for mercury according to Section 7.4, except limit the aliquot size to a maximum of 10 mL. Prepare and analyze a water diluted blank 8 N HCL sample by using the same procedure as that used by Container No. 1.A., except add 5 mL of 8 N HCl with stirring to 40 mL of water, and then dilute to 100 mL with water. Then analyze as instructed for the sample from Container No. 1.A. Because the previous separate permanganate solution rinse (Section 7.2.1) and water rinse (as modified in these guidelines) have the capability to recover a very high percentage of the mercury from the permanganate impingers, the amount of mercury in the HCl rinse in Container No. 1.A. may be very small, possibly even insignificantly small. However, add the total of any mercury analyzed and calculated for the HCl rinse sample Container No. 1.A. to that calculated from the mercury sample from Section 7.3.2 which contains the separate permanganate rinse (and water rinse as modified herein) for calculation of the total sample mercury concentration.]

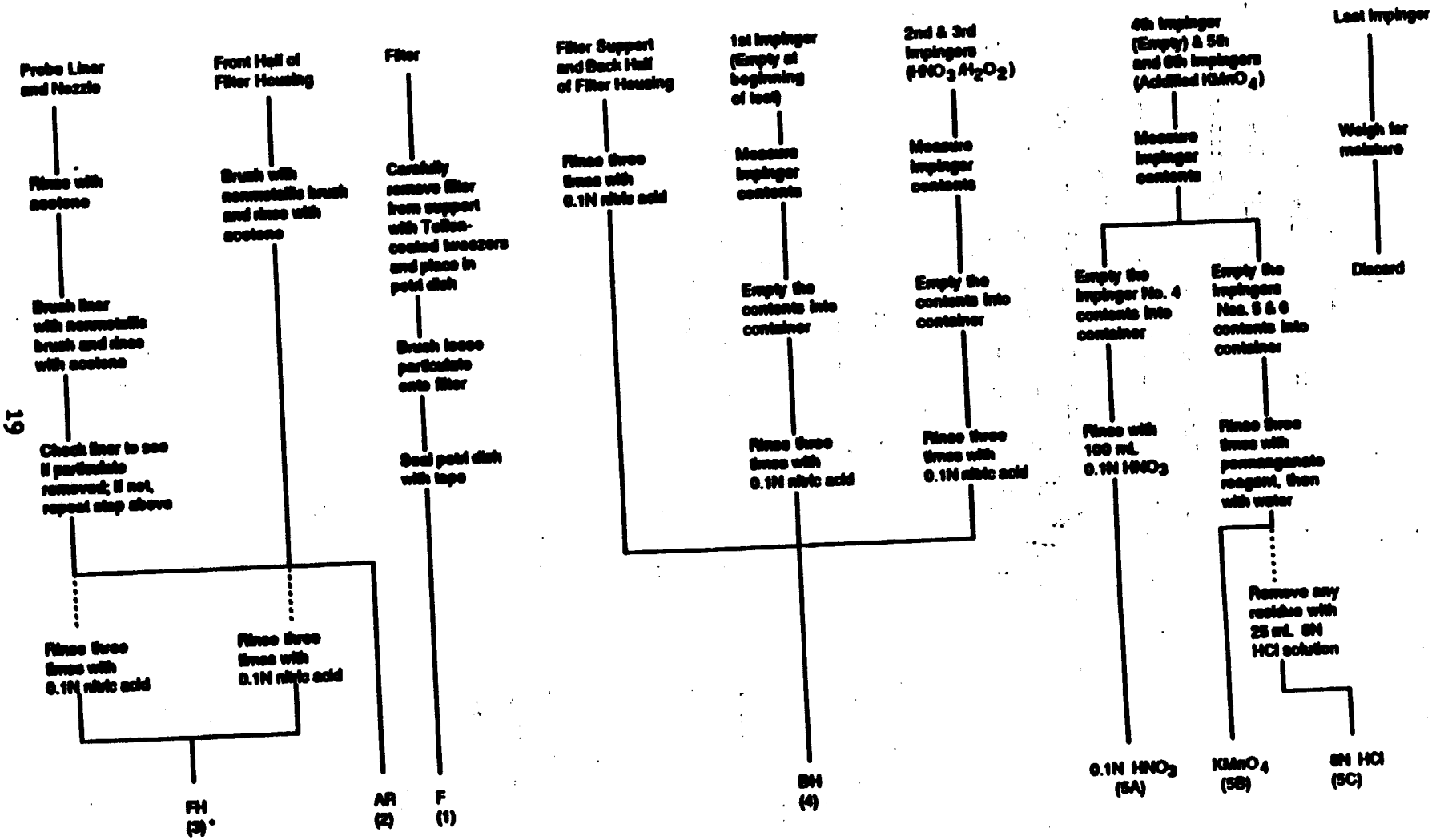
5.1.4 Leak-Check Procedures. Follow the leak-check procedures given in Method 5, Section 4.1.4.1 (Pretest Leak-Check), Section 4.1.4.2 (Leak-Checks During the Sample Run), and Section 4.1.4.3 (Post-Test Leak-Checks).

