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ENVIRONMENTAL ASSESSMENT
OF A COAL/WATER SLURRY FIRED
INDUSTRIAL BOILER
Volume II. Data Supplement

Prepared for

Office of Air Quality Planning and Standards

Prepared by

Air and Energy Engineering Research
Laboratory
Research Triangle Park NC 27711

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Volume II
Data Supplement

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CONTENTS

SECTION 1

INTRODUCTION

The purpose of this data supplement is to document data in greater detail than was possible in Volume I (Technical Results) of this report. It is intended to provide sufficient detail for researchers to perform their own analysis of the data obtained. Readers are referred to the technical volume for objectives, description of source emission results, data interpretation, and conclusions.

The remaining sections of this data supplement contain the following information:

Section 2 -- Boiler Operting Data: pressures, temperatures, and flowrates; efficiency calculations using the ASME heat loss method

Section 3 -- Sampling Data Sheets: continuous monitor data summary; operating data tables and isokinetic calculations for EPA Method 5/8 (for particulate mass and SO_2 and SO_3 emissions), SASS (for trace element and semi- and nonvolatile organic sampling), and VOST (for volatile organic sampling); and C_1 to C_6 hydrocarbon analysis data by onsite GC/FID

Section 4 -- Laboratory Analysis Results: trace element results by spark source mass spectrometry (SSMS), atomic absorption spectroscopy (AAS), and other methods; total chromatographable organic (TCO) and gravimetric (GRAV) results, determination of semivolatile

organic priority pollutants by gas chromatography/mass spectrometry (GC/MS), and infrared (IR) spectra of total sample extracts; analyses of VOST traps by GC/MS; and biological assay reports.

SECTION 2

BOILER OPERATING DATA

BOILER OPERATING DATA: 8-25-83

Time	Inlet Air Temp. (°F)	Windbox Air Temp. (°F)	Windbox Pressure (in. WC)	Economizer Gas Inlet Temp. (°F)	Slurry				
					Header Temp. (°F)	Pump Pressure (psig)	Strainer Discharge Pressure (psig)	Flowrate	
								Magnetic Meter (gpm)	Mass Meter (gpm)
0815	85	523		540	98			9.38	9.95
0930	88	523	11.2	525	98	206		9.36	10.09
1015	92	518	11.2	532	98	205		9.36	10.11
1115	93	518		533	99	204		9.33	10.08
1200	98	520	11.2	535	100	204		9.30	9.92
1245	99	520	11.2	540	101	204		9.30	9.86
1330	99	521	11.2	542	100	210	196	9.29	9.82
1425	101	522	11.2	526	99	214	200	9.27	9.85
1500	102	519	11.2	529	99	212	200	9.26	9.76
1600	99	517	11.2	533	100	214	200	9.25	9.79
1700	98	520	11.2	539	101	210	198	9.24	9.72
1745	99	517	11.2	542	101	210	198	9.26	9.65
1845	97	518	11.2	544	101	210	196	9.26	9.72
Average	96	520	11.2	535	100	209	198	9.30	9.87

(continued)

BOILER OPERATING DATA: 8-25-83 (continued)

	Natural Gas Flow		Steam		Feedwater		
Time	Burner No. 4 (10^3 scfh)	Air Heater (10^3 scfh)	Pressue (psig)	Flow (10^3 lb/hr)	Feed Temp. (°F)	Economizer Inlet Temp. (°F)	Economizer Outlet Temp. (°F)
0815	3.72	3.73	173	55.7		262	200
0930	3.79	3.69	176	56.0	265	262	200
1015	3.51	3.69	175	55.7	265	262	200
1115	3.21	3.61	175	55.7		262	200
1200	2.99	3.52	175	54.6	265	262	200
1245	2.99	3.51	175	55.0		262	200
1330	2.94	3.51	175	54.9	265	262	200
1425	2.96	3.56	175	56.5		262	200
1500	2.98	3.46	175	55.7		262	200
1600	2.93	3.35	176	55.2		262	200
1700	2.89	3.45	174	55.9	265	262	200
1745	2.96	3.50	175	55.8		262	200
1845	2.96	3.55	175	55.2	265	262	200
Average	3.14	3.55	175	55.5	265	262	200

(continued)

BOILER OPERATING DATA: 8-25-83 (continued)

Time	Burner #2		Burner #3		Burner #4		Furnace Pressure (in. WC)	Stack Temp. (°F)	Stack O_2 (% day)
	Air Pressure (psig)	Slurry Pressure (psig)	Air Pressure (psig)	Slurry Pressure (psig)	Air Pressure (psig)	Slurry Pressure (psig)			
0815	206	168	206	166	206	168	-0.15	571	6.7
0930	206	166	206	164	204	176	-0.31	559[a]	6.8
1015	204	164	206	164	204	176	-0.31	567	6.8
1115	206	164	208	164	206	174	-0.30	572	6.8
1200	206	164	208	162	204	174	-0.30	574	6.8
1245	206	164	208	162	206	174	-0.31	577	6.6
1330	204	166	208	166	206	178	-0.31	580	6.8
1425	206	167	208	166	206	178	-0.40	561[b]	7.0
1500	204	168	207	166	206	179	-0.16	563	6.7
1600							-0.16	568	6.7
1700	206	168	208	166	206	178	-0.15	574	7.8
1745	206	168	208	166	206	178	-0.16	578	6.7
1845	206	167	208	166	206	178	-0.16	576	6.8
Average	206	166	208	165	206	176	-0.24	571	6.8

[a]Soothflow at 0915
[b]Soothflow at 1400

SUMMARY SHEET

ASME TEST FORM FOR ABBREVIATED EFFICIENCY TEST

PTC 4.1-a (1964)

	TEST NO 1	BOILER NO. 1	DATE 8-25-72
OWNER OF PLANT DuPont	LOCATION Steele Creek		
TEST CONDUCTED BY Acurex	OBJECTIVE OF TEST Emission check	DURATION 6 hr	
BOILER MAKE & TYPE Foster	RATED CAPACITY 60,000		
STOKER TYPE & SIZE			
PULVERIZER, TYPE & SIZE	BURNER, TYPE & SIZE		
FUEL USED Oil MINE	COUNTY	STATE	SIZE AS FIRED

PRESSURES & TEMPERATURES

1	STEAM PRESSURE IN BOILER DRUM	psia	190
2	STEAM PRESSURE AT S. H. OUTLET	psia	
3	STEAM PRESSURE AT R. H. INLET	psia	
4	STEAM PRESSURE AT R. H. OUTLET	psia	
5	STEAM TEMPERATURE AT S. H. OUTLET	F	
6	STEAM TEMPERATURE AT R H INLET	F	
7	STEAM TEMPERATURE AT R.H. OUTLET	F	
8	WATER TEMP. ENTERING (ECON.) (BOILER)	F	200
9	STEAM QUALITY % MOISTURE OR P. P. M.		100
10	AIR TEMP. AROUND BOILER (AMBIENT)	F	96
11	TEMP AIR FOR COMBUSTION (This is Reference Temperature) †	F	96
12	TEMPERATURE OF FUEL	F	100
13	GAS TEMP. LEAVING (Boiler) (Econ.) (Air Htr.)	F	571
14	GAS TEMP. ENTERING AH (If conditions to be corrected to guarantee)	F	

UNIT QUANTITIES

15	ENTHALPY OF SAT. LIQUID (TOTAL HEAT)	Btu/lb	172
16	ENTHALPY OF (SATURATED) (SUPERHEATED) STM.	Btu/lb	1198
17	ENTHALPY OF SAT. FEED TO (BOILER) (ECON.)	Btu/lb	172
18	ENTHALPY OF REHEATED STEAM R. H. INLET	Btu/lb	
19	ENTHALPY OF REHEATED STEAM R. H. OUTLET	Btu/lb	
20	HEAT ABS/LB OF STEAM (ITEM 16 – ITEM 17)	Btu/lb	1026
21	HEAT ABS/LB R.H. STEAM (ITEM 19 – ITEM 18)	Btu/lb	
22	DRY REFUSE (ASH PIT + FLY ASH) PER LB AS FIRED FUEL	lb/lb	0.061
23	Btu PER LB IN REFUSE (WEIGHTED AVERAGE)	Btu/lb	3920
24	CARBON BURNED PER LB AS FIRED FUEL	lb/lb	0.561
25	DRY GAS PER LB AS FIRED FUEL BURNED	lb/lb	14.7

HOURLY QUANTITIES

26	ACTUAL WATER EVAPORATED	lb/hr	55500
27	REHEAT STEAM FLOW	lb/hr	
28	RATE OF FUEL FIRING (AS FIRED wt)	lb/hr	
29	TOTAL HEAT INPUT $\frac{(\text{Item 28} \times \text{Item 41})}{1000}$	kB/hr	66750
30	HEAT OUTPUT IN BLOW-DOWN WATER	kB/hr	
31	TOTAL HEAT OUTPUT $\frac{(\text{Item 26} \times \text{Item 20}) + (\text{Item 27} \times \text{Item 21}) + \text{Item 30}}{1000}$	kB/hr	56940

FLUE GAS ANAL. (BOILER) (ECON) (AIR HTR) OUTLET

32	CO_2	% VOL	9.5
33	O_2	% VOL	7.0
34	CO	% VOL	—
35	N_2 (BY DIFFERENCE)	% VOL	83.5
36	EXCESS AIR	%	45.5

FUEL DATA

	COAL AS FIRED PROX. ANALYSIS	% wt		OIL			
37	MOISTURE	25.7	51	FLASH POINT F*			
38	VOL MATTER		52	Sp. Gravity Deg. API*			
39	FIXED CARBON		53	VISCOSITY AT SSU* BURNER SSF			
40	ASH	3.2	44	TOTAL HYDROGEN % wt			
	TOTAL		41	Btu per lb			
41	Btu per lb AS FIRED	12410					
42	ASH SOFT TEMP.* ASTM METHOD			GAS	% VOL		
	COAL OR OIL AS FIRED ULTIMATE ANALYSIS		54	~~H_2~~ ~~CO~~	0.4		
43	CARBON	58.6	55	CH_4 METHANE	96.0		
44	HYDROGEN	3.6	56	~~C_3H_8~~ ~~C_2H_4~~ ~~PROPANE~~ ~~ETHYLENE~~	0.2		
45	OXYGEN	3.2	57	~~C_2H_4~~ ~~ETHYLENE~~	0.1		
46	NITROGEN	1.0	58	C_2H_6 ETHANE	3.2		
47	SULPHUR	0.4	59	H_2S	—		
40	ASH	3.2	60	CO_2	1.1		
37	MOISTURE	25.7	61	H_2 HYDROGEN	—		
	TOTAL	100.0		TOTAL	100.0		
	COAL PULVERIZATION			TOTAL HYDROGEN % wt			
48	GRINDABILITY INDEX*		62	DENSITY 68 F ATM. PRESS.			
49	FINENESS % THRU 50 M*		63	Btu PER CU FT			
50	FINENESS % THRU 200 M*		41	Btu PER LB			
64	INPUT-OUTPUT EFFICIENCY OF UNIT %		$\frac{\text{ITEM 31} \times 100}{\text{ITEM 29}}$		85.3		

	HEAT LOSS EFFICIENCY	Btu/lb A.F. FUEL	% of A. F. FUEL
65	HEAT LOSS DUE TO DRY GAS	1676	16.1
66	HEAT LOSS DUE TO MOISTURE IN FUEL	374	3.6
67	HEAT LOSS DUE TO H_2O FROM COMB. OF H_2	403	3.9
68	HEAT LOSS DUE TO COMBUST. IN REFUSE	361	3.5
69	HEAT LOSS DUE TO RADIATION	94	0.9
70	UNMEASURED LOSSES	—	—
71	TOTAL		28.0
72	EFFICIENCY = (100 – Item 71)		72.0

* Not Required for Efficiency Testing

† For Point of Measurement See Par. 7.2.8.1-PTC 4.1-1964

CALCULATION SHEET

ASME TEST FORM FOR ABBREVIATED EFFICIENCY TEST

Revised September, 1965

OWNER OF PLANT ..... TEST NO. ..... BOILER NO. ..... DATE .....

30 HEAT OUTPUT IN BOILER BLOW-DOWN WATER = LB OF WATER BLOW-DOWN PER HR × [(ITEM 15 − ITEM 17) / 1000] = ... kB/hr

24 *If impractical to weigh refuse, this item can be estimated as follows*

DRY REFUSE PER LB OF AS FIRED FUEL = (% ASH IN AS FIRED COAL) / (100 − % COMB. IN REFUSE SAMPLE)

CARBON BURNED PER LB AS FIRED FUEL = ITEM 43 / 100 − [ITEM 22 × ITEM 23 / 14,500] = 0.561

NOTE: IF FLUE DUST & ASH PIT REFUSE DIFFER MATERIALLY IN COMBUSTIBLE CONTENT, THEY SHOULD BE ESTIMATED SEPARATELY. SEE SECTION 7, COMPUTATIONS.

25 DRY GAS PER LB AS FIRED FUEL BURNED = [11CO₂ + 8O₂ + 7(N₂ + CO)] / [3(CO₂ + CO)] × (LB CARBON BURNED PER LB AS FIRED FUEL + 3/8 S)

= [11 × ITEM 32 + 8 × ITEM 33 + 7 × (ITEM 35 + ITEM 34)] / [3 × (ITEM 32 + ITEM 34)] × [ITEM 24 + ITEM 47 / 267]

= [11 × 9.5 + 8 × 7.0 + 7 × (83.5 + ...)] / [3 × (9.5 + ...)] × [0.561 + 0.4 / 267] = 14.7

36 EXCESS AIR† 100 × (O₂ − CO/2) / (.2682N₂ − (O₂ − CO/2)) = 100 × (ITEM 33 − ITEM 34/2) / (.2682 (ITEM 35) − (ITEM 33 − ITEM 34/2))

= 100 × (7.0 − 0) / (.2682 × 83.5 − (7.0 − 0)) = 45.5

	HEAT LOSS EFFICIENCY	Btu/lb AS FIRED FUEL	LOSS/HHV × 100 =	LOSS %
65	HEAT LOSS DUE TO DRY GAS: LB DRY GAS PER LB AS FIRED FUEL × C_p × (t_{lvg} − t_{air}) = ITEM 25 × 0.24 × (ITEM 13) − (ITEM 11) = 14.7 × 0.24 × (571.96 − .....)	1676.	65/41 × 100 =	16.1
66	HEAT LOSS DUE TO MOISTURE IN FUEL = LB H_2O PER LB AS FIRED FUEL × [(ENTHALPY OF VAPOR AT 1 PSIA & T GAS LVG) − (ENTHALPY OF LIQUID AT T AIR)] − ITEM 37/100 × [(ENTHALPY OF VAPOR AT 1 PSIA & T ITEM 13) − (ENTHALPY OF LIQUID AT T ITEM 11)] = ... (1322 − 64)	374.	66/41 × 100 =	3.6
67	HEAT LOSS DUE TO H_2O FROM COMB. OF H_2 = 9H_2 × [(ENTHALPY OF VAPOR AT 1 PSIA & T GAS LVG) − (ENTHALPY OF LIQUID AT T AIR)] = 9 × 3.6/100 × [(ENTHALPY OF VAPOR AT 1 PSIA & T ITEM 13) − (ENTHALPY OF LIQUID AT T ITEM 11)] = ... (1322 − 64)	408.	67/41 × 100 =	3.9
68	HEAT LOSS DUE TO COMBUSTIBLE IN REFUSE: ITEM 22 × ITEM 23 = 0.061 × 5.920	361.	68/41 × 100 =	3.5
69	HEAT LOSS DUE TO RADIATION* = TOTAL BTU RADIATION LOSS PER HR / (LB AS FIRED FUEL − ITEM 28)	.....	69/41 × 100 =	0.9
70	UNMEASURED LOSSES **	.....	70/41 × 100 =	.....
71	TOTAL	.....	.....	28.0
72	EFFICIENCY (100 − ITEM 71)	.....	.....	72.0

† For rigorous determination of excess air see Appendix 9.2 – PTC 4.1-1964

* If losses are not measured, use ABMA Standard Radiation Loss Chart, Fig. 8, PTC 4.1-1964

** Unmeasured losses listed in PTC 4.1 but not tabulated above may by provided for by assigning a mutually agreed upon value for Item 70.

