To determine lime-lime emissions from existing kiln.

EMISSION TEST REPORT
LIME KILN VENTURI SCRUBBER STACK
W. S. FREY COMPANY
CLEAR BROOK, VA 22624

Prepared for:

W. S. FREY COMPANY
Clear Brook, Virginia 22624

Prepared By:

Roy F. Weston, Inc.
Weston Way
West Chester, Pennsylvania 19380

W.O. No.: 6845-01-02

JULY 1992

EMISSION TEST REPORT
LIME KILN VENTURI SCRUBBER STACK
W. S. FREY COMPANY
CLEAR BROOK, VA 22624

Prepared for:

W. S. FREY COMPANY
Clear Brook, Virginia 22624

Richard Ruch
Project Director

Uttam Trivedi, P.E.
Project Manager
(215) 344-3674

Kam Lo (Larry) Si
Project Engineer

Prepared By:

Roy F. Weston, Inc.
Weston Way
West Chester, Pennsylvania 19380

W.O. No.: 6845-01-02

JULY 1992

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SECTION 1
SUMMARY

Roy F. Weston, Inc., (WESTON®) was retained by W.S. Frey Company (FREY) to conduct a source emission testing program on the stack of the venturi scrubber serving the lime kiln process at the Clear Brook, Virginia facility.

The objective of the testing was to measure particulate matter (TSP), sulfur dioxide (SO_2), oxides of nitrogen (NO_x) and carbon monoxide (CO) emission concentrations and mass rates exiting the lime kiln's venturi scrubber. All testing procedures conformed with United States Environmental Protection Agency (EPA) Reference Methods (40 CFR 60, Appendix A). Mr. David A. Taylor of the Commonwealth of Virginia's Department of Air Pollution Control (DAPC) was present during the testing program.

A summary of the test results is presented in Table 1-1.

TABLE 1-1

SUMMARY OF EMISSIONS
LIME KILN VENTURI SCRUBBER STACK
W.S. FREY COMPANY - CLEAR BROOK, VIRGINIA

TEST DATA			
Run No.	One	Two	Three
Date	5-19-92	5-19-92	5-19-92
Time	0845-1024	1154-1329	1455-1624
STACK DATA			
Temperature, °F	148	148	148
Oxygen, % by volume, dry	4.8	5.0	5.8
CO_2, % by volume, dry	20.9	20.7	18.9
Moisture, %	24.1	23.6	24.0
Velocity, ft/sec	92.0	92.0	91.7
Volume Flow Rate			
- Actual, ACFM	34,500	34,500	34,400
- Standard, DSCFM	23,000	23,200	23,000
NITROGEN OXIDE			
Concentration, ppmv (dry)	494.6	479.8	598.0
Mass Rate, lb/hr	81.5	79.7	98.5
Emission Factor, lb/ton of lime	9.1	8.5	10.7
SULFUR DIOXIDE			
Concentration, ppmv (dry)	726.7	891.1	768.3
Mass Rate, lb/hr	166.5	206.0	176.1
Emission Factor, lb/ton of lime	18.5	21.9	19.1
CARBON MONOXIDE			
Concentration, ppmv (dry)	85.3	180.5	50.9
Mass Rate, lb/hr	8.6	18.3	5.1
Emission Factor, lb/ton of lime	1.0	1.9	0.6
PARTICULATE			
Concentration, gr/dscf	0.0485	0.0425	0.0705
Mass Rate, lb/hr	9.57	8.46	13.89
Emission Factor, lb/ton of lime	1.1	0.9	1.5

SECTION 2
INTRODUCTION

WESTON was retained by FREY to conduct a source emission testing program on the stack of the venturi scrubber serving the lime kiln process (reference No. 22 and SCC No. 30501604) at the Clear Brook, Virginia facility.