5.1.5 Sampling Train Operation. Follow the procedures 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 Figure 5-2 of Method 5.

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

5.2 Sample Recovery. Begin cleanup procedures as soon as the probe is removed from the stack at the end of a sampling period.

The probe should be allowed to cool prior to sample recovery. When it can be safely handled, wipe off all external particulate matter near the tip of the probe nozzle and place a rinsed, non-contaminating cap over the probe nozzle to prevent losing or gaining particulate matter. Do not cap the probe tip tightly while the sampling train is cooling. This normally causes a vacuum



* Number in parentheses indicates container number

Figure A-2. Sample recovery scheme.

and particulate matter have been collected in the sample container, tighten the lid on the sample container so that acetone will not leak out when it is shipped to the laboratory. Mark the height of the fluid level to determine whether or not leakage occurred during transport. Label the container clearly to identify its contents.

5.2.3 Container No. 3 (Probe Rinse). Keep the probe assembly clean and free from contamination as described in Section 5.2.2 of this method during the 0.1 N nitric acid rinse described below. Rinse the probe nozzle and fitting, probe liner, and front half of the filter holder thoroughly with 100 mL of 0.1 N nitric acid and place the wash into a sample storage container. Note: The use of exactly 100 mL is necessary for the subsequent blank correction procedures. Perform the rinses as applicable and generally as described in Method 12, Section 5.2.2. Record the volume of the combined rinse. Mark the height of the fluid level on the outside of the storage container and use this mark to determine if leakage occurs during transport. Seal the container and clearly label the contents. Finally, rinse the nozzle, probe liner, and front half of the filter holder with water followed by acetone and discard these rinses.

5.2.4 Container No. 4 (Impingers 1 through 3, HNO_3/H_2O_2 Impingers and Moisture Knockout Impinger, when used, Contents and Rinses). Due to the potentially large quantity of liquid involved, the tester may place the impinger solutions from impingers 1 through 3 in more than one container. Measure the liquid in the first three impingers volumetrically to within 0.5 mL using a graduated cylinder. Record the volume of liquid present. This information is required to calculate the moisture content of the sampled flue gas. Clean each of the first three impingers, the filter support, the back half of the filter housing, and connecting glassware by thoroughly rinsing with 100 mL of 0.1 N nitric acid using the procedure as applicable and generally as described in Method 12, Section 5.2.4. Note: The use of exactly 100 mL of 0.1 N nitric acid rinse is necessary for the subsequent blank correction procedures. Combine the rinses and impinger solutions, measure and record the volume. Mark the height of the fluid level on the outside of the container to determine if leakage occurs during transport. Seal the container and clearly label the contents.

5.2.5 Container Nos. 5A, 5B, and 5C. 5A (0.1 N HNO_3), 5B ($KMnO_4/H_2SO_4$ absorbing solution), and 5C (8 N HCl rinse and dilution). (As described

impinger on its side and rotating it so that the HCl contacts all inside surfaces. Use a total of only 25 mL of 8 N HCl for rinsing both permanganate impingers combined. Rinse the first impinger, then pour the actual rinse used for the first impinger into the second impinger for its rinse. Finally, pour the 25 mL of 8 N HCl rinse carefully with stirring into Container No. 5C. Mark the height of the fluid level on the outside of the bottle to determine if leakage occurs during transport.

