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FINAL REPORT
VOLUME 2 of 2 - APPENDICES

on

**A STUDY OF TOXIC EMISSIONS FROM A
COAL-FIRED POWER PLANT
UTILIZING AN ESP/WET FGD SYSTEM**

Contract No. DE-AC22-93PC93251

Prepared for

**DEPARTMENT OF ENERGY
PITTSBURGH ENERGY TECHNOLOGY CENTER**

by

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July 1994

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APPENDIX A

PROCESS DATA LOG SHEETS FROM COAL CREEK

**PROCESS DATA LOG NO. 1: POWER PLANT CONTROL ROOM
BOILER PROCESS DATA
(Record data hourly)**

Date: 6-21-93

Time	Load, MW GTE003	Excess Oxygen, percent SGM015	Steam temp., F		Drum Steam Pres., psig SGP101 SGP501	Throttle Steam Flow, klb/hr SGF503	Data Taker
			SH Outlet SGT501 SGT405/ SGT406	RH Outlet SGT504			
0900	560	3.50	1004 1000 > 1002	1004	2763	3904.1	Wilke
1000	562	3.5	1004	1005	2784	3933	Wilke
1100	558	3.6	1002	1001	2763	3895	Wilke
1200	559	3.5	1004	1006	2772	3913	Wilke
1300	561	3.6	1002	1007	2783	3929	Wilke
1400	559	3.5	1004	1006	2775	3921	Wilke
1500	559	3.5	1002	1004	2778	3937	Wilke
1600	559	3.6	1000	1001	2775	3929	Wilke
1700	560	3.8	994	988	2789	3977	Wilke
1800	558	3.5	1004	1003	2774	3915	Wilke
1900	560	3.5	1004	1005	2776	3929	Keller
2000	560	3.5	1004	1005	2778	3926	Keller
2100	560	3.6	1004	1005	2779	3927	Keller
2200	560	3.5	1004	1005	2778	3925	Keller
2300	558	3.5	1002	1001	2777	3925	Keller
2400	560	3.5	1007	1007	2781	3920	Keller

PROCESS DATA LOG NO. 2: POWER PLANT CONTROL ROOM
EMISSIONS DATA
 (Record data hourly)

Date: 6-21-93

Time	Stack Oxygen, percent CCM004	Stack SO ₂ , ppm CCM001	Stack NO _x , ppm CCM002	Stack SO ₂ , lb/10 ⁶ Btu CCM516U1	Stack NO _x , lb/10 ⁶ Btu CCM517U1	Stack Opacity, percent CCM003	Data Taker
0900	5.1	396.4	321.3	1.14	0.59	10.5	Wille
1000	5.0	376	290	1.12	0.58	9.1	Wille
1100	5.2	409	297	1.13	0.59	8.9	Wille
1200	5.1	394	297	1.09	0.58	8.4	Wille
1300	5.1	387	290	1.07	0.57	8.7	Wille
1400	5.1	394	295	1.09	0.58	8.8	Wille
1500	5.1	389	297	1.07	0.58	13.6	Wille
1600	5.2	394	297	1.10	0.59	11	Wille
1700	5.4	390	297	1.10	0.60	9.2	Wille
1800	5.1	399	302	1.10	0.60	9.2	Wille
1900	5.1	371	297	1.03	0.59	10.4	Keller
2000	5.1	370	296	1.02	0.59	10.5	Keller
2100	5.1	371	287	1.02	0.57	10.7	Keller
2200	5.1	371	287	1.02	0.58	10.6	Keller
2300	5.2	417	280	1.15	0.55	9.4	Keller
2400	5.2	418	287	1.16	0.57	8.8	Keller

PROCESS DATA LOG NO. 3: POWER PLANT CONTROL ROOM
SCRUBBER PROCESS DATA
 (Record data hourly)

Date: 6-21-93

Time	FGD Inlet Temp., F CCT002	Stack Gas Temp., F CCT001	Slurry Feed Rate, gpm		Slurry Feed Rate, lb/hr 565 505 Board	Data Taker
			Tank A (11) Board	Tank B (12) Board		
0900	321	228	45	65	902	Wilke
1000	319	227	65	75	895	Wilke
1100	320	228	65	75	901	Wilke
1200	321	228	45	60	889	Wilke
1300	323	230	50	70	889	Wilke
1400	325	230	60	70	901	Wilke
1500	328	231	45	60	895	Wilke
1600	330	233	50	70	883	Wilke
1700	331	232	55	75	877	Wilke
1800	330	231	60	70	895	Wilke
1900	330	231	58	74	883	Keller
2000	330	231	58	74	885	Keller
2100	329	233	58	74	889	Keller
2200	329	233	58	74	890	Keller
2300	328	240	70	0	895	Keller
2400	328	247	62	0	877	Keller

Slaker 11 0900 2000
 769250 793900
 Integrator 12 195940 221166

PROCESS DATA LOG NO. 1: POWER PLANT CONTROL ROOM
BOILER PROCESS DATA
(Record data hourly)

Date: 6-22-93

Time	Load, MW GTE003	Excess Oxygen, percent SGM015	Steam temp., F		Drum Steam Pres., psig SGP101 SGP501	Throttle Steam Flow, klb/hr SGF503	Data Taker SGF505
			SH Outlet SGT501 SGT405 SGT406	RH Outlet SGT504			
0100	559	3.5	1003	1004	2775	3919	Keller
0200	559	3.6	1004	1004	2779	3918	Keller
0300	559	3.5	1003	1004	2775	3915	Keller
0400	559	3.5	1005	1002	2776	3914	Keller
0500	561	3.7	1003	1003	2787	3949	Keller
0600	559	3.5	1004	1005	2778	3921	Keller
0700	559	3.5	1003	1002	2778	3914	Wiebe
0800	561	3.5	1006	1007	2780	3922	Wiebe
0900	562	3.6	1004	1005	2788	3938	Wiebe
1000	560	3.5	1003	1003	2784	3922	Wiebe
1100	560	3.5	1001	1004	2778	3926	Wiebe
1200	559	3.5	1001	1003	2779	3931	Wiebe
1300	556	3.4	1004	1002	2767	3895	Wiebe
1400	558	3.5	1008	1006	2778	3912	Wiebe
1500	560	3.5	1003	1005	2782	3931	Wiebe
1600	556	3.5	1000	1001	2773	3918	Wiebe
1700	559	3.6	1002	1002	2782	3932	Wiebe
1800	560	3.5	1002	1005	2778	3924	Wiebe
1900	560	3.6	1004	1006	2788	3936	Keller

PROCESS DATA LOG NO. 3: POWER PLANT CONTROL ROOM
 SCRUBBER PROCESS DATA
 (Record data hourly)

Date: 6-22-93

Time	FGD Inlet Temp., F CCT002	Stack Gas Temp., F CCT001	Slurry Feed Rate, gpm		Lime Feed Rate, lb/hr Coal Flow Board	Data Taker
			Tank A Board	Tank B Board		
0100	325	245	67	0	895	Keller
0200	325	245	68	0	871	Keller
0300	323	244	65	40	901	Keller
0400	322	245	65	0	895	Keller
0500	323	244	62	0	889	Keller
0600	321	247	60	0	883	Keller
0700	319	235	65	30	871	Wicks
0800	319	242	60	30	871	Wicks
0900	320	244	60	20	871	Wicks
1000	321	245	65	20	889	Wicks
1100	322	240	75	20	895	Wicks
1200	324	242	70	20	889	Wicks
1300	324	247	65	20	901	Wicks
1400	325	242	65	35	889	Wicks
1500	326	232	75	40	845	Wicks
1600	328	233	65	20	913	Wicks
1700	328	235	70	15	907	Wicks
1800	325	240	65	15	895	Wicks
1900	323	237	74	0	895	Keller

Slaker 11 0800 818657 2000 845215
 totalizer 12 245813 272030

**PROCESS DATA LOG NO. 2: POWER PLANT CONTROL ROOM
EMISSIONS DATA
(Record data hourly)**

Date: 6-22-93

Time	Stack Oxygen, percent CCM004	Stack SO ₂ , ppm CCM001	Stack NO _x , ppm CCM002	Stack SO ₂ , lb/10 ⁶ Btu CCM516U1	Stack NO _x , lb/10 ⁶ Btu CCM517U1	Stack Opacity, percent CCM003	Data Taker
0100	5.2	428	299	1.18	.59	9.2	Keller
0200	5.2	426	289	1.18	.58	8.9	Keller
0300	5.2	429	298	1.18	.59	11	Keller
0400	5.2	426	297	1.18	.59	9.4	Keller
0500	5.3	414	297	1.15	.60	9.1	Keller
0600	5.2	416	283	1.15	.56	9.2	Keller
0700	5.2	389	287	1.06	.56	13.4	Wicke
0800	5.2	417	299	1.16	.59	9	Wicke
0900	5.2	423	302	1.17	.60	9.6	Wicke
1000	5.2	426	296	1.17	.58	13.9	Wicke
1100	5.2	412	300	1.14	.59	9.8	Wicke
1200	5.2	403	291	1.12	.58	9.6	Wicke
1300	5.2	419	293	1.17	.58	9.9	Wicke
1400	5.1	424	291	1.17	.57	14.5	Wicke
1500	5.2	421	283	1.17	.56	9.8	Wicke
1600	5.2	418	287	1.16	.57	10.3	Wicke
1700	5.3	407	290	1.13	.58	9	Wicke
1800	5.2	422	294	1.17	.59	9.2	Wicke
1900	5.3	417	282	1.17	.57	9.6	Keller

PROCESS DATA LOG NO. 1: POWER PLANT CONTROL ROOM
BOILER PROCESS DATA
(Record data hourly)

Date: June 23 1993

Time	Load, MW GTE003	Excess Oxygen, percent SGM015	Steam temp., F		Drum Steam Pres., psig SGP101	Throttle Steam Flow, klb/hr SGF503	Data Taker
			SH Outlet SGT501 SGT405T SGT406	RH Outlet SGT504			
0900	560	3.4	1007.2	999.8	2779.0	3890	Lec Saitan
1000	558	3.5	1002.9	1002.5	2761.5	3880.6	Lec Saitan
1100	562	3.6	1012.9	1006.2	2781.9	3906.4	Lec Saitan
1200	560.5	3.5	998.9	1003.5	2762.8	3898.5	Lec Saitan
1300	557	3.4	1005.5	1003.3	2756.0	3865.4	L. Saitan
1400	559.8	3.6	999.5	1001.7	2771.0	3908.7	L. Saitan
1500	560.5	3.4	1004.4	1004	2773.9	3923.1	L. Saitan
1600	559.7	3.5	1006.3	1005.3	2776.1	3914.2	L. Saitan
1700	562	3.4	1007.4	1006.7	2776	3925.3	L. Saitan
1800	566.8	3.7	1008.2	1003.7	2800.1	3958.8	L. Saitan
1900	556.5	3.4	1005.6	1009.8	2742.5	3835.2	B. Zaitan
2000	555.3	3.5	1007.0	1003.5	2704.2	3846.8	B. Zaitan
2100	553.7	3.5	1005.7	1001.9	2755.8	3818.5	B. Zaitan
2200	551.7	3.5	1005.0	1000	2743.4	3820.5	B. Zaitan
2300	550.6	3.5	1005.0	1000	2743.4	3820.5	B. Zaitan
2400	554.1	3.5	1005.0	1000	2743.4	3824.3	B. Zaitan
0100	551.9	3.5	1005.0	1000	2734.6	3819	B. Zaitan
0200	551.9	3.5	1005.0	1000	2737.6	3800.5	B. Zaitan
0300	552.8	3.5	1005.0	1000	2737.3	3792	B. Zaitan
0400	552.8	3.5	1005.0	1000	2737.3	3814	B. Zaitan

**PROCESS DATA LOG NO. 2: POWER PLANT CONTROL ROOM
EMISSIONS DATA
(Record data hourly)**

Date: June 23, 1993

Time	Stack Oxygen, percent CCM004	Stack SO ₂ , ppm CCM001	Stack NO _x , ppm CCM002	Stack SO ₂ , lb/10 ⁶ Btu CCM516U1	Stack NO _x , lb/10 ⁶ Btu CCM517U1	Stack Opacity, percent CCM003	Data Taker
0900	5.2	423	305.2	1.17	.604	9.5	L. Sailer
1000	5.3	422.6	303.8	1.17	.604	10.1	L. Sailer
1100	5.3	412.8	307.8	1.15	.613	10.2	L. Sailer
1200	5.4	415.7	300.4	1.16	.600	10.2	L. Sailer
1300	5.2	414	300	1.14	.594	10.7	L. Sailer
1400	5.3	429.5	293.1	1.20	.566	12.9	L. Sailer
1500	5.2	409.2	303.2	1.13	.599	15.2	L. Sailer
1600	5.3	431.2	307.5	1.18	.605	13.5	Lee Sailer
1700	5.2	389.7	301.7	1.18 1.19	.613	9.4	Lee Sailer
1800	5.4	422.6	319.2	1.19	.645	9.6	Lee Sailer
1900	5.3	402.8	304.5	1.12	.610	8.9	B. Zick
2000	5.3	405.5	306	1.14	.620	9.2	B. Zick
2100	5.3	406.8	296.6	1.14	.596	9	B. Zick
2200	5.2	412.7	297.3	1.1	.59	10.5	B. Zick
2300	5.3	408.7	298.3	1.16	.618	11.7	B. Zick
2400	5.3	420.1	305.5	1.17	.612	8.7	B. Zick
0500	5.2	411	311.3	1.15	.627	8.6	B. Zick
0600	5.2	408.8	295.7	1.1	.59	8.1	B. Zick
0700	5.2	437.2	296.9	1.1	.596	8.3	B. Zick
0800	5.2	407.5	295.7	1.16	.593	8.1	B. Zick

PROCESS DATA LOG NO. 3: POWER PLANT CONTROL ROOM
SCRUBBER PROCESS DATA
 (Record data hourly)

Date: June 23, 1993

Time	FGD Inlet Temp., F CCT002	Stack Gas Temp., F CCT001	Slurry Feed Rate, gpm		Lignite Time Feed Rate, lb/hr 56F505 Board	Data Taker
			Tank A Board	Tank B Board		
0900	314.6	238.1	75	25	913,000	L. Scaler
1000	316.1	238.9	72	30	895,000	L. Scaler
1100	317.7	241	75	35	889,000	L. Scaler
1200	318.0	244.2	70	40	901,000	L. Scaler
1300	318.1	245.3	90	40	907,000	L. Scaler
1400	318.2	245.8	60	40	901,000	L. Scaler
1500	318.6	246.9	45	30	901,000	L. Scaler
1600	321.7	251	30	60	919,000	L. Scaler
1700	321.7	246.2	40	75	937,000	L. Scaler
1800	318.6	240.7	40	70	913,000	L. Scaler
1900	320	235.8	15	60	907,000	B. Dietz
2000	322.9	238.2	15	30	901,000	B. Dietz
2100	322.7	236.7	0	30	907,000	B. Dietz
2200	324.2	232.3	0	42	995,000	B. Dietz
2300	328.0	231.1	15	30	915,000	B. Dietz
2400	322.4	229.8	15	45	901,900	B. Dietz
0500	328.8	220.1	15	100	901,000	B. Dietz
0600	327.5	225	30	100	895,000	B. Dietz
0700	327.1	225.3	15	120	917,000	B. Dietz
0800	327.7	220.5	50	10	915,000	B. Dietz

Slaker
 Totalizer

0800	2000
11 869600	900980
12 294330	309200

A-9

PROCESS DATA LOG NO. 1: POWER PLANT CONTROL ROOM
BOILER PROCESS DATA
 (Record data hourly)

Date: June 27 1997

[illegible]

(Record data hourly)

Date: June 24, 1993

[illegible]

PROCESS DATA LOG NO. 3: POWER PLANT CONTROL ROOM
 SCRUBBER PROCESS DATA
 (Record data hourly)

Date: June 24 1993

Time	FGD Inlet Temp, F	Stack Gas Temp, F	Slurry Feed Rate, gpm	Tank A Board	Tank B Board	Slime Feed Rate, lb/hr	Data Taker
0900	307.8	226.1	25	120		931	William
1000	308	227	20	90		919	William
1100	310	229	35	80		907	William
1200	310.3	229.7	55	85		913.000	Lee S. Lee
1300	310.5	227.4	65	96		919.000	Lee S. Lee
1400	311.4	226.1	✓	0		907.000	Lee S. Lee
1500	311.7	226.9	55	95		901.000	Lee S. Lee
1600	311.3	224.7	35	95		907.000	Lee S. Lee
1700	310.9	224.5	55	125		913.000	Lee S. Lee
1800	311.3	222.0	50	95		907.000	Lee S. Lee
1900	311.1	222.8	7	60		907.000	Lee S. Lee
2000	311.6	219.3	7	75		919.000	Lee S. Lee

7: 935070
 40 gpm
 356158
 327260
 356158
 5/10/2285
 5/10/2285

EMISSIONS DATA (Record data hourly)

Date: 6-25-93

[illegible]

Date: 6-25-93

Slaker	11	0800.	2000	
			041625	
Fertilizer	12		418670	A-15

PROCESS DATA LOG NO. 3: POWER PLANT CONTROL ROOM
SCRUBBER PROCESS DATA
(Record data hourly)

26
Date: 5/26/93

Time	FGD Inlet Temp., F CCT002	Stack Gas Temp., F CCT001	Slurry Feed Rate, gpm		Slurry Feed Rate, lb/hr S6F505 Board	Data Taker
			Tank A Board	Tank B Board		
0900	310	221	37	51	895	Kneibach ↑
1000	310	214	43	54	871	
1100	310	221	43	49	877	
1200	310	220	52	56	895	
1300	311	222	43	56	889	
1400	311	223	38	52	889	
1500	311	222	33	42	889	
1600	312	223	47	53	883	
1700	314	225	52	56	907	Kneibach ↓

12Ker 11 0800 2000
 084887 119778
12 437438 468027

(Record data hourly)

26
6/22/93

↑
SGT 501
= $\left(\frac{405 + 406}{2} \right)$ A-17

(Record data hourly)

Date: 6/25/93

[illegible]

(Record data hourly)

Date: 6/27/93

[illegible]

KER 11-119778

12-536107

$$\begin{array}{r} 2000 \\ 136 \overline{) 136136} \end{array}$$

583904

A-19

PROCESS DATA LOG NO. 2: POWER PLANT CONTROL ROOM
EMISSIONS DATA
 (Record data hourly)

Date: 6/27/93

[illegible]

(Record data hourly)

Date: 6/27/93

[illegible]

Coal Creek Unit 1 Coal Feeder Calibration Data

Enclosed is a list of Unit 1 lignite feeder calibrations done on either side of Battelle testing. From it, an overall error was applied to the actual Heat Rate values posted for that time frame, resulting in a possible K#/hr total feed rate error. The 1" poise weight movement equals 17 Btu/kwh adjustment constant was arrived at over the years by mass calibrations followed by comparison of cumulative poise weight movements to Unit 1 versus Unit 2 Heat Rate discrepancy. Feeders are on a quarterly calibration cycle unless a belt is damaged forcing an earlier adjustment.

Feeder #	Pre-Test Cal. Date	Wt.Moved	Post-Test Cal. Date	Wt.Moved
11	5/13/93	-1/16	6/29/93	- 7/16
12	4/03/93	-3 3/8	8/04/93	- 1/4
13	2/17/93	-1 3/16	6/26/93	-11/16
14	2/08/93	-9/16	6/26/93	+ 5/8
15	6/15/93	0	8/30/93	- 1/8
16	5/06/93	+7/8	8/04/93	- 1/4
17	3/18/93	-1/4	7/10/93	- 1/16
18	4/26/93	+3/8	8/04/93	+ 1/8
			Total	- 17/16

- 1 1/16 = + 18 Btu/Kwh = + .18 % Total feeder flow rate

Published average Heat Rate for the 6 days was 9980 Btu/Kwh at 6230 BTU/# average and an average load of 351 GMW. Therefore daily lignite flow was 21,196.7 k# or 883.2 k#/hr, and .18 % of that would be 1.59 k#/hr.

APPENDIX B

AUDITING

AUDITING

B-1. Introduction

This appendix reports the results of external audits conducted by Research Triangle Institute (RTI) during the sampling at Coal Creek. The RTI audit took place on June 23 and 24, 1993. Those two days comprised the second of three two-day sampling periods, i.e. June 23 was the second "organic" sampling day and June 24 was the second "inorganic" sampling day. The RTI activities included technical audits, performance audits, and CEM calibrations. Those separate activities are addressed in Sections B-2 to B-4, respectively. Battelle also conducted an internal audit, presented in Section B-5.

B-2. RTI Technical Audits

The RTI Field Sampling Audit Report for Coal Creek is included at the end of this Appendix. The following are responses to some of the specific comments made by RTI; these are organized in the same way as were the original comments in the RTI report.

Findings

- (1) The SO₂ measurements made by Battelle are described in section 3.3.3 of this report. The absence of one of the planned calibrations on June 21 is of no consequence, since SO₂ data are not reported for that date (see Table 3-14). However, only one calibration was performed on both June 23 and 24 (Table 3-13). The absence of a second calibration on those days has no significant effect on the data quality, since the SO₂ monitor was very stable throughout the field study (Table 3-13), and agreed closely with audit gas supplied by RTI (see Section B-3).
- (2) Use of midget glassware did not affect the reported concentrations of analytes from the aldehyde sampling. This glassware was not found to be significantly harder to maintain leak-free than full-size glassware. Furthermore, all sample trains were leak tested before starting sampling, so no sampling was conducted with a leaking train.

- (3) The reagent volumes and sample gas flow rates used with the midget glassware were fully appropriate, and complete collection of target analytes is expected. If anything, the reagent volume-to-gas flow ratio in the midget impingers was higher than that in the full-size impingers.
- (4) No leakage occurred from any sample bottles during shipment. All bottles were enclosed in zip-lock bags during shipment, so leakage would have been apparent if it had occurred.
- (5) There is no alternative to estimating several of the mass flows within the plant. Direct measurement of those flows would be extremely difficult, and is beyond the scope and resources of this project. Note that coal flow was determined by the plant, not estimated, and was recorded for Battelle hourly during the study.
- (6) The removal of moisture from the Summa canister samples by the midget impinger was quite effective. No adverse effect on the canister or Method 23 data result from this modification.
- (7) No response required, see Section B-1.2.
- (8) The use of VOST sampling periods of various lengths is recommended in cases where the flue gas VOC content is unknown and may saturate the sorbent.

B-3. Performance Evaluation Audits

As indicated in the enclosed RTI Field Sampling Audit Report, RTI performed Performance Evaluation Audits (PEA) by spiking sampling materials with target analytes. Tables B-1, B-2, B-3, and B-4 show the results of the analyses of the spiked samples for metals, PAH, VOST, and aldehydes, respectively. For each spiked sample, the mass of analyte found, the mass of analyte spiked into the sample as reported by RTI, and the percent recovery of the spiked analyte are shown. The significance of these results is discussed according to analyte class in the following paragraphs.

A field spiking procedure for HEST filters was also devised and conducted, after discussions with RTI auditors at Coal Creek. Comments on the spiking of HEST filters are presented in Section 7.4 of this report, which compares HEST and Multi-Metals results.

Metals

At the direction of the RTI auditors, the PEA samples for metals spiked in the field were labelled in the same manner as were actual samples. Unfortunately, that approach led to confusion among analytical personnel in handling the PEA samples for metals that were spiked on June 24. Those samples consisted of two filters, two aliquots of acidified peroxide, and two of acidified permanganate solution. Due to confusion over the sample numbers, the liquid PEA samples were combined during laboratory analysis with fractions of the actual Method 29 train samples from Locations 4a and 5a on June 24. The spike results for the peroxide and permanganate impingers shown in Table B-1 were estimated by identifying elements that appeared to be elevated above typical levels, based on the other two sample runs at Locations 4a and 5a, and subtracting out the average level of those two runs. Consequently, the amount found for the peroxide and permanganate impingers should be considered estimates only and the associated percent recoveries are not discussed further.

The recoveries for metals spiked onto the filter samples were between 70 and 130 percent for five out of the eight results. Battelle's accuracy requirement for metals was 80 to 120 percent recovery for certified standard materials. Since the PEA samples were not certified standards and since analyte losses may have occurred during spiking, a wider range for these analyses was considered acceptable. Selenium had recoveries lower than 70 percent in both samples. This result could be due to potential losses of this compound during the spiking process or during sample handling, preparation, and analysis.

The low recovery for lead from the filter PEA sample C-4a-MUM-624 cannot be explained. The spiking procedure was probably efficient as indicated by the generally acceptable recoveries for the other metal spikes in this same sample. The losses, therefore, may have occurred in the sample preparation or analysis. The quality control data presented in Section E of this volume are acceptable for the instrumental analysis of Method 29 train filters. Losses may have occurred in sample preparation (i.e., filter digestion); similar losses could have occurred in analyses of actual samples.

PAH

As shown in Table B-2, recoveries for almost all of the PAH in the PEA samples were between 50 to 150 percent. This accuracy limit was established on this project for recovery of deuterated PAH spiked into samples prior to extraction and is reasonable to use as a limit for the PEA samples.

The low recovery of the volatile PAH naphthalene results principally because this compound was spiked onto blank filters rather than onto particulate matter on filters. Volatile PAH are more stable on particulate matter than on blank filters. Much of the spiked naphthalene was likely lost from the blank filters during sample handling and transporting. Acenaphthylene and acenaphthene are similarly volatile and also showed slightly lower recoveries on the filter PEA samples in comparison to the other PAH. An alternative approach to spiking would be to spike collected filter samples with deuterated PAH. The low recovery for naphthalene on the filter PEA samples is not expected to affect sample results since this volatile PAH would be bound on particulate in actual filter samples and less susceptible to the losses described here.

VOST

In general, recoveries of volatile organic compounds spiked into the VOST PEA samples were within 26 to 160 percent, as shown in Table B-3. This accuracy limit was established for recovery of surrogate spikes from VOST samples and is reasonable to use as a limit for PEA samples.

Recoveries for the majority of the VOST compounds in PEA sample C-6a-VOC-623-4 were outside of 26 to 160 percent. Recoveries of internal standards spiked into this sample prior to analysis were acceptable and were comparable to those obtained for the subsequent two PEA samples suggesting that the laboratory analysis procedures were not the cause of the low recoveries. Difficulties in the spiking procedure on this initial sample are, therefore, suspected to be a factor in the poor recoveries for this sample. Inefficient spiking in the field would not have an impact on actual sample results since actual samples were not spiked in the field.

The recoveries for bromomethane were lower than most other VOST compounds in C-6a-VOS-623-5 and C-6a-VOS-623-6. These low recoveries are attributed to losses due to volatility. It cannot be determined whether these losses may have occurred during the spiking process or during analysis. If losses occurred during analysis, then sample results may have been affected in a similar manner.

Recoveries for carbon tetrachloride, 1,2-dichloropropane, and tetrachloroethene were higher than 160 percent in either C-6A-VOC-623-5 or C-6a-VOC-623-6. These high recoveries are probably not due to contamination in the field or laboratory since these compounds were not detected in actual samples (detection limit of 0.025 μ g). The high recoveries may be due to an error in the amount spiked or inaccurate quantification (i.e., calibration) of these compounds in the analysis. However, these two causes would not prevent the detection of carbon tetrachloride, 1,2-dichloropropane, and tetrachloroethene in the actual samples; and since these compounds were not detected, inaccurate quantification or field spiking would not affect sample results.

Vinyl chloride was not detected in C-6a-VOS-623-6 at a detection limit of 0.025 μ g. Since the spike level for this PEA sample was well above the detection limit, this non-recovery suggests that, like bromomethane, losses of vinyl chloride may have occurred during the spiking process or during analysis. These losses, however, are not consistent losses as evidenced by the acceptable vinyl chloride recoveries in the other two PEA samples.

Battelle did not analyze 1,3-butadiene, trichlorofluoromethane, or 1,2-dibromomethane as a part of this project so results are not provided for these compounds in the PEA samples.

Aldehydes

The spiked aldehyde impingers were mistakenly used for sampling on June 23 after being spiked by RTI. The results shown in Table B-4 for the aldehyde PEA samples were obtained by correcting for the average of the formaldehyde found in the other two aldehyde runs at Locations 4a and 5a (6/21 and 6/26). At both those locations, the formaldehyde results from the 6/21 and 6/26 samples were closely similar and much lower than the result

found in the spiked sample from 6/23. Thus this correction procedure was expected to give an accurate value for the RTI formaldehyde spike.

The recoveries for formaldehyde spiked into the PEA samples were between 50 to 150 percent as listed in Table B-4. This limit was established on this project for recovery of aldehydes spiked into acetonitrile and is reasonable to use as a limit for the PEA samples. These acceptable recoveries suggest that recovery of target aldehydes from actual samples was effective.

B-4. RTI CEM Measurements

As described in the enclosed RTI Field Sampling Audit Report, RTI audited Battelle's continuous SO₂ monitor used at the FGD inlet. RTI supplied zero and span gas (391.5 ppm SO₂) to the monitor. As shown in the RTI report, the Battelle monitor agreed within 3.0 percent with the RTI audit gas. This result was well within the 10 percent acceptance limit used by RTI in the audit, and is consistent with the stability exhibited by the monitor based on Battelle's own calibrations (See Table 3-16).

B-5. Battelle Internal Audit

Battelle's Quality Assurance Officer for this project, Ms. Sandra Anderson, conducted audits of project activities both in the field at Coal Creek and in Battelle's laboratories in Columbus. The full audit report provided to DOE on those activities is included at the end of this Appendix.

B-6. Results for Coal Analysis Round Robin

Results from the coal analysis round robin coordinated by Consol, Inc. (Consol) for DOE/PETC are presented in Tables B-5 and B-6 for Samples E and N, respectively, which are the duplicate samples generated from Coal Creek coal provided by Battelle to Consol. Battelle was Lab IV in the round robin study. Duplicate results were not provided by Battelle for some of the elements due to insufficient sample size. In addition, only the five

major elements which Battelle analyzed on this program (Si, Al, Ti, Na, K) were analyzed by Battelle in the round robin study; results for other major elements were not provided.

A comparison of the average round robin results for Coal Creek coal from all five laboratories participating in the round robin study, with the average results provided in Table 5-12 of Section 5 of this report for Coal Creek boiler feed coal, is provided in Table B-7. The shaded results in Table B-7 indicate cases where the average round robin result was used in mass balance calculations instead of the result provided in Table 5-12 of this report. For three of the elements (antimony, cadmium, and selenium) the round robin result was used to replace a nondetected value reported in Table 5-12, to provide better accuracy.

A relative percent difference of greater than 30 percent between the results reported in Table 5-12 and the round robin result for Coal Creek coal was obtained for 7 of the 18 detected elements. This variability is not surprising as the round robin study showed that trace element analytical variability is a function of coal rank, increasing as the heating value decreases. Overall trace element analysis repeatability was better for the bituminous coals than for the subbituminous and lignite coals in the round robin study. The Coal Creek lignite coal had the lowest heating value and the highest interlaboratory variability of all the samples tested in the round robin study.

TABLE B-1. RESULTS FOR RTI PERFORMANCE EVALUATION AUDITS - METALS

	C-4a-MUM-624 Filter			C-5a-MUM-624 Filter			C-4a-MUM-624 H2O2 Solution#			C-5a-MUM-624 H2O2 Solution#			C-4a-MUM-624 KMNO4 Solution#			C-5a-MUM-624 KMNO4 Solution#		
	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery
Arsenic	79	90	88	11	15	73	NS	NS	NC	NS	NS	NC	NS	NS	NC	NS	NS	NC
Cadmium	34	45	76	7	10	70	0	10	0 *	15	10	150 *	NS	NS	NC	NS	NS	NC
Lead	3	100	3 *	8	10	80	4	20	20 *	53	60	88	NS	NS	NC	NS	NS	NC
Mercury	NS	NS	NC	NS	NS	NC	NS	NS	NC	NS	NS	NC	23	15	153 *	2	30	7 *
Selenium	34	60	57 *	25	45	56 *	NS	NS	NC	NS	NS	NC	NS	NS	NC	NS	NS	NC

*Recovery outside of 70 to 130 percent.

NS = Not spiked; NC = Not calculated.

#Indicates spiked sample combined with real sample; shaded numbers calculated by subtracting background level in unspiked samples.

TABLE B-2. RESULTS FOR RTI PERFORMANCE EVALUATION AUDITS - PAH

Compound	C-4a-MM5-623 (XAD)			C-5a-MM5-623 (XAD)			C-4a-MM5-623 (Filter)			C-5a-MM5-623 (Filter)		
	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery
Naphthalene	18.4	20.0	92	5.60	5.0	112	0.396	20.0	2 *	0.200	5.0	4 *
Acenaphthylene	30.3	40.0	76	10.3	10.0	103	21.9	40.0	55	5.67	10.0	57
Acenaphthene	15.7	20.0	79	4.29	5.0	86	12.2	20.0	61	2.89	5.0	58
Fluorene	3.52	4.0	98	1.05	1.0	105	3.69	4.0	92	0.842	1.0	84
Phenanthrene	1.82	2.0	91	0.517	0.5	103	1.77	2.0	89	0.455	0.5	91
Anthracene	1.82	2.0	91	0.488	0.5	98	1.70	2.0	85	0.347	0.5	69
Fluoranthene	3.79	4.0	95	1.04	1.0	104	3.68	4.0	92	0.821	1.0	82
Pyrene	1.90	2.0	95	0.496	0.5	99	1.81	2.0	91	0.406	0.5	81
Benz(a)anthracene	1.85	2.0	93	0.558	0.5	112	1.88	2.0	94	0.356	0.5	71
Chrysene	1.59	2.0	80	0.522	0.5	104	2.04	2.0	102	0.370	0.5	74
Benzo(b+k)fluoranthene	5.92	6.0	99	1.82	1.5	121	6.32	6.0	105	1.250	1.5	83
Benzo(a)pyrene	2.3	2.0	115	0.736	0.5	147	2.42	2.0	121	0.384	0.5	77
Indeno(1,2,3-c,d)pyrene	1.73	2.0	87	0.538	0.5	108	1.85	2.0	93	0.294	0.5	59
Dibenzo(a,h)anthracene	4.65	4.0	116	1.14	1.0	114	5.80	4.0	145	0.622	1.0	62
Benzo(g,h,i)perylene	3.64	4.0	91	1.06	1.0	106	3.81	4.0	95	0.659	1.0	66

*Recovery outside of 50 to 150 percent.

TABLE B-3. RESULTS FOR RTI PERFORMANCE EVALUATION AUDITS - VOST

Compound	C-6a-VOS-623-4			C-6a-VOS-623-5			C-6a-VOS-623-6		
	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery
Bromomethane	0.044	0.144	31	0.034	0.134	25 *	0.050	0.152	33
Chloroform	0.130	0.525	25 *	0.514	0.490	105	0.595	0.556	107
1,2-Dichloroethane	0.039	0.450	9 *	0.388	0.420	92	0.419	0.476	88
1,1,1-Trichloroethane	0.110	0.456	24 *	0.221	0.426	52	0.255	0.482	53
Carbon tetrachloride	0.359	0.556	65	0.818	0.519	158	0.974	0.588	166 *
1,2-Dichloropropane	0.011	0.153	7 *	0.249	0.143	174 *	0.196	0.162	121
Trichloroethene	0.040	0.583	7 *	0.864	0.544	159	0.926	0.617	150
Benzene	0.048	0.326	15 *	0.455	0.305	149	0.518	0.345	150
Tetrachloroethene	0.013	0.680	2 *	1.104	0.635	174 *	1.115	0.720	155
Toluene	0.024	0.145	17 *	0.149	0.135	110	0.177	0.153	116
Chlorobenzene	ND	0.165	0 *	0.194	0.154	126	0.201	0.174	116
Ethylbenzene	ND	0.153	0 *	0.170	0.143	119	0.167	0.162	103
Xylenes (Total)	ND	0.159	0 *	0.097	0.148	66	0.094	0.168	56
Vinyl chloride	0.133	0.256	52	0.112	0.239	47	ND	0.271	0 *
1,3-Butadiene	NA	0.242	NC	NA	0.226	NC	NA	0.256	NC
Trichlorofluoromethane	NA	0.197	NC	NA	0.184	NC	NA	0.209	NC
1,2-Dibromomethane	NA	0.273	NC	NA	0.255	NC	NA	0.289	NC

*Recovery outside of 26 to 160 percent.

ND = Not detected (detection limit of 0.025 ug); NR = Not reported; NA = Not analyzed.

TABLE B-4. RESULTS FOR RTI PERFORMANCE EVALUATION AUDITS - ALDEHYDE

Compound	C-4a-ALD-623			C-5a-ALD-623		
	Found (ug)	Spiked (ug)	Percent Recovery	Found (ug)	Spiked (ug)	Percent Recovery
Formaldehyde	11.5	10.4	111	17.9	16	112

TABLE B-5. INDIVIDUAL LABORATORY ANALYSES OF ROUND ROBIN SAMPLE E

PPM DRY WHOLE COAL BASIS

TRACE ELEMENTS	LAB I		LAB II		LAB III		LAB IV		LAB V	
	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2
As	<0.6	8.63	11.53	11.69	4	5	7	8	8.4	9.2
B	153.79	139.65	45.15	45.15	150	150	130	140	151	138
Ba	192.23	266.6	658.9	669.8	795	687	400	380	714	701
Be	0.82	0.71	0.72	0.73	0.7	0.7	0.6	0.7	0.639	0.732
Cd	0.12	<0.06	0.1	0.1	<0.3	<0.3	<0.4	<0.4	0.052	0.092
Cr	8.59	7.87	7.88	9.85	9.8	8.14	8	8	6.4	6
Co	3.33	2.79	2.66	2.54	1.91	1.91	1	2	2.02	ND
Cu	9.36	8.89	6.97	7.1	<48.2	<46.3	7	7	11.9	11
F	<100	<100	55.8	60.87	60	60	ND	ND	54	57
Hg	<0.1	<0.1	0.159	0.144	0.17	0.17	0.18	0.18	0.113	0.136
Mn	108.93	99.02	149.2	151.2	93.9	88.8	140	140	124	122
Mo	3.59	3.3	2.77	2.75	7.51	7.13	<6	<6	ND	0.977
Ni	8.07	5.71	6.97	7.62	18.1	<17.4	6	3	3.7	4.92
Pb	1.92	<0.6	3.04	2.63	4	4	4	4	4	1.8
Sb	<0.8	<0.8	0.77	0.72	0.679	0.073	<1	<1	ND	2.3
Se	<0.6	<0.6	0.88	0.98	<1	<1	1	1	ND	0.746
V	17.94	16.5	14.34	14.32	16.4	15.5	17	18	16.2	16.2

% DRY BASIS

PROXIMATE & ULTIMATE

ASH	17.69	16.32	16.15	16.19	16.23	16.29	17.45	17.5	16.83	16.67
CARBON	55.85	54.93	59.58	59.55	59.05	59.17	58.91	58.61	59.38	59.33
HYDROGEN	7.41	7.38	4.21	4.15	4.24	4.31	3.92	3.9	3.91	3.87
NITROGEN	0.09	0.88	0.99	0.91	1.02	1.02	0.79	0.82	1.05	1.02
SULFUR	1.15	1.09	1.13	1.13	1.15	1.14	1.13	1.12	1.11	1.12
CHLORINE	0.03	0.03	<0.02	<0.02	<0.01	<0.01	ND	ND	0.05	0.05
Btu/lb	9252	8208	9842	9841	9920	9914	9777	9823	9939	9917

% DRY ASH

MAJOR ASH ELEMENTS

SiO ₂	37.26	36.57	39.92	40.18	ND	ND	39.61	ND	38.5	38.7
Al ₂ O ₃	3.01	3.53	12.68	12.69	12.35	11.98	12.38	ND	11.6	11.7
TiO ₂	0.45	0.44	0.45	0.46	0.55	0.43	0.49	ND	0.5	0.4
Fe ₂ O ₃	4.35	4.67	6.93	7	6.43	6.17	ND	ND	6.7	6.6
CaO	2.23	3.16	17.34	17.53	5.32	5.04	ND	ND	16.2	16.3
MgO	0.94	1.15	4.96	4.97	1.19	1.05	ND	ND	4.8	4.8
Na ₂ O ₃	0.67	0.72	0.89	0.89	0.8	0.78	0.87	ND	0.84	0.84
K ₂ O	1.4	0.12	1.39	1.39	1.99	2.1	1.25	ND	1.3	1.3
P ₂ O ₅	0.13	0.13	0.13	0.14	0.22	0.21	ND	ND	0.13	0.11
SO	ND	ND	14.99	15.21	ND	ND	ND	ND	15.42	16.02

B-12

TABLE B-6. INDIVIDUAL LABORATORY ANALYSES OF ROUND ROBIN SAMPLE N
PPM DRY WHOLE COAL BASIS

TRACE ELEMENTS	LAB I		LAB II		LAB III		LAB IV		LAB V	
	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2	RUN 1	RUN 2
As	11.83	10.07	11.69	11.71	4	5	3	ND	8.9	10.1
B	199.3	149.18	41.06	49.2	145	145	150	140	136	124
Ba	361.24	335.65	695.5	655	73	77.9	390	460	754	729
Be	0.97	0.77	0.51	0.51	0.8	0.8	0.6	0.6	0.711	1.13
Cd	0.11	<0.06	0.13	0.13	<0.4	<0.4	<0.4	<0.4	0.11	ND
Cr	10.09	7.71	8.01	8.45	9.06	8.67	8	20	8.4	6
Co	4.73	3.11	2.78	2.67	1.85	1.95	1	1	1.27	1.51
Cu	11.58	8.95	7.72	7.57	<39.7	<40.7	7	7	16.2	13.2
F	<100	<100	62.27	62.91	50	50	2.05	ND	54	56
Hg	<0.1	<0.1	0.129	0.167	0.11	0.1	0.13	0.13	0.153	0.155
Mn	137.02	105.67	150.8	147.9	93.1	96.5	130	130	120	124
Mo	3.99	3.85	2.82	2.88	10.5	11	<6	<6	0.142	0.44
Ni	7.22	5.59	7.3	7.49	15.5	16.4	4	4	5.32	11.8
Pb	3.61	2.98	2.6	2.5	9	8	3	3	1.97	0.05
Sb	<0.8	<0.8	0.77	0.79	0.672	0.704	<1	<1	ND	ND
Se	0.95	<0.6	1.03	1.03	<1	<1	1	ND	1.56	ND
V	21.18	16.16	15.72	15.78	19.4	19.2	16	17	16	16.2

% DRY BASIS

PROXIMATE & ULTIMATE

ASH	16.73	16.96	16.11	16.15	16.64	16.46	16.74	16.69	17.06	17.32
CARBON	58.35	58.36	59.77	59.64	59.26	59.22	58.96	59.22	59.26	59.64
HYDROGEN	6.03	4.36	4.23	4.25	4.28	4.31	4.06	4.02	3.8	3.87
NITROGEN	0.82	0.82	0.91	0.91	1.06	1.05	0.81	0.77	1.02	0.99
SULFUR	1.02	1.02	1.15	1.13	1.18	1.16	1.13	1.14	1.13	1.12
CHLORINE	ND	ND	<0.02	<0.02	<0.01	<0.01	ND	ND	0.04	0.04
Btu/lb	9107	7314	9887	9881	9924	9906	9906	9894	9892	9885

% DRY ASH

MAJOR ASH ELEMENTS

SiO ₂	46.27	34.56	41.36	40.88	ND	ND	39.59	ND	39.6	39.4
Al ₂ O ₃	4.36	3.6	12.34	12.09	12.98	13.13	12.28	ND	12.1	12.2
TiO ₂	0.57	0.44	0.43	0.42	0.44	0.53	0.48	ND	0.5	0.5
Fe ₂ O ₃	5.22	4.19	7.09	7.06	6.25	6.38	ND	ND	6.6	6.6
CaO	4.9	3.9	17.58	17.35	4.77	5.06	ND	ND	15.9	16
MgO	1.23	1.34	4.8	4.73	1.11	1.05	ND	ND	4.7	4.7
Na ₂ O ₃	0.94	0.82	0.87	0.84	0.8	0.81	0.85	ND	0.95	0.92
K ₂ O	1.79	1.24	1.37	1.33	1.19	1.36	1.26	ND	1.4	1.4
P ₂ O ₅	0.19	0.14	0.13	0.12	0.33	0.31	ND	ND	0.18	0.15
SO ₃	ND	ND	14.56	14.4	ND	ND	ND	ND	15.11	14.94

TABLE B-7. COMPARISON OF BOILER FEED COAL RESULTS WITH ROUND ROBIN RESULTS

Analyte	Average Table 5-12 Result (ug/g, as received)	Average Table 5-12 Result (ug/g, dry)*	Average Round Robin Result (E/N) (ug/g, dry)	Relative Percent Difference
Aluminum	7917	9655	9357	3
Antimony	ND< 37	ND< 45	0.75	193
Arsenic	9.4	11.46	7.64	40
Barium	326	398	568	35
Beryllium	0.67	0.82	0.72	13
Boron	143	174	126	32
Cadmium	ND< 0.9	ND< 1.10	0.079	173
Chromium	8.2	10.00	8.05	22
Cobalt	2.2	2.68	2.1	24
Copper	7	8.54	9.28	8
Lead	7.3	8.90	3.31	92
Manganese	97	118	123	4
Mercury	0.08	0.10	0.145	39
Molybdenum	2.3	2.80	3.98	35
Nickel	2.6	3.17	7.26	78
Potassium	1593	1943	1873	4
Selenium	ND< 1.3	ND< 1.59	0.6	66
Silicon	20620	25146	30837	20
Sodium	735	896	1041	15
Titanium	394	480	471	2
Vanadium	15	18	16.8	9

*Calculated using average moisture value of 18 percent for boiler feed coal.

RESEARCH TRIANGLE INSTITUTE
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August 10, 1993

QA/QC AUDITS ON DOE UTILITY BOILER TEST PROGRAM

FIELD SAMPLING AUDIT REPORT

Site: Coal Creek Station Unit 1, Underwood, ND

DOE Contractor: Battelle

DOE Project Officer: Kee Rhee

Performed for

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Under EPA Contract No. 68D10009
Work Assignment No. I-193

B-15

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Field Audit of:

**Coal Creek Station Unit 1
Cooperative Power Company
Underwood, North Dakota**

**Contractors: Battelle Memorial Institute
Chester Environmental
Dates: June 23 through 24, 1993
RTI Personnel: L.L. Pearce and S.V. Kulkarni**

Introduction

The Coal Creek Station is jointly owned and operated by Cooperative Power Company, Eden Prairie, MN, and United Power Association, Elk River, MN. The plant is a mine mouth, 1100 gross MW, coal-fired power plant located in central North Dakota which supplies power to the state of Minnesota. Power is generated by two tangentially fired, water-walled, dry-bottom boilers which are equivalent in size. Battelle tested unit 1, which has a generating capacity of 550 MW. The feed coal is lignite from the Falkirk mine and has an average sulfur content of approximately 0.6 percent.

Unit 1 is equipped with two electrostatic precipitators (ESPs) for particulate control. Each ESP has six fields and captured fly ash is removed through six rows of four hoppers. From the ESPs, the flue gas is fed into a flue gas desulfurization (FGD) scrubber for SO₂ control. Sixty percent of the flue gas is scrubbed before it is combined with the 40 percent bypass gas and then exits the stack. The furnace uses overfire air for reducing NO_x emissions.

Flue gas sampling locations for both organic and inorganic days included ESP 1 and ESP 2's inlet and outlet locations and the FGD outlet (stack) location for both normal and dilution sampling. Solid and liquid sampling locations included the following locations: boiler coal feed, run-of-mine coal feed, coal pile run-off, pyrite rejects, bottom ash, economizer ash, ESP 1 ash, lime, make-up water, and FGD slurry blowdown.

Findings

1. **Finding:** Calibrations of the SO₂ CEM were not being performed according to the QA/QC Plan. Battelle provided RTI with a record of their sulfur dioxide monitor calibrations from June 21 through 24. The calibrations consisted of a zero and a span check against a standard protocol gas. Calibrations were to take place twice a day, at the beginning and end of sampling. A deviation from the QA/QC Plan occurred on June 21 and 23. On June 21, the CEM was calibrated only once at the end of the

sampling day. On June 23, the CEM was calibrated only at the beginning of sampling. The June 21st omission was recorded in the "Alterations from Site-Specific QA/QC and Sampling Plans," but the June 23 omission was not.

Effect on Data: It is important that the calibrations be performed at the beginning and end of the sampling day in order to evaluate the CEM drift. There is insufficient information provided by the calibration data sheet to determine the monitor drift on June 21 and June 23. According to the "Alterations from Site-Specific QA/QC and Sampling Plans", the June 21 calibration was within 20 ppm of the standard. It would be helpful to include the concentration of the reference standard on the calibration data sheet.

2. Finding: Chester Environmental personnel indicated that there were some problems maintaining leak-free sampling trains while using the midget glassware. Aldehyde sampling was performed using miniature sampling trains with reduced flows (e.g., 1 to 2 L/min) and midget glassware. Since grease could not be used to get better seals, Teflon tape was used and the glassware connections were wetted to secure the glassware in the field.

Effect on Data: Greater leakage tendencies of the midget glassware contradicts the "attractiveness" of using this approach. The difficulty in getting a leak-free seal of the sampling train could result in misleadingly lower concentrations of target analytes for a given sample volume.

3. Finding: There is concern for a greater chance of breakthrough of some aldehydes and ketones when using the miniature glassware. Smaller volumes of 2,4-dinitrophenylhydrazine reagent are required in conjunction with reduced sample gas flow rates.

Effect on Data: Insufficient recovery of target analytes will result in erroneous data. Even at reduced flow rates, there may be a possibility that the reagent volume is inadequate for complete target analyte capture.

4. Finding: Sample bottles were not being sealed with tape prior to shipment to the analytical laboratory. In addition to tape, it is necessary to mark the level of the liquid on the container (if the sample is liquid) to detect any leakage.

Effect on Data: The lack of tape could result in leakage during shipment.

5. Finding: A general weakness in the sampling strategy is the lack of direct mass flow measurements of the solid streams (coal, bottom ash, fly ash, and air preheater ash). These are estimates being calculated indirectly based on related data such as the MW output, percentage ash in the coal, and the mass flow data from the measured streams.

Effect on Data: The adequacy of these estimates of mass flow will directly impact the mass balance closure results.

6. **Finding:** Use of an alternate condenser/XAD-2 module design resulted in a change in the SUMMA canister sampling point in the Method 23 sampling train. According to the Sampling Plan, the SUMMA canister samples were to be taken at a point between the condenser and the XAD module, thus allowing the condenser to remove moisture from the gas stream prior to sampling. Battelle's own design, a condenser seated directly on the top of the XAD module and enclosed in a glass casing, was used instead of the standard Method 23 configuration, which consists of a separate condenser and XAD module. As a result of the new design, the SUMMA canister samples were taken prior to the inlet of the condenser/XAD module unit. The samples were passed through a series of midjet impingers held in an ice bath for moisture removal prior to being collected in the canister.

Effect on Data: The impact of this modification is expected to be negligible if the impinger effectively removes the moisture by condensation. According to Method 23, alternate physical configurations of the condenser/XAD module are acceptable; however, this modification should have been included in Coal Creel's Site-Specific Sampling Plans or in the "Alterations from Site-Specific QA/QC and Sampling Plans for the Coal Creek Station."

7. **Finding:** The design modification discussed in Finding 6 resulted in a change of spiking location for the blank XAD-2 sorbent cartridge. After discussing the issue with Jane Chuang, the Laboratory Analysis Leader, it was agreed that the blank XAD-2 sorbent cartridge would be spiked with RTT's SVOC solution up through the outlet location.

Effect on Data: The effect on the data will be considered upon laboratory analysis of the performance evaluation sample.

8. **Finding:** There was a change in sampling time for each pair of traps used in the Volatile Organic Sampling Train (VOST). Each VOST run generated three samples or three pairs of Tenax/charcoal traps. According to the Sampling Plan, each of the three pairs of traps were to be sampled over a 20-minute time period at a flow rate of 0.5 L/min. The sampling times were modified as follows: the first pair of traps was sampled for 5 minutes, the second pair was sampled for 10 minutes, and the third pair of traps was sampled for 30 minutes. This modification in sampling was adopted at all flue gas sampling locations.

Effect on Data: According to Method 0030, collection of a sample volume of 20 liters or less at a reduced flow rate (SLO-VOST) can be used as an alternative procedure to the collection of a 20-liter sample at a flow rate of 1 L/min (FAST-VOST). This change was implemented due to concern for potential breakthrough of the low

molecular weight volatile organic compounds over the 20-minute sampling time period. Also of concern was the possibility of swamping the GC column with volatile analyte. Potential effects on the data will be evident upon laboratory analysis.

Observations

1. The initiation of sampling was delayed by approximately a half day due to the unexpected inaccessibility of sampling ports. Aldehyde sampling at the stack was carried over to the morning of the 24th due to sampling interruption by winds in excess of 50 mph. Sampling was also cancelled on the 25th due to high winds.
2. Battelle personnel were very knowledgeable and effectively coordinated sampling activities and schedules with Chester Environmental. Both Battelle and Chester's sampling management teams were receptive to the issues discussed by the RTI auditors and the DOE Project Officer, Dr. Kee Rhee. They were quick to implement any corrective action deemed necessary in an effort to acquire good data. Cooperative Power personnel were very helpful in assisting the contractors to coordinate sampling activities with plant operations.
3. Battelle had one person on-site who was responsible for QA/QC (Sandy Anderson). She was observing sampling operations by both Battelle and Chester Environmental for compliance to the QA/QC Plan. She was also responsible for performing internal QA/QC audits. Ms. Anderson kept exhaustive notes on her observations and was very conscientious about her role in the project.
4. All personnel used by Battelle and Chester Environmental seemed to understand the importance of following prescribed procedures to ensure data quality. The QA/QC and Sampling Plans were available to all personnel in all trailers. Additionally, the flow diagrams of the required procedures were prominently displayed for quick reference in the work area.
5. Whenever any changes were discussed or implemented, the project manager logged them into a book and made copies for the staff involved, including the QA Officer. Preventive maintenance and spare equipment retained on-site were some of the measures taken by Battelle to avoid possible sampling delays.
6. Clean glassware was flown in from Battelle laboratories; there was no cleaning performed on-site. The sampling activity generated minimal liquid and/or solid waste for disposal by the host facility.
7. Chain-of-custody procedures were rigorously followed including the use of proper identification, preservatives, and distribution lists. Ms. Debbie Smith explained the system to the auditors. Field blanks were collected for all sampling trains. There were no field blanks provided for the solid/liquid process samples.

8. The QA Officer, Ms. Anderson, followed the sample collection and calibrations in this project and had access to the calibration data, if needed.
9. Mr. Richard Smith was added to the staff to guide and support junior staff. Mr. Smith is a very experienced field person from Battelle. He collected most of the process samples and information.
10. Efforts were made to collect the representative process samples for liquids and solids. Some of the samples were collected by the plant personnel and shared with Battelle. Process sampling locations described in section 4.2.4.2 of the Sampling Plan were visited and the sampling procedures were observed by the auditors. Dr. Kee Rhee attended the sampling expeditions and participated in the discussion on improving the representativeness of some of the samples.

Activities

1. Performance Evaluation Audits (PEAs)

All scheduled PEAs were performed with the exception of the dry gas meter audits. The following PEAs were conducted:

- Aldehyde - 2 levels, inlet and outlet of ESP 1
- Metals - 2 levels, inlet and outlet of ESP 1
- PAHs - 2 levels, inlet and outlet of ESP 1
- VOST - 3 10-L samples, FGD outlet (stack)
- CEM - SO₂, pure N₂

Metals and PAHs were spiked onto blank filters/impingers/XAD-2 modules and recovered as if they were true samples obtained during sampling. Due to some confusion, the impinger solutions that were spiked by RTI with aldehydes were later used in sampling. They were then prepared for laboratory analysis.

Battelle analyzed two audit gas cylinders provided by RTI with the continuous emissions monitor (CEM). Battelle brought their own sulfur dioxide monitor to measure sulfur dioxide concentrations at the inlet to the FGD. The monitor was analyzing on the 0- to 2000-ppm scale. The results are shown below. The monitor that was audited measured within 3% of the RTI values. Battelle's CEM was operating within an acceptable range of $\pm 10\%$. The CEM data were used to characterize the performance of the flue gas desulfurization system.

Sulfur Dioxide Continuous Emissions Monitor PEA Results

	RTI	Battelle	% Difference ^a
Zero (pure N ₂)	0	0	--
SO ₂ (ppm)	391.5	380	-3.0

^a Acceptance limits were not specified in the QA Plan. A reasonable acceptance limit of $\pm 10\%$ was used by RTI in evaluating the PEA data.

2. PEA of the HEST Sampling Analysis Method for Mercury

One of the objectives of the DOE Utility Boiler Study is to evaluate several procedures for the measurement of mercury emissions from the stack and compare the results to those obtained by Method 29 for multiple metals testing. In consultation with DOE Project Officers Dr. Kee Rhee and Mr. Tom Brown, a performance evaluation sample was prepared to test the efficacy of the HEST Method. The information on the recovery of the PE sample after exposure to the corrosive gases in the stack was important for the evaluation of the procedure. At the end of the planned sampling activities, a HEST sampling train was assembled and sample collected using a charcoal impregnated filter (CIF) spiked with a known volume of the PE solution provided by RTI. As a control, another filter was spiked and used in the XRF analysis. The spiking was conducted by Battelle. The results, which were expected within a week or two, are still not available. There is no method developed prescribing how to spike the mercury solution evenly on the CIF. The information could not be used for subsequent design of the test at the next Battelle site as planned since the analysis results were not available to DOE.

3. Scheduled Technical Systems Audits (TSAs)

The following flue gas sampling procedures were observed:

- Flue gas sampling (ESP 1 inlet and outlet locations, FGD outlet)
- Sample train preparation and recovery

The following process stream sampling was observed or discussed:

- Boiler feed coal
- Bottom ash
- Economizer ash (could not be observed)
- Pyrite rejects

- ESP ash
- Make-up water
- Pond outlet
- Condenser water
- Coal pile run-off (plant personnel)
- Lime sample
- Scrubber slurry and slurry blowdown

Personnel Present During Site Visit

<i>Name</i>	<i>Organization</i>	<i>Telephone</i>
George Sverdrup	Battelle	614/424-5014
Paul R. Webb	Battelle	614/424-4913
Tom Kelly	Battelle	614/424-3495
Debbie Smith	Battelle	614/424-4114
Sandy Anderson	Battelle	614/424-5220
Joe Tabor	Battelle	
Randy Peltier	Chester Environmental	
Mark Patrick	Chester Environmental	
Mark Grunebach	Chester Environmental	
Kee Rhee	DOE/PETC	
Shri Kulkarni	RTI	919/541-5919
Lori Pearce	RTI	919/541-7182

INTERNAL AUDIT REPORT

on

A STUDY OF TOXIC EMISSIONS FROM A COAL-FIRED
POWER PLANT UTILIZING AN ESP/WET FGD SYSTEM

to

U. S. Department of Energy
Pittsburgh Energy Technology Center

(Contract DE-AC22-93PC93251)

Prepared by

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INTERNAL AUDIT REPORT

on

A STUDY OF TOXIC EMISSIONS FROM A COAL-FIRED POWER PLANT UTILIZING AN ESP/WET FGD SYSTEM

INTRODUCTION

This report summarizes the audit activities conducted on-site at the Coal Creek Station, Underwood, North Dakota, and at Battelle Columbus laboratories from the time period of 21 June through 09 September 1993. As Project Quality Assurance Officer (QAO), I observed field sampling and laboratory activities which were compared to descriptions provided in the Management Plan for 'Study of Toxic Emissions from a Coal-Fired Power Plant Demonstrating the ICCT WSA-SNOX Project and a Plant Utilizing an ESP/Wet FGD System' (DOE Contract DE-AC22-93PC93251) dated 21 June 1993.

During these observations, I recorded detailed notes which are summarized on the attached Checklists including general information (date, place, time, what, who), a brief narrative account, sample collection and related procedures, comments and recommendations. All of the recommendations were discussed in real-time with either the Project Manager, Field Sampling Manager, or Analysis Leader as soon as possible after the observation. Corrective action was implemented in almost every instance before the QAO left the inspection site.

SUMMARY

Field and laboratory inspections conducted during Coal Creek Power Plant activities indicated that, for the most part, the QA/QC Plan included as Section 4.0 in the Management Plan was being followed as written, or according to formal, written deviations. These deviations were initiated either as a need for corrective action or because the technical and physical demands of field and laboratory operations precluded adhering to the original QA/QC Plan.

On-site field observations included: sample tracking, custody, storage and shipping procedures; in-process sampling at Locations 6a and 6b, Flue Gas Desulfurization (FGD) outlet; 5a and 5b, ESP Outlets; and Locations 4a and 4b, ESP inlets. Process sampling was observed at Locations 3 (economizer ash), 7 (pyrite rejects), 8 (ESP ash), 9 (make-up water), 10 (circulating water, formerly called 'pond outlet'), 11 (scrubber make-up water, formerly condenser water for Locations 11 and 12), 15 (lime), 16 (scrubber slurry), and 17 (slurry blowdown). Various sampling train recovery and preparation procedures were also observed.

The Battelle QAO also served as a point of contact, along with the Project Manager, for RTI personnel conducting an independent field audit on 23-24 June 1993.

Laboratory observations included: systems audit of VOC-Canister analysis; ion chromatography data tracking; PAH/SVOC Liquid Samples preparation; PAH/SVOC Liquid Samples analysis; PAH/SVOC preparation of CTE ash composite samples; and filter preparation for dioxin/furan analysis.

It should be noted that several of the laboratory activities for this site were completed or in-process during the Niles Station Boiler No. 2 field sampling audit of 19-22 July 1993. The QAO tried to select representative analytical processes that were different for each field site without repeating any single observations.

Following is a sequential account of Coal Creek audit activities, each with a brief narrative and QAO's Recommendations when applicable. For detailed records, dated observations recorded on either the Field Inspection Checklist or Laboratory Inspection Checklist should be consulted.

CHRONOLOGY

Sampling Day 01, 21 June 1993:

Observations: Flue Gas Sampling at Location 6a and 6b, FGD Outlets. Sampling trains in place at 350-ft platform were packed in ice, all connecting joints tight, and spare parts and clean additional glassware available. Chester staff completing data forms for

instrument readouts using 'MM5 calculators' specially designed for this purpose. Method 29 train recovery, cleaning and reassembly observed. Chester equipment trailer inspected and appeared well-organized, clean, and to have adequate, clean glassware for the next day's activities. Process sampling at Location 8, ESP ash, indicated that not all hoppers are yielding adequate ash samples, as described in the QAP, pg. 4.2-16. Meeting was held with facility staff to hold NUVA feeder dumps at least overnight to add to sample volume. Process sampling at Location 3, economizer ash, was done for six hoppers and the ash composited into three samples.

Recommendations: Management Plan dated 21 June 1993 at point-of-use did not contain any approval signatures. This should be discussed with the on-site DOE monitor ASAP. The number of impingers observed in the Method 23 sampling train does not reconcile to that shown in the QAP, pg. 4.2-28. Documenting of longer sampling times for Location 8, ESP ash, was requested. Compositing of ash samples for Location 3, economizer ash, is not indicated in the QAP, pg. 4.2-15, where only obtaining samples 'from each of six hoppers once daily' is specified. QAP, p 4.1-24 states that sample labels 'will be completely filled out and attached to each sample promptly upon completion by the team member who took the sample'. The sampling team is filling out sample tags except for the actual time collected and attaching them to the sample containers usually in advance. This method does serve as a prompt that all specified samples will be collected and results in legible tags that can be completed without removing gloves. This actually is a more efficient operation when performed carefully, which it appears to be. However, this is a deviation from the exact wording of the QAP and should be addressed.

Issues above were discussed during the first sampling day with Project Manager Sverdrup and Field Sampling Manager Tom Kelly.

Response: A formalized list of deviations was initiated and will be updated as needed, to describe departures from the QAP and the impact of the changes on the study. The Management Plan was signed by DOE's On-Site Representative on June 22, 1993. These deviations were also addressed in a letter from Battelle to Ms. Lori Pearce of Research Triangle Institute, dated July 12, 1993. That letter listed deviations from the Coal Creek Sampling Plan, along with actions taken to correct for them. The last deviation noted was

not discussed in that letter since the procedure used is an improvement over that in the plan. The method used provides unambiguous sample identification and also reduces the time spent by the sample collection staff in the unpleasant ESP environment. These issues were discussed with Battelle's QAO at Coal Creek.

Sampling Day 02, 22 June 1993:

Observations: Location 5a aldehyde train recovery was observed in a separate work area. Impingers were removed from ice and rinsed into glass bottles. Chain-of-custody form initiated as recovery samples are collected. Method 23 MM5 train recovery observed. XAD-2 trap capped off and wrapped in foil; filter placed in clean watch glasses and sealed. Checked subcontractor chain-of-custody forms. Process sampling at Location 9, make-up-water, noted with collection of samples into glass bottles. Location 11, condenser water process sampling observed, also into glass bottles and vials. Location 17a process sampling of slurry blowdown observed, with samples collected in QAP-specified glass bottles. Set-up and leak-checking of impinger trains for acid gases and VOST at Location 5a ESP outlet observed. Probes in place on FGD inlets on unit 1 for traverse sampling. Process sampling at Location 10, circulating water, done by bleeding lines in the power plant lab and collecting into glass bottles. Flue gas sampling in-process at the ESP inlets, Locations 4a and 4b noted, with train well-iced; suspended overhead probe is utilized for vertical traverses. Field sample custody procedures were inspected and discussed with the Custodian.

Recommendations: Completion of custody forms by subcontractor staff before transfer to the Battelle custodian was discussed with R. Peltier. It was also requested that corrected data entries not be obliterated. Locations 9 and 11 sample collection into glass bottles rather than the QAP pg. 4.2-16 polyethylene bottles is to be addressed in the Deviations report. The QAP is incorrect in specifying PE bottles for these samples. There was also a meeting with Coal Creek Plant staff regarding sampling locations for sites 10, 11 and 12. For plant-specified reasons, these locations will now be: 10, Circulating water, collected inside the plant facility lab; and 11, scrubber make-up water. Deviations from the QAP for these three locations are to be addressed. The sample prep trailer used by the

Battelle custodian and train recovery leader is to have far more working space with the transfer of room temperature storage samples to a monitored, limited access room inside the plant facility.

Response: Chester Environmental staff adopted the chain-of-custody procedures noted above after discussions with the QAO. Deviations noted regarding sample bottles and sampling locations were addressed in the July 12 letter to RTI noted above. Following the comments of the QAO, effort was made to improve the work space in Battelle's trailer by moving sample storage and by restricting access of personnel to the trailer.

Sampling Day 03, 23 June 1993:

Observations: RTI staff arrived for conduct of their performance audit. Observed the following operations performed by study staff: Process sampling at Locations 7, 9, 11, 17a, 15, and 16; Sample custody procedures; spiking of XAD traps, MM5 filters, VOST and aldehyde impingers according to the RTI letter of 10 June 1993; isokinetic sampling at FGD Outlet Location 6b; VOST testing at Location 6a.

Recommendations: Spiking of XAD-2 traps was followed by immediately reconnecting and capping both traps. Battelle Laboratory Analysis Manager had advised waiting 2 to 5 minutes before recapping after the spiking procedure in order for solvent evaporation to occur. A change in sampling procedure for Location 7, pyrite rejects, involves the use of a large plastic pan (17-in. x 15 1/2-in.) in which to empty the complete pyrite sample collected in aluminum pans from each hopper. The pyrite sample should be thoroughly mixed then sectioned into progressively smaller fractions before transfer with a hardened steel scraper into a wide mouth bottle. This is to preclude bias of the sampling procedure and to provide a more representative sample from Location 7. The improved procedure was implemented on 24 June.

Response: The change in collection procedure at Location 7, pyrite rejects, was necessitated by the nature of the solid stream at that location. An improved procedure was implemented, as noted.

Sampling Day 04, 24 June 1993:

Observations: RTI staff concluded their performance audit with spiking of the MM5 train for the ESP inlet at Location 4a. The change of ports for vertical probe sampling and monitoring was briefly observed for samples at Location 4a ESP inlet.

There were no recommendations for this abbreviated observation.

VOC-Canister GC/MSD Analysis, 05 August 1993:

Observations: A system audit was conducted of VOC-Canister analysis, from transfer to the analyst by the Lab Sample Custodian, instrument calibration with a 42-component NIST-traceable standard, sample analysis, data acquisition and review, and transfer to canisters for re-cleaning. VOC canisters are shipped within 24 hours of field collection and the analysis is initiated the next morning after sample receipt to maintain the holding time limitation of 2 days.

Recommendations: Clarification of using a 42-component, rather than the QAP p. 4.1-14 'containing the 41 target compounds' should be added to the study record. This is not technically a deviation, however.

Response: The cylinder used for calibration contained 42 compounds; however, for this study, only 41 compounds were targeted for analysis.

Ion Chromatography Analysis, 11 August 1993:

Observations: Data tracking of Coal Creek samples was conducted as part of an in-process inspection for analysis of Niles Station Boiler No. 2 samples. Process samples collected on 22 June 1993 were compared to custody records, and the QAO's field observations for Locations 9, 10, and 11.

There were no recommendation for this observation.

PAH/SVOC Liquid Samples Preparation, 17 August 1993:

Preparation and spiking of sample extracts with internal standard, matrix and surrogates, sample storage and tracking documentation were observed.

There were no recommendations for this observation.

PAH/SVOC Liquid Samples Analysis, 18 August 1993:

Observations: Process sample C-16-PRL-623 was tracked through storage, GC/MSD tuning, performance check, initial and continuing calibrations, analysis by EPA Method 8270 December 1987 version, and data output, review and storage. Instrument maintenance records and manuals were noted. Quality control checks of data by the analyst and Water SVOC Analysis Leader were discussed. Data are generated as hard copy and stored long-term on tape.

Recommendations: The HML electronic data long-term storage facility is in a secure area; however, it is not known whether the cabinet in this area is flame-proof. Hard copy analytical output is stored in a separate building in the analyst's office. Consideration should be given to providing flame-proof storage for electronic media.

Response: The cabinet in the HML is not flame-proof and flame-proof storage is currently not available. The procedure of keeping electronic data separate from hard copy is intended to provide back-up storage. Consideration will be given to storage of electronic media in a flame-proof location should space become available.

PAH/SVOC Preparation of CT and E Ash Composite Samples, 31 August, 1993:

Observations: JN2193ECON SVOC was weighed out, extracted and chromatographed according to the QAP pg. 4.3-11. Sample receipt and tracking was documented in laboratory records and on the chain-of-custody form copy. Spiking of samples according to QAP pg. 4.3-13 was observed.

There were no recommendations for this observation.

Dioxin/Furan Analysis Filter Preparation, 09-10 September 1993:

Observations: Filter sample C-6b-MM5-0621 was followed through partitioning, acid-base silica column partitioning, elution, and alumina column chromatography. Procedures as shown in QAP pg. 4.3-11 were followed. Sample custody is tracked through the laboratory record book and chain-of-custody copy.

There were no recommendations for this observation.

FIELD INSPECTION CHECKLIST

AUDITOR SM Anderson DATE 21 June 1993
 STUDY NUMBER 5C930203 SITE LOCATION Coal Creek Power Plant,
 Bismarck, North Dakota TIME noon - 2 P Day 01
 STUDY PROTOCOL/QAPP Management Plan Contract DE-AC22-93 PC 93251
 Field Phase Inspected Flue Gas Sampling ^{Outlets} FGD Stack 6a; FGD Dilute 6b
 Personnel Involved Randy Peltier and Chester Staff; gte Labor
 Protocol/QAPP/SOP Requirements QAPP pp 4.2-9, 13, 14, 17-18, 19-48
 Narrative Account Sampling train for Method 29 multimetals
and Method 23 Semibols observed in process at
350' platform for traverse sampling. Train components
were packed in ice; all connecting joints tight.
Span. parts and glassware bagged & sealed. Dilution splg.
Equipment described in place by Randy Peltier ③
 Sample collection, containers, custody and transfer procedures 8P Multimetal
(Method 29) Train recovery by gte Labor observed; follows
Fig 4-13 in QAPP p 4.2-25 for filter, filter housing, ②
impinger; Refill & assemble Method 29 train per 4-10 on p 4.2
 Additional Comments ① Management Plan dated 21 June 1993.
No approval signatures on QAO copy.
Ask about number of impingers on the 23 train.
QAPP 4.2-28 specifies four, five imp. in set-up
 Recommendations I. Kelly to prepare list of deviations from
Site Sampling Plan (S. Scheduling. Must include 1 deviation,
2) detailed description and 3) impact on study.
 FLDLST.05/93 Auditor's Signature and Date Randy M. Anderson 25 June 1993

② Train uses flow diagrams & detail recovery for Method 29 (MUM),
 No Acid Gases, 23/MB PAH, Acids, Fuels / ~~50~~ 5V6
 10/11 Formaldehyde; glassware preparation, impinger
 train assembly, Sample recovery procedures, pg 01 of 23
 ③ Chain of custody - B-32

FIELD INSPECTION CHECKLIST

AUDITOR J. M. Anderson DATE 21 June 1993
 STUDY NUMBER SL 930203 SITE LOCATION Coal Creek Power Plant
Bismarck, North Dakota TIME 2-4P Day 01
 STUDY PROTOCOL/QAPP Management Plan # DE-AC22-93PC93251
 Field Phase Inspected Process Sampling ESP Ash - Location 8
 Personnel Involved Dick Smith, Phil Eastop
 Protocol/QAPP/SOP Requirements QAPP pg 4.2-16

Narrative Account NVA feeders collect hopper ESP ash.
Samples collected into pre-cleaned, labelled amber glass
bottles. Plan called for 1 hopper of ash from first three
rows to be collected. Hoppers 4/4 of Row 1 and 3/4 of
Row 2 did not yield ash sample even after 10 conts.

Sample collection, containers, custody and transfer procedures Collection per QAPP
pg 4.2-16. Labels on bottles were filled out before
collection except for actual sampling time. Bottles
(filled) transferred to cardboard box for transport

Additional Comments O valves were left open for 1-2 hours.
at 6 P, D. Smith, G. Sverdrup and K. Lee met c Control
Room staff to hold NVA feeder dumps for another day or
longer for rows 3, 4, 5 and 6 to try to increase ash samples.
 Recommendations Documentation of lengthened holding time
to accumulate adequate sample requested.

FLDLST.05/93

Auditor's Signature and Date Judy M. Anderson 25 June 1993

FIELD INSPECTION CHECKLIST

AUDITOR L. Mahan DATE 21 June 1993
 STUDY NUMBER 54930203 SITE LOCATION Coal Creek, Power Plant,
 Bismarck, North Dakota TIME 6 P Day 01
 STUDY PROTOCOL/QAPP Management Plan # DE-AC22-93R-93251
 Field Phase Inspected Process Sampling Asynchronous Ash Location 3
 Personnel Involved Rick Smith, Phil Castep
 Protocol/QAPP/SOP Requirements QAPP pg. 4.2-15; 4.1-24
 Narrative Account Spls. collected from 13th floor location
 accumulated ash collected from 6 hoppers and
 composited into three samples in a stainless
 steel bucket

Sample collection, containers, custody and transfer procedures Sample composited
 in stainless steel bucket transferred to a labelled
 plastic bucket and transferred to sample custodian.

Additional Comments Check C. T. Kelly, QAPP states samples
 will be collected from each of six hoppers once
 daily and does not mention compositing.

Recommendations See above. Note also QAPP p 4.1-24, says
 spl. label will be completed & attached after collection completion.
 Stop or regularly complete label 24 hrs prior to collecting

FLDLST.05/93

Auditor's Signature and Date Sandy M. Anderson 25 June 1993

Forces spls. Had a discussion, this method saves time,
 seems as a prompt, & results in very legible sample
 tag. Should cite, however, as a deviation from QAPP.

FIELD INSPECTION CHECKLIST

AUDITOR J. Manderson DATE 22 June 1993
STUDY NUMBER 930203 SITE LOCATION Coal Creek Power Plant,
Bismarck, North Dakota TIME 9:15 A Day 02
STUDY PROTOCOL/QAPP Manymat Plan DE-AC22-93R 93251
Field Phase Inspected Recovery of Aldehyde Train Samples Location 5A
Personnel Involved Raj Kangaraj
Protocol/QAPP/SOP Requirements ESP outlet § 4.2-13, 4.1-36, 37; 4.2-36, 37
Narrative Account Recovery done in (clean) storage trailer;
Impingers removed from ice; used 6 ACV into
labeled bottles sealed with teflon tape. Samples
will be chilled on ice overnight.

Sample collection, containers, custody and transfer procedures Spls. designated
3-1, 3-2, 3-3; Chain of custody proc. followed; labels
Completed as train portions collected

Additional Comments Method 264-nonisokinetic sampling

Recommendations None.

FLDLST.05/93

Auditor's Signature and Date Judy M. Manderson 25 June 1993

FIELD INSPECTION CHECKLIST

AUDITOR L. M. Anderson DATE 22 June 1993

STUDY NUMBER 51430203 SITE LOCATION Coal Creek Power Plant
Bismarck, North Dakota TIME 10:05 A Day 02

STUDY PROTOCOL/QAPP Mgt. Plan DE-AC 22-93 R 93251

Field Phase Inspected Method 23 MMS Recovery from Location 5A

Personnel Involved Raj Langaraj

Protocol/QAPP/SOP Requirements QAPP PA.2-28633 Semivols.

Narrative Account XAD trap disconnected, capped off
and firmly wrapped in foil; large and small cyclones
rinsed c. MeCl₂; particulate filter placed in clean
glass (watch glasses) & sealed; front half filter
rinse also collected.

Sample collection, containers, custody and transfer procedures Spls. rinsed into
amber, w. m., labelled pre-cleaned glass jars. C of C
form completed by Raj as he collected samples.

Additional Comments Made comment to R. Peltier re: completion
of Chester Chain of custody forms. Need to fill in all of
required data & forms are transferred. Also asked that
corrected entries not be obliterated

Recommendations Completion of sampling forms by sub-
contractor team prior to transfer of samples to
Battelle Sample Custodian requested.

FLDLST.05/93 Auditor's Signature and Date Larry M. Anderson 25 June 1993

FIELD INSPECTION CHECKLIST

AUDITOR J. M. Anderson DATE 22 June 1993
STUDY NUMBER 30430203 SITE LOCATION Coal Creek Power Plant
Bismarck, North Dakota TIME 10:50 A Day 02
STUDY PROTOCOL/QAPP Mgt. Plan DE-AC 22-93 AC 93251
Field Phase Inspected Process Sampling Make-up Water Location 9
Personnel Involved Dick Smith, Phil Eastop
Protocol/QAPP/SOP Requirements QAPP p 4.2-16
Narrative Account Rinsed stainless steel bucket and sampler
3X then filled ^{Glass} amber bottles (4X) and labelled them "#9
Super Water"; 3X 40 ml VOA bottles filled to displace
bubbles, using same single bucket grab sample.
1X Super Water 40 ml amber bottle filled from ② Contd
Sample collection, containers, custody and transfer procedures Sampling time
filled in on label as spls. collected. Bottles placed
in cooler box for transport.

Additional Comments ② separate bucket grab sample.
Sample pH dropped to 2.0 C. NaOH or H₂SO₄ by
spl. custodian. Dick Smith at 5P.

Recommendations ① Check use of amber glass bottles. QAPP
p 4.2-16 says "a polyethylene bottle."

FLDLST.05/93 Auditor's Signature and Date Linda M. Anderson 25 June 1993

FIELD INSPECTION CHECKLIST

AUDITOR Smadman DATE 22 June 1993
 STUDY NUMBER 50130203 SITE LOCATION Coal Creek Power Plant
Bismarck, North Dakota TIME 11.00 A Day 02
 STUDY PROTOCOL/QAPP NGT Rev 32 AC22-93-AL 95251
 Field Phase Inspected Process Sampling Condenser Water Location 11 ②
 Personnel Involved Dick Smith, Phil Pastex
 Protocol/QAPP/SOP Requirements QAPP p 4.2-16

Narrative Account Samples collected inside Power Plant
Laboratory. Samples bleed water line and
collect 3X 40 ml. spls. in amber vials (larger ones
are running on day 02) and 1X 40 ml. amber vial for VOA's
via tygon tubing collected to bleed lab water valve.

Sample collection, containers, custody and transfer procedures Spring time
added to pre-completed spl. labels as samples
are collected. Transported to cardboard box for
transport.

Additional Comments Do both "separate water lines" inside
plant collect into same bleed valve?

Recommendations ① Check re QAPP p 4.2-16 "a polyethylene
 bottle" once a day ② Meeting at 1500 Brian Stockhill, Les
 Nelson & G. Lundberg Location 11 prior "Scrubber Make-up Water"

FLDLST.05/93 Auditor's Signature and Date Leahy M. Anderson 25 June 1993

Contd. Per this meeting, locations 11 and 12 samples will
 not be collected according to QAPP.

FIELD INSPECTION CHECKLIST

AUDITOR J. Manderson DATE 28 June 1993

STUDY NUMBER 50430203 SITE LOCATION Coal Creek Power Plant

Bismack North Dakota TIME 1130A Day 02

STUDY PROTOCOL/QAPP Mgt Plan DE-AC 22-93 PC 93251

Field Phase Inspected Process Sampling Slurry Blowdown Sps.

Personnel Involved Phil Carter, Nick Smith Location 17A

Protocol/QAPP/SOP Requirements QAPP #12-17

Narrative Account Spl. collected via tygon tubing ^{sticking} connected

to bleed valve. Line sample has numerous air

bubbles trapped so team fills vials very slowly

to try to remove bubbles. Samples collected in

3X clear glass, 1X amber glass 40 ml, 4X large amber

Sample collection, containers, custody and transfer procedures

Bottles prepped

C labels which are complete except for actual

sampling time.

Additional Comments 2 contd.: w. m. bottles; Location 17B

Second slurry blowdown tank sampled at ~ 1135 A.

Team wears gloves & sample at this site. Collects

3X clear glass 40 ml, 1X amber 40 ml, 4X large amber (quart

size) w. m. bottles none.

Recommendations

FLDLST.05/93 Auditor's Signature and Date Larry M. Anderson 25 June 1993

0 env. SMA

FIELD INSPECTION CHECKLIST

AUDITOR J. Mandern DATE 22 June 1993

STUDY NUMBER 2930203 SITE LOCATION Coal. Ash. Power Plant
Bismarck North Dakota TIME 12 noon May 02

STUDY PROTOCOL/QAPP Mgt Plan DE-AC-22-93 PC 93251

Field Phase Inspected EGP #1 Outlet, Location 5A, 5B

Personnel Involved Harry Leonard

Protocol/QAPP/SOP Requirements QAPP P A.2-13, 4.2-33 to 37

Narrative Account Setting up to sample Method 29, VOST, and
acid gases (Method 26A train). Trains being leak-
checked during the ICE tanks being setup. Probes
connected to FGD inlets on Unit #1

Sample collection, containers, custody and transfer procedures _____

acid gases (5B location) X QAPP & 4.2-13 metals
Blue Gas (5A location) Inlet - Method 29, A H₂SO₄

Additional Comments Plastic tent shelter built on top of
roof to shelter sampling instruments and
trains

Recommendations None

FLDLST.05/93

Auditor's Signature and Date Judy M. Anderson 25 June 1993

FIELD INSPECTION CHECKLIST

AUDITOR S. M. Anderson DATE 22 June 1993
STUDY NUMBER 50930203 SITE LOCATION Coal Creek Power Plant
Bismarck North Dakota TIME 1:50 P Day 02
STUDY PROTOCOL/QAPP Met Plan DE-AC22-93 PC 93251
Field Phase Inspected Process Sampling - Circulating Water Location 10
Personnel Involved Dick Smith, Phil Easter
Protocol/QAPP/SOP Requirements QAPP PA2-16
Narrative Account This sample now called "Circulating
Water" ^① and is collected by bleeding lines
in the power plant lab.

Sample collection, containers, custody and transfer procedures Collected 3X VONS
in clear glass bottles, 1X amber glass vial
and 4X 500 ml amber bottles.

Additional Comments ① meeting c Diane Stockill and
Russ Nelson, G. Luedrup, to clarify sampling
points. Locations 9, 11, and 12 in QAPP are changed.
② actual sampling done < meeting at 105 P.

Recommendations See above.

FLDLST.05/93

Auditor's Signature and Date Sandy M. Anderson 25 June 1993

FIELD INSPECTION CHECKLIST

AUDITOR S. M. Anderson DATE 22 June 1993
STUDY NUMBER 58930203 SITE LOCATION Coal Creek Power Plant
Bismarck, North Dakota TIME 530P Day 02
STUDY PROTOCOL/QAPP Mgt. Plan DE-AC22-93 PC 93251
Field Phase Inspected Flue Gas Sampling ESP Inlets, Locations 4A, 4B
Personnel Involved Paul Webb

Protocol/QAPP/SOP Requirements QAPP p 4.2-13, 13; 4.2-17, 18

Narrative Account Methods 29 and 5 sampling in process
(4A and 4B respectively); trains well used; I-beam
C trolley overhead used to support sampling probe
for vertical traverses; data sheet completion
in-process for dry gas meter.