SECTION 3

SAMPLING DATA SHEETS

3.1 Continuous Monitoring Data

3.2 EPA Method 5/8 Field Data

3.3 Source Assessment Sampling System (SASS) Field Data

3.4 Volatile Organic Sampling Train (VOST) Field Data

3.5 C_1 to C_6 Hydrocarbon Analysis Data

3.1 CONTINUOUS MONITORING DATA

Continuous Monitoring Data : 8/25/83

	Stack gas (all readings dry basis) :							
Date/Time	NOx (ppm)	O2 (%)	CO2 (%)	SO2 (ppm)	CO (ppm)	TUHC (ppm)	Temp. (Deg.F)	Comment
0:01	380.	7 7	9.6		395.	2.	563.	
0:30	390.	7.5	9.8		425.	2.	567.	
1:00	385.	7.4	9.8		445.	2.	569.	
1:29	385.	7.4	9.9		465.	2.	570.	
2:00	385.	7.3	9.9		490.	2.	572.	Sootblow
2:29	370.	7.5	9.6		530.	2.	552.	
3:00	380.	7.3	9.9		535.	2.	559.	
3:29	380.	7.2	9.9		555.	2.	562.	
4:00	380.	7.2	9.9		555.	2.	566.	
4:30	375.	7.1	9.9		590.	2.	567	
5:00	370.	7.0	10.0		610.	2.	569.	
5:30	375.	7.0	9.9		635.	2.	571.	
6:00	370.	7.0	9.8		660.	2.	573.	
6:30	370.	6.9	9.9		660.	2.	579.	Sootblow
7:00	375.	6.8	9.9		730.	2.	562.	
7:30	370.	6.8	9.9		730.	1.	565.	Calibrate monitors
8:50	400.	8.4	9.7		230.	2.	572.	All monitors online
8:55	400.	8.0	9.5		245.	2.	574.	
9:00	405.	7.7	9.5		220.	2.	571.	
9:05	400.	7.7	9.4		215.	1.	573.	
9:10	400.	7.6	9.2		205.	1.	573.	
9:14	400.	7.6	9.1		205.	1.	572.	Sootblow
9:19	390.	7.6	8.9		250.	4.	560.	
9:25	385.	7.7	8.8		200.	2.	550.	
9:30	385.	7.6	9.3		205.	3.	555.	
9:35	395.	7.6	9.2		225.	4.	557.	
9:39	385.	7.5	9.3		205.	2.	558.	
9:44	390.	7.5	9.3		210.	2.	559.	
9:50	390.	7.5	9.3		205.	2.	560.	
9:55	375.	7.5	9.3		215.	2.	562.	
10:00	390.	7.5	9.5		220.	2.	562.	
10:05	390.	7.5	9.6		215.	2.	563.	
10:10	395.	7.4	9.7		215.	2.	564.	
10:14	390.	7.4	9.8		210.	1.	558.	
10:19	395.	7.4	9.6		205.	2.	570.	
10:25	390.	7.4	9.6		210.	2.	569.	
10:30	390.	7.4	9.5		225.	4.	570.	
10:35	385.	7.3	9.5		200.	2.	571.	
10:39	390.	7.3	9.6		215.	2.	570.	
10:44	380.	7.4	9.6		230.	2.	566.	
10:50	390.	7.2	10.0		210.	1.	569.	
10:55	395.	7.2	9.9		215.	2.	570.	
11:00	385.	7.2	9.8		220.	2.	570.	
11:05	385.	7.3	9.7		240.	3.	570.	
11:10	390.	7.2	9.7		220.	1.	572.	

Continuous Monitoring Data : 8/25/83 (continued)

	Stack gas (all readings dry basis) :							
Date/Time	NOx (ppm)	O2 (%)	CO2 (%)	SO2 (ppm)	CO (ppm)	TUHC (ppm)	Temp. (Deg.F)	Comment
11:14	390.	7.2	9.6		220.	1.	572.	
11:19	390.	7.2	9.4		225.	1.	572.	
11:25	395.	7.2	9.3		230.	1.	576.	
11:30	395.	7.2	9.2		230.	6.	573.	
11:35	390.	7.2	9.2		235.	3.	573.	
11:39	390.	7.2	9.3		230.	2.	573.	
11:44	390.	7.2	9.3		245.	2.	575.	
11:50	395.	7.2	9.4		255.	1.	575.	
11:55	395.	7.2	9.4		260.	1.	574.	
12:00	395.	7.2	9.4		250.	2.	575.	
12:05	395.	7.2	9.4		260.	1.	575.	
12:10	400.	7.1	9.4		255.	1.	574.	
12:14	390.	7.1	9.4		265.	1.	575.	
12:19	395.	7.1	9.4		255.	1.	575.	
12:25	390.	7.1	9.5		255.	1.	576.	
12:30	390.	7.1	9.5		255.	1.	576.	
12:35	395.	7.1	9.6		270.	1.	576.	
12:39	395.	7.1	9.7		275.	2.	576.	
12:44	395.	7.1	9.6		270.	1.	576.	
12:50	385.	7.1	9.6		275.	1.	576.	
12:55	390.	7.0	9.7		270.	2.	576.	
13:00	390.	7.0	9.6		280.	2.	577.	
13:05	390.	7.0	9.5		290.	2.	576.	
13:10	395.	6.9	9.5		285.	4.	576.	
13:14	390.	7.0	9.4		285.	3.	578.	
13:19	385.	7.0	9.4		290.	2.	578.	
13:35	395.	7.1	9.8		290.	1.	579.	
13:39	395.	7.0	9.7		295.	1.	579.	
13:44	395.	6.9	9.6		300.	1.	580.	
13:50	400.	6.9	9.4		320.	1.	579.	
13:55	395.	6.9	9.3		320.	1.	579.	
14:00	380.	7.0	9.0		330.	1.	579.	
14:05	385.	7.0	8.9		345.	1.	580.	
14:10	405.	6.8	9.2		345.	2.	579.	
14:14	405.	6.8	9.4		335.	1.	579.	
14:19	395.	6.8	9.2		335.	2.	571.	Sootblow
14:25	390.	6.8	9.4		340.	1.	563.	
14.30	400.	6.8	9.3		350.	1.	564.	
14:35	400.	6.6	9.7		340.	1.	563.	
14:39	405.	6.6	9.5		340.	1.	565.	
14:44	410.	6.6	9.4		340.	1.	564.	
14:50	405.	6.7	9.5		325.	3.	564.	
14:55	405.	6.7	9.5		335.	4.	564.	
15:00	405.	6.6	9.7		325.	2.	565.	
15:05	405.	6.6	9.7		335.	2.	564.	

Continuous Monitoring Data : 8/25/83 (concluded)

	Stack gas (all readings dry basis) .							
Date/Time	NOx (ppm)	O2 (%)	CO2 (%)	SO2 (ppm)	CO (ppm)	TUHC (ppm)	Temp. (Deg.F)	Comment
15:10	410.	6.6	9.6		330.	1.	565.	
15:14	410.	6.6	9.6		330.	1.	565.	
15:19	410.	6.6	9.6		335.	1.	566.	
15:25	405.	6.7	9.5		345.	1.	566.	
15:30	405.	6.7	9.5		340.	1.	566.	
15:35	400.	6.6	9.7		335.	1.	567	
15:39	405.	6.6	9.6		345.	1.	568.	
15:44	405.	6.7	9.4		345.	1.	568.	
15:50	400.	6.6	9.5		350.	1.	569.	
15:55	390.	6.6	9.5		355.	1.	568.	
16:00	390.	6.6	9.7		355.	1.	569.	
16:04	400.	6.6	9.6		360.	1.	570.	
16:10	395.	6.6	9.4		360.	1.	570.	
16:14	410.	6.6	9.4		365.	1.	570.	
16:20	415.	6.6	9.5		370.	1.	570.	
16:25	410.	6.6	9.5		375.	1.	571.	Calibrate monitors
17:14	436.	7.7	9.8	349.	209.	1.	572.	All monitors online
17:45	429.	5.7	9.4	349.	223.	2.	576.	Method 8 SO2 test
18:14	425.	7.1	9.7	349.	223.	1.	579.	
18:45	418.	7.0	9.8	349.	234.		577.	TUHC monitor inoperative
19:00	421.	6.9	9.7		266.		556.	
19:29	423.	6.8	9.8		278.		556.	
20:00	413.	6.7	9.7		279.		557.	
20:29	412.	6.6	9.9		286.		560.	
21:00	413.	6.5	9.6		320.		562.	
21:29	408.	6.4	9.7		324.		565.	
22:00	404.	6.3	9.4		334.		567.	
22:29	396.	6.2	9.3		349.		570.	
23:00	404.	6.2	9.3		367.		571.	
23:29	400.	6.1	9.3		380.		571.	

3.2 EPA METHOD 5/8 FIELD DATA

ACUREX CORPORATION

Run 1-M-5/6

Acurex Project No. 307735.71
Field Dates 8-24/26-83
Plant DUPONT - MEMPHIS, TN
Sampling Location BOILER NO 1 CWS
Sampling Date 8-25-83

FIELD CREW

Crew Chief: ERUCE C. DuRoe
Testing Engineer: 1 PETE KAUFMANN - SASS
2 MARTH M MURRAY - M-5/7
Engr. Technician: 1
2
3
Lab Technician: 1
2
Process Engineer: 1
2

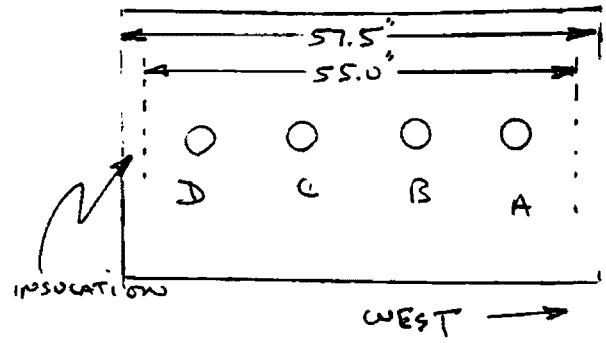
FIELD SAMPLE REFERENCE NUMBERS:

900222
900215
900214
900223
900224
900231
900229

IMP 1	IMP 2	IMP 3	IMP 4
559.0	578.8	532.1	671.9
50.4	544.2	514.6	627.3
49.6	34.6	17.5	44.6

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT DuPont - Memphis, TN
DATE 8-24-83
SAMPLING LOCATION
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) 54.5"
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) 4.5"
STACK I.D., (DISTANCE A - DISTANCE B) 50.0"
NEAREST UPSTREAM DISTURBANCE > 8 DIAM
NEAREST DOWNSTREAM DISTURBANCE
CALCULATOR M. Murray



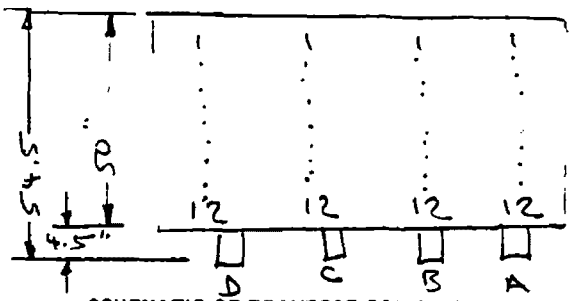
SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)	
1				4.5	3.1	6.6
2					6.25	10.75
3					10.4	14.9
4					14.6	19.1
5					18.75	23.25
6					22.92	27.42
7					27.08	31.58
8					31.25	35.75
9					35.42	39.90
10					39.59	44.09
11					43.75	48.25
12					47.92	52.45

PRELIMINARY VELOCITY TRAVERSE

DUCT CX

PLANT DUPONT - MEMPHIS, TN
DATE 8-24-83 1830
LOCATION BOILER NO 1 - CUOM
STACK I.D.
BAROMETRIC PRESSURE, in. Hg 29.98 (BS)
STACK GAUGE PRESSURE, in. H_2O -0.5
OPERATORS MURRAY / DuRoc



SCHEMATIC OF TRAVERSE POINT LAYOUT

WEST →

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
A-1	.04	519
2	.38	551
3	.50	554
4	.55	556
5	.45	557
6	.48	557
7	.45	558
8	.45	559
9	.48	559
10	.42	5168
11	.25	516
A-12	.30	493
B-1	Ø	548
2	Ø	549
3	.35	552
4	.55	554
5	.52	556
6	.45	558
7	.45	558
8	.45	558
9	.40	559
10	.40	556
11	.40	543
B-12	.30	496
AVERAGE		

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
C-1	.05	535
2	.40	539
3	.40	554
4	.45	556
5	.45	557
6	.42	559
7	.40	559
8	.35	561
9	.35	561
10	.32	560
11	.30	561
C-12	.31	550
D-1	.10	501
2	.25	521
3	.28	527
4	.32	535
5	.30	539
6	.25	542
7	.30	546
8	.33	550
9	.30	550
10	34	555
11	.33	555
12	.33	555
AVERAGE		

$T_s = 546$

ISOKINECTIC NOZZLE CALCULATION
AND
SAMPLING RATE CALCULATION

Plant _____ Performed by _____

Date _____

Sample Location _____

Test No./Type _____

$$N_d = \left(\frac{\Delta H \, T_s}{K \, T_m \, \Delta P} \right)^{.25}$$

where: N_d = Nozzle diameter (inches)

Average pressure differential across the orifice meter (in. H_2O)	ΔH	2.2
Temperature stack gas, average (^oF)	T_s	575
Temperature of gas meter, average (^oF)	T_m	90
Stack gas velocity pressure (in H_2O)	ΔP	.35
$\left(\frac{(\_\_\_)\ (\_\_\_ + 460)}{(\_\_\_)\ (\_\_\_ + 460)(\_\_\_)} \right)^{.25}$	N_d	.367

$$\Delta H = K \, (N_d)^4 \, \frac{T_m}{T_s} \, (\Delta P)$$

where: ΔH = Pressure differential across the orifice meter (in H_2O)

Nozzle diameter, actual (inches)	N_d	.367
Temperature of gas meter (^oF)	T_m	101
Temperature of stack gas (^oF)	T_s	576
Stack gas velocity pressure (in H_2O)	ΔP	
$\left((\_\_\_)\ (\_\_\_)^4 \ \frac{(\_\_\_ + 460)}{(\_\_\_ + 460)}\ (\_\_\_) \right)$	ΔH	
Magic number _____( )^4	$K(N_d)^4$	16.991

ISOKINECTIC SAMPLING WORKSHEET

Plant _____ Peformed by _____

Date _____

Sample Location _____

Test No./Type _____

$$K = \frac{782.687\ (Cp)^2\ (1-B_{wo})^2\ P_s\ M_d}{K_o^2\ M_s\ P_m}$$

where: K = Contant of fixed and assumed parameters (dimensionless)

Pitot coefficient (dimensionless)	C_p assumed	.85
Water vapor in the gas stream (proportion by volume)	B_{wo}	.06
Absolute stack gas pressure (in. Hg)	P_s	29.5
Molecular weight, stack gas dry (lb/lb-mole)	M_d	CO2 = 25 O2 = 25 N2 = 28.1
Orifice coefficient (dimensionless)	K_o assumed	.7126
Molecular weight, stack gas wet (lb/lb-mole) $M_d(1-B_{wo}) + 18(B_{wo})$	M_s	
Abolute meter pressure (in. Hg)	P_m	29.92
$\frac{782.687\ (\_\_\_)^2\ (1-\_\_\_)^2\ (\_\_\_)\ (\_\_\_)}{(\_\_\_)^2\ (\_\_\_)\ (\_\_\_)}$	K	132.93