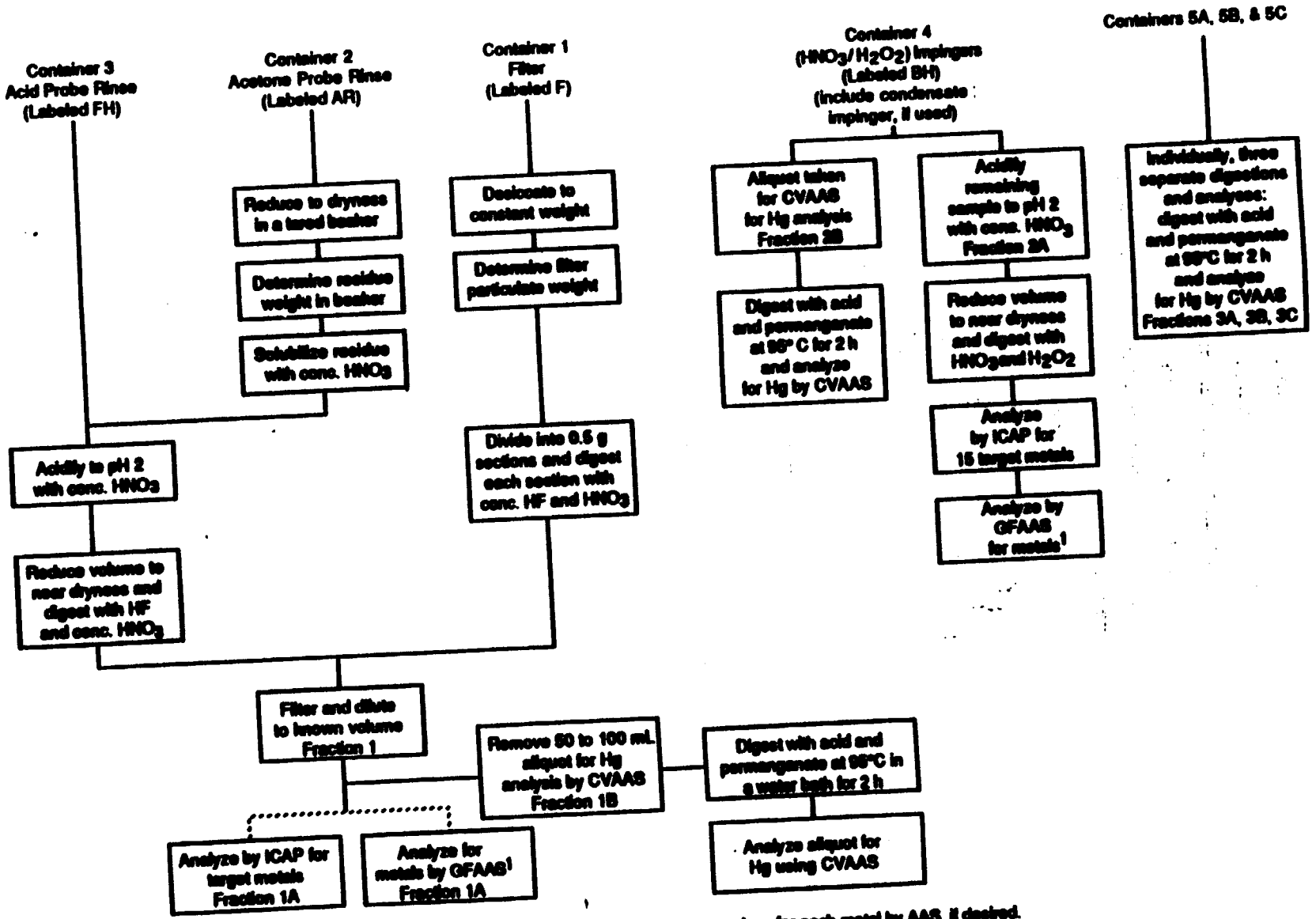
5.2.6 Container No. 6 (Silica Gel). Note the color of the indicating silica gel to determine whether it has been completely spent and make a notation of its condition. Transfer the silica gel from its impinger to its original container and seal. The tester may use a funnel to pour the silica gel and a rubber policeman to remove the silica gel from the impinger. The small amount of particles that may adhere to the impinger wall need not be removed. Do not use water or other liquids to transfer the silica gel since weight gained in the silica gel impinger is used for moisture calculations. Alternatively, if a balance is available in the field, record the weight of the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g.