Sample collection, containers, custody and transfer procedures Sample train
for aldehydes transferred to trailer for recovery

Additional Comments Location 4A Inlet Sampling downstream
of air heaters; Flue Gas Methods 29, HEST,
Method 23, POST

Recommendations None

FLDLST.05/93

Auditor's Signature and Date Sandy M. Anderson 25 June 1993

FIELD INSPECTION CHECKLIST

AUDITOR J. M. Anderson DATE 22 June 1993

STUDY NUMBER SC930203 SITE LOCATION Coal Creek Power Plant

Bismarck North Dakota TIME 7 P Day 02

STUDY PROTOCOL/QAPP Mgt Plan DE-AC 22-93 R 93251

Field Phase Inspected Field Sample Custody Procedures

Personnel Involved Nebr Smith

Protocol/QAPP/SOP Requirements QAPP 4.1-23, 24; 4.1-20; 4.1-22-23

Narrative Account Sample move ment of Process Water Samples; and liquid samples for metals, CN, NH₄ are brought to truck & labels completed; C of C is relinquished to Custodian who adjusts pH by adding preservative (per QAPP Table 4-6.) and stores spls. in Coolers ①

Sample collection, containers, custody and transfer procedures Observed transfer of VOC canisters to N. Smith, who checks spl. labels, relieves C of C and prep for shipment in cardboard boxes same day of collection (QAPP p. 4.1-23)

Additional Comments Contd. & ice until shipped to analytical lab. Process samples - solids - have bottle lids taped, Clear Tape put over completed spl. labels and are stored in boxes at room Temp.

Recommendations Volume of spls collected ea day is overflowing available trailer space. Recommend either shipping out solids & liquids by noon of next day or finding temp.

FLDLST.05/93 Auditor's Signature and Date Sandy M. Anderson 25 June 1993

monitored space & limited access in facility. Room temp spls. & no holding time requirements could be stored there until shipped, in bulk, to analyt. facilities.

FIELD INSPECTION CHECKLIST

AUDITOR S. M. Anderson, RTI Staff DATE 23 June 1993
STUDY NUMBER SL930203 SITE LOCATION Coal Creek Power Plant
Bismarck, North Dakota TIME Starting 9:55A Day 03

STUDY PROTOCOL/QAPP _____

Field Phase Inspected as listed

Personnel Involved Lori Pearce, Shri Kulkarni - RTI

Protocol/QAPP/SOP Requirements RTI letter dated 10 June 1993

Narrative Account 10:55A Process Sampling Location 9

11:20 Process Sampling Location 11

11:30 Process Sampling Location 17A

11:45 Sample custody

12:30 Spiking for performance audit @ cont'd

Sample collection, containers, custody and transfer procedures _____

① by RTI: 2X XAD traps (Shri); 2X MM5 filters (Lori)

aldehyde impingers spiked at 2 levels (Shri).

Performance spikes conducted per RTI letter of 10 June 1993

Additional Comments _____

2 P Location 7 Process Sampling - Pyrite
rejects

Recommendations Location 7 - Sloop used to transfer rejects from aluminum pan into glass bottles; recommend larger container to collect more representative sample, use 1/4 riffling proc. for mixing

FLDLST.05/93

Auditor's Signature and Date Sandy M. Anderson 25 June 1993

FIELD INSPECTION CHECKLIST

AUDITOR L. Anderson, RTI Staff DATE 23 June 1993
STUDY NUMBER 58930203 SITE LOCATION Coal Creek Power Plant,
Bismarck, North Dakota TIME Starting 230P May 03
STUDY PROTOCOL/QAPP _____

Field Phase Inspected as listed

Personnel Involved RTI staff, Battelle

Protocol/QAPP/SOP Requirements QAPP p4.2-14; RTI letter 7/10 June 1993

Narrative Account 230P Process Sampling - Lime Location 15^①
Process Sampling Scrubber Slurry Location 16^②
335 VOST Train - Blue gas spiked by RTI^③
435 Method 23 Train setup / port change
for isokinetic traversing Blue Gas Slurry Location 6B^④

Sample collection, containers, custody and transfer procedures _____

Additional Comments ① Collected off roller & scoop & put into W.M. PE bottle
② Collected grab sample & heater 1X gallon, 4X X 500 ml. amber glass
③ Form 'Stack Sampling data Sheet'; Buck Calibrator used
'Primary Gas Flow Standard'; Septum leak - checked ok,

Recommendations _____

④ from 4:35 to 5:20. Came off stack at 6:30P

FLDLST.05/93

Auditor's Signature and Date

Lindy M. Anderson 25 June 1993
③ Buck Calibrator checked to NIST Std.

FIELD INSPECTION CHECKLIST

AUDITOR J. Manducum DATE 24 June 1993

STUDY NUMBER 58930283 SITE LOCATION Coal Creek Power Plant

Bismarck, North Dakota TIME 930H May 04

STUDY PROTOCOL/QAPP _____

Field Phase Inspected as listed

Personnel Involved RTI Staff Battelle - Tom Kealey, SMA, Paul Wu

Protocol/QAPP/SOP Requirements RTI letter dated 10 June 1993

Narrative Account 930 Spike mms train at 2X levels,

filters, impinger bottles, one 7 ea reagent grade
ESP train inlets & 104 Locations 4A and 4B ^{4A only.} SMA

11:55 HEST Sample at Location 4A Inlet;
Change of probe for vertical probe sampling; monitoring

Sample collection, containers, custody and transfer procedures _____

Additional Comments None

Recommendations None

FLDLST.05/93

Auditor's Signature and Date Andy Anderson 25 June 1993

LAB INSPECTION CHECKLIST

AUDITOR J. Mandum DATE 05 August 1993
 STUDY NUMBER 90030203 SITE LOCATION Coal Creek / Miles Power Plant
 TIME 10A

STUDY PROTOCOL/QAPP DE AC 22-93 PC 93251, dated 21 June 1993

Lab Phase Inspected VOC - Canister Analysis GC/MS Systems Audit

Personnel Involved Richard Keigley

Protocol/QAPP/SOP Requirements QAPP p 4-3-6, 7; 4.1-14, 15; 4.2-3; 4.1-31
over SMS 08/15/93

Narrative Account Canister checked for vacuum & pressurized to zero upon receipt. (8-12 A ea ea of spl. received) 7 samples from Custodian; GC/MS is calibrated c a 42-Component mix traceable to NIST heptameth. (1117305 - calib. std). 42-comp. mix is injected into facility smog chamber, analyzed and

Sample storage, preparation, analysis and custody procedures Sample custodian delivers canisters after receipt & log-in to Bill Keigley who logs them into a facility spl. log book. Also has copy of aug. C-14C forms, indicating trip splits. Trip blank

Additional Comments Cont. Quantitated. Std. quantitation analysis report is placed into G285 study record book for traceability from original mixing by B. Keigley. Data is acquired on an HP 6880 GC/FID with HP 5970 MSD. HP computer system is HP Chemstation. Uses canister ID and Sample IDs as cross reference in logbook. Hard copy output is compared to M. Holden, as well as tape, which is retained for study duration.

LABLST.05/93

Auditor's Signature and Date Judy Mandum 05 Aug. 1993

Analyst checks data & performs review as: Calibration, sample. All data is retained. ea sample's data file includes: C-14C copy run log, hard copy output. Files run by daily sequence. After splits are run, VOC canisters are taken to Richard Smith for cleaning. 12:11 PM
 R-47

LAB INSPECTION CHECKLIST

AUDITOR S. Anderson DATE 11 August 1993

STUDY NUMBER 50931203 SITE LOCATION Coal Creek Power Plant

TIME 10:10A

STUDY PROTOCOL/QAPP DE-AC 22-93 PC 93251, dated 21 June 1993

Lab Phase Inspected Ion Chromatography Analysis

Personnel Involved Steve Hermillion

Protocol/QAPP/SOP Requirements QAPP A.3-5, 6

Narrative Account _____

Sample storage, preparation, analysis and custody procedures _____

Additional Comments Spl. Analysis verified per:

C-9-PRL-622-RW

C-10-PRL-622 CW

C-11-PRL-622 SMW

C-16 PRL-622-LS

Recommendations Data file transferred from D. Hermillion
to R. Ligg includes Final Anion Report, Summary Report,
Calibration Plot, Duplicate and Spike Data, Standards

LABLST.05/93

Auditor's Signature and Date Sandy M. Anderson 12 Aug 1993

Contd. Prep. Data, Analysis Conditions, Chromatograms

LAB INSPECTION CHECKLIST

AUDITOR S. Manderick DATE 17 August 1993

STUDY NUMBER 2930203 SITE LOCATION Coal Creek Power Plant

TIME 4P DM 7245

STUDY PROTOCOL/QAPP DE AC 22-93 PL 93251, dated 21 June 1993

Lab Phase Inspected PAH/SVOC Liquid Samples Preparation (Final)

Personnel Involved Sue Champagne

Protocol/QAPP/SOP Requirements QAPP p A.3-13, 14

Narrative Account Spls kept at room temp in # 7234 for 15 minutes.

Prep Blank = 1 ml MeCl₂ + IS (IS is sonicated before adding)

'Supelco Standard Mix' kept frozen and rethawed for use,

then sonicated before ea reuse. Spl. set prepared

46707-09-03, 04 (Dup.) thru 09-06, 24-10, MB, MSD ^①

Sample storage, preparation, analysis and custody procedures Sample Transfer documents
in lab 46707 by pg ref

Syringe used for spiking = 10 µl Unimetrics

Additional Comments ① Cont'd. Use 50 µl syringe to quantitatively
transfer spl. extract to GC vials & second transfer of
~ 0.5 ml. Analyst pulls up clean dem on top of spl. & 0.5 ml
in syringe. Adds 40 µl IS last, caps vials and mixes

Recommendations one by one until full set of extracts is
completely transferred. Use separate syringe for IS
solution. Prep blank receives IS last. (Cont'd to 17 Aug. 02

LABLST.05/93

Auditor's Signature and Date Sandy Manderick 19 August 1993

LAB INSPECTION CHECKLIST

AUDITOR J. Mander DATE 17 Aug 02 cont'd.

STUDY NUMBER 50930703 SITE LOCATION Isal Creek

TIME _____

STUDY PROTOCOL/QAPP _____

Lab Phase Inspected _____

Personnel Involved _____

Protocol/QAPP/SOP Requirements _____

Narrative Account Spls. put into cooler for transport after spiking. Syringe then cleaned by MEDH aspiration before and after use. Sample Composition = 40µl IS, 1.0ml spl. extract = 1.04 ml final volume

Sample storage, preparation, analysis and custody procedures Sm 7245 locked after house; cooler picked up by J. Hannon-Kenny & transported to HML for GC/MSD analysis. Transfer of spls documented in Lbk 46707.

Additional Comments Surrogate spike tracked to 46399-77-05; Matrix spike in 46399-77-20. Descriptors & cones match; all ok. Laura Hannon-Kenny adds IS tracking for 46399-69-07 and 46399-70 sln. also to study Lbk 46707.

Recommendations Matrix and surrogate spike slns. stored in #7234

LABLST.05/93

Auditor's Signature and Date Judy M Mander 19 Aug. 1992

LAB INSPECTION CHECKLIST

AUDITOR S. Manderson DATE 18 August 1993

STUDY NUMBER 50430203 SITE LOCATION Coal Creek Power Plant

TIME 8:40 AM at HML

STUDY PROTOCOL/QAPP DE AC22-93PL 93251, dated 21 June 1993

Lab Phase Inspected PAH/SVOC Liquid Samples Analysis

Personnel Involved Laura Henson-Kenny, Fred Moore

Protocol/QAPP/SOP Requirements QAPP 4.1-17, 18

Narrative Account Sample analysis preceded by Autotune C FC-413, DF-TPP performance check (Lab 46399-70-01); CONCAL (46399-69-04; Calibration report (ICAL); Calibration Check Report (CONCAL); copy of run log placed in study file; copy of tune, spectra, cgram, mass list, quant report

Sample storage, preparation, analysis and custody procedures Tracked spl. storage Xbm 4124 B: Stds stored in locked compartment of SERVO X44136; containers in plastic bags; spls. from King Ave prep transferred by Laura (from Spl. Custodian) to Fred Moore

Additional Comments Tracked field sample C-16-PR-623; 0 contd. lists hits only. MSD system: HP5890 (X47040), HP5470 MSD (X47038); method 8270 (copy in ^{file} _{MA later}) Dec. 198 describes analytical parameters; Manufacturer's

Recommendations Maintenance record and routine maintenance performed by analysts kept in lab along c instrument manuals for HP MSD system. This page contin to 18 Aug 02

LABLIST.05/93

Auditor's Signature and Date Sandy Manderson 19 Aug 1993

LAB INSPECTION CHECKLIST

AUDITOR S. Marden DATE 18 Aug 02 contd.

STUDY NUMBER 930203 SITE LOCATION Coal Creek

TIME _____

STUDY PROTOCOL/QAPP _____

Lab Phase Inspected _____

Personnel Involved _____

Protocol/QAPP/SOP Requirements _____

Narrative Account Long-term
Data storage for tapes in trailer designed for storage in cabinet. Trailer locked during non-working hours; fire protection of cabinet not known. Initial analyt. data performed by Ted Moore; Laura determines "final hit/no hit" parameter for reporting data.

Sample storage, preparation, analysis and custody procedures QAPP kept in office
men; had copy raw data stored in secure office area
Spl C-16 PRK 623 extract ID-A6707-04-07;
GCMS file > P0036

Additional Comments Contd. Any peaks that are manually
integrated will be so indicated in Analyt. Report.
Sample analysis runs are approx. 60 minutes long.

Recommendations Long term tape storage for HME should
be a flame-proof cabinet. Altho hard copy output,
is provided for every run in this study, long term electronic data
storage needs flame protection.

LABLST.05/93

Auditor's Signature and Date Sandy Marden 19 Aug 1993

LAB INSPECTION CHECKLIST

AUDITOR M. Anderson DATE 31 August 1993

STUDY NUMBER DE 930203 SITE LOCATION Coal Creek from plant

TIME 2 P

STUDY PROTOCOL/QAPP DE H22-93 PC 93251, dated 21 June 1993

Lab Phase Inspected PAH/SROC Preparation of CT and E Ash

Personnel Involved Glenn Ogden, Melinda Hayes

Protocol/QAPP/SOP Requirements QAPP 4.3-10, 11, 12, 15, 13

Narrative Account Sample weighout of Acronize Ash Composite

JN 919 3E CON SROC → 16715-24-2; made up as two X

10 g samples. Ash will be recombined at final extraction
(1X set will be transferred to D. Davis for cleanup. Spl.
set will include 3X spls x 2 = 10g and 1X method blank

Sample storage, preparation, analysis and custody procedures JN 2693 CON SROC spls

stored in 250ml plastic bottles. K¹C¹Q¹C form = Spls. com-
posited by CT & E from C-3-PRS samples. Signed over by
Phil Strickland to Glenn Ogden on 08/30/93

Additional Comments Contd. Glass wool plug used in column
pre-extracted & muffled. Sample stored in 250ml PE
(chrom) weighed into glass vials, spiked, plugged
& extraction started.

Recommendations Contd. IS Spike 16715-3-6 made from
46381-8-1, Chryso and 41829-23-4 in Me Cl₂.

No recommendations made.

LABLST.05/93

Auditor's Signature and Date Shirley M. Anderson 31 Aug. 1993

① = benz[a]fluoranthene. See QAPP 4.3-13

LAB INSPECTION CHECKLIST

AUDITOR Manderon DATE 09 September 1993
STUDY NUMBER 50430203 SITE LOCATION Coal Creek Power Plant
TIME 1140h; 10 Sept 1050A
STUDY PROTOCOL/QAPP DEAC22-93PC.93251, dated 21 June 1993
Lab Phase Inspected Dioxin Filter Preparation & Dioxin/Furan Analysis
Personnel Involved Glenn Ryker
Protocol/QAPP/SOP Requirements OSRP p A.3-11
Narrative Account 09/09/93 HPH partitioning, Al₂O₃-base silica column partitioning, Collected in round bottom flasks; 70 ml elution (hexane). Flasks stoppered and sples stored at room temperature overnight. 09/10/93 alumina column chromatography
Sample storage, preparation, analysis and custody procedures A-B silica sples designated as 2-10, 11, 12 and 13. Have two copy of COC & indicates custody in lab
Additional Comments Tracked Sample C-6B-mm5-0621 (Lab 46715-2-1A, 15, 16); preliminary workup for AD extract done in July
Recommendations Check v. Battelle safety & update hood face velocity monitoring.
LABLST.05/93 Auditor's Signature and Date Leahy Manderon 09 Sept. 1993

APPENDIX C
SAMPLING PROTOCOL

SAMPLING PROTOCOL

C-1. Introduction

The purpose of this Appendix is to summarize important aspects of the field sampling effort at Coal Creek that may not be adequately covered elsewhere. The actual schedules and sample recoveries achieved in the field are described in sections 1 through 3 of this report. This Appendix provides further detail on the procedures used in sampling, recovering, and storing samples from flue gas, solid, and liquid streams. This information is intended to supplement that provided in the QAPP for this project.

C-2. Reagent and Materials Preparation

The sampling conducted at Coal Creek required a variety of chemical reagents and sampling materials, which were prepared or provided either by Battelle or by Battelle's subcontractors. All of the chemical reagents needed for flue gas sampling and sample treatment were prepared by Battelle, and distributed to Chester Environmental sampling personnel as needed at Coal Creek. The purpose of this approach was to minimize sampling variance by using reagents from a single source. The list of reagents included acidified peroxide and permanganate for the Multi-Metals trains, carbonate/bicarbonate solution for the anion trains (Method 26A), 0.1 N H_2SO_4 for ammonia collection, 0.1 M NaOH for cyanide collection, and acidified 2,4-dinitrophenylhydrazine (DNPH) for aldehyde collection. These reagents were made up on-site from high-purity starting materials, including deionized water, or were prepared from concentrated stock solutions brought from Battelle, when reagent stability made that approach appropriate. All reagent solutions were made up fresh on the day of sampling and distributed to Chester personnel.

Various rinse solutions were also brought to the site or made up by Battelle, for use in recovering samples from the various trains. Those brought to the site were deionized water, acetone, acetonitrile, and 50/50 methanol/methylene chloride. Rinse solutions made up at the site were 0.1 N HNO_3 and 8 N HCl. These solutions were supplied to Chester staff as needed.

Sampling materials were provided both by Battelle and by subcontractors. Materials provided by Battelle were Summa polished sampling canisters for VOCs, filters for all flue gas sampling runs except the HEST, and cleaned XAD resin for all SVOC sampling by Modified Method 5. The XAD was obtained and cleaned by Battelle, and was used to fill sampling glassware of different designs for Battelle and Chester. The filters provided by Battelle included 87 mm diameter for Battelle's flue gas sampling, 104 mm diameter for Chester's hot flue gas sampling, and 203 mm x 254 mm (8 in. x 10 in.) for Chester's PSDS sampling. All these filters were high-purity quartz fiber. Filters used for SVOC sampling were muffled and stored in muffled aluminum foil before use. Filters used for Multi-Metals and particulate mass measurements were weighed under constant conditions before shipment to the field. Battelle also supplied pre-cleaned containers for most of the flue gas and solid/liquid samples.

Other sampling materials were supplied by subcontractors. Chester supplied pre-cleaned VOST traps for use by both Chester and Battelle, and provided HEST carbon-impregnated filters and associated quartz particulate pre-filters for both groups. Chester provided cascade impactors and the necessary stage components for particle size determinations at Locations 6a and 6b. Zande Labs provided pre-cleaned 40-ml vials for headspace-free collection of liquid samples for VOC analysis.

C-3. Sample Preparation

The Battelle and Chester field sampling teams prepared their own respective sampling trains using the reagents and materials described above. Within each of the Battelle and Chester field teams, a single staff member was designated the Sample Recovery Leader. That person, and only that person, directed and approved the preparation and recovery of sampling trains. Each group used their own laboratory facilities on-site, as described below:

- Battelle's field laboratory is a 40-foot air conditioned semi-trailer equipped with a side entrance door and an electrically operated platform lift at the rear double doors. The trailer accepts 100 A of 125 V/250 V AC power by hardwiring to a transformer or switch box. This trailer served as the primary contact point for Battelle and Chester staff, and was used for meetings among project personnel to review the previous day's activities and plan for the current day. Such meetings were especially necessary on the 6 sampling days, but were useful in the setup and shutdown phases of the field effort.

- Two 28-foot rental trucks equipped with side entrances were used by Battelle staff for preparation of flue gas sampling equipment and for recovery of some samples. The two trucks were equipped with tables, storage areas, and a desk for equipment setup, and sample recovery. One of these trucks was used as the sample recovery area for aldehyde samples only. This arrangement minimized contamination of aldehyde samples by acetone used in other activities.
- Chester Environmental's field laboratory was a laboratory trailer approximately 15 feet long, and equipped with lights, air conditioning, storage, and work areas. The laboratory trailer was used by Chester for preparation of sampling equipment, cleanup, sample recovery, and sample documentation tasks.

The facilities described above were positioned close to one another near the stack at Unit 1, at the edge of the relatively open area surrounding the stack. That location was roughly centrally located among the various flue gas and process sampling locations. In addition, two commercial compressed gas tube trailers were positioned near the base of the Unit 1 stack. Those trailers were obtained by Chester, and supplied the N₂ and O₂ needed as diluent gas in the plume dilution sampling at the stack.

Written procedures for reagent and train preparation were provided to field staff, and were posted in the train preparation areas of the Field Facilities. Copies of those documents, which included sample recovery as well as preparation procedures, are included at the end of this Appendix. All sampling reagents and trains were prepared under the direction of the Sample Recovery Leader. Every flue gas sampling train was accompanied by a chain-of-custody form specific for that sample and sampling location, from the moment the train was assembled. That custody form remained with the train throughout sampling, and was returned to the field laboratory with the train once sampling was completed. That same form was then used during sample recovery and documentation procedures.

C-4. Sampling Methods

Table C-1 presents a summary of the chemicals measured, the type of samples in which each chemical was measured, and the sampling methods used for each.

The sampling methods used were detailed in the QAPP for this study. Brief descriptions of the sampling methods are as follows:

TABLE C-1. SUMMARY OF REQUIRED MEASUREMENTS AND SAMPLING METHODS USED TO ACHIEVE THEM

Measurement	Type of Sample	Method
Volatile Organic Compounds (VOC)	Flue Gas Flue Gas Liquid	Summa Canisters ^(a) Volatile Organic Sampling Train (VOST) Process Sample Collection
Semivolatile Organic Compounds (SVOC)		
Polycyclic Aromatic Hydrocarbons (PAH) and Other SVOC	Flue Gas (Vapor) Flue Gas (Particulate) Solid Liquid	Method 23/Modified Method 5 Method 23/Modified Method 5 Process Sample Collection Process Sample Collection
Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans (PCDD/PCDF)	Flue Gas (Vapor) Flue Gas (Particulate)	Method 23/Modified Method 5 Method 23/Modified Method 5
Volatile Elements (Hg, As, Se)	Flue Gas (Vapor)	Hazardous Element Sampling Train (HEST)
Elements	Flue Gas (Particulate) Flue Gas (Vapor) Solid Liquid	Method 29 Method 29 Process Sample Collection Process Sample Collection
Anions (F ⁻ , Cl ⁻ , PO ₄ ³⁻ , SO ₄ ²⁻)	Solid Liquid Flue Gas (Particulate)	Process Sample Collection Process Sample Collection Method 26A/CARB 421
HCl, HF	Flue Gas (Vapor)	Method 26A/CARB 421
Ammonia	Flue Gas (Vapor) Liquid	Impingers, APHA 401 Process Sample Collection
Cyanide	Flue Gas (Vapor) Liquid	Impingers, APHA 808 Process Sample Collection
Aldehydes	Flue Gas (Vapor) Liquid	TO-5, APHA 122 Process Sample Collection
Radionuclides	Solid Flue Gas (Particle)	Process Sample Collection Filter from Ammonia/Cyanide Train

TABLE C-1. (Continued)

Measurement	Type of Sample	Method
Carbon	Solid	Process Sample Collection
	Flue Gas (Particle)	Filter from Ammonia/Cyanide Train
Particle Size Distribution	Flue Gas (Particle)	Impactors
	Flue Gas (Particle)	Cyclones with Method 29
	ESP Ash	Process Sample Collection
Moisture, Heat Content, Ultimate/Proximate	Run-of-Mine, Pulverized Coal, Pyrite	Process Sample Collection
	Rejects, Lime	
Particulate Mass	Flue Gas (Particle)	Method 5

(a) On Method 23 train.

USEPA Method 29 (Draft June, 1992) - Multiple Metals. Method 29 is designed to determine emissions of metals from stationary sources. In Method 29, flue gas is withdrawn isokinetically from the source, with particulate emissions collected on a heated quartz filter and gaseous emissions collected in a series of chilled impingers. The series of impinger consists of two impingers containing a solution of dilute nitric acid and hydrogen peroxide, and two impingers containing a solution of dilute potassium permanganate and sulfuric acid.

A series of two glass cyclones preceded the pre-weighed quartz filter at the ESP inlet to provide size cuts of $> 10 \mu\text{m}$, $5\text{-}10 \mu\text{m}$, and $< 5 \mu\text{m}$ in the collected particulate matter. These cyclones were located in the heated sampler box along with the particulate filter. Thus the $10 \mu\text{m}$ and $5 \mu\text{m}$ cyclones replaced the single $10 \mu\text{m}$ cyclone normally used in the Method 5 type train.

Method 29 sampling at the ESP inlet and outlet was modified to include the use of a flexible, heated, Teflon sample line connecting the probe to the heated cyclones and filter. The flexible heated line, which allowed the vertical sampling required at that location, was made of 1/2-in. diameter, thick-walled, Teflon tubing and contained a temperature monitor. An empty impinger was used in the train for condensate drop-out.

USEPA Method 26A - Particulate Matter, Hydrogen Chloride, Hydrogen Fluoride. Sampling was conducted along the general procedures of EPA Method 26A, with adaptations to the guidelines of California Air Resources Board (CARB) Method 421 in the collection solution employed. Method 26A is designed to determine particulate matter, and hydrogen halides in the absence of other chloride-containing volatile species. It is suitable for combustion sources where the primary source of chloride is the dissociation of chlorinated organic compounds. In the present study this method was be used to determine HF/HCl and their corresponding particulate anions, as well as particulate $\text{SO}_4^{=}$ and PO_4^{3-} .

A sample of flue gas is withdrawn isokinetically from the source, with particulate emissions collected on a heated filter and gaseous emissions collected in a series of chilled impingers containing a solution of sodium carbonate (1.8 mM) and sodium bicarbonate (1.7 mM). The method was used in this study in a single-point, nontraversing mode. The use of carbonate/bicarbonate solution as the collecting medium for HCl and HF followed the

guidelines of CARB 421. The solution was prepared by a 1:1000 dilution of stock solution in the field. The same solution was used for rinsing of the probe and filter holder after sample collection. An empty impinger was used at the front of the chilled impinger train to collect condensed water from the stream. The collected condensate was saved as a sample fraction for chemical analysis.

USEPA Method 23 - Semivolatile Organic Compounds. Method 23 is designed to determine specifically dioxins and furans. In this study, Method 23 was adapted, according to Modified Method 5 guidelines, to measure polycyclic aromatic hydrocarbons (PAH). Thus Method 23 as referred to in this document is a modified method for measurement of the following types of chemicals, which collectively are called semivolatile organic compounds (SVOC):

- Polycyclic Aromatic Hydrocarbons (PAH)
- Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans (dioxins/furans).

In addition, whole air samples were collected from the Method 23 train in SUMMA polished canisters, to determine volatile organic compounds (VOC). Samples for VOC were taken with both SUMMA canisters and VOST (volatile organics sampling train) for comparison of the two methods.

Glass cyclones were used in the Method 23 train as described above for the Multi-Metals train. At the ESP inlets and outlets the method employed a flexible heated Teflon sample line connecting the probe to the heated filter. The flexible heated line, which allowed the vertical sampling required at these locations, was made of 1/2-in., thick-walled, Teflon tubing and contained a temperature monitor.

The SUMMA samples were taken directly into evacuated stainless steel canisters. The samples were taken from a tee in the Method 23 train between the condenser and the XAD-2 cartridge for the Chester samples, and were taken from a tee upstream of the integral condenser/XAD unit in the Battelle trains. Each canister was equipped with a manual valve to maintain vacuum until sampling is initiated. A flow orifice was sized and installed in the sampling line (Teflon) between the tee and the canister valve, to provide a time integrated

sample. The orifice was sized to allow the canister to fill over a one-half hour period. The Chester tee fitting was designed so that water condensing in the main air flow to the XAD-2 cartridge was separated by gravity from the small air flow (approximately 200 cm³/min) flowing to the canister. This arrangement prevented water from clogging the flow orifice in the canister line. In the Battelle trains, a glass midget impinger in the flow line to the canister was placed in an ice bath, and served to condense out moisture upstream of the orifice. Each canister connection had a compound pressure/vacuum gauge attached. This gauge was used to measure the initial canister vacuum, monitor canister pressure during sampling, and record the final canister pressure after sampling. Three canister samples were taken (approximately simultaneously with three VOST samples) on each organic sampling day.

VOST. VOST samples for volatile organic analysis were taken with a Graseby-Nutech 280 Volatile Organics Sampling Train (VOST), or equivalent. Sampling was conducted consistent with the procedures of SW-846 Method 0030 which provides for the collection of volatile organic compounds by adsorption onto Tenax and Tenax/charcoal sorbents, and with the guidelines stated in the VOST manual (Graseby-Nutech, Durham, NC). The standard VOST consists of a glass-lined probe followed by an isolation valve, a water-cooled glass condenser, a sorbent cartridge containing Tenax (1.6 g), an empty impinger for condensate removal, a second water-cooled glass condenser, a second sorbent cartridge containing Tenax and petroleum-based charcoal (3:1 by volume; approximately 1 g of each), a silica gel drying tube, a calibrated rotameter, a sampling pump, and a dry gas meter. The gas pressure during sampling and for leak-checking was monitored by pressure gauges which are in line and downstream of the silica gel drying tube. In this study, the Tenax/charcoal sorbent traps were augmented with a combination of modern carbon-based sorbent materials (Carbosieve, Supelco, Inc.). This approach enhanced collection and recovery of a variety of volatile organics from the flue gas streams.

Each VOST run consisted of three samples, each of which comprised a pair of traps in the VOST system. The three samples were taken over periods of 5, 10, and 30 minutes, at a flow rate of 0.5 L/min. Each VOST sample was run during the same time period as the SUMMA canister samples collected from the Method 23 train.

Impinger Sampling. Sampling for gaseous aldehydes, cyanide, and ammonia was conducted using a series of impingers downstream of a Method 26A type train operating at a single point (i.e., nontraversing) in the flue gas flow. The front half of the train consisted of a glass nozzle, glass heated probe, and a heated quartz fiber filter. The back half of the train was a separate set of impingers prepared for each of the analytes listed above, and changed out sequentially over the course of each sampling day at intervals corresponding to the appropriate sampling times.

The aldehyde samples were taken after the general provisions of EPA Methods 0011 and TO-5 and APHA Method 122 (Aldehydes in Ambient Air and Source Emissions). The samples were collected nonisokinetically, and the filter was not analyzed for aldehydes. The first impinger was an empty condensate collector, and the next two impingers contained an acidic 2,4-dinitrophenylhydrazine (DNPH) solution in which aldehydes in the sample are converted to form stable DNPH derivatives. These were followed by a silica gel impinger and a pump and metering box. The aldehyde samples were run for 1 hour at a flow rate of 1.0 L/min.

The sampling train used for ammonia and cyanide contained a filter to collect material for radionuclide and residual carbon analysis. Sampling was isokinetic at a single point. The cyanide samples were taken after the general provisions of APHA Method 808 (Determination of Cyanide in Air) with an impinger train, as those described above, but containing a dilute sodium hydroxide solution to collect gaseous cyanide and retain it in ionic form. The sampling time was about 1 hour.

The ammonia sample was also taken with an impinger train after the provisions of APHA Method 401. The train was similar to those described above, but contained a dilute sulfuric acid solution. Ammonia in the sample gas is converted and retained in the impinger solution as ammonium sulfate. The sampling time was about one-half hour.

The need for analysis of the filter in Method 26A for F^- and Cl^- dictated a large sample flow for that method. Replacing impingers for HF and HCl with those for ammonia, and cyanide readily adapted Method 26A to sampling those constituents as well, but required use of standard glassware and reagent volumes. Consequently, sampling for gaseous ammonia and cyanide employed full-size Method 5 glassware, with sample flow rates of 10-15 L/min. A single particulate filter was used throughout the sampling of ammonia and

cyanide in sequence, to maximize the particulate sample collected for radionuclide and residual carbon analysis.

HEST. The Hazardous Element Sampling Train (HEST) was used to determine volatile elements at the flue gas sampling locations. The HEST sampler consists of a filter pack with a stainless steel support screen, and three 47-mm filters. The air flow entering the HEST sampler first encountered a quartz filter for particle collection, followed by two charcoal-impregnated filters for collection of volatile elements (arsenic, mercury, selenium). The first impregnated filter is for collection of the volatile elements, and the second allows checking for breakthrough. Because only volatile elements are of interest, the HEST was used for nonisokinetic, single point sampling.

Particle Size Determination. Glass cyclones were used to separate particles by size in sampling with the Method 29 trains, as noted above and described in Section 5.11. Pilat Mark III Source Test cascade impactors were used to determine particle size distributions in both hot and dilute sampling at the FGD outlet (Locations 6a and 6b). The impactors had an inlet, seven impactor stages, and a back-up filter. All impaction stages and the filter were glass fiber mat. The impactor performs aerodynamic sizing by routing the sample through a series of bends of increasing sharpness and jets of diminishing diameter. As the gas passes through the impactor jets, aerosol particles, which due to inertia cannot follow the gas flow stream, land on glass fiber filters attached to back-up plates. The smaller particles remain in the gas stream, continuing on to the next stage. With each successive stage, the mean diameter of the particles decreases down to the final back-up filter, which screens out all remaining particulate. The actual aerodynamic cut size per stage depends on the velocities of the gas through the impactor.

Cascade impactors were used at the FGD outlet at Coal Creek, in both hot and dilute sampling modes.

A summary of the testing methodology follows:

1. Isokinetic sampling rates, nozzle size, and sampling times were calculated based on preliminary velocity, temperature, and moisture characteristics.

2. The units were assembled and sealed in a clean area, transported to the sampling location, attached to the sampling probe and train, and tested for leakage at 15 in. Hg vacuum.
3. The sampling head was then pointed downstream for a minimum of 10 minutes, to allow the assembly to warm to stack temperature. The assembly was then turned 180 degrees to begin sampling. The sampling consisted of a single point sample, collected isokinetically at a point of average flue velocity.
4. After the sample was collected, the sampling head was removed from the stack, disconnected from the sampling probe, sealed, and transported to a clean area for disassembly and sample recovery. Collection plate filters were removed stage by stage using tweezers and placed in separate, labelled petri dishes. The jet stages were examined and any blocked jets cleaned.
5. The petri dishes were sealed for transport to Chester's laboratory for gravimetric determinations. The sampling head was then reassembled for the next test.

Hot Versus Dilute Sampling. Sampling was conducted at the FGD outlet (Unit 1 stack) on both hot and diluted stack gases. Although the methods described above were used in both modes of sampling, substantial differences exist in the way the sampling was carried out. The following is a description of those sampling efforts.

The hot stack sampling was conducted using the four 4-in. ports arranged at 90 degree intervals around the circumference of the stack. Methods 29, 23, and 26A sampling were conducted isokinetically with traversing of stack diameters conducted for Methods 29 and 23.

Other gas sampling methods (HEST, VOST, aldehydes) were operated in nonisokinetic, single-point mode at the hot stack locations, since only volatile constituents are of interest.

All of the dilute gas samples at the FGD outlet were taken with Chester's plume simulating dilution sampler (PSDS). The flue gas sample was removed from the stack through a single port, without traversing (traversing is prohibited by the size and configuration of the PSDS and peripherals). After dilution, mixing and retention, particle samples were collected onto an 8 x 10 in. quartz filter for various chemical analyses, and into a cascade impactor for size distribution by mass. Gas phase samples were taken from a common gas sampling manifold following the 8 x 10 in. particle filtration.

The major components of the PSDS are the inlet nozzle, transfer tube, mixing and aging (dilution) chamber, and the various particle and gas phase sampling apparatus. All of the wetted surfaces in the sampler are stainless steel, Teflon, or Viton.

A conventional Method 5 buttonhook sampling nozzle was installed on the transfer tube to extract a hot flue gas sample isokinetically. The nozzle was sized on-site to match sample flow with stack gas velocity within the targeted range of diluent gas rate ($\sim 20\text{-}25$ scfm) and dilution ratio ($\sim 25\text{-}35:1$).

The sample entering the inlet nozzle passed through the transfer tube and the dilution chamber for dilution, aging, and collection, along with secondary particles formed in the dilution process. The transfer tube was maintained at stack temperature to prevent premature condensation. An S-type pitot tube and a thermocouple were installed on the transfer tube to monitor stack gas velocity and temperature. The flow rate through the transfer tube was established by the difference between the total stack pressure at the inlet nozzle and the static pressure in the dilution chamber. This pressure difference, monitored with a Magnehelic gauge installed between the upstream port of the pitot and the dilution chamber, is referred to as chamber pressure. The chamber pressure-flow relationship is established by calibration of the nozzle/transfer tube assembly as an integrated unit. The operating chamber pressure was determined on-site using this calibration with the appropriate temperature and pressure corrections for the actual stack conditions encountered.

The dilution chamber facilitates mixing of the flue gas with dilution gas, cooling, and aging of this mixture to simulate the dilution processes occurring in a plume, and distribution of the aged mixture to the various sampling devices. The chamber sections can be configured to affect variety of dilution, aging, and sampling schemes. The chamber flows were balanced by throttling the dilution gas (supplied under pressure) as required to establish the operating chamber pressure (for the specified flue gas flow rate through the transfer tube) while maintaining the necessary sampling device flow rates (withdrawn under vacuum).

The dilute gas conditions result from the mixing of the flue gas with the dilution gas, at a dilution ratio of 25:1 or more. Accordingly, the composition of the dilution gas is of controlling significance. The purpose of the dilution gas is to simulate atmospheric plume cooling and condensation, while minimizing artifact formation and without adding background contamination.

The targeted dilute sample gas conditions were near ambient temperatures and <30 percent relative humidity (RH), after 2 seconds residence time. These conditions were considered appropriate to provide adequate condensation and equilibration of analyte species and to minimize artifact formation due to acidic condensate on sample substrates. The residence time was achieved by configuring the dilution chamber. In order to achieve the temperature and relative humidity objectives, the dilution gas was delivered at ambient temperature and virtually bone dry, i.e., less than 5 ppm.

A cryogenically pure mixture of 20 percent oxygen/80 percent nitrogen (by volume) was used for the dilution gas. Because both component gases were of cryogenic origin, maximum dryness and organic background purity were achieved. The dilution gas was delivered pre-mixed to the test site in high volume (40,000 scf) compressed gas tube-trailers. A delivery manifold on the trailers provided pressure regulation (50-60 psig) and activated carbon filtration of the gas prior to delivery to the sampling location. The gas was delivered to the sampling location through a Teflon line to a control manifold connected to the inlet of the dilution chamber. The control manifold consists of a rate control valve, temperature and pressure instrumentation, and final HEPA filtration.

The dilution sampler was operated according to Chester's PSDS Standard Operating Procedure, as modified to accommodate the special requirements of this project. This document provided the calibration, calculation, and operating procedures to establish and maintain the required balance of sample and dilution flows. The appropriate operating points were established on-site, using a calculation spreadsheet and a portable computer. The spreadsheet contained calibration constants for all of the appropriate dilution sampler components (transfer tube/nozzle combinations, flow metering orifice) and accepted operator inputs for actual ambient, stack, and sampling parameters. At start-up, initial operating points were calculated using estimated default inputs. Over the course of each test, the spreadsheet was updated with actual operating conditions and the appropriate operating points maintained. The operating parameters were manually recorded at 15-minute intervals on special field data sheets which were designed for this project.

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2 of 5

Particle Sampling. Dilute particle samples were collected with an 8 x 10 in. high-purity quartz fiber filter and with a seven-stage source cascade impactor from two parallel circuits exiting the dilution chamber.

Because of the low concentrations after dilution (< 1 mg/dscm), particulate samples were collected for as long as the dilution sampler operated on any given sampling day. This was typically 8-10 hours, as required to complete the daily sampling schedules. Because of the combination of low concentration and low flow rate, the cascade impactor was operated for 2 consecutive days without changing substrates. This provided for three runs of 16 to 20-hour duration.

Gas Phase Sampling. All of the dilute gas phase samples were taken from a common gas sampling manifold installed downstream of the 8 x 10 in. filter between the metering orifice and the blower. Samples were taken for the same analyses as for the hot gas phase samples, with apparatus of essentially the same description, but using only the back-half of the respective train. The dilute sampling rates were higher than the hot sampling rates, to maximize the volumes of stack gas available within comparable simultaneous sampling times. Full-size impingers and metering systems were used.

SO₂ Measurements. Continuous monitoring of SO₂ was conducted during the daily sampling periods on June 22-24, 26, and 27 at the ESP outlet/FGD inlet (Location 5a). This monitoring was conducted using a non-dispersive infrared (NDIR) SO₂ monitor designed for source sampling (Horiba Model PIR-200). This monitor sampled directly from one of the ports at that location throughout the time period that other sampling was conducted at that location each day. The monitor sampled a flow of about 1 L/min of air through a Teflon inlet tube and filter. SO₂ data were recorded at about 30-minute intervals manually by sampling personnel at that location. The detection limit of this method is 1.0 ppm, more than adequate for monitoring the observed SO₂ level of about 800 ppm. Precision of the monitor was within about ± 5 percent based on daily calibrations with a 491 ppm SO₂ standard. Accuracy was also within 3 percent, as indicated by an independent RTI audit.

Process Stream Sampling. Process samples were collected by grab sampling from the various process locations using appropriate collection methods and containers. Since many of the solid process samples were collected hot, the safety of the personnel collecting samples was of primary importance. Battelle staff called upon Coal Creek staff for assistance as needed in any instance where safety was a concern.

Coal samples were collected by Coal Creek staff and composited on-site by ASTM methods. Pre-cleaned containers of appropriate sizes and materials were used by Battelle staff for collection of other solid samples (e.g., ESP ash, economizer ash, lime, etc).

Bottom ash samples were collected manually by grab sampling using a cleaned scoop. The collected samples were allowed to cool in stainless steel containers before being placed into glass containers.

Collection of liquid process samples differed from that of solid samples in that multiple samples of different sizes were collected in different containers for different purposes. Aliquots of each liquid sample were collected directly into 40 mL glass vials without headspace, for subsequent VOC analysis. In addition, separate glass bottles were used to collect aliquots for elements, ammonia, and cyanide. Each of these aliquots was treated appropriately for sample preservation, e.g., reduction of pH to < 2 to preserve NH_3 for analysis. Finally, a large (≈ 4 L) aliquot was collected in a glass bottle for SVOC and anion analyses.

C-5. Sample Storage and Recovery Procedures

Flue gas sampling trains were returned to the field laboratories after sampling for sample recovery by the Sample Recovery Leader. Sample recovery areas were off-limits to all but those staff involved in the actual preparation, recovery, and documentation of samples. Sample recovery was generally done after the completion of all sampling for the day, and after sampling staff had left the site. This further minimized interference in the sample recovery process. Sample recovery procedures were set out in single-sheet protocol forms, that detailed the train preparation and sample recovery steps for each train. These forms were distributed to sampling staff and were posted at each sample recovery area in the field laboratories. Copies of those forms are included at the end of this Appendix.

Samples recovered typically involved several portions or fractions of various types, or intended for various purposes. Samples were preserved and stored under conditions appropriate for the sample type. Table C-2 summarizes the preservation and storage conditions for various samples. Sample preservation consisted of adjustment of pH for liquid or impinger samples. Most samples were refrigerated in the Battelle field facility (4 C), or were stored at room temperature in shipping boxes ready for transfer to the analytical laboratory. The Modified Method 5 (Method 23) particulate filters were stored on dry ice in the field to maintain the -78 C temperature indicated.

Although as Table C-2 indicates holding times for the collected samples were quite long, in practice some samples were returned to the analytical laboratories immediately after collection by daily express shipment from the plant site. Those samples included liquid samples for anions, VOC, and SVOC, Summa canisters, VOST cartridges, and when space was available impinger samples from flue gas trains. Other samples were returned to Battelle with the field facilities at the end of the study. Chain-of-custody forms accompanied all samples at all times during storage on-site at Coal Creek, and during shipment. A Battelle staff member was designated to serve as Chain-of-Custody officer at Battelle for samples sent back or brought back from the field study. That staff member had complete control over access to samples at Battelle, and distributed samples to the appropriate analytical staff only after cross-checking of chain-of-custody forms.

C-6. Sampling QA/QC

Quality assurance activities in field sampling included collecting samples of all reagent and rinse solutions, including deionized water, for use as reagent blanks. Method blanks were also collected, by preparing a complete sampling train, exposing it to the normal handling and transport procedures used before and after sampling, and recovering the train without sampling of flue gas. This procedure exposes the train to potential sources of background contamination as in normal sampling. In addition, specific QC procedures specific to each of the sampling methods were used. Those specific procedures are described briefly below:

TABLE C-2. PRESERVATION AND STORAGE REQUIREMENTS

Sample	Analysis ^(a)	Preservation Requirements	Storage Conditions	Holding Time
Bulk Solid Samples	Elements, F-C-P	None	Room Temperature	30 days
	SVOC	None	Room Temperature	30 days
	U/P, RAD	None	Room Temperature	30 days
Liquid Samples	Dissolved trace elements	HNO ₃ to pH <2	Room Temperature	30 days
	Total trace elements	HNO ₃ to pH <2	Room Temperature	30 days
	Anions	None	4°C	14 days ^(c,d)
	VOC	No headspace	4°C	14 days ^(c)
	SVOC	None	4°C	14 days ^(b,c)
	CN	NaOH to pH >12	4°C	14 days
	NH ₄	H ₂ SO ₄ to pH <2	4°C	14 days
Method 29 Train Impinger Solutions Particulate Filter	Trace Elements	HNO ₃ to pH <2	4°C	30 days
	Trace Elements	None	Room Temperature	30 days
Method 23 Train XAD-2 Resin Particulate Filter	SVOC, PCDD/PCDF	None	4°C	28 days
	SVOC, PCDD/PCDF	None	-78°C	28 days
Summa Canister	VOC	None	Room Temperature	2 days ^(c)
Aldehyde Impinger Train	Aldehydes	None	4°C	28 days
HEST Samples	Hg, As, Se	None	4°C	6 months
Ammonia Train Impinger Solutions, Liquids	Ammonia	None	4°C	14 days
CN Train Impinger Solutions	CN	None	4°C	28 days
Method 26A Train Impinger Solutions	HF, HCl	None	4°C	28 days
Method 26A Train Filter	SO ₄ ²⁻ , PO ₄ ³⁻ , F ⁻ , Cl ⁻			
VOST Cartridges	VOC	None	4°C	14 days

(a) F-C-P = Fluoride, Chloride, Phosphate

SVOC = Semi-volatile Organics

VOC = Volatile Organics

RAD = Radionuclides

PCDD/PCDF = Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofuran.

UP = Ultimate/proximate coal analyses.

C = Carbon.

CN = Cyanide.

NH₄ = Ammonia.

(b) Extracted within 14 days, analysis within 40 days of extraction.

(c) Samples were returned to Battelle within 24 hours after collection in the field.

(d) Liquid samples were analyzed as soon as possible for phosphate to minimize degradation of this analyte in these samples.

QC Checks for Velocity/Volumetric Flowrate Determination. Prior to flue gas sampling, volumetric gas flow rate data were collected at the flue gas sampling locations and at the flue gas desulfurization (FGD) bypass duct on Unit 1, using the procedures specified in EPA Method 2. Quality control procedures were as follows:

- Visually inspect the S-type pitot tube or standard pitot tube before and after sampling.
- Leak-check both legs of the pitot tube before and after sampling.
- Check the number and location of the sampling traverse points before taking measurements.
- Clean and check inlet tubes periodically and clear ash from impact side of pitot tube as necessary.

Quality Control Procedures for Moisture Determination. The moisture content of the gas streams was determined using the technique specified in EPA Method 4. However, the actual moisture sampling was conducted as part of Methods 23, Method 5, and Method 29 sampling procedures at the flue gas locations. The following internal QC checks were performed as part of the moisture determinations:

- The volume of impinger contents was measured by weighing to the nearest gram before and after sampling.
- The sampling train (including impingers) was leak-checked before and after each run.
- Ice was maintained in the ice bath throughout each run.
- The volume of water in the collection bottle, into which water from the first impinger was periodically drained, was measured by weighing to the nearest gram.

Quality Control Procedures for Flue Gas Sampling Methods. The following pretest QC checks were conducted for all flue gas sampling methods:

- All sampling equipment was thoroughly checked to ensure clean and operable components.

- Equipment was inspected for possible damage from shipment.
- The oil manometer or Magnehelic gauge used to measure pressure across the pitot tube was levelled and zeroed.
- The pitot tubes and connecting tubing were leak checked
- The temperature measurement system was visually checked for damage and operability by measuring the ambient temperature prior to each traverse.

In addition to the general QC procedures listed above, QC procedures specific to each sampling method were also incorporated into the sampling scheme. These method-specific procedures are discussed below.

Quality Control Procedures for Method 29. EPA Method 29 was used to sample for vapor phase and particulate elements. The following quality control procedures were followed:

Prior to Start of All Testing

- The trains were assembled in an environment free from uncontrolled dust.
- Each sampling train was visually inspected for proper assembly.
- All cleaned glassware was kept closed with tightly closed ground glass caps or Teflon tape.
- All filters were stored in a precleaned glass petri dish sealed with Teflon tape.
- Pretest calculations were performed to determine the proper sampling nozzle size.

Prior to Testing Each Day

- The number and location of the sampling points were checked before taking measurements.
- The sampling nozzle was visually inspected.

- Each leg of the pitot tube was leak-checked.
- The entire sampling train was leak-checked.

During Testing Each Day

- The roll and pitch axis of the pitot and the sampling nozzle were properly maintained.
- The train was leak-checked before and after a run, if the train was opened for any reason, and if a filter change took place.
- Additional leak-checks were conducted if a leak exceeded 4 percent of the sampling rate, and efforts were made to improve the leak tightness of the train.
- The filter was maintained at the proper temperature.
- Ice was kept in the ice bath at all times.
- Proper readings of the dry gas meter, delta P and delta H, temperature, and pump vacuum were made during sampling at each traverse point. Copies of the field operator data sheets are shown in Appendix D.
- Isokinetic sampling was maintained within about 15 percent.
- Sample train and field blanks were collected for analysis and maintained at approximately 4°C.

After Testing Each Day

- The final meter reading was recorded.
- Completeness of the data sheet was checked.
- A final leak-check of the sampling train was done at the maximum vacuum observed during the test.
- Each leg of pitot tubes was leak-checked.
- Recovered train following prescribed procedures.

Quality Control Procedures for Method 23 (Modified Method 5, with Summa Canisters).

Prior to Start of All Testing

- The Method 23 trains were assembled in an environment free from uncontrolled dust.
- Each sampling train was visually inspected for proper assembly.
- All quartz filters to be used were muffled and cleaned XAD was prepared.
- Openings of all cleaned glassware and prepared sorbent traps were closed with ground glass caps or precleaned foil until train assembly.
- All filters were stored in a precleaned glass petri dish sealed with Teflon tape, and enclosed in aluminum foil.
- Pretest calculations were done to determine the proper sampling nozzle size.

Prior to Testing Each Day

- The number and location of the sampling points were checked before taking measurements.
- The sampling nozzle was visually inspected.
- Each leg of the pitot tube was leak-checked.
- The entire sampling train was leak-checked.
- The Summa canisters were checked for proper vacuum.

During Testing Each Day

- The roll and pitch axis of the pitot and the sampling nozzle were properly maintained.
- The train was leak-checked before and after the run, if the train was opened, and if a filter change took place.

- Additional leak-checks were conducted if the leak exceeded 4 percent of the sampling rate, and steps were taken to improve the leak tightness of the train.
- The filter and sorbent trap were maintained at the proper temperatures.
- Ice was kept in the ice bath at all times.
- Proper readings of the dry gas meter, delta P and delta H, temperature, and pump vacuum were made during sampling at each traverse point. Copies of the field data sheets are included in Appendix D.
- Isokinetic sampling was maintained within 15 percent.
- Sample train and field blanks were collected for PAH and dioxin/furan.
- Canister pressure was monitored by means of a pressure gauge throughout filling of the canister.

After Testing Each Day

- Final meter reading was recorded.
- Completeness of data sheet was checked.
- Final leak-check of sampling train at maximum vacuum during test was done.
- Final canister pressure was recorded, and the canister tightly closed.
- Each leg of pitot tubes was leak-checked.
- The probe rinses and remaining train were recovered following prescribed procedures.
- Nozzle and cap were reattached for next day and the train was stored in a dry, safe place.

Quality Control Procedures for Method 26A (Impinger Sampling Methods (Cyanide, Acid Gases, Aldehydes, Ammonia)). Impinger-based sampling procedures were used for sampling aldehydes and inorganic compounds. These methods were conducted at

single points in the flue gas stream, isokinetically except for the aldehyde sampling. The following general quality control procedures applicable to all these methods were followed:

Prior to Start of All Testing

- The trains were assembled in an environment free from uncontrolled dust.
- Each sampling train was visually inspected for proper assembly.

Prior to Testing Each Day

- Fresh impinger and rinse solutions were prepared.
- The sampling nozzle was visually inspected.
- The entire sampling train was leak-checked.

During Testing Each Day

- The filter was maintained at the proper temperature.
- Ice was maintained in the ice bath at all times.
- Proper readings of the dry gas meter, delta P and delta H, temperature, and pump vacuum during sampling at each traverse point were made. Sampling data sheets for these methods are included in Appendix D.
- Sample train and field blanks were collected for analysis.

After Testing Each Day

- Final readings were recorded.
- Completeness of data sheet was checked.
- Final leak-check of sampling train at maximum vacuum during test was done.
- Impinger solutions and rinses were recovered according to prescribed procedures.

Quality Control Procedures for VOST. Sampling for volatile organics was

Prior to Start of All Testing

- VOST glassware was cleaned and assembled.
- The entire unit was assembled, visually inspected, leak tested, and its operation was checked.
- All VOST traps were cleaned, sealed, and labelled.

Prior to Testing Each Day

- VOST sorbent traps were kept sealed and stored in a refrigerator at 4°C.
- The VOST unit was assembled, minimizing the amount of time that the sorbent trap was open to air.
- A visual inspection was made and a leak test was made.

During Testing

- Flow rate was monitored.
- Operation of probe heater was monitored.
- Flow of ice water to condenser was maintained.
- Sampling time was watched closely, so the sampling interval was not overrun.

After Testing

- Final leak-check was performed.
- Sorbent traps were sealed immediately upon disassembly of the unit, and stored at 4°C until shipment for analysis.
- The VOST was prepared for its next use.

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IT RATE _____	
ARTICULATE COLLECTED, mg	
FILTER	PROBE WASH
TOTAL _____	

BE FR	ATURE AS ING ER OR PINGER FILE	PUMP VACUUM in. Hg gauge	4112 OUTLET VELOCITY 41
#70	7	47	49
268	8 1/2	10	47
266	6	10	48
	11	11	47
	9	11	47
	10	9	15

check
22 w/o probe-
13 with probe-

Quality Control Procedures for HEST Sampler. Volatile elements in flue gas were determined by means of a HEST sampler, that used carbon impregnated (CI) filters for collection of the metals. Field QC procedures for the HEST were as follows:

Prior to All Testing

- Lab ID numbers were recorded on the petri dishes in which the quartz and carbon impregnated (CI) filters are supplied.
- A clean table area for loading of the HEST filters was prepared.

Prior to Testing Each Day

- The positions of the one quartz and two CI filters in series were recorded as they were loaded into the HEST head, and recorded on the sample data sheet with the corresponding lab ID numbers.
- Both sides of each filter were examined to assure the proper side faced the air flow.
- Teflon-coated tweezers were used in loading the filters.
- The HEST filter assembly was visually inspected during and after assembly.
- Both ends of the assembly were sealed, and the entire assembly was then sealed in a clean plastic bag.

During Testing

- The system was leak tested after attachment of the HEST head to the probe.
- Condensate was not allowed to backwash into the HEST head.
- When inserting the HEST into the duct, care was taken to avoid scraping the head on the port.
- A proper seal was confirmed between the probe and port.
- Flow rate, sample time, and normal Method 5 sampling parameters were recorded.

After Testing

- When the head was removed from the duct, care was taken to avoid scraping the head on the port.
- Final leak test was performed.
- HEST head was kept vertical while the system was disassembled.
- The HEST head was sealed, allowed to cool, and the entire head was then sealed into a plastic bag.
- Filters were kept flat with deposit side up while disassembling the HEST head.
- Filters were placed flat with deposit side up in labelled petri dishes.
- Petri dishes were stored flat.
- Probe and filter chamber were rinsed with acetone and 0.1N HNO₃, and combined washes in a labelled sample jar.

Quality Control Procedures for Particle Size Distributions. At designated sampling locations, particle size distributions in flue gas were determined by cyclone or impactor sampling. The cyclones were incorporated in the Method 29 and Method 23 trains covered above, and used at Locations 4a and 5a. The following are QC procedures applicable to impactor sampling, which was conducted at Locations 6a and 6b.

Prior to Start of All Testing

- All impactor stage filters were preweighed.
- The impactors were assembled in an environment free from uncontrolled dust.
- Each unit was visually inspected for proper assembly.
- Labelled petri dishes were prepared for storage of impactor after sampling.
- Pretest calculations were performed to determine the proper sampling nozzle size.

Prior to Testing Each Day

- The sampling nozzle was visually inspected.
- The entire sampling train was leak-checked.

During Testing Each Day

- The impactor was allowed to warm to flue gas temperature before sampling.
- Isokinetic sampling was maintained within 10 percent.

After Testing Each Day

- Final leak-check of unit was done at maximum vacuum during test.
- Impactor was recovered following prescribed procedures.
- The impactor head was removed from the sampling probe, and sealed for transport to a clean disassembly area.
- Impactor filters were placed in pre-labelled dishes, and the impactor was cleaned for the next run.

Quality Control Procedures for Process Sample Collection. The process sampling quality control included the following procedures:

- The sampling equipment was cleaned and proper sample containers were used.
- Proper scheduling of sampling times was based on consultation with Coal Creek staff.
- Immediate labelling of all samples was done at the time of collection.
- Observations were recorded on preformatted data sheets.
- Log-in and chain-of-custody procedures began as soon as samples were returned to the field laboratory.

Quality Control Procedures for Continuous SO₂ Measurements. Quality control procedures for SO₂ measurements included activities conducted both in the laboratory before the field study and in the field. Activities in the laboratory included full checkout of the instrument and sampling lines, and initial calibration of the SO₂ monitor. For the laboratory tests a compressed gas standard of 491 ppm SO₂ was used.

In the field, daily QA/QC activities included visual inspection of the monitor and sampling line, review of the instrument's built-in diagnostic indicators, and twice daily checks of the instrument zero reading using ambient air as a zero gas, and calibration with an SO₂ standard. The calibration data and SO₂ measurement data are reported in Section 3.3.3 of this report, and indicate precision within about ± 5 percent. Accuracy of the SO₂ measurement was found to be within about 3 percent in an independent audit by RTI, as described in Appendix B.

METHOD 29 - MULTIPLE METALS

NOTE - INITIALLY, THIS GLASSWARE NEEDS TO BE SOAKED IN 10% HNO₃ FOR 4 HOURS IN A PLASTIC TUB, THEN RINSED 3X WITH DI H₂O BEFORE ASSEMBLING IMPINGER TRAINS

REAGENT PREPARATION

CYCLONES	FILTER	GLASSWARE RINSE SOLUTION	ACIDIFIED PEROXIDE IMPINGERS 2 AND 3 MAKE FRESH DAILY	10% H ₂ SO ₄	ACIDIFIED 4% KMNO ₄ IMPINGERS 5 AND 6 MAKE FRESH DAILY	SILICA GEL, INDICATING 3 - 8 MESH NONE
NONE	NONE	900ML DI H ₂ O 6.3ML CONC. HNO ₃ DIL TO 1000ML IN VOLUMETRIC WITH DI H ₂ O	500ML DI H ₂ O IN 1000ML VOLUMETRIC ADD 50ML CONC. ULTRAPURE HNO ₃ ADD 333ML 30% H ₂ O ₂ DILUTE TO VOLUME WITH DI H ₂ O	500ML DI H ₂ O IN 1000ML VOL. FLASK ADD 100ML CONC. H ₂ SO ₄ DILUTE TO VOLUME WITH DI H ₂ O	900ML 10% H ₂ SO ₄ IN 1000ML VOL. FLASK ADD 40GM. KMNO ₄ , DISSOLVE DILUTE TO VOL. WITH 10% H ₂ SO ₄	RINSE FOR #5 & #6 IMPINGER (8N HCL - 90ML DI H ₂ O IN 250ML VOL., ADD TO VOLUME WITH CONC HCL WITH COOLING)

IMPINGER TRAIN ASSEMBLY

CYCLONES (2)	FILTER	#1	#2	#3	#4	#5	#6	#7
		DI H ₂ O TO COVER INLET TUBE (WEIGH) (RECORD)	150ML ACIDIFIED PEROXIDE SOLUTION (WEIGH) (RECORD)	150ML ACIDIFIED PEROXIDE SOLUTION (WEIGH) (RECORD)	EMPTY (WEIGH) (RECORD)	100ML ACIDIFIED KMNO ₄ SOLUTION (WEIGH) (RECORD)	100ML ACIDIFIED KMNO ₄ SOLUTION (WEIGH) (RECORD)	200-300 GM SILICA GEL (WEIGH) (RECORD)

SAMPLE RECOVERY PROCEDURES

CYCLONES	FILTER	FRONT HALF OF FILTER HOUSING	PROBE LINER, NOZZLE AND SAMPLE LINE	FILTER SUPPORT AND BACK HALF OF HOUSING	IMPINGER #1	IMPINGER #2 & #3 (ACIDIFIED PEROXIDE)
EMPTY CONTENTS OF EACH INTO SEPARATE JARS AND SEAL WITH TEFLON TAPE	REMOVE FROM SUPPORT WITH TEFLON-COATED TWEEZERS AND PLACE IN PETRI DISH BRUSH LOOSE PARTICULATE ONTO FILTER WITH NON-METALLIC BRUSH AND SEAL PETRI DISH WITH TEFLON TAPE	BRUSH WITH NON-METALLIC BRUSH AND RINSE WITH ACETONE COMBINE ACETONE RINSES AND LABEL THEN RINSE 3X WITH 0.1N HNO ₃ AND SAVE	RINSE WITH ACETONE BRUSH WITH NON-METALLIC BRUSH AND RINSE WITH ACETONE INSPECT LINER TO INSURE ALL PARTICULATE REMOVED IF NOT, REPEAT BRUSH/RINSE COMBINE WITH ACETONE RINSE FROM FRONT HALF OF HOUSING THEN RINSE 3X WITH 0.1N HNO ₃ AND SAVE WITH FRONT HALF HNO ₃ RINSES	RINSE 3X WITH 0.1N HNO ₃ AND SAVE	WEIGH AND RECORD SAVE AND LABEL RINSE 3X WITH 0.1N HNO ₃ AND COMBINE WITH FILTER SUPPORT RINSE	WEIGH AND RECORD COMBINE AND SAVE RINSE 3X WITH 0.1N HNO ₃ AND COMBINE WITH FILTER SUPPORT RINSE AND RINSE OF IMPINGER #1
IMPINGER #4	IMPINGER #5 & #6 (ACIDIFIED KMNO ₄)	IMPINGER #7 (SILICA GEL)				
WEIGH AND RECORD SAVE AND LABEL RINSE WITH 100ML 0.1N HNO ₃ AND ADD TO SAMPLE BOTTLE	WEIGH AND RECORD COMBINE AND SAVE RINSE 3X WITH ACIDIFIED PERMANGANATE REAGENT THEN WITH DI H ₂ O ADD TO IMPINGER SAMPLE BOTTLE RINSE WITH 25ML 8N HCL AND SAVE SEPARATELY	WEIGH AND RECORD DISCARD				

METHOD 23/ MODIFIED METHOD 5**PAH, DIOXINS/FURANS, SVOC****IMPINGER ASSEMBLY**

CYCLONES (2)	FILTER	XAD/CONDENSER	SUMMA	IMPINGER #1	IMPINGERS #2 & #3	IMPINGER #4	IMPINGER #5
				DI H2O TO COVER INLET TUBE WEIGH AND RECORD	100ML DI H2O WEIGH AND RECORD	EMPTY	FILL 1/2 FULL WITH 3-8 MESH INDICATING SILICA GEL WEIGH AND RECORD

SAMPLE RECOVERY

CYCLONES (2)	FILTER	XAD/CONDENSER	SUMMA	IMPINGER #1	IMPINGERS #2 & #3	IMPINGER #4	IMPINGER #5
POUR INTO SEPARATE CONTAINERS AND LABEL	WEAR COTTON GLOVES REMOVE FROM HOLDER WITH TEFLON-COATED TWEEZERS AND PLACE IN PETRI DISH. BRUSH PARTICULATE ONTO FILTER AND SEAL DISH WITH TEFLON TAPE	CAP BOTH ENDS, WRAP IN ALUMINUM FOIL AND STORE AT 4C. CHESTER'S XAD TRAP WRAP ENDS WITH MUFFLED AL FOIL AND PLACE IN GLASS JAR. PACK WELL WITH MORE AL FOIL SEAL WITH TEFLON TAPE PROBE (SAMPLING PERSONNEL) RINSE WITH 50/50 MEOH/CH2CL2 SAVE AND TRANSPORT TO SAMPLE RECOVERY WITH XAD CARTRIDGE AND FILTER	CLOSE VALVE STORE @ AMBIENT	WEIGH AND RECORD SAVE AND LABEL RINSE WITH 50/50 MEOH/CH2CL2 AND ADD TO SAMPLE	WEIGH AND RECORD DISCARD RINSE WITH 50/50 MEOH/CH2CL2	WEIGH AND RECORD DISCARD RINSE WITH 50/50 MEOH/CH2CL2	WEIGH AND RECORD DISCARD INTO PLASTIC BAG FOR RECYCLING

METHOD 26A - ACID GASES, AMMONIA, AND CYANIDE

REAGENT PREPARATION

CO₃/HCO₃ SOLUTION

SUPPLIED AS A CONCENTRATE
DILUTE 1/200 WITH DI H₂O

0.1N H₂SO₄

500ML DI H₂O
IN 1000ML VOL.
FLASK
ADD 5GM CONC.
H₂SO₄
DILUTE TO VOLUME
WITH DI H₂O

0.1M NAOH

500ML DI H₂O
IN 1000ML VOL.
FLASK
ADD 4GM NAOH
DILUTE TO VOLUME
WITH DI H₂O

IMPINGER ASSEMBLY - ACID GASES

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CYCLONE

(ESP INLET
ONLY)

FILTER

IMPINGER #1

DI H₂O TO
COVER
INLET TUBE
WEIGH AND RECORD

IMPINGERS #2 & #3

100ML CO₃/HC0₃
IN EACH
WEIGH AND RECORD

IMPINGER #4

200-300GM
3-8 MESH
INDICATING
SILICA GEL
WEIGH AND RECORD

SAMPLE RECOVERY - ACID GASES

CYCLONE

EMPTY AND
SAVE

FILTER

REMOVE FROM
HOLDER WITH
TEFLON-COATED
TWEEZERS
AND PLACE IN
PETRI DISH
SEAL WITH
TEFLON TAPE

IMPINGER #1

WEIGH AND RECORD
POUR INTO
SAMPLE BOTTLE.
RINSE WITH
DI H₂O AND ADD
TO SAMPLE

IMPINGERS #2 & #3

WEIGH AND RECORD
POUR INTO
SAMPLE BOTTLE
RINSE WITH
CO₃/HCO₃ SOLUTION
ADD TO SAMPLE

IMPINGER #4

WEIGH AND RECORD
DISCARD IN PLASTIC
BAG FOR RECYCLING

**METHOD 26A - ACID GASES, AMMONIA, AND CYANIDE
IMPINGER ASSEMBLY - AMMONIA**

CYCLONE	FILTER	IMPINGER #1	IMPINGERS #2 & #3	IMPINGER #4
(ESP INLET ONLY)		DI H2O TO COVER INLET TUBE WEIGH AND RECORD	100ML 0.1N H2SO4 IN EACH WEIGH AND RECORD	200-300GM 3-8 MESH INDICATING SILICA GEL WEIGH AND RECORD

SAMPLE RECOVERY - AMMONIA

CYCLONE	FILTER	IMPINGER #1	IMPINGERS #2 & #3	IMPINGER #4
EMPTY AND SAVE	LEAVE IN PLACE FOR NEXT RUN	WEIGH AND RECORD POUR INTO SAMPLE BOTTLE RINSE WITH DI H2O AND ADD TO SAMPLE	WEIGH AND RECORD POUR INTO SAMPLE BOTTLE RINSE WITH 0.1N H2SO4 SOLUTION ADD TO SAMPLE CHECK pH < 2	WEIGH AND RECORD DISCARD IN PLASTIC BAG FOR RECYCLING

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METHOD 26A - ACID GASES, AMMONIA, AND CYANIDE
IMPINGER ASSEMBLY - CYANIDE

CYCLONE	FILTER	IMPINGER #1	IMPINGERS #2 & #3	IMPINGER #4
(ESP INLET ONLY)	SAME FROM PRECEDING RUN	DI H2O TO COVER INLET TUBE WEIGH AND RECORD	100ML 0.1M NAOH IN EACH WEIGH AND RECORD	200-300GM 3-8 MESH INDICATING SILICA GEL WEIGH AND RECORD

SAMPLE RECOVERY - CYANIDE

CYCLONE	FILTER	IMPINGER #1	IMPINGERS #2 & #3	IMPINGER #4
EMPTY AND SAVE	REMOVE FROM HOLDER WITH TEFLON-COATED TWEEZERS AND PLACE IN PETRI DISH BRUSH PARTICULATE ONTO FILTER AND SEAL WITH TEFLON TAPE	WEIGH AND RECORD POUR INTO SAMPLE BOTTLE RINSE WITH DI H2O AND ADD TO SAMPLE	WEIGH AND RECORD POUR INTO SAMPLE BOTTLE RINSE WITH 0.1M NAOH SOLUTION ADD TO SAMPLE CHECK pH > 10	WEIGH AND RECORD DISCARD IN PLASTIC BAG FOR RECYCLING

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MODIFIED METHOD 0011 - FORMALDEHYDE

REAGENT PREPARATION

ACIDIFIED DNPH (DINITRO PHENYL HYDRAZINE) REAGENT
EMPTY PREWEIGHED ALIQUOT OF PURIFIED DNPH
INTO 1000ML BOTTLE OF ACETONITILE, ADD 0 200 ML CONC. H2SO4
STORE UNUSED PORTION AT 4C UNTIL NEEDED

IMPINGER ASSEMBLY

(NOTE - THIS METHOD USES MINI IMPINGERS)

CYCLONES	FILTER	IMPINGER #1	IMPINGER #2 & #3	IMPINGER #4
NONE		DI H2O TO COVER INLET TUBE WEIGH AND RECORD	20ML ACIDIFIED DNPH REAGENT WEIGH AND RECORD	SILICA GEL, 3-8 MESH, INDICATING WEIGH AND RECORD

SAMPLE RECOVERY

FILTER	IMPINGER #1	IMPINGER #2 & #3	IMPINGER #4
REMOVE AND DISCARD	WEIGH AND RECORD POUR INTO SAMPLE BOTTLE RINSE WITH DI H2O AND ADD TO SAMPLE	WEIGH AND RECORD POUR INTO ONE SAMPLE BOTTLE RINSE WITH ACN (ACETONITRILE) AND ADD TO SAMPLE	WEIGH AND RECORD DISCARD INTO PLASTIC BAG FOR RECYCLING

COLLECTED, mg	PROBE WASH	Cfm, _____	INP CUUM Hg uge	VELOCITY fps															
					0	0	0	1.5	1.5	1.0	1.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0	6.0

[REDACTED]

APPENDIX D

FIELD SAMPLING DATA SHEETS

In this Appendix, copies are provided of the original field sampling data sheets and calculation results from the Coal Creek field study. These sheets show the data recorded by the Battelle and Chester staff in conducting the flue gas measurements. The data sheets are organized in the following order:

- D-1: Modified Method 5
- D-2: Multi-Metals
- D-3: Method 5 Particulate
- D-4: Anions Train
- D-5: Ammonia Train
- D-6: Cyanide Train
- D-7: Aldehyde Train
- D-8: VOST Train
- D-9: HEST Samples
- D-10: Cascade Impactors
- D-11: Flue Gas Sampling Calculation Spreadsheets.

Within Sections D-1 to D-10, the data sheets are presented in order by site and date. For example, in Section D-1, data sheets from sites 4a, 5a, and 6a on June 21 are provided, followed by those from sites 4a, 5a, and 6a on June 23, etc.

Section D-11 shows the results of calculations based on the isokinetic, traversing sampling runs on flue gas. Flue gas characteristics as well as derived quantities such as isokinetic rate, flue gas volume flows, etc, are shown. Section D-11 presents the results for Locations 4a, 4b, 5a, 5b, and 6a.