4.93

.7126

FIELD DATA

Plant DuPont, Memphis, TN
Date 8-25-83
Sample Location #1 Baghouse
Sample Type EPA 5/8
Run Number 1
Operator Murray
Ambient Temperature 95
Barometric Pressure 29.98
Static Pressure, (H_2O) -0.5
Filter Number(s) #355 (142mm)

Leak Check: Initial at 15" Hg, .015 CFM
Final at 19" Hg, .018 CFM
Pitot Leak Check: ok

	Impinger Volumes Initial	Final	Net Gain
504.4 IPA	100mL	553.0	49.6
547.2 H_2O_2	100mL	578.8	34.6
514.6 H_2O_2	100mL	532.1	17.5
	Silica Gel		
	627.3	671.3	44.6
SASS Condensate			n/a
Total Volume			146.3

Probe Length and Type 5' Pyrex
Nozzle Size & I.D. P50 0.361"
Pitot Coefficient & I.D. 0.82 (assume) w-.711
Assumed Moisture 6%
Molecular Weight, Dry, (M_d)
Meter Box Number NAPP 05 5[illegible]
Meter Coefficient .7126
α Factor .9908
K =
$K(Nd)^4$ = ___ x (___)^4 = ___
$\Delta H = K(N_d)^4 \left(\frac{Tm}{Ts}\right)$ (P)

Traverse Point Number	Clock Time (24-hr) Clock / Sampling Time, min	Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O Desired	Actual	Temperature °F Stack	Probe	Impinger	Organic Module	Oven	Gas Meter In	Gas Meter Out	Pump Vacuum in. Hg	Avg. ΔP
	1654 / 0	Init. 49.789												
A-1	1654 / 2	~~51.500~~	0	—	—	576	—	—	—	175	91	103	8	0.0
2	1656 / 4	51.500	.25	2.29	2.30	579	—	—	—	175	101	101	10	0.5
3	1700 / 6	53.510	.51	4.69	4.70	579	—	—	—	175	103	101	14	.714
4	1702 / 8	55.895	.52	4.78	4.80	579	—	—	—	185	103	103	14	.721
5	1704 / 10	58.310	.52	4.78	4.80	579				195	104	102	14	.721
6	1706 / 12	60.520	.51	4.70	4.70	579				202	105	102	15	.714
7	1708 / 14	62.679	.51	4.70	4.70	578				202	105	103	15	.714
8	1710 / 16	64.850	.51	4.70	4.70	579				208	105	103	15	.714
9	1712 / 18	67.140	.45	4.14	4.10	579				209	105	103	15	.671

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5201

Comments: Probe heats up but thermostat doesn't work
1ST POINT IN each PAIR IS NULL - points A + B only

Traverse Point Number	Clock Time (24-hr) Clock / Sampling Time, min	Gas Meter Reading (V_m), ft 3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Temperature °F					Gas Meter		Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
				Desired	Actual	Stack	Probe	Impinger	Organic Module	Oven	In	Out		
	18 / 1714	Init. 67.140												
10	20 / 1716	69.20	.32	2.94	2.94	324	—	—	—	212	105	104	11	.566
11	22 / 1718	71.100	.30	3.666	3.70	324	—	—	—	198	104	103	12	.548
12	24 / 1720	72.995	.32	3.91	3.90	350	—	—	—	199	105	101	12	.566
START B	24 / 1728	72.995							—	—	—	—	—	—
B-1	26 / 1722	72.995	0	0	0	575	—	—	—	212	102	103	0	0
2	28 / 1724	73.750	.05	0.46	0.5	577	—	—	—	216	101	103	4	.224
3	30 / 1726	75.300	.30	2.76	2.8	579	—	—	—	212	101	103	10	.548
4	32 / 1728	77.550	.55	5.07	4.90	579	—	—	—	212	101	103	17	.742
5	34 / 1730	79.90	.575	5.53	4.70	574	—	—	—	210	102	103	17	.775
6	36 / 1732	82.20	.50	4.60	4.60	579	—	—	—	210	102	103	17	.707
7	38 / 1734	84.30	.48	4.42	4.40	584	—	—	—	220	104	103	17	.693
8	40 / 1736	86.30	.50	4.58	4.46	585	—	—	—	227	103	103	17	.707
9	42 / 1738	88.50	.45	4.12	4.10	585	—	—	—	224	103	103	17	.674
10	44 / 1740	90.68	.45	4.12	4.10	585	—	—	—	224	103	103	17	.614
11	46 / 1742	92.87	.40	3.68	3.70	585	—	—	—	230	103	102	15	.632
12	48 / 1744	94.440	.3	2.76	2.8	450	—	—	—	240	103	102	13	.548

Run No. 5/8 #1 Date 8-25-13 Sampling Location #1 Boiler

Comments:

Traverse Point Number	Clock Time (24-hr) Clock / Sampling Time, min	Gas Meter Reading (V_m), ft 3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Temperature °F					Gas Meter		Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
				Desired	Actual	Stack	Probe	Impinger	Organic Module	Oven	In	Out		
	48 / 1747	Init. 94.440												
C-1	50 / 1748	95.250	.05	.46	.50	571	—	—	—	225	101	102	5	.224
2	52 / 1750	96.310	.18	1.65	1.70	571	—	—	—	229	102	101	9	.424
3	54 / 1752	98.100	.38	3.48	3.48	582	—	—	—	230	102	101	15	.616
4	56 / 1754	100.250	.45	4.13	4.10	582	—	—	—	230	102	102	17	.671
5	58 / 1756	101.900	.45	4.13	4.10	582	—	—	—	228	102	101	17	.671
6	60 / 1758	104.000	.45	4.13	4.00	579	—	—	—	230	103	102	17	.671
7	62 / 1800	106.050	.43	3.96	4.00	579	—	—	—	235	103	102	17	.656
8	64 / 1802	108.000	.43	3.96	4.00	579	—	—	—	230	103	101	17	.656
9	66 / 1804	109.800	.43	3.96	3.90	579	—	—	—	215	103	102	17	.656
10	68 / 1806	111.600	.40	3.68	3.70	579	—	—	—	219	103	102	17	.632
11	70 / 1808	113.650	.38	3.49	3.50	579	—	—	—	220	102	102	16	.616
12	72 / 1810	115.420	.33	3.03	3.00	579	—	—	—	220	102	102	15	.574
	1812	46												
D-1	74 / 1814	116.450	.10	.94	1.00	558	—	—	—	225	102	102	7	.316
2	76 / 1816	117.700	.28	2.57	2.60	586	—	—	—	220	101	103	14	.529
3	78 / 1818	119.500	.35	3.21	3.20	585	—	—	—	220	102	102	16	.592
4	80 / 1820		.32	2.92	2.90	588	—	—	—	230	102	101	16	.506

7201

Run No. Method 5/8 #1 Date 8-25-83 Sampling Location #1 Boiler

Comments:

Traverse Point Number	Clock Time (24-hr) Clock / Sampling Time, min	Gas Meter Reading (V_m), ft 3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O		Temperature °F					Gas Meter		Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
				Desired	Actual	Stack	Probe	Impinger	Organic Module	Oven	In	Out		
	[redacted] / 1820	Init. 121.280												
D-5	82 / 1822	123.600	.35	3.21	3.2	584	—	—	—	230	102	101	17	.592
6	84 / 1824	125.350	.33	2.93	2.90	584	—	—	—	230	101	101	17	.514
7	86 / 1826	127.080	.33	2.93	2.90	585	—	—	—	226	101	101	17	.514
8	88 / 1828	128.600	.33	2.93	2.90	585	—	—	—	226	101	102	17	.574
9	90 / 1830	130.600	.33	2.93	2.90	585	—	—	—	226	101	102	17	.574
10	92 / 1832	132.200	.35	3.21	3.00	587	—	—	—	226	101	101	17	.592
11	94 / 1834	134.100	.33	2.93	2.90	586	—	—	—	224	101	101	18	.574
12	96 / 1836	135.678	.28	2.78	2.80	501	—	—	—	221	101	101	17	.529
						45[illegible]								
		[illegible]			3.47	584.1					[illegible]			.613

Run No. Method 5/8 #1 Date 8/25/83 Sampling Location #1 Boiler

Comments:

ISOKINETIC PERFORMANCE WORKSHEET & PARTICULATE CALCULATIONS

Plant [illegible] - MEMPHIS, TN. Performed by [illegible]

Date [illegible]

Sample Location [illegible]

Test No./Type [illegible]

Barometric Pressure (in. Hg)	P_b	~7.7
Meter volume (std), $17.64 \left(\frac{V_m}{\alpha}\right)\left(\frac{P_b + \frac{\Delta H}{13.6}}{T_m + 460}\right)$ $17.64 \left(\frac{(85.89)}{(.9904)}\right)\left(\frac{(27.98) + \frac{(-.1)}{13.6}}{(103.3) + 460}\right)$	$V_{m\ std}$	82.124
Volume of liquid collected (grams)	Vl_c	146.3
Volume of liquid at standard condition (scf) $Vl_c \times 0.04707$	$V_{w\ std}$	6.886
Stack gas proportion of water vapor $\frac{V_{w\ std}}{V_{w\ std} + V_{m\ std}}$, $\frac{(6.886)}{(6.886) + (82.124)}$	B_{wo}	.077
Molecular weight, stack gas dry (lb/lb-mole) $(\%\ CO_2 \times 0.44) + (\%\ O_2 \times 0.32) + (\%\ N_2 + \%\ CO \times 0.28)$ $(9.7 \times 0.44) + (6.9 \times 0.32) + (83.4 + \_\_\_\_ \times 0.28)$	M_d	29.83
Molecular weight, stack gas wet (lb/lb-mole) $Md(1-B_{wo}) + 18(B_{wo})$, $(29.83)(1-.077) + 18(.077)$	M_s	28.91
Absolute stack pressure (in. Hg) $P_b + \frac{P_{stack}\ (\text{in. } H_2O)}{13.6}$, $(29.98) + \frac{(-0.5)}{13.6}$	P_s	29.74

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Temperature stack gas, average (^{o}F)	T_s	507.1
Stack velocity (fps) $85.49\ (C_p)\ (\sqrt{\Delta P_{s\ avg}})\ \sqrt{\frac{T_s avg + 460}{P_s \quad M_s}}$ $85.49\ (.80)(\ .\ )\ \sqrt{\frac{(507.1) + 460}{(29.54)(28.71)}}$	$V_{s(avg)}$	44.31
Total sample time (minutes)	θ	76
Nozzle diameter, actual (inches)	N_d	P-32 .267
Percent isokinetic (%) $\frac{17.33\ (T_s + 460)(V_w\ std + V_m\ std)}{\theta \quad V_s \quad P_s \quad N_d^2}$ $\frac{17.33\ (\quad + 460)((\quad) + (\quad))}{(\quad)(\quad)(\quad)(\quad)^2}$	%I	92.1
Area of stack (ft^2) $\pi = 3.1416$ $\pi r^2 \div 144$, $\pi(\quad)^2 \div 144$ $\quad \frac{50 \times 55\ in}{144\ in^2}$	A_s	19.097
Stack gas volume at standard conditions (dscfm) $60\ (1 - B_{wo})Vs_{avg}\ A_s \left(\frac{528}{T_s\ avg + 460}\right) \left(\frac{Ps}{29.92}\right)$ $60\ (1 - \quad)(\quad)(\quad)\left(\frac{528}{\quad + 460}\right) \left(\frac{(\quad)}{(29.92)}\right)$	ACFM Q_s	50,775 24,157
Particulate matter concentration, dry (gr/dscf) $15.432\ \frac{M_p(grams)}{Vm_{std}}$, $\quad 15.432\ \frac{(\quad)}{(\quad)}$	$C_{s(std)}$	
Emission rate of particulate matter (lb/hr) $0.00857\ (Q_s)\ C_{s(std)}$, $0.00857\ (\quad)(\quad)$	E_p	

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ACUREX
ANALYTICAL REPORT

Sample of: CMEA DuPont, Memphis

Sample Date:

Requested By: L. Wakeland

I.D. Number: 307735 71

Analytical Method: EPA 5/8. Ba(ClO4)2 titrations and gravimetric (IPA blank)

Date of Analysis: 10/23/83

Lab I.D. Number	Component	Analytical Result	Unit
900215 (Dish # 89)	particulate (IPA blank)	1.19 mg/100mls	mg
900214	SO_4 (H_2O_2 Blank)	2.62	mg
900224	SO_4	2161.7	mg
900223	SO_3 (H_2SO_4)	15.82	mg
900215	SO_3 (H_2SO_4) IPA Blank	2.02	mg

N.B All reported values have been corrected for blanks.

Analysis By Martha M. Murray

Date 10/25/83

ISOKINETIC CALCULATIONS - USEPA: M/5 BASIS

DUPONT-MEMPHIS, TN NO.1

RUN NUMBER	1-SASS	1-M5/8
DATE OF TEST	8-25-83	8-25-83
OPERATOR	PWK	MMM
METER VOLUME, CF	1107.833	85.889
METER COEF	0.997	0.9908
BAROMETRIC PRES, HG	29.98	29.98
DELTA H, IN H2O	2.13	3.47
METER TEMP, DEG F	112.3	103.3
STACK TEMP, DEG F	576.9	564.7
CONDENSATE, ML	2934.9	146.3
PERCENT CO2	9.5	9.7
PERCENT O2	7	6.9
PERCENT CO	0	0
PERCENT N2	83.5	83.4
STATIC PRES, IN H2O	-0.5	-0.5
PITOT COEF	0.79	0.79
SQRT DELTA P, IN H2O	0.511	0.603
STACK AREA, SQ FT	19.1	19.1
NOZZLE DIAM, IN	0.744	0.367
TEST TIME, MIN	280	96
MASS PARTICULATE, G	0	0
F-FACTOR, DSCF/MBTU	0	0
VOLUME, DSCF	1,032.749	82.124
WATER VAPOR, SCF	138.146	6.886
PERCENT MOISTURE	0.118	0.077
MOLECULAR WT DRY, LB/LB	29.8	29.828
MOLECULAR WT WET, LB/LB	28.41	28.91
STACK PRES, IN HG	29.94	29.94
STACK VELOCITY, FT/SEC	38.10	44.31
MASS FLOW, DSCFM	19,627	24,157
MASS FLOW, ACFM	43,666	50,775
PERCENT EXCESS AIR		
PERCENT ISOKINETIC	118.984	92.145
GRAIN LOADING, GR/DSCF	0.00000	0.00000
GRAIN LOADING, GR/ACF	0.00000	0.00000
EMISSION RATE, LB/HR-STD	0.00000	0.00000
EMISSION RATE, LB/MBTU		

3.3 SOURCE ASSESSMENT SAMPLING SYSTEM (SASS) FIELD DATA

Run 1-SASS

Acurex Project No. 30773S.71
Field Dates 8-24/26-83
Plant DUPONT - MEM
Sampling Location BOILER NO-CWS
Sampling Date 8-25-83

FIELD CREW

Crew Chief: BRUCE C. DuROS, C_1-C_6, N_2O
Testing Engineer: 1 PETE KAUFMANN - SASS
2 MARTH M. MURRAY, VOST, M-5
Engr. Technician: 1 SHERMAN A. SMITH, CM
2 KENT BREWSTER, PROBE
3
Lab Technician: 1 PETE KAUFMANN
2 BRUCE C. DuROS
Process Engineer: 1 LARRY WATERLAND
2

FIELD SAMPLE REFERENCE NUMBERS:

900204	900221
900213	900230
900212	900226
900211	900227
900207	900216
900208	900217
900205	900218
900206	900219
900228	900220

SASS OPERATION WORKSHEET

Plant Dupont — Performed by [illegible]

Date 6/25/83

Sample Location _____

Test No. SASS 1

Stack Gas Composition	CO_2	9.3
	O_2	[illegible]
	CO	0.0
	N_2	83.0
Water Vapor in Gas Stream	B_{ws0}	0.06
Static Pressure in. H_2O	P_{st}	-.5
Barometric Pressure in. Hg.	P_{bar}	29.98
Stack Temperature °F	T_s	545
Square Root ΔP	$\sqrt{\Delta P}$	.567
Pitot coefficient	C_p	.80

$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2 + \%CO) =$ _____

$M_s = M_d(1 - B_{ws0}) + 18(B_{ws0}) =$ _____

$P_s = P_{bar} + (P_{st}/13.6)$ _____

$= 85.49\,(C_p)\sqrt{\Delta P}\sqrt{\dfrac{T_s + 460}{M_s\ P_s}} =$ _____

Ideal Nozzle Size

$$N_d = 0.831\sqrt{\frac{T_s + 460}{P_s\ V_s}} = \text{0.7[illegible]}$$

$$\Delta H = (1.\text{[illegible]} \times 10^{-3})\left[\frac{T_m - 460}{P_m}\right]\left[\frac{(1 - B_{ws0})}{J\ D_o^2}\right]^2$$

Plant Dupont
Date 8/25/83
Sample Location Boiler #1
Sample Type SASS
Run Number 1
Operator Rawlingson
Ambient Temperature ~95
Barometric Pressure 29.98
Static Pressure, (H_2O) -.5
Filter Number(s) 254, 351, 350

Leak Check: Initial at 10" Hg, .041 CFM (20" .032)
Final at 10" Hg, .044 CFM (20" .013)
Pitot Leak Check: O.K.