5.2.7 Container No. 7 (Acetone Blank). If particulate emissions are to be determined, at least once during each field test, place a 100-mL portion of the acetone used in the sample recovery process into a labeled container for use in the front-half field reagent blank. Seal the container.

5.2.8 Container No. 8A (0.1 N Nitric Acid Blank). At least once during each field test, place 300 mL of the 0.1 N nitric acid solution used in the sample recovery process into a labeled container for use in the front-half and back-half field reagent blanks. Seal the container. Container No. 8B (water blank). At least once during each field test, place 100 mL of the water used in the sample recovery process into a labeled Container No. 8B. Seal the container.

5.2.9 Container No. 9 (5% Nitric Acid/10% Hydrogen Peroxide Blank). At least once during each field test, place 200 mL of the 5% nitric acid/10% hydrogen peroxide solution used as the nitric acid impinger reagent into a labeled container for use in the back-half field reagent blank. Seal the container.

5.2.10 Container No. 10 (Acidified Potassium Permanganate Blank). At least once during each field test, place 100 mL of the acidified potassium permanganate solution used as the impinger solution and in the sample recovery



[1] Analysis by AAS for metals found at less than 2 ug/mL in digestate solution, if desired. Or analyze for each metal by AAS, if desired.

Figure A-3. Sample preparation and analysis scheme.

solution to within 0.1 mL. Quantitatively remove a 50-mL aliquot and label as Fraction 1B. Label the remaining 250-mL portion as Fraction 1A. Fraction 1A is used for ICAP or AAS analysis. Fraction 1B is used for the determination of front-half mercury.

5.3.4 Container No. 4 (Impingers 1-3). Measure and record the total volume of this sample (Fraction 2) to within 0.5 mL. Remove a 75- to 100-mL aliquot for mercury analysis and label as Fraction 2B. Label the remaining portion of Container No. 4 as aliquot Fraction 2A. Aliquot Fraction 2A defines the volume of 2A prior to digestion. All of aliquot Fraction 2A is digested to produce concentrated Fraction 2A. Concentrated Fraction 2A defines the volume of 2A after digestion which is normally 150 mL. Only concentrated Fraction 2A is analyzed for metals (except that it is not analyzed for mercury). The Fraction 2B aliquot should be prepared and analyzed for mercury as described in Section 5.4.3. Aliquot Fraction 2A shall be pH 2 or lower. If necessary, use concentrated nitric acid by careful addition and stirring to lower aliquot Fraction 2A to pH 2. The sample should be rinsed into a beaker with water and the beaker should be covered with a ribbed watchglass. The sample volume should be reduced to approximately 20 mL by heating on a hot plate at a temperature just below boiling. Then follow either of the digestion procedures described in Sections 5.3.4.1 and 5.3.4.2, below.

5.3.4.1 Conventional Digestion Procedure. Add 30 mL of 50 percent nitric acid and heat for 30 minutes on a hot plate to just below boiling. Add 10 mL of 3 percent hydrogen peroxide and heat for 10 more minutes. Add 50 mL of hot water and heat the sample for an additional 20 minutes. Cool, filter the sample, and dilute to 150 mL (or the appropriate volume for the expected metals concentrations) with water. This dilution is concentrated Fraction 2A. Measure and record the volume of the Fraction 2A solution to within 0.1 mL.