D-1; Modified Method 5

PARTICULATE YIELD DATA

PLANT Coal Creek N.D. AMBIENT TEMPERATURE 100
 DATE 6-21-93 BAROMETRIC PRESSURE 27.48
 LOCATION ESP IN 4A ASSUMED MOISTURE, % 18
 OPERATOR Webb/Bennett PROBE LENGTH, in. 156
 STACK NO. 1 NOZZLE DIAMETER, in. 2.05
 RUN NO. 1 C-42-MM5-626 STACK DIAMETER, in. 230
 SAMPLE BOX NO. 23 PROBE HEATER SETTING 250
 METER BOX NO. X40873 HEATER BOX SETTING 250

METER ΔH_0 1.64

C FACTOR 0.7

PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg			
SAMPLE	FILTER	PROBE WASH	
FINAL WEIGHT			
TARE WEIGHT			
WEIGHT GAIN			
TOTAL			

SCHEMATIC OF STACK

CROSS SECTION

RAVERSE POINT NUMBER	SAMPLING TIME (s), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (in. H ₂ O)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	PROPERTY
					ACTUAL	DESIRED		INLET (T _{m,i}), °F	OUTLET (T _{m,o}), °F				
1	5.1	-16	243	0.8	1.1	1.1	601.23	116	115	246	243	7	47
2	10.1		306	1.2	1.1	1.1	609.8	117	116	245	248	8/12	49
3	15.1		300	1.6	1.5	1.5	607.2					10	
4	20.1		302	1.5	1.5	1.5	611.6	118	115			11	47
1	5		start	0.5	1.48		605.1			247	246	6	48
2	10	2:01	316	1.5	1.4		618.2	117	116			10	
3	15	2:06		1.5	1.4		621.2	117	116	248		11	47
4	20	2:09	311	1.4	1.3		624.7					9	
1	5		292	1.1	1.0		628.6			37.02/43.02?		9	
2	10	2:22		1.2	1.1		632.0	115	114			10	
3	15	2:30		0.9	1.05		635.4					9	
4	2.2	2:35	STOP	2.5	2.3		638.5					15	
TOTAL													
AVERAGE													

COMMENTS: LEAK check
 .01 at 22 w/o probe
 .01 at 13 with probe

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml				SILICA GEL WEIGHT, g				ORSAT MEASUREMENT				TIME				CO ₂				O ₂				CO				N ₂			
1		2		3		4		1		2		3		4		1		2		3		4		1		2		3		4			
FINAL																																	
INITIAL																																	
LIQUID COLLECTED																																	
TOTAL VOLUME COLLECTED																																	

PARTICULATE YIELD DATA

PLANT Coal Creek N.D. AMBIENT TEMPERATURE 105
 DATE 6-21-93 BAROMETRIC PRESSURE 27.48
 LOCATION APP INlet ASSUMED MOISTURE, % 18
 OPERATOR Webb/Barnett PROBE LENGTH, in. 13' 13 1/2"
 STACK NO. 1 C-4a-MM5-621 NOZZLE DIAMETER, in. 0.205
 RUN NO. 1 STACK DIAMETER, in. 18
 SAMPLE BOX NO. X-40573 PROBE HEATER SETTING 250 F
 METER BOX NO. X-40573 HEATER BOX SETTING 250 F

METER ΔH_p 1.64
 C FACTOR 0.7
 PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (AP _s) (√AP _s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER #2 F #10	PUMP VACUUM in. Hg gauge	VELOCITY /ps
					ACTUAL DESIRED		INLET (T _{m IN}), °F	OUTLET (T _{m OUT}), °F				
1	5	2.45	297	0.5	0.48	641.6	115	115	231	244/263	9	
2	10		315	1.0	0.98	644.1				240/264	13	46.5
3	15	2.48	327	1.0	0.98	647.1						
4	20		319	0.5	0.48	650.1	115	114	251		10	
1	5	3.05	318	0.5	0.48	652.4					9	
2	10		336	1.1	1.0	654.8	115	113	251	242/267	12 1/2	41.5
3	15	3.15	344	1.4	1.3	658.1					15	
4	20		334	0.85	0.8	661.6	115	113	251		14	
1	5	3.28	347	1.0	0.98	664.4					14 1/2	
2	10		353	1.6	1.5	667.9	115	114			18	49
3	15	3.37	349	1.3	1.2	671.5					16	
4	20	3.44	337	0.9	0.85	674.9	115	114	252	241/265		
TOTAL						677.4						

AVERAGE

3:48

VOLUME OF LIQUID WATER COLLECTED	1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					

IMPINGER VOLUME ml

SILICA GEL WEIGHT, g

ORSAT MEASUREMENT

TIME	CO ₂	O ₂	CO	N ₂
1				
2				
3				

Stop Change filter

COMMENTS:

Leak Check after filter change or at 18" H₂O

D-4

PARTICULATE FIELD DATA

PLANT Coal Creek NO AMBIENT TEMPERATURE 100
 DATE 6-21-93 BAROMETRIC PRESSURE 29.48
 LOCATION ESC IN ASSUMED MOISTURE, % 18
 OPERATOR Webb/Bennett PROBE LENGTH, in. 152
 STACK NO. 4 NOZZLE DIAMETER, in. 0.205
 RUN NO. 1 C-4a-M115-621 STACK DIAMETER, in.
 SAMPLE BOX NO. PROBE HEATER SETTING 250 F
 METER BOX NO. X 40573 HEATER BOX SETTING 250 F

METER ΔH_p 1.64
 C FACTOR 0.7

PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

CROSS SECTION			METER BOX NO.			HEATER BOX NO.		6		7		3		Probe		PUMP		xAD2	
TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Approx Time	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (√VP _s)		PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER #2 °F		in. Hg gauge	VELOCITY lps				
				ACTUAL	DESIRED	INLET (T _{m,IN}), °F	OUTLET (T _{m,OUT}), °F		#2	#70									
			4																
				0.7	0.68			671.7											
1	5	4:54	359	0.7	0.68														
2	10		360	1.4	1.3	1.3		682.8	117	116	251	241	270	9					
3	15	5:04	348	1.8		1.3		684.7						10					
4	20		340	1.9		1.3		688.6						11					
			STOP																
1	5			0.25		0.3													
2	10		398	0.8		0.85		693.7											
3	15		342	1.2		1.1		695.2	117	116	252								
4		STOP	can't get last point																
1	5	7:00	357	0.25		0.22		699.2	116	116									
2	10		367	1.0		0.98		701.2											
3	15	7:11		1.4		1.3		704.0	118	116	243								
4	20		373	0.85		0.80		708.0											
TOTAL																			

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
	1	2	3	4							
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					
TOTAL VOLUME COLLECTED						4					

COMMENTS:

PARTICULATE 'ELD DATA

PLANT Coke Break N.D. AMBIENT TEMPERATURE 100
 DATE 6-21-93 BAROMETRIC PRESSURE 27.48
 LOCATION ESD IN ASSUMED MOISTURE, % 18
 OPERATOR Webb/Bennett PROBE LENGTH, in. 180
 STACK NO. 1 NOZZLE DIAMETER, in. 0.205
 RUN NO. 1 C-42-MMS-623 STACK DIAMETER, in. 29F
 SAMPLE BOX NO. - PROBE HEATER SETTING 230F
 METER BOX NO. X-40517 HEATER BOX SETTING 230F

METER ΔH_p 1.64
 C FACTOR 0.7
 PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg			
SAMPLE	FILTER	PROBE	WASH
FINAL WEIGHT			
TARE WEIGHT			
WEIGHT GAIN			
TOTAL			

SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (e), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{V/P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O) ACTUAL DESIRED	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY f/s
							INLET (T _{m,i}), °F	OUTLET (T _{m,out}), °F				
1	5	7:30	366	0.5	1.8	710.0	117	116	243	239	11 1/2	53
2	10	7:35	368	1.4	1.3	712.7	117	116			15 1/2	53
3	15	7:40	372	1.6	1.4	716.9						
4	20					720.2						
1	5	7:45	374	0.5	1.8	725.2	116	116	242	239	7 1/2	54
2	10	7:50	379	1.5	1.4	726.0						
3	15	7:55	387	1.4	1.3	729.9	117	115				
4	20											
1	5	8:12	376	0.8	1.5	735.7	115	116	237	237	9	51
2	10	8:22	378	1.1	1.6	745.2					15	
3	15		383	1.6	1.3							
4	20		383	0.3	1.7							
TOTAL												

AVERAGE

COMMENTS:

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml				ORSAT MEASUREMENT				TIME				CO ₂ O ₂ CO N ₂			
1		1	2	3	4	1	2	3		1	2	3					
FINAL																	
INITIAL																	
LIQUID COLLECTED																	

PARTICULATE 'ELD DATA

PLANT _____ AMBIENT TEMPERATURE _____ METER ΔH_p _____
 DATE _____ BAROMETRIC PRESSURE _____ C FACTOR _____
 LOCATION _____ ASSUMED MOISTURE, % _____ PROCESS WEIGHT RATE _____
 OPERATOR _____ PROBE LENGTH, in. _____
 STACK NO. _____ NOZZLE DIAMETER, in. _____
 RUN NO. 1 C-4a-MM5-621 STACK DIAMETER, in. _____
 SAMPLE BOX NO. _____ PROBE HEATER SETTING _____
 METER BOX NO. _____ HEATER BOX SETTING _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

CROSS SECTION			METER BOX NO.				METER		67		3		Probe		PUMP		20-2	
TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (√V P _s)		PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F		in. Hg gauge	VELOCITY f/s			
				ACTUAL	DESIRED	INLET (T _{m,IN}), °F	OUTLET (T _{m,OUT}), °F		#2	#0								
1	5		381	0.5	0.4			748.0										
2	10		380	0.7	0.68			750.2	114	114	250	187	265	10	12	60		
3	15		389	0.9	0.82			752.6										
4	20	8:48	394	0.8	0.80			755.2										
1	5		382	0.7	0.65			757.4	113	113	251	228	262	8	12 1/2	59		
2	10	9:00	388	1.4	1.3			760.1							15			
3	15		391	1.6	1.4			762.8										
4	20	9:10	385	1.4	1.3			766.3	113	112	250	227	261					
1	5		376	0.9	0.8			769.1							11			
2	10	9:22	382	1.5	1.4			772.1	112	112	250	225	260	17	18	45		
3	15		387	1.5	1.4	1.0												
4	20	9:25	384	1.8	1.7	1.0		780.0	112	111				18				
TOTAL																		

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml	SILICA GEL WEIGHT, g
	1 2 3 4	
FINAL		
INITIAL		
LIQUID COLLECTED		
TOTAL VOLUME COLLECTED		

ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
1					
2					
3					
4					

COMMENTS:

D-7

PARTICULATE FIELD DATA

PLANT _____ AMBIENT TEMPERATURE _____ METER ΔH_0 _____
 DATE _____ BAROMETRIC PRESSURE _____ C FACTOR _____
 LOCATION _____ ASSUMED MOISTURE, % _____ PROCESS WEIGHT RATE _____
 OPERATOR _____ PROBE LENGTH, in. _____
 STACK NO. _____ NOZZLE DIAMETER, in. _____
 RUN NO. 1 C-4a-MMS-621 STACK DIAMETER, in. _____
 SAMPLE BOX NO. _____ PROBE HEATER SETTING _____
 METER BOX NO. _____ HEATER BOX SETTING _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Static Pressure (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (√ΔP _s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	Probe TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY f/s
					ACTUAL DESIRED		INLET (T _{m IN}), °F	OUTLET (T _{m OUT}), °F				
1	5	9.40	376	0.7	.68	781.2	111	111	243	227	12	62
2	10	9.48	379	1.3	1.4 1.4	786.7	110	110	246	225	17	
3	15	9.48	376	1.5	1.4 .85	789.07						
4	20	9.52	STOP									
TOTAL												
AVERAGE												

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g
	1	2	3	4	
FINAL					
INITIAL					
LIQUID COLLECTED					

ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
1					
2					
3					

COMMENTS:

Leak check, Post
 w/o st probe 19" Hg Vac = .015 c/s
 1 st probe at 2" Vac

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NOMOGRAPH DATA

PLANT COAL CREEK

DATE 6/21/93

SAMPLING LOCATION C-5A-MM5-621

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H ₂ O	ΔH_{θ}	1.80
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m_{avg}}$	120
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{w0}	7%
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073 \times$ STACK GAUGE PRESSURE in in. H ₂ O)	P_s	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg}}$	350
AVERAGE VELOCITY HEAD, in. H ₂ O	Δp_{avg}	0.90
MAXIMUM VELOCITY HEAD, in. H ₂ O	Δp_{max}	0.90
C FACTOR		1.0
CALCULATED NOZZLE DIAMETER, in.		0.240
ACTUAL NOZZLE DIAMETER, in.		0.2
REFERENCE Δp , in. H ₂ O		

EPA (Dur) 234
4/72

Checked by: _____

ambient 124°F

SCHEMATIC OF STACK

CROSS SECTION

PARTICULATE FIELD DATA

XAD-2 - 46688-1-1'

2/15/93

PLANT Coal Creek
 DATE 6-21-93
 LOCATION OUTLET
 OPERATOR LEONARD
 STACK NO. _____
 RUN NO. C-5A-MM5-621
 SAMPLE BOX NO. _____
 METER BOX NO. _____

AMBIENT TEMPERATURE _____
 BAROMETRIC PRESSURE 27.48
 ASSUMED MOISTURE, % 7
 PROBE LENGTH, in. 16 FT
 NOZZLE DIAMETER, in. 0.240
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING 250 F
 HEATER BOX SETTING 250 F

METER ΔH_e _____
 C FACTOR 1.0
 PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		

Leak Check : TOTAL

Pre _____ CFM, _____ "Hg; Post _____ CFM, _____ "Hg

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	STATIC PRESSURE (in. H ₂ O)	GAS SAMPLE VOL. ft ³ STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (√ΔP _s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O ACTUAL DESIRED		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		Temp., F		Teledyne water CO ₂ 2		PUMP VACUUM in. Hg gauge	STACK VELOCITY ft/min
					INLET (T _m IN), °F	OUTLET (T _m OUT), °F		Fil- ter	Last Imp.						
1-12.00	14:50:10	230	716.823	0.91		1.00	1.00	127	126	231	73			5.0	345
1-11.00	14:53	235	714.2	0.93		1.00	1.00	128	126	243	67			5.5	345
1-10.00	15:00	232	716.9	0.97		2.10	2.10	130	126	247	66			7.2	345
1-9.00	15:05	235	721.0	0.99		2.10	2.10	131	126	248	63			7.5	345
1-8.00	15:10	236	725.0	0.99		2.10	2.10	133	127	250	63	73	60	7.5	345
1-7.00	15:15	239	729.2	0.91		2.20	2.20	135	125	251	63	72	59	7.5	346
1-6.00	15:20	239	733.6	0.97		2.40	2.40	135	129	251	63	73	58	8.0	345
1-5.00	15:25	238	737.7	0.95		2.20	2.20	138	132	253	65	73	58	8.1	346
1-4.00	15:30	238	742.9			2.20	2.20	139	132	253	67			8.1	346
1-3.00	15:35		746.958											8.0	
2-12.00	15:42	233	746.958			2.20	2.20	137	134	253	68			8.0	354
2-11.00	15:47		750.1												
2-10.00	15:52	237	755.2	0.90		2.20	2.20	141	136	253	65	73	56	8.2	351
2-9.00	15:57	240		0.99		2.60	2.60	143	135	254	70	73	58	10.0	351
2-8.00	16:02		763.7	1.50		3.10	3.10								
TOTAL															

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g
	1	2	3	4	
FINAL					
INITIAL					
LIQUID COLLECTED					

ORSAT MEASUREMENT

TIME	CO ₂	O ₂	CO	N ₂
1				
2				
3				

COMMENTS:

Checked by:

PARTICULATE YIELD DATA

PLANT _____ METER ΔH_g _____
DATE _____ C FACTOR _____
LOCATION _____ PROCESS WEIGHT RATE _____
OPERATOR _____ WEIGHT OF PARTICULATE COLLECTED, mg
STACK NO. _____ PROBE LENGTH, in. _____
RUN NO. C-5A-1025-621 NOZZLE DIAMETER, in. _____
SAMPLE BOX NO. _____ STACK DIAMETER, in. _____
METER BOX NO. _____ PROBE HEATER SETTING _____
HEATER BOX SETTING _____ Pre-5.08 CFM, 15" Hg; Post _____ CFM, _____" Hg

SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (1/ΔP _s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		Temp., °F	Teledyne	PUMP VACUUM in. Hg gauge
							INLET (T _{m,IN}), °F	OUTLET (T _{m,OUT}), °F			
3-6A	16:07			4.6	3.2	760.9				CO ₂	11.0
3-6B	16:12			4.6	3.2	779.5					
3-12A	16:17			5.7	4.5	779.5					15.0
3-11A	16:26			5.3	4.5	786.0				73	15.5
3-10A	16:31			5.5	4.5	798.3					16.0
3-9A	16:36			5.2	4.5	804.3					16.0
3-8A	16:41			5.2	4.5	810.8					16.0
3-7A	16:46			5.2	4.5	816.8					16.0
3-6A	16:51			5.2	4.5	823.4					16.0
3-5A	16:56			5.2	4.5	829.6					7.0
3-4A	17:01			5.2	4.5	835.7					
3-3A	17:06			5.2	4.5	841.8					
3-2A	17:11			5.2	4.5	847.9					
3-1A	17:16			5.2	4.5	854.0					
TOTAL				0.6	1.50	935.2					

COMMENTS:

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				ORSAT MEASUREMENT				TIME			
	1	2	3	4	1	2	3	4	1	2	3	4
FINAL												
INITIAL												
LIQUID COLLECTED												
TOTAL VOLUME COLLECTED												

Checked by: _____

PARTICULATE FIELD DATA

PLANT _____

DATE _____

LOCATION _____

OPERATOR _____

STACK NO. _____

RUN NO. C-5A-MMS-621

SAMPLE BOX NO. _____

METER BOX NO. _____

AMBIENT TEMPERATURE _____

BAROMETRIC PRESSURE _____

ASSUMED MOISTURE, % _____

PROBE LENGTH, in. _____

NOZZLE DIAMETER, in. _____

STACK DIAMETER, in. _____

PROBE HEATER SETTING _____

HEATER BOX SETTING _____

METER ΔH_g _____

C FACTOR _____

PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		

Leak Check : TOTAL

Pre _____ CFM, _____ "Hg; Post _____ CFM, _____ "Hg

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		Temp., °F		Teledyne		PUMP VACUUM in. Hg gauge	VELOCITY fps
					ACTUAL	DESIRED		INLET (T _{m,IN}), °F	OUTLET (T _{m,OUT}), °F	Fil-ter	Last Imp.	CO ₂	O ₂		
4-1100	17:16			0.75	2.0	2.0	839.4							7.5	
4-1000	17:21			0.70	1.85	1.85	843.6							7.5	
4-900	17:26			0.65	1.75	1.75	848.3							7.5	
4-800	17:31			0.60	1.60	1.60	852.0							7.0	
4-700	17:36			0.90	2.50	2.50	855.7							16.0	
4-600	17:41			3.9	4.5	10.0	860.6							16.0	
4-500	17:46			3.2	4.5	8.7	866.4							16.0	
4-400	17:51			3.0	4.5	8.0	874.0							16.0	
	17:56						880.300							16.0	
5-1200	18:02 on			2.8	4.5	7.5	880.300							16.0	
5-1100	18:07			1.9	4.5	5.0	886.4							16.0	
5-1000	18:12			1.1	2.9	2.9	890							16.0	
5-900	18:17			1.0	2.6	2.6	898.2							9.9	
5-800	18:22			0.85	2.3	2.3	903.7							8.5	
5-700	18:27			0.67	1.8	1.8	908.8								
TOTAL															

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT					
	1	2	3	4		TIME	CO ₂	O ₂	CO	N ₂	
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					
						4					

COMMENTS:

Checked by: _____

D-12

PARTICULATE FIELD DATA

PLANT _____ METER ΔH_g _____
DATE _____ AMBIENT TEMPERATURE _____
LOCATION _____ BAROMETRIC PRESSURE _____
OPERATOR _____ ASSUMED MOISTURE, % _____
STACK NO. _____ PROBE LENGTH, in. _____
RUN NO. C-54-1115-621 NOZZLE DIAMETER, in. _____
SAMPLE BOX NO. _____ STACK DIAMETER, in. _____
METER BOX NO. _____ PROBE HEATER SETTING _____
HEATER BOX SETTING _____ Pre _____ CFM, _____ "Hg; Post _____ CFM, _____ "Hg

SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (g), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (√ΔP _s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		Temp., F	Teledyne	PUMP VACUUM in. Hg gauge	VELOCITY f/s
					ACTUAL	DESIRED		INLET (T _{m in}), °F	OUTLET (T _{m out}), °F				
5-617	18:13			0.68	1.80	1.80					CO ₂ O ₂	8.0	
5-618	18:37			0.92	2.40	2.40	918.0					9.0	
5-619	18:42			1.00	2.70	2.70	931.4					10.0	
5-620	18:47			1.06	4.3	4.3	926.117					14.5	
5-621	18:51			1.00	2.70	2.70	931.2					11.5	
5-622	19:01			0.92	2.40	2.40	936.4					10.0	
5-623	19:06			0.74	2.0	2.0	941.4					9.0	
5-624	19:11			0.53	1.45	1.45	945.8					2.5	
5-625	19:16			0.47	1.20	1.20	950.4					7.0	
5-626	19:21			0.42	1.10	1.10	954.0					6.5	
5-627	19:26			1.0	2.70	2.70	957.0					11.0	
5-628	19:31			2.1	4.2	5.5	962.229					16.0	
5-629	19:36			4.3	4.2	10.4	967.639					16.0	
5-630	19:41						961.139						
TOTAL													

COMMENTS:

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml				ORSAT MEASUREMENT				TIME				CO ₂ O ₂ CO N ₂			
FINAL		1	2	3	4	1	2	3	4	1	2	3	4				
INITIAL																	
LIQUID COLLECTED																	
TOTAL VOLUME COLLECTED																	

Checked by: _____

PARTICULATE FIELD DATA

PLANT _____ AMBIENT TEMPERATURE _____ METER ΔH_0 _____
 DATE _____ BAROMETRIC PRESSURE _____ C FACTOR _____
 LOCATION _____ ASSUMED MOISTURE, % _____ PROCESS WEIGHT RATE _____
 OPERATOR _____ PROBE LENGTH, in. _____ WEIGHT OF PARTICULATE COLLECTED, mg
 STACK NO. _____ NOZZLE DIAMETER, in. _____ SAMPLE WEIGHT _____
 RUN NO. C-58-1225-621 STACK DIAMETER, in. _____ TARE WEIGHT _____
 SAMPLE BOX NO. _____ PROBE HEATER SETTING _____ WEIGHT GAIN _____
 METER BOX NO. _____ HEATER BOX SETTING _____ Leak Check : TOTAL _____
 Pre _____ CFM, _____ "Hg; Post _____ "Hg

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (g), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O) ACTUAL DESIRED	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		Temp., °F	Teledyne	PUMP VACUUM in. Hg gauge	VELOCITY f/s
							INLET (T _m), °F	OUTLET (T _m), °F	Pil-Last ter Imp.	CO ₂ O ₂		
7-1187	19:50			4.4	4.2	972.6					16	
7-1082	19:55			4.1	4.2	978.3					16	
7-985	20:00			3.3	4.2	986.4					16	
7-885	20:05	238	370	3.0	4.2	982.0	145	146	247	86	16	
7-228	20:10	240	371	2.7	4.2	987.0	144	145	247	66	16	
7-580	20:15	236	371	2.4	4.2	1003.0	143	143	248	66	16	
7-580	20:20	232	369	1.9	4.1	1008.7	141	141	247	66	16	
7-485	20:25	232	370	1.7	4.1	1014.6	140	141	247	67	16	
	20:30					1020.613						
8-1287	20:39	228	367	2.6	4.1	1020.613	129	132	249	69	16	
8-1180	20:44	244	367	2.4	4.1	1024.4	127	130	244	64	16	
8-1080	20:49	242	366	2.3	4.1	1033.1	123	124	248	62	16	
8-985	20:54	242	367	2.0	4.0	1038.6	122	123	253	63	16	
8-885	20:59	243	367	1.5	3.8	1044.2	121	121	253	63	16	
8-785	21:04	244	369	1.1	2.9	1049.8	121	121	253	64	16	
TOTAL												
AVERAGE												

COMMENTS:

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml				ORSAT MEASUREMENT				TIME				CO ₂ CO N ₂			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
FINAL																	
INITIAL																	
LIQUID COLLECTED																	

Checked by:

STACK SAMPLING DATA SHEET

Page 1 of 4

CLIENT Battelle / DOE
TEST UNIT Stack - Hot Side
PROJECT NO. 93C 028 - 01
CONTROL BOX OPERATOR M. J.
BAROMETRIC PRESSURE 27.73

TEST DATE 6/21/93
TEST NO. C-62 / MM5-621
NOZZLE (SIZE, IN) 0.187 11
STATIC PRESSURE -1.2 120
PORT DIRECTION C

ORIFICE CORRECTION 1.673
METER CORRECTION 0.9912
CALIBRATION DATE 5-19-93
PITOT CORRECTION 0.84
CONTROL BOX NO. 4

HOT BOX NO. 8
COLD BOX NO. 8
PROBE NO. 10-3
FILTER NO. Quincy
STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pipe ΔP (in. H2O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H2O)	Act. (in. H2O)	In (°F)	Out (°F)						
88.8	1042	763.748	2.1	1.53	1.53	104	103	6.0	236	~250	<68°E	~250	3 points / pt 30 min / point
			2.0	1.45	1.45	104	104	7.0	237				
			2.0	1.45	1.45	106	104	7.0	238				Readings every 5 minutes
			2.0	1.45	1.45	105	106	7.0	238				
			2.0	1.45	1.45	108	108	8.0	237				
			2.0	1.45	1.45	107	109	7.5	236				
43.9	1112		2.0	1.45	1.45	109	109	7.5	237		XAD TEMP = 50°F		
			2.0	1.47	1.47	109	111	7.5	235				
			2.0	1.47	1.47	110	112	7.5	235				
			2.0	1.47	1.47	112	112	7.5	234				
			2.0	1.47	1.47	112	114	7.5	236				
			2.0	1.47	1.47	112	114	7.5	235				
13.1	1142		2.0	1.47	1.47	113	114	7.5	237				
			2.0	1.47	1.47	113	115	7.5	236				
			2.0	1.47	1.47	115	117	7.5	236				Estimates:
			2.0	1.47	1.47	115	117	7.5	236				MW = 28.3
			2.0	1.47	1.47	115	118	7.0	237				%H2O = 17.3
			2.0	1.47	1.47	115	118	7.0	237				
	1212	828.440	2.0	1.47	1.47	115	118	7.0	237				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.014
After	8.0	0.015

PITOT LEAK CHECK

	Positive	Negative
Before	OK 15 sec	OK 15 sec
After	OK 15 sec	OK 15 sec

CO2	12.0	
O2	7.0	
CO	0	
N2	81.0	

Impinger No.	XAD + Contents	Final	Initial	Difference
1.	Condensate	2131.2	227.2	904.0
2.	100 mL D.I. H ₂ O	528.3	516.1	12.2
3.	100 mL D.I. H ₂ O	545.4	546.5	-1.1
4.	Empty	443.7	423.0	20.7
5.	200g Silica Gel	676.1	629.8	46.3

Velocity = 96.2 ft/sec

total = 982.
KEYSTONE
ENVIRONMENTAL SCIENCE INC.

Page 1
TIME = 90 MIN
VOLUME = 64.692 dcf
#1
= 2.0

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STACK SAMPLING DATA SHEET

Page 2 of 4

CLIENT Battelle/DOE TEST DATE 6-21-93 ORIFICE CORRECTION 1.673 HOT BOX NO. 8
 TEST UNIT Stack - Hot Side TEST NO. C-62-MM5-621 METER CORRECTION 0.9912 COLD BOX NO. 8
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) 0.187 G1 CALIBRATION DATE 5-19-93 PROBE NO. 10-3
 CONTROL BOX OPERATOR TM, JS STATIC PRESSURE -1.2" H₂O PITOT CORRECTION 0.84 FILTER NO. Quantity
 BAROMETRIC PRESSURE 27.70 PORT DIRECTION B CONTROL BOX NO. 4 STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcb)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1240	828.600	2.0	1.47	1.47	118	118	8.0	238	~250	<68°F	~250	3 points/port
		828.600	2.0	1.47	1.47	118	119	8.0	237				30 min/port
			2.0	1.47	1.47	116	119	8.0	239				Readings every
			2.0	1.47	1.47	116	119	8.0	238				5 minutes
			2.0	1.47	1.47	117	118	8.0	239				
↓			2.0	1.49	1.49	116	119	8.0	238				
43.9	1310		2.0	1.49	1.49	116	119	8.0	239				
			2.0	1.49	1.49	117	118	8.0	239				
			2.0	1.49	1.49	117	120	8.0	239				
			2.0	1.49	1.49	118	119	8.0	238				
			2.0	1.48	1.48	119	120	8.0	240				
↓			2.0	1.48	1.48	119	121	8.0	239				
13.1	1340		2.0	1.48	1.48	119	120	8.0	239				
			2.0	1.48	1.48	118	120	8.0	238				
			2.0	1.48	1.48	119	122	8.0	238				Estimates:
			2.0	1.48	1.48	119	120	8.0	238				MW = 28.81
			2.0	1.48	1.48	120	120	8.0	240				%H ₂ O = 17.3
↓	1410	893.240	2.0	1.48	1.48	120	121	8.0	239				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	8.0	0.015
After	8.0	0.015

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	7.0	
CO	0	
N ₂	81.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #2
 TIME = 90 min
 VOLUME = 64.640 dcf
 Q_{AE 2092} (AP)_{AG} = 2.0
 (ΔH) = 1.48

[T_{stack}]_{air} = 119°F

[T_{stack}]_{air} = 239°F

Velocity = 96.4 ft/sec
 ISO. = 94.9%

D-17

STACK SAMPLING DATA SHEET

Page 3 of 4

CLIENT Battelle / DOE TEST DATE 6-21-93 ORIFICE CORRECTION 1.673 HOT BOX NO. 8
 TEST UNIT Stack - Hot Side TEST NO. C-62-MM5-621 METER CORRECTION 0.9912 COLD BOX NO. 8
 PROJECT NO. 93C028-01 NOZZLE (SIZE, Ø) 0.87611 CALIBRATION DATE 5-19-93 PROBE NO. 10-3
 CONTROL BOX OPERATOR TMJS STATIC PRESSURE -1.2" H₂O PITOT CORRECTION 0.84 FILTER NO. Quantity
 BAROMETRIC PRESSURE 27.70 PORT DIRECTION D CONTROL BOX NO. 4 STACK DIA. 25" Ø

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1442	873.358	2.0	1.48	1.48	115	119	8.0	239	~250	~68°F	~250	3 points/pt 30 min/point
			2.2	1.63	1.63	115	116	8.0	239				
			2.2	1.63	1.63	114	114	8.0	241				Readings every 5 minutes
			2.2	1.63	1.63	114	112	8.0	240				
			2.2	1.61	1.66	113	114	8.0	240				
			2.2	1.61	1.61	112	112	8.5	240				
43.9	1512		2.2	1.61	1.61	112	113	9.0	243				
			2.2	1.61	1.61	112	112	9.0	243				
			2.2	1.61	1.61	112	113	9.0	244				
			2.2	1.61	1.61	112	113	9.0	244				
			2.2	1.61	1.61	111	112	9.0	244				
			2.2	1.61	1.61	112	113	9.0	243				
13.1	1542		2.2	1.61	1.61	112	114	9.0	243				
			2.2	1.61	1.61	113	113	9.0	242				
			2.2	1.61	1.61	113	114	9.0	242				Estimates:
			2.2	1.61	1.61	113	114	9.0	241				MW = 28.81
			2.2	1.61	1.61	113	115	9.0	242				%H ₂ O = 17.3
			2.2	1.61	1.61	114	114	9.0	241				
	1612	962.198	2.2	1.61	1.61	114	114	9.0	241				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	8.0	0.010
After	9.0	0.010

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	7.0	
CO	0	
N ₂	81.0	

Impinger

No.	Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #3

TIME = 90 min
 VOLUME = 68.840 dcf
 (AP)_{AVG} = 2.2

Velocity = 101.3 f/sec
 = 0.170

KEYSTONE
 ENVIRONMENTAL DIVISION

D-18

STACK SAMPLING DATA SHEET

CLIENT *Battelle / DOE* TEST DATE *6-21-93* ORIFICE CORRECTION *1.673* HOT BOX NO. *8*
TEST UNIT *Stack - Hot Side* TEST NO. *C-6a-MM5-621* METER CORRECTION *0.9912* COLD BOX NO. *8*
PROJECT NO. *93C028-01* NOZZLE (SIZE, #) *0.187 G1* CALIBRATION DATE *5-19-93* PROBE NO. *10-3*
CONTROL BOX OPERATOR *TM JS* STATIC PRESSURE *-1.24 Hg* PITOT CORRECTION *0.84* FILTER NO. *Qmty-*
BAROMETRIC PRESSURE *27.70* PORT DIRECTION *A* CONTROL BOX NO. *4* STACK DIA. *25"*

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcl)	Pitot ΔP (in. H2O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H2O)	Act. (in. H2O)	In (°F)	Out (°F)						
88.8	1628	962.348	2.0	1.46	1.46	113	112	8.0	243	~250	~68°F	~250	3 points / port
			2.0	1.46	1.46	113	113	8.0	243				3 points / port
			2.0	1.46	1.46	113	114	8.0	242				Readings every 5 minutes
			2.0	1.47	1.47	113	113	8.0	242				
			2.0	1.47	1.47	113	113	8.5	242				
			2.0	1.47	1.47	113	113	8.5	242				
			2.0	1.47	1.47	114	113	8.5	242				
43.9	1658		2.0	1.47	1.47	114	113	8.5	242				
			2.0	1.47	1.47	114	113	8.5	242				
			2.0	1.47	1.47	113	112	8.5	243				
			2.0	1.47	1.47	114	113	8.5	242				
			2.0	1.47	1.47	114	113	8.5	243				
			2.0	1.47	1.47	114	115	8.5	242				
			2.0	1.47	1.47	113	115	8.5	241				
13.1	1728		2.0	1.47	1.47	113	114	8.5	241				Estimates:
			2.0	1.47	1.47	113	114	8.5	241				MW = 28.81
			2.0	1.47	1.47	114	115	8.5	241				%H2O = 17.3
			2.0	1.47	1.47	113	114	8.5	240				
			2.0	1.47	1.47	113	114	8.5	240				
			2.0	1.47	1.47	113	115	8.5	239				
✓	1758	1028.034	2.0	1.47	1.47	113	115	8.5	239				

SYSTEM LEAK CHECK		PITOT LEAK CHECK	
Vacuum (in. Hg)	DGM Rate (cfm)	Before	After
9.0	0.010		
After	0.010		

PITOT LEAK CHECK		Impinger Contents	
Positive	Negative	No.	Final
		1.	
		2.	
		3.	
		4.	
		5.	

Impinger Contents		Initial		Difference	
No.	Contents	Final	Initial		
1.					
2.					
3.					
4.					
5.					

TIME = 90 min
VOLUME = 65.686 dcl
 $(\Delta P)_{avg} = 2.0$
 $(\Delta H)_{avg} = 1.47$

$[T_{stack}]_{avg} = 114^\circ F$
 $T_{amb} = 74.7^\circ F$
 $Velocity = 96.6 ft/sec$
 $ISO. = 97.5\%$

PARTICULATE FIELD DATA

PLANT _____ DATE 6-23-93 LOCATION 4a OPERATOR _____ STACK NO. _____ RUN NO. 3 - Organic SAMPLE BOX NO. _____ METER BOX NO. _____

AMBIENT TEMPERATURE _____ BAROMETRIC PRESSURE _____ ASSUMED MOISTURE, % 18 PROBE LENGTH, in. _____ NOZZLE DIAMETER, in. .205 STACK DIAMETER, in. _____ PROBE HEATER SETTING _____ HEATER BOX SETTING _____

METER ΔH_p _____ C FACTOR _____ PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Time	4	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) (in. H ₂ O)	ACTUAL DESIRED	GAS SAMPLE VOLUME (V _m), ft ³	6	7	3	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	XAD-2
	0	12:05					988.0						
1	5			.8	.58			88	88	255		6 1/2	
2	10		294	1.2	1.2		990.6				72	12	46
3	15	12:16	299	1.5	1.4		0						
4	20		292	1.5	1.4		999.3						
1	0												
1	5	12:27	278	0.5	.48		1000.1	90	89	263		9	
2	10		305	1.3	1.2		2.8				70	13 1/2	57
3	15	12:37	310	0.85	0.82		6.2				Probes	12	Imp XAD
4	20		297	1.1	1.05		9.0				#2 #10		
	0										230 260		70 99
1	5	12:48	279	1.4	1.3		10.9	89	88	263		15	69 46
2	10		300	1.6	1.5							18	
3	15	12:58	310	2.1	1.4	2.0						18	
4	20			1.7	1.5	1.6							
TOTAL													

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	1	2	3	4	SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
FINAL							12:37		5 1/2		
INITIAL											
LIQUID COLLECTED											

COMMENTS:

Pre leak check .012 cfu at 18" Hg Vac w/ Flex only

PARTICULATE YIELD DATA

PLANT _____ AMBIENT TEMPERATURE _____
 DATE 6-23-92 BAROMETRIC PRESSURE _____
 LOCATION 4a ASSUMED MOISTURE, % _____
 OPERATOR _____ PROBE LENGTH, in. _____
 STACK NO. _____ NOZZLE DIAMETER, in. _____
 RUN NO. 3-Dry STACK DIAMETER, in. _____
 SAMPLE BOX NO. _____ PROBE HEATER SETTING _____
 METER BOX NO. _____ HEATER BOX SETTING _____

METER ΔH_0 _____
 C FACTOR _____
 PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg			
SAMPLE	FILTER	PROBE WASH	
FINAL WEIGHT			
TARE WEIGHT			
WEIGHT GAIN			
TOTAL			

SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (g), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (ft/s)	VELOCITY (ΔP _s) (ft/s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY f/s
								INLET (T _{in}), °F	OUTLET (T _{out}), °F				
	0				0.2		1000	89	88	263	263	9	71
1	5		280	.75	.75	.72	26.1	89	88	263	263	10	71
2	10	13:16	295	.9	.9	.82	30.1	89	88	263	263	10	71
3	15		311	.75	.75	.72		90	89	263	263	10	71
4	20	13:25	300	.45	.45	.42		90	89	263	263	10	71
1	5	13:35	307	.75	.75	.72	36.0	90	89	263	263	10	71
2	10		324	1.4	1.4	1.35		92	90	263	263	10	71
3	15		327	1.4	1.4	1.35	45.0	92	90	263	263	10	71
4	20		325	1.4	1.4	1.35		91	89	262	261	10	71
1	5	13:57	332	.9	.9	.86	46.9	91	89	262	261	10	71
2	10	14:04	336	1.4	1.4	1.35	50.1	91	89	262	261	10	71
3	15		329	1.4	1.4	1.2	54.0					10	71
4	20	14:12	322	.85	.85							10	71
TOTAL													

COMMENTS:

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml				SILICA GEL WEIGHT, g				FYRITE DRY SAT MEASUREMENT				TIME				CO ₂		O ₂		CO		N ₂							
1		2		3		4		1		2		3		4		1		2		3		4		1		2		3		4	
FINAL																															
INITIAL																															
LIQUID COLLECTED																															
TOTAL VOLUME COLLECTED																															

PARTICULATE FIELD DATA

PLANT 00.08 NO AMBIENT TEMPERATURE 27.67
 DATE 6.23.93 BAROMETRIC PRESSURE 27.67
 LOCATION valve ASSUMED MOISTURE, %
 OPERATOR PROBE LENGTH, in. 205
 STACK NO. 3 - Organics NOZZLE DIAMETER, in.
 RUN NO. STACK DIAMETER, in.
 SAMPLE BOX NO. PROBE HEATER SETTING
 METER BOX NO. X 40513 HEATER BOX SETTING

METER ΔH_p
 C FACTOR
 PROCESS WEIGHT RATE
 WEIGHT OF PARTICULATE COLLECTED, mg
 SAMPLE FILTER PROBE WASH
 FINAL WEIGHT
 TARE WEIGHT
 WEIGHT GAIN
 TOTAL

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP), in. H ₂ O	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY /ps
					ACTUAL	DESIRED		INLET (T _{m in}), °F	OUTLET (T _{m out}), °F				
1	0	14.23	342	0.7	.65	.65	58.7	90	90	263	233	10	67
2	5		343	1.3	1.3	1.3	69.0	91	90	263	233	14	67
3	10	14.30	333	1.4	1.35	1.35						16 1/2	44
4	15		333	1.4	1.2	1.35							
5	20	14.43	344	.25	.22	.22	70.1	90	90	263	242	7	
6	0		342	.85	.80	.80	74.6	92	90	263		14	69
7	5	14.53	337	1.2	1.15	1.15	79.255	STOP				15	44
8	10		323	1.0	.95	.95	80.11	after leak check					
9	15	16.31	344	.25	.23	.23	82.3	92	91			7	
10	20	16.37	349	1.0	.95	.95	86.0	92	91	245	232	11 1/2	
11	5	16.46	353	1.4	1.2	1.2	87.0	92	91			11 1/2	
12	10		356	1.4	1.2	1.2						12	68
13	15												48
14	20												
TOTAL													

COMMENTS: * Change filter/leak check
 .017 ef m w/ flat line on

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml		SILICA GEL WEIGHT, g		ORIFICE MEASUREMENT		TIME		CO ₂		CO		N ₂	
1	2	3	4	1	2	3	4	1	2	1	2	1	2	1	2
FINAL															
INITIAL															

PARTICULATE FIELD DATA

SCHEMATIC OF STACK

CROSS SECTION

PLANT

DATE

LOCATION

OPERATOR

STACK NO.

RUN NO.

SAMPLE BOX NO.

METER BOX NO.

AMBIENT TEMPERATURE

BAROMETRIC PRESSURE

ASSUMED MOISTURE, %

PROBE LENGTH, in.

NOZZLE DIAMETER, in.

STACK DIAMETER, in.

PROBE HEATER SETTING

HEATER BOX SETTING

METER ΔH_0

C FACTOR

PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

CROSS SECTION			METER BOX NO. 1002		GAS MTR		6 7		3		Prober				XAD E IMP.	
TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Time	4 STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s)		PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O		GAS SAMPLE VOLUME (V _m), ft ³	INLET (T _{m in}), °F	OUTLET (T _{m out}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F		PUMP VACUUM in. Hg gauge	VELOCITY ips	
				(ΔP _s)	(ΔP _s)	ACTUAL	DESIRED					#2	#10		IMP	XAD
	0	16:57						1000+			268	#2	#10			
1	5		350	.45	6.5	.4		91.5	93	92		315	FLY	8		
2	10		354	1.4		1.3		93.5				233	261	12	69	46
3	15	17:07	355	1.4		1.3		98.7	93	91	266			15		
4	20			1.6	5.0	1.5										
	0	17:14														
1	5		353	.45		.40		102.4	91	90	267	242	257	8		
2	10		352	1.5		1.4		105.2						14 1/2	68	46
3	15		362	1.6	3.5	1.5		107.8				?				
4	20	17:30	367	0.9		.85		112.0	90	89	267	220	253	13 1/2	69	45
	0	17:34														
1	5		352	.75	5.5	.72		114.1	89	88				10	67	42
2	10		348	1.7		1.6								18		
3	15	17:52	357	1.6		1.2	1.5	121.6	90	88	269	229	252	18	66	40
4	20			.35		0.32								9		
TOTAL																

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	1	2	3	4	IMPINGER VOLUME ml	SILICA GEL WEIGHT, g
FINAL						
INITIAL						
LIQUID COLLECTED						
TOTAL VOLUME COLLECTED						

ORIFICE MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
1					
2					
3					
4					

COMMENTS:

PARTICULATE FIELD DATA

PLANT 6-01 ND METER ΔH_p _____
 DATE 6-23-93 C FACTOR _____
 LOCATION 4a PROCESS WEIGHT RATE _____
 OPERATOR _____ WEIGHT OF PARTICULATE COLLECTED, mg
 STACK NO. 3 PROBE LENGTH, in. 0.205
 RUN NO. C-4a-MMS-623 NOZZLE DIAMETER, in. _____
 SAMPLE BOX NO. _____ STACK DIAMETER, in. _____
 METER BOX NO. _____ PROBE HEATER SETTING _____
 HEATER BOX SETTING _____

SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (V _p), ft/s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m,in}), °F	OUTLET (T _{m,out}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg	XAD 3	VELOCITY ft/s
1	5	18.03	352	.45	.42	126.6	97	93	271	239	10	61	45
2	10		352	.98	.90	128.7	88	88	89	253	15	67	40
3	15		360	1.2	1.15	139.6					17		
4	20	18.18	359	.85	.82	137.2	88	87	268	243	14	69	47
1	5		348	.65	.62						19	66	44
2	10	18.31	358	1.5	0.9	143.7	87	85	253				
3	15		363	1.6	1.5	146.5	Before last check						
4	20	18.40	363	1.6	0.8	147.2	after last check						
1	5	18.53	350	0.85	0.42					256	9	65	50
2	10	19.05	364	1.6	1.5	151.5	83	82	241	225	12	61	52
3	15		364	1.4	1.3		84	82	246				
4	20		363	1.7	1.35	158.1							
TOTAL													

Replaced filter
 Leak check .015 ct/mg
 at 1544g

COMMENTS

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml		ORSAT MEASUREMENT		TIME	CO ₂	O ₂	CO	N ₂
1		2		1						
2		3		2						
3		4		3						
FINAL										
INITIAL										
LIQUID COLLECTED										

PARTICULATE ELD DATA

METER NO. _____
C FACTOR _____
PROCESS WEIGHT RATE _____
WEIGHT OF PARTICULATE COLLECTED, mg _____
SAMPLE _____ FILTER _____ PROBE WASH _____
FINAL WEIGHT _____
TARE WEIGHT _____
WEIGHT GAIN _____ TOTAL _____
AMBIENT TEMPERATURE 27.67
BAROMETRIC PRESSURE 18
ASSUMED MOISTURE, % 1
PROBE LENGTH, in. 1
NOZZLE DIAMETER, in. 205
STACK DIAMETER, in. _____
PROBE HEATER SETTING _____
HEATER BOX SETTING _____
PLANT 6-D-ND
DATE 4A Inlet ESP
LOCATION 6
OPERATOR _____
STACK NO. 3 C-4a MM5-623
RUN NO. _____
SAMPLE BOX NO. _____
METER BOX NO. _____

SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (H), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (in. H ₂ O)	VELOCITY (ft/min)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m in}), °F	OUTLET (T _{m out}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING OR CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	XAD Z
1	0	19.20	353	0.7	6.5	1.64	161.1	82	81	240	42	10	Imp
2	5	19.28	354	1.5	1.5	1.35	169.0					14	
3	10	19.36	352	1.6	1.5	1.3	172.674	83	81	249	207	15 1/2	64
4	20		STOP	1.4	1.3	1.3						15 1/2	66
TOTAL													

COMMENTS

Post leak check with flex line = .02 cfm with S/S probe at 204g leak rate = NIL

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml				ORSAT MEASUREMENT				TIME			
FINAL	1	2	3	4		CO ₂	O ₂	CO	N ₂	1	2	3	4
INITIAL													
LIQUID COLLECTED													
TOTAL VOLUME COLLECTED													

NOMOGRAPH DATA

PLANT Coal Creek

DATE 6/23/93

SAMPLING LOCATION C-5A-MM5-623

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H ₂ O	ΔH_0	1.80
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m\text{avg.}}$	120
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{w0}	7
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	27.62
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073 \times \text{STACK GAUGE PRESSURE in in. H}_2\text{O}$)	P_s	0.10"
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1
AVERAGE STACK TEMPERATURE, °F	$T_{s\text{avg.}}$	345
AVERAGE VELOCITY HEAD, in. H ₂ O	$\Delta p_{\text{avg.}}$	0.70
MAXIMUM VELOCITY HEAD, in. H ₂ O	$\Delta p_{\text{max.}}$	0.95
C FACTOR	1.05	
CALCULATED NOZZLE DIAMETER, in.	0.245	
ACTUAL NOZZLE DIAMETER, in.	0.247	
REFERENCE Δp , in. H ₂ O	0.70	

EPA (Dut) 234
4/72

Checked by: _____

PARTICULATE / FLU DATA PLANT Coal Creek DATE 6/23/93 LOCATION ESP outlet side OPERATOR Lernard Hupp STACK NO. RUN NO. C-5A-MM5-623 SAMPLE BOX NO. METER BOX NO. X40513

SCHEMATIC OF STACK

METER ΔH_p 1.80
 C FACTOR 1.0
 PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg			
SAMPLE	FILTER	PROBE WASH	
FINAL WEIGHT			
TARE WEIGHT			
WEIGHT GAIN			
TOTAL			

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (el), min.	probe Temp of static pressure (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (1/16" P ₃)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY of H ₂ S
1-12.80	12:56	180	333	0.82	2.3	333.630	93	90	220	68	7.0	52
1-11.80	13:01	229	332	0.80	2.1	337.6	95	90	235	64	8.0	52
1-10.80	13:06	240	331	0.73	1.9	341.3	95	90	241	63	8.0	52
1-9.80	13:11	253	331	0.78	2.0	345.3	96	90	243	70	8.5	53
1-8.80	13:16	252	332	0.65	1.7	349.4	100	94	246	74	8.0	54
1-7.80	13:21	252	329	0.70	1.85	353.0	102	95	250	78	8.5	56
1-6.80	13:26	253	329	0.72	1.95	357.0	104	98	252	81	9.0	59
1-5.80	13:31	249	328	0.68	1.85	360.0	106	99	254	93	9.0	61
1-4.80	13:36	239	326	0.50	1.35	366.0	103	97	254	82	8.0	61
2-12.80	13:47	252	332	0.80	2.1	368.730	102	100	253	81	8.0	
2-11.80	13:52	253	334	0.74	1.95	372.5	107	102	258	69	9.5	62
2-10.80	13:57	255	334	0.78	2.05	376.4	108	102	257	70	10.0	61
2-9.80	14:02	256	332	0.70	1.95	380.4	107	102	255	71	10.0	59
2-8.80	14:07	254	336	0.56	1.50	384.5	110	105	255	73	9.5	59
TOTAL												

COMMENTS:

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml				ORSAT MEASUREMENT				TIME			
FINAL		1	2	3	4	CO ₂	O ₂	CO	N ₂	1			
INITIAL										2			
LIQUID COLLECTED										3			
TOTAL VOLUME COLLECTED										4			

AVERAGE

93497

PARTICULATE / LD DATA

PLANT Coal Creek
 DATE 6/23/93
 LOCATION ESP outlet
 OPERATOR Leonard, Russ
 STACK NO. _____
 RUN NO. C-5A-MM5-623
 SAMPLE BOX NO. _____
 METER BOX NO. X 40513

METER ΔH_0 1.80
 C FACTOR 1.05
 PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg			
SAMPLE	FILTER	PROBE WASH	
FINAL WEIGHT			
TARE WEIGHT			
WEIGHT GAIN			
TOTAL			

PROBE LENGTH, in. 16.80. 9.00
 NOZZLE DIAMETER, in. 0.247
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING 250°F
 HEATER BOX SETTING 250°F

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min.	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _v) (√ΔP _v)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O) ACTUAL DESIRED	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	XAD-2 OUTLET °F VELOCITY ft/min
							INLET (T _{m in}), °F	OUTLET (T _{m out}), °F		
2-780	14:11	331	0.58	1.55	387.5	105	104	72	9.5	62
2-680	14:16	331	0.62	1.65	391.2	109	105	69	9.5	62
2-580	14:21	329	0.64	1.70	395.0	112	106	69	9.5	60
2-480	14:26	328	0.64	1.70	398.8	111	107	66	9.5	60
	14:31				402.603					
3-1280	14:37	338	0.68	1.85	402.603	105	104	74	10.0	68
3-1180	14:42	341	0.45	1.20	406.2	111	108	68	8.5	57
3-1080	14:47	341	0.52	1.40	409.8	115	110	70	8.5	61
3-980	14:52	339	0.71	1.90	413.2	115	110	66	10.0	62
3-880	14:57	336	0.66	1.80	417.0	112	107	64	10.0	59
3-780	15:02	337	0.70	1.85	421.0	112	108	58	10.0	56
3-680	15:07	334	0.65	1.75	425.1	113	105	58	10.0	56
3-580	15:12	333	0.73	1.90	429.0	110	107	56	10.0	56
3-480	15:17	331	0.58	1.55	432.9	114	112	58	10.0	57
	15:22				437.17					
TOTAL										
AVERAGE										

4-7531 Line - 96 = 2379F 93 = 233°F

Actual line - 96 = 237°F 93 = 233°F

COMMENTS:

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml				ORSAT MEASUREMENT				TIME				CO ₂ O ₂ CO N ₂			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
FINAL																	
INITIAL																	
LIQUID COLLECTED																	
WATER VOLUME COLLECTED																	

PARTICULATE FIELD DATA

PLANT Coal Creek AMBIENT TEMPERATURE 105°F
 DATE 6/23/93 BAROMETRIC PRESSURE _____
 LOCATION ESP outlet ASSUMED MOISTURE, % 7
 OPERATOR Leonard, Napp PROBE LENGTH, in. 16 ft. plus
 STACK NO. _____ NOZZLE DIAMETER, in. 0.247
 RUN NO. C-5A-MM5-623 STACK DIAMETER, in. _____
 SAMPLE BOX NO. _____ PROBE HEATER SETTING 250°F
 METER BOX NO. X 40513 HEATER BOX SETTING 250°F

METER ΔH_0 1.80
 C FACTOR 1.05
 PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	probe temp. STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (1/16" P _s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (1/H) in. H ₂ O		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	XAD-2 OUTLET °F VELOCITY
					ACTUAL	DESIRED		INLET (T _{m in}), °F	OUTLET (T _{m out}), °F				
4-1200	15:29	252	342	0.62	1.65	1.65	437.117	102	103	255	62	9.5	60
4-1400	15:34	252	344	0.70	1.85	1.85	440.7	103	103	254	56	10.0	58
4-1600	15:39	250	345	0.70	1.85	1.85	444.9	104	102	254	56	9.5	59
4-1800	15:44	248	345	0.50	1.35	1.35	448.6	104	102	255	57	9.5	62
4-2000	15:49	250	343	0.52	1.40	1.40	452.3	104	102	254	58	8.5	62
4-2200	15:54	251	340	0.46	1.20	1.20	455.8	103	100	254	57	8.0	62
4-2400	15:59	254	339	0.48	1.25	1.25	459.2	105	102	255	59	7.8	62
4-2600	16:04	254	334	0.48	1.25	1.25	462.4	104	101	254	58	7.8	61
4-2800	16:09	255	333	0.50	1.35	1.35	465.7	102	99	253	57	7.6	58
	16:14						469.160						
5-1200	16:19	261	352	0.42	1.20	1.20	469.160	102	101	255	67	8.0	63
5-1400	16:24	267	351	0.40	1.05	1.05	472.5	105	102	257	60	7.5	58
5-1600	16:29	247	350	0.45	1.20	1.20	476.7	104	100	255	57	7.5	58
5-1800	16:34	250	350	0.49	1.30	1.30	478.9	105	101	256	58	8.0	59
5-2000	16:39	255	352	0.40	1.05	1.05	482.1	104	100	250	58	7.5	58
TOTAL													

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g
	1	2	3	4	
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT

TIME	CO ₂	O ₂	CO	N ₂
1				
2				
3				
4				

COMMENTS:

95 + 93

PARTICULATE / FIELD DATA

PLANT Coal Creek AMBIENT TEMPERATURE 100°F
 DATE 6/23/93 BAROMETRIC PRESSURE 27.64
 LOCATION Espositolet ASSUMED MOISTURE, % 7
 OPERATOR Fernand, Ruge PROBE LENGTH, in. 16.00
 STACK NO. 0, 247
 RUN NO. C-5A-MM5-623
 SAMPLE BOX NO. 250°F
 METER BOX NO. 260°F

SCHEMATIC OF STACK

WEIGHT OF PARTICULATE COLLECTED, mg			
SAMPLE	FILTER	PROBE WASH	
FINAL WEIGHT			
TARE WEIGHT			
WEIGHT GAIN			
TOTAL			

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (g), min.	PROBE TEMP, °F	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s), (1/16")	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (1/16")	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg	STACK 2 OUTLET VELOCITY ft/s
5-780	16:44	253	353	0.45	1.20	485.5	106	102	256	60	7.5	58
5-680	16:49	250	354	0.50	1.30	488.6	103	95	255	58	7.0	56
5-680	16:54	250	354	0.58	1.50	492.0	103	100	255	57	9.0	55
5-480	16:59	245	354	0.60	1.60	495.2	102	95	253	56	9.0	55
6-1280	17:12	247	349	0.40	1.05	499.034	93	93	251	56	7.0	58
6-1180	17:17	252	350	0.52	1.40	502.2	92	92	249	53	8.0	55
6-1080	17:22	248	353	0.50	1.30	505.6	94	92	252	54	8.0	54
6-980	17:27	250	353	0.52	1.40	509.0	94	91	251	53	8.0	53
6-880	17:32	248	353	0.57	1.50	512.5	92	90	255	52	8.5	54
6-780	17:37	243	354	0.57	1.50	515.9	92	90	266	54	9.0	55
6-680	17:42	236	367	0.63	1.70	519.5	90	90	278	54	9.5	56
6-580	17:47	225	356	0.63	1.70	523.1	90	88	278	55	10.0	56
6-480	17:52	197	355	0.57	1.50	526.8	87	86	277	54	9.5	55
TOTAL	17:57					529.9						
AVERAGE												

93 + 91

COMMENTS:

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml		SILICA GEL WEIGHT, g		ORSAT MEASUREMENT		TIME		CO ₂		O ₂		CO		N ₂	
1		2	3	4		1		1									
FINAL																	
INITIAL																	
LIQUID COLLECTED																	

PARTICULATE F LD DATA

PLANT Coal Creek METER 1.80
 DATE 6/23/93 C FACTOR 1.05
 LOCATION ESP outlet PROCESS WEIGHT RATE _____
 OPERATOR Lemuel, Hugg WEIGHT OF PARTICULATE COLLECTED, mg _____
 STACK NO. _____ SAMPLE WEIGHT _____
 RUN NO. C-5A-1775-623 TARE WEIGHT _____
 SAMPLE BOX NO. X40513 WEIGHT GAIN _____
 METER BOX NO. _____ TOTAL _____

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (in. H ₂ O)	ACTUAL DESIRED (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m in}), °F	OUTLET (T _{m out}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY f/s
7-12-00	18:03	211	346	0.42	1.20	528.9	79	90	277	54	8.0	53
7-11-00	18:08	211	343	0.50	1.30	534.6	78	78	276	50	7.5	53
7-10-00	18:13			0.48	1.1	532.1						
7-9-00	18:18			0.47	1.25	540.2						
7-8-00	18:23	223	344	0.40	1.05	543.2	75	75	280	52	7.5	68
7-7-00	18:28	220	342	0.46	1.05	546.3	76	75	278	53	8.0	57
7-6-00	18:33	223	343	0.35	0.92	549.3	76	94	280	53	7.5	58
7-5-00	18:38	222	342	0.40	1.20	552.1	75	73	280	52	7.5	53
7-4-00	18:43											
8-12-00	18:48	223	339	0.45	1.20	558.49	71	70	281	54	8.0	53
8-11-00	18:53	244	341	0.47	1.25	561.7	72	70	278	50	8.0	52
8-10-00	19:04	247	337	0.48	1.20	565.0	73	70	279	52	8.0	53
8-9-00	19:09	247	339	0.47	1.25	568.1	73	69	278	52	8.5	53
8-8-00	19:14	250	341	0.47	1.25	571.4	74	70	278	52	8.5	53
TOTAL												

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				ORSAT MEASUREMENT				TIME				CO ₂ O ₂ CO N ₂			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
FINAL																
INITIAL																
LIQUID COLLECTED																
TOTAL VOLUME COLLECTED																

COMMENTS:

PARTICULATE FIELD DATA

PLANT Coal Creek AMBIENT TEMPERATURE 60° rain METER ΔH_0 1.80
 DATE 6/23/93 BAROMETRIC PRESSURE _____ C FACTOR 1.05
 LOCATION ESP outlet side ASSUMED MOISTURE, % 7 PROCESS WEIGHT RATE _____
 OPERATOR Leonard, Nuge PROBE LENGTH, in. 16 ft. glass
 STACK NO. _____ NOZZLE DIAMETER, in. 0.247
 RUN NO. C-5A-MM5-623 STACK DIAMETER, in. _____
 SAMPLE BOX NO. _____ PROBE HEATER SETTING 250°
 METER BOX NO. X 40513 HEATER BOX SETTING 250°

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Probe Temp STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (√P _s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O ACTUAL DESIRED		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m IN}), °F OUTLET (T _{m OUT}), °F		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	7402 OUT VELOCITY feet
8-7402	19:19	252	340	0.38	1.05	1.05	574.6	74	70	280	53	8.0	55
8-6402	19:24	252	340	0.38	1.05	1.05	577.6	73	69	281	53	7.5	55
8-5402	19:29	249	342	0.50	1.30	1.30	580.6	73	69	280	53	8.0	55
8-4402	19:34	235	342	0.50	1.20	1.30	583.6	73	68	282	52	8.0	54
	19:39 off						586.902						
TOTAL													

AVERAGE

leak test 0.016 at 12" Hg

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
FINAL	1	2	3	4		1					
INITIAL						2					
LIQUID COLLECTED						3					

COMMENTS:

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE TEST DATE 6-23-93 ORIFICE CORRECTION 1.673 HOT BOX NO. 8
 TEST UNIT Stack - Hot Side TEST NO. C-62 - MM5 - 623 METER CORRECTION 0.9912 COLD BOX NO. 8 + 3B
 PROJECT NO. 93 C028-01 NOZZLE (SIZE, #) 0.192 G14 CALIBRATION DATE 5-17-93 PROBE NO. 10-3
 CONTROL BOX OPERATOR JTS STATIC PRESSURE -1.6" H₂O PITOT CORRECTION 0.84 FILTER NO. Quincy
 BAROMETRIC PRESSURE 27.62 PORT DIRECTION C CONTROL BOX NO. 4 STACK DIA. 25"

Traverse Point (feet)	Time	Dry Gas Meter Reading (scf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1033	288.920	2.2	1.71	1.71	93	93	8.0	248	~250	<68°F	~250	3 points / port
			2.2	1.71	1.71	94	96	10.0	249				3 min / point
			2.2	1.71	1.71	93	95	10.0	250				
			2.2	1.71	1.71	93	94	10.5	250				
			2.2	1.71	1.71	94	93	10.5	250				
			2.2	1.71	1.71	95	95	10.5	249				Reading every 5 minutes
43.9	1103		2.2	1.71	1.71	97	98	10.5	250				
			2.2	1.71	1.71	98	99	10.5	248				
			2.2	1.73	1.73	99	101	10.5	249				
			2.2	1.73	1.73	101	102	10.5	248				
			2.2	1.73	1.73	103	104	10.5	247				
			2.2	1.73	1.73	102	105	10.5	249				
			2.2	1.73	1.73	104	107	10.5	249				
13.1	1133		2.2	1.74	1.74	105	106	10.5	248				
			2.0	1.58	1.58	104	106	10.0	249				Estimates:
			2.0	1.58	1.58	105	107	10.0	248				MW = 28.1
			2.0	1.58	1.58	105	109	10.0	250				%H ₂ O = 17.3
			2.0	1.58	1.58	106	109	10.0	252				

SYSTEM LEAK CHECK		PITOT LEAK CHECK		Impinger		Impinger		Difference	
Before	After	Before	After	No.	Contents	Final	Initial		
				1.	KAD + Carbonate	2046.3	1152.8	793.5	
				2.	100 mL D.E. 4.0	560.7	528.3	32.4	
				3.	100 mL D.E. 4.0	545.6	545.4	0.2	
				4.	Empty	432.1	424.8	7.3	
				5.	200g Silica Gel	682.8	632.8	50.0	

SYSTEM LEAK CHECK		PITOT LEAK CHECK		Impinger		Impinger		Difference	
Before	After	Before	After	No.	Contents	Final	Initial		
				1.	KAD + Carbonate	2046.3	1152.8	793.5	
				2.	100 mL D.E. 4.0	560.7	528.3	32.4	
				3.	100 mL D.E. 4.0	545.6	545.4	0.2	
				4.	Empty	432.1	424.8	7.3	
				5.	200g Silica Gel	682.8	632.8	50.0	

SYSTEM LEAK CHECK		PITOT LEAK CHECK		Impinger		Impinger		Difference	
Before	After	Before	After	No.	Contents	Final	Initial		
				1.	KAD + Carbonate	2046.3	1152.8	793.5	
				2.	100 mL D.E. 4.0	560.7	528.3	32.4	
				3.	100 mL D.E. 4.0	545.6	545.4	0.2	
				4.	Empty	432.1	424.8	7.3	
				5.	200g Silica Gel	682.8	632.8	50.0	

Time = 90 min
 Volume = 69.11 scf
 AQE 202 (AP) = 2.2
 (ΔH) = 1.9
 Velocity = 132.0 ft/sec
 ISO = 95.676
 KEYSTONE
 INTERNATIONAL
 2, 6, 10 = 883.4

STACK SAMPLING DATA SHEET

Page 2 of 4

CLIENT Bethell / DOE TEST DATE 6-23-93 ORIFICE CORRECTION 1.673 HOT BOX NO. 8
 TEST UNIT Stack - Hot Side TEST NO. C-6-MM5-623 METER CORRECTION 0.9912 COLD BOX NO. B+35
 PROJECT NO. 93 C 28-01 NOZZLE (SIZE, #) 0.192 G14 CALIBRATION DATE 5-19-93 PROBE NO. 10-3
 CONTROL BOX OPERATOR JPS STATIC PRESSURE -1.6" H₂O PITOT CORRECTION 0.84 FILTER NO. Quartz
 BAROMETRIC PRESSURE 27.62 PORT DIRECTION B CONTROL BOX NO. 4 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1228	358.164	2.0	1.58	1.58	105	107	10.0	255	~250°	~68°F	~250°	3 points/post 30 min/post
			2.0	1.58	1.58	100	105	11.0	257				
			2.0	1.58	1.58	101	105	11.0	257				Reading over 5 minutes
			2.0	1.58	1.58	100	101	11.0	257				
			2.0	1.58	1.58	97	99	11.0	256				
✓			2.0	1.56	1.56	96	98	11.0	256				
43.9	1258		2.0	1.56	1.56	98	100	11.0	254				
			2.0	1.56	1.56	100	100	11.0	254				
			2.0	1.56	1.56	100	103	11.0	254				
			2.0	1.56	1.56	100	102	11.0	254				
			2.0	1.56	1.56	102	103	11.0	253				
✓			2.0	1.56	1.56	101	103	11.0	255				
13.1	1328		1.8	1.40	1.40	101	105	10.5	254				
			1.8	1.40	1.40	101	103	10.5	255				
			1.8	1.40	1.40	103	104	10.5	252				Estimates:
			1.8	1.40	1.40	102	105	10.5	250				MW=28.1
			1.8	1.40	1.40	102	105	10.5	249				%H ₂ O=17.3
✓	1358	424.052	1.8	1.40	1.40	102	104	11.0	252				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	10.5	0.006
After	11.0	0.008

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	80	
CO	0	
N ₂	80.0	

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Velocity = 94.8 ft/sec
 Wt. = 0.777

D-34

Page #2
 Value
 TIME = 90 min
 VOLUME = 65,988 dcf
 AQE 2/92 (40) hrc = 1.9

Gr. Volume = 1.705

STACK SAMPLING DATA SHEET

Page 3 of 4

CLIENT <u>Battelle / DOE</u>		TEST DATE <u>6-23-93</u>		ORIFICE CORRECTION <u>1.673</u>		HOT BOX NO. <u>8</u>	
TEST UNIT <u>Stack - Hot Side</u>		TEST NO. <u>C-6a - MM15 - 623</u>		METER CORRECTION <u>0.9912</u>		COLD BOX NO. <u>8+3B</u>	
PROJECT NO. <u>93C628-01</u>		NOZZLE (SIZE) <u>0.192 G14</u>		CALIBRATION DATE <u>5-19-93</u>		PROBE NO. <u>10-3</u>	
CONTROL BOX OPERATOR <u>JYS</u>		STATIC PRESSURE <u>-1.64 H2O</u>		PITOT CORRECTION <u>0.84</u>		FILTER NO. <u>Quantity</u>	
BAROMETRIC PRESSURE <u>27.62</u>		PORT DIRECTION <u>A</u>		CONTROL BOX NO. <u>4</u>		STACK DIA. <u>25"</u>	

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot Δ P (in. H2O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H2O)	Act. (in. H2O)	In (°F)	Out (°F)						
88.8	1432	424.251	1.8	1.41	1.41	103	105	10.5	252	~250	<68°F	~250	3 points per
			1.8	1.41	1.41	100	102	10.5	254				3 min / point
			1.8	1.41	1.41	101	105	11.5	254				
			1.8	1.41	1.41	102	103	12.0	255				
			1.8	1.41	1.41	102	104	12.0	256				
			1.8	1.41	1.41	102	104	12.0	257				
✓ 43.9	1502		1.8	1.41	1.41	104	105	12.0	257				
			1.8	1.41	1.41	102	107	12.0	258				
			1.8	1.41	1.41	104	106	12.0	259				
			1.8	1.41	1.41	105	107	12.0	266				
			1.8	1.40	1.40	105	108	12.0	265				
✓ 13.1	1532		1.8	1.40	1.40	106	107	12.0	258				
			1.8	1.40	1.40	106	108	12.0	260				
			1.8	1.40	1.40	106	107	12.0	254				
			1.8	1.40	1.40	106	109	12.0	258				Estimates:
			1.8	1.40	1.40	106	108	12.0	260				MW = 28.1
			1.8	1.40	1.40	105	108	12.0	259				% H2O = (7.3)
✓ 1602	186.979		1.8	1.40	1.40	105	108	12.0	260				

SYSTEM LEAK CHECK		PITOT LEAK CHECK	
Vacuum (in. Hg)	DGM Rate (cfm)	Before	Positive
Before 11.0	0.008	After	Negative
After 12.0	0.010		

Impinger Contents		Final		Initial		Difference	
Impinger No.							
1.							
2.							
3.							
4.							
5.							

Bag #1
 TIME = 90 min
 Volume = 62.728 dcf
 AQE 2/92 (AP) AS = 1.8
 (144) ... = 1.41

velocity = 92.8 ft/sec
 T₃₀ = 95.5 °C

STACK SAMPLING DATA SHEET

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CLIENT Battelle / DOE TEST DATE 6-23-93 ORIFICE CORRECTION 1.673 HOT BOX NO. 8
 TEST UNIT Stack - 767 side TEST NO. C-60-MM5-623 METER CORRECTION 0.9912 COLD BOX NO. 8+35
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) 0.192 G14 CALIBRATION DATE 5-19-93 PROBE NO. 10-3
 CONTROL BOX OPERATOR JTS STATIC PRESSURE -1.6" H₂O PITOT CORRECTION 0.84 FILTER NO. Quantity
 BAROMETRIC PRESSURE 27.62 PORT DIRECTION D CONTROL BOX NO. 4 STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1638	487.160	2.1	1.66	1.66	107	108	13.0	255	~250°	<68°F	~250°	3 points/pt
			2.1	1.66	1.66	106	110	13.0	256				30 min./point
			2.1	1.66	1.66	106	109	14.0	256				Readings every
			2.1	1.66	1.66	105	108	14.5	256				5 minutes
			2.1	1.66	1.66	104	106	15.0	252				
43.9	1708		2.1	1.66	1.66	103	106	15.0	251				
			2.1	1.66	1.66	102	105	15.0	252				
			2.1	1.66	1.66	101	104	15.0	253				
			2.1	1.66	1.66	103	105	15.0	254				
			2.1	1.66	1.66	104	105	15.0	253				
13.1	1738		2.1	1.66	1.66	105	106	15.0	251				
			2.1	1.66	1.66	104	106	15.0	251				
			2.1	1.66	1.66	102	103	14.0	252				
			2.1	1.66	1.66	100	102	14.0	253				
			2.1	1.66	1.66	98	101	14.0	253				Estimates:
1808	536.296		2.1	1.66	1.66	97	100	14.0	251				MW=28.1
			2.1	1.66	1.66	97	100	14.0	251				%H ₂ O= 17.3
			2.1	1.66	1.66	97	100	15.0	251				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	12.0	0.010
After	15.0	0.610

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Temperature = 153°C

Impinger

No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

velocity = 1000 ft/sec
 T_{amb} = 97.19

KEYSTONE
 Environmental Systems Inc.

D-36

Page 4 of 4
 DOE 2/92

TIME = 90 min
 volume = 69.136 dcf
 (AP)_{avg} = 2.1

PARTICULATE 'ELD DATA

PLANT 6-26-93 AMBIENT TEMPERATURE 27.70
 DATE 9A Inlet BAROMETRIC PRESSURE 11
 LOCATION 13' ASSUMED MOISTURE, % 20.5
 OPERATOR 5 Organel PROBE LENGTH, in. 205
 STACK NO. 5 NOZZLE DIAMETER, in. 205
 RUN NO. 5 STACK DIAMETER, in. 205
 SAMPLE BOX NO. 5 PROBE HEATER SETTING 5
 METER BOX NO. 5 HEATER BOX SETTING 5

METER $\frac{1}{16}$, 1.6
 C FACTOR 65

WEIGHT OF PARTICULATE COLLECTED, mg			
SAMPLE	FILTER	PROBE WASH	
FINAL WEIGHT			
TARE WEIGHT			
WEIGHT GAIN			
TOTAL			

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (V _p), (ft/s) ²	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	XAD-2 IMP VELOCITY f/s
							INLET (T _{inlet}), °F	OUTLET (T _{outlet}), °F				
						356.01						
1	0	09:40	273	0.2	0.40	360.1	84	81	260	234	6	70
2	5		281	1.2	0.95	361.8					9	45
3	10		292	1.6	1.25	365.1					10	
4	15	09:55	285	1.4	1.1							
1	0		272	0.6	0.48	368.0	84	82	260	238	7	68
2	5	10:03	297	1.3	1.05	371.0	84	82				48
3	10	10:13	302	0.95	0.95	373.7						
4	15		291	1.2		376.6						
1	0	10:25	273	1.2	0.95	380.6	86	84	262	243	12	
2	5	10:30	297	1.7	1.4	383.9					14 1/2	
3	10	10:35	304	2.1	1.5	387.4					18	64
4	15	10:40	292	1.8	1.45	391.3	87	84	262	222	18	48
TOTAL	20	10:45										

COMMENTS
 Pre lead check
 .015 at 22" Hg Vac

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml				ORSAT MEASUREMENT				TIME				CO ₂ , O ₂ , CO, N ₂			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
FINAL																	
INITIAL																	
LIQUID COLLECTED																	
TOTAL VOLUME COLLECTED																	

PARTICULATE FIELD DATA

PLANT 6-26-93

DATE 6-26-93

LOCATION _____

OPERATOR _____

STACK NO. _____

RUN NO. 5 C-4a MMS-626

SAMPLE BOX NO. _____

METER BOX NO. _____

AMBIENT TEMPERATURE _____

BAROMETRIC PRESSURE _____

ASSUMED MOISTURE, % _____

PROBE LENGTH, in. _____

NOZZLE DIAMETER, in. _____

STACK DIAMETER, in. _____

PROBE HEATER SETTING _____

HEATER BOX SETTING _____

METER ΔH _____

C FACTOR _____

PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		

TOTAL

TRAVERSE POINT NUMBER	SAMPLING TIME (H), min.	Time	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (V _p), (ft/s)	O ₂	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O	ACTUAL DESIRED	GAS SAMPLE VOLUME (V _m), (L)	GAS SAMPLE TEMPERATURE AT DRY GAS METER	INLET (T _{m in}), °F	OUTLET (T _{m out}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY ft/s
	0	10:50														
4	5			294	.38		.30		394.5	85	84					
3	10			305	0.74		.58		397.2							
2	15			296	.95	6.5	.75									
1	20															
1	5	11:12		298	.38		.58		403.9	86	84	264	263	261	7	64 44
2	10	11:17		319	1.2		.98		406.5							
3	15	11:22		319	1.4		1.1		410.1							
4	20	11:27		310	.98		1.80		413.3	87	84	263	237			
	0	11:33														
1	5			323	.85	5.0	.7		419.8						9	68 48
2	10	11:42		331	1.5		1.2		417.7	86	84	264	239	260	11	
3	15			318	1.1		.95									
4	20	11:55		317	.90		.70		423.2							
TOTAL																

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
FINAL																				
INITIAL																				
LIQUID COLLECTED																				

COMMENTS

Probe liner a controller inop; go to other controller (1)? go to variac?

PARTICULATE YIELD DATA

SCHEMATIC OF STACK

PLANT 6-26-93 AMBIENT TEMPERATURE METER $\frac{1}{H_p}$
DATE BAROMETRIC PRESSURE C FACTOR
LOCATION ASSUMED MOISTURE, % 11 PROCESS WEIGHT RATE
OPERATOR PROBE LENGTH, in.
STACK NO. 0.205 NOZZLE DIAMETER, in.
RUN NO. 5 C-42-1715-626 STACK DIAMETER, in.
SAMPLE BOX NO. PROBE HEATER SETTING
METER BOX NO. HEATER BOX SETTING

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min.	TIME	STACK TEMPERATURE (T _s), °F	VELOCITY (V _p), (ft/min)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m(in)}), °F	OUTLET (T _{m(out)}), °F	SAMPLE BOX TEMPERATURE °F	PROBES TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	XAD ?
1	5	11:59	336	0.6	0.45	425.9	87	85	264	#2 #10	7	IMP
2	10		336	1.1	0.9					264 263	10	67 45
3	15	12:08	324	1.4	1.1	430.8	88	85	265	249	11	
4	20		320	1.4	1.1	434.0					12	65 44
	0											
1	5	12:19	342	0.3	0.22	435.9	87	85	264	269 263	6	
2	10		342	0.85	0.68	437.7					12	
3	15	12:30	328	1.2	0.98	440.1	88	86	265	248	11	66 44
4	20		317	0.8	0.64	442.9	88	check; before				
	0				STOP	444.80						
1	5	14:15	343	0.3	0.22	445.44	check; before			253 263	5	67 48
2	10		348	0.9	0.68	448.0	"				7 1/2	
3	15	14:25	354	1.4	1.1	450.1	91	88	262	249 265	10	
4	20		354	1.4	1.1	453.3						
TOTAL						455.7						

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT				TIME	CO, O ₂ , CO, N ₂			
	1	2	3	4		1	2	3	4		CO ₂	O ₂	CO	N ₂
FINAL														
INITIAL														
LIQUID COLLECTED														
TOTAL VOLUME COLLECTED														

* Filter replaced;
check check before
at 18" Hg Vac.

PARTICULATE YIELD DATA

PLANT _____ AMBIENT TEMPERATURE _____ METER $\frac{1}{16}$ _____
DATE _____ BAROMETRIC PRESSURE _____ C FACTOR _____
LOCATION 4A ASSUMED MOISTURE, % _____ PROCESS WEIGHT RATE _____
OPERATOR _____ PROBE LENGTH, in. _____ WEIGHT OF PARTICULATE COLLECTED, mg
STACK NO. 5 NOZZLE DIAMETER, in. _____ FINAL WEIGHT _____
RUN NO. C-4a MMS-626 STACK DIAMETER, in. _____ TARE WEIGHT _____
SAMPLE BOX NO. _____ PROBE HEATER SETTING _____ WEIGHT GAIN _____
METER BOX NO. _____ HEATER BOX SETTING _____ TOTAL _____

TRAVERSE POINT NUMBER	SAMPLING TIME (g), min.	Time	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (1/2 ρ V _s ²) (in. H ₂ O)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (1/2 ρ V _s ²) (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m, in}), °F	OUTLET (T _{m, out}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY ft/min
1	0	14:38	349	1.5	1.39	436.0	90	89	262	280	7	69
2	5	14:38	350	1.4	1.2					266		32
3	10	14:48	353	1.3	1.05	461.7	91	88	262	258	10 1/2	64
4	15	14:48	363	1.5	1.2	465.0				269	11 1/2	45
1	0	15:00	355	1.52	1.4	467.0	91	89	265	285	7	70
2	5	15:00	*	1.4	1.2	469.9				263	11 1/2	62
3	10	15:10	*	1.6	1.2	473.9	91	90	263	262	10	67
4	15	15:20	*	0.85	0.68	479.0	91	91	264	290	13 1/2	48
1	0	15:22	364	1.68	1.2	481.4	94	91	262	269	13 1/2	
2	5	15:22	369	1.5	1.2	484.6						
3	10	15:38	370	1.5	1.2	487.5						
4	15	15:38	370	0.4	0.3							
TOTAL	20											

* Black TC erratic on this 1/2 of ESP duct. Also affects Fume-static electric/ESP? only on selected ducts?

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml				ORSAT MEASUREMENT				TIME			
FINAL	INITIAL	1	2	3	4	CO ₂	O ₂	CO	N ₂	1	2	3	4

PARTICULATE YIELD DATA

PLANT _____ AMBIENT TEMPERATURE _____ METER 1H₂ _____
 DATE _____ BAROMETRIC PRESSURE _____ C FACTOR _____
 LOCATION 4A ASSUMED MOISTURE, % _____ PROCESS WEIGHT RATE _____
 OPERATOR _____ PROBE LENGTH, in. _____
 STACK NO. _____ NOZZLE DIAMETER, in. _____
 RUN NO. 5 Oranges STACK DIAMETER, in. _____
 SAMPLE BOX NO. _____ PROBE HEATER SETTING _____
 METER BOX NO. _____ HEATER BOX SETTING _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (H), min.	Time STATIC PRESSURE (in. H ₂ O)	4 STACK TEMPERATURE (T _s), °F	10 ₂ VELOCITY HEAD (V _s), (V _{ps})		PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O ACTUAL DESIRED		GAS SAMPLE VOLUME (V _m), (ft ³)	6 7 GAS SAMPLE TEMPERATURE AT DRY GAS METER		3 SAMPLE BOX TEMPERATURE °F	Probes TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F		PUMP VACUUM in Hg gauge	XAD ± Imp VELOCITY ft/s
									INLET (T _{m IN}), °F	OUTLET (T _{m OUT}), °F					
	0	15:48													
1	5		358	.45		.34		489.6	92	91	263	285	263	3 1/2	74 58
2	10	15:58	377	0.75		0.58		492.0						11	
3	15		376	1.0		0.8		493.5							66 44
4	20	16:00	372	0.9	5.0	0.7		496.4	93	92	261	258	262	12 1/2	
	0	16:05													
1	5		360	.6		.45		498.8	94	92	262	280	263	10	
2	10	16:11	363	1.4		1.1		500.9						15	
3	15		374	1.5		1.15		504.3	99	92	261	268	262	18	70 44
4	20	16:21	374	1.6	5.0	1.25		507.4							
	0	16:27													
1	5		374	0.8		0.62		510.1	99	93	262	290	262	10	79 56
2	10	16:34	373	1.6		1.25		513.0						18	
3	15	16:38	374	1.4		1.1		515.9	99	93	260	269	261	18	71 43
4	20	16:44	378	1.8	5.0	1.0	1.4	518.7							
TOTAL															
AVERAGE															

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT					
	1	2	3	4		TIME	CO ₂	O ₂	CO	N ₂	
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					
TOTAL VOLUME COLLECTED						4					

COMMENTS

D-41

PARTICULATE YIELD DATA

METER 1H, _____
 C FACTOR _____
 PROCESS WEIGHT RATE _____
 WEIGHT OF PARTICULATE COLLECTED, mg
 SAMPLE FILTER PROBE WASH
 FINAL WEIGHT
 TARE WEIGHT
 WEIGHT GAIN
 TOTAL

PLANT _____
 DATE 6-26-93
 LOCATION 94
 OPERATOR _____
 STACK NO. 5
 RUN NO. 5
 SAMPLE BOX NO. _____
 METER BOX NO. _____
 AMBIENT TEMPERATURE _____
 BAROMETRIC PRESSURE _____
 ASSUMED MOISTURE, % _____
 PROBE LENGTH, in. _____
 NOZZLE DIAMETER, in. _____
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING _____
 HEATER BOX SETTING _____

TRAVERSE POINT NUMBER	SAMPLING TIME (g), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (in. ΔP _s)	VELOCITY (ft/min)	DIFFERENTIAL PRESSURE ACROSS ORIFICE METER (in. H ₂ O)	ACTUAL DESIRED	GAS SAMPLE VOLUME (V _m), (ft ³)	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m,in}), °F	OUTLET (T _{m,out}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY (ft/min)
1	0	16.50	363	1.4	1.4	1.1	1.1	521.8	94	93	254	286	11	50
2	5	16.57	367	1.5	6.0	1.0	1.0	524.7	94	93	254	272	18 1/2	74
3	10	16.57	364	1.7	1.7	1.0	1.0	527.2					18 1/2	48
4	15	17.10	STOP					533.0						
5	20													
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Post Leak Check, 18/12/93
 02 cfm at 18/12/93
 with flow line, w/o S/S pre
 with S/S at 4/14g, 0.12 cfm

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml	SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
1	2	3	4					
2								
3								
FINAL								
INITIAL								

NOMOGRAPH DATA

PLANT Coal Creek
 DATE 6/26/93
 SAMPLING LOCATION ESP outlet west side
C-5A-MM5-626

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H ₂ O	$\Delta H_{\odot}$	1.78
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m\text{ avg.}}$	90
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	10
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	27.87
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073 \times \text{STACK GAUGE PRESSURE in in. H}_2\text{O}$)	P_s	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	
AVERAGE STACK TEMPERATURE, °F	$T_{s\text{ avg.}}$	345
AVERAGE VELOCITY HEAD, in. H ₂ O	$\Delta p_{\text{ avg.}}$	0.70
MAXIMUM VELOCITY HEAD, in. H ₂ O	$\Delta p_{\text{ max.}}$	
C FACTOR		0.96
CALCULATED NOZZLE DIAMETER, in.		0.260
ACTUAL NOZZLE DIAMETER, in.		0.247
REFERENCE Δp , in. H ₂ O		0.75

EPA (Dur) 234
 4/72

PAHICULAI ELD DAIA

METER IN, 1.78
C FACTOR 0.96
PROCESS WEIGHT RATE

AMBIENT TEMPERATURE 60°F
BAROMETRIC PRESSURE 27.87
ASSUMED MOISTURE, % 10
PROBE LENGTH, in. 1380. place
NOZZLE DIAMETER, in. 0.247
STACK DIAMETER, in.
PROBE HEATER SETTING 250°F
HEATER BOX SETTING 250°F

PLANT coal Creek
DATE 6/26/93
LOCATION ESP outlet side
OPERATOR Lowery, Hupp
STACK NO.
RUN NO. C-5A-1795-626
SAMPLE BOX NO.
METER BOX NO. X40513

SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min	probe Temp of APPAR. PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (V _p) (1/16")	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _m), °F	OUTLET (T _m), °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY ft/min
1-1280	9:35	252	324	0.92	2.20	839.423	63	62	54	12.0	45
1-1180	9:40	256	325	0.90	2.15	834.7	63	61	55	12.0	43
1-1080	9:45	274	323	0.90	2.15	839.1	66	62	55	10.6	44
1-980	9:50	266	324	0.85	2.10	843.2	68	63	70.0 imp.	10.0	44
1-880	9:55	261	323	0.82	2.00	847.3	69	63		7.5	45
1-780	10:00	260	322	0.82	2.00	851.3	72	66		9.3	45
1-680	10:05	261	322	0.75	1.85	855.3	73	68		8.0	46
1-580	10:10	256	322	0.90	1.90	859.1	73	68		9.0	47
1-480	10:15	253	320	0.63	1.50	863.0	73	67		7.0	48
1-380	10:20	227	333	0.75	1.85	866.607	70	69	64	8.6	48
1-280	10:25	245	332	0.93	2.00	870.3	73	69	64	8.6	47
1-180	10:30	258	331	0.82	2.00	874.0	74	69	62	9.2	47
1-80	10:35	270	331	0.80	1.90	878.1	75	69	62	9.0	47
1-70	10:40	268	329	0.90	1.90	881.9	75	70	60		
TOTAL											

70489
72891

COMMENTS

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
	1	2	3	4							
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					

PARTICULATE FIELD DATA

METER ΔH 1.78
C FACTOR 0.96

PROCESS WEIGHT RATE _____

AMBIENT TEMPERATURE 65°
BAROMETRIC PRESSURE _____

ASSUMED MOISTURE, % 27.88

PROBE LENGTH, in. 1380 phase

NOZZLE DIAMETER, in. 0.247

STACK DIAMETER, in. _____

PROBE HEATER SETTING 250°F

HEATER BOX SETTING 250°F

SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min.	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (V _p), (1/12) ³	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (1/12) ³	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE (T _m), °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in Hg gauge	AD2 OUTLET OF VELOCITY tap
3-780	10:54	265	0.78	1.20	885.9	76	60	9.1	48
3-680	10:59	325	0.72	1.75	889.7	76	59	9.0	47
3-580	11:04	323	0.73	1.80	893.6	76	57	9.0	47
3-480	11:09	324	0.62	1.50	897.3	77	55	9.0	42
	11:14 off				901.136				
4-1280	11:18 on	335	0.63	1.50	901.136	75	275	8.1	49
4-1180	11:23	335	0.63	1.50	904.7	75	275	8.2	48
4-1080	11:28	333	0.62	1.50	908.2	77	275	8.1	48
4-980	11:33	332	0.60	1.40	911.9	78	273	8.0	48
4-880	11:38	333	0.60	1.40	915.5	78	272	7.4	48
4-780	11:43	329	0.60	1.40	919.0	76	271	7.3	48
4-680	11:49	328	0.63	1.50	922.4	78	272	7.2	49
4-580	11:53	325	0.58	1.40	925.8	77	270	7.2	50
4-480	11:58	322	0.58	1.40	929.1	78	271	7.2	51
TOTAL	12:03 off				932.565				

90 + 90

COMMENTS

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
	1	2	3	4							
FINAL											
INITIAL											
LIQUID COLLECTED											
TOTAL VOLUME COLLECTED											

PARTICULATE FIELD DATA

PLANT Coal Creek
 DATE 6/26/93
 LOCATION ESP outlet west side
 OPERATOR Leonard, Nappa
 STACK NO. _____
 RUN NO. C-5A-MM5-626
 SAMPLE BOX NO. _____
 METER BOX NO. X40573

AMBIENT TEMPERATURE 68
 BAROMETRIC PRESSURE 27.86
 ASSUMED MOISTURE, % 10
 PROBE LENGTH, in. 13 ft. glass
 NOZZLE DIAMETER, in. 0.247
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING 250°F
 HEATER BOX SETTING 250°F

METER η , 1.78
 C FACTOR 0.96
 PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Probe Temp of Static Pressure (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (AP _s) (1/2 ρ V _s ²)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	AD-2 OUTLET OF VELOCITY
					ACTUAL	DESIRED		INLET (T _{m,in}), °F	OUTLET (T _{m,out}), °F				
5-12A	12:07	245	342	0.55	1.30	1.30	932.565	76	75	60.273	60	7.0	54
5-11A	12:12	252	343	0.60	1.45	1.45	935.8	78	75	270	55	7.0	50
5-10A	12:17	273	345	0.56	1.35	1.35	939.6	77	73	265	54	7.2	50
5-9A	12:22	265	345	0.60	1.45	1.45	942.9	78	74	270	56	7.2	50
5-8A	12:27	272	347	0.62	1.50	1.50	946.3	78	74	271	55	7.3	52
5-7A	12:32	270	347	0.55	1.30	1.30	949.7	80	76	272	56	7.0	51
5-6A	12:37	260	346	0.65	1.60	1.60	953.0	77	73	270	55	7.8	50
5-5A	12:42	257	349	0.60	1.45	1.45	956.5	76	73	270	55	7.6	50
5-4A	12:47	249	348	0.57	1.40	1.40	960.0	75	72	271	55	7.5	51
	12:52 off						963.348						
7-12A	12:57 on	228	347	0.64	1.55	1.55	963.348	76	75	274	61	7.3	54
7-11A	13:02	240	347	0.66	1.60	1.60	967.0	75	73	270	56	7.7	52
7-10A	13:07	252	346	0.57	1.40	1.40	970.2	77	74	271	56	7.7	53
7-9A	13:12	267	348	0.58	1.40	1.40	973.6	76	73	271	58	7.8	53
7-8A	13:17	265	346	0.57	1.40	1.40	977.0	76	74	270	58	7.8	53
TOTAL													

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT				
	1	2	3	4						
FINAL						1				
INITIAL						2				
LIQUID COLLECTED						3				

COMMENTS

92490
 91499
 static pressure + 5.0" H₂O

PARTICULATE ELD DATA

METER $1H_2$ 1.78
 C FACTOR 0.96
 PROCESS WEIGHT RATE _____
 WEIGHT OF PARTICULATE COLLECTED, mg _____

AMBIENT TEMPERATURE 70°
 BAROMETRIC PRESSURE 27.88
 ASSUMED MOISTURE, % 10
 PROBE LENGTH, in. 13 ft. glass
 NOZZLE DIAMETER, in. 0.247
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING 250°F
 HEATER BOX SETTING 250°F

PLANT Coal Creek
 DATE 6/26/93
 LOCATION ESP outlet side
 OPERATOR Senardi, Hupp
 STACK NO. _____
 RUN NO. C-5A-MM5-626
 SAMPLE BOX NO. _____
 METER BOX NO. 40513

SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (g), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (V _p), (1/P _s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O) ACTUAL DESIRED	GAS SAMPLE VOLUME (V _m), ft. ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING OR CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	APPROXIMATE VELOCITY ft/s
7-780	13:22	266	350	0.62	1.50 1.50	980.4	77	74	272	56	7.8	53
7-680	13:27	256	348	0.65	1.60 1.60	983.8	78	74	271	56	8.0	53
7-580	13:32	254	350	0.66	1.60 1.60	987.3	77	73	271	56	8.0	53
7-480	13:37	255	350	0.68	1.60 1.60	990.8	80	76	272	60	8.0	54
8-1280	13:42	236	348	0.67	1.60 1.60	994.386	78	75	274	66	7.3	54
8-1180	13:51	243	345	0.62	1.50 1.50	997.5	77	74	271	55	7.8	53
8-1080	13:56	256	345	0.74	1.80 1.80	1000.9	76	73	270	56	8.8	53
8-980	14:01	269	345	0.68	1.60 1.60	1004.4	80	25	272	60	8.8	54
8-880	14:06	270	350	0.70	1.70 1.70	1008.1	82	77	273	63	8.8	55
8-780	14:11	265	349	0.72	1.75 1.75	1011.7	81	76	272	62	8.8	54
8-680	14:16	265	349	0.58	1.40 1.40	1015.4	82	76	271	60	8.0	55
8-580	14:21	273	350	0.50	1.20 1.20	1018.9	84	79	273	62	7.2	56
8-480	14:26	271	350	0.37	0.89 0.89	1022.4	87	81	275	65		
TOTAL	14:36 off					1025.474						

91490

COMMENTS

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml				SILICA GEL WEIGHT, g				ORSAT MEASUREMENT				TIME				CO ₂ O ₂ CO N ₂			
FINAL		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
INITIAL																					
LIQUID COLLECTED																					
TOTAL VOLUME COLLECTED																					

PARTICULATE ELD DATA

PLANT Coal Creek AMBIENT TEMPERATURE 80° METER ΔH , 1.78
 DATE 6/26/93 BAROMETRIC PRESSURE 27.88 C FACTOR 0.96
 LOCATION ESP outlet south ASSUMED MOISTURE, % 10 PROCESS WEIGHT RATE _____
 OPERATOR Lemars, Nappa PROBE LENGTH, in. 13.87 phase
 STACK NO. _____ NOZZLE DIAMETER, in. 0.247
 RUN NO. C-5A-MMS-626 STACK DIAMETER, in. _____
 SAMPLE BOX NO. _____ PROBE HEATER SETTING 250°F
 METER BOX NO. X 40573 HEATER BOX SETTING 250°F