The objective of the testing was to measure particulate matter (TSP), sulfur dioxide (SO_2), oxides of nitrogen (NO_x) and carbon monoxide (CO) emission concentrations and mass rates exiting the lime kiln's venturi scrubber. All testing procedures conformed with United States Environmental Protection Agency (EPA) Reference Methods (40 CFR 60, Appendix A).

All tests were performed on 19 May 1992 by WESTON Air Quality Testing Services personnel. Mr. Mark A. Georgiana of FREY coordinated the testing with facility operations and served as WESTON's technical contact throughout the effort. Mr. David A. Taylor of the Commonwealth of Virginia's DAPC was present during the entire testing program.

Section 3 of this report presents the detailed results of the testing effort. Section 4 describes the lime kiln process. Section 5 describes the test location. Section 6 describes sampling trains and general sampling test procedures. Raw test data, laboratory reports, sample calculations, equipment calibration records, process operations data, calibration gas certificates, chain of custody, and a list of WESTON project participants are provided in Appendices A through H, respectively.

SECTION 3
RESULTS AND DISCUSSIONS

A summary of the test results is presented in Table 1-1, page 1-2 of this report. Detailed test data and results are presented in Table 3-1 of this section.

All test data and test results shown herein are believed to be representative of process emissions encountered during the testing periods. Mr. David A. Taylor of the Commonwealth of Virginia's DAPC was present to observe the testing and process operations.

No process, sampling or analytical problems were noted during the entire testing program.

Table 3-1. Detailed Summary Of Emissions - TSP, NOx, SO2, CO. W.S. Frey Co. Lime kiln Venturi Scrubber Stack.

TEST DATA:			
Test run number	1	2	3
Test location		SCRUBBER STACK	
Test date	05-19-92	05-19-92	05-19-92
Test time period	0854-1024	1154-1329	1455-1624
SAMPLING DATA:			
Sampling duration, min.	60.0	60.0	60.0
Nozzle diameter, in.	0.175	0.175	0.175
Cross sectional nozzle area, sq.ft.	0.000167	0.000167	0.000167
Barometric pressure, in. Hg	30.35	30.38	30.41
Avg. orifice press. diff., in H_2O	1.09	1.18	1.19
Avg. dry gas meter temp., deg F	73	79	91
Avg. abs. dry gas meter temp., deg. R	533	539	551
Total liquid collected by train, ml	238.0	244.0	247.0
Std. vol. of H_2O vapor coll., cu.ft.	11.204	11.486	11.627
Dry gas meter calibration factor	0.9915	0.9915	0.9915
Sample vol. at meter cond., dcf	35.428	37.647	38.038
Sample vol. at std. cond., dscf (1)	35.375	37.232	36.805
Percent of isokinetic sampling	95.8	100.1	99.9
GAS STREAM COMPOSITION DATA:			
CO_2, % by volume, dry basis	20.9	20.7	18.9
O_2, % by volume, dry basis	4.8	5.0	5.8
N_2, % by volume, dry basis	74.2	74.3	75.3
Molecular wt. of dry gas, lb/lb mole	31.54	31.51	31.25
H_2O vapor in gas stream, prop. by vol.	0.241	0.236	0.240
Mole fraction of dry gas	0.759	0.764	0.760
Molecular wt. of wet gas, lb/lb mole	28.29	28.32	28.07
GAS STREAM VELOCITY AND VOLUMETRIC FLOW DATA:			
Static pressure, in. H_2O	-0.90	-0.91	-0.97
Static pressure, in. Hg	-0.066	-0.067	-0.071
Absolute pressure, in. Hg	30.28	30.31	30.34
Avg. temperature, deg. F	148	148	148
Avg. absolute temperature, deg.R	608	608	608
Pitot tube coefficient	0.84	0.84	0.84
Total number of traverse points	24	24	24
Avg. gas stream velocity, ft./sec.	92.0	92.0	91.7
Stack/duct cross sectional area, sq.ft.	6.25	6.25	6.25
Avg. gas stream volumetric flow, wacf/min.	34500	34500	34400
Avg. gas stream volumetric flow, dscf/min.	23000	23200	23000
PARTICULATE LABORATORY REPORT:			
Frt half acetone catch, g	0.0293	0.0218	0.0335
Filter catch, g	0.0818	0.0808	0.1346
Total filterable catch weight, g	0.1111	0.1026	0.1681
PARTICULATE EMISSIONS:			
Concentration, gr/dscf	0.0485	0.0425	0.0705
Particulate mass rate, lb/hr	9.57	8.46	13.89