5.3.4.2 Microwave Digestion Procedure. Add 10 mL of 50 percent nitric acid and heat for 6 minutes in intervals of 1 to 2 minutes at 600 Watts. Allow the sample to cool. Add 10 mL of 3 percent hydrogen peroxide and heat for 2 more minutes. Add 50 mL of hot water and heat for an additional 5 minutes. Cool, filter the sample, and dilute to 150 mL (or the appropriate volume for the expected metals concentrations) with water. This dilution is concentrated Fraction 2A. Measure and record the volume of the Fraction 2A solution to within 0.1 mL.

Note: All microwave heating times given are approximate and are

5.4.1 ICAP Analysis. Fraction 1A and Fraction 2A are analyzed by ICAP using EPA SW-846 Method 6010 or Method 200.7 (40 CFR 136, Appendix C). Calibrate the ICAP, and set up an analysis program as described in Method 6010 or Method 200.7. The quality control procedures described in Section 7.3.1 of this method shall be followed. Recommended wavelengths for use in the analysis are listed below.

Element	Wavelength (nm)
Aluminum	308.215
Antimony	206.833
Arsenic	193.696
Barium	455.403
Beryllium	313.042
Cadmium	226.502
Chromium	267.716
Copper	324.754
Iron	259.940
Lead	220.353
Manganese	257.610
Nickel	231.604
Phosphorous	214.914
Selenium	196.026
Silver	328.068
Thallium	190.864
Zinc	213.856

The wavelengths listed are recommended because of their sensitivity and overall acceptance. Other wavelengths may be substituted if they can provide the needed sensitivity and are treated with the same corrective techniques for spectral interference.

Initially, analyze all samples for the desired target metals (except mercury) plus iron and aluminum. If iron and aluminum are present in the sample, the sample may have to be diluted so that each of these elements is at a concentration of less than 50 ppm to reduce their spectral interferences on arsenic, cadmium, chromium, and lead.

Note: When analyzing samples in a hydrofluoric acid matrix, an alumina torch should be used; since all front-half samples will contain hydrofluoric acid, use an alumina torch.

5.4.2 AAS by Direct Aspiration and/or Graphite Furnace. If analysis of metals in Fraction 1A and Fraction 2A using graphite furnace or direct aspiration AAS is desired, Table A-2 should be used to determine which techniques and methods should be applied for each target metal. Table A-2

T. : A-2 (Continued)

Metal	Technique	SW-846 Method No.	Wavelength (nm)	Interference	
				Cause	Minimization
Fe	Aspiration	7380	248.3	Contamination	Great care taken to avoid contamination
Pb	Aspiration	7420	283.3	217.0 nm alternate	Background correction required
Pb	Furnace	7421	283.3	Poor recoveries	Matrix modifier, add 10 uL of phosphorus acid to 1 mL of prepared sample in sampler cup
Mn	Aspiration	7460	279.5	403.1 nm alternate	Background correction required
Ni	Aspiration	7520	232.0	352.4 nm alternate Fe, Co, and Cr	Background correction required Matrix matching or a nitrous-oxide/ acetylene flame
				Nonlinear response	Sample dilution or use 352.3 nm line
Se	Furnace	7740	196.0	Volatility	Spike samples and reference materials and add nickel nitrate to minimize volatilization
				Adsorption & scatter	Background correction is required and Zeeman background correction can be useful
Ag	Aspiration	7760	328.1	Adsorption & scatter AgCl insoluble	Background correction is required Avoid hydrochloric acid unless silver is in solution as a chloride complex
				Viscosity	Sample and standards monitored for aspiration rate
Tl	Aspiration	7840	276.8		Background correction is required Hydrochloric acid should not be used
Tl	Furnace	7841	276.8	Hydrochloric acid or chloride	Background correction is required Verify that losses are not occurring for volatization by spiked samples or standard addition; Palladium is a suitable matrix modifier
Zn	Aspiration	7950	213.9	High Si, Cu, & P Contamination	Strontium removes Cu and phosphate Great care taken to avoid contamination

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 5.5); Leak-Check of the Metering System (Section 5.6); and Barometer (Section 5.7).