TRAVERSE POINT NUMBER	SAMPLING TIME (min-sec)	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (V _p) (1/V _p ²)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O) ACTUAL DESIRED	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING OR CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	XAD-2 OUTLET OF VELOCITY
							INLET (T _{m,in}), °F	OUTLET (T _{m,out}), °F				
6-12.00	14:35.00	2.32	346	0.57	1.40	1025.474	84	80	274	72	7.8	60
6-11.00	14:40	2.45	348	0.62	1.50	1028.6	85	80	272	63	7.8	59
6-10.00	14:45	2.73	347	0.70	1.70	1032.0	87	81	273	63	8.2	58
6-9.00	14:50	2.68	349	0.70	1.70	1036.7	91	85	274	69	8.4	59
6-8.00	14:55	2.71	348	0.72	1.75	1037.3	89	84	275	67	8.8	59
6-7.00	15:00	2.61	349	0.76	1.85	1043.0	89	84	273	67	9.2	59
6-6.00	15:05	2.61	350	0.70	1.70	1046.9	90	84	274	66	9.0	60
6-5.00	15:10	2.63	352	0.72	1.75	1050.7	90	84	274	63	9.0	60
6-4.00	15:15	2.63	351	0.64	1.50	1054.5	92	86	273	63	8.5	59
6-3.00	15:20.00					1058.571						
2-12.00	15:24.00	2.42	331	0.95	2.30	1059.571	89	86	273	64	11.0	61
2-11.00	15:29	2.66	332	0.95	2.20	1062.9	96	90	273	63	11.0	61
2-10.00	15:34	2.75	332	0.76	1.85	1067.4	98	92	276	65	9.0	62
2-9.00	15:39	2.76	330	0.75	1.85	1071.4	96	91	275	61	9.0	61
2-8.00	15:44	2.73	331	0.69	1.60	1075.3	96	93	275	62	8.5	61
TOTAL												
AVERAGE												

92.590
92.592
COMMENTS static pressure + 5.0" H₂O

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
	1	2	3	4						
FINAL										
INITIAL										

PLANT Coal Creek
DATE 6/26/93
LOCATION ESP on the west side
OPERATOR Leonard, Hugo
STACK NO. _____
RUN NO. C-5A-MM5-62
SAMPLE BOX NO. _____
METER BOX NO. X40513

AMBIENT TEMPERATURE 80°
 BAROMETRIC PRESSURE 27.98
 ASSUMED MOISTURE, % 10
 PROBE LENGTH, in. 13.80 glass
 NOZZLE DIAMETER, in. 0.247
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING 250°F
 HEATER BOX SETTING 250°F

METER AM, 1.78

C FACTOR 0.96

PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL

[illegible]

AVERAGE

Leak check 0.019 at 14" H₂O. 92+92

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g
	1	2	3	4	
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N
1					
2					
3					
4					

COMMENTS

static pressure $+ 4.90'' \text{ H}_2\text{O}$

STACK SAMPLING DATA SHEET

Page 1 of 4

CLIENT Bath & DE TEST DATE 6-28-93 (sat.) ORIFICE CORRECTION 1.673 HOT BOX NO. 8
 TEST UNIT Stack - Hot Side TEST NO. C-62-MMS-628 METER CORRECTION 0.9912 COLD BOX NO. 8+33
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) 0.192 G14 CALIBRATION DATE 5-19-93 PROBE NO. 10-3
 CONTROL BOX OPERATOR JPS STATIC PRESSURE -1.8" H₂O PITOT CORRECTION 0.84 FILTER NO. Quantity
 BAROMETRIC PRESSURE 27.70 PORT DIRECTION C CONTROL BOX NO. 4 STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
28.8	0900	826.890	2.1	1.65	1.65	85	84	7.5	228	-250°	468°F	~250°	3 probes/part
			2.1	1.65	1.65	84	84	8.5	226				30 min/part
			2.1	1.65	1.65	85	85	8.5	227				Readings every
			2.1	1.65	1.65	87	86	8.5	224		52°		5 minutes
			2.1	1.65	1.65	88	89	9.0	223				
			2.1	1.65	1.65	89	90	9.0	223				
43.9	0930		2.0	1.57	1.57	90	91	8.0	223				
			2.0	1.57	1.57	88	90	8.0	222				
			2.0	1.60	1.60	89	91	8.0	221				
			2.0	1.60	1.60	89	91	8.0	222				
			2.0	1.60	1.60	90	93	8.0	221				
			2.0	1.60	1.60	90	93	8.0	222				
13.1	1000		2.0	1.60	1.60	91	94	8.0	221				
			2.0	1.60	1.60	92	95	8.0	221				
			2.0	1.62	1.62	92	93	8.0	222		48°		Estimates:
			2.0	1.62	1.62	93	96	8.0	221				MW= 28.7
			2.0	1.62	1.62	92	95	8.0	222				%H ₂ O= 17.3
			2.0	1.62	1.62	93	94	8.0	222				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	7.0	0.010
After	9.0	0.005

PITOT LEAK CHECK 15 sec

	Positive	Negative
Before	OK	OK
After	OK	OK

CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Impinger

No.	XAD + Contents	Final	Initial	Difference
1.	Condensate	2146.8	1752.5	894.3
2.	Wet D. A. H ₂ O	497.1	492.8	4.3
3.	Wet D. A. H ₂ O	544.9	544.2	0.7
4.	Empty	447.0	426.3	20.7
5.	Silica Gel	688.6	635.1	53.5

velocity = 95.4 ft/sec
 T_{ED} = 98.4°

4973.5g total
KEYSTONE
 1100 BROADWAY, PITTSBURGH, PA 15204

D-50

Page #1
 velocity

TIME = 90 min
 volume = 67.810 dcf
 (AP) avg = 2.0
 AQE 2/92

STACK SAMPLING DATA SHEET

Page 2 of 4

CLIENT Battelle DOE TEST DATE 6-25-93 (Sat.) ORIFICE CORRECTION 1.673 HOT BOX NO. 8
 TEST UNIT Stack - Hot Side TEST NO. C-60-MM5-628 METER CORRECTION 0.9912 COLD BOX NO. 8 + 3B
 PROJECT NO. 93C-28-01 NOZZLE (SIZE, #) 0.192 G14 CALIBRATION DATE 5-19-93 PROBE NO. 10-3
 CONTROL BOX OPERATOR JPS STATIC PRESSURE -1.8" H₂O PITOT CORRECTION 0.84 FILTER NO. Quincy
 BAROMETRIC PRESSURE 27.70 PORT DIRECTION B CONTROL BOX NO. 4 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1047	894.820	1.8	1.46	1.46	93	93	10.0	227	~250°	468°F	~250°	3 points/port
			1.8	1.46	1.46	92	94	10.0	228		47°		30 min/port
			1.8	1.46	1.46	92	94	10.0	228				Readings over
			1.8	1.46	1.46	93	94	10.0	227				5 minutes
			1.8	1.45	1.45	91	95	10.0	228				
↓			1.8	1.45	1.45	91	95	10.0	228		46°		
43.9	1117		1.8	1.45	1.45	92	95	10.0	228				
			1.8	1.45	1.45	92	95	10.0	227				
			1.8	1.45	1.45	93	94	10.0	227				
			1.8	1.45	1.45	92	94	10.0	228				
			1.8	1.45	1.45	92	96	10.0	227				
↓			1.8	1.45	1.45	94	95	10.0	228				
13.1	1147		1.8	1.45	1.45	92	95	10.0	227				
			1.8	1.45	1.45	93	97	10.0	227				
			1.8	1.45	1.45	94	95	10.0	227				Estimates:
			1.8	1.45	1.45	92	95	10.0	227				MW= 28.1
			1.8	1.45	1.45	93	97	10.0	227		43°		%H ₂ O= 17.3
↓	1217	959.226	1.8	1.45	1.45	93	95	10.0	228				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	9.0	0.005
After	10.0	0.010

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Temperature = 94°F
 T₁ = 72.7°F

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

velocity = 90.7 ft/sec
 ISO. = 98.1%

D-51

Page #2
 values

TIME = 90 min
 VOLUME = 64.406 dcf
 (AP)_{AVG} = 1.8
 (ΔH)_{AVG} = 1.45

AQE 2/92

STACK SAMPLING DATA SHEET

Page 3 of 4

CLIENT Battelle / DOE TEST DATE 6-28-93 (Sat.) ORIFICE CORRECTION 1.673 HOT BOX NO. 8
 TEST UNIT Stack - Hot Side TEST NO. C-6-MM5-625 METER CORRECTION 0.9912 COLD BOX NO. 8+3B
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) 0.192 G14 CALIBRATION DATE 5-19-93 PROBE NO. 10-3
 CONTROL BOX OPERATOR JTS STATIC PRESSURE -1.8" H₂O PITOT CORRECTION 0.84 FILTER NO. Quarterly
 BAROMETRIC PRESSURE 27.70 PORT DIRECTION A CONTROL BOX NO. 4 STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1240	959.413	1.8	1.45	1.45	91	94	10.0	229	~250°	~68°F	~250°	3 points / port 30 min / point
			1.8	1.45	1.45	92	96	11.0	231				
			1.8	1.44	1.44	94	94	11.0	230				Readings every 5 minutes
			1.8	1.44	1.44	92	95	11.0	229				
			1.8	1.44	1.44	92	94	11.0	229				
			1.8	1.44	1.44	92	93	11.0	230				
43.9	1310		1.7	1.36	1.36	92	94	11.0	230				
			1.7	1.36	1.36	91	93	11.0	229				
			1.7	1.36	1.36	92	95	11.0	229				
			1.7	1.36	1.36	92	93	11.0	229				
			1.7	1.36	1.36	93	95	11.0	230				
			1.7	1.36	1.36	93	94	11.0	231				
13.1	1340		1.7	1.36	1.36	94	96	11.0	230				
			1.7	1.36	1.36	95	94	11.0	230				
			1.7	1.36	1.36	94	97	11.0	230				Estimates:
			1.7	1.36	1.36	93	95	11.0	229				MW=28.1
			1.7	1.36	1.36	93	97	11.0	230				%H ₂ O=17.3
	1410	1023.323	1.7	1.36	1.36	92	97	11.0	229		49°F		

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	10.0	0.010
After	11.0	0.010

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

velocity = 88.4 ft/sec
 ISO. = 100.3%

KEYSTONE
 Environmental & Safety Solutions

Page #3
 Value
 TIME = 90 min
 VOLUME = 63.910 dcf
 (AP) AVG = 1.7
 AQE 2/92

STACK SAMPLING DATA SHEET

Page 4 of 4

CLIENT Battelle / DOE TEST DATE 6-25-93 (Sat.) ORIFICE CORRECTION 1.673 HOT BOX NO. 8
 TEST UNIT Stack - Hot Side TEST NO. C-62-MM5-628 METER CORRECTION 0.9912 COLD BOX NO. 8+3B
 PROJECT NO. 93C628-01 NOZZLE (SIZE, #) 0.192 G14 CALIBRATION DATE 5-19-93 PROBE NO. 10-3
 CONTROL BOX OPERATOR JPB STATIC PRESSURE -1.8" H₂O PITOT CORRECTION 0.84 FILTER NO. Quincy
 BAROMETRIC PRESSURE 27.70 PORT DIRECTION D CONTROL BOX NO. 4 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcl)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1447	1023.687	2.0	1.58	1.58	87	90	13.0	230	~250°	~68°F	~250°	3 points/port 30 min/port Readings every 5 minutes
			2.0	1.58	1.58	85	88	13.0	230				
			2.0	1.58	1.58	82	86	13.0	231				
			2.0	1.57	1.57	80	82	13.0	231				
			2.0	1.57	1.57	80	82	13.0	231				
43.9	1517		2.0	1.57	1.57	80	78	14.0	229				
			2.0	1.57	1.57	81	80	14.0	229				
			2.0	1.57	1.57	83	84	14.0	231				
			2.0	1.57	1.57	85	85	14.0	231				
			2.0	1.57	1.57	87	87	14.0	231				
13.1	1547		2.0	1.57	1.57	90	90	14.0	230				
			1.8	1.41	1.41	90	93	12.5	230				
			1.8	1.41	1.41	90	94	12.5	230				
			1.8	1.41	1.41	91	93	12.5	230				
			1.8	1.41	1.41	92	94	12.5	230				
			1.8	1.41	1.41	91	96	12.5	229				Estimates: MW = 28.1 %H ₂ O = 17.3
			1.8	1.41	1.41	92	95	12.5	228				
			1.8	1.41	1.41	92	95	12.5	228				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	11.0	0.010
After	14.0	0.010

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Boyle's Law
 TIME = 90 min
 VOLUME = ~~66.813~~ dcl
 (AP) AG = 1.9
 (Alt) AG = ~~1.52~~

(T_{meter}) = ~~87°F~~ 87°F
 T_{amb} = ~~72.0°F~~

velocity = ~~93.4~~ ft/sec
 ISO = 10059

D-2: Multi-Metals Trains

Left to right

PARTICULATE YIELD DATA

PLANT Co-op AMBIENT TEMPERATURE 100
 DATE 6-22-93 BAROMETRIC PRESSURE 27.62
 LOCATION 4A ASSUMED MOISTURE, % 18
 OPERATOR _____ PROBE LENGTH, in. _____
 STACK NO. _____ NOZZLE DIAMETER, in. _____
 RUN NO. 2 C-4 MUM 622 STACK DIAMETER, in. 0.205
 SAMPLE BOX NO. _____ PROBE HEATER SETTING _____
 METER BOX NO. 40513 HEATER BOX SETTING _____

METER ΔH_p _____
 C FACTOR _____
 PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Time, Approx STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (V _s P _s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O ACTUAL DESIRED	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m in}), °F OUTLET (T _{m out}), °F		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	Probes VELOCITY ft/s
	0	12:07				789.85						#2 #10
1	5			.8	.78				225			
2	10		375	1.5	1.35	794.0	105	103			6	
3	15		374	1.5	1.35						6	
4	20			2.0	1.8	801.0				72	7	
	0											
1	5	1:00	374	.85	.8	804.6	106	104	255		6	233 260
2	10		378	1.0	1.2	808.0				73	7 1/2	
3	15	1:12	388	1.4	1.4	811.1						
4	20			1.7	1.6							
	0											
1	5	1:24	379	0.75	0.7	818.7	108	106	259	76	5	256 20
2	10		382	1.7	1.55						8	
3	15	1:34	385	1.6	1.50	824.8					9	
4	20			1.7	1.53		109	107	258	67	10	
TOTAL												

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g
	1	2	3	4	
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
1					
2					
3					
4					

COMMENTS: Pre leak .01 cfm at 19'

PARTICULATE YIELD DATA

PLANT COOP N.D.
 DATE 6-22-97
 LOCATION 4A
 OPERATOR _____
 STACK NO. _____
 RUN NO. 2 C-4a MUM-62
 SAMPLE BOX NO. _____
 METER BOX NO. X-40513

AMBIENT TEMPERATURE _____
 BAROMETRIC PRESSURE _____
 ASSUMED MOISTURE, % _____
 PROBE LENGTH, in. _____
 NOZZLE DIAMETER, in. _____
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING _____
 HEATER BOX SETTING _____

METER ΔH_p _____
 C FACTOR _____
 PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP_s) (in. H ₂ O)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	Probes	
					ACTUAL	DESIRED		INLET (T _{m IN}), °F	OUTLET (T _{m OUT}), °F				#2	#10
	0													
1	5	1.44	378	1.0	.98		831.2	109	107	259	72	7		
2	10		385	1.3	1.2		834.1					10		
3	15		383	.95	.90		837.7					10	257	264
4	0	missed a point?												
1	5		370	.65	.62		841.2	109	107	262	68	10		
2	10	2.08	364	1.5	1.35							11 1/2		
3	15		388	1.6	1.5							14		
4	20	2.20	380	0.5	.48		852.5				75	11		
1	5	2.26	368	.45	0.4		854.6	109	108	261	erratic stack Temp	5	245	264
2	10			1.5	1.35		856.7					1		
3	15	2.37	368	1.7	1.6		860.2					13		
4	20			0.9	.82		863.5	111	109		75	12		
TOTAL														

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
	1	2	3	4							
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					

COMMENTS * You check at 90° = 0 (No)
 * Notice accuracy of probe to ground/shocking operator

PARTICULATE YIELD DATA

PLANT CO-OP IND METER ΔH_0 _____
 DATE 6-22-73 C FACTOR _____
 LOCATION _____ PROCESS WEIGHT RATE _____
 OPERATOR _____ WEIGHT OF PARTICULATE COLLECTED, mg
 STACK NO. C-11A-174M622 SAMPLE BOX NO. _____
 RUN NO. _____ HEATER BOX SETTING _____
 METER BOX NO. _____

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (g), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (1/2 ρ V _s ²)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m in}), °F	OUTLET (T _{m out}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	Notes
1	0	2:50	363	0.5	0.48	866.1	109	108	88	85	5	
2	5	3:00	364	1.3	1.3	868.0				73	8	
3	10	3:13	358	1.4	1.35	871.6	110	108	258		10	
4	15	3:26	350	1.7	1.6	874.1					12	
5	20	3:33	357	2.5	2.3	877.2				70	5	
6	5	3:46	346	1.0	0.95	879.7	109	108	258		9	
7	10	3:59	346	1.6	1.5	883.5					12 1/2	
8	15	4:12	331	1.3	1.25	885.2					13	
9	20	4:22	331	0.8	0.75	887.1	107	107			6	
10	5	4:32	331	0.8	0.75	892.3				71	8	
11	10					895.1					8	
12	15											
13	20											
14	0											
15	5											
16	10											
17	15											
18	20											
19	0											
20	5											
21	10											
22	15											
23	20											
24	0											
25	5											
26	10											
27	15											
28	20											
29	0											
30	5											
31	10											
32	15											
33	20											
34	0											
35	5											
36	10											
37	15											
38	20											
39	0											
40	5											
41	10											
42	15											
43	20											
44	0											
45	5											
46	10											
47	15											
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81	10											
82	15											
83	20											
84	0											
85	5											
86	10											
87	15											
88	20											
89	0											
90	5											
91	10											
92	15											
93	20											
94	0											
95	5											
96	10											
97	15											
98	20											
99	0											
100	5											

COMMENTS: * XNW measured at 90° NUL
 A Switch sides
 Stack TC problem only

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml	SILICA GEL WEIGHT, g
FINAL	1 2 3 4	1 2 3 4
INITIAL		
LIQUID COLLECTED		
TOTAL VOLUME COLLECTED		

PARTICULATE YIELD DATA

PLANT OWOL ND AMBIENT TEMPERATURE _____ METER ΔH_p _____

DATE 6-22-93 BAROMETRIC PRESSURE _____ C FACTOR _____

LOCATION 4A ASSUMED MOISTURE, % 18 PROCESS WEIGHT RATE _____

OPERATOR _____ PROBE LENGTH, in. _____

STACK NO. _____ NOZZLE DIAMETER, in. 0.205

RUN NO. 2 C-4a MUM-622 STACK DIAMETER, in. _____

SAMPLE BOX NO. _____ PROBE HEATER SETTING _____

METER BOX NO. _____ HEATER BOX SETTING _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Time. Approx	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (AP _s) (V _s)	VELOCITY (ft/min)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) (in. H ₂ O)	ACTUAL DESIRED	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER	INLET (T _{m IN}), °F	OUTLET (T _{m OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	Probes	VELOCITY ft/min
	0			4						6 7 3							#2/#10
1	5		4.35	350	.75		.70		897.8	897	107	107	267		8		
2	10				1.3		1.2		900.7						11		
3	15		4.45	341	1.5		1.4										
4	20						1.0										
1	5			337	0.9		.9		911.8	106	106	267			11		
2	10		5:07	342	1.7		1.6		914.0						15		
3	15			339	1.6	1.2	1.2								16		
4	20		5:17	332	0.9		0.9		920	105	105				15 1/2	236	264
1	5		5:26	306	0.7		0.7		923.8	105	104	266	73		12		
2	10				1.6		1.5								18		
3	15		5:36		1.0		1.0		929.3	107	107				7		
4	20			322	1.5		1.0		932.2	107	106	268	73		18		
TOTAL									934.265								

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	1	2	3	4	SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
FINAL							1				
INITIAL							2				
LIQUID COLLECTED							3				

COMMENTS:

PARTICULATE FIELD DATA

PLANT COOP N.Y. AMBIENT TEMPERATURE _____ METER ΔH_p _____
 DATE 6-22-93 BAROMETRIC PRESSURE _____ C FACTOR _____
 LOCATION 4A ASSUMED MOISTURE, % 18 PROCESS WEIGHT RATE _____
 OPERATOR _____ PROBE LENGTH, in. _____
 STACK NO. _____ NOZZLE DIAMETER, in. .205
 RUN NO. 2 CHMUM-622 STACK DIAMETER, in. _____
 SAMPLE BOX NO. _____ PROBE HEATER SETTING _____
 METER BOX NO. _____ HEATER BOX SETTING _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Time		STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP_s) (V _{SP})		PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (VH) in. H ₂ O	GAS SAMPLE VOLUME (V _m), l _i	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	Probe	
		Static Pressure (in. H ₂ O)	4		Actual	Desired			Inlet (T _{min}), °F	Outlet (T _{out}), °F				Velocity	Probe
	0														
1	5	6:11	281	.5	.48		935.2	107	107	268		4		#2	#10
2	10			.9	.9										
3	15	6:21	316	1.2	1.15		941.4					68	5	2x	267
4	20		304	0.6	.58		944.9					70			
	0														
1	5	6:33	280	1.2	1.2		946.6	109	108	269		68	6		
2	10			2.0	2.0								7 1/2		
3	15	6:44	309	2.2	2.15							67	9		
4	20			1.7	1.78		960.2	111	108				10		
	0														
1	5	6:58	279 262	0.48	.6	0.6	963.1				269		6		
2	10		307 262	1.5	1.5								9		
3	15		311	1.1	1.1		969.0	109	108					257	264
4	20	7:13	302	1.2	1.2		971.8								
TOTAL															

AVERAGE FLUX agrees with Nutech TC.

(STACK Temp) FLUX 33F ICE BATH
 OVER = 2.61

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g
	1	2	3	4	
FINAL					
INITIAL					
LIQUID COLLECTED					
WATER COLLECTED					

ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	H ₂
1					
2					
3					
4					

COMMENTS

Leak Check / Filter Change
 .02 efm

D-60

METER ΔH_p _____
C FACTOR _____
PROCESS WEIGHT RATE _____

[illegible]

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
	1	2	3	4							
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					

COMMENTS:

Post leak check w/o
S/S probe .014 ctn at 18"
with = Nil at 2 1/4"

NOMOGRAPH DATA

PLANT Coal Creek
 DATE 6/22/93
 SAMPLING LOCATION C-57A-MUM-622

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H ₂ O	ΔH_0	1.80
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\text{ avg.}}$	140
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{w0}	7
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	27.40
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073 \times$ STACK GAUGE PRESSURE in in. H ₂ O)	P_s	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1.0
AVERAGE STACK TEMPERATURE, °F	$T_{s\text{ avg.}}$	350
AVERAGE VELOCITY HEAD, in. H ₂ O	$\Delta P_{\text{avg.}}$	0.9
MAXIMUM VELOCITY HEAD, in. H ₂ O	$\Delta P_{\text{max.}}$	
C FACTOR		1.0
CALCULATED NOZZLE DIAMETER, in.		.130
ACTUAL NOZZLE DIAMETER, in.		.247
REFERENCE Δp , in. H ₂ O		0.70

EPA (Dur) 234
 4/72

PARTICULATE FIELD DATA

PLANT Coal Creek
 DATE 6/22/93
 LOCATION ESP outlet
 OPERATOR Lemay, Russ
 STACK NO. C-5A-MUM-622
 RUN NO. X-40513
 SAMPLE BOX NO. X-40513
 METER BOX NO. X-40513

AMBIENT TEMPERATURE 116°F
 BAROMETRIC PRESSURE 27.48
 ASSUMED MOISTURE, % 7
 PROCESS WEIGHT RATE 1680
 PROBE LENGTH, in. 1680
 NOZZLE DIAMETER, in. 0.247
 STACK DIAMETER, in. 250°F
 PROBE HEATER SETTING 250°F
 HEATER BOX SETTING 250°F

METER ΔH_0 1.00
 C FACTOR 1.0
 WEIGHT OF PARTICULATE COLLECTED, mg
 SAMPLE FILTER
 FINAL WEIGHT
 TARE WEIGHT
 WEIGHT GAIN
 TOTAL

nipple 14" from setting
 on probe to top of breeching
 SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Probe Temp Static Pressure (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (1/ρV _s ²)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔP) (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m,IN}), °F	OUTLET (T _{m,OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY f/s
1-1280	14:50:00	244	340	0.95	2.3	71.175	118	118	240	79	2.5	
1-1180	14:55	244	339	0.90	2.3	74.7	117	117	242	76	3.0	
1-1080	15:00	248	341	0.85	2.2	78.6	121	119	247	75	3.0	
1-980	15:05	249	341	0.80	2.1	83.1	122	119	247	70	3.0	
1-880	15:10	248	340	0.80	2.1	97.1	122	118	245	68	3.0	
1-780	15:15	242	337	0.78	2.0	91.7	118	115	245	66	3.0	
1-680	15:20	240	337	0.72	1.9	99.8	118	116	243	68	3.0	
1-580	15:25	244	338	0.50	1.3	103.9	117	116	250	71	3.0	
1-480	15:30	246	346	0.82	2.2	107.555	116	115	253	86	3.0	
2-1280	15:41 on	252	347	0.82	2.2	111.8	117	116	254	71	3.0	
2-1180	15:46	249	345	0.80	2.1	116.4	115	115	250	65	3.0	
2-1080	15:51	252	346	0.71	1.8	120.5	115	114	251	65	3.0	
2-980	15:56	251	346	0.61	1.6	124.6	116	115	250	68		
2-880	16:01											
TOTAL												
AVERAGE												

73 + 72

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml	SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
FINAL	1	2	3	4	5	6	7	8
INITIAL								
LIQUID COLLECTED								

COMMENTS: Static pressure = 0.12" H₂O

PARTICULATE ELD DATA

PLANT Coal Creek
 DATE 6/22/93
 LOCATION ESP OUTLET ^{WEST SIDE}
 OPERATOR Leonard, Kupp
 STACK NO. _____
 RUN NO. C-5A-MUM-622
 SAMPLE BOX NO. _____
 METER BOX NO. X-40513

AMBIENT TEMPERATURE 112°F
 BAROMETRIC PRESSURE _____
 ASSUMED MOISTURE, % 7
 PROBE LENGTH, in. 16.87 ^{glass}
 NOZZLE DIAMETER, in. 0.247
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING 250°F
 HEATER BOX SETTING 250°F

METER ΔH_g 1.80
 C FACTOR 1.0

PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	probe Temp. STACK PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (V ₁ P _s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY f/s
					ACTUAL	DESIRED		INLET (T _{m,IN}), °F	OUTLET (T _{m,OUT}), °F				
2-7.80	16:06	248	342	0.62	1.5	1.5	128.4	116	115	251	69	3.0	
2-6.80	16:11	246	342	0.70	1.85	1.85	132.0	112	111	250	68	3.0	
2-5.80	16:16	246	339	0.70	1.85	1.85	136.1	113	112	250	69	3.0	
2-4.80	16:21	246	340	0.68	1.80	1.80	140.1	113	111	251	65	3.0	
	16:26						143.984						
3-12.80	16:31	246	345	0.70	1.85	1.85	143.984	107	106	250	68	3.0	
3-11.80	16:36	246	346	0.70	1.85	1.85	147.9	104	105	247	59	3.0	
3-10.80	16:41	244	346	0.75	1.95	1.95	151.9	102	103	247	58	3.0	
3-9.80	16:46	245	347	0.80	2.1	2.1	155.9	101	102	248	60	3.0	
3-8.80	16:51	242	348	0.75	1.95	1.95	160.0	100	101	248	63	3.0	
3-7.80	16:56	246	343	0.75	1.95	1.95	164.1	98	98	248	62	3.5	
3-6.80	17:01	252	345	0.70	1.85	1.85	168.2	102	101	252	66	3.5	
3-5.80	17:06	252	340	0.65	1.70	1.70	172.3	104	101	253	67	3.5	
3-4.80	17:11	249	338	0.65	1.70	1.70	175.9	103	101	253	69	3.5	
	17:16						179.902						
TOTAL													
AVERAGE													

80480

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g
	1	2	3	4	
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
1					
2					
3					
4					

COMMENTS:

PARTICULATE FIELD DATA

PLANT Coal Creek AMBIENT TEMPERATURE 101 METER ΔH_g 1.80
 DATE 6/22/93 BAROMETRIC PRESSURE 7 C FACTOR 1.0
 LOCATION ESP outlet ASSUMED MOISTURE, % 7 PROCESS WEIGHT RATE 9800
 OPERATOR Leonard, Napp PROBE LENGTH, in. 16.870 WEIGHT OF PARTICULATE COLLECTED, mg
 STACK NO. C-5A-MUM-622 NOZZLE DIAMETER, in. 0.247 FINAL WEIGHT
 RUN NO. C-5A-MUM-622 STACK DIAMETER, in. 250°F TARE WEIGHT
 SAMPLE BOX NO. X40513 PROBE HEATER SETTING 250°F WEIGHT GAIN
 METER BOX NO. X40513 HEATER BOX SETTING 250°F TOTAL

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP) (in. H ₂ O)	VELOCITY (ft/min)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)	ACTUAL DESIRED	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m,in}), °F	OUTLET (T _{m,out}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING OR CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY f.p.s
4-12A	17:21	248	350	0.50	1.3	1.3	1.3	179.902	106	104	255	80	3.0	
4-11A	17:24	263	348	0.50	1.3	1.3	1.3	183.2	107	104	253	72	3.0	
4-10A	17:31	245	348	0.48	1.2	1.2	1.2	186.6	106	103	250	69	3.0	
4-9A	17:36	248	348	0.45	1.2	1.2	1.2	190.0	110	107	254	74	3.0	
4-8A	17:41	245	345	0.40	1.0	1.0	1.0	193.1	106	104	252	69	3.0	
4-7A	17:46	245	345	0.50	1.3	1.3	1.3	196.3	105	103	253	69	3.0	
4-6A	17:51	247	342	0.45	1.2	1.2	1.2	199.7	105	102	252	70	3.0	
4-5A	17:56	245	340	0.50	1.3	1.3	1.3	203.0	105	102	252	70	3.0	
4-4A	18:01	239	336	0.50	1.3	1.3	1.3	206.3	107	104	253	70	3.0	
AVERAGE	18:06							209.902						
5-12A	18:13	224	353	0.42	1.1	1.1	1.1	209.802	101	99	254	78	3.0	
5-11A	18:18	247	353	0.42	1.1	1.1	1.1	213.1	103	101	254	72	3.0	
5-10A	18:23	246	353	0.42	1.1	1.1	1.1	216.4	103	100	253	72	3.0	
5-9A	18:28	246	352	0.42	1.1	1.1	1.1	219.6	102	100	253	70	3.0	
5-8A	18:33	247	354	0.42	1.1	1.1	1.1	222.8	103	101	254	68	3.0	
TOTAL														

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml	SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
1	2	3	4	5	6	7	8	9
FINAL								
INITIAL								

COMMENTS: 17:30 temp high winds

PARTICULATE ELD DATA

PLANT Coal Creek AMBIENT TEMPERATURE 9.5 METER ΔH_p 1.80
 DATE 6/22/93 BAROMETRIC PRESSURE 7 C FACTOR 1.0
 LOCATION ESP Outlet ASSUMED MOISTURE, % 7 PROCESS WEIGHT RATE _____
 OPERATOR Leonard, Russ PROBE LENGTH, in. 16.00 WEIGHT OF PARTICULATE COLLECTED, mg _____
 STACK NO. _____ NOZZLE DIAMETER, in. 0.247 FINAL WEIGHT _____
 RUN NO. C-5A-MUM-622 STACK DIAMETER, in. _____ TARE WEIGHT _____
 SAMPLE BOX NO. _____ PROBE HEATER SETTING 250°F WEIGHT GAIN _____
 METER BOX NO. X40513 HEATER BOX SETTING 250°F TOTAL _____

SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (e), min.	probe Temp STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (in. H ₂ O)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg	VELOCITY fps
5-787	18:38	245	355	0.45	1.2	225.9	INLET (T _{m,IN}), °F	OUTLET (T _{m,OUT}), °F	253	68	3.0	
5-680	18:43	244	357	0.48	1.25	229.1	101	99	251	68	3.0	
5-685	18:48	241	358	0.50	1.3	232.3	98	97	253	68	3.0	
5-485	18:53	234	356	0.60	1.3	235.7	95	92	248	65	3.0	
6-1287	19:03	227	354	0.45	1.2	239.026	91	90	250	73	3.0	
6-1187	19:08	242	354	0.52	1.4	242.0	92	92	249	64	3.0	
6-1087	19:13	243	355	0.53	1.45	245.9	92	90	250	60	3.0	
6-985	19:18	246	353	0.57	1.50	249.1	92	89	250	58	3.0	
6-887	19:23	246	355	0.62	1.60	252.6	90	87	249	56	3.0	
6-787	19:28	246	357	0.62	1.60	255.9	90	87	249	59	3.0	
6-687	19:33	244	356	0.64	1.65	259.5	90	88	249	60	3.0	
6-587	19:38	237	355	0.67	1.50	263.2	88	86	249	61	3.0	
6-487	19:43	235	356	0.58	1.50	266.9	87	85	251	62	3.0	
TOTAL	19:48					270.903						

AVERAGE

COMMENTS:

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml				ORSAT MEASUREMENT				TIME			
1	2	3	4	5	6	CO ₂	O ₂	CO	N ₂	1	2	3	4
FINAL													
INITIAL													
LIQUID COLLECTED													
TOTAL VOLUME COLLECTED													

PARTICULATE ELD DATA

PLANT Coal Creek AMBIENT TEMPERATURE 85 METER ΔH_g 1.80
DATE 6/22/93 BAROMETRIC PRESSURE 7 C FACTOR 1.0
LOCATION ESP outlet side ASSUMED MOISTURE, % 9.44 PROCESS WEIGHT RATE _____
OPERATOR Bernard, Ralph PROBE LENGTH, in. 16.82 WEIGHT OF PARTICULATE COLLECTED, mg _____
STACK NO. _____ NOZZLE DIAMETER, in. 0.247 SAMPLE _____
RUN NO. C-5A-MUM-622 STACK DIAMETER, in. _____ FINAL WEIGHT _____
SAMPLE BOX NO. _____ PROBE HEATER SETTING 250°F TARE WEIGHT _____
METER BOX NO. X40513 HEATER BOX SETTING 250°F WEIGHT GAIN _____
TOTAL _____

SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Probe of Static Pressure (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (1/16" P ₃)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m in}), °F	OUTLET (T _{m out}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY ft/s
7-12.80	19:56	227	354	0.50	1.3	270.903	84	83	246	67	3.0	
7-11.80	20:01	245	354	0.58	1.5	294.4	85	83	249	63	3.0	
7-10.80	20:06	243	355	0.67	1.5	277.6	86	83	250	65	3.0	
7-9.80	20:11	242	356	0.50	1.3	281.2	86	83	250	64	3.0	
7-8.80	20:16	245	357	0.45	1.2	284.6	86	83	245	65	3.0	
7-7.80	20:21	245	356	0.45	1.2	288.6	85	82	250	67	3.0	
7-6.80	20:26	244	357	0.50	1.45	291.8	84	81	248	67	3.2	
7-5.80	20:31	245	358	0.58	1.50	294.4	83	81	248	68	3.2	
7-4.80	20:36	244	358	0.58	1.50	298.0	83	80	249	69	3.2	
	20:41.00					301.496						
8-12.80	20:51.00	230	355	0.55	1.45	301.496	79	78	251	74	3.0	
8-11.80	20:56	241	355	0.55	1.45	304.8	81	79	250	68	3.0	
8-10.80	21:01	242	355	0.59	1.50	308.3	82	79	250	65	3.0	
8-9.80	21:06	247	355	0.58	1.50	312.8	85	80	251	64	3.0	
9-8.80	21:11	247	354	0.58	1.50	315.7	85	80	251	63	3.0	
TOTAL												

91 + 89
92 + 91

COMMENTS:

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml			ORSAT MEASUREMENT			TIME			CO ₂ O ₂ CO N ₂		
1	2	3	4	5	1	2	3	1	2	3	1	2	3
FINAL													
INITIAL													

PLANT coal creek AMBIENT TEMPERATURE 84 METER ΔH_g 1.80
 DATE 6/22/93 BAROMETRIC PRESSURE _____ C FACTOR 1.0
 LOCATION ESP outlet west side ASSUMED MOISTURE, % 7 PROCESS WEIGHT RATE _____
 OPERATOR Leonard, Rupp PROBE LENGTH, in. 1680. piece
 STACK NO. _____ NOZZLE DIAMETER, in. 0.247
 RUN NO. C-5A-MUM-622 STACK DIAMETER, in. _____
 SAMPLE BOX NO. _____ PROBE HEATER SETTING 250°F
 METER BOX NO. X40513 HEATER BOX SETTING 250°F

[illegible]

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
	1	2	3	4							
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					
TOTAL VOLUME COLLECTED						4					

COMMENTS:
leak check .005 at 4PS

D-67

STACK SAMPLING DATA SHEET

Page 1 of 4

CLIENT Battelle / DOE TEST DATE 6-22-93 ORIFICE CORRECTION 1.673 HOT BOX NO. 6
 TEST UNIT Stack - Hot Side TEST NO. C-1662 MUM-622 METER CORRECTION 0.9912 COLD BOX NO. 643
 PROJECT NO. 93C020-01 NOZZLE (SIZE, I) 0.187 G11 CALIBRATION DATE 5-19-93 PROBE NO. 10-4
 CONTROL BOX OPERATOR JTS STATIC PRESSURE -1.6" H₂O PITOT CORRECTION 0.84 FILTER NO. Quarry
 BAROMETRIC PRESSURE 27.54 PORT DIRECTION C CONTROL BOX NO. 4 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (scf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1000	028.519	2.2	1.60	1.60	99	99	13.0	252	~250	48°C	~250	3 points / port
			2.2	1.60	1.60	99	99	13.0	257				30 min / port
			2.3	1.60	1.60	99	102	13.0	257				Readings array
			2.3	1.60	1.60	101	102	13.0	257				5 minutes
			2.3	1.60	1.60	100	102	13.0	255				
			2.3	1.60	1.60	102	104	13.0	253				
43.9	1030		2.3	1.60	1.60	102	106	13.0	253				
			2.3	1.63	1.63	103	104	13.0	252				
			2.3	1.63	1.63	104	107	13.0	252				
			2.3	1.63	1.63	104	107	13.0	252				
			2.3	1.63	1.63	103	106	13.0	251				
			2.3	1.63	1.63	105	106	13.0	252				
13.1	1100		2.1	1.48	1.48	105	107	12.0	251				
			2.1	1.48	1.48	106	108	12.0	251				
			2.1	1.50	1.50	106	110	12.5	252				Estimates:
			2.1	1.50	1.50	106	108	12.5	251				MW = 28.1
			2.1	1.50	1.50	106	108	13.0	252				% H ₂ O = 17.3
			2.1	1.50	1.50	106	108	13.0	252				
			2.1	1.50	1.50	108	110	13.0	251				
1130	096.122		2.1	1.50	1.50	108	110	13.0	251				

SYSTEM LEAK CHECK				PITOT LEAK CHECK				Impinger Contents				Difference	
	Vacuum (in. Hg)	DGM Rate (cfm)		Before	After	Positive	Negative	No.	Impinger	Final	Initial		
Before	5.0	0.005		OK 15 sec	OK 15 sec			1.	50mL D.I. H ₂ O	803.1	486.8	316.3	
After	13.0	0.018		OK 15 sec	OK 15 sec			2.3	150mL H ₂ O / H ₂ O ₂	854.5	452.6	401.9	
								8.4	150mL H ₂ O / H ₂ O ₂	781.3	585.1	196.2	
								8.5	Empty	383.5	380.0	3.5	
								8.6	100mL KMnO ₄	507.5	491.3	16.2	
								8.7	100mL KMnO ₄	584.3	547.3	37.0	
								7.8	200g Silica Gel	707.1	662.9	44.2	
													955.9

TIME = 90 min
 VOLUME = 67.603 scf
 (BP) AVG = 2.2

KEYSTONE

STACK SAMPLING DATA SHEET

Page 2 of 4

CLIENT Bethell DOE TEST DATE 6-22-93 ORIFICE CORRECTION 1.673 HOT BOX NO. 6
TEST UNIT Stack - Hot Side TEST NO. C-622-MJM-622 METER CORRECTION 0.9912 COLD BOX NO. 6-43
PROJECT NO. 93C628-01 NOZZLE (SIZE, #) 0.87 CALIBRATION DATE 5-19-93 PROBE NO. 10-4
CONTROL BOX OPERATOR JB STATIC PRESSURE -1.6" H₂O PITOT CORRECTION 0.84 FILTER NO. Q-257
BAROMETRIC PRESSURE 27.51 PORT DIRECTION B CONTROL BOX NO. 24 STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1151	096.310	2.1	1.50	1.50	107	107	13.0	253	~250	~68°F	~250	3 points / port
			2.1	1.50	1.50	107	107	14.0	253				30 min / port
			2.1	1.50	1.50	108	110	14.0	253				Readings every 5 minutes
			2.1	1.50	1.50	107	110	14.0	254				
			2.1	1.50	1.50	109	109	14.0	252				
✓			2.1	1.51	1.51	109	110	14.0	253				
43.9	1221		2.1	1.51	1.51	109	112	14.0	253				
			2.1	1.51	1.51	107	110	14.0	253				
			2.1	1.51	1.51	108	109	14.0	251				
			2.1	1.51	1.51	108	111	14.5	254				
			2.1	1.51	1.51	108	112	15.0	253				
✓			2.1	1.51	1.51	107	110	15.0	254				
13.1	1251		2.1	1.51	1.51	107	111	15.0	254				
			2.1	1.51	1.51	110	112	15.0	254				
			2.1	1.51	1.51	110	113	15.0	255				Estimates:
			2.1	1.51	1.51	110	112	15.0	256				MW = 28.1
			2.1	1.51	1.51	110	114	15.0	258				% H ₂ O = 17.3
✓	1321	161.460	2.1	1.51	1.51	110	114	15.0	259				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DCM Rate (cfm)
Before	13.0	0.018
After	15.0	0.010

Page #1
TIME = 90 min
volume = 65.150 dcf
(ΔP) / Δt = 2.1
(Δt) / ΔP = 1.51
AGE 2092

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Time = 110°F
T.T. = 1.1 - 1.21°F

Impinger Contents

No.	Final	Initial	Difference
1.			
2.			
3.			
4.			
5.

velocity = 100.2 ft/sec
ISO = 95.670

STACK SAMPLING DATA SHEET

CLIENT Bethelle / DSE TEST DATE 6-12-93 ORIFICE CORRECTION 1.673 HOT BOX NO. 6
 TEST UNIT Stack - Hot Side TEST NO. C-62-MUM-622 METER CORRECTION 0.9912 COLD BOX NO. 6+3
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) 0.187 CALIBRATION DATE 5-19-93 PROBE NO. 10-4
 CONTROL BOX OPERATOR STS STATIC PRESSURE -1.6" H₂O PITOT CORRECTION 0.84 FILTER NO. Q274
 BAROMETRIC PRESSURE 27.54 PORT DIRECTION A CONTROL BOX NO. 4 STACK DIA. 25" ID

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1341	161.733	2.0	1.42	1.42	112	115	14.0	256	~250°	~68°F	~250°	3 points / pit
			2.0	1.42	1.42	112	113	15.0	257				3 minutes / pit
			2.0	1.42	1.42	112	113	15.0	253				Readings gray
			2.0	1.42	1.42	110	113	15.0	254				5 minutes
			2.0	1.42	1.42	110	115	15.0	253				
			2.0	1.44	1.44	111	113	15.5	251				
			2.0	1.44	1.44	112	115	15.5	249				
43.9	1411		2.0	1.44	1.44	112	113	15.0	249				
			1.8	1.30	1.30	112	113	16.0	249				
			2.0	1.44	1.44	113	115	16.0	249				
			2.0	1.44	1.44	114	114	16.0	249				
			2.0	1.44	1.44	114	115	16.0	249				
			2.0	1.44	1.44	114	116	16.0	245				
			2.0	1.44	1.44	114	117	15.5	244				
13.1	1441		1.9	1.37	1.37	113	117	15.5	243				Estimates:
			1.9	1.37	1.37	113	115	15.5	244				MW=28.1
			1.9	1.37	1.37	114	117	15.5	243				% H ₂ O=17.3
			1.9	1.37	1.37	114	117	15.5	244				
			1.9	1.37	1.37	113	117	15.5	243				
			1.9	1.37	1.37	115	118	15.5	243				

SYSTEM LEAK CHECK		PITOT LEAK CHECK		IMPINGER CONTENTS		DIFFERENCE	
Before	After	Positive	Negative	Impinger No.	Final	Initial	Difference
				1.			
				2.			
				3.			
				4.			
				5.			

SYSTEM LEAK CHECK		PITOT LEAK CHECK		IMPINGER CONTENTS		DIFFERENCE	
Before	After	Positive	Negative	Impinger No.	Final	Initial	Difference
				1.			
				2.			
				3.			
				4.			
				5.

Velocity = 97.4 f/sec
 T₅₀ = 0.120

Page 4
 Time = 90 min
 Volume = 63.74 dcf
 ACE 2092 (AP) AG = 2.10

STACK SAMPLING DATA SHEET

Page 4 of 4

CLIENT Battelle/DRE TEST DATE 6-22-93 ORIFICE CORRECTION 1.673 HOT BOX NO. 6
TEST UNIT Stack - Hot Side TEST NO. C-62-MUM-1622 METER CORRECTION 0.9912 COLD BOX NO. 6+3
PROJECT NO. 93C628-01 NOZZLE (SIZE, #) 0.187 G11 CALIBRATION DATE 5-19-93 PROBE NO. 10-4
CONTROL BOX OPERATOR JD STATIC PRESSURE -1.6750 PITOT CORRECTION 0.84 FILTER NO. Q274
BAROMETRIC PRESSURE 27.54 PORT DIRECTION D CONTROL BOX NO. 4 STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (scf)	Pitot Δ P (in. H2O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd (in. H2O)	Act. (in. H2O)	In (°F)	Out (°F)						
88.8	1523	225.738	2.0	1.46	1.46	116	117	16.0	245	250	68°F	250	3 points per point
			2.0	1.46	1.46	114	118	16.0	246				3 points per point
			2.0	1.46	1.46	114	117	16.0	246				Recalling error
			2.0	1.46	1.46	114	117	16.0	246				5 minutes
			2.0	1.46	1.46	115	117	16.0	247				
43.9	1553		2.0	1.46	1.46	115	118	16.0	246				
			2.0	1.46	1.46	115	119	16.0	246				
			1.9	1.39	1.39	115	118	15.5	245				
			1.9	1.39	1.39	116	119	15.5	246				
			1.9	1.39	1.39	118	116	15.5	245				
			1.9	1.39	1.39	116	118	15.5	246				
13.1	1623		1.9	1.39	1.39	117	119	15.5	246				
			1.9	1.39	1.39	118	119	15.5	248				Estimates:
			1.9	1.39	1.39	118	120	15.5	248				MW=28.1
			1.9	1.39	1.39	116	121	15.5	250				%H2O=17.3
			1.9	1.39	1.39	117	119	16.5	248				

SYSTEM LEAK CHECK		PITOT LEAK CHECK		Impinger		Impinger		Difference	
Before	After	Before	After	No.	Contents	No.	Initial	Final	
				1.		1.			
				2.		2.			
				3.		3.			
				4.		4.			
				5.		5.

Velocity = 97.2 ft/sec
Iso. = 92.8%

SYSTEM LEAK CHECK		PITOT LEAK CHECK	
Before	After	Before	After

SYSTEM LEAK CHECK		PITOT LEAK CHECK	
Before	After	Before	After

Page #4
Time = 90 min
Volume = 62.8 ft def
AOE 2002 (AP) AO = 2.0
Velocity
(Alt) Ave = 1.42

PARTICULATE YIELD DATA

PLANT CO-OP N.D. AMBIENT TEMPERATURE 27.63
 DATE 6-24-93 BAROMETRIC PRESSURE 18
 LOCATION 4A ASSUMED MOISTURE, % 18
 OPERATOR _____ PROBE LENGTH, in. _____
 STACK NO. 4 C-4a-MUM624 NOZZLE DIAMETER, in. _____
 RUN NO. _____ STACK DIAMETER, in. _____
 SAMPLE BOX NO. 6837984 PROBE HEATER SETTING _____
 METER BOX NO. GM SN HEATER BOX SETTING _____

SCHEMATIC OF STACK

CROSS SECTION

METER ΔH 1.64 Ref AVG
 C FACTOR 0.65 ΔH^2

PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (a), min.	TIME	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (in. H ₂ O)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY f/s
							INLET (T _{m,in}), °F	OUTLET (T _{m,out}), °F				
1	5	10:57	361	1.4	1.7	172.832	89	87	279	240	4	Imp
2	10	11:07	359	1.4	1.4	179.4	90	87		235	5	66
3	15		355	1.7	1.65	186.2						
4	20		358	1.7	1.65							
1	5	11:19	355	.85	.9	189.8	91	89	257	252	5	
2	10		360	1.4	1.4	192.9				236	6	
3	15	11:30	368	1.4	1.4	195.8	92	90		265	6.12	
4	20		368	1.6	1.35	200.1						
1	5	11:43	355	.75	.63	202.	91	90	292	251	5	68
2	10	11:49	363	1.5	1.25	208.4	93	91	264	236	7	
3	15		371	1.5	1.25	211.9						
4	20	12:00	374	1.6	1.4							
TOTAL												

COMMENTS

Card checked .022 at 18%
 with test line
 Reset c Factor / Ref ΔH = 2.2

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml			SILICA GEL WEIGHT, g			ORSAT MEASUREMENT			TIME			CO ₂ O ₂ CO N ₂		
1		1	2	3	4			1								
2								2								
3								3								
FINAL																
INITIAL																
LIQUID COLLECTED																

PARTICULATE YIELD DATA

PLANT CO-OP NW AMBIENT TEMPERATURE 27.63
DATE 6-24-93 BAROMETRIC PRESSURE 18
LOCATION 4A ASSUMED MOISTURE, % 18
OPERATOR _____ PROBE LENGTH, in. 203
STACK NO. 9 C-46 NW 624 NOZZLE DIAMETER, in. _____
RUN NO. _____ STACK DIAMETER, in. _____
SAMPLE BOX NO. _____ PROBE HEATER SETTING _____
METER BOX NO. _____ HEATER BOX SETTING _____

SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (V _p), (ft/s) ²	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), (l)	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	Probes	PUMP VACUUM in. Hg gauge	VELOCITY ft/s
							INLET (T _m), °F	OUTLET (T _m), °F				
					ACTUAL DESIRED							
1	0	12:05	358	0.6	0.5	214.9	93	91	268	#2 #11	5 1/2	65
2	5		364	0.85	0.7	217.3				250 266	6	65
3	10		367	1.2	1.0	220-			284 272		7 1/2	63
4	20	12:20	365	0.9	0.8	223-	94	91				67
1	0	12:26	350	0.7	0.6	225.8						65
2	5		350	1.5	1.3	228.6	97	95	270	249 265	7	70
3	10	12:35	361	1.5	1.3	231.4					7 1/2	65
4	20		362	0.3	0.5							
1	0	12:48	352	0.48	0.4	236.3	93	92	268	250 264	5	70
2	5		340	1.4	1.2	239.						
3	10	13:00	356	1.7	1.4	242.1	94	92	269	2	9	
4	20		363	0.85	0.7	244.9						
TOTAL												
AVERAGE												

COMMENTS

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				ORSAT MEASUREMENT				TIME				CO ₂ O ₂ CO N ₂			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
FINAL																
INITIAL																
LIQUID COLLECTED																
TOTAL VOLUME COLLECTED

AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

3 of 5

PARTICULATE YIELD DATA

PLANT CO-OP AMBIENT TEMPERATURE 100
 DATE 6-24-93 BAROMETRIC PRESSURE 27.63
 LOCATION 4A ASSUMED MOISTURE, % 18
 OPERATOR _____ PROBE LENGTH, in. _____
 STACK NO. _____ NOZZLE DIAMETER, in. .205
 RUN NO. 4 CHA-MU-624 STACK DIAMETER, in. _____
 SAMPLE BOX NO. _____ PROBE HEATER SETTING _____
 METER BOX NO. _____ HEATER BOX SETTING _____

METER ΔH 1.64
 C FACTOR 0.76 ΔP 2.4
 PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	TIME	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s), (ΔP _s), in. H ₂ O	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH), in. H ₂ O	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER	INLET (T _{m,IN}), °F	OUTLET (T _{m,OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	Imp VELOCITY ft/s
	0	13:23									#2 #10		
1	5		347	.4	.32	247.4	93	92	268		240	4	
2	10		355	1.5	1.2	250.8					267	9	
3	15		356	1.4	1.15								
4	20	13:25	356	1.5	1.2	255.2	94	93	268			9	62
	0	13:42											74
1	5	13:47	342	.25	.2	258.5						9	
2	10	13:52	349	.95	.8	259.9	94	93	268				
3	15	13:57	346	1.5	1.25	262.9							
4	20	14:02				269.5	STOP Change filter End leak check				242	266	10
	0	15:05				269.7							3 1/2
1	5		336	.25	1.9								
2	10	15:12	334	.8	.66	272.2	93	93	260		235	267	
3	15			1.1	0.9								4
4	20	15:20	313	0.85	0.6	277.3	95	94					
TOTAL													

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g
	1	2	3	4	
FINAL					
INITIAL					
LIQUID COLLECTED					

ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
1					
2					
3					

COMMENTS

change filter leak rate at 11" Hg = .01 cfm

⊗ Reset Nomograph for 12" Hg

PARTICULATE YIELD DATA

PLANT 6-24-93 AMBIENT TEMPERATURE _____
DATE 6-24-93 BAROMETRIC PRESSURE _____
LOCATION QA ASSUMED MOISTURE, % 12
OPERATOR _____ PROBE LENGTH, in. _____
STACK NO. _____ NOZZLE DIAMETER, in. _____
RUN NO. 4 C-4a-M47-624 STACK DIAMETER, in. _____
SAMPLE BOX NO. _____ PROBE HEATER SETTING _____
METER BOX NO. _____ HEATER BOX SETTING _____

WEIGHT OF PARTICULATE COLLECTED, mg			
SAMPLE	FILTER	PROBE WASH	
FINAL WEIGHT			
TARE WEIGHT			
WEIGHT GAIN			
TOTAL			

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min.	Time	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (in. H ₂ O)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER in. H ₂ O		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		Probes	PUMP VACUUM in. Hg	Imp OUTLET VELOCITY ft/s
					ACTUAL	DESIRED		INLET (T _{m in}), °F	OUTLET (T _{m out}), °F			
1	0											
1	5	15:28	326	1.65	0.5		279.5	94	94	262	4 1/2	62
2	10		338	1.2	.92		281.8					
3	15	15:42	328	1.6	1.25		287.5	96	99	264	5 1/2	
4	20		321	1.3	1.05							
1	0	15:50					290.8				5 1/2	64
2	5		329	0.8	.65							
3	10		333	1.5	1.2						7	
4	15	16:00	327	1.1	.9		296.4	96	94	265		
1	0	16:05	315	0.95	.72		299.3					
2	5	16:13	303	0.7	.58		301.9	92	91	263	5	72
3	10		319	1.3	1.05		304.3					
4	15		323	1.5	1.2		308.6	91	90		8 1/2	
1	0	16:29	311	.5	.38		310.8					
TOTAL												

AVERAGE

COMMENTS

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml				ORSAT MEASUREMENT				TIME			
FINAL		1	2	3	4	CO ₂	O ₂	CO	N ₂	1	2	3	4
INITIAL													
LIQUID COLLECTED													
TOTAL VOLUME COLLECTED													

PARTICULATE YIELD DATA

PLANT 60-08 ND AMBIENT TEMPERATURE 95
DATE 6-24-93 BAROMETRIC PRESSURE 27.63
LOCATION 9A ASSUMED MOISTURE, % 11
OPERATOR _____ PROBE LENGTH, in. _____
STACK NO. _____ NOZZLE DIAMETER, in. 0.205
RUN NO. 4 Match STACK DIAMETER, in. _____
SAMPLE BOX NO. _____ PROBE HEATER SETTING _____
METER BOX NO. _____ HEATER BOX SETTING _____

SCHEMATIC OF STACK

CROSS SECTION

WEIGHT OF PARTICULATE COLLECTED, mg			
SAMPLE	FILTER	PROBE WASH	
FINAL WEIGHT			
TARE WEIGHT			
WEIGHT GAIN			
TOTAL			

TRAVERSE POINT NUMBER	SAMPLING TIME (H), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (V _p), ft/s	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	PUMP VACUUM in. Hg gauge	VELOCITY ft/s
							INLET (T _{m,in}), °F	OUTLET (T _{m,out}), °F			
1	0		280	.5	.34	313.7	89	89	4	6	Lost Temp
2	5	16:41	301	1.1	.9	314.6			264		
3	10		308	.70	.58	317.0	91	89		7 1/2	
4	20		294	0.4	.32						
1	0	17:00	266	1.1	0.9	321.3	88	88	264	5 1/2	65
2	5	17:05	293	2.0	1.55	324.9				10	
3	10		302	2.3	1.8	326.8	89	87	264		
4	20	17:15	293	1.8	1.4	330.7					
1	0	17:21	273	.55	.43	334.0	88	87	264	4	70
2	5		297	1.3	1.0					6 1/2	67
3	10	17:30	302	1.1	0.9	339.3					
4	20		293	1.3	1.0	342.6	88	86	262		
TOTAL											

AVERAGE

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml			SILICA GEL WEIGHT, g			ORSAT MEASUREMENT			COMMENTS		
FINAL		1	2	3	4			CO ₂	O ₂	CO	N ₂		
INITIAL													
LIQUID COLLECTED													

E	
ATE COLLECTED, mg	
FILTER	PROBE WASH
TOTAL	

PUMP VACUUM in. Hg gauge	IMP VELOCITY fps
4 1/2	
8	
9 1/2	66
5	73
8	
11	
11 1/2	
6	77
9	
11	71
10	

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PARTICULATE 'ELD DATA

PLANT _____ DATE 6-24-93 LOCATION _____ OPERATOR _____ STACK NO. _____ RUN NO. 4 Metals SAMPLE BOX NO. _____ METER BOX NO. _____

AMBIENT TEMPERATURE _____ BAROMETRIC PRESSURE _____ ASSURED MOISTURE, % 11 PROBE LENGTH, in. _____ NOZZLE DIAMETER, in. .205 STACK DIAMETER, in. _____ PROBE HEATER SETTING _____ HEATER BOX SETTING _____

METER ΔH , _____ C FACTOR _____ PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Time	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s), (in. H ₂ O)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O		GAS SAMPLE VOLUME (V _m), (l)	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	Probes TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in Hg gauge	Last Imp VELOCITY fps
						ACTUAL	DESIRED		INLET (T _{m in}), °F	OUTLET (T _{m out}), °F				
	0	17:43			02							#2 #70		72
1	5			278	.5	.4		395.0	87	86	262		7 1/2	
2	10	17:49		294	1.3	5.0	1.05	396.8				238 260		
3	15			297	1.5	1.2		399.6					9	
4	20	18:03		290	1.4	1.15	STD (355.440)		88	86	262			
TOTAL														

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
	1	2	3	4							
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					
TOTAL VOLUME COLLECTED						4					

COMMENTS

Post leak check
 .02 cfm at 18 1/2" Hg V_o
 with flex line
 with SS probe, N₂

NOMOGRAPH DATA

PLANT coal Creek
DATE 6/24/93
SAMPLING LOCATION C-5A-MUM-624

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H ₂ O	$\Delta H_{@}$	1.80
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m\text{ avg.}}$	120
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	7%
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073 \times$ STACK GAUGE PRESSURE in in. H ₂ O)	P_s	5.0" H ₂ O
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1.0
AVERAGE STACK TEMPERATURE, °F	$T_{s\text{ avg.}}$	350
AVERAGE VELOCITY HEAD, in. H ₂ O	$\Delta p_{\text{ avg.}}$	0.60
MAXIMUM VELOCITY HEAD, in. H ₂ O	$\Delta p_{\text{ max.}}$	
C FACTOR		1.0
CALCULATED NOZZLE DIAMETER, in.		0.257
ACTUAL NOZZLE DIAMETER, in.		0.247
REFERENCE Δp , in. H ₂ O		0.70

EPA (Dur) 234
4/72

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DATE _____		CALCULATE COLLECTED, mg		FILTER PROBE WASH		TOTAL	IMP	PUMP VACUUM in Hg gauge	VELOCITY ft/s
2	2							10	
7	7							15	
7	7							17	67
7	7							13	
5	5							17 1/2	71
								5	
6	6							6 1/2	66
								6	

filter: 0.19 g/gay
at 18 ft/s

1.64

2.75

RATE

ICULATE COLLECTED, mg

FILTER PROBE WASH

TOTAL

IMP.

PUMP
VACUUM
in. Hg
gauge

VELOCITY
fps

66

66

62

62

62

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PARTICULATE FIELD DATA

PLANT Coal Creek

DATE 6/24/83

LOCATION Esposito side

OPERATOR Demond, Rupp

STACK NO. 0, 247

RUN NO. C-5A-MUM-624

SAMPLE BOX NO. 540513

METER BOX NO. 540513

SCHEMATIC OF STACK

CROSS SECTION

METER ΔH_0 1.80

C FACTOR 1.00

PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE FILTER PROBE WASH

FINAL WEIGHT

TARE WEIGHT

WEIGHT GAIN

TOTAL

AMBIENT TEMPERATURE 55

BAROMETRIC PRESSURE 27.63

ASSUMED MOISTURE, % 7

PROBE LENGTH, in. 16 ft. plus

NOZZLE DIAMETER, in. 0, 247

STACK DIAMETER, in. 250°F

PROBE HEATER SETTING 250°F

HEATER BOX SETTING 250°F

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (in. H ₂ O)	VELOCITY (V _s) (ft./min.)	ACTUAL DESIRED PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _m), °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER OUTLET (T _{out}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY fps
1-1280	10:29	218	334	0.61	160	1.60	598.712	56	56	242	47	3.5	
1-1180	10:34	219	334	0.80	185	1.85	592.0	59	57	275	49	3.8	
1-1080	10:39	222	337	0.83	190	1.90	595.4	60	57	278	51	3.8	
1-980	10:44	224	337	0.81	215	2.15	599.3	62	58	279	51	3.8	
1-880	10:49	234	338	0.91	240	2.40	603.2	63	59	278	53	4.1	
1-780	10:54	235	334	1.00	270	2.70	607.4	66	60	279	55	4.4	
1-680	10:59	240	333	1.0	270	2.70	611.7	66	61	280	55	4.5	
1-580	11:04	233	330	1.0	270	2.70	616.2	67	62	280	56		
1-480	11:09	232	330	1.0	270	2.70	622.429						
2-1280	11:34	216	326	0.90	210	2.10	622.4	62	61	280	54	4.4	
2-1180	11:39	236	326	0.88	240	2.40	626.7	63	62	280	57	4.5	
2-1080	11:44	244	327	0.74	190	1.90	631.0	62	64	280	53	4.0	
2-980	11:49	243	328	0.62	160	1.60	634.9	66	63	280	56	4.2	
2-880	11:54	238	325	0.62	160	1.60	638.5	65	62	278	57	3.8	
TOTAL													
AVERAGE													

91689

COMMENTS:

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml	SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
FINAL	1	2	3	4				
INITIAL								
LIQUID COLLECTED								
TOTAL VOLUME COLLECTED								

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PARTICULATE FIELD DATA

PLANT Coal Creek
 DATE 6/24/93
 LOCATION ESP outlet west side
 OPERATOR Leonard, R. J.
 STACK NO. _____
 RUN NO. C-5A-MUM-624
 SAMPLE BOX NO. _____
 METER BOX NO. 40513

AMBIENT TEMPERATURE 60°
 BAROMETRIC PRESSURE 27.63
 ASSUMED MOISTURE, % 7
 PROBE LENGTH, in. 16.50 glass
 NOZZLE DIAMETER, in. 0.247
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING 250°F
 HEATER BOX SETTING 250°F

METER ΔH_g 1.80
 C FACTOR 1.0
 PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	probe temp STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP_s) (in. H ₂ O)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY fps
2-6.00	11:59	235	325	0.70	1.85	640.0	65	62	278	55	4.0	
2-5.00	12:04	224	321	0.73	1.90	645.9	65	62	276	59	4.0	
2-4.00	12:09	228	322	0.90	2.30	649.6	67	64	277	56	4.3	
	12:14 off					653.890						
3-12.00	12:18 on	223	328	0.73	1.90	653.890	65	63	279	57	4.0	
3-11.00	12:23	235	326	0.75	2.0	657.5	66	64	279	47	4.0	
3-10.00	12:28	240	329	0.75	2.0	661.4	66	64	276	46	4.0	
3-9.00	12:33	236	328	0.85	2.2	665.4	67	64	277	47	4.2	
3-8.00	12:38	246	328	0.62	1.65	669.5	68	65	278	48	4.0	
3-7.00	12:43	237	329	0.75	2.0	673.3	68	65	279	49	4.2	
3-6.00	12:48	232	325	0.86	2.2	677.2	70	66	277	50	4.3	
3-5.00	12:53	227	321	0.89	2.3	681.2	70	66	278	50	4.4	
3-4.00	12:58	217	320	0.86	2.2	685.4	68	66	278	52	4.5	
	13:03 off					689.710						
4-12.00	13:08 on	205	332	0.63	1.65	689.710	67	65	279	56	4.0	
TOTAL												

AVERAGE

90488

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml	SILICA GEL WEIGHT, g	ORSAT MEASUREMENT				
	1	2	3	4	5	6	7
FINAL							
INITIAL							
LIQUID COLLECTED							

COMMENTS:

D-80

PARTICULATE FIELD DATA

PLANT Coal Creek AMBIENT TEMPERATURE 60°F
 DATE 6/24/93 BAROMETRIC PRESSURE 27.64
 LOCATION ESP outlet west ASSUMED MOISTURE, % 7
 OPERATOR Leonard, Napp PROBE LENGTH, in. 16 ft. plus
 STACK NO. NOZZLE DIAMETER, in. 0.247
 RUN NO. C-5A-MUM-624 STACK DIAMETER, in.
 SAMPLE BOX NO. PROBE HEATER SETTING 250°
 METER BOX NO. 240513 HEATER BOX SETTING 2500

SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (in. H ₂ O)	VELOCITY (ΔP _s) (in. H ₂ O)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m,in}), °F	GAS SAMPLE TEMPERATURE OUTLET (T _{m,out}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY f/s
4-1180	13:13	215	331	0.50	0.50	1.30	693.6	69	66	278	54	3.8	
4-1080	13:18	219	332	0.68	0.68	1.50	697.0	65	66	279	56	3.8	
4-980	13:23	223	332	0.55	0.55	1.45	700.0	70	67	278	57	3.8	
4-880	13:28	221	330	0.45	0.45	1.20	703.3	69	67	278	54	3.5	
4-780	13:33	216	331	0.43	0.43	1.10	706.5	68	66	279	53	3.0	
4-680	13:38	205	327	0.55	0.55	1.45	709.6	69	67	278	54	3.8	
4-580	13:43	208	327	0.65	0.65	1.70	713.0	70	68	276	56	3.9	
4-480	13:48	205	321	0.75	0.75	2.0	716.4	69	67	278	56	4.0	
5-1280	13:53	215	340	0.45	0.45	1.20	720.033	69	67	278	58	3.6	
5-1180	14:04	224	340	0.40	0.40	1.05	723.3	69	66	278	57	3.6	
5-1080	14:09	235	340	0.40	0.40	1.05	726.4	67	67	278	52	3.5	
5-980	14:14	235	341	0.49	0.49	1.30	729.4	68	66	276	58	3.5	
5-880	14:19	238	342	0.66	0.66	1.60	732.9	69	67	277	60	3.5	
5-780	14:24	245	343	0.66	0.66	1.60	736.1	68	66	276	60	3.5	
TOTAL													

72 x 90

COMMENTS:

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml	SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
FINAL			1					
INITIAL			2					
LIQUID COLLECTED			3					
TOTAL VOLUME COLLECTED			4					

740

PARTICULATE FIELD DATA

PLANT Cool Creek
 DATE 6/24/93
 LOCATION ESP outlet
 OPERATOR Bernard, Napp
 STACK NO. _____
 RUN NO. C-5A-MVM-624
 SAMPLE BOX NO. _____
 METER BOX NO. X40563

AMBIENT TEMPERATURE 65°
 BAROMETRIC PRESSURE 27.64
 ASSUMED MOISTURE, % 7
 PROBE LENGTH, in. 1650 glass
 NOZZLE DIAMETER, in. 0.247
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING 250°F
 HEATER BOX SETTING R500F

METER ΔH_p 1.80
 C FACTOR 1.00
 PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Probe Temp. of STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (ΔV _P)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O		GAS SAMPLE VOLUME (V _m), l	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY lps
					ACTUAL	DESIRED		INLET (T _{m,in}), °F	OUTLET (T _{m,out}), °F				
5-6 RT.	14:29	235	343	0.35	0.91	0.91	739.7	68	66	278	63	3.0	
5-5 RT.	14:34	226	346	0.40	1.05	1.05	742.6	68	66	278	64	3.0	
5-4 RT.	14:39	220	347	0.70	1.85	1.85	745.4	69	66	278	67	4.0	
	14:44 off						749.140						
7-12 RT.	14:50 on	245	344	0.24	0.66	0.66	749.140	67	66	278	64	2.5	
7-11 RT.	14:55	246	344	0.25	0.62	0.62	751.6	65	65	279	62	2.5	
7-10 RT.	15:00	246	343	0.33	0.87	0.87	753.8	64	63	278	60	3.0	
7-9 RT.	15:05	248	344	0.33	0.87	0.87	756.6	64	63	278	61	3.0	
7-8 RT.	15:10	238	344	0.27	0.70	0.70	759.1	62	61	278	60	2.8	
7-7 RT.	15:15	239	346	0.35	0.91	0.91	761.5	64	63	277	64	3.0	
7-6 RT.	15:20	236	346	0.40	1.05	1.05	764.1	66	64	278	61	3.0	
7-5 RT.	15:25	246	346	0.42	1.10	1.10	766.9	69	66	278	56	3.2	
7-4 RT.	15:30	247	346	0.30	0.78	0.78	769.9	70	67	278	56	2.8	
	15:35 off			0.36	0.94	0.94	772.485	71	69	278	56		
8-12 RT.	15:40 on	238	345	0.36	0.94	0.94	772.485	71	69	278	56	3.0	
TOTAL													

AVERAGE

91489

VOLUME OF LIQUID WATER COLLECTED	1	2	3	4	SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					

COMMENTS:

PARTICULATE FIELD DATA

PLANT Coal Creek
 DATE 6/24/93
 LOCATION ESP Outlet
 OPERATOR Leonard, Kupp
 STACK NO. _____
 RUN NO. C-5A-MUM-624
 SAMPLE BOX NO. _____
 METER BOX NO. X40513

AMBIENT TEMPERATURE 62
 BAROMETRIC PRESSURE 27.64
 ASSUMED MOISTURE, % 7
 PROBE LENGTH, in. 1600. glass
 NOZZLE DIAMETER, in. 0.247
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING 250°F
 HEATER BOX SETTING 1250°F

METER ΔH_0 1.80
 C FACTOR 1.0

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Probe Temp. of STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY fps
					ACTUAL	DESIRED		INLET (T _{min}), °F	OUTLET (T _{out}), °F				
8-11A7	15:45	238	346	0.32	0.84	0.84	775.4	73	70	278	54	3.0	
8-10A7	15:50	229	344	0.42	1.10	1.10	778.0	70	68	279	52	3.2	
8-9A7	15:55	230	345	0.46	1.20	1.20	780.9	70	68	278	54	3.2	
8-8A7	16:00	235	347	0.35	0.92	0.92	783.9	74	72	277	58	3.0	
8-7A7	16:05	243	346	0.35	0.92	0.92	786.8	71	69	278	58	3.0	
8-6A7	16:10	238	344	0.32	0.84	0.84	789.5	71	69	278	60	3.0	
8-5A7	16:15			0.37	0.95	0.95	792.4						
8-4A7	16:20			0.37	0.95	0.95	795.7						
	16:25						797.988						
6-12A7	16:35	246	341	0.40	1.05	1.05	797.988	74	73	278	66	3.2	
6-11A7	16:40	244	342	0.50	1.30	1.30	801.0	73	72				
6-10A7	16:45	239	342	0.60	1.54	1.54	804.1	70	69	279	66	3.8	
6-9A7	16:50	222	354	0.62	1.7	1.70	807.6	63	63	277	65	4.0	
6-8A7	16:55	217	356	0.62	1.70	1.70	811.3	66	66	278	73	4.0	
6-7A7	17:00	218	358	0.65	1.70	1.70	814.8	67	65	277	69	4.0	
TOTAL													

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g
	1	2	3	4	
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT

TIME	CO ₂	O ₂	CO	N ₂
1				
2				
3				
4				

COMMENTS:

92889

PLANT Coal Creek
DATE 6/24/93
LOCATION ESP on the ^{west} side
OPERATOR Lemard, Huff
STACK NO. _____
RUN NO. C-5A-MUM-624
SAMPLE BOX NO. _____
METER BOX NO. X 4051.3

AMBIENT TEMPERATURE 60°
 BAROMETRIC PRESSURE 27.62
 ASSUMED MOISTURE, % 7-11%
 PROBE LENGTH, in. 16 ft. 0 in.
 NOZZLE DIAMETER, in. 0.247
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING 250°F
 HEATER BOX SETTING 250°F

METER ΔH_p 1.80
C FACTOR 1.0
PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	<i>probe temp of static</i> PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY <i>✓</i> fps
					ACTUAL	DESIRED		INLET (T _{m IN}), °F	OUTLET (T _{m OUT}), °F				
6-6A	17:05	218	358	0.65	1.70	1.70	819.3	67	65	278	63	4.0	
6-5A	17:10	227	359	0.65	1.70	1.70	822.1	72	68	278	64	4.0	
6-4A	17:15	225	353	0.67	1.80	1.80	825.8	73	69	277	62		
	17:20 off						829.585			276	61		
TOTAL													
AVERAGE													

Leak check 0.018 at 6"Hg

AVERAGE

leaf chert 0.018 at 6" Hg

COMMENTS:

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
	1	2	3	4							
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					

STACK SAMPLING DATA SHEET

Page 1 of 4

CLIENT Battelle/DXE TEST DATE 6-24-93 ORIFICE CORRECTION 1.673 HOT BOX NO. 6
 TEST UNIT Stack - Hot side TEST NO. 0-100-MUM-624 METER CORRECTION 0.9912 COLD BOX NO. 643
 PROJECT NO. 93CB28-01 NOZZLE (SIZE, IN) 0.193 615 CALIBRATION DATE 5-19-93 PROBE NO. 10-4
 CONTROL BOX OPERATOR TBS STATIC PRESSURE -2.0" H₂O PITOT CORRECTION 0.84 FILTER NO. Quartz
 BAROMETRIC PRESSURE 27.54 PORT DIRECTION C CONTROL BOX NO. 4 STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dct)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1009	556.609	2.2	1.75	1.75	83	83	6.00	235	~250°	<68°F	~250°	3 points / port 30 min / point
			2.2	1.75	1.75	82	84	6.0	235				
			2.2	1.75	1.75	85	85	6.0	236				
			2.2	1.75	1.75	85	84	6.0	235				
			2.1	1.67	1.67	86	87	6.0	236				
↓			2.1	1.67	1.67	86	87	6.0	235				
43.9	1039		2.1	1.67	1.67	88	88	6.0	236				
			2.1	1.67	1.67	89	89	6.0	237				
			2.1	1.69	1.69	89	92	6.0	237				
			2.1	1.69	1.69	91	92	6.0	238				
			2.1	1.69	1.69	91	93	6.0	238				
↓			2.1	1.69	1.69	91	92	6.0	237				
13.1	1109		1.9	1.53	1.53	92	92	6.0	236				
			1.9	1.53	1.53	90	95	6.0	236				
			1.9	1.53	1.53	91	93	6.0	236				
			1.9	1.53	1.53	92	93	6.0	236				
			1.9	1.53	1.53	90	93	6.0	236				
↓	1139	624.925	1.9	1.53	1.53	93	93	6.0	237				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before	6.0	0.005
After	6.0	0.005

PITOT LEAK CHECK 15 sec

	Positive	Negative
Before	OK	OK
After	OK	OK

	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

(T_{stack})_{avg} = 89°F
 (T_{amb})_{avg} = 23.6°F

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	50 mL H ₂ O	1088.3	452.1	636.2
2.	Empty	732.1	453.0	279.1
3.	150 mL H ₂ O / H ₂ O ₂	655.4	598.3	57.1
4.	150 mL H ₂ O / H ₂ O ₂	618.2	616.2	2.0
5.	Empty	382.3	380.0	2.3
6.	100 mL KMnO ₄	565.4	564.8	0.6
7.	100 mL KMnO ₄	553.0	556.8	-3.8
8.	200 mg Silica Gel	710.8	661.7	49.1

Velocity = 91.0 ft/sec
 Iss. = 96.6%

Page #1
 Volume
 TIME = 90 min
 Volume = 68.316 dct
 (AP)_{avg} = 2.1
 (Alt)_{avg} = 1.65

total = 1022.0

KEYSTONE

STACK SAMPLING DATA SHEET

Page 2 of 4

CLIENT *Battelle / DOE* TEST DATE *6-24-93* ORIFICE CORRECTION *1.673* HOT BOX NO. *6*
 TEST UNIT *Stack - Hot side* TEST NO. *C-6a-MUM-624* METER CORRECTION *0.9912* COLD BOX NO. *643*
 PROJECT NO. *93C028-01* NOZZLE (SIZE, IN) *0.193 615* CALIBRATION DATE *5-19-93* PROBE NO. *10-4*
 CONTROL BOX OPERATOR *ITS* STATIC PRESSURE *-2.0" H₂O* PITOT CORRECTION *0.84* FILTER NO. *Quantity*
 BAROMETRIC PRESSURE *27.54* PORT DIRECTION *8* CONTROL BOX NO. *4* STACK DIA. *28"*

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcl)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1200	625.038	1.9	1.53	1.53	91	94	6.0	233	~250°	<68°F	250°	3 points / port 30 min / point
			1.9	1.53	1.53	91	93	6.0	235				
			1.9	1.53	1.53	91	93	6.0	234				
			1.8	1.43	1.43	92	92	5.5	234				Reading every 5 min / port
			1.8	1.43	1.43	90	92	5.5	235				
			1.8	1.45	1.45	90	93	6.0	234				
43.9	1230		1.8	1.45	1.45	90	93	6.0	235				
			1.8	1.45	1.45	92	92	6.0	235				
			1.8	1.45	1.45	90	94	6.5	235				
			1.8	1.45	1.45	90	94	7.0	235				
			1.8	1.45	1.45	91	92	7.0	236				
			1.7	1.37	1.37	92	92	7.0	233				
13.1	1300		1.6	1.29	1.29	90	94	6.5	231				
			1.6	1.29	1.29	92	93	6.5	231				
			1.5	1.21	1.21	92	94	7.0	233				Estimates:
			1.5	1.21	1.21	91	95	7.0	233				MW = 28.1
			1.5	1.21	1.21	91	95	7.0	234				%H ₂ O = 17.3
	1330	686.010	1.5	1.21	1.21	91	96	7.0	234				← Empty First Impinger

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	6.0	0.005
After	7.0	0.005

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Impinger

Impinger No.	Impinger Contents	Final	Initial	Impinger Difference
1.				
2.				
3.				
4.				
5.				

velocity = 88.9 ft/sec
 = 95.170

KEYSTONE
 ENVIRONMENTAL SYSTEMS, INC.

D-86

Page #2
 values

TIME = 90 min
 VOLUME = 60.972 dcl
 (AP) AG = 1.7
 AGE 2/92

STACK SAMPLING DATA SHEET

Page 3 of 4

CLIENT Battelle / DOE TEST DATE 6-24-93 ORIFICE CORRECTION 1.673 HOT BOX NO. 6
 TEST UNIT Stack - Hot Side TEST NO. C-6a-MUM-624 METER CORRECTION 0.9712 COLD BOX NO. 6-3
 PROJECT NO. 93 CD 28-01 NOZZLE (SIZE, #) 0.93 B15 CALIBRATION DATE 5-19-93 PROBE NO. 10-4
 CONTROL BOX OPERATOR JPS STATIC PRESSURE 2.0" H₂O PITOT CORRECTION 0.84 FILTER NO. Quarter
 BAROMETRIC PRESSURE 27.54 PORT DIRECTION A CONTROL BOX NO. 4 STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1413	6086.110	2.0	1.60	1.60	90	93	6.0	230	-250°	<68°F	-250°	3 points/port 30 min/port
			2.0	1.62	1.62	90	92	5.5	233				
			2.0	1.62	1.62	90	94	6.0	235				Readings every 5 minutes
			2.0	1.61	1.61	92	94	7.5	234				
			2.0	1.61	1.61	93	93	7.5	234				
			2.0	1.61	1.61	93	95	7.5	234				
43.9	1443		2.0	1.61	1.61	91	94	7.5	233				
			2.0	1.61	1.61	91	93	7.5	233				
			2.0	1.61	1.61	92	94	7.5	234				
			2.0	1.61	1.61	93	95	7.5	232				
			2.0	1.61	1.61	94	96	7.5	232				
13.1	1513		1.8	1.45	1.45	92	94	7.5	227				
			1.8	1.45	1.45	93	95	7.5	227				
			1.8	1.45	1.45	93	96	7.5	227				Estimates:
			1.8	1.45	1.45	93	94	8.0	227				MW= 28.1
			1.8	1.45	1.45	94	95	8.0	227				%H ₂ O= 17.3
1543	1543	752.674	1.8	1.45	1.45	93	94	8.0	229				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before	7.0	0.005
After	8.0	0.005

PITOT LEAK CHECK

	Positive	Negative
Before		
After		
	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Impinger

Impinger No.	Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #3
Volume

TIME = 90 min
 Volume = 66.564 dcf
 (ΔP)/Δt = 1.9
 (ΔH)_{avg} = 1.56

(T_{meter})_{avg} = 93°F
 (T₁)_{11.0} = 97.9°F

velocity = 93.7 ft/sec
 ISO = 97.7%

D-87

STACK SAMPLING DATA SHEET

Page 4 of 4

CLIENT Bethell 1002 TEST DATE 6-24-93 ORIFICE CORRECTION 1.673 HOT BOX NO. 6
 TEST UNIT Stack - Hot Side TEST NO. C-62-MJM-624 METER CORRECTION 0.9712 COLD BOX NO. 6-3
 PROJECT NO. 93C028-01 NOZZLE (SIZE) 0.193 G/5 CALIBRATION DATE 5-19-93 PROBE NO. 10-4
 CONTROL BOX OPERATOR JB STATIC PRESSURE -2.0" H₂O PITOT CORRECTION 0.84 FILTER NO. Quartz
 BAROMETRIC PRESSURE 27.94 PORT DIRECTION D CONTROL BOX NO. 4 STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (scf)	Pitot Δ P		Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
			Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)								
88.8	1610	752.749	2.4	1.94	88	92	8.0	228	8.0	228	~230	~68°F	~250	3 points / point
			2.4	1.94	89	90	10.0	227	10.0	227				30 min / point
			2.4	1.94	90	90	10.0	228	10.0	228				Readings every 5 minutes
			2.4	1.94	89	91	10.0	228	10.0	228				
			2.4	1.94	90	90	10.0	227	10.0	227				
			2.4	1.94	91	91	10.0	228	10.0	228				
			2.4	1.94	90	90	10.0	228	10.0	228				
			2.4	1.94	91	91	10.0	228	10.0	228				
			2.4	1.94	91	92	10.0	228	10.0	228				
			2.4	1.94	89	92	10.0	229	10.0	229				
			2.4	1.94	91	92	10.0	228	10.0	228				
			2.4	1.94	92	93	11.0	229	11.0	229				
			2.4	1.94	92	93	11.0	228	11.0	228				Estimates:
			2.4	1.94	92	94	11.0	229	11.0	229				MW = 28.1
			2.4	1.94	92	93	11.0	229	11.0	229				% H ₂ O = 17.3
			2.4	1.94	90	93	11.0	228	11.0	228				
			2.4	1.94	91	92	11.0	228	11.0	228				

SYSTEM LEAK CHECK		PITOT LEAK CHECK		Impinger Contents		Impinger Final		Impinger Initial		Difference	
Vacuum (in. Hg)	DGM Rate (cfm)	Before	After	Positive	Negative	No.	Final	Initial	Difference		
Before	8.0					1.					
After	11.0					2.					
						3.					
						4.					
						5.					