(1) Standard conditions = 68 deg. F. (20 deg. C.) and 29.92 in Hg (760 mm Hg)

TABLE 3-1
(continued)

TEST DATA:			
Test Run No.	1	2	3
Test Date	5/19/92	5/19/92	5/19/92
Test Time Period	0845-1024	1154-1329	1455-1624
NO_x EMISSIONS:			
Concentration, ppmv (dry)	494.6	479.8	598.0
Mass Rate, lb/hr	81.5	79.7	98.7
SO_2 EMISSIONS:			
Concentration, ppmv (dry)	726.7	891.1	768.3
Mass Rate, lb/hr	166.5	206.0	176.1
CO EMISSIONS:			
Concentration, ppmv (dry)	85.3	180.5	50.9
Mass Rate, lb/hr	8.6	18.3	5.1

SECTION 4
PROCESS DESCRIPTION

The W.S. Frey Company, Inc. owns and operates a limestone quarry in Clear Brook, Frederick County, Virginia. In recent years, approximately 800,000 tons per year of limestone, i.e., calcium carbonate, have been quarried at the facility. While most of the total quantity of limestone quarried is processed into aggregate stone and other limestone products, such as agricultural lime, an average quantity in 1990 and 1991 of 54,000 tons per year of lime, i.e., calcium oxide, was produced by processing limestone through a coal-fired horizontal rotary kiln. The kiln is a refractory-lined steel cylinder approximately 165 feet long. Limestone travels through the kiln countercurrent to the flow of hot gases produced from coal combustion, and the heat results in decomposition of the limestone to lime and carbon dioxide. The kiln is equipped with a venturi scrubber to reduce particulate matter and sulfur dioxide emissions prior to discharge to the atmosphere through a 30-foot stack. Figure 4-1 presents the process and control equipment flow diagram.

Due to an increase in market demand for lime and the age of its existing kiln, FREY proposes to replace the existing Allis Chalmers rotary kiln with a newer, higher capacity F.L. Smidth rotary kiln. The existing kiln has an average rated capacity of approximately 216 tons of lime per day. The proposed kiln will have a maximum rated capacity of 500 tons of lime per day.

In order to determine the specific air quality permitting requirements associated with the facility modification, FREY conducted a stack test of the existing kiln to characterize baseline emissions of SO_2, NO_x, and CO. The air pollutants and other exhaust gas parameters were measured using EPA Test Methods given in Appendix A, 40CFR60. The SO_2, NO_x, and CO tests were conducted in the venturi scrubber stack using instrumental analyzers. Details of the test methods are discussed in the following sections.