6.2 Inductively Coupled Argon Plasma Spectrometer Calibration. Prepare standards as outlined in Section 4.4. Profile and calibrate the instrument according to the instrument manufacturer's recommended procedures using the above standards. The instrument calibration should be checked once per hour. If the instrument does not reproduce the concentrations of the standard within 10 percent, the complete calibration procedures should be performed.

6.3 Atomic Absorption Spectrometer - Direct Aspiration, Graphite Furnace and Cold Vapor Mercury Analyses. Prepare the standards as outlined in Section 4.4. Calibrate the spectrometer using these prepared standards. Calibration procedures are also outlined in the EPA methods referred to in Table A-2 and in SW-846 Method 7470 or Standard Methods for Water and Wastewater, 15th Edition, Method 303F (for mercury). Each standard curve should be run in duplicate and the mean values used to calculate the calibration line. The instrument should be recalibrated approximately once every 10 to 12 samples.

7. Quality Control

7.1 Sampling. Field Reagent Blanks. When analyzed, the blank samples in Container Numbers 7 through 12 produced previously in Sections 5.2.7 through 5.2.12, respectively, shall be processed, digested, and analyzed as follows. Digest and process one of the filters from Container No. 12 per Section 5.3.1, 100 mL from Container No. 7 per Section 5.3.2, and 100 mL from Container No. 8A per Section 5.3.3. This produces Fraction Blank 1A and Fraction Blank 1B from Fraction Blank 1. [If desired, the other two filters may be digested separately according to Section 5.3.1, diluted separately to 300 mL each, and analyzed separately to produce a blank value for each of the two additional filters. If these analyses are performed, they will produce two additional values for each of Fraction Blank 1A and Fraction Blank 1B. The three Fraction Blank 1A values will be calculated as three values of M_{fab} in Equation 3 of Section 8.4.3, then the three values shall be totalled and divided by 3 to become the value M_{fab} to

(must be within 25% of calibration), and one duplicate analysis (must be within 10% of average or repeat all analyses).

7.3.2 Direct Aspiration and/or Graphite Furnace AAS Analysis for antimony, arsenic, barium, beryllium, cadmium, copper, chromium, lead, nickel, manganese, mercury, phosphorus, selenium, silver, thallium, and zinc. All samples should be analyzed in duplicate. Perform a matrix spike on at least one front-half sample and one back-half sample or one combined sample. If recoveries of less than 75 percent or greater than 125 percent are obtained for the matrix spike, analyze each sample by the method of additions. A quality control sample should be analyzed to check the accuracy of the calibration standards. The results must be within 10% or the calibration repeated.

7.3.3 Cold Vapor AAS Analysis for Mercury. All samples should be analyzed in duplicate. A quality control sample should be analyzed to check the accuracy of the calibration standards (within 15% or repeat calibration). Perform a matrix spike on one sample from the nitric impinger portion (must be within 25% or samples must be analyzed by the method of standard additions). Additional information on quality control can be obtained from EPA SW-846 Method 7470 or in Standard Methods for Water and Wastewater, 15th Edition, Method 303F.

8. Calculations

8.1 Dry Gas Volume. Using the data from this test, calculate $V_{m(std)}$, the dry gas sample volume at standard conditions as outlined in Section 6.3 of Method 5.

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

8.3 Stack Gas Velocity. Using the data from this test and Equation 2-9 of Method 2, calculate the average stack gas velocity.

8.4 Metals (Except Mercury) in Source Sample.

8.4.1 Fraction 1A, Front Half, Metals (except Hg). Calculate separately the amount of each metal collected in Fraction 1 of the sampling train using the following equation:

$$M_{Fh} = C_{a1} F_d V_{soln.1} \qquad \text{Eq. 1*}$$

*If Fractions 1A and 2A are combined, proportional aliquots must be used. Appropriate changes must be made in Equations 1-3 to reflect this approach.