Pop #44
 Time = 90 min
 Volume = 73.761 scf
 ΔP/Δt = 2.4
 velocity = 105.2 ft/sec
 KEystone

PARTICULATE ELD DATA

PLANT 6-27-93 AMBIENT TEMPERATURE ~75 METER ΔH_p 1.64
DATE 6-27-93 BAROMETRIC PRESSURE 75 C FACTOR 75
LOCATION 4A ASSUMED MOISTURE, % 11 PROCESS WEIGHT RATE _____
OPERATOR _____ PROBE LENGTH, in. _____ WEIGHT OF PARTICULATE COLLECTED, mg _____
STACK NO. 4A Metals NOZZLE DIAMETER, in. 0.247 FINAL WEIGHT _____
RUN NO. C-4a-RUN 637 STACK DIAMETER, in. _____ TARE WEIGHT _____
SAMPLE BOX NO. _____ PROBE HEATER SETTING _____ WEIGHT GAIN _____
METER BOX NO. _____ HEATER BOX SETTING _____ TOTAL _____

SCHEMATIC OF STACK

CROSS SECTION

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	Time	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (in. H ₂ O)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	Probes	VELOCITY f/s
					ACTUAL	DESIRED		INLET (T _{m, in}), °F	OUTLET (T _{m, out}), °F					
1	0	09:58	362	1.7	1.2	1.2	534.30	75	75	245		5		
2	5		362	1.5	2.5	2.5	537.80					6		
3	10		360	1.5	2.5	2.5	542.2	79	75	247		6 1/2		
4	20		360	1.5	2.5	2.5	546.8					7		
	0	10:27												
1	5		358	.9	1.5	1.5	551.6	77	76	246	61	6	291	
2	10		364	1.5	2.5	2.5	555.7					8	#2 #10	
3	15		369	1.5	2.5	2.5	559.2					10		
4	20		369	1.7	3.0	3.0	562.7			260			257	257
	0	10:50												
1	5		359	.55	.95	.95	568.3	81	78	257	63	6 1/2		
2	10		366	1.4	2.4	2.4	571.6					11 1/2		272 257
3	15	11:05	371	1.5	2.5	2.5	576.3							
4	20		371	1.5	2.5	2.5	580.7	83	79	259	62	12	257	257
TOTAL														

Pre leak check = .02 cfm at 20" Hg
Broken cross-over - replaced at probe outlet

COMMENTS

VOLUME OF LIQUID WATER COLLECTED		IMPINGER VOLUME ml		SILICA GEL WEIGHT, g		ORSAT MEASUREMENT		TIME		CO ₂ O ₂ CO		N ₂	
FINAL		1		1		1		1					
INITIAL		2		2		2		2					
LIQUID COLLECTED		3		3		3		3					
TOTAL VOLUME COLLECTED		4		4		4		4					

80 2 of 24
0.6 + 3
10.4
Quantity
25'
Comments
points per
bowl per
points every
minutes
W= 28.1
H2O= 17.3

Difference

Pots; Left to Right

PARTICULATE FIELD DATA

METER H_2 1
C FACTOR _____
PROCESS WEIGHT RATE _____
WEIGHT OF PARTICULATE COLLECTED, mg
SAMPLE _____ FILTER _____ PROBE WASH _____
FINAL WEIGHT _____
TARE WEIGHT _____
WEIGHT GAIN _____ TOTAL _____
AMBIENT TEMPERATURE _____
BAROMETRIC PRESSURE _____
ASSUMED MOISTURE, % 11
PROBE LENGTH, in. _____
NOZZLE DIAMETER, in. .247
STACK DIAMETER, in. _____
PROBE HEATER SETTING _____
HEATER BOX SETTING _____
PLANT 6-27-93
DATE 4A
LOCATION _____
OPERATOR _____
STACK NO. Metals
RUN NO. C-1/2 19417 637
SAMPLE BOX NO. _____
METER BOX NO. _____

TRAVERSE POINT NUMBER	SAMPLING TIME (H), min	STATIC PRESSURE (in. H ₂ O)	TIME	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (V _p), (ft/s) ²	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m,IN}), °F	OUTLET (T _{m,OUT}), °F	SAMPLE BOX TEMPERATURE °F	Probes	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	IMP VLOCITY f/s
1	5	11:11		357	.4	.68	584.4	82	77	258	3	#2 #10	7	
2	10			364	1.0	1.7	586.8					282 258	11 1/2	
3	15	11:28		369	1.2	2.0	590.4	83	80	259			11	
4	20			375	0.9	1.5	594.7							
	0	11:33												
1	5			356	0.65	1.1	598.0	83	80	259		295 257	17	68
2	10			365	1.6	2.0	601.0							
3	15	11:50		372	.35	.50	609.6	82	80	261		252 258	8 1/2	63
4	20	12:35					611.0	Lead check stop at 611.0 ftm					4	59
* 1	5			354	.4	.68	611.8						4	
2	10				1.5	2.6	615.0						7 1/2	
3	15	12:50			1.6	2.7	620.1	87	82	260		260 260	6	
4	20				1.85	1.5	623.9							
TOTAL														
AVERAGE														

Stack temp erratic
Change filter - look check
0.1 ftm at 1700 ft
Stack TG erratic?
Static electricity

VOLUME OF LIQUID WATER COLLECTED	1	2	3	4	5	SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₁	O ₂	CO	N ₂
FINAL												
INITIAL												
LIQUID COLLECTED												

D-90

Page 3 of 4
NO. 6
NO. 673
10-4
Quantity
.25
Comments
3 points per
20 min point
Readings every
5 minutes
Estimates:
MW = 28.1
% H2O = 17.3

Difference

3YSTONE

PLANT	6-27-93	AMBIENT TEMPERATURE		METER $\sqrt{H_u}$	
DATE	4A	BAROMETRIC PRESSURE		C FACTOR	
LOCATION		ASSUMED MOISTURE, %		PROCESS WEIGHT RATE	
OPERATOR		PROBE LENGTH, in.		WEIGHT OF PARTICULATE COLLECTED	
STACK NO.		NOZZLE DIAMETER, in.		SAMPLE	PROBE
RUN NO.	C-4a-1447-827	STACK DIAMETER, in.		FINAL WEIGHT	
SAMPLE BOX NO.		PROBE HEATER SETTING		TARE WEIGHT	
METER BOX NO.		HEATER BOX SETTING		WEIGHT GAIN	
				TOTAL

[illegible]

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂	COMMENTS
	1	2	3	4								
FINAL						1						
INITIAL						2						
LIQUID COLLECTED						3						
TOTAL VOLUME COLLECTED						4						

PARTICULATE FIELD DATA

PLANT _____ AMBIENT TEMPERATURE _____ METER IN _____
DATE _____ BAROMETRIC PRESSURE _____ C FACTOR _____
LOCATION 4A ASSUMED MOISTURE, % _____ PROCESS WEIGHT RATE _____
OPERATOR _____ PROBE LENGTH, in. _____
STACK NO. _____ NOZZLE DIAMETER, in. _____
RUN NO. C-4a-MUM-627 STACK DIAMETER, in. _____
SAMPLE BOX NO. _____ PROBE HEATER SETTING _____
METER BOX NO. _____ HEATER BOX SETTING _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

D-92

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min	Time		STACK TEMPERATURE (T _s), °F	O ₂		PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	Probes		PUMP VACUUM in. Hg gauge	IMP VELOCITY f/s
		STATIC PRESSURE (in. H ₂ O)			VELOCITY HEAD (ΔP _s) (in. H ₂ O)		ACTUAL	DESIRED		INLET (T _{m IN}), °F	OUTLET (T _{m OUT}), °F		TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F			
	0	14:17											#2	#40		
1	5		340	0.65	1.1		669.6		87	86	235				10	
2	10		342	1.2	2.1		672.6								15	
3	15		327	1.5	2.1	2.6	676.8		89	86	266	293	267		17	
4	20		324	1.4	1.9	2.4	684.3								17	67
	0	14:39														
1	5		332	0.9	5.5	1.5	1.5	685.1	87	86	266	300	267		13	
2	10		336	1.5	1.8	2.6									17 1/2	
3	15	14:50	333	1.2	2.5	2.1	692.4		88	87	266	291	265		17 1/2	71
4	20		333	1.0	1.5	1.7	696.5									
	0	15:12					698.65		STOP	START	698.83				5	
* 1	5		312	0.7	1.2											
2	10		330	1.4	2.4		703.6		89	87	263	262	266		6 1/2	66
3	15		332	1.5	4.0	2.6	707.6									
4	20	15:28	321	0.7	1.25										6	
TOTAL																

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
	1	2	3	4							
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					

COMMENTS * Change filter; leak check: 0.19 cfm at 18" Hg

706

PLANT 6-27-93

LOCATION 4A
OPERATOR _____
STACK NO. _____
RUN NO. C-4a-MUM-62
SAMPLE BOX NO. _____
METER BOX NO. X 40513

[illegible]

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂	COMMENTS
	1	2	3	4								
FINAL						1						
INITIAL						2						
LIQUID COLLECTED						3						
AS VOLUME COLLECTED						4						

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X NO. 3
 BOX NO. 3
 NO. 10-3
 NO. QUARTS #1
 DIA. 106" (deck) x 16"

Constrains
3 min/point
start at point 13.3, end at point 92.8
start at point 13.7, end at point 92.8
start at point 13.3, end at point 92.8
Estimates: at point MW=28.3 %H2O=17.3

Difference

22	243.9
5	47.1
6	-57.1
8	34.5
9	22.0

$$22.0 \quad 799.96 = 777.96$$

KEYSTONE

PARTICULATE YIELD DATA

PLANT _____ AMBIENT TEMPERATURE _____ METER NO. _____
 DATE _____ BAROMETRIC PRESSURE _____ C FACTOR _____
 LOCATION 4A ASSUMED MOISTURE, % _____ PROCESS WEIGHT RATE _____
 OPERATOR _____ PROBE LENGTH, in. _____
 STACK NO. _____ NOZZLE DIAMETER, in. _____
 RUN NO. C-4a-MUM-627 STACK DIAMETER, in. _____
 SAMPLE BOX NO. _____ PROBE HEATER SETTING _____
 METER BOX NO. _____ HEATER BOX SETTING _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min.	Time	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD		PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	Probe TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F		PUMP VACUUM in. Hg gauge	Imp VELOCITY lps
		Static Pressure (in. H ₂ O)		(V _p)	(V _s)	ACTUAL	DESIRED		INLET (T _{min}), °F	OUTLET (T _{out}), °F					
	0	16.40													
1	5		283	.55		92		760.9	89	88	264			6 1/2	
2	10		299	1.2	6.5	2.0	2.0	764.1				290	259	12	
3	15		302	1.5		2.5	2.5	768-						14	
4	20	17.00	291	1.3		2.1	2.2	775.465	91	89	265	230	258	17	67
TOTAL															

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
	1	2	3	4							
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					

COMMENTS

Post leak check
 CFM = .018 at 17" Hg
 with probe N.I. at 9" Hg

NOMOGRAPH DATA

PLANT Cool Creek
 DATE 6/27/93
 SAMPLING LOCATION ESP outlet, west side
C-5A-MUM-627

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H ₂ O	$\Delta H_{@}$	1.78
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\text{ avg.}}$	120
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	10
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	27.85
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073 \times$ STACK GAUGE PRESSURE in in. H ₂ O)	P_s	0
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1.0
AVERAGE STACK TEMPERATURE, °F	$T_{s\text{ avg.}}$	340
AVERAGE VELOCITY HEAD, in. H ₂ O	$\Delta p_{\text{ avg.}}$	0.75
MAXIMUM VELOCITY HEAD, in. H ₂ O	$\Delta p_{\text{ max.}}$	0.78
C FACTOR		0.98
CALCULATED NOZZLE DIAMETER, in.		0.242
ACTUAL NOZZLE DIAMETER, in.		0.247
REFERENCE Δp , in. H ₂ O		0.72

EPA (Dur) 234
 4/72

PARTICULATE ELU DATA

PLANT Coal Creek
 DATE 6/27/93
 LOCATION ESP outlet
 OPERATOR Lemay, Hupp
 STACK NO. _____
 RUN NO. C-5A-MUM-627
 SAMPLE BOX NO. _____
 METER BOX NO. X40573

AMBIENT TEMPERATURE 70°F
 BAROMETRIC PRESSURE 27.86
 ASSUMED MOISTURE, % 10
 PROBE LENGTH, in. 13 ft. glass
 NOZZLE DIAMETER, in. 0.247
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING 250°F
 HEATER BOX SETTING 250°F

METER ΔH , 1.78
 C FACTOR 0.98
 PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min	probe Temp OF STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (ΔP _s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O		GAS SAMPLE VOLUME (V _m), l ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY lps
					ACTUAL	DESIRED		INLET (T _{m in}), °F	OUTLET (T _{m out}), °F				
1-12 ft.	9:45 am	264	325	0.90	2.15	2.15	96.862	73	72	252	52	4.0	
1-11 ft.	9:50	272	324	0.84	2.00	2.00	100.9	76	73	263	53	4.0	
1-10 ft.	9:55	262	325	0.85	2.20	2.20	104.9	78	73	261	52	4.2	
1-9 ft.	10:00	263	326	0.87	2.25	2.25	109.0	79	73	258	51	4.2	
1-8 ft.	10:05	262	325	0.85	2.20	2.20	113.2	82	75	258	52	4.2	
1-7 ft.	10:10	256	324	0.82	2.15	2.15	117.4	83	75	259	52	4.1	
1-6 ft.	10:15	254	323	0.76	2.00	2.00	121.6	83	76	258	53	4.0	
1-5 ft.	10:20	252	322	0.65	1.70	1.70	125.6	84	77	259	55	3.6	
1-4 ft.	10:25	251	321	0.52	1.35	1.35	129.4	85	86	259	57	3.3	
	10:30 am						133.817						
2-12 ft.	10:36 am	244	326	0.96	2.50	2.50	133.517	82	78	258	56	4.5	
2-11 ft.	10:41	249	329	0.84	2.20	2.20	138.3	85	76	260	56	4.3	
2-10 ft.	10:46	253	327	0.78	2.00	2.00	143.0	85	75	256	52	4.0	
2-9 ft.	10:51	254	327	0.70	1.85	1.85	146.7	86	80	259	51	4.0	
2-8 ft.	10:56	255	326	0.65	1.70	1.70	150.6	86	80	259	49	3.9	
TOTAL													

AVERAGE

93+93 96+96
 96=246

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
	1	2	3	4							
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					

COMMENTS

CROSS SECTION

static pressure $+5.2'' \text{H}_2\text{O}$

PARTICULATE FIELD DATA

SCHEMATIC OF STACK

CROSS SECTION

PLANT Coal Creek
 DATE 6/27/93
 LOCATION ESP outlet ^{west} side
 OPERATOR Leonard, Hupp
 STACK NO. _____
 RUN NO. C-SA-MUM-627
 SAMPLE BOX NO. _____
 METER BOX NO. 440573

AMBIENT TEMPERATURE 76°
 BAROMETRIC PRESSURE 27.85
 ASSUMED MOISTURE, % 10
 PROBE LENGTH, in. 13 ft. glass
 NOZZLE DIAMETER, in. 0.247
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING 250°F
 HEATER BOX SETTING 250°F

METER 1.78
 C FACTOR 0.98

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (ΔP _s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H ₂ O		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY fpm
					ACTUAL	DESIRED		INLET (T _{m in}), °F	OUTLET (T _{m out}), °F				
4-1200	12:11 on	239	337	0.63	1.65	1.65	205.818	82	85	260	56	4.0	
4-1100	12:16	248	336	0.63	1.65	1.65	209.5	91	86	260	54	4.0	
4-1000	12:21	252	336	0.62	1.60	1.60	213.2	92	86	260	56	4.0	
4-900	12:26	252	336	0.58	1.50	1.50	216.8	92	86	260	57	4.0	
4-800	12:31	254	334	0.64	1.65	1.65	220.4	90	86	259	53	4.0	
4-700	12:36	254	330	0.55	1.45	1.45	224.0	92	87	260	54	3.7	
4-600	12:41	253	331	0.60	1.55	1.55	227.6	92	88	261	54	3.6	
4-500	12:46	251	326	0.52	1.35	1.35	231.2	91	87	259	54	3.4	
4-400	12:51	249	326	0.55	1.45	1.45	234.6	92	88	259	57	3.4	
	12:56 off						238.038						
5-1200	12:58 on	238	343	0.50	1.30	1.30	238.038	91	89	260	66	3.3	
5-1100	13:04	245	345	0.54	1.40	1.40	241.6	92	85	262	61	3.3	
5-1000	13:09	250	347	0.58	1.50	1.50	245.1	96	91	262	66	3.5	
5-900	13:14	253	347	0.58	1.50	1.50	248.4	97	92	262	64	3.5	
5-800	13:19	253	347	0.60	1.55	1.55	252.0	96	91	261	60	3.6	
TOTAL													

AVERAGE

102 ± 100

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g
	1	2	3	4	
FINAL					
INITIAL					
LIQUID COLLECTED					

ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
1					
2					
3					

COMMENTS

PARTICULATE FIELD DATA

PLANT Coal Creek
 DATE 6/27/93
 LOCATION ESP outlet
 OPERATOR Leonard, Hupp
 STACK NO. _____
 RUN NO. C-5A-MUM-627
 SAMPLE BOX NO. _____
 METER BOX NO. X40513

AMBIENT TEMPERATURE 80°
 BAROMETRIC PRESSURE 28.50
 ASSUMED MOISTURE, % 10
 PROBE LENGTH, in. 13.00 glass
 NOZZLE DIAMETER, in. 0.247
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING 250°F
 HEATER BOX SETTING 250°F

METER RH, 1.78
 C FACTOR 0.98
 PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	probe temp °F STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (in. ΔP _s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)		GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER		SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY f/s
					ACTUAL	DESIRED		INLET (T _{m,IN}), °F	OUTLET (T _{m,OUT}), °F				
5-7.00	13:24	254	349	0.62	1.60	1.60	255.5	97	93	262	61	3.8	
5-6.00	13:29	253	349	0.65	1.60	1.60	259.2	98	93	262	61	3.8	
5-5.00	13:34	252	351	0.65	1.60	1.60	262.9	95	94	262	60	3.8	
5-4.00	13:39	252	352	0.56	1.45	1.45	266.6	95	94	262	56	3.8	
	13:44 off						270.128						
7-12.00	13:47 on	239	351	0.62	1.60	1.60	270.128	98	95	262	63	3.8	
7-11.00	13:52	248	353	0.62	1.60	1.60	274.1	99	96	261	56	3.8	
7-10.00	13:57	253	351	0.62	1.60	1.60	277.7	101	97	262	58	3.8	
7-9.00	14:02	253	351	0.54	1.40	1.40	281.4	99	96	261	60	3.8	
7-8.00	14:07	253	351	0.54	1.40	1.40	284.9	101	97	260	61	3.8	
7-7.00	14:12	254	353	0.60	1.55	1.55	288.4	102	98	261	62	3.8	
7-6.00	14:17	252	353	0.65	1.60	1.60	292.0	102	98	261	65	3.8	
7-5.00	14:22	252	354	0.67	1.75	1.75	295.6	103	99	262	67	3.9	
7-4.00	14:27	253	355	0.62	1.60	1.60	299.5	103	99	263	68	3.8	
	14:32 off						303.153						
TOTAL													

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
	1	2	3	4							
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					
TOTAL VOLUME COLLECTED						4					

COMMENTS

103+102
103+99

PARTICULATE FIELD DATA

PLANT Coal Creek AMBIENT TEMPERATURE 85°F METER $\frac{1}{4}$ " 1.78
 DATE 6/27/93 BAROMETRIC PRESSURE 27.83 C FACTOR 0.98
 LOCATION Escondido ASSUMED MOISTURE, % 10 PROCESS WEIGHT RATE _____
 OPERATOR Leonard, Napp PROBE LENGTH, in. 138.0, 96.0 WEIGHT OF PARTICULATE COLLECTED, mg _____
 STACK NO. _____ NOZZLE DIAMETER, in. 0.247 SAMPLE FILTER _____
 RUN NO. C-5A-MUM-627 STACK DIAMETER, in. _____ FINAL WEIGHT _____
 SAMPLE BOX NO. _____ PROBE HEATER SETTING 250°F TARE WEIGHT _____
 METER BOX NO. X 40573 HEATER BOX SETTING 250°F WEIGHT GAIN _____
 TOTAL _____

TRAVERSE POINT NUMBER	SAMPLING TIME (h), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD ($\frac{1}{2} \rho V^2$) (in. H ₂ O)	VELOCITY (ft/min)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (in. H ₂ O)	ACTUAL DESIRED (in. H ₂ O)	GAS SAMPLE VOLUME (V _m), ft ³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (T _{m,in}), °F	OUTLET (T _{m,out}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING OR CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY f/s
8-1287	14:36.00	242	354	0.65	0.65	1.70	1.70	303.153	102	99	262	66	3.8	
8-1187	14:41	249	354	0.68	0.68	1.75	1.75	307.3	104	100	261	62	3.9	
8-1087	14:46	252	354	0.70	0.70	1.80	1.80	311.1	103	99	260	60	4.0	
8-987	14:51	255	356	0.68	0.68	1.75	1.75	315.0	105	101	263	63	4.0	
8-887	14:56	256	355	0.67	0.67	1.70	1.70	318.9	105	101	262	64	4.0	
8-787	15:01	255	356	0.64	0.64	1.60	1.60	322.7	106	102	262	64	4.0	
8-687	15:06	252	356	0.58	0.58	1.50	1.50	326.4	107	103	260	60	4.0	
8-587	15:11	252	357	0.48	0.48	1.25	1.25	330.0	106	103	261	56	3.6	
8-487	15:16	252	356	0.42	0.42	1.10	1.10	333.4	106	104	261	57	3.4	
6-1287	15:21.00	236	354	0.55	0.55	1.40	1.40	337.126	104	104	262	60	3.8	
6-1187	15:25.00	246	355	0.57	0.57	1.50	1.50	340.5	106	105	263	58	3.8	
6-1087	15:35	251	355	0.65	0.65	1.70	1.70	344.0	105	103	260	58	4.0	
6-987	15:40	252	355	0.65	0.65	1.70	1.70	347.8	103	101	259	58	4.0	
6-887	15:45	253	355	0.67	0.67	1.70	1.70	351.6	103	101	259	60	4.0	
TOTAL														
AVERAGE														

102499
101499

COMMENTS

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml	SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
1	2	3	4	5	6	7	8	9
FINAL								
INITIAL								
LIQUID COLLECTED								

CROSS SECTION

SIDE VIEW

The side view diagram illustrates the vertical profile of the stack. It shows a vertical shaft with an upward-pointing arrow labeled "GAS FLOW". Two horizontal dashed lines indicate specific levels: the upper one is labeled "DISTURBANCE" and the lower one is labeled "SAMPLING SITE". A vertical double-headed arrow between these two levels is labeled "A", representing the distance between the disturbance and the sampling site. The bottom of the stack is labeled "DISTURBANCE".

PLANT Coal Creek
DATE 6/27/93
LOCATION ESP outlet west side
OPERATOR Leonard, Hupp
STACK NO. _____
RUN NO. C-5A-MUM-62
SAMPLE BOX NO. _____
METER BOX NO. X40513

AMBIENT TEMPERATURE 80°F
 BAROMETRIC PRESSURE 27.82
 ASSUMED MOISTURE, % 10
 PROBE LENGTH, in. 13 ft. glass
 NOZZLE DIAMETER, in. 0.247
 STACK DIAMETER, in. _____
 PROBE HEATER SETTING 250°F
 HEATER BOX SETTING 250°F

METER IN 1.72
C FACTOR 0.92

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

[illegible]

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g
	1	2	3	4	
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

leak check 0.02 CFM
at 6" Hg

1004101

static pressure
+ 5.0" H₂O

ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N
1					
2					
3					
4					

STACK SAMPLING DATA SHEET

Page 1 of 4

CLIENT Battelle / DOE TEST DATE 6-27-93 (Sun.) ORIFICE CORRECTION 1.673 HOT BOX NO. 6
 TEST UNIT Stack - Hot Side TEST NO. C-62-MUM-627 METER CORRECTION 0.9912 COLD BOX NO. 6-43
 PROJECT NO. 93C028-01 NOZZLE (SIZE, IN) 0.193 6/5 CALIBRATION DATE 5-19-93 PROBE NO. 10-4
 CONTROL BOX OPERATOR JPS STATIC PRESSURE -1.5" H₂O PITOT CORRECTION 0.84 FILTER NO. Quantity
 BAROMETRIC PRESSURE 27.76 PORT DIRECTION C CONTROL BOX NO. 4 STACK DIA. 24"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcl)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	0902	090.080	2.1	1.70	1.70	83	83	6.5	223	~250°	<68°F	~250°	3 points/port
			2.1	1.70	1.70	82	83	7.0	223				3 min/port
			2.1	1.70	1.70	84	83	7.0	223				Readings every 5 minutes
			2.1	1.70	1.70	84	86	7.0	223				
			2.1	1.70	1.70	85	85	7.0	222				
			2.1	1.70	1.70	85	88	7.0	223				
43.9	0932		2.0	1.62	1.62	89	88	7.0	221				
			2.0	1.64	1.64	89	91	7.0	221				
			2.0	1.64	1.64	88	91	7.0	221				
			2.0	1.64	1.64	89	90	7.0	222				
			2.0	1.64	1.64	89	92	7.0	222				
			2.0	1.64	1.64	92	92	7.0	223				
13.1	1002		2.0	1.64	1.64	91	93	7.0	223				
			2.1	1.72	1.72	92	93	7.0	223				
			2.1	1.72	1.72	90	95	7.0	223				Estimates:
			2.1	1.72	1.72	91	95	7.0	223				MW = 28.1
			2.1	1.72	1.72	91	94	7.5	224				% H ₂ O = 17.3
	1032	159.917	2.1	1.72	1.72	92	94	7.5	223				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	7.0	0.010
After	7.5	0.005

PITOT LEAK CHECK 15 Sec

	Positive	Negative
Before	OK	OK
After		

	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Impinger

No.	Contents	Final	Initial	Difference
1.	50ml D.I. H ₂ O	945.2	455.4	489.8
2.	Empty	811.5	452.9	364.6
3.	150ml H ₂ O/H ₂ O ₂	726.3	599.4	126.9
4.	150ml H ₂ O ₂ /H ₂ O	619.0	615.4	3.6
5.	Empty	384.7	380.0	4.7
6.	100ml KMnO ₄	559.5	558.7	0.8
7.	100ml KMnO ₄	560.2	561.7	-1.5

Page 1 of 4

TIME = 90 min
 Volume = 69.837 dcl
 (AP)/AG = 2.1

AQE 2/92

Temp. = 89°F

velocity = 976 ft/sec
 T_{avg} = 20.15

1034.2
 total

KEYSTONE

STACK SAMPLING DATA SHEET

Page 2 of 4

CLIENT Battelle / DOE TEST DATE 6-27-93 (Sun) ORIFICE CORRECTION 1.673 HOT BOX NO. 6
 TEST UNIT Stack - Hot Side TEST NO. C-6a-MUM-627 METER CORRECTION 0.9912 COLD BOX NO. 6+3
 PROJECT NO. 93C028-01 NOZZLE (SIZE, Ø) 0.193 Ø15 CALIBRATION DATE 5-19-93 PROBE NO. 10-4
 CONTROL BOX OPERATOR JPS STATIC PRESSURE -1.5" H₂O PITOT CORRECTION 0.84 FILTER NO. Quantity
 BAROMETRIC PRESSURE 27.76 PORT DIRECTION B CONTROL BOX NO. 4 STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcl)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1050	160.000	1.8	1.49	1.49	92	94	7.0	224	~250°	<68°F	~250°	3 points/part
			1.8	1.49	1.49	94	95	7.0	224				30 min/part
			1.8	1.49	1.49	92	95	7.0	226				Readings every 5 minutes
			1.8	1.49	1.49	93	95	7.0	226				
			1.8	1.48	1.48	91	95	7.0	226				
			1.8	1.48	1.48	93	94	7.0	225				
↓			1.7	1.40	1.40	93	94	7.0	226				
43.9	1120		1.7	1.40	1.40	93	94	7.0	226				
			1.7	1.40	1.40	93	94	7.0	226				
			1.7	1.40	1.40	93	94	7.0	225				
			1.7	1.40	1.40	93	95	7.0	226				
			1.7	1.40	1.40	93	94	7.0	226				
			1.7	1.40	1.40	94	95	7.0	226				
↓			1.6	1.32	1.32	93	97	7.0	227				
13.1	1150		1.6	1.32	1.32	92	95	7.0	227				
			1.6	1.32	1.32	94	97	7.5	226				Estimates:
			1.6	1.32	1.32	93	97	7.0	226				MW = 28.1
			1.6	1.32	1.32	93	96	7.5	225				%H ₂ O = 17.3
↓	1220	223.390	1.6	1.32	1.32	94	98	7.5	225				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	7.5	0.005
After	7.5	0.005

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

(T_{stack})_{avg} = 94°F
 (T_{amb})_{avg} = 77°F

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Velocity = 88.0 ft/sec
 ISO = 98.3%

D-103

Page #2
 Volume
 AQE 2/92
 TIME = 90 min
 VOLUME = 63.390 dcl
 (ΔP)_{avg} = 1.7
 (ΔH)_{avg} = 1.40

STACK SAMPLING DATA SHEET

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CLIENT Battelle / DOE TEST DATE 6-27-93 (Sun) ORIFICE CORRECTION 1.673 HOT BOX NO. 6
 TEST UNIT Stack - Hot Side TEST NO. C-66-MUM-627 METER CORRECTION 0.9912 COLD BOX NO. 6+3
 PROJECT NO. 93CB28-01 NOZZLE (SIZE, #) 0.193 9/15 CALIBRATION DATE 5-19-93 PROBE NO. 10-4
 CONTROL BOX OPERATOR JPS STATIC PRESSURE -1.5" H₂O PITOT CORRECTION 0.84 FILTER NO. Quartz
 BAROMETRIC PRESSURE 27.76 PORT DIRECTION A CONTROL BOX NO. 4 STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1245	223.470	1.8	1.48	1.48	93	97	8.5	224	~250°	468°F	~250°	3 points / port 90 min / point
			1.8	1.48	1.48	93	95	8.0	226				
			1.8	1.48	1.48	91	96	8.0	227				Readings every 5 minutes
			1.8	1.48	1.48	91	93	8.5	227				
			1.8	1.48	1.48	90	91	8.5	226				
↓			1.8	1.48	1.48	89	91	8.5	227				
43.9	1315		1.8	1.47	1.47	89	93	9.0	227				
			1.8	1.47	1.47	90	94	9.0	227				
			1.8	1.47	1.47	91	92	9.0	227				
			1.8	1.47	1.47	92	93	9.0	227				
			1.8	1.47	1.47	91	93	9.0	225				
↓			1.8	1.47	1.47	93	94	9.0	227				
13.1	1345		1.8	1.47	1.47	92	94	9.0	225				
			1.8	1.47	1.47	93	95	9.0	226				
			1.8	1.47	1.47	89	95	9.0	226				Estimates:
			1.8	1.47	1.47	90	92	9.0	226				MW = 28.1
			1.8	1.47	1.47	89	94	9.0	226				%H ₂ O = 17.3
↓	1415	288.501	1.8	1.47	1.47	90	93	9.0	227				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	7.5	0.002
After	9.0	0.005

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Impinger

No.	Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

velocity = 90.5 ft/sec
 98.4%

KEYSTONE
 ENVIRONMENTAL SYSTEMS, INC.

D-104

Prep #3
 value? TIME = 90 min
 Volume = 65.031 dcf
 ΔP / Δt = 1.8

STACK SAMPLING DATA SHEET

Page 4 of 4

CLIENT *Bette 16 / DOE* TEST DATE *6-27-93 (con.)* ORIFICE CORRECTION *1.673* HOT BOX NO. *6*
 TEST UNIT *Stack - Hot Side* TEST NO. *C-62 - MUM - 627* METER CORRECTION *0.9912* COLD BOX NO. *643*
 PROJECT NO. *93C020-01* NOZZLE (SIZE, IN) *0.93* CALIBRATION DATE *5-19-93* PROBE NO. *10-4*
 CONTROL BOX OPERATOR *JPS* STATIC PRESSURE *-1.5" H₂O* PITOT CORRECTION *0.84* FILTER NO. *Q25-ty*
 BAROMETRIC PRESSURE *27.76* PORT DIRECTION *D* CONTROL BOX NO. *4* STACK DIA. *25"*

Traverse Point (inches)	Time	Dry Gas Meter Reading (scf)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
88.8	1441	288.578	2.1	1.71	1.71	92	92	13.0	226	~250°	~68°F	~250°	3 points / port
			2.1	1.71	1.71	94	92	11.0	227				30 min / point
			2.1	1.72	1.72	92	95	10.0	226				Readings every
			2.1	1.72	1.72	94	95	10.5	227				5 minutes
			2.1	1.72	1.72	96	95	11.5	226				
			2.1	1.72	1.72	95	98	11.5	227				
			2.1	1.72	1.72	97	99	11.5	227				
13.9	1511		2.1	1.72	1.72	97	100	12.0	229				
			2.1	1.72	1.72	99	100	12.0	228				
			2.1	1.74	1.74	98	100	12.0	229				
			2.1	1.74	1.74	98	100	12.0	230				
			2.1	1.74	1.74	100	102	12.0	230				
			2.1	1.73	1.73	99	102	12.0	228				
13.1	1541		2.1	1.73	1.73	99	100	12.0	229				Estimates:
			2.1	1.73	1.73	100	101	12.0	229				MW = 28.1
			2.1	1.73	1.73	100	101	12.5	228				% H ₂ O = 17.3
			2.1	1.73	1.73	101	101	12.5	229				
			2.1	1.73	1.73	102	103	12.5	232				

SYSTEM LEAK CHECK		PITOT LEAK CHECK		IMPINGER		IMPINGER		DIFFERENCE	
Vacuum (in. Hg)	DGM Rate (cfm)	Before	After	Positive	Negative	No.	Contents	Final	Initial
Before	9.0					1.			
After	13.0					2.			
						3.			
						4.			
						5.

velocity = 97.9 ft/sec
 ISO = 97.7%

SYSTEM LEAK CHECK		PITOT LEAK CHECK		IMPINGER		IMPINGER		DIFFERENCE	
Vacuum (in. Hg)	DGM Rate (cfm)	Before	After	Positive	Negative	No.	Contents	Final	Initial
Before	9.0					1.			
After	13.0					2.			
						3.			
						4.			
						5.			

TIME = 90 min
 WINDS = 70.367 dcf
 AQE 292 (ΔP) / AVG = 2.1
 (ΔH) / AVG = 1.73

D-3: Method 5 Particulate Runs

These runs were made at the parallel ESP locations 4b and 5b, on alternate days.

STACK SAMPLING DATA SHEET

Page 1 of 6

CLIENT Battelle / DOE TEST DATE 6-11-93 ORIFICE CORRECTION 1.734 HOT BOX NO. 3
 TEST UNIT ESP #2 Inlet TEST NO. C-46-PM-621 METER CORRECTION 0.9832 COLD BOX NO. 3
 PROJECT NO. 93C62B-01 NOZZLE (SIZE, #) #22 181 CALIBRATION DATE 05-17-93 PROBE NO. 10-3
 CONTROL BOX OPERATOR RIC STATIC PRESSURE -16" H₂O PITOT CORRECTION 0.81 FILTER NO. Quartz #1
 BAROMETRIC PRESSURE 27.20 PORT DIRECTION L1 → L3 CONTROL BOX NO. FIVE STACK DIA. 106" (dptk) x 16" (wid)

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP X (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
L1 92.8	14:09	293.180	1.00	.35	.35	110	110	2.0	300	~250	<68°F	~250	3 min/point
66.3			1.5	.88	.88	117	109	3.0	316				
39.8			1.7	1.00	1.00	118	110	3.5	320				start at point
13.3	14:21	299.246	1.8	1.06	1.06	120	110	3.5	320				13.3 ended at point 92.8
L2 92.8	14:24	299.246	1.0	.59	.59	124	114	2.5	309				start at point 13.7
66.3			1.60	.91	.91	127	115	3.0	326				ended at point 92.8
39.8			1.60	.91	.91	133	117	3.0	328				
13.3	14:36	305.610	1.90	1.08	1.08	138	120	3.5	326				
L3 92.8	14:39	305.610	1.20	.68	.68	138	120	3.0	309				start at point 13.3, ended
66.3			1.20	.68	.68	141	125	3.0	321				Estimates: of point 92.
39.8			1.50	.85	.85	143	127	4.0	332				MW=28.3
13.3	14:51	311.372	1.30	.74	.74	147	129	3.5	325				%H ₂ O=17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before	5.0	<0.016 cfm
After	7.5	0.01 cfm

PITOT LEAK CHECK

	Positive	Negative
Before	0.4/15 sec	0.4/15 sec
After		

	1	2
CO ₂	11.0	
O ₂	610	
CO	0	
N ₂	83.0	

(T_{meter})_{avg} = 123°F
 (T_{stack})_{avg} = 319°F

Impinger No.	Contents	Empty	Final	Initial	Difference
1.	100mL DI H ₂ O		767.6	524.2	243.4
2.	100mL DI H ₂ O		601.6	554.5	47.1
3.	Empty 100mL H ₂ O		499.5	556.6	-57.1
4. MT	200g Silica Gel		494.1	459.6	34.5
5.	200g Silica Gel		656.8	634.8	22.0

velocity = 86.6 ft/sec
 ISO = 90.5%

289.9g = total
KEYSTONE
 Environmental & Safety Solutions

Paup #1
 Values
 TIME = 36 min
 VOLUME = 18.192 dcf
 AQE 2/92 (OP/AG = 1.4)
 (ΔH/AG = 0.81)

D-107

2.002
0.9812
6.9-93
0.84
6

STACK SAMPLING DATA SHEET

Page 2 of 6

CLIENT Battelle / DOE TEST DATE 6-21-93 ORIFICE CORRECTION 1.234 HOT BOX NO. 3
 TEST UNIT EST #2 Inlet TEST NO. C-45-PM-621 METER CORRECTION 0.9832 COLD BOX NO. 3
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) 22 181 CALIBRATION DATE 05-12-93 PROBE NO. 10-2
 CONTROL BOX OPERATOR LPC STATIC PRESSURE -16" H₂O PITOT CORRECTION 0.84 FILTER NO. Q2279
 BAROMETRIC PRESSURE 27.70 PORT DIRECTION Left: L4 → L6 CONTROL BOX NO. FILE STACK DIA. 15" (depth) × 16" (dia)

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pilot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ 92.8	14:53	311.372	.80	.45	.45	145	133	3.0	325	~250	<68°F	~250	3 min/point
↓ 66.3			1.35	.76	.76	151	135	3.5	339				started at
39.8	15:00	314.161	1.2	.68	.68	151	135	3.5	346				point 13.3
↓ 13.3	15:30	686.500	1.25	.71	.71	82	80	3.5	348				ended at point
	15:35	688.600										92.8	switched to
													control box #6
													started at 15:30
↑ 92.8	15:38	698.600	.80	.45	.45	102	93	3.0	339				started at
↓ 66.3			1.50	.85	.85	112	93	4.0	344				point 13.3
39.8			1.80	1.19	1.19	120	95	5.0	340				ended at
↓ 13.3	15:50	694.248	1.80	1.19	1.19	125	100	5.0	340				point 92.8
↑ 92.8	15:53	694.248	.80	.45	.45	120	105	4.0	340				started at point 13.3,
↓ 66.3			1.50	.99	.99	129	109	5.5	350				ended at point 92.8
39.8			1.60	1.06	1.06	134	110	5.5	356				Estimates:
↓ 13.3	16:05	700.070	1.60	1.06	1.06	137	113	5.5	346				MW = 28.3
													%H ₂ O = 17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	11.0	
O ₂	6.0	
CO	0	
N ₂	83.0	

Impinger No.

Impinger Contents

Final

Initial

Difference

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page #2
 TIME = 36 min
 corrected volume = 16.057 dcf
 (AP)_{avg} = 1.30
 AQE 2/92
 1/14/1 12/14/1

(corrected) _{avg} = 1170F

velocity = 84.7 ft/sec
 Iso. = 86.5% → 86.7%

D-108

6993
~~5555~~

2013

2.002

1

COLD BOX NO. 3

- PROBE NO. 10-2
FILTER NO. 0-1

FILTER NO. Quartz

STACK DIA. 106" (4213) X 16' HGT

SH20-173

Impinger

No.	Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.	80.0			

$(T_{\text{inlet}})_{\text{avg}} = 129^{\circ}\text{F}$
 $(T_{\text{stack}})_{\text{avg}} = 350^{\circ}\text{F}$

STACK SAMPLING DATA SHEET

Page 4 of 6

CLIENT Battelle / DOE TEST DATE 6-24-93 ORIFICE CORRECTION 0.9832
 TEST UNIT ESP #2 Inlet TEST NO. C-45-PA-621 METER CORRECTION 2.002
 PROJECT NO. 93C028-01 NOZZLE (SIZE, IN) 0.181 CALIBRATION DATE 00-17-93 HOT BOX NO. 3
 CONTROL BOX OPERATOR RPC STATIC PRESSURE -16.0" H₂O PITOT CORRECTION 0.81 COLD BOX NO. 3
 BAROMETRIC PRESSURE 27.70 PORT DIRECTION Right: R1 → R3 CONTROL BOX NO. 5 FILTER NO. 42
 STACK DIA. 106" (depth) × 16" (width)

	Traverse Point (inches)	Time	Dry Gas Meter Reading (dcl)	Pilot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
					Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ R1 ↓	92.8	18:14	315.375	1.20	0.82	0.82	109	107	3.0	365	~250	~68°F	~250	3 min point
	66.3			1.45	0.82	0.82	114	107	3.5	366				new filter
	39.8			1.40	0.79	0.79	119	108	3.5	366				installed
	13.3	18:26	321.000	1.40	0.79	0.79	124	108	3.5	364				
↑ R2 ↓	92.8	18:28	321.000	1.65	0.94	0.94	123	112	4.5	369				
	66.3			1.70	0.96	0.96	128	114	4.5	366				
	39.8			1.65	0.94	0.94	131	115	4.5	365				
	13.3	18:40	327.125	0.90	0.51	0.51	131	115	3.0	340				
↑ R3 ↓	92.8	18:43	327.125	1.65	0.94	0.94	133	121	4.5	360				
	66.3			1.70	0.96	0.96	135	122	5.0	369				
	39.8			1.50	0.85	0.85	139	124	4.5	370				Estimates:
	13.3	18:55	333.430	0.90	0.51	0.51	139	124	4.5	350				MW=28.6 %H ₂ O=17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before	5.0	20.02 cfm
After	8.0	20.01 cfm

TIME = 36 min
 VOLUME = 18.055 dcl
 AQE 2192 (4) H₂O = 1.40
 (1.41) = 0.021

PITOT LEAK CHECK

	Positive	Negative
Before	0.6/sec	0.15/sec
After	0.6/sec	0.11/sec

	1	2
CO ₂	11.0	
O ₂	6.0	
CO	0	
N ₂	83.0	

(Temperature) avg = 121°F

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

velocity = 89.0 ft/sec
 IS. = 92.7%

D-110

STACK SAMPLING DATA SHEET

1.774/2.002

0.9832

Page 5 of 6

CLIENT Battelle / DOE

TEST DATE 6-21-93

ORIFICE CORRECTION

HOT BOX NO. 3

TEST UNIT ESP #2 Inlet

TEST NO. C-46-PM-621

METER CORRECTION

COLD BOX NO. 3

PROJECT NO. 93C028-01

NOZZLE (SIZE, IN) 0.75 0.81

CALIBRATION DATE 05-12-93/6993

PROBE NO. 10-2

CONTROL BOX OPERATOR APC

STATIC PRESSURE -16.0" H₂O

PITOT CORRECTION 0.84

FILTER NO. 22

BAROMETRIC PRESSURE 27.20

PORT DIRECTION Right: R4 → R6

CONTROL BOX NO. 5/6

STACK DIA. 106 (dia) x 16 (in)

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ 92.8	19:00	333.430	1.0	.57	.57	138	129	4.0	383	~250	~68°F	-250°	3 min/point
R4 66.3			1.60	.91	.91	140	129	5.0	377				
↓ 39.8			1.35	.77	.77	141	129	5.0	374				
13.3	19:12	339.570	1.35	.77	.77	141	129	5.0	379				PORTS R5 R6
													ARG RUN ON
													GOOD R6
↑ 92.8	19:24	710.748	1.0	.65	.65	110	110	5.0	386				Y = .9812
R5 66.3			1.0	.65	.65	115	110	5.0	387				X = 2.002
↓ 39.8			1.25	.81	.81	117	110	5.0	380				06-09-93
13.3	19:36	716.336	.90	.58	.58	120	109	5.0	380				Box 5 was broken.
													Re calibrated.
↑ 92.8	19:39	716.336	1.80	1.16	1.16	117	111	6.0	381				
R6 66.3			1.75	1.13	1.13	123	109	6.0	391				
↓ 39.8			1.50	.97	.97	124	109	6.0	392				Estimates:
13.3	19:51	722.458	1.40	.90	.90	127	110	5.0	391				MW = 28.3
													%H ₂ O = 17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	16.0	
O ₂	6.0	
CO	0	
N ₂	83.0	

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Velocity = 26.8 ft/sec
ISO = 96.170

D-111

Page 15
TIME = 30 min
corrected volume = 17.527
AQE 2002 (ΔP)_{avg} = 1.30
(ΔH)_{avg} = 0.82

(T_{stack})_{avg} = 121°F
(T_{stack})_{no} = 383°F

STACK SAMPLING DATA SHEET

Page 6 of 6

CLIENT Bottle / DOE

TEST DATE 6-21-93

ORIFICE CORRECTION 2.002
1.734

HOT BOX NO. 3

TEST UNIT ESP #2 Inlet

TEST NO. C-45-PM-621

METER CORRECTION .9882

COLD BOX NO. 3

PROJECT NO. 93C628-01

NOZZLE (SIZE, #) #22 0.181

CALIBRATION DATE 06-08-93

PROBE NO. 10-2

CONTROL BOX OPERATOR R/C

STATIC PRESSURE -16.0" H₂O

PITOT CORRECTION 0.84

FILTER NO. #2

BAROMETRIC PRESSURE 27.70

PORT DIRECTION Right: R7+R8

CONTROL BOX NO. 5:10

STACK DIA. 16" (depth) x 16" (width)

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ 92.8	19:53	722.458	1.5	.97	.97	120	110	5.5	388	-250°	168°F	~250°	3 mlu/part
R7 66.3			1.55	1.00	1.00	125	111	5.5	390				
↓ 39.8			1.20	.77	.77	129	111	4.5	381				
13.3	20:05	728.111	.80	.52	.52	129	111	3.5	350				
↑ 92.8	20:07	728.111	1.65	1.06	1.06	117	111	4.5	360				
R8 66.3			1.45	.94	.94	129	112	5.0	371				
↓ 39.8			1.20	.77	.77	129	112	5.0	370				
13.3	20:19	733.750	1.0	.65	.65	130	111	5.0	340				
													Estimates:
													MW= 28.3
													%H ₂ O= 17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	11.0	
O ₂	6.0	
CO	0	
N ₂	83.0	

(Inlet temp) = 119°F

Impinger No.

Impinger Contents

Final

Initial

Difference

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Velocity = 86.0 ft/sec
ISO = 90.8%

D-112

Rep #10
AQE 2/92
TIME = 24 min
VOLUME = 11.292 dcf
(AP) AC = 1.30

STACK SAMPLING DATA SHEET

Page 1 of 4

CLIENT Battelle / DOE TEST DATE 06-22-93 ORIFICE CORRECTION 1.277 HOT BOX NO. 1
 TEST UNIT ESP #2 OUTLET TEST NO. C-5B-PM-622 METER CORRECTION 2 COLD BOX NO. 1
 PROJECT NO. 920628-01 NOZZLE (SIZE, IN) 0.247 CALIBRATION DATE 2 PROBE NO. 16-1
 CONTROL BOX OPERATOR RPC STATIC PRESSURE 716.0" H₂O PITOT CORRECTION 2 FILTER NO.
 BAROMETRIC PRESSURE 27.48 PORT DIRECTION Port #1, Port #2 CONTROL BOX NO. Battelle Box #1 STACK DIA. 4' x 26'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp (°F)	Comments / depth width
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
10.5	15:06	379.888	.20	.42	.42	105	105	1.0	366	~250		-250	3 in / 1 ft
31.5			.65	1.36	1.36	108	109	1.0	370				
52.5			.85	1.77	1.77	114	114	1.0	369				
73.5			.85	1.77	1.77	116	114	1.0	360				
94.5			.85	1.77	1.77	118	113	1.0	370				
115.5			.85	1.77	1.77	119	111	1.0	380				
136.5			.85	1.77	1.77	120	111	1.0	350				
157.5	18:30	394.116	.85	1.77	1.77	121	107	1.0	350				
10.5	15:36	394.116	.65	1.36	1.36	112	108	1.0	365				
31.5			.90	1.67	1.67	112	109	2.0	366				
52.5			.79	1.65	1.65	112	110	2.0	369				
73.5			.75	1.56	1.56	118	111	2.5	366				
94.5			.80	1.67	1.67	119	111	2.5	370				
115.5			.80	1.67	1.67	119	111	2.5	375				Estimates:
136.5			.90	1.88	1.88	121	111	2.5	368				MW= 28.5
157.5	16:00	410.856	.90	1.88	1.88	121	111	2.5	369				%H ₂ O= 17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	20.01 cfm
After	6.0	20.01 cfm

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	7.0	
CO	0	
N ₂	81.0	

Impinger No.

Impinger Contents

		Final	Initial	Difference
1.	DI H ₂ O	880.2	425.2	455.0
2.	DI H ₂ O	631.1	423.6	207.5
3.	EMPTY	461.9	458.3	3.7
4.	1st Silica Sol	229.5	582.8	14.2
5.	2nd Silica Sol	687.4	671.1	16.3

597.0

696.7 g total
KEYSTONE

D-113

STACK SAMPLING DATA SHEET

Page 2 of 4

CLIENT Battelle / DOE TEST DATE 06-22-93 ORIFICE CORRECTION 1.77 HOT BOX NO. 1
 TEST UNIT ESP #2 04787 TEST NO. C-5B-PM-622 METER CORRECTION ? COLD BOX NO. 1
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) 0.247 CALIBRATION DATE ? PROBE NO. 16-1
 CONTROL BOX OPERATOR RPL STATIC PRESSURE +16.0" H₂O PITOT CORRECTION ? FILTER NO.
 BAROMETRIC PRESSURE 27.48 PORT DIRECTION Port 3, Port 4 CONTROL BOX NO. Battelle Box #1 STACK DIA. 14' x 26'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
10.5	16:06	410.856	.51	1.06	1.06	106	106	1.0	365	~250	~68°F	~250°F	3 min / 125
31.5			.70	1.46	1.46	108	107	1.0	367				
52.5			.73	1.52	1.52	109	111	1.0	369				
73.5			.85	1.77	1.77	110	111	2.5	368				
94.5			.81	1.69	1.69	119	112	2.0	370				
115.5			.95	1.98	1.98	120	109	2.5	371				
136.5			.95	1.98	1.98	121	109	2.5	368				
157.5	16:30	426.950	.85	1.77	1.77	121	109	2.5	370				Switched on silica gel
10.5	16:36	426.950	.60	1.25	1.25	121	109	2.5	371				Port 4
31.5			.60	1.25	1.25	121	107	2.5	370				
52.5			.60	1.25	1.25	121	109	3.0	369				
73.5			.78	1.71	1.71	122	101	3.0	368				
94.5			.70	1.53	1.53	123	110	3.0	369				
115.5			.75	1.64	1.64	123	110	3.0	376				Estimates:
136.5			.75	1.64	1.64	127	116	3.0	376				MW = 28.5
157.5	17:00	442.228	.75	1.64	1.64	128	116	3.0	375				%H ₂ O = 16

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	7.0	
CO	0	
N ₂	81.0	

Impinger No.

Impinger Contents

Final

Initial

Difference

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.	1.1			
5.

STACK SAMPLING DATA SHEET

Page 3 of 4

CLIENT Coal Creek Station TEST DATE 6-22-97 ORIFICE CORRECTION 1.777 HOT BOX NO. 1
 TEST UNIT ESP #2 OUTLET TEST NO. C-5B-PM-622 METER CORRECTION 2 COLD BOX NO. 1
 PROJECT NO. 93CB20-01 NOZZLE (SIZE, IN) 0.247 CALIBRATION DATE ? PROBE NO. 16-1
 CONTROL BOX OPERATOR RPC STATIC PRESSURE +16.0" H₂O PITOT CORRECTION 2 FILTER NO.
 BAROMETRIC PRESSURE 27.48 PORT DIRECTION PORT 5 & 6 CONTROL BOX NO. Booth 15 Box 71 STACK DIA. 14' x 26'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ 10.5	17:44	442.421	.55	1.20	1.26	103	102	6.5	361	~250	~68	~250	3mm/ft
31.5			.60	1.31	1.31	103	102	6.5	370				
52.5			.50	1.09	1.09	104	102	6.5	380				
72.5			.50	1.09	1.09	105	103	6.5	369				
94.5			.50	1.09	1.09	106	103	6.5	370				
115.5			.55	1.20	1.20	107	103	6.5	369				
136.5			.55	1.20	1.20	107	103	6.5	361				
↓ 157.5	17:38	455.338	.95	1.20	1.20	108	104	6.5	370				
↑ 10.5	17:51	455.338	.65	1.42	1.42	100	95	6.5	371				
31.5			.50	1.09	1.09	100	95	6.5	377				
52.5			.60	1.31	1.31	100	95	6.5	377				
73.5			.50	1.09	1.09	100	95	6.5	365				
94.5			.55	1.20	1.20	100	95	6.5	361				
115.5			.85	1.86	1.86	101	96	6.5	360				Estimates:
136.5			.70	1.53	1.53	100	95	6.5	350				MW= 28.5
↓ 157.5	18:15	470.045	.70	1.53	1.53	100	95	6.0	350				%H ₂ O= 15.0

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOG Rate (cfm)
Before	5.0	0.016 cfm
After	7.6	0.026 cfm

LOW LEAK CHECK ROL
 96.78 ARTS 3.122 gal
 change!

AQE 2/92

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	7.0	
CO	0	
N ₂	81.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.

STACK SAMPLING DATA SHEET

Page 4 of 4

CLIENT Battelle / DOE TEST DATE 06-28-93 ORIFICE CORRECTION 1.777 HOT BOX NO. 1
 TEST UNIT ESP #2 OUTLET TEST NO. C-5B-PM-628 METER CORRECTION ? COLD BOX NO. 1
 PROJECT NO. 93C028-01 NOZZLE (SIZE, IN) 0.247 CALIBRATION DATE ? PROBE NO. 16-1
 CONTROL BOX OPERATOR RL STATIC PRESSURE 16.0" H₂O PITOT CORRECTION ? FILTER NO.
 BAROMETRIC PRESSURE 27.4" PORT DIRECTION PORTS 7 & 8 CONTROL BOX NO. BATGUS Box #1 STACK DIA. 14' x 26'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
10.5	18:21	470.045	.60	1.31	1.31	95	90	4.0	361	~250	250	250	3 min/PT
31.5			.71	1.55	1.55	97	90	4.0	369				
52.5			.80	1.75	1.75	97	90	4.0	370				
73.5			.76	1.66	1.66	98	90	3.5	363				
94.5			.72	1.58	1.58	99	90	3.5	364				
115.5			.85	1.86	1.86	99	90	3.5	367				
136.5			.85	1.86	1.86	99	90	3.5	361				
157.5	18:45	486.175	.87	1.90	1.90	99	90	3.5	370				
10.5	18:51	486.175	.45	.99	.99	98	89	3.5	370				
31.5			.40	.88	.88	96	89	2.0	360				
52.5			.40	.88	.88	95	88	2.5	360				
73.5			.40	.88	.88	95	89	2.5	360				
94.5			.80	1.75	1.75	96	88	3.5	350				
115.5			.80	1.75	1.75	96	86	3.5	349				
136.5			.70	1.53	1.53	96	86	3.0	359				Estimates:
157.5	19:15	500.400	.40	.88	.88	96	86	2.5	346				MW= 28.5 %H ₂ O= 15.0

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

time = 192 min
 volume = 120.512 dcf
 AQE 292 (AP)AG = 0.70
 (AP)AG = 1.157

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	7.0	
CO	0	
N ₂	81.0	

temperature = 105°F

Impinger

No.	Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

velocity =
 Iso. =

D-116

STACK SAMPLING DATA SHEET

Page 1 of 6

CLIENT Bohella / DOE TEST DATE 6-23-93 ORIFICE CORRECTION 1.734 HOT BOX NO. 3
 TEST UNIT ESP #2 Inlet TEST NO. C-46-PM-623 METER CORRECTION 0.9232 COLD BOX NO. 3
 PROJECT NO. 93C020-01 NOZZLE (SIZE, #) 0.183 #22 CALIBRATION DATE 05-17-93 PROBE NO. 10-2
 CONTROL BOX OPERATOR RPC STATIC PRESSURE -10.0" H₂O PITOT CORRECTION 0.84 FILTER NO. #1
 BAROMETRIC PRESSURE 27.60 PORT DIRECTION L1 → L3 CONTROL BOX NO. F.15 STACK DIA. 16" (depth) x 16" (width)

	Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pilot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
					Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ L1 ↓	92.8	12:57	516.500	.50	.29	.28	89	84	1.0	309	~250°	~68°F	~250°	3 min./point
	66.3			1.40	.79	.71	94	85	3.5	310				
	39.8			1.40	.79	.79	94	85	3.5	311				
	13.3	13:09	522.140	1.0	.57	.57	95	86	3.0	300				
↑ L2 ↓	92.8	13:12	522.140	2.0	1.13	1.13	96	88	4.5	295				
	66.3			1.2	.69	.68	99	89	3.5	312				
	39.8			1.3	.74	.74	99	85	3.5	315				
	13.3	13:24	528.170	.80	.47	.47	101	90	3.0	301				
↑ L3 ↓	92.8	13:28	528.170	1.4	.83	.83	100	90	3.5	299				28.3 actual
	66.3			1.6	.95	.95	101	92	4.0	312				
	39.8			1.8	1.06	1.06	101	92	4.0	314				Estimates: ↓
	13.3	13:40	534.500	.70	.41	.41	103	92	2.5	302				MW= 28.3 %H ₂ O= 17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before	5.0	50.01 cfm
After	15.0	40.01 cfm

PITOT LEAK CHECK

	Positive	Negative
Before	0.15 cfm	0.15 cfm
After	0.15 cfm	0.15 cfm

CO ₂	11.0	
O ₂	6.0	
CO	0	
N ₂	87.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100 mL DI H ₂ O	795.8	573.0	222.8
2.	100 mL DI H ₂ O	569.1	539.8	29.3
3.	Empty	459.8	456.5	3.3
4.	200g Polysci Gel	687.3	659.9	27.4
5.				

STACK SAMPLING DATA SHEET

Page 2 of 6

CLIENT Battle 116 / DOE TEST DATE 6-23-93 ORIFICE CORRECTION 1.734 HOT BOX NO. 3
 TEST UNIT ESP #2 Tilt TEST NO. C-46-PM-623 METER CORRECTION .9832 COLD BOX NO. 3
 PROJECT NO. 93C6 28-01 NOZZLE (SIZE, #) #22 0.183 CALIBRATION DATE 05-17-95 PROBE NO. 10-2
 CONTROL BOX OPERATOR RPC STATIC PRESSURE -16.0" H₂O PITOT CORRECTION 0.81 FILTER NO. #1
 BAROMETRIC PRESSURE 27.60 PORT DIRECTION 24 → 46 CONTROL BOX NO. FIVE STACK DIA. 106" (depth) x 16' curv

	Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
					Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ L4 ↓	92.8	13:42	534.500	1.0	.59	.59	99	93	4.0	291	~250°	~68°F	~250°	3 min / point
	66.3			1.0	.59	.59	99	93	4.0	310				
	39.8			1.1	.65	.65	102	93	4.0	311				
	13.3	13:54	537.410	.80	.47	.47	102	93	4.0	311				
↑ L5 ↓	92.8	13:56	539.410	1.20	.71	.71	100	94	4.5	300				
	66.3			.95	.56	.56	101	94	4.0	304				
	39.8			1.50	.89	.89	103	95	5.5	330				
	13.3	14:08	548.191	1.25	.74	.74	103	94	5.5	331				
↑ L6 ↓	92.8	14:11	545.191	.95	.56	.56	99	95	6.0	300				
	66.3			1.45	.86	.86	102	94	6.5	333				
	39.8			1.50	.89	.89	102	94	7.0	337				Estimates:
	13.3	14:23	551.405	1.50	.89	.89	102	94	7.0	336				MW = 29.3 %H ₂ O = 17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	11.0	
O ₂	6.0	
CO	0	
N ₂	83.6	

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.

STACK SAMPLING DATA SHEET

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CLIENT Bethell / DC TEST DATE 6-23-92 ORIFICE CORRECTION 1.734 HOT BOX NO. 3
 TEST UNIT ESP #2 Inlet TEST NO. C-46-PM-623 METER CORRECTION 0.9832 COLD BOX NO. 3
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) #229183 CALIBRATION DATE 05-17-92 PROBE NO. 10-2
 CONTROL BOX OPERATOR RPC STATIC PRESSURE -16.0" H₂O PITOT CORRECTION 0.84 FILTER NO. #1
 BAROMETRIC PRESSURE 22.60 PORT DIRECTION L7 + L8 CONTROL BOX NO. FIVE STACK DIA. 106" (46" x 16" oval)

	Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
					Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑	92.8	1425	557.405	1.10	.65	.65	100	94	5.5	340	~250°	~68°F	~250°	3 min / point
L7	66.3			1.15	.68	.68	101	94	6.0	335				
	39.8			1.15	.68	.68	102	95	6.0	345				
↓	13.3	1437	556.345	1.10	.65	.65	103	94	6.0	340				
↑	92.8	1439	556.345	1.40	.83	.83	101	95	6.5	330				
L8	66.3			1.60	.95	.95	102	94	7.0	336				
	39.8			1.60	.95	.95	103	95	7.0	337				
↓	13.3	1451	562.756	1.10	.65	.65	102	94	5.0	319				
Left Side Ports	A = 96 min	A = 46.256 dcf	(AP) _{avg} = 1.20	(ΔH) _{avg} = 0.72	(T _{meter}) _{avg} = 96°F	(T _{stack}) _{avg} = 318°F								Estimates: MW = 28.3 %H ₂ O = 17.3
					Velocity = 80.5 ft/sec	ISO. = 95.1%								

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	4.002 cfm
After		

PITOT LEAK CHECK

	Positive	Negative
Before	0.218 c	0.536 c
After		
	1	2
CO ₂	11.0	
O ₂	6.0	
CO	0	
N ₂	87.0	

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.

STACK SAMPLING DATA SHEET

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CLIENT Battelle / DOE TEST DATE 6-23-93 ORIFICE CORRECTION 1.734 HOT BOX NO. 3
 TEST UNIT ESP #2 Inlet TEST NO. C-46-PM-623 METER CORRECTION 0.9832 COLD BOX NO. 3
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) #22 0.183 CALIBRATION DATE 05-17-92 PROBE NO. 10-2
 CONTROL BOX OPERATOR R/C STATIC PRESSURE -16.0 "H₂O PITOT CORRECTION 0.24 FILTER NO. #2
 BAROMETRIC PRESSURE 27.60 PORT DIRECTION L R1 → R3 CONTROL BOX NO. FIVE STACK DIA. 10.1" (depth) × 6.1" (width)

	Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
					Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ R1 ↓	92.8	15:33	563.028	1.50	.88	.88	96	73	4.5	362	~25°	468°F	250°	3 min/point
	46.3			1.50	.88	.88	97	93	4.5	360				New filter installed
	39.8			1.50	.88	.88	99	93	4.5	351				
	13.3	15:45	568.852	1.40	.82	.82	101	93	4.5	344				
↑ R2 ↓	92.8	15:47	568.852	1.65	.97	.97	99	93	4.5	356				
	46.3			1.70	1.00	1.00	101	93	5.0	357				
	39.8			1.30	.76	.76	102	94	4.0	359				
	13.3	15:59	574.691	.65	.38	.38	102	93	2.5	340				
↑ R3 ↓	92.8	16:01	574.691	1.20	.70	.70	101	94	4.5	362				
	46.3			1.20	.70	.70	102	94	4.5	363				
	39.8			1.20	.70	.70	103	94	4.5	355				Estimates:
	13.3	16:13	580.465	1.00	.59	.59	103	94	4.5	350				MW = 28.3 %H ₂ O = 17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	4.002 cfm
After	8.5	2.0015

PITOT LEAK CHECK

	Positive	Negative
Before	0.15366	0.15366
After	0.15366	0.15366

	1	2
CO ₂	11.0	
O ₂	6.0	
CO	0	
N ₂	93.0	

Impinger

No.	Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.

STACK SAMPLING DATA SHEET

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CLIENT Battelle / DOE TEST DATE 6-23-93 ORIFICE CORRECTION 1.734 HOT BOX NO. 3
 TEST UNIT ESP #2 Inlet TEST NO. C-46-PM-623 METER CORRECTION 0.9832 COLD BOX NO. 3
 PROJECT NO. 93C428-01 NOZZLE (SIZE, IN) 2.20183 CALIBRATION DATE 05-17-93 PROBE NO. 10-2
 CONTROL BOX OPERATOR RPC STATIC PRESSURE -16.0" H₂O PITOT CORRECTION 0.84 FILTER NO. 2
 BAROMETRIC PRESSURE 29.60 PORT DIRECTION R4 → R6 CONTROL BOX NO. FIVE STACK DIA. 106" (depth) x 16" width

	Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
					Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ R4 ↓	92.8	16:16	580.465	.95	.56	.56	102	95	5.0	370	-250°	268°F	-250°	3 min/point
	66.3			1.0	.59	.59	102	95	5.0	371				
	39.8			1.45	.85	.85	104	95	6.5	360				
	13.3	16:27	586.061	1.40	.82	.82	104	96	6.5	363				
↑ R5 ↓	92.8	16:29	586.061	1.10	.62	.62	101	95	4.5	375				
	66.3			1.30	.74	.74	102	96	5.5	374				
	39.8			1.25	.71	.71	103	96	5.5	374				
	13.3	16:41	591.900	1.0	.57	.57	104	96	5.0	370				
↑ R6 ↓	92.8	16:43	591.900	1.40	.79	.79	102	95	6.5	374				
	66.3			1.40	.79	.79	103	95	6.5	378				
	39.8			1.50	.85	.85	103	95	6.5	378				Estimates:
	13.3	16:55	597.821	.75	.42	.42	103	96	4.5	346				MW= 28.3 %H ₂ O= 17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	16.0	
O ₂	6.0	
CO	0	
N ₂	83.0	

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

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HOT BOX NO. 3
COLD BOX NO. 3
PROBE NO. 10-2
FILTER NO. 2
STACK DIA. 106" (depth) x 16" (width)

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

STACK SAMPLING DATA SHEET

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CLIENT Battelle/DIE TEST DATE 6-24-93 ORIFICE CORRECTION 1.77 HOT BOX NO. 1
 TEST UNIT EXP #2 outlet TEST NO. C-5B-PM-624 METER CORRECTION ? COLD BOX NO. 1
 PROJECT NO. 93C028-01 NOZZLE (SIZE, IN) 0.247 CALIBRATION DATE ? PROBE NO. 16-1
 CONTROL BOX OPERATOR RAC STATIC PRESSURE +16.0" H₂O PITOT CORRECTION ? FILTER NO.
 BAROMETRIC PRESSURE 27.54 PORT DIRECTION PORT #1, #2 CONTROL BOX NO. BATTB-16 Box 1 STACK DIA. 41" (depth) x 26" (width)

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pilot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
10.5	1309	501.151	.40	0.83	0.83	75	74	1.00	354	~250°	~68°F	-250°	8 parts
31.5			.55	1.14	1.14	77	75	1.0	350				8 parts/port
52.5			.70	1.45	1.45	77	75	1.0	300				3 min/port
73.5			.70	1.45	1.45	77	75	1.0	350				
94.5			.80	1.86	1.86	79	75	2.0	354				
115.5			.90	1.86	1.86	79	75	2.0	354				
136.5			.80	1.66	1.66	80	75	2.0	350				
157.5	1333	513.666	.80	1.66	1.66	80	79	2.0	350				
10.5	1337	513.666	.55	1.14	1.14	78	75	1.0	354				
31.5			.55	1.14	1.14	78	75	1.0	350				
52.5			.75	1.55	1.55	78	75	1.0	358				
73.5			.72	1.47	1.47	78	76	1.0	356				
94.5			.70	1.45	1.45	80	76	1.0	350				
115.5			.85	1.76	1.76	80	76	2.0	354				Estimates:
136.5			.85	1.76	1.76	80	76	2.0	354				MW=28.1
157.5	14:01	528.093	.85	1.76	1.76	80	76	2.0	350				%H ₂ O=17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	6.0	<0.015 cfm
After	9.0	<0.015 cfm

PITOT LEAK CHECK

	Positive	Negative
Before	OK 15 sec	OK 15 sec
After	OK 15 sec	OK 15 sec

CO ₂	12.0	
O ₂	7.0	
CO	0	
N ₂	81.0	

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	1.00m DE H ₂ O	847.3	568.9	277.4
2.	100m DE H ₂ O	1009.0	576.1	32.9
3.	EMPTY	462.0	458.2	3.8
4.	Silica GEL	696.3	672.8	23.5
5.				

2,337.69 total
KEYSTONE
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STACK SAMPLING DATA SHEET

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CLIENT Battelle / DOE TEST DATE 6-24-93 ORIFICE CORRECTION 1.777 HOT BOX NO. 1
 TEST UNIT ESP #2 outlet TEST NO. C-5B-PM-624 METER CORRECTION ? COLD BOX NO. 1
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) 0.247 CALIBRATION DATE ? PROBE NO. 16-1
 CONTROL BOX OPERATOR RPC STATIC PRESSURE +16.0" H₂O PITOT CORRECTION ? FILTER NO.
 BAROMETRIC PRESSURE 27.54 PORT DIRECTION PORT #3, #4 CONTROL BOX NO. BATT046 BOX # 1 STACK DIA. 14" (depth) x 26" (width)

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
10.5	14:04	528.093	.55	1.14	1.14	85	75	1.0	351	~250°	~68°F	~250°	8 ports
31.5			.65	1.35	1.35	85	75	2.0	350				3 min/port
52.5			.65	1.35	1.35	85	75	2.0	354				
73.5			.85	1.76	1.76	85	76	2.0	352				
94.5			.85	1.76	1.76	88	77	3.0	350				
115.5			.85	1.76	1.76	88	77	3.0	351				
136.5			.80	1.66	1.66	88	77	3.0	354				
157.5	14:28	543.438	.80	1.66	1.66	89	77	3.0	351				
10.5	14:32	543.438	.50	1.03	1.03	80	76	1.0	350				
31.5			.55	1.14	1.14	80	76	1.0	349				
52.5			.60	1.24	1.24	80	76	1.0	355				
73.5			.65	1.35	1.35	82	77	1.0	349				
94.5			.70	1.45	1.45	83	77	1.0	354				
115.5			.70	1.45	1.45	83	77	1.5	361				Estimates:
136.5			.70	1.45	1.45	84	78	1.5	366				MW= 28.1
157.5	14:36	558.170	.65	1.35	1.35	85	77	1.0	366				%H ₂ O=17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	7.0	
CO	0	
N ₂	81.0	

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.

STACK SAMPLING DATA SHEET

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CLIENT Battelle / DOE TEST DATE 6-24-93 ORIFICE CORRECTION 1.777 HOT BOX NO. 1
 TEST UNIT ESP #2 Outlet TEST NO. C-58-PM-624 METER CORRECTION ? COLD BOX NO. 1
 PROJECT NO. 93C028-01 NOZZLE (SIZE, IN) 0.247 CALIBRATION DATE ? PROBE NO. 16-1
 CONTROL BOX OPERATOR LPL STATIC PRESSURE 16.0" H₂O PITOT CORRECTION ? FILTER NO.
 BAROMETRIC PRESSURE 27.54 PORT DIRECTION PORT #5, #6 CONTROL BOX NO. DATE: 10/6/91 STACK DIA. 44" (depth) x 24" (wid)

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pilot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
10.5	15:02	558.170	.55	1.14	1.14	80	75	1.0	355	~256	<68°F	~250	8 ports
31.5			.55	1.14	1.14	82	76	1.0	352				3 min / point
52.5			.65	1.35	1.35	83	77	1.0	361				
73.5			.65	1.35	1.35	83	77	1.0	366				
94.5			.75	1.55	1.55	85	78	1.0	367				
115.5			.70	1.45	1.48	85	78	1.0	361				
136.5			.65	1.35	1.38	83	75	1.0	366				
157.5	15:26	572.680	.55	1.14	1.14	83	73	1.0	361				
10.5	15:29	572.680	.60	1.24	1.24	80	70	1.0	360				
31.5			.70	1.41	1.41	82	71	1.0	365				
52.5			.70	1.41	1.41	83	71	1.0	371				
73.5			.80	1.62	1.62	84	70	2.0	329				
94.5			.80	1.62	1.62	85	71	2.5	328				
115.5			.80	1.62	1.62	87	72	2.5	339				Estimates:
136.5			.65	1.31	1.31	88	72	2.5	330				MW= 28.1
157.5	15:53	587.646	.65	1.31	1.31	88	72	2.5	341				%H ₂ O=17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	7.0	
CO	0	
N ₂	81.0	

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.

STACK SAMPLING DATA SHEET

Page 4 of 4

CLIENT Battelle DOE TEST DATE 6-24-93 ORIFICE CORRECTION 1.777 HOT BOX NO. 1
 TEST UNIT ESP #2 outlet TEST NO. C-5B-PM-624 METER CORRECTION ? COLD BOX NO. 1
 PROJECT NO. 93C028-01 NOZZLE (SIZE, IN) 0.247 CALIBRATION DATE ? PROBE NO. 16-1
 CONTROL BOX OPERATOR R/R STATIC PRESSURE +16.0" H2O PITOT CORRECTION ? FILTER NO.
 BAROMETRIC PRESSURE 27.59 PORT DIRECTION PORT #7, #8 CONTROL BOX NO. BATT-16-01 #1 STACK DIA. 14" (depth) x 24" (width)

	Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
					Req'd. (in. H2O)	Act. (in. H2O)	In (°F)	Out (°F)						
↑ PORT #7 ↓	10.5	15.57	587.646	.50	1.01	1.01	80	77	2.0	325	~250°	~68°F	~250°	8 ports
	31.5			.65	1.31	1.31	83	73	2.5	309				8 points/port
	52.5			.65	1.31	1.31	83	73	2.5	329				3 min/port
	73.5			.65	1.31	1.31	83	74	2.5	331				
	94.5			.80	1.62	1.62	85	75	2.5	328				
	115.5			.80	1.62	1.62	85	76	2.5	341				
	136.5			.70	1.41	1.41	85	76	2.5	341				
	157.5	16:01	602.330	.70	1.41	1.41	85	76	2.5	339				
↑ PORT #8 ↓	10.5		PORT #8 NOT SAMPLED DUE TO High winds causing hazardous condition.											
	31.5													
	52.5													
	73.5	A =	A =	(ΔP) =	(ΔH) =	(T _{amb}) = 77°F	(T _{stack}) = 348°F							
	94.5	16.8	101.179		1.43									
	115.5	min	dcf	0.70										Estimates:
	136.5													MW = 28.1
	157.5													%H2O = 7.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	12.0	
O2	7.0	
CO	0	
N2	81.0	

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.

STACK SAMPLING DATA SHEET

Page 1 of 6

CLIENT Battelle / DOE TEST DATE 6-26-93 (Sat.) ORIFICE CORRECTION 1.734 HOT BOX NO. 3
 TEST UNIT E3P #2 Inlet TEST NO. C-46-PM-626 METER CORRECTION 0.9832 COLD BOX NO. 3
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) 0.183 #22 CALIBRATION DATE 05-17-93 PROBE NO. 10-2
 CONTROL BOX OPERATOR RPC STATIC PRESSURE +16.0" H₂O PITOT CORRECTION 0.84 FILTER NO. #1
 BAROMETRIC PRESSURE 27.70 PORT DIRECTION L1 → L3 CONTROL BOX NO. FIVE STACK DIA. 106" (depth) X

	Traverse Point (inches)	Time	Dry Gas Meter Reading (scf) (dcl)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments 16' (width)
					Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ L1 ↓	92.8	11:34	707.415	1.3	.76	.76	85	82	3.0	300	~250°	<68°F	~250°	3 min/point
	66.3		713.100	1.3	.76	.76	89	82	3.0	292				
	39.8			1.2	.70	.70	91	82	3.0	306				
	13.3	11:46	719.090	1.0	.58	.58	93	83	2.5	300				
↑ L2 ↓	92.8	11:48	719.090	1.5	.87	.87	92	84	3.0	299				
	66.3			1.65	.96	.96	95	84	4.0	305				
	39.8			1.25	.73	.73	96	85	3.5	309				
	13.3	12:00	725.218	.80	.46	.46	97	86	2.5	299				
↑ L3 ↓	92.8	12:02	725.218	1.3	.76	.76	95	87	3.5	304				
	66.3			1.3	.76	.76	98	87	3.5	309				
	39.8			1.9	1.10	1.10	98	88	5.0	319				
	13.3	12:14	733.915	1.85	1.11	1.11	100	88	5.0	311				Estimates: MW= 28.3 %H ₂ O= 14

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	<0.016 cfm
After	8.5	<0.015 cfm

Leak ports
FLT #1.

PITOT LEAK CHECK

	Positive	Negative
Before	OK/1536C	OK/1536C
After	OK/1536C	OK/1536C
	1	2
CO ₂	11.0	11.0
O ₂	7.0	7.0
CO	0	0
N ₂	82.0	82.0

Impinger

Impinger No.	Contents	Final	Initial	Difference
1.	100 mL D.F. H ₂ O	809.8	560.5	249.3
2.	100 mL D.F. H ₂ O	472.1	539.5	-67.4
3.	Empty	529.9	416.7	113.2
4.	200g Silica Gel	683.8	659.7	24.1
5.				

308.2g total
KEYSTONE
 Environmental Systems Inc.

STACK SAMPLING DATA SHEET

Page 2 of 6

CLIENT Bethell / DOE TEST DATE 6-26-93 (Sat.) ORIFICE CORRECTION 1.734 HOT BOX NO. 3
 TEST UNIT ESP #2 Inlet TEST NO. C-46-M-626 METER CORRECTION 0.9832 COLD BOX NO. 3
 PROJECT NO. 93C628-14 NOZZLE (SIZE, #) 0.183 #22 CALIBRATION DATE 05-17-93 PROBE NO. 10-2
 CONTROL BOX OPERATOR RPC STATIC PRESSURE -16.0" H₂O PITOT CORRECTION 0.84 FILTER NO. FET #1
 BAROMETRIC PRESSURE 27.70 PORT DIRECTION 44 → 46 CONTROL BOX NO. FIVE STACK DIA. 106" (depth) x

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments 16' (width)
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ 42.8	12:17	733.915	1.0	.60	.60	96	89	4.0	299	~250°	~68°F	~250°	3 min/point
↓ 66.3			.95	.57	.57	98	89	4.0	300				
↓ 39.8			.95	.57	.55	99	90	4.0	309				
↓ 13.3	12:29	737.177	.85	.57	.57	100	90	4.0	321				
↑ 42.8	12:32	737.177	.90	.54	.54	97	90	4.0	303				
↓ 66.3			1.1	.66	.66	99	91	4.0	319				
↓ 39.8			1.3	.78	.78	99	91	4.5	328				
↓ 13.3	12:44	742.235	1.0	.60	.60	99	91	4.0	319				
↑ 42.8	12:46	742.235	.95	.57	.57	98	92	5.0	307				
↓ 66.3			1.40	.84	.84	99	92	6.0	323				
↓ 39.8			1.40	.84	.84	99	92	6.0	330				Estimates:
↓ 13.3	12:58	748.670	1.30	.78	.78	99	91	6.0	330				MW= 28.3 %H ₂ O= 14

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	11.0	11.0
O ₂	7.0	7.0
CO	0	0
N ₂	82.0	82.0

Impinger No.

Impinger Contents

Final

Initial

Difference

1.				
2.				
3.				
4.				
5.				

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STACK SAMPLING DATA SHEET

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CLIENT Battelle / DOE TEST DATE 6-26-93 (Sat.) ORIFICE CORRECTION 1.734 HOT BOX NO. 3
 TEST UNIT ESP #2 Inlet TEST NO. C-46-PM-626 METER CORRECTION 0.9832 COLD BOX NO. 3
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) 0.183 #22 CALIBRATION DATE 05-17-93 PROBE NO. 10-2
 CONTROL BOX OPERATOR RPC STATIC PRESSURE -16.0" H₂O PITOT CORRECTION 0.84 FILTER NO. PLT #1
 BAROMETRIC PRESSURE 27.70 PORT DIRECTION L7 > L8 CONTROL BOX NO. FIVE STACK DIA. 106" (depth) x

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pilot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑	92.8	13:00	749.670	1.30	.78	.78	97	92	5.5	317	~250°	~460°	3 min / point
L7	66.3			1.20	.72	.72	99	92	5.5	314			
↓	39.8			1.50	.90	.90	100	91	6.5	331			
↓	13.3	13:12	754.890	1.20	.72	.72	100	92	5.5	321			
↑	92.8	13:14	754.890	1.25	.75	.75	98	91	5.0	317			
L8	66.3			1.50	.90	.90	99	92	7.5	318			
↓	39.8			1.0	.60	.60	100	92	6.0	338			
↓	13.3	13:26	760.813	.80	.48	.48	100	92	6.5	330			
Left ports Δ = Δ = (ΔP) _{avg} = (ΔH) _{avg} = (T _{meter}) _{avg} = 93°F (T _{stack}) _{avg} = 313°F 96/min 47.713 dcf 1.20 0.73 Velocity = 79.8 ft/sec T ₅₀ = 95.1%													
													Estimates:
													MW = 28.3
													%H ₂ O = 14

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	16.0	11.0
O ₂	7.0	7.0
CO	0	0
N ₂	82.0	82.0

Impinger No.