Org + Impg.

Impinger Volumes	Initial	Final	Net Gain
	500	900	400
	500		
	500	1800	1300
Silica Gel			
	803.3	1033.1	229.8
	851.8	1184.1	332.3
SASS Condensate			592 FM 1
Total Volume			2754.1

Probe Length and Type 3 ft S.S
Nozzle Size & I.D. P-44 0.744
Pitot Coefficient & I.D. - .79
Assumed Moisture 6%
Molecular Weight, Dry, (M_d)
Meter Box Number 16
Meter Coefficient 0.692
α Factor .997
K = N/A
$K(Nd)^4$ = ___ , ( )^4 = N/A
$\Delta H = K(N_d)^4 \left(\frac{Tm}{Ts}\right)$ (P)

500 .35

Traverse Point Number	Clock Time (24-hr) Clock / Sampling Time, min	Gas Meter Reading (V_m), ft^3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O Desired	Actual	Temperature °F Stack	Probe	Impinger	Organic Module	Oven	Gas Meter In	Gas Meter Out	Pump Vacuum in. Hg	Avg. ΔP
	1015 / 0	Init. 160.652												
	10	200.17	.26	[illegible]	2.1	570	395		63	401	102	96	17	.510
	20	238.43	.26	2.2	2.1	573	404		64	402	105	97	17	.510
	30	277.31	.27	2.2	2.1	575	407		62	402	110	100	18	.520
	40	316.40	.26	2.2	2.2	572	397		62	401	112	102	19	.510
	50	355.60	.26	2.2	2.2	574	405		64	404	116	105	19	.510
	60	394.5*	.26	2.2	2.2	576	401		67	404	117	107	20	.520
	70	435.10	.26	2.2	2.2	578	411		63	405	116	108	19	.520
	80	474.65	.26	2.2	2.1	578	412		62	406	116	108	20	.510
	Stop 90	514.317	.28	2.2	2.1	578	402		64	405	117	108	20	.520

* [illegible]

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Comments: Stop at main 90 to change filter

Traverse Point Number	Clock Time (24-hr) Clock / Sampling Time, min	Gas Meter Reading (V_m), ft 3	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure—Differential (ΔH), in. H_2O		Temperature °F					Gas Meter		Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
				Desired	Actual	Stack	Probe	Impinger	Organic Module	Oven	In	Out		
	1215 / 90	Init. 514.317												
	100	552.05	.26	2.2	2.2	579	399		62	362	106	105	16	.510
	110	592.00	.26	2.2	2.2	581	405		62	397	111	106	17	.510
	120	631.9	.27	2.2	2.1	582	416		63	402	118	108	17	.520
	130	—	.26	2.2	2.2	582	404		25	402	118	110	19	.510
	140	716.5	.26	2.3	2.2	584	403		63	404	120	111	19	.510
	150	754.0	.27	2.3	2.2	585	409		65	403	119	111	19	.520
	160	794.23	.24	2.3	2.2	585	407		64	404	118	111	19	.490
	170	834.05	.27	2.3	2.1	586	401		64	402	118	111	20	.520
stop	180	873.625	.29	2.3	2.0	585	405		62	402	115	111	20	.540
	1420 / 180	873.625	—	—	—	—	—		—	—	—	—	—	—
	190	912.7	.26	2.2	2.2	583	404		64	380	105	106	17	.510
	200	953.31	.25	2.2	2.2	568	394		63	397	111	107	18	.500
	210	993.9	.26	2.2	2.2	571	401		64	380	117	111	19	.510
	220	1031.3	.25	2.3	2.0	571	411		64	400	120	113	19	.500
	230	74.0	.26	2.3	2.1	570	413		64	432	120	112	19	.510
	240	115.2	.27	2.3	2.1	570	413			404	122	114	19	.520
	250	153.5	.27	2.3	2.0	577	432		66	402	123	114	20	.530

Run No. SASS 1 Date 8/25/83 Sampling Location Boiler #1

Comments: Min 180 stop to change filter + silica gel and allow plant to blow soot

Traverse Point Number	Sampling Time, min / Clock Time (24-hr) Clock	Gas Meter Reading (V_m), ft^3 Init.	Velocity Head (ΔP_s), in. H_2O	Orifice Pressure Differential (ΔH), in. H_2O Desired	Actual	Temperature °F Stack	Probe	Impinger	Organic Module	Oven	Gas Meter In	Gas Meter Out	Pump Vacuum in. Hg	Avg. $\sqrt{\Delta P}$
	260	1191.6	.22	2.3	2.0	578	440		69	455	122	117	19	.477
	270	1230.1	.25	2.3	2.0	578	457		66	452	123	117	19	.500
	stop 280	1268.485	.25	2.3	1.9	578	455		67	452	121	115	20	.500
	280	1107.835			2.13	576.9					115.8	108.7		[illegible]

1615 [illegible] (112.3) 14 [illegible]

Run No. SASS 1 Date [illegible]/83 Sampling Location Boiler [illegible]

Comments: 3241 / 28 3043 / 28

ISOKINETIC PERFORMANCE WORKSHEET & PARTICULATE CALCULATIONS

Plant DISTRICT - MEMPHIS, TN Performed by DAVES

Date 3-25-93

Sample Location BOILER NO. 1 CAN

Test No./Type - 2453

Barometric Pressure (in. Hg)	P_b	27.75
Meter volume (std), $17.64 \left(\frac{V_m}{\alpha}\right)\left(P_b + \frac{\Delta H}{13.6}\right)\left(\frac{}{T_m + 460}\right)$ $17.64 \left(\frac{(1007.935)}{(.997)}\right)\left(\frac{(29.98) + \frac{(2.13)}{13.6}}{(112.5) + 460}\right)$	$V_{m\ std}$	1,032.747
Volume of liquid collected (grams)	Vl_c	2734.7
Volume of liquid at standard condition (scf) Vl_c x 0.04707	$V_{w\ std}$	135.196
Stack gas proportion of water vapor $\frac{V_{w\ std}}{V_{w\ std} + V_{m\ std}}$, $\frac{(\quad)}{(\quad) + (\quad)}$	B_{wo}	.118
Molecular weight, stack gas dry (lb/lb-mole) (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28) (9.5 x 0.44) + (7.0 x 0.32) + 83.5 + ____ x 0.28)	M_d	29.8
Molecular weight, stack gas wet (lb/lb-mole) $Md(1-B_{wo}) + 18(B_{wo})$, (29.8)(1-.118) + 18(.118)	M_s	28.41
Absolute stack pressure (in. Hg) $P_b + \frac{P_{stack}\ (\text{in. } H_2O)}{13.6}$, $(29.98) + \frac{(0.5)}{13.6}$	P_s	29.94

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Temperature stack gas, average (^{o}F)	T_s	576.1
Stack velocity (fps) $85.49\ (C_p)\ (\sqrt{\Delta P_{s\ avg}})\ \sqrt{\frac{T_s avg + 460}{P_s \quad M_s}}$ $85.49\ (\_\_\_)(\_\_\_)\ \sqrt{\frac{(576.9) + 460}{(29.14)(28.41)}}$	$V_{s(avg)}$	38.10
Total sample time (minutes)	θ	120
Nozzle diameter, actual (inches)	N_d	P-1 .744
Percent isokinetic (%) $\frac{17.33\ (T_s + 460)(V_w\ std + V_m\ std)}{\theta \quad V_s \quad P_s \quad N_d^2}$ $\frac{17.33\ (\_\_\_ + 460)((\_\_\_) + (\_\_\_))}{(\_\_\_)(\_\_\_)(\_\_\_)(\_\_\_)^2}$	%I	118.754
Area of stack (ft^2) $\pi = 3.1416$ $\pi r^2 \div 144$, $\pi(\_\_\_)^2 \div 144$ $\frac{50 \times 55 in}{144 in^2}$	A_s	19.097
Stack gas volume at standard conditions (dscfm) $60\ (1 - B_{wo})Vs_{avg}\ A_s \left(\frac{528}{T_s\ avg + 460}\right) \left(\frac{Ps}{29.92}\right)$ $60\ (1 - \_\_\_)(\_\_\_)(\_\_\_)\left(\frac{528}{\_\_\_ + 460}\right) \left(\frac{(\_\_\_)}{(29.92)}\right)$	ACFM Q_s	43,666 19,627
Particulate matter concentration, dry (gr/dscf) $15.432\ \frac{M_p(grams)}{Vm_{std}}$, $15.432\ \frac{(\_\_\_)}{(\_\_\_)}$	$C_{s(std)}$	
Emission rate of particulate matter (lb/hr) $0.00857\ (Q_s)\ C_{s(std)}$, $0.00857\ (\_\_\_)(\_\_\_)$	E_p	

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3.4 VOLATILE ORGANIC SAMPLING TRAIN (VOST) FIELD DATA

ACUREX CORPORATION

Run 1-VOS-

Acurex Project No. 20772.71
Field Dates 8-24/26-82
Plant DUPONT - MEMPHIS, TN
Sampling Location COILEX No 1
Sampling Date 8-25-82

FIELD CREW

Crew Chief: BRUCE C. DeRoy
Testing Engineer: 1 ROBERT M. MURRAY
2
Engr. Technician: 1
2
3
Lab Technician: 1
2
Process Engineer: 1
2

FIELD SAMPLE REFERENCE NUMBERS:

Trip Blank 819612
Trip Blank 819613
819610
819611
Field Blank 819598
Field Blank 819599
819608
819609
819601
819600

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Volatile Organic Sampling Sampling Train (VOST) Data Sheet

Plant DUPONT, MEMPHIS, TN — Project No. SI 11C5.11

Date 5-25-85 — Operator [illegible]

Sample Location BOILER NO 1 GAS — Barometric Pressure (in. Hg) 31.15

Run No. 1 — Ambient Temperature (°F) 72

Trap Set	Trap I.D.	Clock Time 24 Hour	Elapsed Time (minutes)	Dry Gas Meter (L)	Volume Sampled (L)	Temperature (°F) DGM	Probe	Heated Line	Tenax Inlet	Rotometer Setting	Pump Vacuum (in. Hg)	Leak Rate LPM at Vacuum	Comments
A	25	Start: 1242	20		20.0	102	252	N/A	67		7	.026 / 1"	
	7A	Stop: 1302							-		—	.022 / 10"	
B	20	Start: 1322	20		20.0	102	251	N/A	72		7	.016 / 5"	SWEEP BLOWN OVERBOARD AFTER THIS SET
	52A	Stop: 1342							65		14	.056 / 20"	
C	27	Start: 1431	20		20.51	108	251	N/A	61		7	.014 / 8"	
	55A	Stop: 1451							- -		-	.062 / 15"	
D	24	Start:	~	~	~								FIELD BLANKS
	5EA	Stop:											
E	7	Start:	~	~	~								TRIP BLANKS
	51A	Stop:											
F		Start:											
		Stop:											
Summary	X	X		X								X	X

Notes: TEMPERATURE(°F) AT INLET OF TRAP NO 2 — SET A DIRECT 45° STOP —; SET B 105 " 105; SET C " 110 —

3.5 C_1 TO C_6 HYDROCARBON ANALYSIS DATA

GAS CHROMAT APH OPERATING CONDITIONS AND FIELD LOG

Client EPA/CMEA, Location DUPONT-MEMPHIS, Job No. 3077735.71

07:54:34

Injection Date 8-25-83, Time 07:48:17, Instrument ID VARIAN 940

Recorder/Printout Reference No. 37+58, Recorder ID 3390A/HP

Purpose of Run CALIBRATION STD.

Sample Description He 66 cc/m Air 166 cc/m H2 30cc/m

GC CONDITIONS

Amount Injected 1cc, Inj. Port or Sample Loop Used INJ

Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)

Detector Attenuation 10^{-11}, Amplifier or Range ___

Column: Liquid Phase ___, Solid Phase PORAPAK P,

Length 10', O.D. 1/8", I.D. ___, Material SS

Temperature: Injector 220°, Oven 160°, Detector 220°

Temperature Program N/A

ANALYSIS: METHANE 16.8 ETHANE 16.3 PROPANE 15.5 N-BUTANE 15.3 N-PENTANE 16.7 N-HEXANE 15.1 BAL N2 ±5%

SAMPLE RUN

Sampling Method CYL NO AAL 3244 (8151) SCOTT SPEC.