Note: If the measured blank value for the front half (m_{fhb}) is in the range 0.0 to A ug [where A ug equals the value determined by multiplying 1.4 ug per square inch (1.4 ug/in.^{2}) times the actual area in square inches (in.^{2}) of the filter used in the emission sample], m_{fhb} may be used to correct the emission sample value (m_{fh}); if m_{fhb} exceeds A ug, the greater of the two following values (either I. or II.) may be used:

I. A ug, or

II. the lesser of (a) m_{fhb}, or (b) 5 percent of m_{fh}.

If the measured blank value for the back half (m_{bhb}) is in the range 0.0 to 1 ug, m_{bhb} may be used to correct the emission sample value (m_{bh}); if m_{bhb} exceeds 1 ug, the greater of the two following values may be used: 1 ug or 5 percent of m_{bh}.

8.5 Mercury in Source Sample.

8.5.1 Fraction 1B, Front Half, Hg. Calculate the amount of mercury collected in the front half, Fraction 1, of the sampling train using the following equation:

$$Hg_{fh} = \frac{Q_{fh}}{V_{f1B}} \times V_{soln.1} \qquad \text{Eq. 4}$$

where:

Hg_{fh} = total mass of mercury collected in the front half of the sampling train (Fraction 1), ug.

Q_{fh} = quantity of mercury in analyzed sample, ug.

$V_{soln.1}$ = total volume of digested sample solution (Fraction 1), mL.

V_{f1B} = volume of Fraction 1B analyzed, mL. See the following Note.

Note: V_{f1B} is the actual amount of Fraction 1B analyzed. For example, if 1 mL of Fraction 1B were diluted to 100 mL to bring it into the proper analytical range, and 1 mL of the 100-mL dilution were analyzed, V_{f1B} would be 0.01.

8.5.2 Fraction 2B and Fractions 3A, 3B, and 3C, Back Half, Hg. Calculate the amount of mercury collected in Fractions 2 using Equation 5 and in Fractions 3A, 3B, and 3C using Equation 6. Calculate the total amount of mercury collected in the back half of the sampling train using Equation 7.

where:

Hg_t = total mass of mercury collected in the sampling train, ug.
Hg_{frb} = blank correction value for mass of mercury detected in front-half field reagent blank, ug.
Hg_{bhb} = blank correction value for mass of mercury detected in back -half field reagent blanks, ug.

Note: If the total of the measured blank values ($Hg_{frb} + Hg_{bhb}$) is in the range of 0 to 6 ug, then the total may be used to correct the emission sample value ($Hg_{fh} + Hg_{bh}$); if it exceeds 6 ug, the greater of the following two values may be used: 6 ug or 5 percent of the emission sample value ($Hg_{fh} + Hg_{bh}$).

8.6 Metal Concentration of Stack Gas. Calculate each metal separately for the cadmium, total chromium, arsenic, nickel, manganese, beryllium, copper, lead, phosphorus, thallium, silver, barium, zinc, selenium, antimony, and mercury concentrations in the stack gas (dry basis, adjusted to standard conditions) as follows:

$$C_s = K_4 \ (M_t / V_{m(std)}) \qquad \text{Eq.9}$$

where:

C_s = concentration of each metal in the stack gas, mg/dscm.
K_4 = 10^{-3} mg/ug.
M_t = total mass of each metal collected in the sampling train, ug; (substitute Hg_t for M_t for the mercury calculation).
$V_{m(std)}$ = volume of gas sample as measured by the dry gas meter, corrected to dry standard conditions, dscm.

8.7 Isokinetic Variation and Acceptable Results. Same as Method 5, Sections 6.11 and 6.12, respectively.

9. Bibliography

9.1 Method 303F in Standard Methods for the Examination of Water Wastewater, 15th Edition, 1980. Available from the American Public Health Association, 1015 18th Street N.W., Washington, D.C. 20036.

9.2 EPA Methods 6010, 7000, 7041, 7060, 7131, 7421, 7470, 7740, and 7841. Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. SW-846, Third Edition. September 1988. Office of Solid Waste and Emergency Response, U. S. Environmental Protection Agency, Washington, D.C. 20460.