Impinger Contents

Final

Initial

Difference

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

STACK SAMPLING DATA SHEET

Page 4 of 6

CLIENT Battelle / DOE TEST DATE 6-26-93 (Sat.) ORIFICE CORRECTION 1.734 HOT BOX NO. 3
 TEST UNIT ESP #2 Inlet TEST NO. C-46-PM-626 METER CORRECTION 0.9832 COLD BOX NO. 3
 PROJECT NO. 93C028-01 NOZZLE (SIZE, NO.) 1/2" #22 CALIBRATION DATE 05-07-93 PROBE NO. 10-2
 CONTROL BOX OPERATOR PK STATIC PRESSURE -16.0" H₂O PITOT CORRECTION 0.84 FILTER NO. FLT #2
 BAROMETRIC PRESSURE 27.20 PORT DIRECTION R1-R3 CONTROL BOX NO. FIVE STACK DIA. 106" (depth) x

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ R1 ↓	92.8	14:14	762.024	1.1	.66	.66	91	91	4.0	354	-250°	~250°	3 min/point
	66.3			1.1	.66	.66	94	90	4.0	353			
	39.8			1.35	.81	.81	96	90	5.0	349			new filter
	13.3	14:26	767.741	1.35	.81	.81	98	90	5.0	351			inst.illed
↑ R2 ↓	92.8	14:28	767.741	1.55	.93	.93	96	90	5.0	354			
	66.3			1.30	.78	.78	98	90	5.0	353			
	39.8			1.55	.93	.93	98	90	6.0	349			
	13.3	14:40	773.581	.80	.48	.48	99	91	5.0	356			
↑ R3 ↓	92.8	14:43	773.581	1.20	.72	.72	96	91	5.0	361			
	66.3			1.25	.75	.75	99	91	5.0	357			
	39.8			1.55	.93	.93	100	91	5.5	358			Estimates:
	13.3	14:55	779.651	1.10	.66	.66	101	91	5.0	341			MW= 28.3 %H2O= 14

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	<0.01 cfm
After	9.0	<0.01 cfm

PITOT LEAK CHECK

	Positive	Negative
Before	62/15500	87/15500
After	62/15500	87/15500

	1	2
CO2	11.0	11.0
O2	7.0	7.0
CO	0	0
N2	82.0	82.0

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

STACK SAMPLING DATA SHEET

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CLIENT Battelle / DOE TEST DATE 6-26-93 (Sat.) ORIFICE CORRECTION 1.734 HOT BOX NO. 3
 TEST UNIT ESP #2 Inlet TEST NO. C-46-PM-626 METER CORRECTION 0.9832 COLD BOX NO. 3
 PROJECT NO. 93CB28-01 NOZZLE (SIZE, Ø) 1/8" #22 CALIBRATION DATE 05-17-93 PROBE NO. 10-2
 CONTROL BOX OPERATOR RIC STATIC PRESSURE -16.0" H₂O PITOT CORRECTION 0.84 FILTER NO. FLT #8
 BAROMETRIC PRESSURE 27.20 PORT DIRECTION R4 → R6 CONTROL BOX NO. FIVE STACK DIA. 106" (depth) x

	Traverse Point (inches)	Time	Dry Gas Meter Reading (dcl)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
					Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ R4	92.8	14:56	779.651	.85	.51	.51	99	92	4.0	369	~200°	168°F	~250°	3 min/point
	66.3			1.55	.93	.93	100	92	5.5	365				
	39.8			1.60	.96	.96	101	92	5.5	363				
↓	13.3	15:08	785.729	1.20	.72	.72	102	93	5.0	361				
↑ R5	92.8	15:10	785.729	.95	.57	.57	100	93	5.0	370				
	66.3			.95	.57	.57	101	93	5.0	373				
	39.8			1.25	.75	.75	102	94	5.5	375				
	13.3	15:22	791.143	1.20	.72	.72	102	94	5.5	339				
↑ R6	92.8	15:25	791.143	1.40	.84	.84	99	94	6.0	375				
	66.3			1.25	.75	.75	101	95	6.5	376				
	39.8			1.50	.90	.90	101	95	6.0	377				Estimates:
	13.3	15:37	797.275	1.15	.69	.69	102	95	6.0	374				MW= 28.3 %H ₂ O= 14

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	11.0	11.0
O ₂	7.0	7.0
CO	0	0
N ₂	82.0	82.0

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

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CLIENT <u>Battelle / DOE</u>	TEST DATE <u>6-26-93 (Sat.)</u>	ORIFICE CORRECTION <u>1.734</u>	HOT BOX NO. <u>3</u>
TEST UNIT <u>ESP in Inlet</u>	TEST NO. <u>C-46-PM-626</u>	METER CORRECTION <u>0.9832</u>	COLD BOX NO. <u>3</u>
PROJECT NO. <u>93CP20-0</u>	NOZZLE (SIZE, #) <u>#22 0.183</u>	CALIBRATION DATE <u>05-17-93</u>	PROBE NO. <u>10-2</u>
CONTROL BOX OPERATOR <u>RPC</u>	STATIC PRESSURE <u>-16.0" H₂O</u>	PITOT CORRECTION <u>0.84</u>	FILTER NO. <u>FLT 20</u>
BAROMETRIC PRESSURE <u>27.70</u>	PORT DIRECTION <u>R7 → R8</u>	CONTROL BOX NO. <u>FIVE</u>	STACK DIA. <u>106" (diameter)</u>

	Traverse Point (inches)	Time	Dry Gas Meter Reading (dcl)	Pilot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
					Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ R7 ↓	92.8	15:39	797.275	1.60	.96	.96	101	94	7.5	384	~250°	468°F	~250°	3 min/point 16' (width)
	66.3			1.80	1.08	1.08	103	95	8.5	385				
	39.8			1.15	.69	.69	102	95	7.0	384				
	13.3	15:51	803.939	1.35	.81	.81	103	96	8.0	381				
↑ R8 ↓	92.8	15:53	803.939	1.50	.90	.90	101	95	8.0	366				
	66.3			1.35	.81	.81	102	96	7.5	360				
	39.8			1.40	.84	.84	103	96	7.5	371				
	13.3	16:05	810.169	.80	.48	.48	103	96	6.0	364				
Right ports	$\Delta = 96$ min $\Delta = 48.445$ dcl $(\Delta P)_{Avg} = 1.25$ $(\Delta H)_{Avg} = 0.77$ $(T_{meter})_{Avg} = 96^{\circ}F$ $(T_{stack})_{Avg} = 364^{\circ}F$													
	Estimates: MW = 28.3 %H ₂ O = 14													
	velocity = 84.1 ft/sec ISO = 96.5%													

PITOT LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

	Positive	Negative
Before		
After		

	1	2
CO2	11.0	11.0
O2	7.0	7.0
CO	0	0
N2	82.0	82.0

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

STACK SAMPLING DATA SHEET

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CLIENT Battelle / DOE TEST DATE 6-27-93 ORIFICE CORRECTION 1.77 HOT BOX NO. 1
 TEST UNIT ESP #2 OUTLET TEST NO. C-56-M-627 METER CORRECTION COLD BOX NO. 1
 PROJECT NO. 93CD28-01 NOZZLE (SIZE, Ø) 0.247 CALIBRATION DATE PROBE NO. 16-1
 CONTROL BOX OPERATOR RPC STATIC PRESSURE 1.00 PITOT CORRECTION 0.84 FILTER NO. 1
 BAROMETRIC PRESSURE 27.76 PORT DIRECTION RT #1, #2 CONTROL BOX NO. Battelle Box #1 STACK DIA. 14 (depth) x 26 (wid)

	Traverse Point (inches)	Time	Dry Gas Meter Reading (dcl)	Pitot ΔP (in. H2O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
					Req'd. (in. H2O)	Act. (in. H2O)	In (°F)	Out (°F)						
↑ PORT #1	10.5	10:48	602.480	.45	.96	.96	78	76	1.0	357	~250°	168°F	~250°	8 ports
	31.5			.45	.96	.96	79	76	1.0	354				8 ports/port
	52.5			.65	1.38	1.38	79	76	1.5	351				3 mic/point
	73.5			.80	1.70	1.70	79	76	1.5	356				
	94.5			.90	1.91	1.91	79	76	2.0	351				
	115.5			.85	1.81	1.81	80	77	1.5	350				
	136.5			.95	1.81	1.81	90	77	1.5	351				
	157.5	11:12	617.113	.80	1.70	1.70	85	77	1.5	354				
↑ PORT #2	10.5	11:16	617.113	.60	1.27	1.27	85	77	1.5	357				
	31.5			.55	1.17	1.17	89	77	1.5	344				
	52.5			.75	1.59	1.59	93	79	1.5	345				
	73.5			.70	1.49	1.49	98	80	2.0	350				
	94.5			.70	1.49	1.49	98	81	2.0	357				
	115.5			.73	1.55	1.55	98	81	2.0	329				Estimates:
	136.5			.85	1.81	1.81	99	93	2.5	355				MW= 28.5
	157.5	11:40	632.313	.93	1.76	1.76	91	83	2.5	354				%H2O= 14

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before	2.0	10.01 cfm
After		

PITOT LEAK CHECK

	Positive	Negative
Before	0.15/0.10	0.15/0.10
After		

	1	2
CO2	13.0	13.0
O2	8.5	8.5
CO	0	0
N2	78.5	78.5

Impinger

Impinger No.	Contents	Final	Initial	Difference
1.	100mL DI H2O	867.0	572.9	294.1
2.	100mL DI H2O	633.1	578.6	54.5
3.	Empty	470.7	461.9	8.8
4.	200g Silica Gel	706.8	676.4	30.4
5.				

387.89 total
KEYSTONE
 ENVIRONMENTAL SERVICES, INC.

D-133

STACK SAMPLING DATA SHEET

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CLIENT Battelle DOE TEST DATE 6-27-93 ORIFICE CORRECTION 1.77 HOT BOX NO. 1
 TEST UNIT ESP #2 OUTLET TEST NO. C-5b-PM-627 METER CORRECTION 1 COLD BOX NO. 1
 PROJECT NO. 93C628-01 NOZZLE (SIZE, #) 0.247 CALIBRATION DATE 16-1 PROBE NO. 16-1
 CONTROL BOX OPERATOR RPC STATIC PRESSURE 6.0 H₂O PITOT CORRECTION 0.84 FILTER NO. +
 BAROMETRIC PRESSURE 27.76 PORT DIRECTION PORT #3, #4 CONTROL BOX NO. BATTELLE BOX #1 STACK DIA. 14 (depth) x 26 (circ)

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pilot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ 10.5	11:45	623.313	.50	1.06	1.06	93	87	2.0	351	~250°	468°F	~250°	8 ports
31.5			.50	1.06	1.06	94	87	2.0	354				8 points/port
PORT #3 52.5			.75	1.59	1.59	98	87	2.0	351				3 min/port
73.5			.70	1.49	1.49	98	86	3.0	350				
94.5			.85	1.81	1.81	100	86	3.5	344				
115.5			.90	1.91	1.91	100	86	3.5	349				
136.5			.70	1.49	1.49	101	86	3.0	355				
↓ 157.5	12:09	647.781	.70	1.49	1.49	101	86	3.0	354				
↑ 10.5	12:12	647.781	.50	1.06	1.06	95	86	1.0	351				
31.5			.60	1.27	1.27	96	86	1.5	350				
52.5			.65	1.38	1.38	102	86	1.5	354				
PORT #4 73.5			.60	1.27	1.27	102	88	1.5	361				
94.5			.60	1.27	1.27	102	88	1.5	357				
115.5			.65	1.38	1.38	103	89	1.5	344				Estimates:
136.5			.65	1.38	1.38	103	89	1.5	350				MW-28.5
↓ 157.5	12:36	662.196	.60	1.27	1.27	103	89	1.5	355				%H ₂ O-14

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	13.0	13.0
O ₂	8.5	8.5
CO	0	0
N ₂	78.5	78.5

Impinger No.

Impinger Contents

Final

Initial

Difference

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

STACK SAMPLING DATA SHEET

Page 3 of 4

CLIENT Battelle DOE TEST DATE 6-27-93 ORIFICE CORRECTION 1.77 HOT BOX NO. 1
 TEST UNIT ESP #2 outlet TEST NO. C-55-PM-627 METER CORRECTION 1 COLD BOX NO. 1
 PROJECT NO. 93C62B-01 NOZZLE (SIZE, #) 0.247 CALIBRATION DATE 16-1 PROBE NO. 16-1
 CONTROL BOX OPERATOR RPC STATIC PRESSURE 6.0" H₂O PITOT CORRECTION 0.84 FILTER NO. 41
 BAROMETRIC PRESSURE 27.76 PORT DIRECTION PORT #5, #6 CONTROL BOX NO. Battelle Box #1 STACK DIA. 14" (dph) x 26" (dia)

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp (°F)	Probe Temp (°F)	Impinger Temp (°C/°F)	Hot Box Temp (°F)	Comments
				Req'd (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
↑ 10.5	12:39	666.2196	.50	1.06	1.06	95	87	1.0	358	~250°	168°F	-250°	8 ports
31.5			.65	1.38	1.38	97	85	1.5	361				8 ports/port
PORT 52.5			.70	1.49	1.49	99	88	3.0	351				3 min/port
#5 73.5			.65	1.38	1.38	100	88	2.5	355				
94.5			.70	1.49	1.49	102	89	3.0	356				
115.5			.70	1.49	1.49	101	89	3.0	360				
136.5			.55	1.17	1.17	103	90	2.0	360				
157.5	13:03	676.605	.50	1.06	1.06	103	90	2.0	355				
↑ 10.5	13:51	676.607	.60	1.27	1.27	88	88	2.0	356				
31.5			.65	1.38	1.38	95	89	2.0	357				
52.5			.65	1.38	1.38	98	89	2.0	354				
PORT 73.5			.60	1.27	1.27	99	90	2.0	353				
#6 94.5			.80	1.70	1.70	100	90	3.0	351				
115.5			.80	1.70	1.70	101	90	3.0	350				Estimates:
136.5			.75	1.59	1.59	101	90	3.0	367				MW=28.5
157.5	14:15	691.630	.70	1.48	1.48	101	90	3.0	355				%H ₂ O=14

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	13.0	15.0
O ₂	8.5	8.5
CO	0	0
N ₂	78.5	78.5

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.

STACK SAMPLING DATA SHEET

Page 4 of 4

CLIENT Battelle DOE
 TEST UNIT BP #2 outlet
 PROJECT NO. 93 CD28-01
 CONTROL BOX OPERATOR RA
 BAROMETRIC PRESSURE 27.76

TEST DATE 6-27-93
 TEST NO. C-56-PM-627
 NOZZLE (SIZE, #) 0.247
 STATIC PRESSURE 6.0" H₂O
 PORT DIRECTION PORT #7, #8

ORIFICE CORRECTION 1.77
 METER CORRECTION
 CALIBRATION DATE
 PITOT CORRECTION 0.24
 CONTROL BOX NO. BATTB-01

HOT BOX NO. 1
 COLD BOX NO. 1
 PROBE NO. 16-1
 FILTER NO. 1
 STACK DIA. 14" (dup) x 26" (width)

	Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
					Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
PORT #7 ↑ ↓	10.5	14:20	691.630	.55	1.17	1.17	90	88	2.5	369	~250°	<68°F	~250°	8 ports
	31.5			.50	1.06	1.06	85	88	2.5	355				8 ports/port
	52.5			.65	1.38	1.38	96	85	3.0	360				3 min/port
	73.5			.65	1.38	1.38	100	88	3.0	361				
	94.5			.65	1.38	1.38	102	89	3.0	366				
	115.5			.80	1.70	1.70	103	89	3.5	361				
	136.5			.80	1.70	1.70	103	90	3.5	360				
	157.5	14:44	706.656	.70	1.49	1.49	103	90	3.5	360				
PORT #8 ↑ ↓	10.5	14:49	706.696	.45	.96	.96	95	88	1.5	239				
	31.5			.60	1.27	1.27	98	89	2.0	240				
	52.5			.65	1.38	1.38	99	89	2.0	236				
	73.5			.65	1.38	1.38	101	90	2.0	341				
	94.5			.75	1.59	1.59	103	92	3.5	346				
	115.5			.85	1.81	1.81	103	93	3.5	340				Estimates:
	136.5			.70	1.49	1.49	103	93	3.5	331				MW = 28.5
	157.5	15:13	721.856	.70	1.49	1.49	103	93	3.5	331				%H ₂ O = 14

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	13.0	13.0
O ₂	8.5	8.5
CO	0	0
N ₂	78.5	78.5

Impinger

No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Test values
 TIME = 192 min
 VOLUME = 119.376 dcf
 AQE 202 (ΔP)_{avg} = 0.65
 (1.11) = 1.12

(T_{meter})_{avg} = 91°F

(T_{stack})_{avg} = 257°C

velocity =

ISO. =

D-4: Anions Train (F⁻/Cl⁻)

~~FRA METHOD 04~~ SOURCE SAMPLING DATA SHEET

[illegible]

	Vacuum (in. Hg)	Rate (cc/min)
Before		0.05 cc/min
After		

	Run 1	Run 2
GAS		
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

STACK SAMPLING DATA SHEET

Page 1 of 1

CLIENT: Bethelle DOE TEST DATE: 6-22-93 ORIFICE CORRECTION: 1.886 HOT BOX NO. 5
 TEST UNIT: Stack - Hot Side TEST NO.: C-6a-FCL-622 METER CORRECTION: 0.9837 COLD BOX NO. 5
 PROJECT NO.: 93C028-01 NOZZLE (SIZE, #): 0.191 G12 CALIBRATION DATE: 4-5-93 PROBE NO. 7-2
 CONTROL BOX OPERATOR: TM STATIC PRESSURE: -1.6" H₂O PITOT CORRECTION: 0.84 FILTER NO. Quartz
 BAROMETRIC PRESSURE: 27.54 PORT DIRECTION: C CONTROL BOX NO. 1 STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
	14:45	257.020	2.0	1.01	1.01	116	110	8.0	242	~250	<68°F	~250	Single Point
			2.2	1.99	1.99	122	110	8.0	245				Isokinetic
			2.2	1.99	1.99	123	110	8.0	244				Sampling for
			2.3	2.08	2.08	124	110	8.5	240				2.5 H ₂
			2.3	2.08	2.08	125	110	8.5	241				
			2.4	2.17	2.17	127	112	9.0	244				Reaching every
			2.4	2.17	2.17	127	112	9.0	245	250	52	250	5 minutes
			2.4	2.17	2.17	127	113	9.0	243				
			2.4	2.17	2.17	127	113	9.0	245				
			2.4	2.17	2.17	127	113	9.0	245				
			2.4	2.17	2.17	127	113	9.0	245				
			2.4	2.17	2.17	127	113	9.0	245				
			2.4	2.17	2.17	127	113	9.0	244				
	15:45		2.3	2.08	2.08	127	113	9.0	242	250	55	250	
			2.4	2.17	2.17	127	114	9.0	244				
			2.4	2.17	2.17	127	114	9.0	243				Estimates:
			2.4	2.17	2.17	127	114	9.0	244				MW=28.1
			2.4	2.17	2.17	127	114	9.0	245				%H ₂ O=17.3
	16:15	332.201	2.4	2.17	2.17	127	114	9.0	245				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.025
After	5.0	0.10

TIME = 90 min

VOLUME = 75.681 dcf

AQE 2/92

(AD)_h = 2.3

PITOT LEAK CHECK

	Positive	Negative
Before	OK	OK
After	OK	OK

	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Fr 1.7 - 1110°F

Impinger

No.	Contents	Final	Initial	Difference
1.	50 mL D.I. H ₂ O	710.0	508.2	201.8
2.	100 mL CO ₂ /H ₂ O	591.7	532.7	59.0
3.	100 mL CO ₂ /H ₂ O	571.8	563.3	8.5
4.	200g Silica Gel	655.6	630.2	25.4
5.				

Velocity = 104.1 ft/sec

TSD = 99.8%

2.361 = 294.7
KEYSTONE

D-139

D-140

DOF

Page of

[illegible]

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	DI H ₂ O			
2.	CO ₃ ²⁻ , HCO ₃ ⁻			
3.	" "			
4.	Silica Gel			
5.				

KEYSTONE

CHAIN OF CUSTODY RECORD

PROJECT NUMBER - G2825			SAMPLE TYPE (✓)												REMARKS			
DATE	TIME	SAMPLE I.D. NO.	Filter #1 + #2	Impinger #1 - HI H ₂ O	Impinger #2 - CO ₂ /H ₂ O													
7/24	14:08	C-4A-FCL-624	✓	✓	✓													
<p>Note: At a little past 30 min of sampling time, the vacuum pump was accidentally switched off. The duct vacuum sucked the filter paper off the glass frit. The run was stopped. The filter paper and fly ash recovered. A new filter paper was installed in the filter holder. The sampling was continued 40 minutes later. The sampled volume up to this point was 16 cft. The sample The sample restart will start from this figure and continue until 55 cft sample is ordered.</p>																		
<p>Log-in # 1288 # 4697-</p>			(20-23)															
			-10-12	-20-24	-20-25													
ELINQUISHED by: (Signature)			DATE	TIME	Received by: (Signature)		DATE	TIME										
<p><i>Joseph L. Smith</i></p>			7/7/93	9:55	<p><i>[Signature]</i></p>		7-7-93	10:00										
elinquished by: (Signature)			DATE	TIME	Received by: (Signature)		DATE	TIME										
<p><i>[Signature]</i></p>			7-7-93	12:30	<p>D.V. V</p>		7-7-93	12:50 P										
elinquished by: (Signature)			DATE	TIME	Received by: (Signature)		DATE	TIME										

D-141

28.20 FCL

~~FR-METHOD-06~~ SOURCE SAMPLING DATA SHEET

LIENT _____	TEST DATE <u>6/24/93</u>	DRY GAS METER NO. <u>1044/31</u>
EST UNIT _____	TEST NO. <u>C-5a-ACID-624</u>	METER CORRECTION (Y) _____
ROJECT NO. _____	SITE NO. _____	CALIBRATION DATE <u>6/21/93</u>
YSTEM OPERATOR _____	STACK DIAMETER _____	
AROMETRIC PRESSURE _____	PORT DIRECTION _____	

[illegible]

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (cc/min)
Before	0.09	
After		

831.51

Q 14th H₂

WRITE MEASUREMENTS

GAS	Run 1	Run 2
CO ₂		
O ₂		
CO		
N ₂		

QE 7/92

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

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Page 1 of 1

CLIENT <i>Bottle DOE</i>	TEST DATE <i>6-24-93</i>	ORIFICE CORRECTION <i>1.886</i>	HOT BOX NO. <i>5</i>
TEST UNIT <i>Stack - Hot Side</i>	TEST NO. <i>C6a-FCL-624</i>	METER CORRECTION <i>0.9837</i>	COLD BOX NO. <i>5</i>
PROJECT NO. <i>93C028-01</i>	NOZZLE (SIZE, #) <i>0.191 G12</i>	CALIBRATION DATE <i>4-5-93</i>	PROBE NO. <i>7-2</i>
CONTROL BOX OPERATOR <i>TM</i>	STATIC PRESSURE <i>-1.8" H₂O</i>	PITOT CORRECTION <i>0.84</i>	FILTER NO. <i>Quarter</i>
BAROMETRIC PRESSURE <i>27.54</i>	PORT DIRECTION <i>C</i>	CONTROL BOX NO. <i>1</i>	STACK DIA. <i>25"</i>

[illegible]

PITOT LEAK CHECK 1950

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.005
After	5.0	0.004

	Positive	Negative
Before	OK	OK
After	OK	OK

CO2	12.0	
O2	8.0	
CO	0	
N2	80.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	50 mL D.F. H ₂ O	690.2	495.9	194.3
2.	100 mL Ca ²⁺ /HCO ₃ ⁻	572.4	534.1	38.3
3.	100 mL Ca ²⁺ /HCO ₃ ⁻	568.2	563.5	4.7
4.	200g Silica Gel	640.8	623.2	17.6
5.				

total = 254.99

KEYSTONE

South Milwaukee, Wis. U.S.A. 53191

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KEYSTONE ENVIRONMENTAL RESOURCES, INC.
AIR QUALITY ENGINEERING

Page of

~~PARAMETER~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE TEST DATE 6/27 DRY GAS METER NO. _____
EST UNIT ESP Inlet TEST NO. C-4A-FCL-627 METER CORRECTION (Y) _____
PROJECT NO. _____ SITE NO. _____ CALIBRATION DATE _____
SYSTEM OPERATOR Rennie STACK DIAMETER _____
BAROMETRIC PRESSURE _____ PORT DIRECTION _____

Traverse Point (inches)	Clock Time (min)	Dry Gas Meter Reading (scf)	Buck Reading (cft/min)	Rotameter Reading (cft/min)	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. (°F)	Impinger Temp. (°F)	Probe Temp. (°F)	Comments
13:31	13:30	627.300		DP	78	1	352	225	64	114	
13:36	5	629.041	.47	.60	80	2	353	231	55	168	
14:01	30	640.135		.54	82	2.5	352	254	57	187	
see note: The time to complete drawings activities was not discussed in note was not recorded. I estimated it took 10 minutes.											
14:41	60	655.518	.42	.56	82	5.0	357	252	70	185	
15:16	95	669.723	.43	.55	83	8.0	358	255	71	188	
15:46	125	681.895		.50	83	9.0	353	252	72	186	
5:54		685.461									
Note: At Volume 297 I noticed Impinger #4 (Silica gel) was installed backward. Turned off flow and reoriented impinger correctly. Continued experiment from that point. Drawed .03 scf of ambient air when reconnecting probe. I will subtract subtract this amount from total.											
SYSTEM LEAK CHECK ending volume to get volume of impinger duct gases withdrawn.											

	Vacuum (in. Hg)	Rate (scfm) cft/min	Impinger No.	Contents	Final	Initial	Difference
Before	7	.01	1.				
After			2.				
			3.				
			4.				
			5.				

WRITE MEASUREMENTS		
GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

QE 7/92

648 647

.180 in

$$A = \frac{\pi}{4} d^2 = \frac{\pi}{4} (.180)^2 = \frac{\pi}{4} \left(\frac{.180}{12} \right)^2 = .0001767 \text{ ft}^2$$

$$V = Q/A = \frac{.45 \text{ ft}^3/\text{min}}{.0001767 \text{ ft}^2} = 2546 \text{ ft}^3/\text{min}$$

D-144

6

Log-in
LRB#
46697

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[illegible]

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.004
After	6.0	0.003

	Positive	Negative
Before	OK	OK
After		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	50 mL D.I. H ₂ O	698.0	513.2	184.8
2.	100 mL CO ₂ / H ₂ O	589.9	534.4	55.5
3.	100 mL CO ₂ / H ₂ O	575.3	563.6	11.7
4.	200g Silica Gel	654.3	631.8	22.5
5.				

274.59 total
KEYSTONE
100% WHOLESALE IN ALL 48 STATES

D-146

D-5: Ammonia Trains

6/22

C-4A-NH₃-622

~~FRA METHOD 04~~ SOURCE SAMPLING DATA SHEET

TEST DATE 6/22/93
TEST NO. C-4A-NR3-622
SITE NO. Cool Creek 4a
STACK DIAMETER _____
PORT DIRECTION _____

DRY GAS METER NO. _____
 METER CORRECTION (Y) _____
 CALIBRATION DATE _____

[illegible]

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

D-148

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CLIENT _____	TEST DATE <u>6/22/13</u>	DRY GAS METER NO. <u>704837</u>
EST UNIT _____	TEST NO. <u>C-5a-NH4-G22</u>	METER CORRECTION (Y) _____
PROJECT NO. _____	SITE NO. <u>52</u>	CALIBRATION DATE _____
SYSTEM OPERATOR <u>GLENN CAMSTRA</u>	STACK DIAMETER _____	
BAROMETRIC PRESSURE _____	PORT DIRECTION _____	

Estimates:
MW=
%H ₂ O=

	Vacuum (in. Hg)	Rate (cc/min)
Before		
After		

GAS	Run 1	Run 2
CO ₂		
O ₂		
CO		
N ₂		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

105

Page 1 of 1

TEST DATE 6-22-93

ORIFICE CORRECTION

HOT BOX NO. 7

TEST UNIT *Stack - Hot Side*

TEST NO. C-62-NH-622

METER CORRECTION

COLD BOX NO.

PROJECT NO. 93 CØ28-Ø1

NOZZLE (SIZE, #) 0.191 612

CALIBRATION DATE

PROBE NO.

CONTROL BOX OPERATOR

STATIC PRESSURE - 1.6" H₂O

PITOT CORRECTION

FILTER NO. *Quartz*

BAROMETRIC PRESSURE 27.54

PORT DIRECTION

CONTROL BOX NO.

STACK DIA. 25'

D-150

PITOT LEAK CHECK 15 JEL

	Positive	Negative
Before	OK	OK
After	OK	OK

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	50 mL D.I. H ₂ O	562.6	498.8	63.8
2.	100 mL 0.1 N K ₂ SO ₄	576.0	552.7	23.3
3.	100 mL 0.1 N K ₂ SO ₄	574.3	570.3	4.0
4.	200g Silica Gel	640.3	632.4	7.9
5.				

99.09 total

KEYSTONE

ESTABLISHED 1914

~~FRM METHOD 04~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE TEST DATE 6/24/93 DRY GAS METER NO. _____
TEST UNIT _____ TEST NO. C-4A-NH₃-624 METER CORRECTION (Y) _____
PROJECT NO. _____ SITE NO. 42 CALIBRATION DATE _____
SYSTEM OPERATOR Rennie STACK DIAMETER _____
BAROMETRIC PRESSURE 27.67 PORT DIRECTION _____

[illegible]

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (cc/min)
Before	11	0.01 cc in
After		

TYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

Impinger
No.

1.				
2.				
3.				
4.				
5.				

Impinger Contents

Final	Initial	Difference
100	100	0
90	100	-10
80	100	-20
70	100	-30
60	100	-40
50	100	-50
40	100	-60
30	100	-70
20	100	-80
10	100	-90
0	100	-100

Remember to rectify sample recovery of yesterday run which the form stated cft wle it was really lit!!! VOST test! on Alkyde

CHAIN OF CUSTODY RECORD

PROJECT NUMBER - G2825

Impellers (Signature)

Ben Amato

Plant Description

Coal Creek

SAMPLE TYPE (✓)

These are make-up samples for the NH₃ run that was missed at site 5a on 6/24.
TJK

DATE TIME SAMPLE I.D. NO.

6/24/93 12:14 C-5a-NH₃-626

12:14

12:32

Impinger #1 DI H₂O
Impinger #2 H₂SO₄
Filter (N + NH₄)

ITEM

Log in LRB # 10597

Target: 0.5 to 0.6 cfm to 10.5 ft³ total

REMARKS

gas meter reading

833.401

847.95

leak rate

0.04 ft³/min @ 25.5" Hg

0 cfm @ 5.0" Hg

2" Hg

6/24/93 1300 C-5A-NH₄-626

✓ ✓

2 W

18-22 gm
18-23 gm
33-39 ps

Filter cut into parts A & B for analysis. 8 July JRG

ELINQUISHED by: (Signature)

Ben Amato 6/24/93 12:40

DATE TIME

Received by: (Signature)

Abraham L. Smith

DATE TIME

6/24/93 1300

elinquished by: (Signature)

Abraham L. Smith

DATE TIME

7/7/93 950

Received by: (Signature)

John - A

DATE TIME

7/7 21

elinquished by: (Signature)

John - A

DATE TIME

7-7-93 2:00

Received by: (Signature)

John - A

DATE TIME

7-7-93 12:00

for all except highlighted sample

Page / of /

HOT BOX NO. 7
COLD BOX NO. 7
PROBE NO. 7-2
FILTER NO. Quartz
STACK DIA. 25

$$I_{SO} = 103.2^\circ$$

Impinger

No.	Contents	Final	Initial	Difference
1.	50 ml D.F. H ₂ O	553.2	500.5	52.7
2.	100 ml 0.1 N H ₂ SO ₄	576.2	549.7	26.5
3.	100 ml 0.1 N H ₂ SO ₄	573.7	569.2	4.5
4.	200 ml Silica gel	647.8	631.3	16.5
5.				

KEYSTONE

Page of

CLIENT _____	TEST DATE <u>8/27/13</u>	DRY GAS METER NO. _____
TEST UNIT _____	TEST NO. <u>C-4A-NH₂-627</u>	METER CORRECTION (Y) _____
PROJECT NO. _____	SITE NO. <u>4a</u>	CALIBRATION DATE _____
SYSTEM OPERATOR <u>Kent Rennie</u>	STACK DIAMETER _____	
BAROMETRIC PRESSURE _____	PORT DIRECTION _____	

[illegible]

	Vacuum (in. Hg)	Rate (cc/min) <i>ccft/hr</i>
Before	11	< 0.1
After		

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

D-154

CHAIN OF CUSTODY RECORD

PROJECT NUMBER - G2825			SAMPLE TYPE (✓)					
DATE	TIME	SAMPLE I.D. NO.	Impinger #1	Impinger #2	Filter (CA+NH ₄)			
6/27/93		C-Sa-NH ₄ -627	✓	✓	•			
	16:36							
	18:53							
			18-25	18-26	33-09			
			1	1	1			
RELINQUISHED by: (Signature)			DATE	TIME	Received by: (Signature)		DATE	TIME
[Signature]			6/27/93	17:04				
RELINQUISHED by: (Signature)			DATE	TIME	Received by: (Signature)		DATE	TIME
[Signature]			7/7/93	9:00	[Signature]		7-7-93	12:00
RELINQUISHED by: (Signature)			DATE	TIME	Received by: (Signature)		DATE	TIME
[Signature]			7/7/93	2:00	[Signature]		7/7	2P

Log-in LRB# 46697-

gas meter readings
0.0552
0.075.00

leak rate
0.01 cfm @ 4" H₂O
0.01 cfm @ 4.3 H₂O

Filter Cut into Parts A & B for Analysis 7/8 JKB

for items 1 and 2 only
D-155-3

STACK SAMPLING DATA SHEET

Page 1 of 1

CLIENT Bathelk DOE TEST DATE 6-27-93 (Sun) ORIFICE CORRECTION 1.886 HOT BOX NO. 2
 TEST UNIT Stack - Hot Side TEST NO. C-66-NH4-627 METER CORRECTION 0.9837 COLD BOX NO. 7
 PROJECT NO. 93C028-01 NOZZLE (SIZE, Ø) 0.191" G12 CALIBRATION DATE 4-5-93 PROBE NO. 7-2
 CONTROL BOX OPERATOR TN STATIC PRESSURE -1.6" H₂O PITOT CORRECTION 0.84 FILTER NO. Quarry
 BAROMETRIC PRESSURE 22.76 PORT DIRECTION C CONTROL BOX NO. 1 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcl)	Pilot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
	15:15	052.521	2.0	1.80	1.80	104	99	4.5	225	~250	~68°F	~250	Single Point
			2.2	1.99	1.99	111	99	5.0	226				Isokinetic
			2.1	1.90	1.90	113	98	5.5	225				Sampling for
			2.0	1.81	1.81	113	98	5.0	226				30 min
			2.0	1.81	1.81	114	99	5.0	226				
			2.2	1.99	1.99	114	100	5.5	225				Reckings every 5 min
	15:45	001.716											
	A=30 min	Δ=23.895 dcl	(ΔP) _{avg} = 2.1	(ΔH) _{avg} = 1.88	(T _{stack}) _{avg} = 105°F	(T _{probe}) _{avg} = 226°F							
													Estimates:
													MW=28.1
													%H ₂ O=17.3

velocity = 97.8 ft/sec

I₅₀ = 99.5%

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before	5.0	0.005
After	5.5	0.004

PITOT LEAK CHECK

	Positive	Negative
Before	OK	OK
After	OK	OK

CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	50 mL D.F. H ₂ O	577.9	551.9	26.0
2.	100 mL 0.1N H ₂ SO ₄	550.8	497.2	53.6
3.	100 mL 0.1N H ₂ SO ₄	577.5	570.6	6.9
4.	200g Silica Gel	645.0	635.6	9.4
5.				

95.9g total
KEYSTONE
ENVIRONMENTAL SYSTEMS, INC.

D-6: Cyanide Trains

Page of

CLIENT _____	TEST DATE <u>6/22/93</u>	DRY GAS METER NO. _____
TEST UNIT _____	TEST NO. <u>C-4A-CFN-622</u>	METER CORRECTION (Y) _____
PROJECT NO. _____	SITE NO. <u>Cool Creek</u>	CALIBRATION DATE _____
SYSTEM OPERATOR <u>Rennie</u>	STACK DIAMETER _____	
BAROMETRIC PRESSURE _____	PORT DIRECTION _____	

[illegible]

	Vacuum (in. Hg)	Rate (cc/min)
Before		
After		

GAS	Run 1	Run 2
CO ₂		
O ₂		
CO		
N ₂		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

D-158

30

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE TEST DATE 6-22-93 ORIFICE CORRECTION 1.886 HOT BOX NO. 2
TEST UNIT Stack - Hot Side TEST NO. C-62-CN-622 METER CORRECTION 0.8837 COLD BOX NO. 2
PROJECT NO. 93C028-01 NOZZLE (SIZE, IN) 0.71 CALIBRATION DATE 4-5-73 PROBE NO. 7-2
CONTROL BOX OPERATOR TAM STATIC PRESSURE -1.6" H₂O PITOT CORRECTION 0.84 FILTER NO. Quincy
BAROMETRIC PRESSURE 27.34 PORT DIRECTION C CONTROL BOX NO. 1 STACK DIA. 25.1"

Traverse Point (feet)	Time	Dry Gas Meter Reading (scf)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
18.20		358.061	2.4	2.17	2.17	131	113	9.0	242	-250	<68°F	-210	Stack Point
			2.4	2.17	2.17	124	113	9.0	242				Isokinetic
			2.4	2.17	2.17	123	113	9.0	243				Sampling for
			2.4	2.17	2.17	126	113	9.0	246				1 W
			2.4	2.17	2.17	127	113	9.0	246				
			2.4	2.17	2.17	127	113	9.0	244				Reading only
			2.4	2.17	2.17	120	113	9.0	244				5 unbraked
			2.3	2.17	2.08	127	113	9.0	243				
			2.4	2.17	2.07	127	113	9.0	244				
			2.5	2.26	2.26	127	113	9.0	243				
			2.4	2.17	2.17	127	113	9.0	245				
			2.4	2.17	2.17	127	113	9.0	245				
18.20		410.450											
A=60 min		A=52.389	(ΔP) _{h₂} = 2.4	(ΔH) _{h₂} = 2.17	(T _{stack}) _{h₂} = 199°F				(T _{stack}) _{h₂} = 244°F				Estimates:
													MW= 28.1
													%H ₂ O= 17.3

SYSTEM LEAK CHECK			PITOT LEAK CHECK			Impinger			Impinger			Final			Difference		
	Vacuum (in. Hg)	DOM Rate (cfm)		Before	Positive	Negative	No.	Contents	No.	Contents	Final	Initial					
Before	5.0	0.0022					1.	50 mL DI. H ₂ O	1.	DI. H ₂ O	617.5	477.1			140.4		
After	5.0	0.0022					2.	100 mL 0.1M NaOH	2.	0.1M NaOH	575.1	534.7			40.4		
							3.	100 mL 0.1M NaOH	3.	0.1M NaOH	567.8	563.7			4.1		
							4.	200g Silica Gel	4.	Silica Gel	684.9	667.2			17.7		
							5.		5.								

2202.69 tot
KEYSTONE
100% POLYURETHANE 100% POLYURETHANE

Page of

CLIENT <u>DOF</u>	TEST DATE <u>6/24/93</u>	DRY GAS METER NO. _____
TEST UNIT _____	TEST NO. <u>C-4A-CYN-629</u>	METER CORRECTION (Y) _____
PROJECT NO. _____	SITE NO. <u>ESP Inlet</u>	CALIBRATION DATE _____
SYSTEM OPERATOR <u>Panne</u>	STACK DIAMETER _____	
BAROMETRIC PRESSURE _____	PORT DIRECTION _____	

D-160

	Vacuum (in. Hg)	Rate (cc/min)
Before	10	.01
After		

GAS	Run 1	Run 2
CO ₂		
O ₂		
CO		
N ₂		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

CHAIN OF CUSTODY RECORD

[illegible]

D-161

STACK SAMPLING DATA SHEET

Page 1 of 1

CLIENT Bathelk / 20E TEST DATE 6-24-93 ORIFICE CORRECTION 1.886 HOT BOX NO. 23
TEST UNIT Stack - Hot Side TEST NO. C-60 - CV - 624 METER CORRECTION 0.9837 COLD BOX NO. 2
PROJECT NO. 43C-028-01 NOZZLE (SIZE, #) 0.191 CALIBRATION DATE 4-5-91 PROBE NO. 7-2
CONTROL BOX OPERATOR CV STATIC PRESSURE -1.8 PITOT CORRECTION 0.84 FILTER NO. 20079
BAROMETRIC PRESSURE 29.54 PORT DIRECTION C CONTROL BOX NO. 1 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (scf)	Pitot Δ P (in. H2O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H2O)	Act. (in. H2O)	In (°F)	Out (°F)						
	18:00	721.235	2.3	2.03	2.03	100	89	7.0	230	250	46.5	250	Stack Port
			2.2	1.94	1.94	105	90	6.5	232				Isokinetic
			2.2	1.94	1.94	103	90	6.0	232				Sampling for 1 hr
			2.2	1.94	1.94	106	91	6.0	231				
			2.2	1.94	1.94	106	91	6.0	231				Reading every 5 minutes
			2.2	1.94	1.94	106	91	6.0	230				
			2.2	1.94	1.94	107	91	4.0	232				
			2.2	1.94	1.94	107	92	4.0	231				
			2.2	1.94	1.94	107	92	6.0	232				
			2.2	1.94	1.94	108	92	6.0	232				
	19:00	768.151											
	Δ = 60 min	Δ = 46.906 scf	2.2	(46.906) / 1.94 = 24.18	(24.18) / 1.94 = 12.46								Estimates: MW = 28.1 %H2O = 17.3

SYSTEM LEAK CHECK

Vacuum (in. Hg)	DGM Rate (cfm)
Before 5.0	0.003
After 7.0	0.007

PITOT LEAK CHECK

Before	Positive	Negative
After		

1 2

CO2	2.0
O2	5.0
CO	0
N2	80.0

Impinger No. 1. 50ml D.F. #20 587.8 459.4 128.4
2. 100ml 0.1M NaOH 575.4 536.0 39.4
3. 100ml 0.1M NaOH 576.7 566.8 9.9
4. 200g Silica Gel 683.4 667.0 16.4
5.
Total = 194.1g

KEYSTONE

Page of

CLIENT DOE TEST DATE 6/27/93 DRY GAS METER NO. _____
 TEST UNIT ESP Inlet TEST NO. C-4A-CYN-627 METER CORRECTION (Y) _____
 PROJECT NO. _____ SITE NO. _____ CALIBRATION DATE _____
 SYSTEM OPERATOR Pennie STACK DIAMETER _____
 BAROMETRIC PRESSURE _____ PORT DIRECTION _____

D-163

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

PROJECT NUMBER - G2825

amplers (Signature)

Want Description

and Greek, 50c

DATE	TIME	SAMPLE I.D. NO.
------	------	-----------------

12/27/23	C-5a-CN-627
----------	-------------

1720	1720
------	------

17:47

-	19-30
-	19-31

Impinger #1 DI H₂O
Impinger #2 + #3 NaOH

gas meter reading (GPM²)

0	7	7	1	6
---	---	---	---	---

02819

log-in
LRB#
46697

REMARKS

Back rest

200 gm @ 4% H_2

0.002 gms @ 5H₂

ELINQUISHED by: (Signature)

Dear Cousin

elinguished by: (Signature)

Charles F. Smith

elinquished by: (Signature)

DATE	TIME
------	------

6/27/93	18.02
---------	-------

DATE	TIME
------	------

7/7/83	1030
--------	------

DATE	TIME
------	------

Received by: (Signature)

--	--

Received by: (Signature)

1000

Received by: (Signature)

DATE	TIME
------	------

DATE	TIME
4-2	10:15

12:00	12:00
-------	-------

DATE	TIME
------	------

STACK SAMPLING DATA SHEET

Page 1 of 1

CLIENT Battelle DOE TEST DATE 6-27-93 (Sun.) ORIFICE CORRECTION 1.886 HOT BOX NO. 2
 TEST UNIT Stack - Hot Side TEST NO. C-62-CN-627 METER CORRECTION 0.9837 COLD BOX NO. 2
 PROJECT NO. 93C02B-01 NOZZLE (SIZE, #) 0.191 G12 CALIBRATION DATE 4-5-93 PROBE NO. 7-2
 CONTROL BOX OPERATOR JM STATIC PRESSURE -1.4" H₂O PITOT CORRECTION 0.84 FILTER NO. Century
 BAROMETRIC PRESSURE 27.760 PORT DIRECTION C CONTROL BOX NO. 1 STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
	15:53	087.495	2.0	1.80	1.80	105	100	7.0	225	~250	~68°F	~250°	Single Point Isokinetic Sampling for 1 hr
			2.0	1.81	1.81	108	100	7.0	225				
			2.0	1.82	1.82	113	100	7.0	226				
			2.0	1.82	1.82	113	99	7.0	224				
			2.0	1.82	1.82	114	99	7.0	225				
			2.0	1.82	1.82	114	99	7.0	225				Readings every 5 min
			2.0	1.82	1.82	113	99	7.0	225				
			2.0	1.82	1.82	113	99	7.0	226				
			2.0	1.82	1.82	114	100	7.0	226				
			2.0	1.82	1.82	114	100	7.0	225				
			2.0	1.82	1.82	114	99	7.0	225				
			2.0	1.82	1.82	113	99	7.0	224				
	16:53	129.362											
	Δ = 6.0 min	Δ = 47.867 dcf	(ΔP) _{avg} = 2.0	(ΔH) _{avg} = 1.82	(T _{meter}) _{avg} = 106°F	(T _{stack}) _{avg} = 225°F							Estimates: MW = 28.1 %H ₂ O = 7.3
								velocity = 95.3 ft/sec					
								ISO = 101.9%					

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.005
After	7.0	0.007

PITOT LEAK CHECK

	Positive	Negative
Before	OK	OK
After	OK	OK

CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Impinger

No.	Contents	Final	Initial	Difference
1.	50 mL D.I. H ₂ O	590.0	466.3	123.7
2.	100 mL 0.1M NaOH	577.9	535.6	42.3
3.	100 mL 0.1M NaOH	572.3	566.9	5.4
4.	200g Silica Gel	680.7	667.4	13.3
5.				

184.7g total
KEYSTONE
 ENVIRONMENTAL SYSTEMS, INC.

D-165

D-7: Aldehyde Trains

CHAIN OF CUSTODY RECORD

PROJECT NUMBER - G2825			SAMPLE TYPE (✓)												REMARKS	
Samplers (Signature)			<div style="border: 1px solid black; border-radius: 50%; padding: 10px; display: inline-block;"> Log in LRB# 46697-16 </div>													
Plant Description																
Coal Creek																
DATE	TIME	SAMPLE I.D. NO.														
7/21	22:20	CHAAALD6211	Lit -20												Imagers 1	
		CHAAALD6212	Lit -21												" 2	
		" " 6213	Lit -22												3	
7/21		" " 6214	Lit												4	
			initial V = 118.0 L													
			total V = 172.7 L													
			sample V = 54.7 L													
			total sampling time = 50 minutes													
ELINQUISHED by: (Signature)			DATE		TIME		Received by: (Signature)						DATE		TIME	
<i>Deborah L. Smith</i>			7/1/93		9:58		<i>Jon Petola</i>						7-7-93			
elinquished by: (Signature)			DATE		TIME		Received by: (Signature)						DATE		TIME	
<i>Jon Petola</i>			7-7-93		12:40		<i>P. J. Callahan</i>						7/7/93		12:40	
elinquished by: (Signature)			DATE		TIME		Received by: (Signature)						DATE		TIME	

D-167

CHAIN OF CUSTODY RECORD

PROJECT NUMBER - G2825			SAMPLE TYPE (✓)												REMARKS		
Impingers (Signature)			#1 Impinger	#2 Impinger	#3 Impinger												
Plant Description																	
Coal Creek - 5A																	
DATE	TIME	SAMPLE I.D. NO.															
7/21	7:49	CALD- C-5A-ALD-621															
			~ 1 liter/min.														
			2 L in 2 min 5.7 sec														
			again 2 L in 2 min 2.7 sec														
			" 2 liters in 2 min 4.0 sec														
	8:21		" 2 L in 2 min 5.7 sec.														
	8:32		2 L in 2 min 0.1 sec.														
7/21/93	7:49	C-5A-ALD-621	✓														} Aldehydes
↓	↓	↓	✓														
↓	↓	↓	✓														
ELINQUISHED by: (Signature)			DATE	TIME	Received by: (Signature)								DATE	TIME			
Abraham L. Smith			7/7/93	7:58	[Signature]								7/7/93				
elinquished by: (Signature)			DATE	TIME	Received by: (Signature)								DATE	TIME			
[Signature]			7/7/93	12:40	P.J. Callahan								7/7/93	12:40			
elinquished by: (Signature)			DATE	TIME	Received by: (Signature)								DATE	TIME			

D-168

AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

4 of 5

STACK SAMPLING DATA SHEET

Page 1 of 1

CLIENT Battelle DOE TEST DATE 6-21-93 ORIFICE CORRECTION — HOT BOX NO. 4
 TEST UNIT Stack - Hot Side TEST NO. C-6a-A-D-621 METER CORRECTION 0.9735 COLD BOX NO. 4
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) GLASS Tube CALIBRATION DATE 6-14-93 PROBE NO. 5-1
 CONTROL BOX OPERATOR MG STATIC PRESSURE -1.2" H₂O PITOT CORRECTION 0.84 FILTER NO. —
 BAROMETRIC PRESSURE 27.70 PORT DIRECTION D CONTROL BOX NO. DEM-93-458655 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (in. H ₂ O)	Pilot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
5 IN	1740	1.902		1.000	1010	106	106	2.0	242	255	ECG 48	250	Single Point @ 1 L/min for 60 min
					1011	106	106	2.0	244				
		1.072			1027	106	106	2.0	243				
					1021	106	106	2.0	243	260	54	255	
					1012	106	106	2.0	245				
					1031	106	106	2.0	244				
					1005	106	106	2.0	244	260	57	250	
					1013	106	106	2.0	240				
					1020	105	105	2.0	241	260	58	255	
					1021	105	105	2.0	242				
					1009	105	105	2.0	240				
					1001	105	105	2.0	241	260	59	252	
	1840	61.580			985	105	105	2.0	241				
	Δ=60 min	Δ=59.678 dry Liter			AVG = 1013 cc/min	(T _{meter}) _{AVG} = 106°F			(T _{stack}) _{AVG} = 242°F				Estimates: MW= 28.1 %H ₂ O= 17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate cc/min (min)
Before	10	19.3
After	5	20.2

↑
 ≈ 2% g average flow rate

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	7.0	
CO	0	
N ₂	81.0	

Impinger

Impinger No.	Contents	Final	Initial	Difference
1.	10 mL D.I. H ₂ O	93.3	85.2	8.1
2.	20 mL DNPH	89.7	94.1	-4.4
3.	20 mL DNPH 9%	99.4	97.4	2.0
4.	Silica Gel	101.4	96.7	4.7
5.				

total = 10.4g

CHAIN OF CUSTODY RECORD

PROJECT NUMBER - G2625			SAMPLE TYPE (✓)												REMARKS		
Samplers (Signature)			Impinger #1	Impinger #2	Impinger #3												
Plant Description																	
DATE	TIME	SAMPLE I.D. NO.															
7/23	18:40	C-4A-ALD-623	✓	✓	✓												
			•	•	•												
			<p>Observed that Impinger #1 had separated separated from its ground glass seal with packet. I do not know the exact time at which this occurred occurred. However, based on visual monitoring of drain I estimate the separation occurred near completion of the 60 minute run. After noticing seal breach, I fitted the pieces together upon which water from impinger #1 was sucked into the back end of filter. This backflow of water will be drained into back into impinger #1 during sample recovery. Filter is not analyzed for this test.</p>														
			-24	-25	-26												
RELINQUISHED by: (Signature)			DATE	TIME	Received by: (Signature)			DATE	TIME								
Orlando I. Smith			7/7/93	258	[Signature]			7-7-93									
Relinquished by: (Signature)			DATE	TIME	Received by: (Signature)			DATE	TIME								
[Signature]			7-7-93	12:40	P. J. Callahan			7/7/93	12:40								
Relinquished by: (Signature)			DATE	TIME	Received by: (Signature)			DATE	TIME								

D-170

C-4 - ALD - 625
6/23 16:00 hrs
SCHEMATIC OF STACK

CROSS SECTION

PARTICULATE FIELD DATA

PLANT Coal Creek AMBIENT TEMPERATURE 33°C
DATE 6/23 BAROMETRIC PRESSURE _____
LOCATION 16:00 Hrs ASSUMED MOISTURE, % _____
OPERATOR Rennie PROBE LENGTH, in. 4 ft
STACK NO. 4A NOZZLE DIAMETER, in. NONE
RUN NO. 1 STACK DIAMETER, in. _____
SAMPLE BOX NO. nutech 200 PROBE HEATER SETTING _____
METER BOX NO. 11 6 HEATER BOX SETTING _____

METER ΔH_p _____
C FACTOR _____
PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP _s) (√ΔP _s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) (in. H ₂ O) ACTUAL DESIRED	GAS SAMPLE VOLUME (lit)	PROBE TEMPERATURE (T _{m IN}), °F	ICE BATH TEMPERATURE (T _{m OUT}), °C	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER	PUMP VACUUM in. Hg gauge	VELOCITY f/s
	0		356°F			213.35	162°F	1°C	238°F	26°C	1	
	15		355 "			224.50	163°F	2°C	257°F	24°C	1.5	
	30		352 "			240.57	169°F	1°C	263°F	25°C	1.5	
	45		357 "			258.58	166°F	1°C	256°F	26°C	1.5	
	60								258°F	25°C		
	61		275.89			275.89						
TOTAL												

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g	ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
	1	2	3	4							
FINAL						1					
INITIAL						2					
LIQUID COLLECTED						3					
TOTAL VOLUME COLLECTED						4					

COMMENTS:

CHAIN OF CUSTODY RECORD

PROJECT NUMBER - G2825		SAMPLE I.D. NO.		DATE		TIME		SAMPLE TYPE (✓)		REMARKS	
ant Description Cool Creek		C-5a-ALD-623		1/23/93	14:39	15:39					
ampers (Signature) <i>Norm D. Smith</i>											
Impinger #1		✓									
Impinger #2		✓									
Impinger #3		✓									
about : 0175.18		about : 0232.68									
46697-17-											
gas meter reading											
1 hour duration @ 1 Lpm											

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(C-6A-AID-624)

STACK SAMPLING DATA SHEET

CLIENT Battle / Dye TEST DATE 6-14-93 ORIFICE CORRECTION --- HOT BOX NO. 4
TEST UNIT Stack - Hot Side TEST NO. C-6C-AID-624 METER CORRECTION 0.9735 COLD BOX NO. 4
PROJECT NO. 93C028-01 NOZZLE (SIZE, #) GEA Tube CALIBRATION DATE 6-14-93 PROBE NO. 5-1
CONTROL BOX OPERATOR MG STATIC PRESSURE -1.7" H₂O PITOT CORRECTION 0.84 FILTER NO. ---
BAROMETRIC PRESSURE 27.54 PORT DIRECTION D CONTROL BOX NO. 64 93-458655 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (scfh) LTR	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
5'	0925	11.801		100 cc/min	1069	70	70	2.0	233	~220°	468°F	~250°	Single Point @ 1 L/min
					1075	68	68	2.0	233				for 60 min
		22.20			1076	65	65	2.0	236	250	43	249	
					1070	59	59	2.0	237				
		32.40			1039	55	55	2.0	234	241	47	244	
					1042	55	55	2.0	234				
		42.80			1069	56	56	2.0	233	248	41	246	
					1055	56	56	2.0	233				5 min purge
		53.00			1055	57	57	2.0	233	251	40	250	
					1061	58	58	2.0	234				
		63.30			1035	58	58	2.0	234	251	44	250	
					1042	58	58	2.0	235				
	1025	73.80Z			1030	57	57	2.0	235	248	47	251	
		A=60			A6 =	(T _{meter}) = 59°				(T _{stack}) = 234°F			Estimates:
		min			1055								MW = 23.1
													% H ₂ O = 17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate cc/(min)
Before	4.0	4.0
After	4.0	16.2

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	8.0	

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	10 mL D.I. H ₂ O	92.5	84.0	8.5
2.	20 mL DNPH	91.5	96.5	-5.0
3.	20 mL DNPH	99.5	98.0	1.5
4.	Silica Gel	103.8	98.8	1.5
5.				

22% of average flow rate

19.170
total 10.0g
KEYSTONE
ANALYTICAL SERVICES, INC.

CH 8

[illegible]

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NE

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HOT BOX NO. 4
 COLD BOX NO. 4
 PROBE NO. 5-1
 FILTER NO. —
 STACK DIA. 25"

Hot Box Temp. (°F)	Comments
~250	Single Point
240	Sampling at 1 $\frac{1}{2}$ min
250	for 60 min
254	
255	
247	
248	
	Estimates:
	MW = 28.1
	%H ₂ O = 17.3

PITOT LEAK CHECK	
	Positive
Before	
After	

CO2	12.0
O2	8.0
CO	0
N2	80.0

SYSTEM LEAK CHECK		
	Vacuum (in. Hg)	DGM Rate cc (in.) ³ /min
Before	4.0	12.0
After	4.0	9.5

No.	Contents	Final	Initial	Difference
1.	10mL 2F, 15D	91.7	83.1	8.4
2.	20mL 2NPH	92.9	96.2	-3.3
3.	20mL 2NPH	96.9	97.2	-0.3
4.	5Ltra Gel	102.9	98.4	4.5
5.				8.9

= 1% of average flow rate

AOE 2/92

2

KEYSTONE
9.59

TOTAL

D-8: VOST Sampling Trains

Note that the samples designated as C-6a-VOS-623-4, -5, and -6 were extra VOST samples taken as part of RTI's audit procedures.

$T_1 = 24^\circ\text{C}$

5 min sample time

$\approx 0.5 \text{ lit/min}$

Meter Reading Beg = 67.68 L

End = 72.94 L

~~$T_1 = 21^\circ\text{C}$~~

Flow Rate $\approx 0.5 \text{ Lit/min}$

Sample Time: 10 min

$$\begin{array}{r} 72.94 \\ - 67.68 \\ \hline 5.26 \end{array}$$

Meter Reading: Beginning: 80.05 L
End: 96.04 L

$T_1 = 25^\circ\text{C}$

Flow Rate: 0.55 Lit/min

Sample Time: 30 min

Vacuum 10 in Hg

Calculated Flow Rate = 0.532 Lit/min

$$\begin{array}{r} 96.04 \\ - 80.05 \\ \hline 15.99 \end{array}$$

$$\begin{array}{r} 532 \\ 30 \overline{) 15.96} \\ \underline{150} \\ 96 \\ \underline{90} \\ 60 \end{array}$$

copy of checked rec
CHAIN OF CUSTODY RECORD

PROJECT NUMBER - G2825			SAMPLE TYPE (✓)												REMARKS	
Samplers (Signature) <i>Abner Cantre</i>																
Plant Description Coal Creek SA																
DATE	TIME	SAMPLE I.D. NO.														
7/21/93	5:05	C-5a-VOS-621														
		1	}	5 min.	gas meter reading: 0 04 0.6 (1 min.) 0 04 8.05						T 016 T 019 (no note on installation) TC010					
		2														
		new 2														
7/21	5:30	C-5a-VOS- 625 621	}	10 min.	" " 0 05 0.38 (2 min) 51.42						T 012 TC021					
		2														
7/21	5:53	C-5a-VOS- 625 621	}	30 min	" " 00 56.20 (22 min) 66.32						T 017 TC004					
		2														
RELINQUISHED by: (Signature) <i>Thomas Kelly</i>			DATE	TIME	Received by: (Signature) <i>Robert H. Hockett</i>						DATE	TIME				
			6/21	20:36							6/21/93	20:36				
Relinquished by: (Signature)			DATE	TIME	Received by: (Signature)						DATE	TIME				
Relinquished by: (Signature)			DATE	TIME	Received by: (Signature)						DATE	TIME				

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11/21/11
HOT

STACK SAMPLING DATA SHEET

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CLIENT Buttrick / DOE

TEST DATE 6-21-93

ORIFICE CORRECTION

HOT BOX NO. —

TEST UNIT Stack - Hot Sick

TEST NO. C-6a-VOS-621-1

METER CORRECTION 0.9735

COLD BOX NO. —

PROJECT NO. 93C028-01

NOZZLE (SIZE,#)

CALIBRATION DATE 6-14-93

PROBE NO.

CONTROL BOX OPERATOR MG

STATIC PRESSURE -1.2

PITOT CORRECTION

FILTER NO. —

BAROMETRIC PRESSURE 27.70

PORT DIRECTION **A**

CONTROL BOX NO. DGM 4586555

STACK DIA. 25'

[illegible]

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate <i>5.2</i> $\frac{\text{cm}^3}{\text{min}}$ (liter)
Before	10.0	5.2
After	10.0	0.0

↑
≈ 1000/
average flow rate

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

CO2		
O2		
CO		
N2		

Impinger

Impinger

No.	Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

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Page 1 of 1

[illegible]

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

	Vacuum (in. Hg)	DGM Rate (cc/min)
Before	10.0	0.2
After	10.0	0.0

↑
 $< 1\%$ of average
 flow rate

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

STACK SAMPLING DATA SHEET

Page 1 of 1

CLIENT Battelle / DOE TEST DATE 6-24-93 ORIFICE CORRECTION — HOT BOX NO. —
 TEST UNIT Stack - Hot Side TEST NO. C-6a-V05-621-3 METER CORRECTION 0.9735 COLD BOX NO. —
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) — CALIBRATION DATE 6-14-93 PROBE NO. —
 CONTROL BOX OPERATOR MG STATIC PRESSURE -1.2 PITOT CORRECTION — FILTER NO. —
 BAROMETRIC PRESSURE 27.70 PORT DIRECTION A CONTROL BOX NO. DGM U586556 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (scf)	Pitot Δ P (in. H2O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H2O)	Act. (in. H2O)	In (°F)	Out (°F)						
5'	1507	4.172		500	494	105	105	4.0	240	245	42		Test Tube #3
					513	105	105	4.0					0.5L/min
					503	105	105	4.0	242				30 min run
		13.68			518	105	105	4.0					
	1527	13.68			516	105	105	4.5	244	245	43		
					503	105	105	4.5					
	1537	19.052			501	105	105	4.5	243	245	43		
	Δ=30 min	Δ=14.880 dry L/min			ΔH=507 cfm	(T _{meter}) = 105°F			(T _{stack}) = 242°F				Tube ID
													T _{probe} = T-014
													T _{probe} & charcoal = TC007
													TC007
													Estimates:
													MW=
													%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	10.0	0.0
After	10.0	0.0

↑
 < 1% of average flow rate

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

CHAIN OF CUSTODY RECORD

PROJECT NUMBER - G2825			SAMPLE TYPE (✓)																REMARKS	
amplers (Signature) <i>Kent Remick</i> Plant Description																				
DATE	TIME	SAMPLE I.D. NO.																		
6/23	1:10	C-4A- ^{VOS} 6231 -6231																	T048	A ?
"	(13:00)	C-4A- ^{VOS} 6231 -6231																	T048 TC029	B }
6/23	1:30	C-4A- ^{VOS} 6232 -6232																	T037	A ?
	(13:30)	C-4A- ^{VOS} 6232 -6232																	T037	A }
6/23	2:00	C-4A- ^{VOS} 6233 -6233																	TC039	B }
	(14:00)	C-4A- ^{VOS} 6233 -6233																	T036	A }
																			TC044	B }
ELINQUISHED by: (Signature)			DATE	TIME	Received by: (Signature)										DATE	TIME				
<i>Kent Remick</i>			6/27	3:00 PM																
elinquished by: (Signature)			DATE	TIME	Received by: (Signature)										DATE	TIME				
elinquished by: (Signature)			DATE	TIME	Received by: (Signature)										DATE	TIME				

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PARTICULATE FIELD DATA

PLANT Cool Creek AMBIENT TEMPERATURE 72°C
DATE 6/23/93 BAROMETRIC PRESSURE _____
LOCATION _____ ASSUMED MOISTURE, % _____
OPERATOR Rennie PROBE LENGTH, in. _____
STACK NO. _____ NOZZLE DIAMETER, in. _____
RUN NO. 1, 2 + 3 STACK DIAMETER, in. _____
SAMPLE BOX NO. Nutched 200 PROBE HEATER SETTING _____
METER BOX NO. 11 1 HEATER BOX SETTING _____

METER ΔH_g _____

C FACTOR _____

PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (t), min.	STATIC PRESSURE (in. H ₂ O)	STACK TEMPERATURE (T _s), °F	VELOCITY HEAD (ΔP_s) (V ΔP_s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) (in. H ₂ O) ACTUAL DESIRED	GAS SAMPLE VOLUME (V _m), ft ³	Sample Trap GAS SAMPLE TEMPERATURE ALERT GAS METER A INLET B OUTLET (T _{inlet}) (T _{outlet}) °F		Eur Bath SAMPLE BOX TEMPERATURE °C	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °C	PUMP VACUUM in. Hg gauge	VELOCITY lps
	0		355			177.55	T048	TC029	4	19°C	5	
	5.5					181.35						
	0		352			182.05	T037	TC039	9°C	23°C		
	5		353			184.65			11°C	22°C	4	
	10		354			187.15			8°C	22°C	4	
	0		354			187.65	T036	TC044	10°C	22°C		
	10		355			193.00			6°C	19°C	5.5	
	20		357			197.95			7°C	18°C	7.5	
	30		356			204.60			10°C	21°C	7.5	
TOTAL												

AVERAGE

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml				SILICA GEL WEIGHT, g
	1	2	3	4	
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					

ORSAT MEASUREMENT	TIME	CO ₂	O ₂	CO	N ₂
1					
2					
3					
4					

COMMENTS:

CHAIN OF CUSTODY RECORD

PROJECT NUMBER - G2825			SAMPLE TYPE (✓)												REMARKS
Samplers (Signature) <i>Alvin [Signature]</i>															
Plant Description <i>Coal Creek</i>															
DATE	TIME	SAMPLE I.D. NO.													
			Target flow rate: 0.5 lpm.												
12/23/93	1:09	VOS ⑥	gas meter reading		0149.35		start						} 5 min sample.		
	1:14	C-5a-VOS-623 ⑥			0151.65		end								
		①	T024												
		②	TC033												
	1:27	①	T023		0152.67		start						} 10 min sample.		
	1:37	②	TC020		0157.71		end								
	1:51	①	T010		0158.46		start						} 30 min sample.		
	2:21	②	TC015		0174.08		end								
RELINQUISHED by: (Signature) <i>Neal L. Smith</i>			DATE	TIME	Received by: (Signature)								DATE	TIME	
			6/22/93	1450											
Relinquished by: (Signature)			DATE	TIME	Received by: (Signature)								DATE	TIME	
Relinquished by: (Signature)			DATE	TIME	Received by: (Signature)								DATE	TIME	

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3 mins

STACK SAMPLING DATA SHEET

CLIENT Bethelle / DOE TEST DATE 6-23-93 ORIFICE CORRECTION --- HOT BOX NO. ---
TEST UNIT Stack - Hot Side TEST NO. C-62-vos-623-1 METER CORRECTION 0.9735 COLD BOX NO. ---
PROJECT NO. 93-c-28-01 NOZZLE (SIZE, #) --- CALIBRATION DATE 6-14-93 PROBE NO. GLASS LINER
CONTROL BOX OPERATOR MJ STATIC PRESSURE -16" H₂O PITOT CORRECTION --- FILTER NO. ---
BAROMETRIC PRESSURE 27.62 PORT DIRECTION A CONTROL BOX NO. DGM-4686553 STACK DIA. 25"

Traverse Point (feet)	Time	Dry Gas Meter Reading (scf)	Pilot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
5'	1131	8.711		500	563	91	91	2.5	243	240	33°C / 91°F	245	VOST TUBE #1 0.5 L/min
	1136	11.500		500	551	91	91	2.5	242		39		5 min RUN
	A=5 min	A=2.789 day liters		ARG=557		T _{meter} = 91°F			T _{stack} = 245°F				
												TENAX = 100.1	
												TENAX = TC-023	
												charcoal	
												PURGE 10 min	Estimates: MW= %H ₂ O=

SYSTEM LEAK CHECK

Vacuum (in. Hg)	DGM Rate cc/(scf) min
Before	10
After	10

PITOT LEAK CHECK

	Before	After	Positive	Negative
CO ₂			1	2
O ₂				
CO				
N ₂				

↑
< 1% average flow rate

Impinger

No.	Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.

$\frac{K}{(width)}$

total

.....

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total

.....

AQE 2/92

< 1% of average flow rate

CO2		
O2		
CO		
N2

KEYSTONE
ESTABLISHED IN 1942 BY THE I.R.A.

30 MINS

STACK SAMPLING DATA SHEET

CLIENT Battelle / DOE TEST DATE 6-23-93 ORIFICE CORRECTION --- HOT BOX NO. ---
TEST UNIT Stack - Hot Side TEST NO. C-62-V05-623-3 METER CORRECTION 0.9735 COLD BOX NO. ---
PROJECT NO. 93 CP28-01 NOZZLE (SIZE, #) --- CALIBRATION DATE 6-14-93 PROBE NO. 6481 L-4-E2
CONTROL BOX OPERATOR MG STATIC PRESSURE -1.6" H₂O PITOT CORRECTION --- FILTER NO. ---
BAROMETRIC PRESSURE 27.62 PORT DIRECTION A CONTROL BOX NO. DGM 4586555 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (SCFH)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
5'	1328	27.110		500	546	86	86	6.0	249	250	iced down	255	VOST TUBE #3
					560	86	86	6.0	251				0.5L/min
					558	86	86	6.0	247				30 min RUN
					554	86	86	6.0	243				
					556	86	86	6.8	245				
					551	86	86	6.5	244				
	1358	42.983			545	86	86	6.8	246				
					cf/min								
	1430	Δ=15.873 min dry liter		AS=53 cc/min						246°F			
											TENAX → TO11		
											TENAX & TC01G		
											CHARAC!		
											PURGE 5 min		Estimates:
													MW=
													%H ₂ O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate cc/(min)
Before	10	6.3
After	10	3.4

↑
~1% of average flow rate

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

1

2

CO ₂		
O ₂		
CO		
N ₂		

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page 1 of 1

CLIENT <u>Battelle/DXE</u>	TEST DATE <u>6/23/93</u>	ORIFICE CORRECTION <u>—</u>	HOT BOX NO. <u>—</u>
TEST UNIT <u>Stack - Hot Side</u>	TEST NO. <u>C-6A-105-623-8</u>	METER CORRECTION <u>0.9735</u>	COLD BOX NO. <u>—</u>
PROJECT NO. <u>93C028-01</u>	NOZZLE (SIZE, #) <u>—</u>	CALIBRATION DATE <u>6-14-93</u>	PROBE NO. <u>—</u>
CONTROL BOX OPERATOR <u>MG</u>	STATIC PRESSURE <u>-1.6" H₂O</u>	PITOT CORRECTION <u>—</u>	FILTER NO. <u>—</u>
BAROMETRIC PRESSURE <u>27.62</u>	PORT DIRECTION <u>—</u>	CONTROL BOX NO. <u>PCA-934586555</u>	STACK DIA. <u>25"</u>

[illegible]

PITOT LEAK CHECK

	Vacuum (in. Hg)	DGM Rate $\frac{cc/min}{(cm)}$
Before	10.0	0.0
After	10.0	0.0

	Positive	Negative
Before		
After		

CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 2/92

< 1% of average
flow rate

KEYSTONE

CHAIN OF CUSTODY RECORD

OBJECT NUMBER - G2825			SAMPLE TYPE (✓)													
Inquirers (Signature)																
Inquiry Description																
DATE	TIME	SAMPLE I.D. NO.													REMARKS	
26	10:00	C-4A-VDS-6261													TO32 on TO33 77 A?	
		" " "													TC043 B}	
26	10:20	C-4A-VDS-6262													TO30 A?	
		" " "													TC051 B}	
26	10:45	C-4A-VDS-6263													TO31 A?	
		" " "													TC036 B}	
LINQUISHED by: (Signature)			DATE	TIME	Received by: (Signature)								DATE	TIME		
H. C. Rennie			8-26	11:30	Richard J. Heston								8-26	11:34		
linquished by: (Signature)			DATE	TIME	Received by: (Signature)								DATE	TIME		
linquished by: (Signature)			DATE	TIME	Received by: (Signature)								DATE	TIME		

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
AIR QUALITY ENGINEERING

Page of

~~PPA METHOD 24~~ SOURCE SAMPLING DATA SHEET

CLIENT DOE TEST DATE 6/26/93 DRY GAS METER NO. _____
TEST UNIT ESP Inlet TEST NO. C-4A-VOS-6261 METER CORRECTION (Y) _____
PROJECT NO. _____ SITE NO. 4A CALIBRATION DATE _____
SYSTEM OPERATOR Rennle STACK DIAMETER _____
BAROMETRIC PRESSURE _____ PORT DIRECTION _____

Traverse Point Depth (inches)	Clock Time	Dry Gas Meter Reading (scf)	Buck Reading Trap Name (scf/min)	Rotameter Reading	Meter Exit Temp. (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Hot Box Temp. °C (°F)	Impinger Temp. °C (°F)	Probe Temp. (°F)	Comments
10:00	0	277.66	T032 or 33?	.75	77	5	345	6	18	99	C-4A-VOS-6261
	5.05	280.25	TC043 B	.75	77	5	351	5	18	98	" " " "
10:20	0	280.28	T030	.78	78	5.5	349	5	18	119	C-4A-VOS-6262
	10.5	286.36	TC051	.80	78	6	350	5	18	118	" " " "
10:45	0	286.36	T031	.80	78	6.0	348	7	17	127	C-4A-VOS-6263
	15	295.49	TC036	.60	78	6.8	349	3	15	145	C-4A-VOS-6263
	30.3	303.18		.75	78	8.0	350	4	17	121	
											Estimates:
											MW=
											%H2O=

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	Rate (scf/min) $\frac{L}{min}$
Before	4	<.01
After		

FYRITE MEASUREMENTS

GAS	Run 1	Run 2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 7/92

286.36
286.36 / 15 = 19.09
2% = .01

D-194

CHAIN OF CUSTODY RECORD

OBJECT NUMBER - G2825			SAMPLE TYPE (✓)												REMARKS	
Operators (Signature) <i>James Christa</i>																
Sample Description <i>Coal Creek</i>																
DATE	TIME	SAMPLE I.D. NO.														
9/93		C-5a-VOS-626	gas meter reading												break rate	
09:42		(1) T025	0240.36 liters start												5 min. run 175cc/min @ 20 in. Hg.	
09:47		(2) TC037	0242.45 end												—	
			4.5 in. Hg.													
10:04		(1) T043	0244.07 start												10 min run. 50cc/min @ 24" Hg.	
10:14		(2) TC041	0248.95 end												75cc/min @ 25" Hg.	
			4.5 in. Hg.													
10:44		(1) T045 T046	0251.52 start												30 min run 60cc/min @ 24" Hg.	
11:14		(2) TC046	0277.02 end													
			4.5 in. Hg.												Temps	
															air: 13°C	
															condens: 8°C	
															ice bath 2°C	
INQUIRED by: (Signature) <i>Frank L Smith</i>			DATE	TIME	Received by: (Signature) <i>Patricia Hobbs</i>							DATE	TIME	T045 broken on		
inquired by: (Signature)			DATE	TIME	Received by: (Signature)							DATE	TIME	installation - not		
														run.		
inquired by: (Signature)			DATE	TIME	Received by: (Signature)							DATE	TIME			

D-195

- min

Page / of (

HOT BOX NO. _____
COLD BOX NO. _____
PROBE NO. _____
FILTER NO. _____
STACK DIA. 25'

D-196

PITOT LEAK CHECK

	1	2
CO2	12.0	
O2	8.0	
CO	0	
N2	80.0	

$\approx 1\%$ of average flow rate

KEYSTONE
INSURANCE CO. OF COLORADO

min

STACK SAMPLING DATA SHEET

Page / of (

CLIENT *Bethelle DOE*

TEST DATE 6-26-93 (sect.)

ORIFICE CORRECTION

HOT BOX NO. —

TEST UNIT Stack + Hot Side

TEST NO. C-6a-V68-626-2

METER CORRECTION 0.9735

COLD BOX NO. _____

PROJECT NO. 93C028-01

NOZZLE (SIZE, #) _____

CALIBRATION DATE 6-14-93

PROBE NO. _____

CONTROL BOX OPERATOR M G

STATIC PRESSURE - 1.8' H₂O

PITOT CORRECTION	0.84
------------------	------

FILTER NO.

BAROMETRIC PRESSURE 27.70

PORT DIRECTION A

CONTROL BOX NO. GM 4586555

STACK DIA. 25

[illegible]

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate <i>cc/(min)</i>
Before	10.0	0.0
After	10.0	0.0

↑
 $< 1\%$ of
 average flow rate

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	12.0	
O2	8.0	
CO	0	
N2	80.0	

Impinger

Impinger

No.	Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

30 min's

STACK SAMPLING DATA SHEET

Page / of /

CLIENT <i>Bottle 16 / DOE</i>	TEST DATE <i>6-25-93 (Sat.)</i>	ORIFICE CORRECTION <i>—</i>	HOT BOX NO. <i>—</i>
TEST UNIT <i>Stack - Hot Side</i>	TEST NO. <i>C-62-V05-625-3</i>	METER CORRECTION <i>0.9735</i>	COLD BOX NO. <i>—</i>
PROJECT NO. <i>93CD28-01</i>	NOZZLE (SIZE, #) <i>—</i>	CALIBRATION DATE <i>6-14-93</i>	PROBE NO. <i>GLASS</i>
CONTROL BOX OPERATOR <i>M.G.</i>	STATIC PRESSURE <i>1.8" H₂O</i>	PITOT CORRECTION <i>0.84</i>	FILTER NO. <i>—</i>
BAROMETRIC PRESSURE <i>27.70</i>	PORT DIRECTION <i>A</i>	CONTROL BOX NO. <i>DEM 4586535</i>	STACK DIA. <i>25"</i>

[illegible]

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate cc/(cm) ² min
Before	10.0	0.0
After	11.0	0.8

$< 1\%$ of average flow rate

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2	12.0	
O2	8.0	
CO	0	
N2	80.0	

Impinger

Impinger

No.	Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

AQE 2/92

D-9: HEST Samples

The HEST sampler is a collector for vapor-phase metals that employs carbon-impregnated filters for adsorption of these elements from the vapor phase. It was used at the primary sampling locations at Coal Creek, and at the parallel ESP outlet location (5b).

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
---	---	---	---	---	---	---	---	---	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	-----

HEST FILTERS: 930 2697
93M 227
93M 228

STACK SAMPLING DATA SHEET

847
CLIENT Battelle

8-4-1
CLIENT Battelle TEST DATE 06/22/93
TEST UNIT Exlet-Exp #1 TEST NO. C-4A-M-622
PROJECT NO. NOZZLE (SIZE, #) 0.750
CONTROL BOX OPERATOR STATIC PRESSURE -
BAROMETRIC PRESSURE 27. PORT DIRECTION

Page of

CLIENT	DATE	TEST DATE	ORIFICE CORRECTION	HOT BOX NO.
SAFETY	11/2	06 22 93	2.002	3
TEST UNIT	EXP #1	TEST NO. C-4A-4-622	METER CORRECTION	COLD BOX NO.
PROJECT NO.		NOZZLE (SIZE, #) 0.250	0.9812	4
CONTROL BOX OPERATOR		STATIC PRESSURE -	CALIBRATION DATE	PROBE NO.
			06-09-93	7-1
BAROMETRIC PRESSURE	27.	PORT DIRECTION	PITOT CORRECTION	FILTER NO.
			0.84	HCS
			CONTROL BOX NO.	STACK DIA.
			6	10 1/2

[illegible]

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DCM Rate (cfm)
Before	8.0	0.6
After	34.5	0.13

0.24 cfr

$$\begin{array}{r} 30 \\ 30 \\ \hline 24 \end{array}$$

PITOT LEAK CHECK

	Positive	Negative
Before	OKISSA	OKISSA
After		

C02		
O2		
C0		
N2		

[illegible]

No.	Contents	Final	Initial	Difference
1.	100 ml H ₂ O	634.2	538.2	
2.	100 ml H ₂ O	545.7	543.7	
3.	D.R.	441.9	436.5	
4.	5.1 cc I	702.9	666.0	
5.				

$$\begin{array}{r} 1320 \\ 24 \overline{) 3168} \\ \underline{48} \\ 80 \\ \underline{48} \\ 32 \\ \underline{24} \\ 8 \end{array}$$

AOE 2/92

6.7 $\mu\text{f}/\text{cm}^2$

CHAIN OF CUSTODY RECORD

PROJECT NUMBER - G2825			SAMPLE TYPE (✓)												REMARKS	
Samplers (Signature) <i>David Hunter</i>																
Plant Description Coal Creek																
DATE	TIME	SAMPLE I.D. NO.														
6/24/93	10:15	C-5A-H-622	Target flow rate: 0.39 dscfm, 4 hrs duration gas meter reading 4946.60 4854 4946.60 10:40 gas meter reading start 501.55 cfm end 504.18 (6 min) 2.63 ⇒ .44 cfm 10:50 " " end 5079.6 start 5061.0 (5 min) 1.80 ⇒ 0.37 cfm 11:05 0.40 11:43 Stop test 70.9 min. water trap full restart gas meter reading end: 586.92													
RELINQUISHED by: (Signature)			DATE	TIME	Received by: (Signature)						DATE	TIME				
Relinquished by: (Signature)			DATE	TIME	Received by: (Signature)						DATE	TIME				
Relinquished by: (Signature)			DATE	TIME	Received by: (Signature)						DATE	TIME				

D-201

STACK SAMPLING DATA SHEET

Battelle / DOE

Page 1 of 2

CLIENT ~~DOE~~ Battelle / DOE TEST DATE 06-22-93 ORIFICE CORRECTION 1.734 HOT BOX NO. 3
 TEST UNIT ESP #2 Outlet TEST NO. C-5b-HW-622 METER CORRECTION 0.9832 COLD BOX NO. 3
 PROJECT NO. 91C02B-01 NOZZLE (SIZE, IN) 1/2 CALIBRATION DATE 05-17-93 PROBE NO. 7-3
 CONTROL BOX OPERATOR RPC STATIC PRESSURE +16.0" H₂O PITOT CORRECTION 0.84 FILTER NO. 8455
 BAROMETRIC PRESSURE 27.47 PORT DIRECTION 162.12.02 CONTROL BOX NO. FILE STACK DIA. 14 (upth) K

Traverse Point (inches)	Time	Dry Gas Meter Reading (scf)	Pitot ΔP (in. H ₂ O)	Req'd. (in. H ₂ O)	Orifice ΔH Act. (in. H ₂ O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
65"	11:15	342.148		1.10	1.10	87	87	10.0	361	2250	46.8	2250	10 min / 125
	11:25	350.000		1.10	1.10	104	92	10.0	364		10 min		STARTED AT 125 TO ADJUST PROBE POSITION
	11:32	350.000		1.10	1.10		102	10.0	364				RESUME AT 1132
				1.10	1.10	123	105	10.0	366		45 min		SHUT BOX DOWN
				1.10	1.10	130	110	10.0	367				AT 12:17 TO
				1.10	1.10	140	120	10.0	365				COOL OFF PUMP
	12:17	382.701		1.10	1.10	48	130	10.0	365				
	14:18	392.761		1.10	1.10	102	110	10.0	367				TEST #1
				1.10	1.10	126	114	10.0	365		40 min		
				1.10	1.10	136	120	10.0	360				
	14:58	411.478		1.10	1.10	145	125	10.0	366				Estimates: Filler #9302696
													MW= 21.3
	15:06	411.478		1.10	1.10	137	130	9.0	366				#93M221
				1.10	1.10	125	120	9.0	367				#93M222
													Estimates: #93M222
													MW= 21.3
													%H ₂ O= 7.3
													7.7

↑ actual = 10.890

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100 ml H ₂ O	836.9	567.2	269.7
2.	100 ml H ₂ O	569.9	539.5	30.4
3.	100 ml H ₂ O	466.3	456.0	10.3
4.	50 ml H ₂ O	718.2	669.9	48.3
5.				

PITOT LEAK CHECK

	Positive	Negative
Before	0.1566	0.1566
After		

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before	5.0	<0.016 cfm
After	10.0	<0.02 cfm

	1	2
CO ₂	12.0	
O ₂	7.0	
CO	0	
N ₂	81.0	

74.08
 5.0000
 2.0000
 8.0000
 10.0000
 358.79 total

← FLOW

STACK SAMPLING DATA SHEET

Bottle / DPE

Page 2 of 2

CLIENT Boyle / DPE TEST DATE 06-22-93 ORIFICE CORRECTION 1.234 HOT BOX NO. 3
 TEST UNIT ESP #2 boiler TEST NO. C-5 D-H METER CORRECTION 0.9832 COLD BOX NO. 3
 PROJECT NO. 73028-0 NOZZLE (SIZE, I) 1.10 CALIBRATION DATE 05-17-93 PROBE NO. 7-3
 CONTROL BOX OPERATOR LPC STATIC PRESSURE +16.0" H₂O PITOT CORRECTION 0.84 FILTER NO. 50033
 BAROMETRIC PRESSURE 27.48 PORT DIRECTION Vertical CONTROL BOX NO. Five STACK DIA. 14" (Depth) x 26"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
65"				1.10	1.10	118	111	9.0	360	2290	468°F	2250	HEAT #1
	15:56	443.382		1.10	1.10	117	108	9.0	369				
	16:08	443.382		1.10	1.10	115	107	9.0	366	5000			
				1.10	1.10	113	109	9.0	367				
				1.10	1.10	113	109	9.0	371				
				1.10	1.10	112	104	9.0	368				Simple Point
				1.10	1.16	110	103	9.0	361				Not Isokinetic
				1.10	1.10	108	100	9.0	369	9500			Sampling for 4 hr
				1.10	1.10	109	101	9.0	370				
				1.10	1.10	109	101	9.0	371				
				1.10	1.10	109	101	9.0	368				Filter # 93Q2696
				1.10	1.10	109	101	9.0	368				# 93M221
				1.10	1.10	110	101	9.0	369				# 93M222
	Δ =	Δ =		(ΔH) = 1.10	(Inlet) = 113°F					(Stack) = 366°F			Estimates:
	240 min	168,212 dcf											MW = 28.3
													% H ₂ O = 15.0

SYSTEM LEAK CHECK

Vacuum (in. Hg)	DGM Rate (cfm)
Before	
After	

PITOT LEAK CHECK

Before	Positive	Negative
After		

	1	2
CO ₂	12.0	
O ₂	7.0	
CO	0	
N ₂	81.0	

Impinger Count Data

Impinger No.	Impinger Count Data	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.

STACK SAMPLING DATA SHEET

Page 1 of 2

CLIENT *Battelle / DOE* TEST DATE *6-22-93* ORIFICE CORRECTION *1.886* HOT BOX NO. *1*
 TEST UNIT *Stack - Hot Side* TEST NO. *C-6a-28-622* METER CORRECTION *0.9837* COLD BOX NO. *1*
 PROJECT NO. *93C028-01* NOZZLE (SIZE, IN) *H 0.188* CALIBRATION DATE *4-5-93* PROBE NO. *5-1*
 CONTROL BOX OPERATOR *TM* STATIC PRESSURE *-1.7 in H₂O* PITOT CORRECTION *0.84* FILTER NO. *HE7-# A*
 BAROMETRIC PRESSURE *27.94* PORT DIRECTION *D* CONTROL BOX NO. *1* STACK DIA. *25"*

Traverse Point (inches)	Time	Dry Gas Meter Reading (Acf)	Pitot & P (in. H ₂ O)	Orifice & H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
	10:00	137.022	2.6	0.90	0.90	97	91	20.0	227	~250	~68°F	-25.0°	Suble Point
			2.4	0.90	0.90	90	90	20.0	228				Not-Isokinetic
			2.4	0.90	0.90	88	88	20.0	228				Sampling at
			2.6	0.85	0.85	88	87	20.0	224			target	15 L/min
			2.6	0.85	0.85	87	86	20.0	224				(0.53 acfm)
			2.5	0.85	0.85	87	86	20.0	225	250	60	250	
	11:00		2.4	0.85	0.85	88	86	20.0	226				Readings every
			2.6	0.85	0.85	88	86	20.0	221				10 minutes
			2.6	0.85	0.85	87	86	20.0	221				
			2.4	0.85	0.85	90	86	20.0	220	250	59	250	
			2.4	0.80	0.80	90	87	20.0	220				
			2.6	0.80	0.80	91	88	20.0	221				
	12:00		2.5	0.80	0.80	92	88	20.0	221				
			2.8	0.80	0.80	92	87	20.0	220	250	57	250	Estimates:
			2.6	0.80	0.80	96	92	20.0	218				MW=28.1
			2.7	0.80	0.80	96	92	20.0	217				%H ₂ O=17.3
			2.4	0.80	0.80	100	98	20.0	218				
			2.6	0.80	0.80	104	97	20.0	218				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.003
After	20.0	0.007

PITOT LEAK CHECK

	Positive	Negative
Before	0.5	0.5
After	0.5	0.5

	CO ₂	O ₂	CO	N ₂
	12.0	8.0	0	80.0

Impinger

Impinger No.	Impinger Concentrate	Final	Initial	Difference
1.	100 ml H ₂ O	890.8	523.3	367.5
2.	100 ml H ₂ O	534.6	525.9	8.7
3.	DAY	470.7	451.2	19.5
4.	Sil. Gel	675.8	630.0	45.8
5.				