RT	Area (Ave. 2 of 2 injections)	Peak Height	Amount (ppm)	Component
.04	N/A		N/A	AIR
.33	38556	.0005322435	16.8	C_1
.52	10425	.0014223296	15.3	C_2
.84	11862	.0012618541	16.3	C_3
1.63	15355	.0010171453	16.7	C_4
2.76	19896	.0007279	15.5	C_5
8.83	23637	.0006361913	15.1	C_6

Name of Operator [signature], Date 8-25 1983

GAS CHROMAT APH OPERATING CONDITIONS AND FIELD LOG

Client EPA/CMEA, Location DUPONT-MEMPHIS, Job No. 30735.71

Injection Date 8-25-83, Time 11:29:29, Instrument ID VARIAN 740
Recorder/Printout Reference No. 44, Recorder ID 3390A/HP
Purpose of Run SAMPLE NO 900199 C_1-C_4 ANALYSIS

Sample Description TIME 1055 STACK TEMP 570°F
SAMPLE RAW TEMP @ 380°F

GC CONDITIONS

Amount Injected 1cc, Inj. Port or Sample Loop Used INJ
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)
Detector Attenuation 10^{-11}, Amplifier or Range ___
Column: Liquid Phase ___, Solid Phase PORAPACK R,
Length 10', O.D. 1/8", I.D. ___, Material SS
Temperature: Injector 220 °C, Oven 160 °C, Detector 220 °C
Temperature Program N/A

SAMPLE RUN

Sampling Method GRAB

RT	Area	Peak Height	Amount ( )	Component
0.03	2620			Air
0.32	22411			C_1
0.42	5402			C_2
0.98	2035			C_3
1.54	582			C_4

Name of Operator [signature], Date 8-25 1983

GAS CHROMAT APH OPERATING CONDITIONS AND FIELD LOG

Client EPA/C.M.E.A., Location DUPONT-MEMPHIS, Job No. 307235.71

Injection Date 8-25-83, Time 11:43:57, Instrument ID VARIAN 940
Recorder/Printout Reference No. 45, Recorder ID 3390A/HP
Purpose of Run SAMPLE NO. 900199 C_1-C_4 ANALYSIS

Sample Description TIME 1055 STACK TEMP 570°F
SAMPLE BOMB TEMP @ 382°F

GC CONDITIONS

Amount Injected 1cc, Inj. Port or Sample Loop Used INJ
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)
Detector Attenuation 10^{-11}, Amplifier or Range ___
Column: Liquid Phase ___, Solid Phase PORAPAK R,
Length ___, O.D. ___, I.D. ___, Material ___
Temperature: Injector 220 °C, Oven 160 °C, Detector 220 °C
Temperature Program N/A

SAMPLE RUN

Sampling Method GRAB

RT	Area	Peak Height	Amount ( )	Component
0.04	4570			Air
0.34	20250			C_1
1.04	7019			C_3
1.64	934			C_4

Name of Operator Bruce C. DeRa, Date 8-25 1983

GAS CHROMAT APH OPERATING CONDITIONS AND FIELD LOG

Client EPA/CMEA, Location DUPONT-MEMPHIS, Job No. 3077735.71

Injection Date 8-25-83, Time 11:55:46, Instrument ID VARIAN 940
Recorder/Printout Reference No. 46, Recorder ID 3390A/HP
Purpose of Run SAMPLE No 900199 C1-C3 ANALYSIS

Sample Description TIME 1055 STACK TEMP 520°F
SAMPLE BOMB @ 295°F

GC CONDITIONS

Amount Injected 1.CC, Inj. Port or Sample Loop Used INJ
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)
Detector Attenuation 10^{-11}, Amplifier or Range ___
Column: Liquid Phase ___, Solid Phase POROPAK R,
Length 10', O.D. 1/8", I.D. ___, Material SS
Temperature: Injector 220 °C, Oven 160 °C, Detector 220 °C
Temperature Program N/A

SAMPLE RUN

Sampling Method GRAB

RT	Area	Peak Height	Amount ( )	Component
0.03	3219			Air
0.34	20009			C_1
1.04	1957			C_3

Name of Operator Bruce G. DaRin, Date 8-25- 1983

GAS CHROMAT APH OPERATING CONDITIONS AND FIELD LOG

Client EPA/CMEA, Location DuPont-Memphis Job No. 30773571

Injection Date 8-, Time 12:09:30, Instrument ID VARIAN 2740
Recorder/Printout Reference No. 46, Recorder ID 3390A/HP
Purpose of Run CAL STANDARD C_1-C_6

Sample Description n-alkanes

GC CONDITIONS

Amount Injected 1 cc, Inj. Port or Sample Loop Used INJ
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)
Detector Attenuation 10^{-11}, Amplifier or Range ___
Column: Liquid Phase ___, Solid Phase PORAPAK R,
Length 10', O.D. 1/8, I.D. ___, Material ___
Temperature: Injector 220 °C, Oven 160 °C, Detector 220 °C
Temperature Program N/A

SAMPLE RUN

Sampling Method CAL GAS AAL 7244

RT	Area	Peak Height	Amount ( )	Component
0.03	3324			N_2
0.35	35199			C_1
0.56	12600			C_2
0.93	14730			C_3
1.86	15045			C_4
4.15	24736			C_5
9.00	26545			C_6

Name of Operator Byron C. Dale, Date 8-25 1983

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client EPA/CMEA, Location DUPONT-MEMPHIS, Job No. 30T735.71

Injection Date 8-25-83, Time 14:44:15, Instrument ID VARIAN 940
Recorder/Printout Reference No. 51, Recorder ID 3390A/HP
Purpose of Run SAMPLE 900201 C_1-C_6 ANALYSIS

Sample Description

GC CONDITIONS

Amount Injected 1 cc, Inj. Port or Sample Loop Used INJ
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)
Detector Attenuation 10^{-11}, Amplifier or Range ___
Column: Liquid Phase ___, Solid Phase ___,
Length 10', O.D. 1/8", I.D. ___, Material SS
Temperature: Injector 220 °C, Oven 160 °C, Detector 320 °C
Temperature Program ___

SAMPLE RUN

Sampling Method GRAB @ 1435

RT	Area	Peak Height	Amount ( )	Component
0.03	1370			Air
0.32	16172			C_1
0.43	3561			C_2
1.02	1610			C_3

Name of Operator [signature], Date 8-25 1983

GAS CHROMAT APH OPERATING CONDITIONS AND FIELD LOG

Client EPA/CMEA, Location Dugout-Memphis, Job No. 307735.71

Injection Date 8-25-83, Time 17:59:40, Instrument ID VARIAN 940
Recorder/Printout Reference No. 57, Recorder ID 3390A/HP
Purpose of Run Samples No 900201

Sample Description

GC CONDITIONS

Amount Injected 1cc, Inj. Port or Sample Loop Used INJ
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)
Detector Attenuation 10^{-11}, Amplifier or Range ___
Column: Liquid Phase ___, Solid Phase Porapack R,
Length 10', O.D. 1/8", I.D. ___, Material SS
Temperature: Injector 220 °C, Oven 160 °C, Detector 220 °C
Temperature Program N/A

SAMPLE RUN

Sampling Method GRAB @ 1735

RT	Area	Peak Height	Amount ( )	Component
0.04	3543			Air
0.34	16219			C_1
0.45	3880			C_2
1.01	2251			C_3

Name of Operator Byron C Dalton, Date 8-25 1983

GAS CHROMAT APH OPERATING CONDITIONS AND FIELD LOG

Client EPA/CMEA, Location DURANT-MEM, Job No. 307735.71

Injection Date 8-25-83, Time 15:22:10, Instrument ID VARIAN 940
Recorder/Printout Reference No. 53, Recorder ID 3390A/HP
Purpose of Run Sample 900201 C_1-C_6 ANALYSIS

Sample Description

GC CONDITIONS

Amount Injected 1.0, Inj. Port or Sample Loop Used INJ
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)
Detector Attenuation 10^{-11}, Amplifier or Range ___
Column: Liquid Phase ___, Solid Phase PORAPAK R,
Length 10', O.D. 1/8", I.D. ___, Material SS
Temperature: Injector 220 °C, Oven 160 °C, Detector 220 °C
Temperature Program ___

SAMPLE RUN

Sampling Method GRAB @ 1435

RT	Area	Peak Height	Amount ( )	Component
0.03	2832			Air
0.34	16669			C_1
0.44	3738			C_2
0.95	7256			C_3

Name of Operator Bruce Dorr, Date 8-25 1983

GAS CHROMAT APH OPERATING CONDITIONS AND FIELD LOG

Client EPA/CMEA, Location DuPont-Memphis, Job No. 307185.71

Injection Date 8-25-83, Time 15:59:52, Instrument ID VARIAN 940
Recorder/Printout Reference No. 55, Recorder ID 3390A/HP
Purpose of Run C_1-C_3 Analysis

Sample Description Sample 900202

GC CONDITIONS

Amount Injected 1 cc, Inj. Port or Sample Loop Used INT
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)
Detector Attenuation 10^{-11}, Amplifier or Range ___
Column: Liquid Phase ___, Solid Phase PORAPAK R,
Length 10', O.D. 1/8", I.D. ___, Material SS
Temperature: Injector 220 °C, Oven 160 °C, Detector 220 °C
Temperature Program ___

SAMPLE RUN

Sampling Method GRAB @ 1555

RT	Area	Peak Height	Amount ( )	Component
0.03	7651			Air
0.33	15409			C_1
0.44	3603			C_2
1.01	2503			C_3

Name of Operator Bruce C. DeRee, Date 8-25 1983

GAS CHROMAT APH OPERATING CONDITIONS AND FIELD LOG

Client EPA/CMEA, Location DUPONT-MEM, Job No. 3677.35.71

Injection Date 8-25-83, Time 16:11:26, Instrument ID VARIAN 340
Recorder/Printout Reference No. 56, Recorder ID 3390A/HP
Purpose of Run C_1-C_6 ANALYSIS

Sample Description SAMPLE 900201

GC CONDITIONS

Amount Injected _____, Inj. Port or Sample Loop Used _____
Detector Used: FID ___, ECD ___, FPD ___, TCD ___ (Current _____)
Detector Attenuation 10^-11, Amplifier or Range _____
Column: Liquid Phase _____, Solid Phase POROPAK R,
Length 10', O.D. 1/8", I.D. _____, Material _____
Temperature: Injector 220 °C, Oven 160 °C, Detector 220 °C
Temperature Program _____

SAMPLE RUN

Sampling Method GRAB @ 1555

RT	Area	Peak Height	Amount ( )	Component
0.04	1448			Air
0.33	16034			C_1
0.44	3685			C_2
1.03	1766			C_3
13.08	3121			C_6

Name of Operator [signature], Date 8-25 1983

GAS CHROMAT APH OPERATING CONDITIONS AND FIELD LOG

Client EPA/CMEA, Location DUPONT-MEM, Job No. 307735.71

Injection Date 8-25-83, Time 17:14:05, Instrument ID VARIAN 940
Recorder/Printout Reference No. 58, Recorder ID _____
Purpose of Run $C_1 - C_4$ ANALYSIS

Sample Description SAMPLE 900225

GC CONDITIONS

Amount Injected 1 cc, Inj. Port or Sample Loop Used INJ
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current _____)
Detector Attenuation 10^{-11}, Amplifier or Range _____
Column: Liquid Phase _____, Solid Phase PORAPAK R,
Length 10', O.D. 1/8", I.D. _____, Material SS
Temperature: Injector 220 °C, Oven 180 °C, Detector 220 °C
Temperature Program N/A

SAMPLE RUN

Sampling Method GRAB @ 1220

RT	Area	Peak Height	Amount ( )	Component
0.03	1036			Air
0.31	8125			C_1
0.43	773			C_2
0.84	9171			C_3
1.90	1445			C_4

Name of Operator [signature], Date 8-25 1983

GAS CHROMAT APH OPERATING CONDITIONS AND FIELD LOG

Client EPA/CMEA, Location DuPont, MEM, Job No. 3077335.71

Injection Date 8-25-83, Time 17:31:16, Instrument ID VARIAN 940
Recorder/Printout Reference No. 66, Recorder ID 3390A/HP
Purpose of Run C_1-C_6 ANALYSIS

Sample Description 900225

GC CONDITIONS

Amount Injected 1cc, Inj. Port or Sample Loop Used INT
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)
Detector Attenuation 10-11, Amplifier or Range ___
Column: Liquid Phase ___, Solid Phase Porapak R,
Length 10', O.D. 1/8", I.D. ___, Material SS
Temperature: Injector 220 °C, Oven 160 °C, Detector 220 °C
Temperature Program N/A

SAMPLE RUN

Sampling Method Grab @ 1720

RT	Area	Peak Height	Amount ( )	Component
0.41	447			Air
0.32	7738			C_1
0.43	1511			C_2
1.19	3544			C_3

Name of Operator Bruce G Dolan, Date 8-25-83 19 83

GAS CHROMAT APH OPERATING CONDITIONS AND FIELD LOG

Client EPA/CMEA, Location DUPONT-MEMPHIS, Job No. 307735.71

Injection Date 8-25-83, Time 17:42:21, Instrument ID VARIAN 940
Recorder/Printout Reference No. 61, Recorder ID 3390A/HP
Purpose of Run C_1-C_6 ANALYSIS

Sample Description 900225

GC CONDITIONS

Amount Injected 1cc, Inj. Port or Sample Loop Used INJ
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current _____)
Detector Attenuation 10^{-11}, Amplifier or Range _____
Column: Liquid Phase _____, Solid Phase PORAPAK R,
Length 10', O.D. 1/8", I.D. _____, Material SS
Temperature: Injector 220 °C, Oven 160 °C, Detector 220 °C
Temperature Program N/A

SAMPLE RUN

Sampling Method GRAB @ 1720

RT	Area	Peak Height	Amount ( )	Component
0.03	418			Air
0.31	8043			C_1
0.43	941			C_2
1.23	1463			C_3

Name of Operator [signature], Date 8-25-83 19 83

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client EPA/CMEA, Location DUPONT-MEM, Job No. 307955.71

Injection Date 8-25-83, Time 18:43:31 (18:18:23), Instrument ID VARIAN 940
Recorder/Printout Reference No. 65 + 70, Recorder ID 3390A/HP
Purpose of Run SAMPLE BOMB BLANK – C_1-C_6 ANALYSIS

Sample Description N_2

GC CONDITIONS

Amount Injected 1cc, Inj. Port or Sample Loop Used INJ
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)
Detector Attenuation 10^{-11}, Amplifier or Range ___
Column: Liquid Phase ___, Solid Phase PORAPAK R,
Length 10', O.D. 1/8", I.D. ___, Material SS
Temperature: Injector 220 °C, Oven 160 °C, Detector 220 °C
Temperature Program N/A.

SAMPLE RUN

Sampling Method PURGE SAMPLE BOMB W N_2

RT	Area (Average of 3 Samples)	Peak Height	Amount ( )	Component
0.05	351			N_2
0.32	16408			C_1

Name of Operator [signature], Date 8-25 1983

GAS CHROMATOGRAPH OPERATING CONDITIONS AND FIELD LOG

Client EPA/CMEA, Location DUPONT-MEMPHIS, Job No. 307735.71

Injection Date 8-25-83, Time 19:10:04, Instrument ID VARIAN 940
Recorder/Printout Reference No. 74 + 73, Recorder ID 3390A/HP
Purpose of Run CALIBRATION STANDARD

Sample Description SCOTT CYL NO. AAL-7244

GC CONDITIONS

Amount Injected 1cc, Inj. Port or Sample Loop Used I.N.T.
Detector Used: FID X, ECD ___, FPD ___, TCD ___ (Current ___)
Detector Attenuation 10^{-11}, Amplifier or Range ___
Column: Liquid Phase ___, Solid Phase POROPACK R,
Length 10', O.D. 1/8", I.D. ___, Material SS
Temperature: Injector 220 °C, Oven 160 °C, Detector 220 °C
Temperature Program N/A

SAMPLE RUN

Sampling Method AAL 7244 SCOTT

RT	Area (Ave. of 3 injections)	Peak Height ppm/mm recorder	Amount (ppm) ±5%	Component
.05				N_2
.34	24593	0.683×10^{-3}	16.8	C_1
.55	11089	illegible	15.3	C_2
.97	13973	1.167×10^{-3}	16.3	C_3
2.1	17482	0.955×10^{-3}	16.7	C_4
4.89	22122	0.701×10^{-3}	15.5	C_5
12.14	23833	0.634×10^{-3}	15.1	C_6

Name of Operator Bruce C. Dale, Date 8-25 1983

SECTION 4

LABORATORY ANALYSIS RESULTS

4.1 Trace Element Analyses

4.2 TCO, GRAV, GC/MS, and IR Analyses of SASS Samples

4.3 GC/MS Analysis of VOST Traps

4.4 Bioassay Analysis Report

4.1 TRACE ELEMENT ANALYSES

COMMERCIAL TESTING & ENGINEERING CO.

SINCE 1908

Reply to
Instrumental Analysis Division
490 Orchard Street
Golden, CO 80401

Phone: 303-278-9521

December 30, 1983

Mr. Christopher Mann
Acurex Corporation
555 Clyde Avenue
Mountain View, CA 94039

Re: IAD #97-N312-116-10
Subcontract #SW59159A
Release #12

Analytical Report

Ten samples were received for analysis on December 14, 1983. These samples were assigned our IAD identification #97-N312-116-10.

Trace element analysis is being performed using spark source mass spectrometry. Reports will be forwarded upon completion of the analysis.