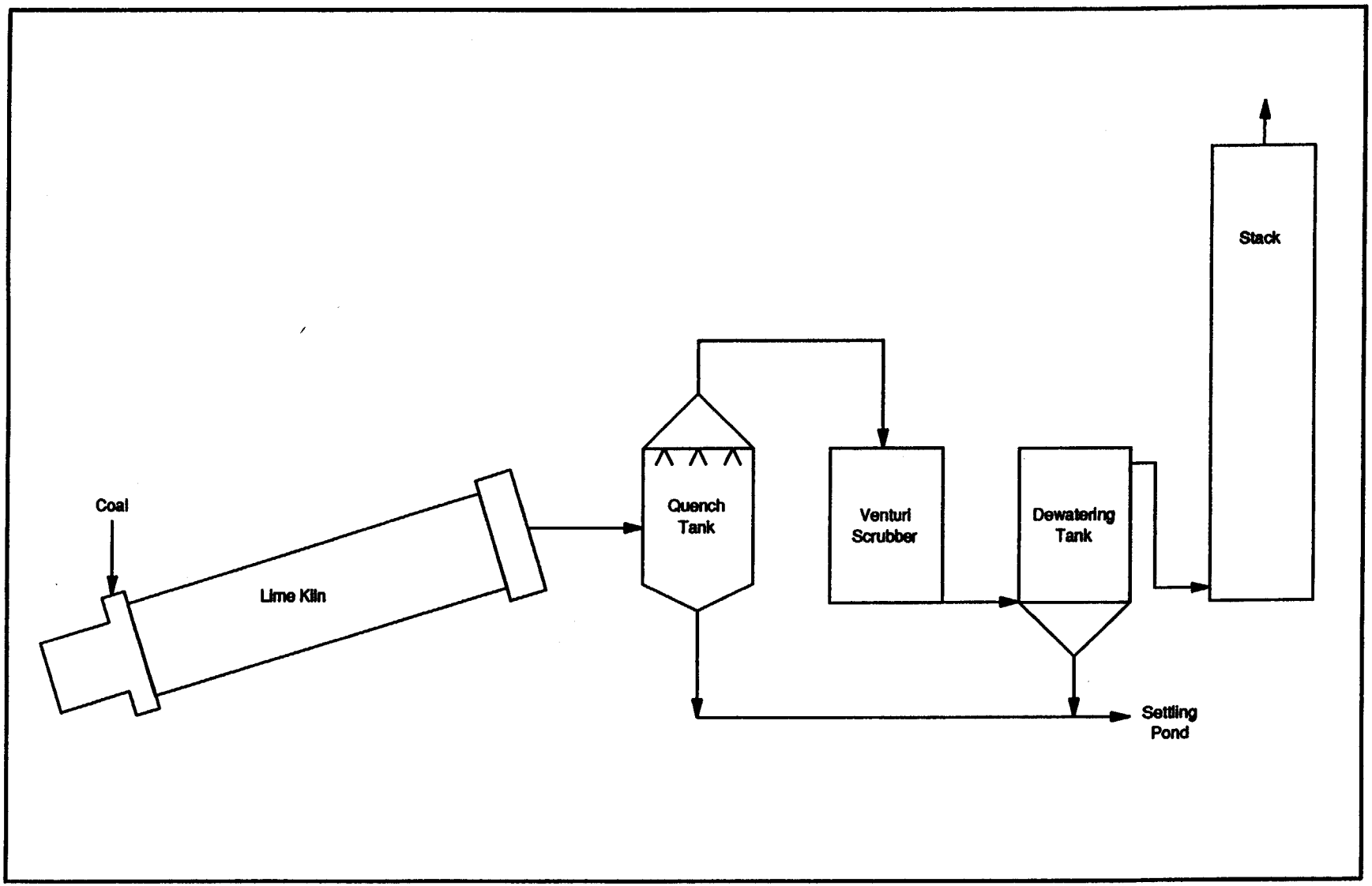


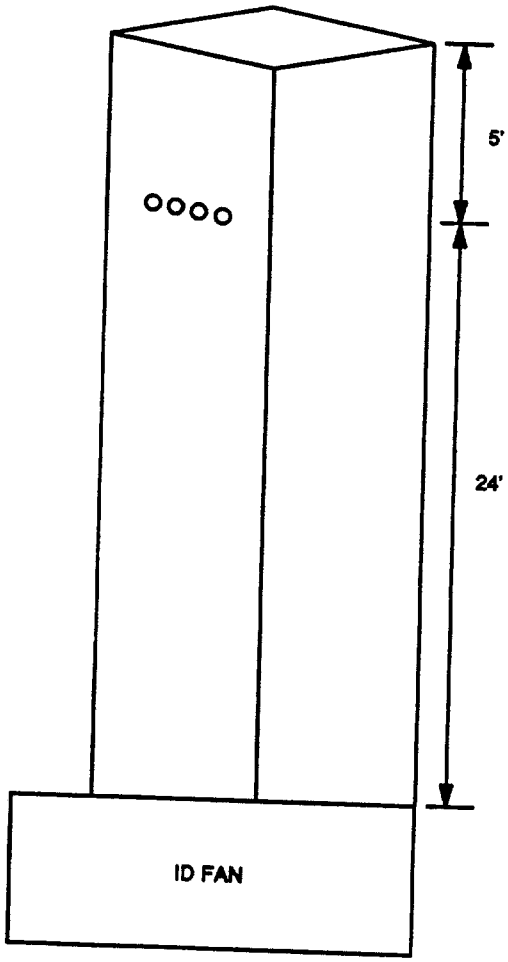
Figure 4-1
W.S. Frey Co.
Lime Kiln Process and Control Equipment Flow Diagram

WSFREY01-d16

SECTION 5
DESCRIPTION OF TEST LOCATION

Four, 3-inch ID test ports were installed horizontally on the 30″ by 30″ square vertical duct. The ports were placed ~ 24 feet downstream (9.6 duct diameters) from the scrubber ID fan and 5 feet (2 duct diameters) upstream from the stack discharge point. Twenty-four traverse points (6 per port) were selected based on requirements of EPA Reference Method One. These traverse points were utilized to determine a representative velocity profile and volumetric flowrate of the discharge gases. Figure 5-1 illustrates test port placement and traverse point locations.

W.S. FREY COMPANY
CLEARBROOK, VIRGINIA



TRAVERSE POINT NUMBER	DISTANCE FROM INSIDE NEAR WALL (INCHES)
1	2 1/2
2	7 1/2
3	12 1/2
4	17 1/2
5	22 1/2
6	27 1/2

FIGURE 5-1
LIME KILN VENTURI SCRUBBER
PORT LOCATIONS AND TRAVERSE POINT DISTANCES

WSFREY02-D15

SECTION 6
DESCRIPTION OF SAMPLING TRAINS AND GENERAL SAMPLING TEST PROCEDURES

Test procedures conformed with the United States Environmental Protection Agency (EPA) Reference Methods (40CFR60, Appendix A). Table 6-1 summarized the emissions test parameters and test methods.

6.1 CONTINUOUS MONITORING SYSTEM