File # 93-Q2698
 93-M225
 93-M226

total = 441.5

STACK SAMPLING DATA SHEET

Page 1 of 2

CLIENT Battelle TEST DATE 6/24/93 ORIFICE CORRECTION 2.002 HOT BOX NO. 1
TEST UNIT Inlet Esp #1 4A TEST NO. C-4A-H-624 METER CORRECTION 0.9812 COLD BOX NO. 1
PROJECT NO. 93030 NOZZLE (SIZE, #) 0.250 CALIBRATION DATE 6/9/93 PROBE NO. 7-1
CONTROL BOX OPERATOR STATIC PRESSURE PITOT CORRECTION 0.84 FILTER NO. H2ST
BAROMETRIC PRESSURE PORT DIRECTION Vertical CONTROL BOX NO. 6 STACK DIA. 106" X

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcl)	Pitot ΔP (in. H2O)	Orifice ΔH Req'd. (in. H2O)	Orifice ΔH Act. (in. H2O)	Meter Temperature In (°F)	Meter Temperature Out (°F)	Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°F)	Hot Box Temp. (°F)	Comments
66.25	1125	783.462	1.1	4.0	1.55	79	75	20	285	250	55.5	240	One Point
	1140	788.930	1.1		.20	83	79	22.5	282		68		4 hour Run
	1155	792.675	1.2		.10	85	83	23	294				10 minute data
	1210	795.717	1.1		.10	85	85	23	300				15 min
	1225	798.395	1.2		.09	85	85	23	301				data point 5
	1240	800.765	1.2		.05	85	85	23.5	302				
	1255	802.955	1.1		.05	85	85	23.8	304				
	1310	805.955	1.1		.05	85	85	23.4	304				
	1325	806.915	1.2		.05	85	87	23.9	307				
	1340	808.716	1.2		.05	85	87	23.9	305				
	1355	810.456	1.1		.05	85	87	23.9	304				
	1410	812.095	1.2		.05	85	87	23.9	304				
	1425	813.682	1.2		.05	87	89	23.5	307				
	1440	815.212	1.2		.03	87	89	23.5	303				
	1455	816.742	1.1		.05	87	89	23.9	304				Estimates:
	1510	818.125	1.2		.03	85	89	23.8	302				MW=
	1525	819.535	1.2		.05	85	87	23.8	303				%H2O=
	1540	820.980	1.2		.03	87	89	23.8	307				

SYSTEM LEAK CHECK		PITOT LEAK CHECK		Impinger Contents		Final		Initial		Difference	
Vacuum (in. Hg)	DGM Rate (cfm)	Before	After	Positive	Negative	No.	Contents	Final	Initial	Difference	
Before	10.0					1.	100 ml H2O	675.5	541.6		
After	0.015					2.	100 ml H2O	494.7	539.6		
						3.	DAY	455.4	451.3		
						4.	511 Gcl	667.7	635.3		
						5.

* If 10 minute data points can't be taken, take 30 minute data points at 10 minute intervals

STACK SAMPLING DATA SHEET

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CLIENT BaHelle/DOE TEST DATE 6/24/93 ORIFICE CORRECTION
 TEST UNIT ESP outlet #1 SA TEST NO. C-H-5A-624 METER CORRECTION Y
 PROJECT NO. 93C030 NOZZLE (SIZE, #) 2 CALIBRATION DATE 6/21/93 HOT BOX NO.
 CONTROL BOX OPERATOR STATIC PRESSURE PITOT CORRECTION PROBE NO.
 BAROMETRIC PRESSURE 27.63" Hg PORT DIRECTION CONTROL BOX NO. model 2343 serial 1970 FILTER NO. HES1
 STACK DIA.

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcl)	Pitot ΔP (in. H2O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H2O)	Act. (in. H2O)	In (°F)	Out (°F)						
24"	11:00	659.025	0.82		1.0	58		13	314	212/212			One Point
	11:10	664.425	0.83		1.0	57		13	312	290			4 hour Run
	11:20	669.530	0.79		1.0	57		13	312	300			10 minute data print
	11:30	674.670	0.80		1.0	58		12.9	313	280			
	11:40	679.920	0.81		1.0	58		12.9	315	283			
	11:50	685.110	0.79		1.0	59		12.9	311	284			
	12:00	690.303	0.80		1.0	59		12.9	317	284			
	12:10	695.540	0.81		1.0	60		12.9	318	285			
	12:20	700.750	0.78		1.0	60		12.0	316	283			
	12:30	707.630	0.77		1.0	60		12.0	309	278			
	12:40	710.91	0.80		1.0	61		12.0	310	278			
	12:50	715.84	0.81		1.0	62		12.0	318	275			
	13:00	726.04	0.79		1.0	62		12.0	313	277			
	13:20	731.13	0.77		1.0	64		12	312	276			
	13:30	735.71	0.76		1.0	62		12	316	273			Estimates:
	13:40	741.37	0.80		1.0	63		12	314	277			MW=
	13:50	746.37	0.75		1.8	63		11.9	315	225			%H2O=
	13:51	747.13											damp water trap

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before	15	0.45
After	13	0.23

target < 0.02 cfm

PITOT LEAK CHECK

	Positive	Negative
Before		
After		
	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Targeted Rate: .50 dcfm

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CLIENT	TEST DATE <u>6/24/93</u>	ORIFICE CORRECTION	HOT BOX NO.
TEST UNIT <u>ESP OUTLET #1 SA</u>	TEST NO. <u>C-5a-H-624</u>	METER CORRECTION	COLD BOX NO.
PROJECT NO.	NOZZLE (SIZE, θ)	CALIBRATION DATE	PROBE NO.
CONTROL BOX OPERATOR <u>Camryn</u>	STATIC PRESSURE	PITOT CORRECTION	FILTER NO.
BAROMETRIC PRESSURE <u>27.63 inHg</u>	PORT DIRECTION	CONTROL BOX NO.	STACK DIA.

[illegible]

Impinger No.	Impinger Contents	Final	Initial	Difference
-----------------	----------------------	-------	---------	------------

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

1.	2.	3.	4.	5.

STACK SAMPLING DATA SHEET

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CLIENT BATTGLG/DOE
 TEST UNIT ESP #2 OUTLET
 PROJECT NO. 93CB28-01
 CONTROL BOX OPERATOR R/C
 BAROMETRIC PRESSURE 27.54

TEST DATE 06-24-93
 TEST NO. C-5B-H-624
 NOZZLE (SIZE, #) 1/2"
 STATIC PRESSURE 16.0" H₂O
 PORT DIRECTION PORT #6

ORIFICE CORRECTION 1.734
 METER CORRECTION 0.9832
 CALIBRATION DATE 05-17-93
 PITOT CORRECTION 0.84
 CONTROL BOX NO. FILE

HOT BOX NO. 3
 COLD BOX NO. 3
 PROBE NO. 10-1
 FILTER NO. 81155
 STACK DIA. 36" X 14"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
7'	13:03	614.410		.50	.50	89	87	19.0	350	~250	168°F	250	Single Point
				.50	.50	90	88	19.0	354				Non-Isometric
				.50	.50	94	90	19.0	355				Sampling for
				.50	.50	95	93	19.0	355				4 hrs
				.50	.50	92	90	19.0	354				
				.50	.50	90	88	19.0	357				TEST #1
				.50	.50	90	88	19.0	355				
				.50	.50	90	88	19.0	365				
				.50	.50	90	88	19.0	360				
				.50	.50	89	86	19.0	360		2425		Port 6
				.50	.50	88	85	19.0	380				
	15:03	665.400		.50	.50	88	85	19.0	380				File # 93Q2701
													# 93M231
													# 93M232
													Estimates:
													MW= 28.1
													%H ₂ O= 17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	16.0	20.012 cfm
After	20.0	<0.01 cfm

PITOT LEAK CHECK

	Positive	Negative
Before	NA	NA
After		

	1	2
CO ₂	12.0	
O ₂	7.0	
CO	0	
N ₂	81.0	

Impinger

Impinger No.	Contents	Final	Initial	Difference
1.	100 ml H ₂ O	760.8	561.4	199.4
2.	100 ml H ₂ O	611.8	571.0	40.8
3.	DRY	467.7	459.6	8.1
4.	Sil. Gel	704.6	659.6	45.0
5.				

actual = 14.3%

293.3 g tot
KEYSTONE
 Environmental & Safety Services, Inc.

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CLIENT <u>BATTLE / DOE</u>	TEST DATE <u>06-24-93</u>	ORIFICE CORRECTION <u>1.734</u>	HOT BOX NO. <u>3</u>
TEST UNIT <u>ESP #2 OUTLET</u>	TEST NO. <u>C-5B-11624 (165)</u>	METER CORRECTION <u>0.9232</u>	COLD BOX NO. <u>3</u>
PROJECT NO. <u>93C028-01</u>	NOZZLE (SIZE, #) <u>—</u>	CALIBRATION DATE <u>05-17-93</u>	PROBE NO. <u>101</u>
CONTROL BOX OPERATOR <u>RPC</u>	STATIC PRESSURE <u>16.0" H₂O</u>	PITOT CORRECTION <u>0.84</u>	FILTER NO. <u>BYPASS</u>
BAROMETRIC PRESSURE <u>27.54</u>	PORT DIRECTION <u>PORT #3</u>	CONTROL BOX NO. <u>FILE</u>	STACK DIA. <u>26" x 141</u>

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pilot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments	
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						width	depth
7'	15:14	665.400		.55	.85	80	80	19.0	365	2350	468°F	2250	24.25	Perot #3
				.55	.55	80	80	19.0	350					
				.55	.55	82	79	19.0	354					Single Point
				.50	.50	82	79	19.0	330					Non-Isokinetic
				.50	.50	82	79	19.0	331					Sampling for
				.50	.50	82	79	19.0	329					4 MB
				.50	.50	82	79	19.0	339					
				.50	.50	84	80	19.0	339					Test #1
				.50	.50	82	78	19.0	328					
				.50	.50	82	78	19.0	331					Filter #
				.50	.50	82	77	19.0	345					93Q2701
				.50	.50	81	76	19.0	350					# 93M231
				.50	.50	81	76	19.0	350					# 93M232
	17:14	709.225		.50	.50	80	72	19.0	340					
	A=120 min	A=43.825 dcf		(ΔH) _{avg} = 0.50	(T _{meter}) _{avg} = 80°F				(T _{stack}) _{avg} = 341°F					Estimates:
														MW = 28-1
														%H ₂ O = 17.5

PITOT LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

	Positive	Negative
Before		
After		

	1	2
CO2	12.0	
O2	7.0	
CO	0	
N2	81.0	

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

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STACK SAMPLING DATA SHEET

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CLIENT Bethelle / DCE TEST DATE 6-24-93 ORIFICE CORRECTION 1.886 HOT BOX NO. 4
 TEST UNIT Stack - Hot Side TEST NO. C-6A-H-624 METER CORRECTION 0.9837 COLD BOX NO. 4
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) 0.188 CALIBRATION DATE 4-5-93 PROBE NO. 5-1
 CONTROL BOX OPERATOR JM STATIC PRESSURE -1.8" H₂O PITOT CORRECTION 0.84 FILTER NO. HEST # A
 BAROMETRIC PRESSURE 27.54 PORT DIRECTION D CONTROL BOX NO. 1 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
	11:05	496.795	2.4	1.15	1.15	69	69	20.0	285	~250°	48°F	-250°	Single Point
			2.4	1.20	1.20	66	68	20.0	286				Non-Reliable
			2.3	1.20	1.20	67	65	20.0	236				Sampling at
			2.4	1.20	1.20	67	65	20.0	236				target [15 L/min
			2.4	1.15	1.15	68	61	20.0	238				(0.53 dcf/min)
			2.3	1.15	1.15	68	61	20.0	236				
	12:05		2.4	1.15	1.15	68	61	20.0	236				Readings every
			2.5	1.10	1.10	67	65	20.0	238				10 minutes
			2.4	1.10	1.10	67	65	20.0	236				
			2.3	1.10	1.10	72	68	20.0	236				
			2.3	1.10	1.10	72	67	20.0	236				
			2.4	1.10	1.10	72	67	20.0	236				
	13:05		2.4	1.10	1.10	72	67	20.0	234				
			2.4	1.10	1.10	74	68	20.0	235				
			2.4	1.10	1.10	74	68	20.0	233				Estimates:
			2.3	1.10	1.10	78	74	20.0	232				MW= 28.1
			2.3	1.10	1.10	82	80	20.0	234				%H ₂ O= 17.3
			2.3	1.10	1.10	80	83	20.0	227				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.002
After	20.0	0.005

PITOT LEAK CHECK

	Positive	Negative
Before	OK	OK
After	OK	OK

	1	2
CO ₂	18.0	
O ₂	8.0	
CO	0	
N ₂	82.0	

Impinger

Impinger No.	Contents	Final	Initial	Difference
1.	100 mL D ₂ O	774.4	538.0	236.4
2.	100 mL D ₂ O	711.8	546.2	165.6
3.	Empty	469.3	444.0	25.3
4.	200g Silica Gel	687.7	652.5	35.2
5.				Total 462.5g

STACK SAMPLING DATA SHEET

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CLIENT Bottle / DOE TEST DATE 6-24-93 ORIFICE CORRECTION 1.886 HOT BOX NO. 4
 TEST UNIT Spill - Hot Side TEST NO. C-6a-H-624 METER CORRECTION 0.9837 COLD BOX NO. 4
 PROJECT NO. 93 CD 28-01 NOZZLE (SIZE, #) 0.188 CALIBRATION DATE 4-5-93 PROBE NO. 5-1
 CONTROL BOX OPERATOR TM STATIC PRESSURE -1.8" H₂O PITOT CORRECTION 0.84 FILTER NO. HEAT # A
 BAROMETRIC PRESSURE 27.54 PORT DIRECTION 5 CONTROL BOX NO. 1 STACK DIA. 25"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
	14:05		2.3	1.10	1.10	83	81	20.0		~240°	~68°F	~250°	Single Point
			2.7	1.05	1.05	83	81	20.0					Non-Isokinetic
			2.3	1.05	1.05	83	81	20.0					Sampling at
			2.4	1.05	1.05	84	80	20.0				target	15 L flow
			2.7	1.05	1.05	84	80	20.0					(0.53 dscfm)
			2.4	1.05	1.05	84	80	20.0					
	15:05	633.145											Readings every 10 minutes
	A=240 min.	Δ = 136.350 dcf	(ΔP) _{avg} = 2.4	(ΔH) _{avg} = 1.11	(T _{stack, avg}) = 73°F	(T _{probe, avg}) = 236°F							
													velocity = 165.8 ft/sec
													Estimates:
													MW = 28.1
													%H ₂ O = 17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		
	1	2
CO ₂		
O ₂		
CO		
N ₂		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

STACK SAMPLING DATA SHEET

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CLIENT BaHelle / DoE TEST DATE 6/27/93 ORIFICE CORRECTION 2.002 HOT BOX NO.
 TEST UNIT ESP INLET #1 (4A) TEST NO. C-4A-H-627 METER CORRECTION 9.212 COLD BOX NO.
 PROJECT NO. 93C028 NOZZLE (SIZE, IN) .250 in CALIBRATION DATE 64-08-92 PROBE NO. 7-1
 CONTROL BOX OPERATOR STATIC PRESSURE PITOT CORRECTION -.81 FILTER NO.
 BAROMETRIC PRESSURE 27.26 PORT DIRECTION CONTROL BOX NO. 54 STACK DIA.

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H2O)	Act. (in. H2O)	In (°F)	Out (°F)						
	9:20	876.389	1.2	✓	0.8	75	71	20	301		ICE	< 68°F	
	9:35	882.155	1.2	✓	0.35	77	73	22.3	304				
	9:50	886.254	1.2	✓	0.15	79	77	23.0	309				
	10:05	889.625	1.2	✓	0.10	80	79	23.2	304				
	10:20	892.604	1.2	✓	0.10	80	80	23.5	304				
	10:35	895.305	1.2	✓	0.08	81	81	23.8	305				
	10:50	897.745	1.2	✓	0.05	81	81	23.8	305				
	11:05	900.084	1.2	✓	0.05	81	81	23.8	307				
	11:20	902.214	1.2	✓	0.05	81	81	24	307				
	11:35	904.215	1.2	✓	0.05	81	82	24	309				
	11:50	906.094	1.2	✓	0.05	82	82	24	309				
	12:05	907.931	1.2	✓	0.05	82	83	24	305				
	12:20	909.694	1.1	✓	0.05	83	83	24	307				
	12:35	911.381	1.2	✓	0.05	84	84	24	309				
	12:50	913.027	1.2	✓	0.05	84	85	24	309				Estimates:
	13:05	914.617	1.2	✓	0.05	84	85	24	311				MW=
	13:20	916.177	1.2	✓	0.05	85	85	24	309				%H2O=
	13:35	917.708	1.2	✓	0.05	85	85	24	309				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.6	0.01 cfm
After	25.0	0.02 cfm

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100 ml	602.1	516.9	
2.	100 ml	543.8	528.4	
3.	100 ml	450.9	443.5	
4.	50 ml	689.4	649.4	35.4
5.		689.4		

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COULD BOX NO.

PROBE NO.

FILTER NO.

STACK DIA.

BLACK DIA.

Estimates:

MW=	
%H2O=	

PTTOT LEAK CHECK		
	Positive	Negative
Before		
After		

CO2		
O2		
CO		
N2		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.	"			
3.				
4.				
5.				

STACK SAMPLING DATA SHEET

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CLIENT Battelle / DOE TEST DATE 6/27/93 ORIFICE CORRECTION
 TEST UNIT ESP OUTLET #1 (5A) TEST NO. C-5A-H-627 METER CORRECTION
 PROJECT NO. 93C028 NOZZLE (SIZE, #) — CALIBRATION DATE
 CONTROL BOX OPERATOR Glenn STATIC PRESSURE PITOT CORRECTION
 BAROMETRIC PRESSURE 27.89 PORT DIRECTION CONTROL BOX NO. (2) FILTER NO.
 STACK DIA.

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H2O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H2O)	Act. (in. H2O)	In (°F)	Out (°F)						
24"	0955	882.03	0.72		1.0	64		16	295	225			
	1005	887.45	0.68		0.98	65		16.1	284	278			
	1016	893.06	0.69		1.0	65		16.1	274	306			
	1025	897.67	0.71		1.0	64		15.9	298	314			
	1035	902.87	0.65		1.0	63		15.9	292	317			
	1045	908.25	0.61		1.0	66		15.6	277	319			
	1055	913.40	0.65		1.0	67		15.5	277	321			
	1105	918.89	0.61		1.1	67		15.5	278	320			
	1115	924.24	0.68		1.1	66		15.2	295	323			
	1125	929.59	0.63		1.0	66		14.5	295	323			
	1135	934.88	0.69		1.0	66		14.5	303	323			
	1145	940.17	0.67		1.0	66		14.4	318	318			
	1155	945.54	0.60		1.0	68		14.4	299	322			
	1205	956.24	0.60		1.0	66		14.0	313	328			
	1225	961.67	0.60		1.8	70		13.9	296	326			Estimates:
	1227	962.34	—								Stop	Steam	MW=
	1230	962.34	—								Restart	water	up H2O=
	1235	965.31	0.83		1.1	71		13.8	287	327			

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	10"	.006 cfm
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO2		
O2		
CO		
N2		

Impinger

Impinger No.	Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

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TEST DATE 6/27/93

TEST NO. C-SA-H-677

HOT BOX NO.

NOZZLE (SIZE. 1)

COLD BOX NO.

STATIC PRESSURE

PROBE NO.

PORT DIRECTION

FILTER NO.

Origin

STACK DIA.

SYSTEM LEAK CHECK

PRINT LEAK CHECK

Impinger

2**LAQE 2/92**

KEY

STACK SAMPLING DATA SHEET

Page 1 of 2

CLIENT Battelle/DOE TEST DATE 6-27-93 (Sun) ORIFICE CORRECTION 1.734 HOT BOX NO. 3
 TEST UNIT ESP #2 Outlet TEST NO. C-56-H-627 METER CORRECTION 0.9832 COLD BOX NO. 3
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) --- CALIBRATION DATE 05-17-93 PROBE NO. 10-1
 CONTROL BOX OPERATOR R/C STATIC PRESSURE 16.0" H₂O PITOT CORRECTION 0.84 FILTER NO. HEST #1
 BAROMETRIC PRESSURE 27.76 PORT DIRECTION Port #6 CONTROL BOX NO. FIVE STACK DIA. 14' x 26'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
7'	09:46	809392		1.0	1.0	72	73	19.0	349	~250°	<68°F	~250°	Single Point
				.80	.80	75	73	19.0	349				Non-Isokinetic
				.80	.80	76	73	19.0	349				Sampling for 4 hours
				.85	.85	77	76	19.0	348				
				.85	.85	79	77	19.0	354				
				.85	.85	81	79	19.0	354				HEST #1
				.85	.85	83	81	19.0	357				
				.85	.85	88	86	19.0	354				File #93-02712
				.85	.85	88	86	19.0	354				#93-M254
				.85	.85	89	87	19.0	344				#93-M255
				.85	.85	90	88	19.0	354				
				.85	.85	90	88	19.0	355				
				.75	.75	90	89	19.0	361				
				.75	.75	91	88	19.0	350				
				.75	.75	90	88	19.0	355				Estimate:
				.75	.75	90	89	19.0	351				MW= 28.5
				.75	.75	94	90	19.0	361				%H ₂ O= 14
				.75	.75	94	91	19.0	360				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before	5.0	2001 cfm
After	23.0	20.01 cfm

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

	1	2
CO ₂	13.0	13.0
O ₂	8.5	8.5
CO	0	0
N ₂	78.5	78.5

Impinger

Impinger No.	Contents	Final	Initial	Difference
1.	100 ml H ₂ O	838.2	571.7	266.5
2.	100 ml H ₂ O	613.4	560.2	53.2
3.	Dry	479.6	471.8	7.8
4.	Sil. Gel	713.3	666.1	47.2
5.				

374.7 g total
KEYSTONE
ANALYTICAL SERVICES, INC. 201 West 10th St. Ste. 200

STACK SAMPLING DATA SHEET

Page 2 of 2

CLIENT Battelle TEST DATE 6-27-93 (Sun.) ORIFICE CORRECTION 1.734 HOT BOX NO. 3
TEST UNIT ESP #2 TEST NO. C-56-H-627 METER CORRECTION 0.9822 COLD BOX NO. 3
PROJECT NO. 93C028-D1 NOZZLE (SIZE, IN) 1/2 CALIBRATION DATE 05-17-93 PROBE NO. 10-1
CONTROL BOX OPERATOR RPL STATIC PRESSURE 116.0" H₂O PITOT CORRECTION 0.84 FILTER NO. NEST #1
BAROMETRIC PRESSURE 27.76 PORT DIRECTION PET #6 CONTROL BOX NO. Five STACK DIA. 14" x 26"

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcl)	Pitot Δ P (in. H ₂ O)	Orifice Δ H		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
				170	70	90	89	19.0	355	-250	468°F	~250	depth with
				70	70	90	89	19.0	360				Sample Point
				.65	.65	90	89	19.0	360				Not - Soluble
				.65	.65	91	89	19.0	354				Sampling for
				.65	.65	92	89	19.0	354				4 heads
				.65	.65	93	89	19.0	350				
	1346	933.415											File #93-Q2742
	A=240	A=		(ΔH) _{req} = 0.70									#93-M251
	min	124.023											#93-M255
		dcl											
													Estimates:
													MW= 28.5
													% H ₂ O= 14

SYSTEM LEAK CHECK

Vacuum (in. Hg)	DGM Rate (cfm)
Before	
After	

PITOT LEAK CHECK

	Positive		Negative	
	Before	After	Before	After
CO ₂	13.0	13.0		
O ₂	8.5	8.5		
CO	0	0		
N ₂	78.5	78.5		

Impinger Contents

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.				

Page 1 of 1

TEST DATE 6-27-93 (Sun.)

ORIFICE CORRECTION 1.754

HOT BOX NO. 3

TEST UNIT ESP #2 outlet

TEST NO. C-56-H-627-BLK

METER CORRECTION 0.9832

COLD BOX NO. 3

PROJECT NO. 93C028-01

NOZZLE (SIZE, #) _____

CALIBRATION DATE 05-17-93

PROBE NO. 10-7

CONTROL BOX OPERATOR *R/c*

STATIC PRESSURE $+16.8" \text{ H}_2\text{O}$

PITOT CORRECTION 0.84

FILTER NO. 45 ST

BAROMETRIC PRESSURE 27.76

PORT DIRECTION

CONTROL BOX NO. Five

STACK DIA. 1.125

Estimates:

MW= 28.3

3H2O- 10:0

PITOT LEAK CHECK

	Positive	Negative
Before		
After		

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100ml D.I. H ₂ O	571.7	571.7	0
2.	100ml D.I. H ₂ O	560.2	560.2	0
3.	Empty	471.8	471.8	0
4.	200g Silica Gel	666.1	666.1	0
5.				

total = 0 g
KEYSTONE
SINCE 1954

D-220

STACK SAMPLING DATA SHEET

Page 1 of 2

CLIENT Battelle / DOE TEST DATE 6-27-93 (Sun.) ORIFICE CORRECTION 1.886 HOT BOX NO. 1
 TEST UNIT Stack - Hot Side TEST NO. C-6a-H-627 METER CORRECTION 0.9837 COLD BOX NO. 1
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) 0.188 CALIBRATION DATE 4-5-93 PROBE NO. 5-1
 CONTROL BOX OPERATOR TM STATIC PRESSURE -1.8" H₂O PITOT CORRECTION 0.84 FILTER NO. NEST # A
 BAROMETRIC PRESSURE 27.76 PORT DIRECTION D CONTROL BOX NO. 1 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pilot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
	9:00	208.42	2.3	1.00	1.00	80	77	20.5	222	~250°	~68°F	~250°	Single Point
			2.4	0.90	0.90	83	82	20.5	225				Non-Isokinetic
			2.4	0.90	0.90	83	80	20.5	225				Sampling at
			2.3	0.90	0.90	85	82	20.5	225				target 15 cfm
			2.3	0.90	0.90	85	82	20.5	224				(0.53 dscfm)
			2.4	0.90	0.90	87	84	20.5	224				
	10:00		2.4	0.90	0.90	87	84	20.5	223				Readings over 10 min
			2.3	0.90	0.90	86	84	20.5	223				
			2.4	0.90	0.90	87	84	20.5	222				
			2.2	0.90	0.90	88	84	20.5	224				Filter # 93-Q2713
			2.2	0.90	0.90	88	84	21.0	224				# 93-M256
			2.3	0.90	0.90	89	84	21.0	222				# 93-M257
	11:00		2.3	0.90	0.90	89	85	21.0	221				
			2.3	0.90	0.90	89	85	21.0	222				
			2.4	0.90	0.90	89	86	21.0	223				Estimates:
			2.4	0.90	0.90	89	86	21.0	224				MW = 28.1
			2.4	0.90	0.90	90	88	21.0	224				%H ₂ O = 17.3
			2.4	0.90	0.90	90	88	21.0	224				

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	0.002
After	21.0	0.003

PITOT LEAK CHECK

	Positive	Negative
Before	OK	OK
After	OK	OK

	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Impinger

No.	Contents	Final	Initial	Difference
1.	100 mL D.I. H ₂ O	759.8	520.4	239.4
2.	100 mL D.I. H ₂ O	641.9	523.9	118.0
3.	Empty	474.6	450.2	24.4
4.	200g Silica Gel	682.0	640.5	41.5
5.				

423.39 total
KEYSTONE
 100% Guaranteed to Meet or Exceed All Requirements

STACK SAMPLING DATA SHEET

Page 2 of 2

CLIENT Bottle 1/DOE TEST DATE 6-27-93 (Sun.) ORIFICE CORRECTION 1.886 HOT BOX NO. 1
 TEST UNIT Stack - Hot Side TEST NO. C-66-H-627 METER CORRECTION 0.9837 COLD BOX NO. 1
 PROJECT NO. 73C 028-01 NOZZLE (SIZE, IN) 0.188 CALIBRATION DATE 4-5-93 PROBE NO. 5-1
 CONTROL BOX OPERATOR YH STATIC PRESSURE -1.8" H₂O PITOT CORRECTION 0.84 FILTER NO. HBT #A
 BAROMETRIC PRESSURE 27.76 PORT DIRECTION D CONTROL BOX NO. 1 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pitot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
	12:00		2.3	0.90	0.90	91	89	21.0	224	~250°	468°F	~250°	Simple Point
			2.3	0.90	0.90	91	89	21.0	225				Non-Impinger
			2.4	0.90	0.90	91	89	21.0	225				Sampling at
			2.3	0.90	0.90	92	89	21.0	225				target (15 L/min)
			2.3	0.90	0.90	92	90	21.0	224				(0.53 dscfm)
	↓		2.4	0.90	0.90	92	90	21.0	224				
	13:00	98.7447											Readings every 10 min
	A=	A=	(ΔP) _{avg}	(ΔH) _{avg}	= 0.90	(T _{stack}) _{avg}	= 87°F		(T _{stack}) _{avg}	= 224°F			
	240	129.305	=										Filter #93-Q271
	min	dcf	2.3										#93-M25
													#93-M25
													Estimates:
													MW= 28.1
													%H ₂ O= 17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before		
After		

PITOT LEAK CHECK

	Positive	Negative
Before		
After		
	1	2
CO ₂	12.0	
O ₂	8.0	
CO	0	
N ₂	80.0	

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.				
2.				
3.				
4.				
5.

D-10: Cascade Impactors

Page 7 of 10

[illegible]

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	1.02
After	11.0	0.885

	Positive	Negative
Before	OK	OK
After	OK	OK

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100 mL D.F. H ₂ O	787.2	527.0	260.2
2.	100 mL D.F. H ₂ O	575.3	522.3	53.0
3.	Empty	467.9	455.4	12.5
4.	200g Silica Gel	666.3	637.1	29.2
5.				

354.99 total
KEYSTONE
BANK OF AMERICA

STACK SAMPLING DATA SHEET

Page 1 of 1

CLIENT Battelle DOE TEST DATE 6-23-93 ORIFICE CORRECTION 1.886 HOT BOX NO. 1
 TEST UNIT Stack - Hot Side TEST NO. C-602-IMP-623 METER CORRECTION 0.9837 COLD BOX NO. 1
 PROJECT NO. 93C028-01 NOZZLE (SIZE, #) 0.185 CALIBRATION DATE 4-5-93 PROBE NO. 5-1
 CONTROL BOX OPERATOR TM STATIC PRESSURE -1.8" H₂O PITOT CORRECTION 0.84 FILTER NO. Pilot Set #111
 BAROMETRIC PRESSURE 27.62 PORT DIRECTION D CONTROL BOX NO. 1 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (dcf)	Pilot ΔP (in. H ₂ O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H ₂ O)	Act. (in. H ₂ O)	In (°F)	Out (°F)						
	10:35	410.380	2.4	1.84	1.84	95	92	13.5	245	~250	168°F	~250	Simple Point
			2.4	1.84	1.84	104	94	14.0	246				Isokinetic
			2.4	1.84	1.84	108	96	14.0	246				Sampling for
			2.4	1.84	1.84	111	99	14.0	244				2 hr
			2.2	1.84	1.84	111	98	13.5	245	250	53	250	
			2.2	1.84	1.84	114	100	13.0	247				
	11:35		2.2	1.71	1.71	114	100	13.0	246				
			2.2	1.71	1.71	115	101	13.0	245				
			2.4	1.80	1.80	115	102	13.5	246	250	51	250	
			2.4	1.80	1.80	115	102	13.5	245				
			2.4	1.80	1.80	114	102	13.5	245				
			2.4	1.80	1.80	114	102	13.5	243	250	48	250	
	12:35	498.965											
	A=120 min	A=88.585 dcf	(ΔP) _{AG} =	(ΔH) _{AG} =1.80	(T _{stack}) _{AG} =105°F				(T _{stack}) _{AG} =245°F				Estimates:
			2.3										MW=28.1
													%H ₂ O=17.3
													velocity = 164.0 ft/sec T _{sp} = 95.0%

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DOM Rate (cfm)
Before	5.0	0.004
After	15.5	0.005

PITOT LEAK CHECK

	Positive	Negative
Before	OK	OK
After	OK	OK

CO ₂	12.0	
O ₂	8.0	
CO	6	
N ₂	80.0	

Impinger

No.	Contents	Final	Initial	Difference
1.	100 mL DI. H ₂ O	759.5	537.1	222.4
2.	100 mL DI. H ₂ O	586.0	534.6	51.4
3.	Empty	461.2	450.6	10.6
4.	200 μl Silica Gel	1079.3	647.4	31.9
5.				

2316.39 total
KEYSTONE
 ENVIRONMENTAL DESIGN, INC.

STACK SAMPLING DATA SHEET

Page 1 of 1

CLIENT Bethelle / DWE TEST DATE 6-24-93 ORIFICE CORRECTION 1.876 HOT BOX NO. 1
 TEST UNIT Stack - Hot Side TEST NO. C-62 - IMP-621 METER CORRECTION 0.2837 COLD BOX NO. 1
 PROJECT NO. 93C628-01 NOZZLE (SIZE, #) 0.185 CALIBRATION DATE 4.3.73 PROBE NO. 351
 CONTROL BOX OPERATOR AM STATIC PRESSURE -1.0 PITOT CORRECTION 0.84 FILTER NO. Pt 62 # 11C
 BAROMETRIC PRESSURE 27.70 PORT DIRECTION Atmosphere CONTROL BOX NO. 1 STACK DIA. 25'

Traverse Point (inches)	Time	Dry Gas Meter Reading (scf)	Pitot ΔP (in. H2O)	Orifice ΔH		Meter Temperature		Vacuum (in. Hg)	Stack Temp. (°F)	Probe Temp. (°F)	Impinger Temp. (°C/°F)	Hot Box Temp. (°F)	Comments
				Req'd. (in. H2O)	Act. (in. H2O)	In (°F)	Out (°F)						
1	17:00	049.300	2.0	1.55	1.55	107	109	9.5	240	250	24.5/-	250	Single Point
			1.8	1.40	1.40	106	116	9.5	241				Isokinetic
			1.7	1.36	1.36	109	122	9.0	242				Sampling for
			1.9	1.52	1.52	111	125	9.5	241				Atk (bottom)
			1.8	1.44	1.44	113	127	10.0	243				
			1.9	1.52	1.52	114	129	10.0	244	250		250	
			1.9	1.52	1.52	116	128	10.0	243				
			2.0	1.60	1.60	117	129	10.0	244				
			2.0	1.60	1.60	117	128	10.0	245				
			2.0	1.60	1.60	116	127	10.0	244	250		250	
			2.0	1.60	1.60	114	127	10.5	242				
			2.0	1.60	1.60	115	127	10.5	243				
	18:00	135.529											
Δ = 120 min		Δ = 86.229 scf	ΔP _{ave} = 1.9	ΔH _{avg} = 1.53									Estimates:
													MW = 28.1
													%H2O = 17.3

SYSTEM LEAK CHECK

	Vacuum (in. Hg)	DGM Rate (cfm)
Before	5.0	5.02
After	10.5	1.005

PITOT LEAK CHECK

	Positive	Negative
Before	OK 15 sc	OK 15 sc
After	OK 15 sc	OK 15 sc

	1	2
CO2	12.0	
O2	8.0	
CO	0	
N2	80.0	

Impinger

Impinger No.	Impinger Contents	Final	Initial	Difference
1.	100 mL D.J. H ₂ O	830.2	559.1	271.1
2.	100 mL D.J. H ₂ O	587.7	552.4	35.3
3.	Empty	456.0	450.9	5.1
4.	200g Silica Gel	661.7	641.9	19.8
5.				

Velocity = 94.2 ft/sec

AQE 2092 Iso. = 99.1%

D-11: Flue Gas Sampling Calculation Spreadsheets

These spreadsheets show calculations based on measurements at the primary sampling locations. Note that in these spreadsheets flow rates given in normal cubic meters per minute (NCMM, e.g., page D-231) refer to actual flue gas oxygen conditions. Flow rates normalized to 3 percent O₂ are given in Sections 2 and 3 of this report.

NORTH DAKOTA, ESP INLET RESULTS, LOCATION 4A

RUN NO.	1	2	3
TEST DATE	6/21	6/22	6/23
SAMPLING TIME, 24 HOUR CLOCK	1330	1237	1205
FROM TO	2152	1943	1938
DN SAMPLING NOZZLE DIAMETER, IN.	0.200	0.205	0.205
T NET TIME OF TEST, MIN.	320	315	320
B BAROMETRIC PRESSURE, IN. HG	27.50	27.62	27.67
M AVG. ORIFICE PRESSURE DROP, IN. H2O	1.80	1.50	1.50
M VOLUME OF DRY GAS SAMPLED AT METER CONDITIONS, CF (DRY)	187.9	197.4	184.7
M AVG. GAS METER TEMPERATURE, F	115	107	89
MSTD VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS, NCF (DRY)	145.0	155.1	150.1
W TOTAL H2O COLLECTED IN IMPINGERS AND SILICA GEL, ML	476.0	493.0	786.0
WGAS VOLUME OF H2O VAPOR COLLECTED, NCF	20.9	21.7	34.6
i MOISTURE IN STACK GAS BY VOLUME, PERCENT	12.61	12.26	18.71
ID MOLECULAR FRACTION OF DRY GAS	0.87	0.88	0.81
O2 STACK GAS CO2, VOL PERCENT DRY	15.0	15.0	15.0
O2 STACK GAS O2, VOL PERCENT DRY	5.0	5.0	5.0
O STACK GAS CO, VOL PERCENT DRY	0.0	0.0	0.0
O2 STACK GAS N2, VOL PERCENT DRY	80.0	80.0	80.0
A STACK GAS EXCESS AIR, PERCENT	31.0	31.0	31.0
WD MOLECULAR WEIGHT OF STACK GAS, DRY BASIS	30.6	30.6	30.6
W MOLECULAR WEIGHT OF STACK GAS, WET BASIS	29.0	29.0	28.2
P PITOT TUBE COEFFICIENT	0.85	0.85	0.85
S AVG. STACK TEMPERATURE, F	352	344	334
IP NET SAMPLING POINTS	62	62	64

NORTH DAKOTA, ESP INLET RESULTS, LOCATION 4A

RUN NO. TEST DATE SAMPLING TIME, 24 HOUR CLOCK		1 6/21 1330 2152	2 6/22 1237 1943	3 6/23 1205 1938
PST	STATIC PRESSURE OF STACK GAS, IN. HG.	-1.18	-1.18	-1.18
PS	STACK GAS ABS. PRESSURE, IN. HG	26.32	26.44	26.49
VS	STACK GAS VELOCITY AT STACK CONDITIONS, FPM	4622	4747	4678
AS	STACK AREA, SQ. IN.	45360.	43560.	43560.
QS	STACK GAS VOLUMETRIC FLOW RATE AT NORMAL CONDITIONS, NCFM (DRY)	678517	681172	630762
QA	STACK GAS VOLUMETRIC FLOW RATE AT STACK CONDITIONS, ACFM (WET)	1455908	1435878	1415141
I	ISOKINETIC RATE, PERCENT	96.5	95.4	98.2
MF	PARTICULATE MASS--PROBE, CYCLONE, AND FILTER, MG	0.0	52574.1	0.0
CAN	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/NCF (DRY)	0.000	5.220	0.000
CAT	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/ACF (WET)	0.000	2.476	0.000
CAN3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/NCF (DRY)	0.000	5.877	0.000
CAT3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/ACF (WET)	0.000	2.788	0.000
CAW	PARTICULATE EMISSIONS--PROBE, CYCLONE AND FILTER, LB/HR	0.00	30474.42	0.00

NORTH DAKOTA, ESP INLET RESULTS, LOCATION 4A

RUN NO. TEST DATE	1 6/21	2 6/22	3 6/23
VOLUME OF GAS SAMPLED, NCF (DRY)	145.0	155.1	150.1
MOISTURE FRACTION VOLUME, PERCENT	12.6	12.3	18.7
AVERAGE STACK TEMPERATURE, F	352	344	334
STACK VOLUMETRIC FLOW RATE, NCFM (DRY)	678517	681172	630762
STACK VOLUMETRIC FLOW RATE, ACFM (WET)	1455908	1435878	1415141
SOKINETIC RATE, PERCENT	96.5	95.4	98.2
EXCESS AIR, PERCENT	31.0	31.0	31.0
ARTICULATE MASS - PROBE, CYC, FILTER CATCH, G	0.0	52574.1	0.0
ARTICULATE LOADING, R/NCF AT STACK O2 (DRY)	0.000	5.220	0.000
ARTICULATE LOADING, R/ACF AT STACK O2 (WET)	0.000	2.476	0.000
ARTICULATE LOADING, R/NCF AT 3% O2 (DRY)	0.000	5.877	0.000
ARTICULATE LOADING, R/ACF AT 3% O2 (WET)	0.000	2.788	0.000
ARTICULATE EMISSIONS, LB/HR	0.0	30474.4	0.0

NORTH DAKOTA, ESP INLET RESULTS, LOCATION 4A

RUN NO. TEST DATE	1 6/21	2 6/22	3 6/23
VOLUME OF GAS SAMPLED, NCM	4.11	4.39	4.25
MOISTURE FRACTION VOLUME, PERCENT	12.6	12.3	18.7
AVERAGE STACK TEMPERATURE, C	177	173	167
STACK VOLUMETRIC FLOW RATE, NCMM	19213	19288	17861
STACK VOLUMETRIC FLOW RATE, CMM	41226	40659	40072
ISOKINETIC RATE, PERCENT	96.5	95.4	98.2
EXCESS AIR, PERCENT	31.0	31.0	31.0
PARTICULATE MASS - PROBE,CYC,FILTER CATCH,			
MG	0.0	52574.1	0.0
PARTICULATE LOADING, MG/NCM AT STACK O2 (DRY)	0.0	11946.2	0.0
PARTICULATE LOADING, MG/CM AT STACK O2 (WET)	0.0	5666.9	0.0
PARTICULATE LOADING, MG/NCM AT 3% O2 (DRY)	0.0	13448.9	0.0
PARTICULATE LOADING, MG/CM AT 3% O2 (WET)	0.0	6379.7	0.0
PARTICULATE EMISSIONS, KG/HR	0.0	13823.2	0.0

NORTH DAKOTA, ESP INLET RESULTS, LOCATION 4A

RUN NO. TEST DATE SAMPLING TIME, 24 HOUR CLOCK		4 6/24 1057 1803	5 6/26 940 1710	6 6/27 958 1700
		FROM		
		TO		
ON	SAMPLING NOZZLE DIAMETER, IN.	0.200	0.205	0.247
NT	NET TIME OF TEST, MIN.	320	315	320
PB	BAROMETRIC PRESSURE, IN. HG	27.63	27.70	27.89
PM	AVG. ORIFICE PRESSURE DROP, IN. H2O	1.00	1.00	2.50
PM	VOLUME OF DRY GAS SAMPLED AT METER CONDITIONS, CF (DRY)	179.6	177.0	241.2
PM	AVG. GAS METER TEMPERATURE, F	91	88	85
PMSTD	VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS, NCF (DRY)	145.1	144.1	199.6
W	TOTAL H2O COLLECTED IN IMPINGERS AND SILICA GEL, ML	534.0	580.0	797.0
WGAS	VOLUME OF H2O VAPOR COLLECTED, NCF	23.5	25.5	35.0
	MOISTURE IN STACK GAS BY VOLUME, PERCENT	13.93	15.04	14.94
D	MOLECULAR FRACTION OF DRY GAS	0.86	0.85	0.85
O2	STACK GAS CO2, VOL PERCENT DRY	15.0	15.0	15.0
2	STACK GAS O2, VOL PERCENT DRY	5.0	5.0	5.0
O	STACK GAS CO, VOL PERCENT DRY	0.0	0.0	0.0
2	STACK GAS N2, VOL PERCENT DRY	80.0	80.0	80.0
A	STACK GAS EXCESS AIR, PERCENT	31.0	31.0	31.0
WD	MOLECULAR WEIGHT OF STACK GAS, DRY BASIS	30.6	30.6	30.6
W	MOLECULAR WEIGHT OF STACK GAS, WET BASIS	28.8	28.7	28.7
P	PITOT TUBE COEFFICIENT	0.85	0.85	0.85
S	AVG. STACK TEMPERATURE, F	332	335	334
P	NET SAMPLING POINTS	63	63	64

NORTH DAKOTA, ESP INLET RESULTS, LOCATION 4A

RUN NO. TEST DATE SAMPLING TIME, 24 HOUR CLOCK		4 6/24 1057 1803	5 6/26 940 1710	6 6/27 958 1700
		FROM		
		TO		
PST	STATIC PRESSURE OF STACK GAS, IN. HG.	-1.10	-1.10	-1.10
PS	STACK GAS ABS. PRESSURE, IN. HG	26.53	26.60	26.79
VS	STACK GAS VELOCITY AT STACK CONDITIONS, FPM	4544	4587	4613
AS	STACK AREA, SQ. IN.	45360.	43560.	43560.
QS	STACK GAS VOLUMETRIC FLOW RATE AT NORMAL CONDITIONS, NCFM (DRY)	678221	648342	658272
QA	STACK GAS VOLUMETRIC FLOW RATE AT STACK CONDITIONS, ACFM (WET)	1431211	1387637	1395493
I	ISOKINETIC RATE, PERCENT	96.5	93.1	86.1
MF	PARTICULATE MASS--PROBE, CYCLONE, AND FILTER, MG	46361.5	0.0	56603.8
CAN	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/NCF (DRY)	4.921	0.000	4.368
CAT	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/ACF (WET)	2.332	0.000	2.060
CAN3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/NCF (DRY)	5.540	0.000	4.917
CAT3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/ACF (WET)	2.625	0.000	2.319
CAW	PARTICULATE EMISSIONS--PROBE, CYCLONE AND FILTER, LB/HR	28603.74	0.00	24639.67

NORTH DAKOTA, ESP INLET RESULTS, LOCATION 4A

RUN NO. TEST DATE	4 6/24	5 6/26	6 6/27
VOLUME OF GAS SAMPLED, NCF (DRY)	145.1	144.1	199.6
MOISTURE FRACTION VOLUME, PERCENT	13.9	15.0	14.9
AVERAGE STACK TEMPERATURE, F	332	335	334
STACK VOLUMETRIC FLOW RATE, NCFM (DRY)	678221	648342	658272
STACK VOLUMETRIC FLOW RATE, ACFM (WET)	1431211	1387637	1395493
ISOKINETIC RATE, PERCENT	96.5	93.1	86.1
EXCESS AIR, PERCENT	31.0	31.0	31.0
PARTICULATE MASS - PROBE, CYC, FILTER CATCH,			
MG	46361.5	0.0	56603.8
PARTICULATE LOADING, LB/NCF AT STACK O2 (DRY)	4.921	0.000	4.368
PARTICULATE LOADING, LB/ACF AT STACK O2 (WET)	2.332	0.000	2.060
PARTICULATE LOADING, LB/NCF AT 3% O2 (DRY)	5.540	0.000	4.917
PARTICULATE LOADING, LB/ACF AT 3% O2 (WET)	2.625	0.000	2.319
PARTICULATE EMISSIONS, LB/HR	28603.7	0.0	24639.7

NORTH DAKOTA, ESP INLET RESULTS, LOCATION 4A

RUN NO.	4	5	6
TEST DATE	6/24	6/26	6/27
VOLUME OF GAS SAMPLED, NCM	4.11	4.08	5.65
MOISTURE FRACTION VOLUME, PERCENT	13.9	15.0	14.9
AVERAGE STACK TEMPERATURE, C	166	168	167
STACK VOLUMETRIC FLOW RATE, NCMM	19205	18359	18640
STACK VOLUMETRIC FLOW RATE, CMM	40527	39293	39516
ISOKINETIC RATE, PERCENT	96.5	93.1	86.1
EXCESS AIR, PERCENT	31.0	31.0	31.0
PARTICULATE MASS - PROBE,CYC,FILTER CATCH,			
MG	46361.5	0.0	56603.8
PARTICULATE LOADING, MG/NCM AT STACK O2 (DRY)	11261.7	0.0	9995.0
PARTICULATE LOADING, MG/CM AT STACK O2 (WET)	5336.4	0.0	4714.5
PARTICULATE LOADING, MG/NCM AT 3% O2 (DRY)	12678.2	0.0	11252.2
PARTICULATE LOADING, MG/CM AT 3% O2 (WET)	6007.6	0.0	5307.5
PARTICULATE EMISSIONS, KG/HR	12974.7	0.0	11176.6

NORTH DAKOTA, ESP INLET RESULTS, LOCATION 4B, METHOD 5

RUN NO. TEST DATE SAMPLING TIME, 24 HOUR CLOCK		1 6/21 1409 2019	2 6/23 1257 1723	3 6/26 1134 1537
ON	SAMPLING NOZZLE DIAMETER, IN.	0.181	0.183	0.183
OT	NET TIME OF TEST, MIN.	192	192	192
PB	BAROMETRIC PRESSURE, IN. HG	27.70	27.60	27.70
PM	AVG. ORIFICE PRESSURE DROP, IN. H2O	0.81	0.73	0.75
PM	VOLUME OF DRY GAS SAMPLED AT METER CONDITIONS, CF (DRY)	91.7	93.3	95.9
PM	AVG. GAS METER TEMPERATURE, F	122	97	95
PMSTD	VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS, NCF (DRY)	70.7	74.9	77.6
PMW	TOTAL H2O COLLECTED IN IMPINGERS AND SILICA GEL, ML	289.9	282.8	308.2
PMWGAS	VOLUME OF H2O VAPOR COLLECTED, NCF	12.7	12.4	13.6
PM	MOISTURE IN STACK GAS BY VOLUME, PERCENT	15.27	14.24	14.87
PMID	MOLECULAR FRACTION OF DRY GAS	0.85	0.86	0.85
PMO2	STACK GAS CO2, VOL PERCENT DRY	14.0	14.0	13.1
PMO2	STACK GAS O2, VOL PERCENT DRY	6.0	6.0	7.0
PMCO	STACK GAS CO, VOL PERCENT DRY	0.0	0.0	0.0
PMN2	STACK GAS N2, VOL PERCENT DRY	80.0	80.0	79.9
PMXA	STACK GAS EXCESS AIR, PERCENT	39.7	39.7	49.6
PMWD	MOLECULAR WEIGHT OF STACK GAS, DRY BASIS	30.5	30.5	30.4
PMW	MOLECULAR WEIGHT OF STACK GAS, WET BASIS	28.6	28.7	28.5
PMPT	PITOT TUBE COEFFICIENT	0.84	0.84	0.84
PMST	AVG. STACK TEMPERATURE, F	355	342	339
PMNP	NET SAMPLING POINTS	6	6	6

NORTH DAKOTA, ESP INLET RESULTS, LOCATION 4B, METHOD 5

RUN NO.		1	2	3
TEST DATE		6/21	6/23	6/26
SAMPLING TIME, 24 HOUR CLOCK	FROM	1409	1257	1134
	TO	2019	1723	1537
PST	STATIC PRESSURE OF STACK GAS, IN. HG.	-1.18	-1.18	-1.18
PS	STACK GAS ABS. PRESSURE, IN. HG	26.52	26.42	26.52
VS	STACK GAS VELOCITY AT STACK CONDITIONS, FPM	5105	4902	4898
AS	STACK AREA, SQ. IN.	45360.	45360.	45360.
QS	STACK GAS VOLUMETRIC FLOW RATE AT NORMAL CONDITIONS, NCFM (DRY)	729593	717868	717419
QA	STACK GAS VOLUMETRIC FLOW RATE AT STACK CONDITIONS, ACFM (WET)	1608039	1543993	1542838
I	ISOKINETIC RATE, PERCENT	89.0	93.7	97.1
MF	PARTICULATE MASS--PROBE, CYCLONE, AND FILTER, MG	12694.3	16779.2	13587.8
CAN	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/NCF (DRY)	2.764	3.450	2.697
CAT	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/ACF (WET)	1.254	1.604	1.254
CAN3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/NCF (DRY)	3.321	4.145	3.474
CAT3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/ACF (WET)	1.507	1.927	1.615
CAW	PARTICULATE EMISSIONS--PROBE, CYCLONE AND FILTER, LB/HR	17285.31	21225.43	16584.70

NORTH DAKOTA, ESP INLET RESULTS, LOCATION 4B, METHOD 5

RUN NO. TEST DATE	1 6/21	2 6/23	3 6/26
VOLUME OF GAS SAMPLED, NCF (DRY)	70.7	74.9	77.6
DISTURBANCE FRACTION VOLUME, PERCENT	15.3	14.2	14.9
AVERAGE STACK TEMPERATURE, F	355	342	339
STACK VOLUMETRIC FLOW RATE, NCFM (DRY)	729593	717868	717419
STACK VOLUMETRIC FLOW RATE, ACFM (WET)	1608039	1543993	1542838
DECOMPOSITION RATE, PERCENT	89.0	93.7	97.1
EXCESS AIR, PERCENT	39.7	39.7	49.6
PARTICULATE MASS - PROBE, CYC, FILTER CATCH,			
:	12694.3	16779.2	13587.8
PARTICULATE LOADING, LB/NCF AT STACK O2 (DRY)	2.764	3.450	2.697
PARTICULATE LOADING, LB/ACF AT STACK O2 (WET)	1.254	1.604	1.254
PARTICULATE LOADING, LB/NCF AT 3% O2 (DRY)	3.321	4.145	3.474
PARTICULATE LOADING, LB/ACF AT 3% O2 (WET)	1.507	1.927	1.615
PARTICULATE EMISSIONS, LB/HR	17285.3	21225.4	16584.7

NORTH DAKOTA, ESP INLET RESULTS, LOCATION 4B, METHOD 5

RUN NO. TEST DATE	1 6/21	2 6/23	3 6/26
VOLUME OF GAS SAMPLED, NCM	2.00	2.12	2.20
MOISTURE FRACTION VOLUME, PERCENT	15.3	14.2	14.9
AVERAGE STACK TEMPERATURE, C	179	172	170
STACK VOLUMETRIC FLOW RATE, NCMM	20659	20327	20315
STACK VOLUMETRIC FLOW RATE, CMM	45534	43721	43688
ISOKINETIC RATE, PERCENT	89.0	93.7	97.1
EXCESS AIR, PERCENT	39.7	39.7	49.6
PARTICULATE MASS - PROBE,CYC,FILTER CATCH,			
MG	12694.3	16779.2	13587.8
PARTICULATE LOADING, MG/NCM AT STACK O2 (DRY)	6326.3	7895.2	6172.9
PARTICULATE LOADING, MG/CM AT STACK O2 (WET)	2870.2	3670.6	2870.2
PARTICULATE LOADING, MG/NCM AT 3% O2 (DRY)	7600.0	9484.8	7949.2
PARTICULATE LOADING, MG/CM AT 3% O2 (WET)	3448.0	4409.6	3696.2
PARTICULATE EMISSIONS, KG/HR	7840.6	9627.9	7522.8

ORTH DAKOTA, ESP OUTLET RESULTS, LOCATION 5A

RUN NO. TEST DATE SAMPLING TIME, 24 HOUR CLOCK		1 6/21 1450 2124	2 6/22 1450 2136	3 6/23 1256 1939
	FROM TO			
N	SAMPLING NOZZLE DIAMETER, IN.	0.240	0.247	0.247
T	NET TIME OF TEST, MIN.	360	360	360
B	BAROMETRIC PRESSURE, IN. HG	27.50	27.48	27.67
M	AVG. ORIFICE PRESSURE DROP, IN. H2O	1.80	2.00	2.00
M	VOLUME OF DRY GAS SAMPLED AT METER CONDITIONS, CF (DRY)	357.5	250.8	253.3
M	AVG. GAS METER TEMPERATURE, F	131	99	95
MSTD	VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS, NCF (DRY)	274.9	203.9	208.7
W	TOTAL H2O COLLECTED IN IMPINGERS AND SILICA GEL, ML	922.0	872.0	921.0
WGAS	VOLUME OF H2O VAPOR COLLECTED, NCF	40.5	38.3	40.5
	MOISTURE IN STACK GAS BY VOLUME, PERCENT	12.85	15.83	16.25
D	MOLECULAR FRACTION OF DRY GAS	0.87	0.84	0.84
O2	STACK GAS CO2, VOL PERCENT DRY	15.0	15.0	15.0
O2	STACK GAS O2, VOL PERCENT DRY	5.0	5.0	5.0
CO	STACK GAS CO, VOL PERCENT DRY	0.0	0.0	0.0
N2	STACK GAS N2, VOL PERCENT DRY	80.0	80.0	80.0
A	STACK GAS EXCESS AIR, PERCENT	31.0	31.0	31.0
WD	MOLECULAR WEIGHT OF STACK GAS, DRY BASIS	30.6	30.6	30.6
W	MOLECULAR WEIGHT OF STACK GAS, WET BASIS	29.0	28.6	28.5
P	PITOT TUBE COEFFICIENT	0.85	0.85	0.85
S	AVG. STACK TEMPERATURE, F	347	349	341
P	NET SAMPLING POINTS	48	72	72

NORTH DAKOTA, ESP OUTLET RESULTS, LOCATION 5A

RUN NO.		1	2	3
TEST DATE		6/21	6/22	6/23
SAMPLING TIME, 24 HOUR CLOCK	FROM TO	1450	1450	1256
		2124	2136	1939
PST	STATIC PRESSURE OF STACK GAS, IN. HG.	0.50	0.50	0.50
PS	STACK GAS ABS. PRESSURE, IN. HG	28.00	27.98	28.17
VS	STACK GAS VELOCITY AT STACK CONDITIONS, FPM	3308	3364	3243
AS	STACK AREA, SQ. IN.	54912.	54912.	54912.
QS	STACK GAS VOLUMETRIC FLOW RATE AT NORMAL CONDITIONS, NCFM (DRY)	626922	614082	598909
QA	STACK GAS VOLUMETRIC FLOW RATE AT STACK CONDITIONS, ACFM (WET)	1261449	1282798	1236596
I	ISOKINETIC RATE, PERCENT	147.9	105.7	111.0
MF	PARTICULATE MASS--PROBE, CYCLONE, AND FILTER, MG	0.0	203.5	0.0
CAN	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/NCF (DRY)	0.000	0.015	0.000
CAT	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/ACF (WET)	0.000	0.007	0.000
CAN3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/NCF (DRY)	0.000	0.017	0.000
CAT3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/ACF (WET)	0.000	0.008	0.000
CAW	PARTICULATE EMISSIONS--PROBE, CYCLONE AND FILTER, LB/HR	0.00	80.90	0.00

ORTH DAKOTA, ESP OUTLET RESULTS, LOCATION 5A

RUN NO. TEST DATE	1 6/21	2 6/22	3 6/23
OLUME OF GAS SAMPLED, NCF (DRY)	274.9	203.9	208.7
OISTURE FRACTION VOLUME, PERCENT	12.9	15.8	16.2
VERAGE STACK TEMPERATURE, F	347	349	341
ACK VOLUMETRIC FLOW RATE, NCFM (DRY)	626922	614082	598909
ACK VOLUMETRIC FLOW RATE, ACFM (WET)	1261449	1282798	1236596
SOKINETIC RATE, PERCENT	147.9	105.7	111.0
XCESS AIR, PERCENT	31.0	31.0	31.0
ARTICULATE MASS - PROBE,CYC,FILTER CATCH, G	0.0	203.5	0.0
ARTICULATE LOADING, R/NCF AT STACK O2 (DRY)	0.000	0.015	0.000
ARTICULATE LOADING, R/ACF AT STACK O2 (WET)	0.000	0.007	0.000
ARTICULATE LOADING, R/NCF AT 3% O2 (DRY)	0.000	0.017	0.000
ARTICULATE LOADING, R/ACF AT 3% O2 (WET)	0.000	0.008	0.000
ARTICULATE EMISSIONS, LB/HR	0.0	80.9	0.0

NORTH DAKOTA, ESP OUTLET RESULTS, LOCATION 5A

RUN NO. TEST DATE	1 6/21	2 6/22	3 6/23
VOLUME OF GAS SAMPLED, NCM	7.78	5.77	5.91
MOISTURE FRACTION VOLUME, PERCENT	12.9	15.8	16.2
AVERAGE STACK TEMPERATURE, C	175	176	171
STACK VOLUMETRIC FLOW RATE, NCMM	17752	17388	16959
STACK VOLUMETRIC FLOW RATE, CMM	35720	36324	35016
ISOKINETIC RATE, PERCENT	147.9	105.7	111.0
EXCESS AIR, PERCENT	31.0	31.0	31.0
PARTICULATE MASS - PROBE,CYC,FILTER CATCH,			
MG	0.0	203.5	0.0
PARTICULATE LOADING, MG/NCM AT STACK O2 (DRY)	0.0	35.2	0.0
PARTICULATE LOADING, MG/CM AT STACK O2 (WET)	0.0	16.8	0.0
PARTICULATE LOADING, MG/NCM AT 3% O2 (DRY)	0.0	39.6	0.0
PARTICULATE LOADING, MG/CM AT 3% O2 (WET)	0.0	19.0	0.0
PARTICULATE EMISSIONS, KG/HR	0.0	36.7	0.0

ORTH DAKOTA, ESP OUTLET RESULTS, LOCATION 5A

RUN NO.		4	5	6
TEST DATE		6/24	6/26	6/27
SAMPLING TIME, 24 HOUR CLOCK	FROM	1029	935	945
	TO	1720	1609	1610
N	SAMPLING NOZZLE DIAMETER, IN.	0.247	0.240	0.247
T	NET TIME OF TEST, MIN.	360	360	360
B	BAROMETRIC PRESSURE, IN. HG	27.63	27.87	27.85
M	AVG. ORIFICE PRESSURE DROP, IN. H2O	1.50	1.80	1.50
M	VOLUME OF DRY GAS SAMPLED AT METER CONDITIONS, CF (DRY)	240.9	264.9	273.9
M	AVG. GAS METER TEMPERATURE, F	66	78	90
MSTD	VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS, NCF (DRY)	208.9	226.7	229.0
M	TOTAL H2O COLLECTED IN IMPINGERS AND SILICA GEL, ML	789.0	946.0	877.0
MGAS	VOLUME OF H2O VAPOR COLLECTED, NCF	34.7	41.6	38.6
	MOISTURE IN STACK GAS BY VOLUME, PERCENT	14.24	15.50	14.41
M	MOLECULAR FRACTION OF DRY GAS	0.86	0.84	0.86
M2	STACK GAS CO2, VOL PERCENT DRY	15.0	15.0	15.0
M	STACK GAS O2, VOL PERCENT DRY	5.0	5.0	5.0
M	STACK GAS CO, VOL PERCENT DRY	0.0	0.0	0.0
M	STACK GAS N2, VOL PERCENT DRY	80.0	80.0	80.0
M	STACK GAS EXCESS AIR, PERCENT	31.0	31.0	31.0
MND	MOLECULAR WEIGHT OF STACK GAS, DRY BASIS	30.6	30.6	30.6
M	MOLECULAR WEIGHT OF STACK GAS, WET BASIS	28.8	28.6	28.8
M	PITOT TUBE COEFFICIENT	0.85	0.85	0.85
M	AVG. STACK TEMPERATURE, F	338	338	339
M	NET SAMPLING POINTS	70	72	73

NORTH DAKOTA, ESP OUTLET RESULTS, LOCATION 5A

RUN NO.		4	5	6
TEST DATE		6/24	6/26	6/27
SAMPLING TIME, 24 HOUR CLOCK	FROM	1029	935	945
	TO	1720	1609	1610
PST	STATIC PRESSURE OF STACK GAS, IN. HG.	0.50	0.50	0.50
PS	STACK GAS ABS. PRESSURE, IN. HG	28.13	28.37	28.35
VS	STACK GAS VELOCITY AT STACK CONDITIONS, FPM	3255	3560	3518
AS	STACK AREA, SQ. IN.	54912.	54912.	54912.
QS	STACK GAS VOLUMETRIC FLOW RATE AT NORMAL CONDITIONS, NCFM (DRY)	617272	671018	669862
QA	STACK GAS VOLUMETRIC FLOW RATE AT STACK CONDITIONS, ACFM (WET)	1241057	1357681	1341515
I	ISOKINETIC RATE, PERCENT	107.7	113.9	108.8
MF	PARTICULATE MASS--PROBE, CYCLONE, AND FILTER, MG	90.5	0.0	58.6
CAN	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/NCF (DRY)	0.007	0.000	0.004
CAT	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/ACF (WET)	0.003	0.000	0.002
CAN3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/NCF (DRY)	0.008	0.000	0.004
CAT3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/ACF (WET)	0.004	0.000	0.002
CAW	PARTICULATE EMISSIONS--PROBE, CYCLONE AND FILTER, LB/HR	35.29	0.00	22.63

ORTH DAKOTA, ESP OUTLET RESULTS, LOCATION 5A

RUN NO. TEST DATE	4 6/24	5 6/26	6 6/27
VOLUME OF GAS SAMPLED, NCF (DRY)	208.9	226.7	229.0
DISTURE FRACTION VOLUME, PERCENT	14.2	15.5	14.4
AVERAGE STACK TEMPERATURE, F	338	338	339
STACK VOLUMETRIC FLOW RATE, NCFM (DRY)	617272	671018	669862
STACK VOLUMETRIC FLOW RATE, ACFM (WET)	1241057	1357681	1341515
OKINETIC RATE, PERCENT	107.7	113.9	108.8
XCESS AIR, PERCENT	31.0	31.0	31.0
ARTICULATE MASS - PROBE,CYC,FILTER CATCH, g	90.5	0.0	58.6
ARTICULATE LOADING, g/NCF AT STACK O2 (DRY)	0.007	0.000	0.004
ARTICULATE LOADING, g/ACF AT STACK O2 (WET)	0.003	0.000	0.002
ARTICULATE LOADING, g/NCF AT 3% O2 (DRY)	0.008	0.000	0.004
ARTICULATE LOADING, g/ACF AT 3% O2 (WET)	0.004	0.000	0.002
ARTICULATE EMISSIONS, LB/HR	35.3	0.0	22.6

NORTH DAKOTA, ESP OUTLET RESULTS, LOCATION 5A

RUN NO. TEST DATE	4 6/24	5 6/26	6 6/27
VOLUME OF GAS SAMPLED, NCM	5.92	6.42	6.48
MOISTURE FRACTION VOLUME, PERCENT	14.2	15.5	14.4
AVERAGE STACK TEMPERATURE, C	170	170	170
STACK VOLUMETRIC FLOW RATE, NCMM	17479	19001	18968
STACK VOLUMETRIC FLOW RATE, CMM	35143	38445	37987
ISOKINETIC RATE, PERCENT	107.7	113.9	108.8
EXCESS AIR, PERCENT	31.0	31.0	31.0
PARTICULATE MASS - PROBE,CYC,FILTER CATCH, MG	90.5	0.0	58.6
PARTICULATE LOADING, MG/NCM AT STACK O2 (DRY)	15.3	0.0	9.0
PARTICULATE LOADING, MG/CM AT STACK O2 (WET)	7.6	0.0	4.5
PARTICULATE LOADING, MG/NCM AT 3% O2 (DRY)	17.2	0.0	10.2
PARTICULATE LOADING, MG/CM AT 3% O2 (WET)	8.5	0.0	5.1
PARTICULATE EMISSIONS, KG/HR	16.0	0.0	10.3

ORTH DAKOTA, ESP OUTLET RESULTS, LOCATION 5B, METHOD 5

RUN NO. TEST DATE SAMPLING TIME, 24 HOUR CLOCK	FROM TO	1	2	3
		6/22 1506 1915	6/24 1309 1621	6/27 1048 1513
✓ SAMPLING NOZZLE DIAMETER, IN.		0.247	0.247	0.247
✓ NET TIME OF TEST, MIN.		192	168	192
✓ BAROMETRIC PRESSURE, IN. HG		27.48	27.54	27.76
✓ AVG. ORIFICE PRESSURE DROP, IN. H ₂ O		1.47	1.43	1.43
✓ VOLUME OF DRY GAS SAMPLED AT METER CONDITIONS, CF (DRY)		120.5	101.2	119.4
✓ AVG. GAS METER TEMPERATURE, F		105	79	91
✓ STD VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS, NCF (DRY)		97.4	85.9	99.9
✓ TOTAL H ₂ O COLLECTED IN IMPINGERS AND SILICA GEL, ML		496.7	337.6	387.8
✓ GAS VOLUME OF H ₂ O VAPOR COLLECTED, NCF		21.8	14.8	17.1
MOISTURE IN STACK GAS BY VOLUME, PERCENT		18.32	14.73	14.58
✓ MOLECULAR FRACTION OF DRY GAS		0.82	0.85	0.85
✓ O ₂ STACK GAS CO ₂ , VOL PERCENT DRY		12.0	12.0	13.0
✓ O ₂ STACK GAS O ₂ , VOL PERCENT DRY		7.0	7.0	8.5
✓ O ₂ STACK GAS CO, VOL PERCENT DRY		0.0	0.0	0.0
✓ O ₂ STACK GAS N ₂ , VOL PERCENT DRY		81.0	81.0	78.5
✓ A STACK GAS EXCESS AIR, PERCENT		48.7	48.7	69.5
✓ WD MOLECULAR WEIGHT OF STACK GAS, DRY BASIS		30.2	30.2	30.4
✓ W MOLECULAR WEIGHT OF STACK GAS, WET BASIS		28.0	28.4	28.6
✓ P PITOT TUBE COEFFICIENT		0.84	0.84	0.84
✓ S AVG. STACK TEMPERATURE, F		366	349	347
✓ P NET SAMPLING POINTS		64	56	64

NORTH DAKOTA, ESP OUTLET RESULTS, LOCATION 5B, METHOD 5

RUN NO.		1	2	3
TEST DATE		6/22	6/24	6/27
SAMPLING TIME, 24 HOUR CLOCK	FROM	1506	1309	1048
	TO	1915	1621	1513
PST	STATIC PRESSURE OF STACK GAS, IN. HG.	1.18	1.18	1.18
PS	STACK GAS ABS. PRESSURE, IN. HG	28.66	28.72	28.94
VS	STACK GAS VELOCITY AT STACK CONDITIONS, FPM	3601	3555	3476
AS	STACK AREA, SQ. IN.	54912.	54912.	54912.
QS	STACK GAS VOLUMETRIC FLOW RATE AT NORMAL CONDITIONS, NCFM (DRY)	640037	675042	667829
QA	STACK GAS VOLUMETRIC FLOW RATE AT STACK CONDITIONS, ACFM (WET)	1373291	1355623	1325394
I	ISOKINETIC RATE, PERCENT	90.8	86.8	89.3
MF	PARTICULATE MASS--PROBE, CYCLONE, AND FILTER, MG	90.5	39.5	81.1
CAN	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/NCF (DRY)	0.014	0.007	0.012
CAT	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/ACF (WET)	0.007	0.004	0.006
CAN3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/NCF (DRY)	0.018	0.009	0.018
CAT3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/ACF (WET)	0.009	0.005	0.009
CAW	PARTICULATE EMISSIONS--PROBE, CYCLONE AND FILTER, LB/HR	78.49	40.97	71.53

ORTH DAKOTA, ESP OUTLET RESULTS, LOCATION 5B, METHOD 5

RUN NO. TEST DATE	1 6/22	2 6/24	3 6/27
VOLUME OF GAS SAMPLED, NCF (DRY)	97.4	85.9	99.9
MOISTURE FRACTION VOLUME, PERCENT	18.3	14.7	14.6
AVERAGE STACK TEMPERATURE, F	366	349	347
STACK VOLUMETRIC FLOW RATE, NCFM (DRY)	640037	675042	667829
STACK VOLUMETRIC FLOW RATE, ACFM (WET)	1373291	1355623	1325394
OXIDATION RATE, PERCENT	90.8	86.8	89.3
EXCESS AIR, PERCENT	48.7	48.7	69.5
ARTICULATE MASS - PROBE, CYC, FILTER CATCH, g	90.5	39.5	81.1
ARTICULATE LOADING, g/NCF AT STACK O2 (DRY)	0.014	0.007	0.012
ARTICULATE LOADING, g/ACF AT STACK O2 (WET)	0.007	0.004	0.006
ARTICULATE LOADING, g/NCF AT 3% O2 (DRY)	0.018	0.009	0.018
ARTICULATE LOADING, g/ACF AT 3% O2 (WET)	0.009	0.005	0.009
ARTICULATE EMISSIONS, LB/HR	78.5	41.0	71.5

NORTH DAKOTA, ESP OUTLET RESULTS, LOCATION 5B, METHOD 5

RUN NO. TEST DATE	1 6/22	2 6/24	3 6/27
VOLUME OF GAS SAMPLED, NCM	2.76	2.43	2.83
MOISTURE FRACTION VOLUME, PERCENT	18.3	14.7	14.6
AVERAGE STACK TEMPERATURE, C	185	176	175
STACK VOLUMETRIC FLOW RATE, NCMM	18123	19115	18910
STACK VOLUMETRIC FLOW RATE, CMM	38887	38387	37531
ISOKINETIC RATE, PERCENT	90.8	86.8	89.3
EXCESS AIR, PERCENT	48.7	48.7	69.5
PARTICULATE MASS - PROBE, CYC, FILTER CATCH, MG	90.5	39.5	81.1
PARTICULATE LOADING, MG/NCM AT STACK O2 (DRY)	32.7	16.2	28.6
PARTICULATE LOADING, MG/CM AT STACK O2 (WET)	15.3	8.1	14.4
PARTICULATE LOADING, MG/NCM AT 3% O2 (DRY)	42.2	20.9	41.3
PARTICULATE LOADING, MG/CM AT 3% O2 (WET)	19.7	10.4	20.8
PARTICULATE EMISSIONS, KG/HR	35.6	18.6	32.4

ORTH DAKOTA, STACK, LOCATION 6A, METHOD 5

RUN NO. TEST DATE SAMPLING TIME, 24 HOUR CLOCK		1 6/21 1042 1758	2 6/23 1033 1808	3 6/26 900 1617
	FROM TO			
N	SAMPLING NOZZLE DIAMETER, IN.	0.187	0.192	0.192
I	NET TIME OF TEST, MIN.	360	360	360
3	BAROMETRIC PRESSURE, IN. HG	27.70	27.62	27.70
4	AVG. ORIFICE PRESSURE DROP, IN. H2O	1.51	1.57	1.50
4	VOLUME OF DRY GAS SAMPLED AT METER CONDITIONS, CF (DRY)	263.9	266.9	262.9
4	AVG. GAS METER TEMPERATURE, F	114	103	91
4STD	VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS, NCF (DRY)	208.4	214.5	216.3
4	TOTAL H2O COLLECTED IN IMPINGERS AND SILICA GEL, ML	982.1	883.4	973.5
4GAS	VOLUME OF H2O VAPOR COLLECTED, NCF	43.2	38.8	42.8
	MOISTURE IN STACK GAS BY VOLUME, PERCENT	17.17	15.33	16.52
0	MOLECULAR FRACTION OF DRY GAS	0.83	0.85	0.83
02	STACK GAS CO2, VOL PERCENT DRY	13.1	12.1	12.1
2	STACK GAS O2, VOL PERCENT DRY	7.0	8.0	8.0
0	STACK GAS CO, VOL PERCENT DRY	0.0	0.0	0.0
2	STACK GAS N2, VOL PERCENT DRY	79.9	79.9	79.9
1	STACK GAS EXCESS AIR, PERCENT	49.6	61.1	61.1
4D	MOLECULAR WEIGHT OF STACK GAS, DRY BASIS	30.4	30.3	30.3
4	MOLECULAR WEIGHT OF STACK GAS, WET BASIS	28.2	28.4	28.2
0	PITOT TUBE COEFFICIENT	0.84	0.84	0.84
3	AVG. STACK TEMPERATURE, F	240	252	228
0	NET SAMPLING POINTS	4	4	4

NORTH DAKOTA, STACK, LOCATION 6A, METHOD 5

RUN NO.		1	2	3
TEST DATE		6/21	6/23	6/26
SAMPLING TIME, 24 HOUR CLOCK	FROM	1042	1033	900
	TO	1758	1808	1617
PST	STATIC PRESSURE OF STACK GAS, IN. HG.	-0.09	-0.12	-0.13
PS	STACK GAS ABS. PRESSURE, IN. HG	27.61	27.50	27.57
VS	STACK GAS VELOCITY AT STACK CONDITIONS, FPM	5841	5814	5504
AS	STACK AREA, SQ. IN.	69104.	69104.	69104.
QS	STACK GAS VOLUMETRIC FLOW RATE AT NORMAL CONDITIONS, NCFM (DRY)	1506740	1500526	1454088
QA	STACK GAS VOLUMETRIC FLOW RATE AT STACK CONDITIONS, ACFM (WET)	2803161	2790114	2641277
I	ISOKINETIC RATE, PERCENT	96.7	94.8	98.6
MF	PARTICULATE MASS--PROBE, CYCLONE, AND FILTER, MG	0.0	0.0	0.0
CAN	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/NCF (DRY)	0.000	0.000	0.000
CAT	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/ACF (WET)	0.000	0.000	0.000
CAN3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/NCF (DRY)	0.000	0.000	0.000
CAT3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/ACF (WET)	0.000	0.000	0.000
CAW	PARTICULATE EMISSIONS--PROBE, CYCLONE AND FILTER, LB/HR	0.00	0.00	0.00

ORTH DAKOTA, STACK, LOCATION 6A, METHOD 5

RUN NO. TEST DATE	1 6/21	2 6/23	3 6/26
VOLUME OF GAS SAMPLED, NCF (DRY)	208.4	214.5	216.3
MOISTURE FRACTION VOLUME, PERCENT	17.2	15.3	16.5
AVERAGE STACK TEMPERATURE, F	240	252	228
STACK VOLUMETRIC FLOW RATE, NCFM (DRY)	1506740	1500526	1454088
STACK VOLUMETRIC FLOW RATE, ACFM (WET)	2803161	2790114	2641277
ISOKINETIC RATE, PERCENT	96.7	94.8	98.6
EXCESS AIR, PERCENT	49.6	61.1	61.1
ARTICULATE MASS - PROBE, CYC, FILTER CATCH, G	0.0	0.0	0.0
ARTICULATE LOADING, R/NCF AT STACK O2 (DRY)	0.000	0.000	0.000
ARTICULATE LOADING, R/ACF AT STACK O2 (WET)	0.000	0.000	0.000
ARTICULATE LOADING, R/NCF AT 3% O2 (DRY)	0.000	0.000	0.000
ARTICULATE LOADING, R/ACF AT 3% O2 (WET)	0.000	0.000	0.000
ARTICULATE EMISSIONS, LB/HR	0.0	0.0	0.0

NORTH DAKOTA, STACK, LOCATION 6A, METHOD 5

RUN NO. TEST DATE	1 6/21	2 6/23	3 6/26
VOLUME OF GAS SAMPLED, NCM	5.90	6.07	6.13
MOISTURE FRACTION VOLUME, PERCENT	17.2	15.3	16.5
AVERAGE STACK TEMPERATURE, C	115	122	108
STACK VOLUMETRIC FLOW RATE, NCMM	42666	42490	41175
STACK VOLUMETRIC FLOW RATE, CMM	79377	79007	74793
ISOKINETIC RATE, PERCENT	96.7	94.8	98.6
EXCESS AIR, PERCENT	49.6	61.1	61.1
PARTICULATE MASS - PROBE,CYC,FILTER CATCH, MG	0.0	0.0	0.0
PARTICULATE LOADING, MG/NCM AT STACK O2 (DRY)	0.0	0.0	0.0
PARTICULATE LOADING, MG/CM AT STACK O2 (WET)	0.0	0.0	0.0
PARTICULATE LOADING, MG/NCM AT 3% O2 (DRY)	0.0	0.0	0.0
PARTICULATE LOADING, MG/CM AT 3% O2 (WET)	0.0	0.0	0.0
PARTICULATE EMISSIONS, KG/HR	0.0	0.0	0.0

ORTH DAKOTA, STACK, LOCATION 6A, MULTI-METALS

	RUN NO. TEST DATE SAMPLING TIME, 24 HOUR CLOCK	FROM TO	1 6/22 1000 1653	2 6/24 1009 1740	3 6/27 902 1611
N	SAMPLING NOZZLE DIAMETER, IN.		0.187	0.193	0.193
T	NET TIME OF TEST, MIN.		360	360	360
B	BAROMETRIC PRESSURE, IN. HG		27.54	27.54	27.76
M	AVG. ORIFICE PRESSURE DROP, IN. H2O		1.47	1.64	1.57
M	VOLUME OF DRY GAS SAMPLED AT METER CONDITIONS, CF (DRY)		259.6	269.6	268.6
M	AVG. GAS METER TEMPERATURE, F		111	91	93
MSTD	VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS, NCF (DRY)		204.9	220.6	220.7
W	TOTAL H2O COLLECTED IN IMPINGERS AND SILICA GEL, ML		955.9	1022.0	1034.2
WGAS	VOLUME OF H2O VAPOR COLLECTED, NCF		42.0	44.9	45.5
	MOISTURE IN STACK GAS BY VOLUME, PERCENT		17.02	16.92	17.08
O	MOLECULAR FRACTION OF DRY GAS		0.83	0.83	0.83
O2	STACK GAS CO2, VOL PERCENT DRY		12.1	12.1	12.1
O2	STACK GAS O2, VOL PERCENT DRY		8.0	8.0	8.0
CO	STACK GAS CO, VOL PERCENT DRY		0.0	0.0	0.0
N2	STACK GAS N2, VOL PERCENT DRY		79.9	79.9	79.9
AIR	STACK GAS EXCESS AIR, PERCENT		61.1	61.1	61.1
MD	MOLECULAR WEIGHT OF STACK GAS, DRY BASIS		30.3	30.3	30.3
MD	MOLECULAR WEIGHT OF STACK GAS, WET BASIS		28.2	28.2	28.2
P	PITOT TUBE COEFFICIENT		0.84	0.84	0.84
T	AVG. STACK TEMPERATURE, F		251	232	226
P	NET SAMPLING POINTS		4	4	4

NORTH DAKOTA, STACK, LOCATION 6A, MULTI-METALS

RUN NO.		1	2	3
TEST DATE		6/22	6/24	6/27
SAMPLING TIME, 24 HOUR CLOCK	FROM	1000	1009	902
	TO	1653	1740	1611
PST	STATIC PRESSURE OF STACK GAS, IN. HG.	-0.12	-0.15	-0.11
PS	STACK GAS ABS. PRESSURE, IN. HG	27.42	27.39	27.65
VS	STACK GAS VELOCITY AT STACK CONDITIONS, FPM	5950	5791	5603
AS	STACK AREA, SQ. IN.	69104.	69104.	69104.
QS	STACK GAS VOLUMETRIC FLOW RATE AT NORMAL CONDITIONS, NCFM (DRY)	1503793	1503295	1478200
QA	STACK GAS VOLUMETRIC FLOW RATE AT STACK CONDITIONS, ACFM (WET)	2855540	2779016	2688669
I	ISOKINETIC RATE, PERCENT	95.2	96.3	98.0
MF	PARTICULATE MASS--PROBE, CYCLONE, AND FILTER, MG	140.2	28.9	9.3
CAN	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/NCF (DRY)	0.011	0.002	0.001
CAT	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT STACK O2, GR/ACF (WET)	0.006	0.001	0.000
CAN3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/NCF (DRY)	0.015	0.003	0.001
CAT3	PARTICULATE LOADING--PROBE, CYCLONE, AND FILTER AT 3% O2, GR/ACF (WET)	0.008	0.002	0.000
CAW	PARTICULATE EMISSIONS--PROBE, CYCLONE AND FILTER, LB/HR	135.80	25.99	8.22

NORTH DAKOTA, STACK, LOCATION 6A, MULTI-METALS

RUN NO. TEST DATE	1 6/22	2 6/24	3 6/27
VOLUME OF GAS SAMPLED, NCF (DRY)	204.9	220.6	220.7
MOISTURE FRACTION VOLUME, PERCENT	17.0	16.9	17.1
AVERAGE STACK TEMPERATURE, F	251	232	226
STACK VOLUMETRIC FLOW RATE, NCFM (DRY)	1503793	1503295	1478200
STACK VOLUMETRIC FLOW RATE, ACFM (WET)	2855540	2779016	2688669
STACK OXYGEN RATE, PERCENT	95.2	96.3	98.0
EXCESS AIR, PERCENT	61.1	61.1	61.1
ARTICULATE MASS - PROBE, CYC, FILTER CATCH,			
GRAMS	140.2	28.9	9.3
ARTICULATE LOADING, LB/NCF AT STACK O2 (DRY)	0.011	0.002	0.001
ARTICULATE LOADING, LB/ACF AT STACK O2 (WET)	0.006	0.001	0.000
ARTICULATE LOADING, LB/NCF AT 3% O2 (DRY)	0.015	0.003	0.001
ARTICULATE LOADING, LB/ACF AT 3% O2 (WET)	0.008	0.002	0.000
ARTICULATE EMISSIONS, LB/HR	135.8	26.0	8.2

NORTH DAKOTA, STACK, LOCATION 6A, MULTI-METALS

RUN NO. TEST DATE	1 6/22	2 6/24	3 6/27
VOLUME OF GAS SAMPLED, NCM	5.80	6.25	6.25
MOISTURE FRACTION VOLUME, PERCENT	17.0	16.9	17.1
AVERAGE STACK TEMPERATURE, C	121	111	107
STACK VOLUMETRIC FLOW RATE, NCMM	42582	42568	41858
STACK VOLUMETRIC FLOW RATE, CMM	80860	78693	76135
ISOKINETIC RATE, PERCENT	95.2	96.3	98.0
EXCESS AIR, PERCENT	61.1	61.1	61.1
PARTICULATE MASS - PROBE,CYC,FILTER CATCH,			
MG	140.2	28.9	9.3
PARTICULATE LOADING, MG/NCM AT STACK O2 (DRY)	24.1	4.6	1.5
PARTICULATE LOADING, MG/CM AT STACK O2 (WET)	12.7	2.5	0.8
PARTICULATE LOADING, MG/NCM AT 3% O2 (DRY)	33.5	6.4	2.1
PARTICULATE LOADING, MG/CM AT 3% O2 (WET)	17.6	3.5	1.1
PARTICULATE EMISSIONS, KG/HR	61.6	11.8	3.7

APPENDIX E

QA/QC

QA/QC

E-1 Sampling Completeness

The goal for data completeness in this study was defined in the QAPP as at least 85 percent. One aspect of achieving this goal is the completeness of sampling activities. Table E-1 shows the percent completeness of sampling of flue gas, solid and liquid streams at Coal Creek. Footnotes to the table identify the causes of any incomplete sampling efforts; any such deviations from plan are also discussed in section 3.2.4 of this report.