After appropriate prepartion of each of the samples, arsenic and antimony were determined using hydride generation atomic absorption spectrophotometry, and mercury was determined using cold vapor flameless atomic absorption spectrophotometry.

The results of these determinations are presented in Table No. I and are reported in parts per million (ppm) on an "as received" basis.

Carbon and hydrogen were determined by an external laboratory in accordance with the procedures of ASTM, Part 05.05, Method D3178.

The results of these determinations are presented in Table No. II and are reported in weight percent (wt. %) on an "as received" basis except sample 900209 which is reported on a dry basis with the moisture at 107°C also reported.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, IL 60148 AREA CODE 312 953-9300

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Table No. I
(ppm - As Received)

Sample ID	Mercury (Hg)	Arsenic (As)	Antimony (Sb)
1) 900204 DM Filter +1µm	0.08	xxxx	xxxx
2) 902175 DM Filter Blank	0.03	xxxx	xxxx
3) 900217 DM 10µm + 3µm	0.08	xxxx	xxxx
4) 900206 DM XAD-2	0.05	xxxx	xxxx
5) 900205 DM XEAD-2 Blank	0.02	xxxx	xxxx
6) 900219 DM Impinger 1	0.004	xxxx	xxxx
7) 900208 DM Impinger 1 Blank	0.004	xxxx	xxxx
8) 900209 DM CWS Fuel	0.02*	xxxx	xxxx
9) 900220 DM Impinger 2 & 3	$\leq$0.0002	0.002	$\leq$0.001
10) 900207 DM Impinger 2 & 3 Blank	0.003	0.007	0.003

Table No. II
(Wt. % - As Received)

Sample ID	Carbon	Hydrogen	Moisture
1) 900204 DM Filter + 1µm	13.13	0.09	xxxx
3) 900217 DM 10µm + 3µm	42.67	0.13	xxxx
8) 900209 DM CWS Fuel	82.56*	5.03*	74.41

*Reported on Dry Basis

If you have any questions concerning these results, please call.

Harold A. Connell
Assistant Lab Manager

Robert L. Taylor, Ph.D., Mngr.
Instrumental Analysis Division

30 Dec 83

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES, 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 AREA CODE 312 953-9300
Reply to INSTRUMENTAL ANALYSIS DIVISION, 490 ORCHARD STREET, GOLDEN, COLORADO 80401, PHONE: 303 278-9521

To: Mr. Christopher Mann
Acurex Corporation
555 Clyde Avenue
Mountian View, CA 94039

Date: February 8, 1984

Analyst: G. Meagher

Subcontract #SW59159A
P. O. No.: Release #12

Sample No.: 900209
DM CWS fuel

IAD No.: 97-N312-116-10

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

CONCENTRATION IN PPM WEIGHT
Dry Coal Basis

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	2	Terbium		Ruthenium		Vanadium	8
Thorium	4	Gadolinium		Molybdenum	2	Titanium	MC
Bismuth		Europium	0.3	Niobium	1	Scandium	3
Lead	3	Samarium	2	Zirconium	6	Calcium	270
Thallium		Neodymium	2	Yttrium	4	Potassium	MC
Mercury	NR	Praseodymium	0.9	Strontium	17	Chlorine	610
Gold		Cerium	4	Rubidium	2	Sulfur	MC
Platinum		Lanthanum	6	Bromine	8	Phosphorus	460
Iridium		Barium	23	Selenium	8	Silicon	MC
Osmium		Cesium		Arsenic	1	Aluminum	MC
Rhenium		Iodine	5	Germanium	0.6	Magnesium	MC
Tungsten		Tellurium	$\leq$0.7	Gallium	3	Sodium	MC
Tantalum		Antimony	2	Zinc	6	Fluorine	NR
Hafnium		Tin	0.5	Copper	8	Oxygen	NR
Lutetium		Indium	STD	Nickel	3	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	3	Carbon	NR
Thulium		Silver		Iron	MC	Boron	8
Erbium		Palladium		Manganese	6	Beryllium	9
Holmium		Rhodium		Chromium	31	Lithium	50
Dysprosium						Hydrogen	NR

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.2 ppm
MC — Major Component >1000 ppm
INT — Interference

Approved: 4-5

Robert L. Douglas
7 Feb 84

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES. 1919 SOUTH HIGHLAND AVE., SUITE 210-B. LOMBARD. ILLINOIS 60148 AREA CODE 312 953-9300

Reply to INSTRUMENTAL ANALYSIS DIVISION. 490 ORCHARD STREET. GOLDEN. COLORADO 80401. PHONE: 303 278-9521

To: Mr. Christopher Mann
Acurex Corporation
555 Clyde Avenue
Mountain View, CA 94039

Date: February 8, 1984

Analyst: G. Meagher

P. O. No.: Subcontract #SW59159A
Release #12

Sample No.: 900217
DM 10 µm + 3 µm

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

IAD No.: 97-N312-116-10

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	7	Terbium	0.9	Ruthenium		Vanadium	120
Thorium	13	Gadolinium	4	Molybdenum	12	Titanium	MC
Bismuth		Europium	1	Niobium	18	Scandium	20
Lead	28	Samarium	7	Zirconium	45	Calcium	MC
Thallium	0.4	Neodymium	12	Yttrium	41	Potassium	MC
Mercury	NR	Praseodymium	8	Strontium	250	Chlorine	590
Gold		Cerium	26	Rubidium	18	Sulfur	MC
Platinum		Lanthanum	32	Bromine	30	Phosphorus	600
Iridium		Barium	330	Selenium	8	Silicon	MC
Osmium		Cesium	2	Arsenic	14	Aluminum	MC
Rhenium		Iodine	7	Germanium	5	Magnesium	MC
Tungsten	0.9	Tellurium		Gallium	41	Sodium	MC
Tantalum	2	Antimony	5	Zinc	100	Fluorine	NR
Hafnium	0.8	Tin	2	Copper	84	Oxygen	NR
Lutetium	0.2	Indium	STD	Nickel	320	Nitrogen	NR
Ytterbium	1	Cadmium	≤ 1	Cobalt	30	Carbon	NR
Thulium	0.5	Silver	1	Iron	MC	Boron	20
Erbium	3	Palladium		Manganese	20	Beryllium	87
Holmium	4	Rhodium		Chromium	180	Lithium	>440
Dysprosium	7					Hydrogen	NR

STD – Internal Standard
NR – Not Reported
All elements not detected < 0.1 ppm
MC – Major Component >1000 ppm
INT – Interference

Approved: Robert L. Douglas 7 Feb 84

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 AREA CODE 312 953-9300
Reply to INSTRUMENTAL ANALYSIS DIVISION, 490 ORCHARD STREET, GOLDEN, COLORADO 80401, PHONE: 303 278-9521

To: Mr. Christopher Mann
Acurex Corporation
555 Clyde Avenue
Mountian View, CA 94039

Date: February 8, 1984

Subcontract #SW59159A
P. O. No.: Release #12

Analyst: G. Meagher

Sample No.: 900204
DM filter + 1 µm

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS
CONCENTRATION IN PPM WEIGHT

IAD No. 97-N312-116-10

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium	75	Terbium	4	Ruthenium		Vanadium	MC
Thorium	91	Gadolinium	13	Molybdenum	12	Titanium	MC
Bismuth	16	Europium	4	Niobium	27	Scandium	82
Lead	310	Samarium	22	Zirconium	140	Calcium	MC
Thallium	10	Neodymium	32	Yttrium	93	Potassium	MC
Mercury	NR	Praseodymium	25	Strontium	680	Chlorine	400
Gold		Cerium	120	Rubidium	46	Sulfur	MC
Platinum		Lanthanum	180	Bromine	82	Phosphorus	MC
Iridium		Barium	MC	Selenium	17	Silicon	MC
Osmium		Cesium	7	Arsenic	59	Aluminum	MC
Rhenium		Iodine	4	Germanium	38	Magnesium	MC
Tungsten	9	Tellurium	1	Gallium	180	Sodium	MC
Tantalum	1	Antimony	42	Zinc	400	Fluorine	NR
Hafnium	5	Tin	15	Copper	140	Oxygen	NR
Lutetium	1	Indium	STD	Nickel	770	Nitrogen	NR
Ytterbium	11	Cadmium	3	Cobalt	130	Carbon	NR
Thulium	1	Silver	4	Iron	MC	Boron	89
Erbium	8	Palladium		Manganese	43	Beryllium	710
Holmium	10	Rhodium		Chromium	490	Lithium	>600
Dysprosium	16					Hydrogen	NR

STD – Internal Standard
NR – Not Reported
All elements not detected < 0.2 ppm
MC – Major Component >1000 ppm
INT – Interference

Approved: Robert L. Taylor 7 Feb '84

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 AREA CODE 312 953-9300
Reply to INSTRUMENTAL ANALYSIS DIVISION, 490 ORCHARD STREET, GOLDEN, COLORADO 80401, PHONE: 303 278-9521

To: Mr. Christopher Mann
Acurex Corporation
555 Clyde Avenue
Mountain View, CA 94039

Date: February 8, 1984

Subcontract No. SW59159A
P. O. No.: Release No. 12

Analyst: G. Meagher

Sample No.: 900206
DM XAD-2

IAD No.: 97-N312-116-10

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS
CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium		Terbium		Ruthenium		Vanadium	<0.05
Thorium	≤0.4	Gadolinium		Molybdenum	2	Titanium	2
Bismuth		Europium		Niobium	<0.05	Scandium	<0.05
Lead	0.2	Samarium		Zirconium	0.3	Calcium	10
Thallium		Neodymium		Yttrium		Potassium	5
Mercury	NR	Praseodymium		Strontium	0.2	Chlorine	10
Gold	≤0.05	Cerium		Rubidium	0.3	Sulfur	10
Platinum	*1	Lanthanum	0.1	Bromine	0.4	Phosphorus	2
Iridium		Barium	1	Selenium	0.4	Silicon	3
Osmium		Cesium	0.2	Arsenic	0.2	Aluminum	1
Rhenium		Iodine	0.2	Germanium	<0.05	Magnesium	3
Tungsten		Tellurium		Gallium	0.2	Sodium	5
Tantalum		Antimony	0.1	Zinc	3	Fluorine	≈50
Hafnium		Tin	0.5	Copper	0.5	Oxygen	NR
Lutetium		Indium	STD	Nickel	0.5	Nitrogen	NR
Ytterbium		Cadmium	0.05	Cobalt	≤0.05	Carbon	NR
Thulium		Silver		Iron	5	Boron	<0.05
Erbium		Palladium		Manganese	0.2	Beryllium	
Holmium		Rhodium		Chromium	1	Lithium	<0.05
Dysprosium						Hydrogen	NR

*Probable contamination from sample preparation

STD – Internal Standard
NR – Not Reported
All elements not detected < 0.05 ppm
MC – Major Component >500 ppm
INT – Interference

Approved: Robert L. Ziegler
7 Feb 84

4-8

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES 1919 SOUTH HIGHLAND AVE SUITE 210-B, LOMBARD, ILLINOIS 60148 AREA CODE 312 953-9300
Reply to
INSTRUMENTAL ANALYSIS DIVISION, 490 ORCHARD STREET, GOLDEN, COLORADO 80401, PHONE: 303 278-9521

To: Mr. Christopher Mann
Acurex Corporation
555 Clyde Avenue
Mountain View, CA 94039

Date: February 3, 1984

Subcontract No. SW59159A
P. O. No.: Release No. 12

Analyst: G. Meagher

Sample No.: 900205
DM XAD-2 Blank

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

IAD No. 97-N312-116-10

CONCENTRATION IN PPM WEIGHT

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium		Terbium		Ruthenium.		Vanadium	0.05
Thorium		Gadolinium		Molybdenum	0.4	Titanium	1
Bismuth		Europium		Niobium		Scandium	0.1
Lead		Samarium		Zirconium	<0.05	Calcium	10
Thallium		Neodymium		Yttrium		Potassium	10
Mercury	NR	Praseodymium		Strontium	0.05	Chlorine	50
Gold		Cerium	0.1	Rubidium	<0.05	Sulfur	10
Platinum	*0.3	Lanthanum	0.2	Bromine	0.1	Phosphorus	5
Iridium		Barium	0.4	Selenium	0.2	Silicon	25
Osmium		Cesium	0.2	Arsenic	<0.05	Aluminum	1
Rhenium		Iodine	0.05	Germanium		Magnesium	5
Tungsten		Tellurium		Gallium	0.1	Sodium	25
Tantalum		Antimony		Zinc	3	Fluorine	≈15
Hafnium		Tin		Copper	1	Oxygen	NR
Lutetium		Indium	STD	Nickel	35	Nitrogen	NR
Ytterbium		Cadmium		Cobalt	0.1	Carbon	NR
Thulium		Silver		Iron	5	Boron	0.1
Erbium		Palladium		Manganese	5	Beryllium	
Holmium		Rhodium		Chromium	15	Lithium	0.1
Dysprosium						Hydrogen	NR

*Probable contamination from sample preparation

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.05 ppm
MC — Major Component >500 ppm
INT — Interference

Approved: Robert L. Daylon
7 Feb 84

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES. 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 AREA CODE 312 953-9300
Reply to INSTRUMENTAL ANALYSIS DIVISION, 490 ORCHARD STREET, GOLDEN, COLORADO 80401, PHONE: 303 278-9521

To: Mr. Christopher Mann
Acurex Corporation
555 Clyde Avenue
Mountain View, CA 94039

Date: February 8, 1984

Analyst: G. Meagher

P. O. No.: Subcontract #SW59159A
Release #12

Sample No.: 900219
DM impinger 1

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS
CONCENTRATION IN µg/mL

IAD No.: 97-N312-116-10

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium		Terbium		Ruthenium		Vanadium	0.01
Thorium		Gadolinium		Molybdenum	0.2	Titanium	≤0.009
Bismuth		Europium		Niobium	0.004	Scandium	<0.001
Lead	0.1	Samarium		Zirconium	0.002	Calcium	0.4
Thallium		Neodymium	≤0.001	Yttrium	<0.001	Potassium	0.2
Mercury	NR	Praseodymium		Strontium	0.003	Chlorine	0.9
Gold		Cerium	<0.001	Rubidium	<0.001	Sulfur	MC
Platinum		Lanthanum		Bromine	0.03	Phosphorus	0.09
Iridium		Barium	0.03	Selenium	0.06	Silicon	2
Osmium		Cesium	<0.001	Arsenic	0.003	Aluminum	0.03
Rhenium		Iodine	0.01	Germanium	<0.001	Magnesium	0.4
Tungsten	0.004	Tellurium	≤0.002	Gallium	0.005	Sodium	MC
Tantalum	<0.001	Antimony	0.003	Zinc	0.7	Fluorine	NR
Hafnium		Tin	0.02	Copper	1	Oxygen	NR
Lutetium		Indium	STD	Nickel	1	Nitrogen	NR
Ytterbium		Cadmium	0.003	Cobalt	0.04	Carbon	NR
Thulium		Silver	0.004	Iron	MC	Boron	0.003
Erbium		Palladium		Manganese	0.4	Beryllium	
Holmium	≤0.009	Rhodium		Chromium	MC	Lithium	0.02
Dysprosium						Hydrogen	NR

STD – Internal Standard
NR – Not Reported
All elements not detected < 0.001 µg/mL
MC – Major Component >10 µg/mL
INT – Interference

Approved: Robert L. Douglas
7 Feb '84

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD ILLINOIS 60148 AREA CODE 312 953-9300
Reply to INSTRUMENTAL ANALYSIS DIVISION, 490 ORCHARD STREET, GOLDEN COLORADO 80401, PHONE 303 278-9521

To: Mr. Christopher Mann
Acurex Corporation
555 Clyde Avenue
Mountain View, CA 94039

Date: February 8, 1984

Analyst: G. Meagher

P. O. No.: Subcontract #SW59159A
Release #12

Sample No.: 900208
DM impinger 1 Blank

SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS

IAD No. 97-N312-116-10

CONCENTRATION IN µg/mL

ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.	ELEMENT	CONC.
Uranium		Terbium		Ruthenium		Vanadium	
Thorium		Gadolinium		Molybdenum	*0.4	Titanium	<0.001
Bismuth		Europium		Niobium		Scandium	
Lead		Samarium		Zirconium	0.007	Calcium	0.08
Thallium		Neodymium		Yttrium		Potassium	0.04
Mercury	NR	Praseodymium		Strontium	0.001	Chlorine	0.2
Gold		Cerium		Rubidium		Sulfur	0.3
Platinum		Lanthanum		Bromine	0.005	Phosphorus	0.03
Iridium		Barium	0.004	Selenium	0.005	Silicon	1
Osmium		Cesium		Arsenic	<0.001	Aluminum	0.006
Rhenium		Iodine	0.001	Germanium		Magnesium	0.1
Tungsten		Tellurium		Gallium	0.001	Sodium	0.1
Tantalum		Antimony		Zinc	0.01	Fluorine	NR
Hafnium		Tin	0.02	Copper	<0.001	Oxygen	NR
Lutetium		Indium	STD	Nickel	0.007	Nitrogen	NR
Ytterbium		Cadmium	0.002	Cobalt	0.01	Carbon	NR
Thulium		Silver		Iron	0.08	Boron	0.002
Erbium		Palladium		Manganese		Beryllium	
Holmium		Rhodium		Chromium	0.01	Lithium	0.005
Dysprosium						Hydrogen	NR

*Heterogeneous

STD — Internal Standard
NR — Not Reported
All elements not detected < 0.001 µg/mL
MC — Major Component >10 µg/mL
INT — Interference

Approved: Robert L. Taylor
7 Feb 84

4-11

COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • (312) 953 9300

ROBERT L. TAYLOR, Ph.D.
MANAGER
INSTRUMENTAL ANALYSIS DIVISION

PLEASE ADDRESS ALL CORRESPONDENCE TO
490 ORCHARD ST., GOLDEN, CO 80401
OFFICE TEL. (303) 278-9521

May 16, 1984

Mr. Christopher Mann
Acurex Corporation
P.O. Box 7555
Mountain View, CA 94039

RE: IAD #97-N814-116-05
Subcontract #SW 59159A
Release # 14

Analytical Report

Five samples, previously analyzed for trace elements by spark source mass spectrometry, under our IAD identification #97-N312-116-10, were logged in under our IAD identification #97-N814-116-05 on February 22, 1984.

Fluorine was determined using specific ion electrode methodology. Depending on the sample type and the amount of sample available, Sulfur was determined either turbidimetrically or by X-ray fluorescence spectrometry. The remaining elemental analysis was performed using either atomic absorption/emission spectrophotometry or X-ray fluorescence spectrometry.

The results of these determinations are presented in the following tables. Samples #1, 2 and 5 are reported in micrograms per gram (µg/g) on an "as received" basis, except #5 which is reported on a dry coal basis. Samples #3 and 4 are reported in micrograms per millilitre (µg/mL) on an "as received" basis.

If you have any questions concerning these results, please call.

Harold A. Connell
Assistant Lab Manager

Robert L. Taylor, Ph.D., Mngr. 16 May 84
Instrumental Analysis Div.

as

Charter Member

Table No. I
(Wt.%-As Received)

Parameter	900204 DM Filter + 1 µm	
Aluminum (Al)	4.29	
Barium (Ba)	0.13	
Calcium (Ca)	0.52	
Fluorine (F)	0.03	(300 µg/g)
Iron (Fe)	3.07	
Potassium (K)	0.99	
Lithium (Li)	0.004	(44 µg/g)
Magnesium (Mg)	0.23	
Sodium (Na)	0.54	
Phosphorus (P)	0.06	(600 µg/g)
Sulfur (S)	0.30	
Silicon (Si)	5.13	
Titanium (Ti)	0.57	
Vanadium (V)	0.04	(400 µg/g)

Table No. II
(Wt.%-As Received)

Parameter	900217 DM 10µm + 3 µm	
Aluminum (Al)	9.19	
Calcium (Ca)	0.41	
Fluorine (F)	<0.01	
Iron (Fe)	2.25	
Potassium (K)	0.90	
Lithium (Li)	0.009	(87 µg/g)
Magnesium (Mg)	0.25	
Sodium (Na)	0.88	
Sulfur (S)	0.06	(640 µg/g)
Silicon (Si)	13.17	
Titanium (Ti)	0.54	

Table No. III
(µg/mL-As Received)

Parameter	900219 DM Impinger 1	
Chromium (Cr)	29	
Fluorine (F)	19	
Iron (Fe)	150	
Sodium (Na)	380	
Sulfur (S)	4,700	(0.47%)

Table No. IV
(µg/mL-As Received)

Parameter	900208 DM Impinger 1 Blank
Fluorine (F)	0.43

Table No. V
(µg/g-Dry Coal Basis)

Patameter	900209 DM CWS Fuel	
Aluminum (Al)	7,000	(0.70%)
Fluorine (F)	34	
Iron (Fe)	1,700	(0.17%)
Potassium (K)	80	
Magnesium (Mg)	200	
Sodium (Na)	70	
Silicon (Si)	12,800	(1.28%)
Titanium (Ti)	400	
Moisture	74.41%	

4.2 TCO, GRAV, GC/MS, AND IR ANALYSES OF SASS SAMPLES

ACUREX Corporation

Energy & Environmental Division

Acurex/ES (CMEA)
M/S 2-2260

January 18, 1984
Acurex ID: 8310-004
Client PO#: 307736.72

Attention: Larry Waterland

Sample: Memphis, 1 SASS Train; Received 8/29/83

The above samples were analyzed by Level 1 protocol. The XAD and OMC extracts were combined per your instruction. Organic extracts were also analyzed for the semivolatile priority pollutants by gas chromatography/mass spectrometry employing a J&W SE-54 30 meter capillary column. The column was held at 30°C for 2 minutes, then ramped at 10°C per minute to 27°C. In addition to the priority pollutants, other organics including benzo(c)phenanthrene, dibenzo(c,g)carbazole, 7,12-dimethylbenzo(a)anthracene, 3-methylcholanthrene, and perylene were sought employing the computerized library search and manual interpretation. The assignment and quantitation of these organics is tentative since analytical standards of these compounds were not available for analysis. Benzo(c)phenanthrene, dibenzo(c,g)carbazole, 7,12-dimethylbenzo(a)anthracene, 3-methylcholanthrene and perylene were not detected in any of the samples at levels above 400 µg per 10 ml of extract.

Submitted by:

Greg Nicoll
Operations Manager

Viorica Lopez-Avila, Ph.D.
Technical Director

GN/VLA/ats

Enclosures

555 Clyde Avenue, P.O. Box 7555, Mountain View, CA 94039 (415) 964-3200 Telex: 34-6391 TWX: 910-7796593

ACUREX Corporation
ANALYSIS LABORATORIES

DATA REPORTING FORM

CUSTOMER CMEA DATE January 19, 1984

CUSTOMER CONTRACT NO. 307736.72 ACUREX CONTRACT NO. _____

RESULTS REPORT TO _____ TELEPHONE _____

ADDRESS _____

SAMPLE ID (CUSTOMER)	XAD	XAD Blk	Filter + 1μ	3 μ + 10 μ						
SAMPLE ID (LAB)	12	13	11-30-1	11-30-5						
PARAMETER										UNITS
GRAV	7	<4	<9	<30						mg/train
TCO	1.6, 1.5*	<0.2	--	--						mg/train
PAH - Naphthalene	0.05	<0.01	<0.02	<0.08						mg/train
- Others	<0.01	<0.01	<0.02	<0.08						mg/train

* Duplicate injections

ANALYST U. Spannagel, C. Beeman, S. Kraska

REVIEWER _____

IR REPORT

SAMPLE: 8311-30-2 10 μ + 3μ

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2929	S	C-H Alkane	weak spectrum
2840	M	C-H Alkane	

IR REPORT

SAMPLE: 8311-30-1 Filters + 1μ

Wave Number (cm^{-1})	Intensity	Assignment	Comments
		No peaks	

IR REPORT

SAMPLE: 8310-04-12 XAD

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2970	M	C-H Alkane	
2920	S	C-H Alkane	
2840	M	C-H Alkane	
1740	M	C=O	
1450	W	CH	
1260	W	C-O	
			Spectrum is
			not strong
			Aliphatic

IR REPORT

SAMPLE: 8310-04-13 XAD Blk

Wave Number (cm^{-1})	Intensity	Assignment	Comments
2920	S	C-H Alkane	
2840	M	C-H Alkane	
1740	W	C=O	Tentative Assignments
1460	W	CH	
1370	W	CH	
1100	W	C-O	
			Aliphatic

4.3 GC/MS ANALYSIS OF VOST TRAPS

ACUREX Corporation

Energy & Environmental Division

Acurex/ES

September 27, 1983
Acurex ID#: 8309-006
Client PO#: 307736.72

Attention: Carlo Castaldini

Subject: Analysis of 3 Tenax Traps and 3 Tenax/Charcoal Traps for Volatile Priority Pollutants and Allyl Chloride.

Enclosed please find the results of the gas chromatographic/mass spectrometric analyses of the 6 Tenax and Tenax/Charcoal traps from the CMEA tests at Memphis. Analyses for propylene oxide, ethylene oxide and 2-nitropropane were not performed due to unavailability of standards. Allyl chloride standard was not available, however retention time and mass spectrum of compound were available from a previous project performed recently at Acurex. Analyses were performed on September 7, 1983.

Results are summarized in Tables 1 and 2. Analyses were performed according to procedures in the VOST protocol[a]. A Nutech desorption unit interfaced to a Tekmar LSC-2 purge and trap device was used. The GC/MS conditions are summarized in Table 3.

If you have any questions regarding these analyses, please call.

Prepared by: William G. Hellier
William G. Hellier
Staff Chemist

Approved by: Viorica Lopez-Avila
Viorica Lopez-Avila, Ph.D.
Technical Director

WGH/VLA/ats

a - Draft Protocol for the Collection and Analysis of Volatile POHCs using a Volatile Organic Sampling Train (VOST) by Envirodyne Engineers, Inc., April 1983.

555 Clyde Avenue, P.O. Box 7555, Mountain View, CA 94039 (415) 964-3200 Telex: 34-6391 TWX: 910-7796593

Table 1. Percent Recovery of VOA Standards Spiked on Traps

Compound \ Spiking Level (ng)	Tenax			Tenax/Charcoal		
	50	100	200	50	100	200
Chloromethane	260	219	188	0	0	0
Bromomethane	128	108	157	146	168	160
Vinyl chloride	114	114	188	121	134	130
Chloroethane	148	120	185	100	107	100
Dichloromethane	248	130	116	210	122	72
1,1-Dichloroethylene	160	133	171	115	106	99
1,1-Dichloroethane	146	131	157	110	98	101
Trans-1,2-dichloroethylene	156	120	157	108	95	105
Chloroform	142	123	146	100	85	104
1,2-Dichloroethane	103	96	110	108	94	110
1,1,1-Trichloroethane	144	128	174	121	100	113
Carbon tetrachloride	130	114	181	105	103	116
Dichlorobromomethane	106	116	148	102	119	144
1,2-Dichloropropane	88	91	95	105	97	108
1,3-Dichloropropene(trans)	200	106	61	211	100	59
Trichloroethylene	110	103	111	150	121	135
Chlorodibromomethane	39	57	59	106	144	185
1,1,2-Trichloroethane	101	56	52	94	117	116
1,3-Dichloropropene(cis)	67	59	83	102	101	123
Benzene	360	232	157	164	99	104
2-Chloroethyl vinyl ether	67	0	0	0	0	0
Bromoform	0	11	16	90	210	250
Tetrachloroethylene	106	98	110	165	101	104
1,1,2,2-Tetrachloroethane	17	17	19	72	94	87
Toluene	101	96	95	280	101	106
Chlorobenzene	48	62	48	94	96	100
Ethylbenzene	51	64	50	176	84	115
Percent Surrogate Recovery						
Toluene-d_8	87	89	82	88	89	95

Table 2. Test Results

	Concentration (ng/trap)					
Test #	1A	1B	3A	3B	4A	4B
Trap ID	25	7A	29	3B	24	36A
Acurex ID	819600	819601	819610	819611	819598	819599
Chloromethane	140	1010	115	735	132	489
Vinyl chloride	ND	98	ND	159	ND	ND
Chloroethane	ND	154	ND	248	ND	ND
Dichloromethane	694	673	943	2050	2120	2711
Trans-1,2-dichloroethylene	ND	ND	ND	ND	49	24
Chloroform	22	18	8	13	16	16
1,2-Dichloroethane	7	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	38	25	47	84	268	330
Carbon tetrachloride	ND	ND	ND	ND	42	40
1,3-Dichloropropene(trans)	30	53	31	74	43	54
Trichloroethylene	138	13	104	441	1370	1900
Benzene	586	35	681	81	193	147
2-Chloroethyl vinyl ether	747	468	1180	1000	610	1530
Tetrachloroethylene	ND	ND	ND	57	ND	227
1,1,2,2-Tetrachloroethane	15	38	33	27	59	55
Toluene	595	361	953	755	1450	1210
Chlorobenzene	ND	ND	28	ND	ND	ND
Ethylbenzene	22	89	58	66	58	44
Allyl chloride	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	ND	3640	241	7910	4990	1970
Percent Surrogate Recovery						
Toluene-d_8	78	92	101	109	97	92

ND - Not detected (Detection limit- 5 ng per trap)

Table 3. GC/MS Operating Conditions

• Instrument:	Finnigan 1020 GC/MS System interfaced with an INCOS 2300 data system
• Column:	1 percent SP-1000 on Carbopack B 60/80 mesh
• Injector Temperature:	220°C (for spiking internal standards)
• Separator Temperature:	250°C
• Carrier Gas:	Helium at 40 mL/min
• Temperature Program	45°C (3 min hold) to 250°C (10 min hold) at 8°C/min
• Multiplier Voltage:	1600V
• Mass Range:	40 to 250 amu
• Scan Rate:	3 sec/scan
• Total Scans Acquired:	700

4.4 BIOASSAY ANALYSIS REPORT

In the following, samples with the prefix "DM" are for these tests. Samples with prefixes "HR" or "RA" are for other tests performed.

Litton BIONETICS

5516 Nicholson Lane Kensington Maryland 20895 301 881-5600 • Telex 89-8369

April 18, 1984

Dr. Larry Waterland
Acurex Corporation
485 Clyde Avenue
Mountain View, California 94042

RE: Acurex Subcontract No. RB59178A
Release No. 6

Dear Larry:

Enclosed are three bound, and one unbound, copies of the final reports for the five XAD resin extract samples and six ash samples submitted for testing and evaluation in IERL-EPA Level 1 Ames/Salmonella mutagenesis and CHO cytotoxicity bioassays. All studies were conducted and evaluated under IERL-EPA Level 1 guidelines.

Bioassay of the samples took slightly longer than normal because a phased testing approach was used with the XAD-2 resin extract samples. This phased approach involved initial CHO cytotoxicity testing, then preliminary range-finding Ames tests with only one strain, followed by one or more definitive Ames assays. By using this approach, we were able to adequately test and evaluate all samples.

The summary of the bioassay data, the criteria used to evaluate the results, the critical data upon which the evaluations were based, and a graphic display of the relative ranking of the samples are presented in the attached tables and figures.

If you have any questions or comments concerning these reports or future testing, please fell free to contact me at (301) 881-5600, extension 536.

Sincerely,

LITTON BIONETICS, INC.