Table E-1 shows that flue gas sampling was 100 percent complete with the exception of single samples of ammonia, cyanide, and VOCs by canisters, and one filter for carbon/radionuclide analyses. Solid sample collection was complete, and liquid sample collection was complete with the exceptions of samples in the lime slurry area, and the coal pile runoff sample. Collection of the latter sample was dependent on rainfall, and its absence does not indicate a deficiency in the sampling effort. Completeness of all sample collections was 89 to 100 percent, with the lone exception of the lime slurry, for which samples were collected on five of the six sampling days. The absence of this sample on June 24 was due to the lack of water flow to the slurry mixing tank, i.e., the FGD unit did not require input of lime slurry at that time and so none was being made up. Repeated trips to the slurry area were made, but no slurry sample could be obtained.

The ESP ash sample collection is indicated in Table E-1 as 100 percent complete, and that was the case in that all achievable samples were collected. However, the ash collection rate of ESP hopper rows 4 to 6 was too low for any sample to be collected, even after those hoppers had been withheld from the dumping schedule for several days. This occurrence has been noted as a deviation from the sampling plan, in section 3.2.4 of this report.

TABLE E-1. COMPLETENESS OF SAMPLE COLLECTION AT COAL CREEK

Type of Sample	Completeness (percent)
Flue Gas	
Multi-Metals (Method 29)	100
Modified Method 5 (Method 23)	100
Particulate Mass (Locations 4b, 5b)	100
HEST Sampler	100
Canisters (VOC) ^(a)	92
VOST (VOC)	100
TO-5 (Aldehydes)	100
Method 26A (Anions)	100
APHA 401 (Ammonia) ^(b)	92
APHA 808 (Cyanide) ^(c)	92
Filter Carbon ^(d)	89
Filter Radionuclides ^(d)	89
Particle Size Distribution	
Impactors	100
Cyclones	100
Solid Samples	
Boiler Feed Coal	100
Bottom Ash	100
Economizer Ash	100
Pyrite Rejects	100
ESP Ash	100
Run-of-mine Coal	100
Lime Input	100
Liquid Samples	
River Make-up Water	100
Circulating Water	100
Scrubber Make-up Water	100
Lime Slurry ^(e)	83
Slurry Blowdown ^(f)	92
Coal Pile Runoff ^(g)	0

(a) No canisters collected at Location 5a on June 21.

(b) Ammonia sample from Location 6a lost after collection on June 27.

(c) No cyanide sample collected at Location 5a on June 22.

(d) Locations 4a, 5a, 6a only; 6b PSDS filters too lightly loaded for analysis. No filter sample collected at Location 5a on June 22.

(e) Unable to collect sample on June 24.

(f) Unable to collect sample at Location 17a on June 24; sample collection at Location 17b complete.

(g) Insufficient rainfall for coal pile runoff collection.

E-2 Analytical

E-2.1 Elements (ICP)

Accuracy, precision, and completeness for ICP analysis of elements are provided in Table E-2. Accuracy was determined by evaluating the recovery of a known amount of a standard solution spiked into a digested sample. Precision was determined by evaluating the relative percent difference of duplicate instrument analyses of a single digested sample. A completeness of 100 percent was achieved for ICP analysis of elements.

Method detection limits (DL) for elements in gas samples were calculated as follows:

FILTER

$$DL(\mu\text{g}/\text{Ncm}) = \frac{\text{Instrument Detection Limit} * (\mu\text{g}/\text{sample})}{\text{Gas Sample Volume (Ncm)}}$$

FRONT HALF

$$DL(\mu\text{g}/\text{Ncm}) = \frac{\text{Instrument Detection Limit} * (\mu\text{g}/\text{sample})}{\text{Gas Sample Volume (Ncm)}}$$

BACK HALF

$$DL(\mu\text{g}/\text{Ncm}) = \text{Instrument Detection Limit} * \frac{\text{Digested Sample Volume (mL)}}{\text{Gas Sample Volume (Ncm)}} \times \frac{\text{Total Sample Volume (mL)}}{\text{Volume of Sample Used for Digestion (mL)}}$$

As an example, the detection limit for nickel in C-5a-MUM-627 was calculated as follows:

FILTER

0.124 $\mu\text{g}/\text{Ncm}$ (detected)

* Calculated from three times the standard deviation of replicate blank/low level sample analysis.

AIM

Association for Information and Image Management

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Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

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5 of 5

TABLE E-2. ACCURACY, PRECISION, AND COMPLETENESS FOR ELEMENT (ICP) ANALYSIS

Analyte Compounds	Accuracy			Precision			Completeness (%)
	How Measured	Target (%)	Actual (%) ^(b)	How Measured	Target (%)	Actual (%) ^(b)	
GAS (Method 29 Back-Half)	Spike Recovery	75-125		RPD of Duplicate Analysis	< 20		100
Aluminum			78.6			11.5	
Barium			83			8.6	
Boron			82.5			5.0	
Beryllium			78.9			196 ^(a)	
Calcium			102.7			0.9	
Cadmium			82.8			83 ^(a)	
Cobalt			79.4			86 ^(a)	
Chromium			78.7			30 ^(a)	
Copper			94.7			9.4	
Potassium			100.7			10.8	
Manganese			83.6			1.3	
Molybdenum			90.4			29.2	
Sodium			92.0			2.5	
Nickel			86.7			15.1	
Silicon			101.4			15	
Titanium			105.0			7.5	
Vanadium			84.3			192	
GAS (Method 29 Front-Half)	Spike Recovery	75-125		RPD	< 20		100
Aluminum			93.6			2.0	
Barium			92.5			0.9	
Boron			92.0			3.1	
Beryllium			98.9			10.5	
Calcium			87.7			3.0	
Cadmium			90.6			5.0	
Cobalt			104.0			1.7	
Chromium			90.6			3.9	
Copper			96.9			2.9	
Potassium			119.9			36	
Manganese			94.7			2.4	
Molybdenum			101.6			3.6	
Sodium			101.7			4.5	
Nickel			106.4			2.7	
Silicon			89.0			60.4	
Titanium			95.0			2.4	
Vanadium			97.5			0.5	

TABLE E-2. (Continued)

Analyte Compounds	Accuracy			Precision			Completeness (%)
	How Measured	Target (%)	Actual (%) ^(b)	How Measured	Target (%)	Actual (%) ^(b)	
GAS (Method 29 Filters)	Spike Recovery ^(c) Reference Standards ^(d)	75-125		RSD of Standard Analysis	< 20		100
Aluminum			93-100			0.5-2.3	
Barium			93-103			0.3-2.1	
Beryllium			93-100			1.0-5.5	
Boron			94,96			1.3-13.1	
Cadmium			90-98			0-14	
Calcium			94-105			0-14.5	
Chromium			83-115			1.2	
Cobalt			96-112			0.5-2.5	
Copper			86-106			0.5-3.5	
ELEMENTS IN SAMPLES BY ICP	Spike Recovery ^(c) Reference Method ^(d)	75-125		< 20			100
Manganese			83-102			10-30	
Molybdenum			76-102			0.2-16.5	
Nickel			87-117			0.6-7.2	
Potassium			93-102			1.35,338	
Silicon			99			0-1.8	
Sodium			90-106			0.5-18	
Titanium			96			0.5-2	
Vanadium			92-102			1-4.2	

(a) Value < 5 times the detection limit.

(b) Except where indicated, range represents range of results for multiple samples, two numbers separated by a comma represents results for two samples, and single number represents results for single number sample or determination.

FRONT HALF

$$DL = \frac{3.4 \text{ } \mu\text{g/sample}}{5.771 \text{ Ncm}} = 0.589 \text{ } \mu\text{g/Ncm}$$

BACK HALF

$$DL = 0.0796 \text{ } \mu\text{g/mL} \times \frac{100 \text{ mL}}{5.771 \text{ Ncm}} \times \frac{1373 \text{ mL}}{840 \text{ mL}} = 2.25 \text{ } \mu\text{g/Ncm}$$

TOTAL

$$0.124 \text{ } \mu\text{g/Ncm} + \frac{0.589 \text{ } \mu\text{g/Ncm}}{2} + \frac{2.25 \text{ } \mu\text{g/Ncm}}{2} = 1.54 \text{ } \mu\text{g/Ncm}$$

The total result for C-5a-MUM-627 defaults to ND < 2.25 $\mu\text{g/Ncm}$ since the total detected is less than highest detection limit.

E-2.2 Elements (GFAA)

Accuracy, precision, and completeness results for GFAA analysis of antimony, arsenic, lead, and selenium are presented in Table E-3. Accuracy was determined by evaluating the recovery of target analytes spiked into digested sample matrix. Precision was determined by calculating the relative percent difference of duplicate instrument analyses of a single sample. Accuracy and precision obtained met the target objectives in all cases. A completeness of 100 percent was obtained for all GFAA element analyses. The method detection limits for GFAA elements in gas samples were calculated as previously described for ICP elements.

TABLE E-3. ACCURACY, PRECISION, AND COMPLETENESS FOR ELEMENT (GFAA) ANALYSIS OF GAS SAMPLES

Analyte/Surrogate Compounds	Accuracy			Precision			Analytical Completeness (%)
	How Measured	Target (%)	Actual (%)(a)	How Measured	Target (%)	Actual (%)(a)	
GAS (Cyclones)	Spike Recovery			RPD of Duplicate Analysis			100
Antimony		75-125	105,113		< 20	0,8	
Arsenic		75-125	95,100		< 20	1,2	
Lead		75-125	101,107		< 20	1-11	
Selenium		75-125	100,116		< 20	11-15	
GAS (Method 29 Filters)	Spike Recovery			RPD of Duplicate Analysis			100
Antimony		75-125	92,103		< 20	3,18	
Arsenic		75-125	92-101		< 20	6,14	
Lead		75-125	100,109		< 20	0-5	
Selenium		75-125	100		< 20	0-15	
GAS (Method 29 Front Half)	Spike Recovery			RPD of Duplicate Analysis			100
Antimony		75-125	92-98		< 20	4-8	
Arsenic		75-125	95-103		< 20	1-6	
Lead		75-125	94,103		< 20	2-7	
Selenium		75-125	100-115		< 20	1-5	
GAS (Method 29 Back Half)	Spike Recovery			RPD of Duplicate Analysis			100
Antimony		75-125	88-105		< 20	5-18	
Arsenic		75-125	99-102		< 20	3-15	
Lead		75-125	86-102		< 20	4-5	
Selenium		75-125	93-103		< 20	8-18	

(a) Except where indicated, range represents range of results for multiple samples, two numbers separated by a comma represents results for two samples, and single number represents results for single sample or determination.

(b) Duplicate results at 0.05 ± 0.01 µg/mL, less than twice of detection limit, 0.03 µg/mL.

(c) Duplicate results at 0.04 ± 0.01 µg/mL, less than twice of detection limit.

E-2.3 Mercury

Accuracy, precision, and completeness results for CVAA analysis of mercury are presented in Table E-4. Accuracy was determined by evaluating the recovery of mercury spiked into digested sample matrix. Precision was determined by calculating the relative percent difference of duplicate instrument analyses of a single sample. Accuracy and precision obtained met the target objectives in all cases. A completeness of 100 percent was obtained for all mercury analyses. The method detection limits for mercury in gas samples were calculated as previously described for ICP elements.

TABLE E-4. ACCURACY, PRECISION, AND COMPLETENESS FOR MERCURY ANALYSIS^(a)

Analyte/Surrogate Compounds	Accuracy			Precision			Completeness
	How Measured	Target (%)	Actual (%) ^(b)	How Measured	Target (%)	Actual (%) ^(b)	
Mercury	Spike Recovery	75-125	94-100	RPD of Duplicate Analysis	<20	2-13	100

- (a) Represents results from analysis of gas samples only.
- (b) Except where indicated, range represents range of results for multiple samples, two numbers separated by a comma represents results for two samples, and single number represents results for single sample or determination.

E-2.4 Ammonia/Cyanide

A summary of the accuracy, precision, and completeness obtained for the ammonia/cyanide analysis of the gas and liquid samples is provided in Table E-5. Accuracy was determined by calculating the recovery of a known amount of analyte spiked into a sample. Precision was determined by duplicate instrument analysis of a single sample. The accuracy and precision obtained met the target quality objectives in all cases, except for the precision associated with the duplicate analysis of a sample containing ammonia at a level less than the detection limit. A completeness of 100 percent was achieved for the gas samples; a completeness of 64 percent was obtained for the liquid samples, reflecting the five Location 17 samples that were not analyzed.

The method detection limits for ammonia and cyanide in gas samples were determined as follows:

$$DL\ (\mu g/Ncm) = \frac{Instrument\ Detection\ Limit\ (\mu g/sample) *}{Gas\ Sample\ Volume\ (Ncm)}$$

For example, the detection limit for ammonia in C-6a-NH₄-622 was calculated as follows:

$$DL = \frac{2\ \mu g/sample}{0.3954\ Ncm} = 5.06\ \mu g/Ncm$$

* Calculated from three times the standard deviation for replicate analysis of low-level samples.

TABLE E-5. ACCURACY, PRECISION, AND COMPLETENESS FOR AMMONIA AND CYANIDE ANALYSIS OF GAS AND LIQUID SAMPLES

Analyte/Surrogate Compounds	Accuracy			Precision			Analytical Completeness (%)
	How Measured	Target (%)	Actual (%) ^(a)	How Measured	Target (%)	Actual (%) ^(a)	
GAS	Spike Recovery			RPD of Duplicate Analysis			
Ammonia		75-125	99,125		<20	40 ^(b) , 50 ^(c)	100
Cyanide		75-125	93,94		<20	1,7 ^(d)	100
LIQUID							
Ammonia		75-125	87-98		<20	7,8	64
Cyanide		75-125	83,87		<20	1,1	64

- (a) Except where indicated, range represents range of results for multiple samples, two numbers separated by a comma represents results for two samples, and single number represents results for single sample or determination.
- (b) Duplicate results at 0.05 ± 0.01 µg/mL, less than twice detection limit of 0.03 µg/mL.
- (c) Duplicate results at 0.04 ± 0.01 µg/mL, less than twice detection limit.
- (d) Samples from Location 17a, 17b (Slurry Blowdown) not analyzed.

E-2.5 Anions

Accuracy, precision, and completeness results for anion analysis are presented in Table E-6. Accuracy was determined by evaluating the recovery of target analytes spiked into sample matrix as well as analysis of a standard reference material (SRM). Precision was determined by calculating the relative percent difference of duplicate analysis of a single sample. Accuracy and precision obtained met the target objectives in all cases. A completeness of 100 percent was obtained for all anion analyses.

Detection limits for anion analyses of gas samples by ion chromatography were determined by the observation of a calibration standard which when analyzed provided an approximate 3:1 signal-to-noise ratio.

Species which interfered with the chromatographic analysis of a sample, i.e. a species which overloaded the column or eluted near the retention window of interest, were corrected for by sample dilution which in turn required a proportional increase in the detection limit for the sample. The method detection limit is calculated as follows:

$$DL (\mu g/Ncm) = \frac{\text{Lowest Level Calibration Std } (\mu g/mL) \times \text{Sample Dilution Factor} \times \text{Extraction Volume (mL)}}{\text{Gas Sample Volume (Ncm)}}$$

For example, in the analysis of Coal Creek filter sample C-4a-FCL-627, a large sulfate interference in the sample extract required a dilution of 1:2 to determine the absence of phosphate. The detection limit for the sample was then determined as follows:

$$0.050 \mu g/mL \times 2 \times 20 mL / 1.211 Ncm = 2 \mu g/Ncm$$

TABLE E-6. ACCURACY, PRECISION, AND COMPLETENESS FOR ANION ANALYSIS^(a)

Analyte/Surrogate Compounds	Accuracy		Precision		Completeness
	How Measured	Target (%)	Actual (%)	How Measured Target (%)	
	Spike Recovery			RPD of Duplicate Analysis	100
Chloride		75-125	109	< 20	0.7, 0.2
Fluoride		75-125	94	< 20	1.4, 2.5
Sulfate		75-125	NA	< 20	19
Phosphate		75-125	77,103	< 20	NA
	SRM Analysis				
Chloride		143-171 ppm	145.01 ppm, 152.272 ppm	± 25	-13, -8-34
Fluoride		1.55-2.02 ppm	1.715 ppm, 1.715 ppm	± 25	-62, -4-3
Sulfate		70.1-93.9 ppm	71.96 ppm	± 25	-56, -8-9
Phosphate		0.555-0.779 ppm	0.552 ppm	± 25	-126, -1-1

NA = not analyzed or data not available.

(a) QC data for solid sample analysis not available at this time and are not included.

E-2.6 VOC

E-2.6.1 Gas Samples (VOST)

A summary of the accuracy, precision, and completeness obtained for analysis of VOC in VOST samples is shown in Table E-7. To determine accuracy, each sample was spiked with four surrogate compounds prior to analysis. Recovery of the surrogate spike was then considered as the analytical accuracy. As shown, the surrogate spike recovery met the original objectives of 26-160 percent.

A method detection limit of 25 ng/sample was determined by calculating ten times the standard deviation of replicate analyses of a 50 ng standard. Detection limits for individual samples were then calculated by dividing 25 ng/sample by the associated gas sample volume.

TABLE E-7. ACCURACY, PRECISION, AND COMPLETENESS FOR VOC VOST ANALYSIS

Analyte/Spike Compounds	Accuracy			Precision			Completeness
	How Measured	Target (%)	Actual (%)	How Measured	Target (%)	Actual (%)	
	Surrogate Spike Recovery						100
d ₄ -1,2-Dichloroethane		26-160	69-114		<20	0.7, 0.2	
d ₈ -Toluene		26-160	67-114		<20	1.4, 2.5	
d ₆ -Benzene		26-160	96-127		<20	19	
p-Bromofluorobenzene		26-160	26-154		<20	NA	

E-2.6.2 Gas Samples (Canister)

A summary of the precision, accuracy and completion obtained for analysis of VOC in canister samples is shown in Table E-8. Information on accuracy was obtained from a canister spiked with four target compounds. The concentrations of the four components were established by reference to the 41 component calibration cylinder. This cylinder has been recently audited by US EPA and shown to be within ± 10 percent of the stated values for 15 compounds common to both mixtures. The contents of the spiked canister were directed through the sampling train and into a second canister. Both canisters were analyzed to determine the amount recovered. Analytical precision was determined by repeated analyses (3 times) of a 1/100 dilution mixture from the 41 component calibration cylinder. The four components used during the field spike experiment are reported. The RSD values for all components averaged ± 18 percent with a range from 8 to 34 percent.

Detection limits for VOC in canister samples were calculated as follows:

$$DL\ (ppb) = \frac{Concentration\ of\ Sids\ (ppb)}{Average\ of\ Range\ of\ Std\ Peak\ Areas\ (all)} \times 3 \times (Peak\ Area\ Noise)$$

The calibration cylinder contained the 41 target components each at a nominal concentration of 200 ppb. The cylinder was dynamically diluted to the 6 ppb level. Using the selective ion monitoring mode of the GC/MS, area counts from 850,000 to 1,700,000 were obtained for the target compounds. The peak area noise was approximately 35,000 area units. No changes in electron multiplier gain was made during the study so the above responses hold throughout the time period. With these results, the actual detection limit achieved was calculated as follows:

$$DL\ (ppb) = \frac{6\ ppb}{((1,700,000 + 850,000)/2)} \times 3\ (35,000) = 0.5\ ppb$$

The detection limit in ppb units was then converted to µg/Ncm units by multiplying by a conversion factor. For example, 1 ppb of trichlorofluoromethane at 0°C, 760 mm, and 3 percent oxygen is equal to 7.52 µg/Ncm; therefore the converted detection limit was 3.76 µg/Ncm.

TABLE E-8. ACCURACY, PRECISION, AND COMPLETENESS FOR VOC CANISTER ANALYSES

Analyte/Spike Compounds	Accuracy			Precision		Completeness (%)
	How Measured	Target (%)	Actual (%)	How Measured	Target (%) Actual (%)	
	Spike of Sampling Train with Canister			Repeated Analysis of Standard Cylinder		97 ^(b)
Benzene	25.6 µg/dscm	75-125	101		± 20 ± 18	
Toluene	23.0 µg/dscm	75-125	99		± 20 ± 19	
Ethylbenzene	25.6 µg/dscm	75-125	113		± 20 ± 11	
Styrene	19.2 µg/dscm	75-125	114		± 20 ± 3	

(a) A 41-component calibration cylinder was analyzed each analytical day (RSD values averaged ± 18 and ranged from 8 to 34 percent).

(b) A total of 37 canister samples were collected and data are reported for 36.

E-2.6.3 Liquid Samples

QA/QC results for the analysis of VOC in liquid samples are presented in Table E-9.

Each sample was spiked with three surrogate compounds prior to analysis to evaluate accuracy. Sample C-9-PRL-623 Matrix Spike fell outside the surrogate recovery limits for all of the three surrogates. Samples C-17A-PRL-623, C-9-PRL-626 and C-17A-PRL-626 exceeded the surrogate recovery limit for 1,2-dichloroethane-d₄.

Four matrix spikes and matrix spike duplicates were analyzed for precision. The relative percent difference (RPD) for one set of MS/MSDs was out of the target limit of ± 25 percent. The matrix spike sample in this set exhibited low recovery while the matrix spike duplicate recoveries exhibited average to high recoveries. The RPDs for the other three matrix spike/matrix spike duplicate pairs were well within the 25 percent target range. Two of these MS/MSDs were from samples collected on June 27, 1993, which was not a sampling day for liquid VOC samples. Both unspiked samples were free of target analytes and their associated MS/MSDs indicate good precision and accuracy, thus their inclusion in this appendix.

Limits for surrogate recoveries as they appear in the appendices were taken directly from Method 8240. Limits for spike recoveries as they appear in the appendices were taken from Method 8240 QC Acceptance Criteria Table.

TABLE E-9. ACCURACY, PRECISION, AND COMPLETENESS FOR VOC ANALYSIS OF LIQUID SAMPLES

Analyte/Surrogate Compounds	Accuracy			Precision			Completeness
	How Measured	Target (%)	Actual (%)	How Measured	Target (%)	Actual (%)	
	Surrogate Spike Recovery						100
1,2-Dichloroethane-d ₄		76-114	91-118	RPD of Matrix Spike/ Matrix Spike Duplicate	NA ^(a)	NA	
Toluene-d ₈		88-110	75-109		NA	NA	
4-Bromofluorobenzene		86-115	76-104		NA	NA	
	Matrix Spike Recovery						100
Benzene		37-151	57-116		± 25	-39 ^(b)	
Bromomethane		D-242	46-171		± 25	-80,-4 to 7	
Bromoform		45-169	71-92		± 25	-13,-8 to 34	
Carbon tetrachloride		70-140	46-118		± 25	-62,-4 to 3	
Chlorobenzene		37-160	45-104		± 25	-56,-8 to 9	
Chloromethane		D-273	26-161		± 25	-126,-1 to 1	
1,1-Dichloroethane		59-155	60-116		± 25	-45,-11 to 17	
1,2-Dichloroethane		49-155	76-109		± 25	-19,-8 to 8	
cis-1,3-Dichloropropene		D-227	63-76		± 25	-1,-8 to 4	
trans-1,3-Dichloropropene		17-183	61-81		± 25	-7,-5 to 3	
Ethylbenzene		37-162	40-105		± 25	-63,-5 to 1	
Methylene chloride		D-221	39-119		± 25	-83,-2 to (-1)	
Toluene		47-150	47-115		± 25	-46,-6 to 7	
1,1,1-Trichloroethane		52-162	47-122		± 25	-60,-8 to 5	
1,1,2-Trichloroethane		52-150	75-101		± 25	-8,-8 to 3	
Trichloroethylene		71-157	70-156		± 25	-44,-7 to 5	
Vinyl chloride		D-251	76-153		± 25	-8,-16 to 11	

D = detected.

(a) NA = not available.

(b) First precision result is outlier due to matrix spike sample with low recovery.

E-2.7 PAH/SVOC

E-2.7.1 Gas and Solid Samples

Accuracy, precision, and completeness results for PAH/SVOC analysis of gas and solid samples are presented in Table E-10. Accuracy was determined by recovery of perdeuterated PAH spike compounds added to the samples prior to extraction. In most cases, spike recoveries met the target objective of 50 to 150 percent. Precision was determined by evaluating the relative standard deviation of calibration standard analyses. The average RSD for three calibration standards, 0.05 ng/ μ L, 0.1 ng/ μ L, and 0.5 ng/ μ L is presented in Table E-10. As shown, this average RSD is below the target 30 percent in all cases. Individual RSD for these three standards were also below the 30 percent target. A completeness of 100 percent was achieved for the gas and solid samples.

The estimated detection limit for PAH is 0.01 ng on column and for SVOC is 0.05 ng on column with a 1- μ L injection. At these concentration levels, the signal-to-noise ratio is about 3. The detection limit for PAH/SVOC was calculated using the following equation:

$$DL = \frac{\text{Estimated Detection Limit Concentration} \times \text{Final Volume of Extract Analyzed}}{\text{Gas Sample Volume} \times \text{Fraction of Extract Analyzed}}$$

For example, the detection limit for hexachloroethane in C-6a-MM5-X-621 was calculated as follows:

$$\frac{0.05 \text{ ng}/\mu\text{L} \times 100 \mu\text{L}}{4.596 \times 0.5} = 2.18 \text{ ng/Ncm}$$

TABLE E-10. ACCURACY, PRECISION, AND COMPLETENESS FOR PAH/SVOC ANALYSIS OF GAS AND SOLID SAMPLES

Analyte/Surrogate Compounds	Accuracy			Precision			Completeness
	How Measured	Target (%)	Actual (%)	How Measured	Target (%)	Actual (%)	
	Recovery of Perdeuterated PAH Spike						
GAS							100
d ₁₂ -Chrysene		50-150	38-129				
d ₁₂ -Benzo(k)fluoranthene		50-150	30-117				
SOLID							100
d ₁₂ -Chrysene		50-150	53-106				
d ₁₂ -Benzo(k)fluoranthene		50-150	46-123				
				RSD of Calibration Standard Analysis	< 30		
GAS/SOLID							
Benzylchloride						13.7	
Acetophenone						11.3	
Hexachloroethane						11.7	
Naphthalene						9.4	
Hexachlorobutadiene						12.5	
Quinoline						10.7	
2-Chloroacetophenone						7.7	
1-Methylnaphthalene						9.7	
2-Methylnaphthalene						8.1	
Hexachlorocyclopentadiene						13.9	
Biphenyl						9.5	
Acenaphthylene						9.4	
2,6-Dinitrotoluene						11.7	
Acenaphthene						9.7	
Dibenzofuran						8.1	
2,4-Dinitrotoluene						15.9	
Fluorene						10.4	
Hexachlorobenzene						12.7	
Pentachlorophenol						11.7	
Phenanthrene						8.6	
Anthracene						7.7	
Fluoranthene						10.3	

TABLE E-10. (Continued)

Analyte/Surrogate Compounds	Accuracy			Precision			Completeness
	How Measured	Target (%)	Actual (%)	How Measured	Target (%)	Actual (%)	
				RSD of Calibration Standard Analysis			
Pyrene						12.6	
Benz(a)anthracene						11.3	
Chrysene-d ₁₂						20.6	
Chrysene						13.1	
d ₁₂ -benzo(k)fluoranthene						17.3	
Benzo(b & k)fluoranthene						11.0	
Benzo(e)pyrene						14.0	
Benzo(a)pyrene						18.2	
Indeno(1,2,3-c,d)pyrene						14.6	
Dibenzo(a,h)anthracene						16.5	
Benzo(g,h,i)perylene						13.8	

D = detected.

E-2.7.2 Liquid Samples

Accuracy, precision, and completeness results for PAH/SVOC analysis of liquid samples are presented in Table E-11. Each sample was fortified with eight surrogate compounds prior to analysis. Two of the surrogates do not have established recovery limits. All samples were within surrogate recovery limits except sample C-9-PRL-621 was borderline for 2-fluorophenol with recovery of 20.8 percent and a recovery limit of 21 percent and its spiked sample C-9-PRL-MS recovery for 2-fluorobiphenyl was 39 percent with a surrogate recovery limit of 43 percent.

Four matrix spikes and matrix spike duplicates were analyzed and one spiked method blank and spiked method blank duplicate. The Relative Percent Difference (RPD) for one set of MS/MSDs was out of the target range of ± 25 percent. The matrix spike sample in this set exhibited low recovery, while the matrix spike duplicate recoveries exhibited average recoveries. The other matrix spike/matrix spike duplicate pairs were well within the RPD target of 25 percent.

Limits for surrogate recoveries as they appear in Table E-11 were taken directly from Method 8270. Limits for spike recoveries as they appear in the appendices were taken from Method 8270 QC Acceptance Criteria Table.

TABLE E-11. ACCURACY, PRECISION, AND COMPLETENESS FOR PAH/SVOC ANALYSIS OF LIQUID SAMPLES

Analyte/Surrogate Compounds	Accuracy			Precision			Completeness
	How Measured	Target (%)	Actual (%)	How Measured	Target (%)	Actual (%)	
	Surrogate Spike Recovery						100
2-Fluorophenol		21-100	21-67	NA ^(a)	NA	NA	
Phenol-d ₅		10-94	20-52	NA	NA	NA	
2-Chlorophenol-d ₄		NE ^(b)	41-88	NA	NA	NA	
1,2-Dichlorobenzene-d ₄		NE	35-79	NA	NA	NA	
Nitrobenzene-d ₅		35-114	37-94	NA	NA	NA	
2-Fluorobiphenyl		43-116	39-95	NA	NA	NA	
2,4,6-Tribromophenol		10-123	30-110	NA	NA	NA	
Terphenyl-d ₁₄		33-141	41-88	NA	NA	NA	
	Matrix Spike Recovery			RPD of Matrix Spike and Matrix/Spike Duplicate			100
Phenol		5-112	21-41		< 25	57.1 ^(c) , 3-7	
2-Chlorophenol		23-134	46-171		< 25	49.9, 1-5	
1,4-Dichlorobenzene		20-124	71-92		< 25	53.9, 5-7	
1,2,4-Trichlorobenzene		44-142	46-118		< 25	53.5, 1-7	
4-Chloro-3-Methylphenol		22-147	45-104		< 25	52.1, 1-6	
Acenaphthene		47-145	26-161		< 25	52.8, 0.05-5	
4-Nitrophenol		D-132	60-116		< 25	68.9, 0.4-5	
2,4-Dinitrotoluene		39-139	76-109		< 25	52.6, 2-6	
Pentachlorophenol		14-176	63-76		< 25	61.5, 0.1-6	
Pyrene		52-115	61-81		< 25	57.4, 0.6-9	

D = detected.

(a) NA = not available.

(b) NE = not established.

(c) First value is single poor RPD obtained.

E-2.8 Dioxins/Furans

Accuracy, precision, and completeness results for dioxin/furan analysis are presented in Table E-12. Accuracy was determined by evaluating recovery of $^{13}\text{C}_{12}$ -labelled internal standards spiked into the samples prior to extraction and by evaluating recovery of native dioxins/furans spiked into a matrix spike sample. In all cases, recoveries of internal standards and matrix spike compounds met the accuracy objective of 40 to 120 percent. Precision was determined by calculating the relative standard deviation of internal standard recoveries obtained for samples. As shown, the precision obtained met the target objective of <25 percent in all cases.

The detection limit for dioxins/furans in gas samples was calculated using the following equation:

$$DL = \frac{\text{Sum of Noise Heights at Native Isomer Retention Time}}{\text{Sum of Peak Heights for Labeled Internal Standard}} \times \frac{\text{Quantity of Internal Standard}}{\text{Native Response Factor}} \times \frac{2.5}{\text{Gas Sample Volume}}$$

For example, actual detection limits were calculated for 2,3,7,8-tetrachlorodibenzo-p-dioxin in C-6a-MM5-621 as follows:

$$\text{Filter } DL = \frac{(1 + 4)}{(3267 + 4021)} \times \frac{2000 \text{ pg}}{1.136} \times \frac{2.5}{2.298 \text{ Ncm}} = 1.31 \text{ pg/Ncm}$$

$$\text{XAD } DL = \frac{(5 + 4)}{(2335 + 2880)} \times \frac{2000 \text{ pg}}{1.136} \times \frac{2.5}{2.298 \text{ Ncm}} = 3.30 \text{ pg/Ncm}$$

The detection limit for the total sample was then calculated as the average of the filter + XAD detection limits as follows:

$$\text{C-6a-MM5-621 total detection limit} = \frac{1.31 \text{ pg/Ncm} + 3.30 \text{ pg/Ncm}}{2} = 2.31 \text{ pg/Ncm}$$

TABLE E-12. ACCURACY, PRECISION, AND COMPLETENESS FOR DIOXIN/FURAN ANALYSES

Analyte Compounds	Accuracy			Precision		Completeness (%)
	How Measured	Target (%)	Actual (%)	How Measured	Target (%) (RSD)	Actual (%) (RSD)
	Spike Recovery			NA		100
2378-TCDD		40-120	97.6-102.6		NA	NA
12378-PeCDD		40-120	103.6- 108.1		NA	NA
123478-HxCDD		40-120	97.9-98.3		NA	NA
123678-HxCDD		40-120	90.7-94.0		NA	NA
123789-HxCDD		40-120	94.3-104.7		NA	NA
1234678-HpCDD		40-120	97.6-100.9		NA	NA
OCDD		40-120	100.9- 103.3		NA	NA
2378-TCDF		40-120	91.1-93.2		NA	NA
12378-PeCDF		40-120	95.3-97.1		NA	NA
23478-PeCDF		40-120	93.0-97.3		NA	NA
123478-HxCDF		40-120	94.9-100.6		NA	NA
123678-HxCDF		40-120	93.4-93.8		NA	NA
123789-HxCDF		40-120	93.3-93.7		NA	NA
234678-HxCDF		40-120	92.4-92.6		NA	NA
1234678-HpCDF		40-120	84.1-87.8		NA	NA
1234789-HpCDF		40-120	98.0-100.6		NA	NA
OCDF		40-120	89.6-102.2		NA	NA
2378-TCDD-13C12		40-120	73-91	RSD of Standard	<25	5.6
12378-PeCDD-13C12		40-120	66-104		<25	10.0
123478-HxCDD-13C12		40-120	85-110		<25	7.2
123678-HxCDD-13C12		40-120	74-101		<25	7.6
1234678-HpCDD-13C12		40-120	78-99		<25	7.6
OCDD-13C12		40-120	69-108		<25	11.5
2378-TCDF-13C12		40-120	55-76		<25	8.2
12378-PeCDF-13C12		40-120	59-82		<25	9.2
23478-PeCDF-13C12		40-120	65-86		<25	8.3
123478-HxCDF-13C12		40-120	68-86		<25	6.8
123678-HxCDF-13C12		40-120	66-83		<25	5.5
123789-HxCDF-13C12		40-120	62-84		<25	7.7
234678-HxCDF-13C12		40-120	75-96		<25	6.5
1234678-HpCDF-13C12		40-120	67-105		<25	11.4
1234789-HpCDF-13C12		40-120	68-98		<25	9.9
2378-TCDD-37CL4		40-120	73-93		<25	6.7

NA = Not available.

E-2.9 Aldehydes

Accuracy, precision, and completeness results for analysis of aldehydes in gas and liquid samples are presented in Table E-13. Accuracy was determined by recovery of analytes spiked into water. As shown, except for a 179 percent recovery of formaldehyde spiked into water at or near the method detection limit, all recoveries met the target objective of 50 to 150 percent. The precision was determined by the relative standard deviation of standard analyses and also met the target objectives. Completeness of 100 percent was obtained for both gas and liquid samples.

Method detection limits for aldehydes in gas samples were calculated using the following equation:

$$DL(\mu g/Ncm) = A_{\min} \times \frac{C_{std}(\mu g/mL)}{A_{STD}} \times \frac{V_{e-avg}(mL)}{V_{sampled}(Ncm)} \times \frac{MW_{neat}}{MW_{DER}}$$

where:

- DL = Detection Limit
- $A_{\min}$ = Minimum detectable peak area of carbonyl
- A_{std} = Peak area of carbonyl derivative in standard solution
- C_{std} = Concentration of carbonyl derivative in standard solution
- V_{e-avg} = Average final volume of DNPH-acetonitrile solution
- $V_{sampled}$ = Average volume of air sampled
- MW_{neat} = Molecular weight of neat carbonyl compound
- MW_{DER} = Molecular weight of carbonyl derivative.

For Coal Creek, the actual detection limit for C-4a-ALD-621 was calculated as follows:

$$4300 \times \frac{2 \mu g/mL}{337042} \times \frac{28.2 mL}{0.04303 Ncm} \times \frac{30.03}{210} = 2.4 \mu g/Ncm$$

TABLE E-13. ACCURACY, PRECISION, AND COMPLETENESS FOR ALDEHYDE ANALYSES

Analyte/Spike Compounds	Accuracy			Precision			Completeness (%)
	How Measured	Target (%)(a)	Actual (%)(a)	How Measured	Target (%)	Actual (%)	
GAS	Spike Recovery			RSD of Standard Analysis			100
Formaldehyde		50-150	114-122(b)		± 15	1.8	
Acetaldehyde		50-150	85-100		± 15	1.2	
Acrolein		50-150	NA		± 15	1.1	
Propionaldehyde		50-150	81-95		± 15	1.1	
LIQUID	Spike Recovery			RSD of Standard Analysis			100
Formaldehyde		50-150	114-122(b)		± 15	4.1	
Acetaldehyde		50-150	85-100		± 15	5.1	
Acrolein		50-150	NA		± 15	4.1	
Propionaldehyde		50-150	81-95		± 15	3.7	

- (a) Except where indicated, range represents range of results for multiple samples, two numbers separated by a comma represents results for two samples, and single number represents results for single sample or determination.
- (b) Excludes 179 percent recovery for spike at detection limit of method.
- (c) NA = Not analyzed.

E-2.10 Radionuclides

Accuracy, precision, and completeness results for radionuclide analysis are presented in Table E-14. Accuracy was determined by evaluating the recovery of cesium-137 spiked into sample matrix. Precision was determined by evaluating results of duplicate sample analyses. The precision achieved met the target objective of ± 3 standard deviations; relative percent differences (RPD) are provided in Table E-14 for comparability with other analytical data. A completeness of 100 percent was obtained for all radionuclides analyses.

The method detection limit for radionuclides was calculated using the following equation:

$$MDC = \frac{4.65 \sqrt{BKG} + 2.71}{(2.22)(EFF)(AVOL)(CTIME)(Ab)(D)}$$

where:

MDC	=	Minimal detectable concentration
BKG	=	Background counts
EFF	=	Counting efficiency
AVOL	=	Aliquot volume (g or L)
CTIME	=	Count time (min)
Ab	=	Abundance of emission
D	=	Decay correction
2.22	=	Conversion from dpm to pCi
4.65, 2.71	=	Constants.

This equation is derived from the following reference:

"Lower Limit of Detection: Definition and Elaboration of a Proposed Position for Radiological Effluent and Environmental Measurements", L. A. Currie, NUREG/CR-4007, U.S. Nuclear Regulatory Commission, September 1984.

- Routine continuing calibration response factors for OCDD-¹³C₁₂ were slightly above the ± 30 percent limit from the initial calibration on all analysis days. In

by a conversion factor of 1.0 for each radionuclide.

3 percent oxygen is equal to 7.52 µg/Ncm; therefore the converted detection limit was 3.76 µg/Ncm.

TABLE E-14. ACCURACY, PRECISION, AND COMPLETENESS FOR RADIONUCLIDE ANALYSIS

Analyte/Surrogate Compounds	Accuracy			Precision			Completeness
	How Measured	Target (%)	Actual (%)	How Measured	Target (%)	Actual (%)	
	Spike Recovery			RPD of Duplicate Analysis ^(b)			100
Cs-137		NA	100-109	--		9-47	
Pb-210				--		0-45	
Pb-212				--		6,16	
Ra-212				--		2-37	
Ra-228				--		2-38	
Th-234				--		59	
U-234				--		1	
U-235							

(a) Precision not provided for radionuclides not detected in both sample and duplicate.

(b) All duplicate results agreed to within ±3 standard deviations target objective; RPD provided for comparability with other analytical data.

NA = Not available.

in the actual samples. The standard water samples were reacted with the DNPH in the same manner as the actual samples.

E-3 Method Detection Limit

Approximate emission detection limits obtained for gas samples in which analytes were not detected are listed in Table E-15.

TABLE E-15. EMISSION DETECTION LIMITS

Element	Actual Emission Detection Limit ($\mu\text{g}/\text{Ncm}$) ^(a)	Target Emission Detection Limit ($\mu\text{g}/\text{Ncm}$)
Mo	NC	1.5
B	NC	1.2
Sb	0.1	0.3
As	NC	0.06
Ba	NC	0.3
Be	NC	0.3
Cd	NC	0.3
Cr	NC	1.2
Pb	NC	0.06
Mn	NC	0.3
Hg	0.02	0.03
Ni	NC	1.2
Se	NC	0.12
V	NC	0.6
Cu	NC	0.6
Co	NC	0.9
Ammonia	7	750
Cyanide	7 ^(c)	191
Anions		
F ⁻	NC	3
Cl ⁻	1	3
PO ₄ ⁼	2	30
SO ₄ ⁼	NC	7.5
PAH/SVOC	0.3-11	0.1-10 ng/Ncm ^(b)
Dioxins/Furans		
TCDD/TCDF	0.003	0.03 ng/Ncm
PeCDD/PeCDF	0.004	0.053 ng/Ncm
HxCDD/HxCDF	0.004	0.053 ng/Ncm
HpCDD/HpCDF	0.008	0.053 ng/Ncm
OCDD/OCDF	0.04	0.08 ng/Ncm
Aldehydes	2	2
VOC - Canister	4	6
VOC - VOST	6	1.3-7.5

(a) Approximate emission detection limit obtained in sample analyses. Values for PAH/SVOC and dioxins/furans are in ng/Ncm.

(b) Calculated target emission detection limit will range from 0.1 to 10 ng/Ncm depending upon SVOC compound and matrix.

(c) Calculated for dilute gas sample volumes only.

NC = Not calculated since analyte concentration above method detection limits in samples.

APPENDIX F
ANALYTICAL PROTOCOL

F-1. Element Analytical Protocols

Elements in flue gas, solid, and liquid samples were analyzed by various methods (ICP, GFAA, PIXE, CVAA) according to the procedures described in the QAPP. Specific deviations from those procedures were as follows:

- (1) Samples sent to CTE for analysis instead of Battelle. In order to meet the reporting deadline, it was necessary to send process solid, process liquid, PSDS filter, and Method 5 samples to Commercial Testing and Engineering Company (CTE) in Denver, Colorado, for analysis. CTE followed the Coal Creek Quality Assurance Plan for element determinations with the following exceptions:
 - The analyses of solid samples by CTE for mercury were accomplished by a double gold film amalgamation CVAA technique. No spike samples were performed due to the use of a solid sample matrix. However, recoveries for solid reference materials were within the limits established for this program.
 - Silicon, aluminum, titanium, potassium, and sodium in solid samples (bottom ash), lime, economizer ash, pyrite rejects, and ESP ash were determined by X-ray fluorescence spectroscopy, in accordance with ASTM D4326, instead of by ICP-AES.
- (2) Reagent blanks not processed/subtracted as in Method 29. Those field reagent blanks from acid probe rinse and from back-half impingers that were obtained were subtracted from sample runs, but not always according to explicit Method 29 procedures. The element concentrations in reagent blanks are expected to be very small, i.e., either within experimental error or below the detection limit. For example, arsenic in C-4A-MUM-622-RB and C-6A+B-MUM-620-FB from front half composite are $0.025 \pm 0.043 \mu\text{g/sample}$ and $0.004 \pm 0.05 \mu\text{g/sample}$, respectively. These blank levels are negligible relative to the lowest arsenic content of $1.21 \mu\text{g/sample}$ in the C-6A-MUM-622 samples.
- (3) Addition of RTI spike samples to back-half impingers and KMnO_4 impingers. RTI spike samples labelled C-4A-MUM-624 (Sequence 2), Impingers 2 and 3, and Impingers 5 and 6 were inadvertently added to the C-4A-MUM-624 peroxide impingers and KMnO_4 impingers, respectively. Similarly, the spike samples from C-5A-MUM-624 (Sequence 2) were mistakenly added to C-5A-MUM-624 peroxide and KMnO_4 impingers. A sample ID for spiked samples that is clearly distinguishable from normal samples is highly recommended.
- (4) Samples for dissolved elements not analyzable -- alternate samples of small volume used. Samples taken for analysis of dissolved elements were

accidentally added to the collecting bottles containing nitric acid for total element determination. Alternate samples collected without acidification were used for dissolved elements determination. These alternate samples had a smaller volume than that originally planned to be used for dissolved element determinations.

- (5) Problems with Si and B determinations of Method 29 samples by CTE. Boric acid was used to complex excess hydrofluoric acid after microwave digestion by CTE. Hydrofluoric acid may also react with glassware or the glass mixing chamber of the ICP analyzer, and may interfere with silicon results. Thus CTE has not reported Si and B results for some samples.

F-2. Ammonia/Cyanide Protocols

Samples were analyzed for ammonia and cyanide according to the procedures stated in the QAPP. A deviation from the planned analyses was that slurry blowdown samples (Locations 17a and 17b) were not analyzed for ammonia and cyanide. These samples consisted of lime slurry after circulation through the FGD unit, and were a mixture of solid and liquid. The pH of these samples could not be readily adjusted to < 2 (for ammonia preservation) or to > 12 (for cyanide preservation) in the field. As a result, these samples were not considered valid for ammonia/cyanide analysis.

F-3. Analytical Protocol for Anions

Anions (fluoride, chloride, sulfate, phosphate) were analyzed by ion chromatography (IC), using a Dionex DX300 instrument with an ion exchange separator column and Micro-Membrane suppressor for conductance detection. All analyses were conducted as described in the QAPP, including the selection of anion exchange columns and the techniques to optimize selectivity and minimize matrix effects. Liquid samples and impinger samples from the anion train (Method 26A) were analyzed directly. Solid samples and flue gas particulate samples were extracted overnight in IC eluent for analysis.

F-4. Analytical Protocol for VOC

F-4.1 Analysis of VOST Traps for VOC

Analysis of VOST sorbent traps for VOC was conducted as described in the QAPP, according to the provisions of SW-846 Method 5041, using thermal desorption GC/MS. Each sampled pair of VOST traps was placed in a heated desorption unit and purged with organic-free nitrogen or helium. The purge gas flow transferred VOC desorbed from the VOST traps to a cold trap for focussing. Heating of the cold trap released collected VOC in a small volume onto the inlet of the GC column. The VOC were then determined by temperature programmed chromatography with detection by low resolution mass spectrometry. Internal standards were used to quantify the VOC.

F-4.2 Canister Analysis for VOCs

Canister samples were analyzed with a gas chromatograph equipped with a mass spectrometric detector. Upon receipt, the initial pressure of each can was recorded and the can was filled with zero air to facilitate sample extraction. The initial and final pressures were used to determine the dilution correction factor. Since acidic gases have been shown to strip the analytical column of bonded liquid phase within a short time period, sampled air from the canister was first directed through a sodium bicarbonate trap to reduce the content of acidic gases. The use of alkaline water was originally specified in the Analytical Management Plan but was shown prior to the field study to partly remove several of the target compounds when challenged with the 41 component calibration mixture. The effluent from the sodium bicarbonate trap was then directed to an adsorbent trap (Carbopak B/ Carbosieve S-III) to preconcentrate the target VOC species. A six-port valve and thermal desorption step were used to inject the adsorbed material onto the analytical column. The column was temperature programmed from -50 to 200°C to resolve the VOCs. Selective ion monitoring was used to quantify the target species. However, sufficient acidic gases were still present in the injected sample that prohibited the operation of the mass spectrometer

until 11 minutes into the run. As a result, the first six species on the 41 component target list were not analyzed. A method detection level of 0.5 ppb was achieved with a sample volume of 60 cc.

F-4.3 Liquid VOC Samples

Volatile organic compounds (VOC) in liquid samples were analyzed by Zande Environmental Laboratories using purge and trap gas chromatography/mass spectrometry. EPA SW846 Method 8240 was followed for the analysis of these samples. All samples were initially analyzed within 14 days of receipt at the laboratory.

Calibration curves were generated and the appropriate Calibration Check Compounds (CCC) and System Performance Compounds (SPCC) were within the limits stated in Method 8240. The system was initially tuned with 4-bromofluorobenzene prior to analysis of the initial calibration curve. The system was not tuned every 12 hours of operation although continuing calibration standards were analyzed every 12 hours and in all instances met the continuing calibration criteria required by Method 8240.

Each sample was fortified with three surrogate compounds prior to analysis. Sample C-9-PRL-623 Matrix Spike fell outside the surrogate recovery limits for all of the three surrogates. Samples C-17A-PRL-623, C-9-PRL-626, and C-17A-PRL-626 exceeded the surrogate recovery limit for 1,2-Dichloroethane- d_4 . There were no target analytes found in any of the samples with the exception of a field and trip blank.

Four matrix spikes and matrix spike duplicates were analyzed. The Relative Percent Difference (RPD) for one set of MS/MSDs was out of the target limit of ± 25 percent. The matrix spike sample in this set exhibited low recovery while the matrix spike duplicate recoveries exhibited average to high recoveries. The other three matrix spike/matrix spike duplicate pairs RPDs were well below 25 percent. Two of these MS/MSDs were from samples collected on 6/27/93 which were off sampling days for liquid VOC samples. Both unspiked samples were free of target analytes and their associated MS/MSDs indicate good precision and accuracy, thus their inclusion in the appendices.

Limits for surrogate recoveries as they appear in the appendices were taken directly from Method 8240. Limits for spike recoveries as they appear in the appendices were taken from Method 8240 QC Acceptance Criteria Table.

F-5. Analytical Protocol for PAH/SVOC

F-5.1 PAH/SVOC in Gas and Solid Samples

Cleaning procedures for PAH/SVOC flue gas sampling materials were as follows. Precleaned XAD-2 resin was purchased from Supelco, Bellefonte, PA. The XAD-2 was further cleaned by Soxhlet extraction with dichloromethane (DCM) for 16 hours, and was dried with a high-purity nitrogen gas stream. The clean XAD-2 resin was then packed in a cleaned MM5 glass cartridge. Quartz fiber filters were purchased from Pallfex Products Corporation in 8-in. x 10-in. sheets. Some of the 8-in. x 10-in. filters were cut to make the 104 mm and 87 mm diameter filters needed for the MM5 sampling trains. Other 8-in. x 10-in. filters were used full size in the PSDS sampling train. All quartz filters were placed in an oven and heated at 450°C for 16 hours to remove trace amounts of organic contaminants. The clean 87 mm and 104 mm filters were then placed in clean petri dishes and sealed with Teflon tape. The clean 8-in. x 10-in. filters were enclosed in clean aluminum foil.

The MM5 samples were prepared according to the Coal Creek Analytical Plan. The MM5 filter and probe rinse filter were spiked with known amounts of d_{12} -chrysene and d_{12} -benzo(k)fluoranthene before Soxhlet extraction. If dioxin/furan analysis was required for the sample, known amounts of $^{13}C_{12}$ -labelled dioxin/furan internal standards were also spiked onto the sample. The filters were then extracted with dichloromethane (DCM) for 18 hours. Note that in the Coal Creek QAPP the extraction time is indicated as 16 hours, but the actual extraction time for all the samples was 18 hours. The DCM extract was combined with the filtrate from the probe rinse and concentrated by Kuderna-Danish (K-D) evaporation. If dioxin/furan analysis was required, the combined extract was split into two equal portions: one portion for SVOC analysis and one portion for dioxin/furan analysis. Cyclone samples collected at Locations 4a and 5a were spiked with perdeuterated PAH and extracted with

DCM for 18 hours. The DCM extracts were concentrated to 1 mL by K-D evaporation for silica gel column chromatography.

The XAD-2 samples were spiked with perdeuterated PAH and/or ^{13}C -labelled dioxin/furan and extracted with DCM. The condensate was adjusted to pH 7 and extracted with DCM according to the QAPP. The XAD-2 extract was combined with the module rinse and condensate, and concentrated to 1 mL for silica gel column chromatography.

Aliquots of the solid process samples were spiked with perdeuterated PAH and extracted with DCM for 18 hours. The DCM extracts were concentrated to 1 mL for silica gel column chromatography.

The DCM extract was solvent exchanged into hexane (C_6) and applied to a silica gel column. The column was packed with 5 percent water deactivated silica gel with C_6 . Three elution solvents, C_6 , C_6/DCM (50/50), and methanol were applied to the column. The C_6/DCM fractions were concentrated to 1 mL with K-D evaporation and further concentrated to 100 μL with nitrogen evaporation for GC/MS analysis. Some of the C_6/DCM fractions of XAD-2 extracts were diluted to 1 mL or more to minimize sample matrix effects for GC/MS analysis. The methanol fractions were concentrated to 1 mL, evaporated almost to dryness, and solvent exchanged into 1 mL of DCM for GC/MS analysis.

A Finnigan TSQ-45 GC/MS/MS operated in GC/MS mode equipped with an INCOS 2300 data system was employed. Helium was the GC carrier gas and a 70 eV electron beam was used. The MS was operated in the selected ion monitoring mode. Ion peaks monitored by MS are the molecular ions and characteristic fragment ions of target analytes. Identification of the target analytes was based on the correct molecular ion, correct fragment ions, and the correct retention time relative to the internal standard. Quantification of each target analyte followed the method described in the Coal Creek QAPP.

F-5.2 Liquid SVOC Samples

Semivolatile organic compounds (SVOC) in liquid samples were extracted and analyzed by Battelle using liquid/liquid extraction, and analysis by gas chromatography/mass spectrometry. EPA SW846 Method 3560 and 8270 was followed for the analysis of these

samples. All samples were initially extracted within 7 days of receipt at the laboratory and the extracts analyzed within 40 days.

One liter aliquots of each sample were fortified with the appropriate surrogate compounds to monitor extraction efficiency, serially extracted three times with methylene chloride, concentrated to 1 mL, fortified with internal standards, and analyzed on an HP 5970 MSD. Every sample with the exception of blanks and spiked blanks formed emulsions. The emulsions were much more pronounced in the base/neutral extraction than in the acid extraction. Due to the formation of emulsions, each 60 mL aliquot of extract was collected in a centrifuge bottle, centrifuged, the organic removed, and the remainder added back to the separatory funnel prior to the next addition of solvent. No problems were encountered in the concentration step.

Calibration curves were generated and the appropriate Calibration Check Compounds (CCC) and System Performance Compounds (SPCC) were within the limits stated in Method 8270.

The system was initially tuned with decafluorotriphenylphosphine prior to analysis of the initial calibration curve. The system was also tuned every 12 hours of operation and met the required ion abundances. Continuing calibration standards were analyzed every 12 hours and in all instances met the continuing calibration criteria required by Method 8270 for CCCs and SPCCs. Method 8270 allows for 30 percent RSD on CCCs and this criteria was used. The QAPP incorrectly stated 25 percent RSD.

Each sample was fortified with eight surrogate compounds prior to analysis. Two of the surrogates do not have established recovery limits. All samples were within surrogate recovery limits except sample C-9-PRL-621 was borderline for 2-fluorophenol with recovery of 20.8 percent and a recovery limit of 21 percent and its spiked sample C-9-PRL-MS recovery for 2-fluorobiphenyl was 42.8 percent with a surrogate recovery limit of 43 percent.

Four matrix spikes and matrix spike duplicates were analyzed and one spiked method blank and spiked method blank duplicate. The Relative Percent Difference (RPD) for one set of MS/MSDs was out of the target limit of ± 25 percent. The matrix spike sample in this set exhibited low recovery while the matrix spike duplicate recoveries exhibited average recoveries. The other matrix spike/matrix spike duplicate pairs were well below the RPD target of 25 percent.

Limits for surrogate recoveries as they appear in the appendices were taken directly from Method 8270. Limits for spike recoveries as they appear in the appendices were taken from Method 8270 QC Acceptance Criteria Table.

F-6. Analytical Protocol for Dioxins/Furans

Samples of the vapor phase and particulates from the MM5 sampling train were extracted for dioxin/furan analysis with the same procedures used for PAH/SVOC gas and solid samples. The front half of the MM5 train, including the probe rinse and particulate filter, were prepared and analyzed for dioxins/furans in the solid phase and the back half of the MM5 train, including XAD-2 resin, module rinse and condensate, were prepared and analyzed for dioxins/furans in the vapor phase as outlined in the QAPP.

The solid phase sample was prepared by filtering the probe rinse, combining the probe rinse filter and the particulate filter in a Soxhlet extractor, spiking with $^{13}\text{C}_{12}$ -labeled dioxin/furan standards and extracting with methylene chloride. The extract was combined with the probe rinse filtrate and the combined solution was split into two equal portions, one of which was further processed for dioxin/furan analysis. The vapor phase sample was prepared by Soxhlet extracting with methylene chloride the XAD-2 resin spiked with $^{13}\text{C}_{12}$ -labeled dioxin/furan standards. The XAD-2 extract was combined with the module rinse and condensate extracts. The combined solution was split into two equal portions, one of which was further processed for dioxin/furan analysis.

Both the solid and vapor phase samples were processed through dioxin/furan cleanup procedures which included spiking the extracts with 2,3,7,8-TCDD- $^{37}\text{Cl}_4$ cleanup standard, washing with acidic and basic solutions, and processing through acid/base silica, alumina, and carbon cleanup columns. The clean extracts were concentrated and spiked with 1,2,3,4-TCDD- $^{13}\text{C}_{12}$ and 1,2,3,7,8,9-HxCDD- $^{13}\text{C}_{12}$ recovery standards. Samples were then analyzed for dioxins/furans by gas chromatography/high resolution mass spectrometry.

The sample preparation procedures outlined above and described in the QAPP differ somewhat from the preparation procedure detailed in EPA Method 23. A major difference is that the sampling trains were prepared to obtain two sample fractions, one representative of the solid phase and one representative of the vapor phase. Other differences include:

- Soxhlet were pre-extracted and samples extracted with methylene chloride rather than toluene. Methylene chloride was the preferred extraction solvent for obtaining volatile PAH analytes. As stated in the QAPP, both dioxin/furan and PAH data were obtained by extracting one sample and splitting the extract into two portions, one for dioxin/furan specific cleanup and one for PAH specific cleanup. To insure recovery of the volatile PAHs while not affecting the efficiency of extracting dioxins/furans, methylene chloride was used as the extraction solvent.
- Samples were Soxhlet extracted for 18 hours rather than 16 as specified in Method 23 and the QAPP. The additional extraction time should not have impacted the analytical results.
- The calibration and spiking solutions used were at concentrations recommended by EPA Method 1613. Method 1613 solution concentrations vary slightly from Method 23 and also include additional $^{13}\text{C}_{12}$ -labeled internal standards. The additional labeled internal standards provide better accuracy in identifying and quantifying analytes.
- Extract cleanup involved two additional steps which are recommended cleanup procedures in EPA Method 1613. First, the addition of 2,3,7,8-TCDD- $^{37}\text{Cl}_4$ as a recovery standard to each extract prior to any cleanup was used to evaluate the recovery of analytes through the cleanup procedures. Second, the addition of acid/base washing the extract prior to column cleanups. The acid/base wash is a routine step in both EPA Methods 8290 and 1613.
- Cleanup columns included acid/base silica, alumina, and AX21/celite as required in Method 23; however, amounts of column packing material and elution solvents were similar to those listed in EPA Method 1613 and varied slightly from Method 23 in some instances.
- The GC oven temperature program for separating analytes on a DB-5 column follows Method 1613, which varies somewhat from Method 23, but provides adequate separation of all analytes of interest.
- No second column confirmation of 2,3,7,8-TCDF on a DB-225 column was performed. The DB-5 column does not separate 2,3,7,8-TCDF from other TCDF isomers. As a result, values reported for 2,3,7,8-TCDF could include contributions from coeluting, non-2,3,7,8 isomers.
- No surrogate standards listed in Method 23 were added to the sampling trains before collecting field samples; therefore, the sampling train collection efficiency was not determined.

- Routine continuing calibration response factors for OCDD-¹³C₁₂ were slightly above the ± 30 percent limit from the initial calibration on all analysis days. In addition, on 10/5/93 the continuing calibration response factors for 1,2,3,4,6,7,8-HpCDD-¹³C₁₂ and 1,2,3,4,6,7,8-HpCDF-¹³C₁₂ were slightly above the ±30 percent limit from initial calibration. Because of the very low level of analytes found in the samples, and because only three response factors out of a total of 33 native and recovery response factors were out of limits, the initial calibration was not repeated.

F-7. Analytical Protocol for Aldehydes

Gas samples (DNPH impinger solutions) collected from the ESP inlet, outlet, and the FGD outlet, as well as liquid process samples were analyzed for formaldehyde, acetaldehyde, acrolein, and propionaldehyde using high performance liquid chromatography with ultraviolet detection (HPLC/UV). Prior to the collection of the gas aldehydes, the DNPH reagent for the impinger samples was prepared by mixing 0.06 g of purified DNPH crystals per 250 mL of acetonitrile. Fifty (50) µL of sulfuric acid was also added to each 250 mL of DNPH reagent.

After the gas samples had been collected and prior to analysis, the volume of DNPH impinger solution collected from each impinger was measured with a graduated cylinder. Next, a 4-mL aliquot from each sample was transferred to a 4-mL HPLC sample vial with a septa-seal top. The HPLC vials were used as the permanent storage vessel for the impinger samples. These HPLC vials were refrigerated before and after analysis.

For liquid samples (both process liquid samples and condensed water samples from the gas sampling trains), all samples were reacted with DNPH just prior to analysis. An aliquot of 2 mL of each liquid sample and 2 mL of DNPH reagent were mixed in a 4-mL HPLC sample vial with septa-seal top. The HPLC vials were used as the permanent storage vessel for the liquid samples. The liquid-DNPH solutions were allowed to react for at least 3 hours prior to analysis. This reaction time is necessary to assure that all of the aldehyde species present in the liquid will be converted to carbonyl-DNPH derivatives. After the waiting period, the samples were analyzed. For the liquid samples, standards were prepared by adding the neat aldehydes to HPLC water at concentrations above and below those found

in the actual samples. The standard water samples were reacted with the DNPH in the same manner as the actual samples.

For the process liquid samples, additional sample preparation steps had to be implemented because of the large amount of dissolved solids in the samples and because of the varying pH of the samples. Prior to reaction with the DNPH solution, the process liquid samples were filtered through a 0.22 μm filter and the pH of the liquid was checked with pH indicator paper. If any sample had a strongly alkaline pH (e.g. pH = 10) a drop of sulfuric acid was added to the sample to acidify it. The pH of the condensed water samples was also monitored and adjusted.

After the process liquid samples were reacted with the DNPH, a white precipitate settled out in a number of the samples. To protect the HPLC system, the liquid above the precipitate was decanted off and placed into a new HPLC vial. It was this liquid that was analyzed on the samples in which precipitation occurred.

All of the samples were analyzed with a Waters HPLC system. An acetonitrile/H₂O mixture (65/35) serves as the mobile phase. Column flow is 0.8 mL/min. Typically, the injection volume used for aldehyde samples was 30 μL .

F-8. Analytical Protocol for Radionuclides

Radiological analysis of both the gas (filter) samples and the solid samples was performed by the International Technology (IT) Corporation's Oak Ridge, Tennessee, laboratory using a gamma scan method. The samples were prepared for gamma spectrometry using that laboratory's standard operating procedure OR-7003, Revision 0. Then the radioactivity counts were obtained using IT-Oak Ridge standard operating procedure OR-7212, Revision 0.

During the analysis procedures the following reports were prepared:

- Peak Search Report
- Nuclide Identification Report
- Nuclide Line Activity Report
- Minimum Detectable Activity Report
- Summary of Nuclide Activity

For each sample the analysis results were summarized by reporting the activity in pico Curies per gram for the following isotopes as was called for in the QAPP:

Pb-210	Pb-211
Pb-212	Th-229
Ra-226	Th-230
Ra-228	U-234
Th-234	U-235

For those isotopes which were within the detection limits, the 2-sigma error was also reported.

APPENDIX G
UNCERTAINTY ANALYSIS

UNCERTAINTY ANALYSIS

An error analysis was conducted to provide an estimate of the uncertainty of the reported values for average emission factors. Emission factors on three days are reported in Section 6.2, along with the arithmetic average, $\bar{E}$. This Appendix describes the calculations done to estimate the total uncertainties in emission factors, shown as TU in the tables in Section 6.2. Daily emission factors were calculated by:

$$E_i = \frac{2.205 * g * (s + v)}{(HHV * cf)} \quad (G-1)$$

where

E_i = daily emission factor, lb/10¹²Btu

g = daily flue gas flow rate, Ncm/hr

s = daily solid phase concentration of substance in flue gas, $\mu\text{g}/\text{Ncm}$

v = daily vapor phase concentration of substance in flue gas, $\mu\text{g}/\text{Ncm}$

HHV = daily higher heating value of feed coal, Btu/lb

cf = coal feed rate, klb/hr

A goal of this project was to determine a representative value for E , the average emission factor for a substance from the power plant. The reported value of $\bar{E}$ is an average from only three days of sampling. Daily variation in operation of the power plant contributes to uncertainty in the estimation of the long term average emission rates of substances.

G-1. Identification of Sources of Error

Two types of errors must be considered (ANSI/ASME PTC 19.1-1985, "Measurement Uncertainty", available from the American Society of Mechanical Engineers): random errors (or precision errors) and bias.

Three factors contribute to precision errors or variability in the reported daily emission factors. First, plant operating conditions change from day to day. Second,

variability in collecting samples leads to errors in determining the five parameters in equation G-1 that are used to calculate the estimate of E_i . Third, variability in analyzing the collected samples for s , v , and HHV leads to errors in estimating E_i .

Bias in determining E_i can result from systematic errors in determining any of the five parameters in equation G-1. Bias errors are assumed to be constant throughout the measurement process. They can be significant, known and accounted for in calibrations; insignificant, known, and ignored in the uncertainty analysis; or estimated and included in the uncertainty analysis. The bias, when included in an uncertainty analysis, is estimated as a upper limit of the bias error.

G-2. Procedures for Estimating Uncertainty

The error analysis for this project was designed to provide uncertainty intervals around the reported average emission factors of the form

$$\text{Emission factor (lb/10}^{12} \text{ Btu)} = \bar{E} \pm (U^2 + B^2)^{1/2} \quad (\text{G-2})$$

where

$\bar{E}$ = arithmetic average of the daily emission factors E_i

U = an approximate 95% confidence bound accounting for random errors

B = possible bias due to systematic errors.

Precision Errors

The 95 percent confidence bounds were calculated by

$$U = \frac{t \cdot S}{\sqrt{3}}$$

where

t = 4.303, the upper 97.5 percentile of Student's t distribution with two degrees of freedom

S = standard deviation of the three daily emission factors.

Thus,

$$U = 2.48 * S.$$

The resulting confidence level is approximately 95 percent. This assumes that the distribution of daily emission factors for each substance approximates a normal distribution.

Battelle evaluated whether or not to use propagation of error methods, such as those described in the ANSI/ASME document cited above, to determine the statistical uncertainty of the average emission factors. Propagation methods are often used to establish the uncertainty of a function of several measured input parameters. Battelle believes that the approach described above is preferred over propagation of error methods because the objective of this error analysis is to estimate the uncertainty of the average of independent determinations of daily emission factors. Computing the standard deviation of the E_i accounts for the three sources of variability cited above: day-to-day variations in plant operations, sampling error, and measurement error. The propagation of errors method is an approximate solution that will produce similar results, provided that the correlations among the input parameters are taken into account. For example, one would expect a high degree of correlation between the measured solid and vapor phase concentrations on each day and between the daily coal feed rates and flue gas flow rates.

Bias

The potential bias on E due to systematic errors in any of the five measured parameters in equation G-1 was calculated by

$$B = (\sum B_j^2)^{1/2} \quad (G-3)$$

where $B_j = dE_i/dp_j * \beta_j$ is the resulting bias in E_i caused by a systematic error of β_j in measuring parameter p_j ($j=1-5$ for g, s, v, HHV, and cf). These errors could not be specifically identified or confirmed; thus no correction was applied to the measured parameters. Battelle's estimates of the values of β_j are described below.

Flue gas flow rate. Determination of the flue gas flow rate, g, was assigned an upper limit of 4 percent for bias error. The bias for the gas flow measurement was estimated by comparing measured gas flows rates to flow rates calculated from the coal feed

rate and the oxygen content at the various sampling points. The ratio of measured flow rates to calculated flow rates for Locations 4, 5, and 6 were 1.14, 1.02, and 1.04, respectively. The results from Location 6 were used to calculate the emission factors, and thus the ratio of measured to calculated flow rate for Location 6 was the basis for estimating bias. An evaluation of Locations 4 and 5 was made for comparison. Location 4 was known to be the poorest sampling location, as evidenced by the 14 percent discrepancy.

Solid phase concentrations. Solid phase concentrations, s , were calculated by dividing the quantity of a substance determined in the laboratory analysis of a sample by the flue gas volume associated with that sample. The amount of sample collected from the flue gas stream approximates the actual concentration. Potential bias in the quantity of collected material is summarized in Table G-1.

Sources of analytical bias (Quality Assurance for Chemical Measurements; Taylor, John Keenan; Lewis Publishers, Inc., Chelsea, Michigan, 1987) are listed in Table G-2 along with the estimate of the magnitude of the bias associated with each source. The estimates shown in Table G-2 were derived as follows:

Inefficiency Losses - Results for organic analyses are corrected for extraction recoveries. A bias of 2 percent is estimated for inorganic analyses based on matrix spike and SRM recovery results.

Calibration - For most organic and inorganic analytes, routine calibration results were required to be within ± 25 percent of initial calibration. Battelle's estimate of the bias in calibration is 5 percent.

Interference Resolution - The estimate of bias is zero because interferences are typically corrected for in organic and inorganic analyses or data are flagged as being affected by interference.

Contamination Gains - Data are corrected for contamination gains derived from field sampling, sample handling, and sample shipping by subtracting train blank results from sample data; therefore, the bias estimate is zero.

Instrumental Shifts - Instrumental shifts are considered to be corrected for by calibration bias; therefore the estimate is zero.

Matrix Effects - Matrix effects are evaluated by use of matrix spike samples. The estimate is zero because no consistent bias was detected in analysis of either inorganic or organic matrix spike samples.

Theoretical - Battelle's extensive experience with the inorganic and organic analyses conducted on this program has not detected any consistent bias based on theoretical effects; therefore the estimate is zero.

Operator Bias - Many of the analyses were conducted by different operators and no consistent bias was detected; therefore the estimate is zero.

Tolerance Adjustments - Based on Battelle's laboratory analysis experience, consistent bias with tolerance adjustments is nonexistent; therefore the estimate is zero.

Uncorrected Blank - Most sample results are corrected for laboratory method blanks and reagent blanks (where applicable) or blank results are negligible. Therefore the estimated bias from uncorrected blanks is zero.

Based upon these estimates, a bias error of 5 percent for organic solid phase determinations was estimated. Seven percent was estimated for inorganic solid phase determinations.

Considering both sampling and analysis together, the estimates of β_j for solid substances were computed as the square root of the sum of the squares of the individual bias estimates (see Table G-4).

Vapor phase concentrations. Vapor phase concentrations, v , were calculated by dividing the quantity of a substance determined in the laboratory analysis of a sample by the flue gas volume associated with that sample. The amount of sample collected from the flue gas stream approximates the actual concentration. Potential bias in the quantity of collected material is summarized in Table G-3.

Sources of analytical bias and associated bias estimates for vapor phase samples are the same as those listed in Table G-2 for solid phase samples except for the bias associated with the inefficiency losses for inorganic analyses. This bias is estimated to be 1 percent rather than 2 percent because the difficulty with preparing liquid phase samples for inorganic analysis is typically less than that for solid phase samples.

Combining the errors for sampling and analysis, Battelle estimated the β_j for vapor substances as shown in Table G-5.

Higher heating value of coal. The bias for the coal heating value determination was estimated at 2 percent. This estimate is based on the fact that the coal heating value is determined by a well-proven ASTM procedure by laboratories doing many samples daily. Additionally, utilities keep careful watch over their boiler efficiency and heat rate values. As the heating value is a major input to boiler efficiency and heat rate calculations, a bias as large as 2 percent would be obvious. Hence, a 2 percent bias estimate was assigned to the heating value determinations.

Coal feed rate. The bias for the coal feed rate measurement for the Niles Station Boiler No. 2 was estimated at 2 percent. This estimate was based on the fact that utilities, in general, keep careful watch over their fuel consumption and boiler efficiency. (The cost of fuel is typically 40 to 50 percent of the cost of generating electricity and, thus, is of major importance.) A bias as large as 2 percent in the fuel feed rate would be very obvious to the plant operators and action would be taken to correct any problem. However, many plant operators do not regularly calibrate their coal scales and are content to use the indicated coal feed rate as a relative measure of the coal being fired. Such is not the case at Coal Creek, where each coal feed scale is calibrated quarterly. Results of these calibrations, presented in Appendix A, indicate bias error of less than 0.2 percent. Hence, a 2 percent upper limit estimate was selected for β_5 .

Summary. The estimated upper limits for bias terms are listed in Table G-6. Because of the uncertainty in estimating values for the β_j themselves, a decision was made to combine the values for β_2 and β_3 into one term. Therefore the values of $\beta_{2/3}$ were assigned as follows: elements - 7 percent, anions - 7 percent, radionuclides - 9 percent, particulate matter - 8 percent, SVOC - 7 percent, dioxins/furans, 7 percent, ammonia/cyanide - 6 percent, VOC - 8 percent, and aldehydes - 6 percent. Together with calculations of precision error, these terms were used to calculate the uncertainty intervals shown in the tables of emission factors in Section 6.2.

G-3. Example Calculation

The following example calculation applies to calculating the uncertainty in the average emission factor for mercury.

Daily emission factors were calculated using Equation G-1:

$$E_1 = \frac{2.205 * 1,841,280 * 11.2}{6,132 * 897} = 8.27 \text{ lb}/10^{12} \text{ Btu}$$

$$E_2 = \frac{2.205 * 1,840,620 * 17.1}{5,916 * 911} = 12.9$$

$$E_3 = \frac{2.205 * 1,809,960 * 9.74}{6,062 * 881} = 7.27$$

Where E_1 , E_2 , E_3 are the mercury emission factors for June 22, 24, and 27, respectively. For example, the parameters used to calculate E_1 , for June 22, 1993, are found as follows:

<u>Parameter</u>	<u>Value</u>	<u>Where Found</u>
g	1,841,280 Ncm/hr	Table 2-3 as 30,688 Ncm/min
s+v	11.2 $\mu\text{g}/\text{Ncm}$	Table 5-8
HHV	6,132 Btu/lb	Table 5-105
cf	897 klb/hr	Table 2-5

The average value $\bar{E}$ was calculated as

$$\bar{E} = \frac{(8.27 + 12.9 + 7.27)}{3} = 9.48 \text{ lb}/10^{12} \text{ Btu}$$

The standard deviation, S, of the daily emission factors was calculated as

$$S = \sqrt{\frac{1}{(N-1)} \sum_{i=1}^N (E_i - \bar{E})^2}$$

$$= \sqrt{\frac{1}{2}[(8.27 - 9.48)^2 + (12.9 - 9.48)^2 + (7.27 - 9.48)^2]} = 3.00 \text{ lb/10}^{12} \text{ Btu}$$

The parameter U was calculated as

$$U = 2.48 * S = 2.48 * 3.00 = 7.44 \text{ lb/10}^{12} \text{ Btu}$$

The bias parameter B was calculated using Equation G-3. The B_j components were calculated as follows:

$$B_1 = \frac{dE}{dg} \beta_1$$

$$B_{2/3} = \frac{dE}{d(s+v)} \beta_{2/3} \text{ (j=2, s and j=3, v were combined)}$$

$$B_4 = \frac{dE}{dHHV} \beta_4$$

$$B_5 = \frac{dE}{dcf} \beta_5$$

where E, g, (s+v), HHV, and cf are each the average value.

Now,

$$\frac{dE}{dg} = \frac{2.205 * (s+v)}{HHV * cf}, \quad j=1$$

$$\frac{dE}{d(s+v)} = \frac{2.205 * g}{HHV * cf}, \quad j=2/3$$

$$\frac{dE}{dHHV} = \frac{-2.205 * g * (s+v)}{(HHV)^2 * cf}, \quad j=4$$

$$\frac{dE}{d cf} = \frac{-2.205 * g * (s+v)}{HHV * cf^2}, \quad j=5$$

From Table G-6, the β_j are:

$$\beta_1 = 4\% \text{ of } g$$

$$\beta_{2/3} = 7\% \text{ of } (s+v) \quad (\text{see text on page G-7})$$

$$\beta_4 = 2\% \text{ of } HHV$$

$$\beta_5 = 2\% \text{ of } cf$$

The term B_1 was calculated as follows:

$$\frac{dE}{dg} = \frac{2.205 * 12.7}{6,037 * 896} = 5.18 \times 10^{-6} \text{ (lb/10}^{12} \text{ Btu)/(Ncm/hr)}$$

where $(s+v)$ = average of daily values (Table 5-8)

$$= (11.2 + 17.1 + 9.74)/3 = 12.7 \text{ } \mu\text{g/Ncm}$$

HHV = average of coal heating values

$$= (6,132 + 5,916 + 6,062)/3 = 6,037 \text{ Btu/lb}$$

cf = average of coal feed rate (Table 2-5)

$$= (897 + 911 + 881)/3 = 896 \text{ lb/hr}$$

therefore,

$$B_1 = 5.18 \times 10^{-6} * 0.04 * 1,830,620 = 0.379 \text{ lb/10}^{12} \text{ Btu}$$

where g = average of daily values (Table 2-3)

$$= (30,688 + 30,677 + 30,166) * 60/3 = 1,830,620 \text{ Ncm/hr}$$

Using the values above, the other components of bias were calculated in a similar manner, i.e.,

$$B_{2/3} = \frac{2.205 * 1,830,620}{6,037 * 896} * 0.07 * 12.7 = 0.663 \text{ lb/10}^{12} \text{ Btu}$$

$$B_4 = \frac{-2.205 * 1,830,620 * 12.7}{(6,037)^2 * 896} * 0.02 * 6,037 = -0.190 \text{ lb/10}^{12} \text{ Btu}$$

and

$$B_5 = \frac{-2.205 * 1,830,620 * 12.7}{6,037 * (896)^2} * 0.02 * 896 = -0.190 \text{ lb/10}^{12} \text{ Btu}$$

Then,

$$B = (0.379^2 + 0.663^2 + (-0.190)^2 + (-0.190)^2)^{1/2}$$

$$B = 0.810 \text{ lb/10}^{12} \text{ Btu}$$

Finally, the total uncertainty was calculated as

$$U = (7.44^2 + 0.81^2)^{1/2} = 7.48 \text{ lb/10}^{12} \text{ Btu}$$

TABLE G-1. BIAS ESTIMATES FOR FLUE GAS SAMPLING OF
SOLID SUBSTANCES

Analyte Class	Estimated Bias (percent)	Source of Bias; Documentation
Elements Anions SVOC Dioxins/Furans Radionuclides Particulate Matter	5	Departure from isokinetic sampling; value is based on sampling data that show maximum departure of about 5 percent from isokinetic conditions. The bias for collection of solid phase material was assumed to be equal in magnitude to the departure from isokinetic conditions.
Elements Anions SVOC Dioxins/Furans Radionuclides Particulate Matter	2	Flow measurement error; required by Method regulations and maintained so by gas meter calibrations. Also consistent with RTI audits of Battelle's gas meters.
Elements SVOC Dioxins/Furans Particulate Matter	0	Loss of particulate matter in probe; value of zero results from recovery of particulate matter in probe wash.
Anions Radionuclides	5	Loss of particulate matter in probe; value is an estimate based on use of short probe, with no probe rinse. Consistent with losses of particles observed in long probe and flexible line.

TABLE G-2. BIAS ESTIMATES FOR LABORATORY ANALYSIS

Source of Bias ^(a)	Estimated Bias (percent)	
	Organic ^(b)	Inorganic ^(c)
Inefficiency Losses	0	2 (solid) 1 (vapor)
Calibration	5	5
Interference Resolution	0	0
Contamination Gains	0	0
Instrumental Shifts	0	0
Matrix Effects	0	0
Theoretical	0	0
Operator Bias	0	0
Tolerance Adjustments	0	0
Uncorrected Blank	0	0

(a) Quality Assurance for Chemical Measurements; Taylor, John Keenan; Lewis Publishers, Inc., Chelsea, Michigan, 1987.

(b) Organic analytes include SVOC, VOC, dioxins/furans, and aldehydes.

(c) Inorganic analytes include elements, anions, ammonia/cyanide, and radionuclides.

TABLE G-3. BIAS ESTIMATES FOR FLUE GAS SAMPLING OF
VAPOR SUBSTANCES

Analyte Class	Bias (percent)	Source of Bias; Documentation
Elements Ammonia/Cyanide Anions VOC SVOC Dioxins/Furans Aldehydes	2	Flow measurement error; required by Method regulations and maintained so by gas meter calibrations. Also consistent with RTI audits of Battelle's gas meters.
Elements Ammonia/Cyanide Anions Aldehydes	2	Completeness of collection in impinger solutions; based on experience with similar systems, including DNPH for aldehydes.
VOC SVOC Dioxins/Furans	5	Completeness of collection on solid sorbents; based on experience with similar systems, including XAD for PAH/SVOC.
Elements SVOC Dioxins/Furans	0	Loss in probe; value of zero results from recovery of probe wash.
Ammonia/Cyanide Anions VOC Aldehydes	2	Loss in probe; value is maximum likely value given elevated temperature of probe, but no probe wash.

TABLE G-4. CALCULATION OF BIAS ERROR TERMS (β_2) FOR SOLID PHASE SAMPLES

Substance	Sampling Bias ^(a) Errors (percent)	Analytical Bias ^(a) Errors (percent)	$\beta_2^{(b)}$ (percent)
Inorganic			
Elements	5,2	5,2	8
Anions	5,2,5	5,2	9
Radionuclides	5,2,5	5,2	9
Particulate Matter	5,2	5,2	8
Organic			
SVOC	5,2	5	7
Dioxins/Furans	5,2	5	7

(a) See text for origin of individual estimates.

(b) Computed as the square root of the sum of the squared error estimates for sampling and analysis.

TABLE G-5. CALCULATION OF BIAS ERROR TERMS (β_3) FOR VAPOR PHASE SAMPLES

Substance	Sampling Bias ^(a) (percent)	Analytical Bias ^(a) (percent)	$\beta_3^{(b)}$ (percent)
Inorganic			
Elements	2,2	1,5	6
Anions	2,2,2	1,5	6
Ammonia/Cyanide	2,2,2	1,5	6
Organic			
SVOC	2,5	5	7
Dioxins/Furans	2,5	5	7
VOC	2,5,2	5	8
Aldehydes	2,2,2	5	6

(a) See text for origin of individual estimates.

(b) Computed as the square root of the sum of the squared error estimates for sampling and analysis.

TABLE G-6. ESTIMATED VALUES FOR BIAS TERMS IN THE
UNCERTAINTY ANALYSIS

Parameter	Substance	Upper Limit Bias Term β_i (percent)
g		4
s	Elements	8
	Anions	9
	Radionuclides	9
	Particulate Matter	8
	SVOC	7
	Dioxins/Furans	7
v	Elements	6
	Anions	6
	Ammonia/Cyanide	6
	SVOC	7
	Dioxins/Furans	7
	VOC	8
	Aldehydes	6
HHV		2
cf		2

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