Robert R. Young
Environmental Assessment Section
Department of Molecular Toxicology

RRY/mg

Enclosures: Ames and CHO 7330-7346 Reports.

cc: Contracts, LBI No. 20993, 20988

TABLE 1
BIOASSAY SUMMARY TABLE

Technical Directive or Project No. LBI Project No. 20988 and 20993.

Contract No. EPA No. 68-02-3188; ACUREX Subcontract No. RB 59178A Release No. 6.

	Health Effects Tests				Ecological Effects Tests									
					Aquatic						Terrestrial			
					Fresh Water			Marine						
Sample Identification	AMES Salmonella	RAM Cytotoxicity	CHO Cytotoxicity	Rodent Toxicity	Fish	Invertebrate	Algal	Fish	Invertebrate	Algal	Plant Stress Ethylene	Root Elongation	Insect Toxicity	Notes
HR XAD-2 EXTRACT, INLET (819369)	H		M/H											
HR XAD-2 EXTRACT, OUTLET (819370)	M		M											
RA XAD-2 EXTRACT, TEST 1 (819459)	H		M											
RA XAD-2 EXTRACT, TEST 2 (819465)	M		H/M											
DM XAD-2 EXTRACT (900206)	M		M											
RA BOTTOM ASH, TEST 1 (819488)	ND		ND											
RA BOTTOM ASH, TEST 2 (819498)	ND		ND											
RA CYCLONE ASH, TEST 1 (819476)	M/H		ND											
RA CYCLONE ASH, TEST 2 (819504)	L/M		ND											
DM FILTER + 1 µm PART. (900204)	ND		L											
DM 10 µm + 3 µm PART. (900218)	ND		L											

ND = No Detectable Toxicity
L = Low Toxicity
M = Moderate Toxicity
H = High Toxicity

LBI-0468 R 11/80

TABLE 2

DEFINITION OF TOXICITY CATEGORIES FOR HEALTH EFFECTS ASSAYS

Assay[a]	Activity Measured[b]	Sample Type[c]	MAD[d]	Units	Range of Concentration or Dosage			
					High	Moderate	Low	Not Detectable (ND)
Ames	MEC (mutagenesis)	S	5	mg/plate	<0.05	0.05-0.5	0.5-5	ND at >5
		AL,NAL	200	µl/plate	<2	2-20	20-200	ND at >200
		E	5000	L/plate	<50	50-500	500-5000	ND at >5000
RAM	EC_{50} (lethality)	S	1	mg/ml	<0.01	0.01-0.1	0.1-1	ND at >1
		AL	600	µl/ml	<6	6-60	60-600	ND at >600
		NAL	20	µl/ml	<0.2	0.2-2	2-20	ND at >20
		E	1000	L/ml	<10	10-100	100-1000	ND at >1000
CHO	EC_{50} (lethality)	S	1	mg/ml	<0.01	0.01-0.1	0.1-1	ND at >1
		AL	600	µl/ml	<6	6-60	60-600	ND at >600
		NAL	20	µl/ml	<0.2	0.2-2	2-20	ND at >20
		E	1000	L/ml	<10	10-100	100-1000	ND at >1000
WAT	LD_{50} (lethality and toxic signs)	S	5	gm/kg	<0.05	0.05-0.5	0.5-5	ND at >5
		AL,NAL	5	ml/kg	<0.05	0.05-0.5	0.5-5	ND at >5

[a]Standard test abbreviations are as follows:
Ames: Ames Salmonella/microsome mutagenesis assay
RAM: Rabbit alveolar macrophage cytotoxicity assay
CHO: Rodent cell clonal toxicity assay
WAT: Acute in vivo test in rodents (whole animal test)

[b]Standard abbreviations for measured endpoints are as follows:
MEC: Minimum effective concentration
EC_{50}: Calculated concentration expected to produce effect in 50 percent of population
LD_{50}: Calculated dose expected to kill 50 percent of population

[c]S = Solid, AL = Aqueous liquid, NAL = Nonaqueous liquid, E = Extract and/or concentrate of unknown organic content (use equivalent volume of SASS train gas)

[d]MAD = Maximum applicable dose

TABLE 3

HEALTH EFFECTS CRITICAL DATA SUMMARY FORM[a]

Contract No. EPA No. 68-02-3188 **Technical Directive or Project No.** LBI No. 20988 and 20993 **Site Sampled** HR, RA and DM
Acurex Subcontract No. RB 59178A
Release No. 6

Sample Identification	Ames Mutagenicity [MEC]b	CHO Clonal Toxicity [EC_{50}]c	RAM Cytotoxicity [EC50]c				Rodent Toxicity	
			Viability	Viability Index	ATP	ATP/Per 10^6 Cells	LD_{50}d	Toxic Signs[e]
HR XAD-2 EXTRACT, INLET 819369	25[f]	11.5[f]						
HR XAD-2 EXTRACT, OUTLET 819370	100	18.4						
RA XAD-2 EXTRACT, TEST 1 819459	20	35.2						
RA XAD-2 EXTRACT, TEST 2 819465	137.5	9.35						
DM XAD-2 EXTRACT 900206	200	16.0						
RA BOTTOM ASH, TEST 1 819488	>10000	>1000 (4000)						
RA BOTTOM ASH, TEST 2 819498	>10000	1400						
RA CYCLONE ASH, TEST 1 819476	50	>1000 (5000)						
RA CYCLONE ASH, TEST 2 819504	500	>1000 (1200)						
DM FILTER + 1 μm PART. 900204	>10000	140						
DM 10 μm + 3 μm PART. 900218	>10000	450						

[a]The assays, observed parameters and evaluation criteria are presented in IERL-RTP Procedures Manual; Level 1 Environmental Assessment Biological Tests, [EPA Contract No. 68-02-2681, Litton Bionetics, Inc., Kensington, Md.]

[b]MEC: Minimum Effective Concentration - Lowest concentration for any tester strain giving a mutagenic response.

[c]EC_{50}: Effective concentration that reduces the observed parameter to 50 percent of the appropriate negative control.

[d]LD_{50}: The dose lethal to 50 percent of treated animals.

[e]Toxic signs are identified in a numbered list in the Level 1 manual. Only the number is reported here.

[f]Concentrations are μg organics per plate for Ames assay and per ml of culture medium for the CHO assay. Values in parenthesis are extrapolated values.

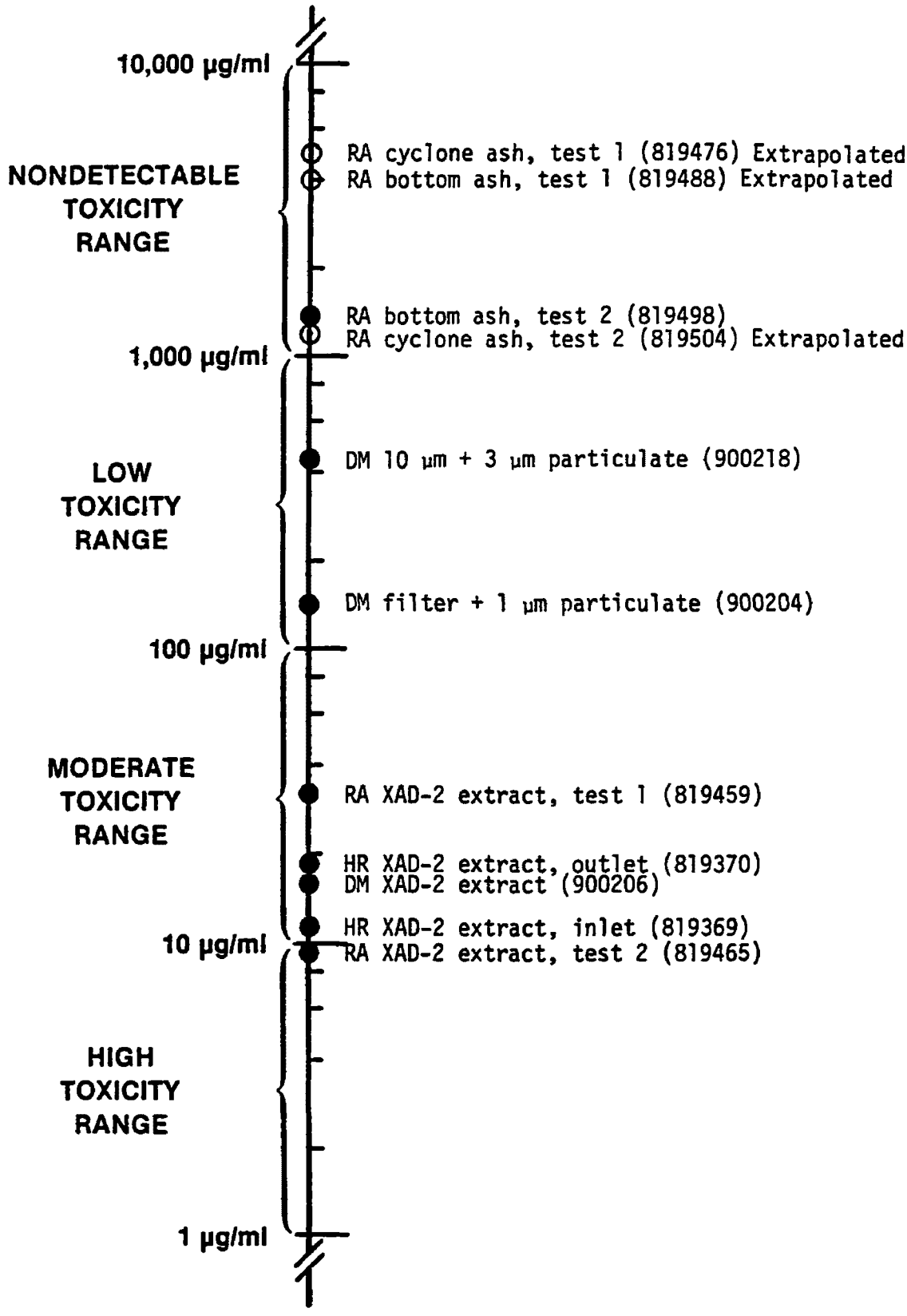

Figure 1. Ranking of test material toxicity using EC_{50} in EPA level 1 CHO clonal toxicity assay.

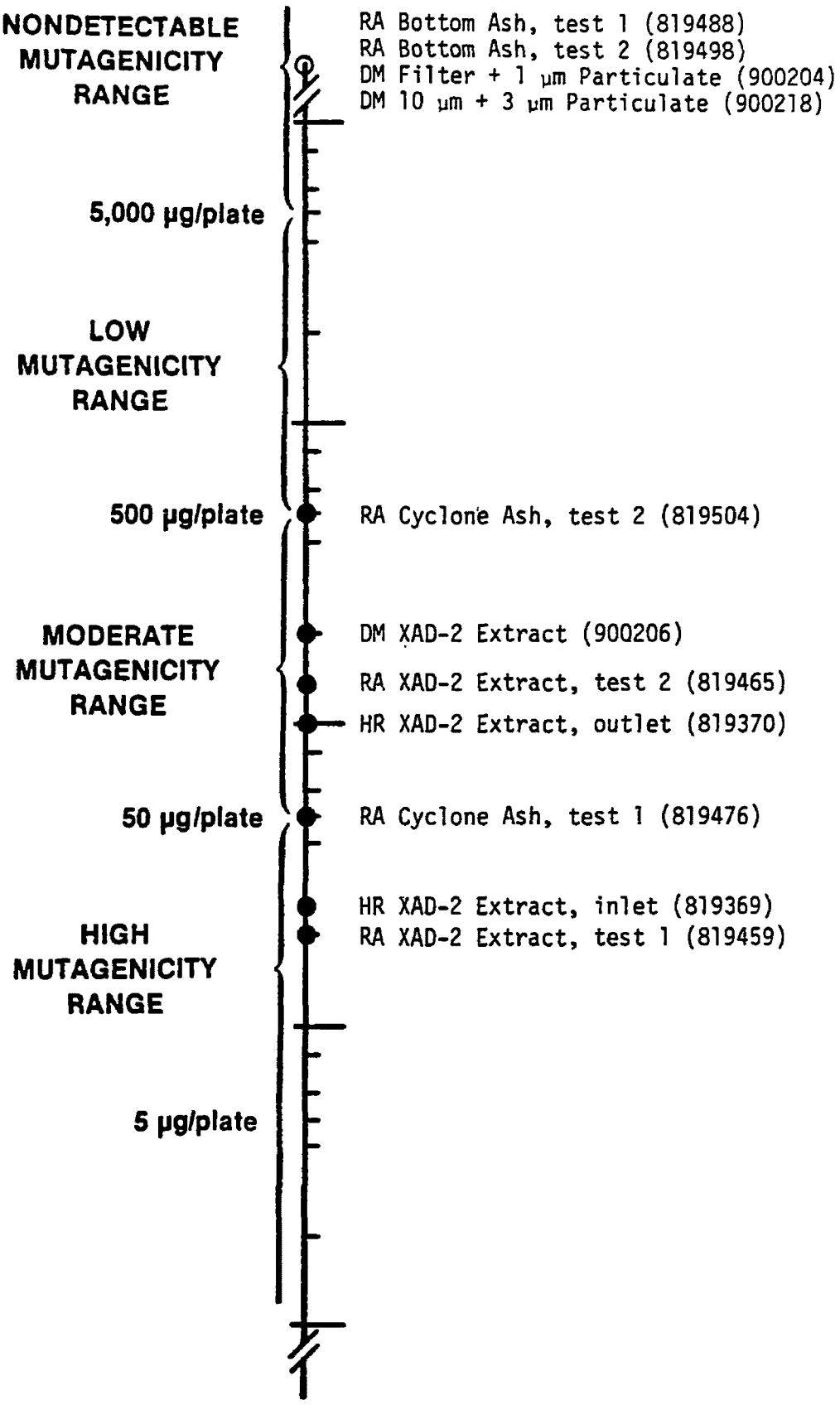

Figure 2. Ranking of test material mutagenicity using minimum effective concentration in EPA level 1 Ames mutagenesis assay.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-600/7-86-012b		

4. TITLE AND SUBTITLE	5. REPORT DATE
Environmental Assessment of a Coal/Water Slurry Fired Industrial Boiler; Volume II. Data Supplement	April 1986
	6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
D. Van Buren and L. R. Waterland	

9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
Acurex Corporation Energy and Environmental Division P.O. Box 7555 Mountain View, California 94039	11. CONTRACT/GRANT NO. 68-02-3188

12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
EPA, Office of Research and Development Air and Energy Engineering Research Laboratory Research Triangle Park, NC 27711	Final; 7/83 - 4/85
	14. SPONSORING AGENCY CODE EPA/600/13

15. SUPPLEMENTARY NOTES AEERL project officer is Joseph A. McSorley, Mail Drop 65, 919/541-2920. Volume I contains technical results.

16. ABSTRACT The report gives results of comprehensive emission measurements and analyses for a 7.6 kg/s (60,000 lb/hr) watertube industrial boiler firing a coal/water slurry. Measurements included continuous monitoring of flue gas; quantitation of semivolatile organics and 73 trace elements; volatile organic sampling train (VOST) quantitation of volatile organic priority pollutants; EPA Method 5/8 for particulate and SOx; controlled condensation for SOx; Andersen impactors for particle size distribution; and grab samples for N2O. Emissions of NOx, SO2, CO, and hydrocarbons averaged 510, 450, 285, and 1 ppm, corrected to 3% oxygen. Particulate emissions were 4.3 g/dscm, and particle size was biased to larger size fractions with over half of particulate mass at 10 micrometers or greater. Over 90% were 3 micrometers or greater. Combustible losses were high with over 40% carbon content in particulate. Total organic emissions were 15 to 17 mg/dscm with half in the C1 to C6 range. Naphthalene was the only semivolatile detected.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution Assessments Slurries Coal Water Combustion Water Tube Boilers	Polluation Control Stationary Sources Environmental Assessment	13B 13A 14B 11G 21D 07B 21B

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
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