A Continuous Emissions Monitoring (CEM) system was employed to measure sulfur dioxide, carbon monoxide and nitrogen oxides. A flow diagram of the CEM system is presented in Figure 6-1.

A heated (~250°F) stainless steel probe was used to collect a sample at the centroid of the stack. At the back end of the probe, a pneumatic valve that permits the introduction of calibration gas was used. The sample was drawn through a heated Teflon® sample line to the sample conditioner. The sample conditioner consists of a two-pass refrigeration cooler with a Teflon® headed pump. Sample system pressure was monitored immediately before the sample pump. The dried sample was directed to the analyzers. The output from the CEM system were maintained with a data logger and recorded on a Molytek Model 2702 strip chart recorder. Simultaneously, a computer was hooked up to the data logger for data collection. The data logger averages one second values to form one-minute averages. These one-minute averages are used to compute an average one-hour concentration. These data were all stored in the computer.

TABLE 6-1

TEST PARAMETERS AND ASSOCIATED SAMPLING PROCEDURES

LIME KILN VENTURI SCRUBBER

PARAMETER	SAMPLING AND ANALYTICAL PROCEDURES[1]
Gas Velocity and Volumetric Flow Rate	EPA 1, 2
Gas Composition (CO_2 and O_2 Concentrations)	EPA 3
Moisture Content	EPA 4
Particulate	EPA 5
Carbon Monoxide	EPA 10
Sulfur Dioxide	EPA 6C
Oxides of Nitrogen	EPA 7E

[1] EPA = U.S. Environmental Protection Agency 40CFR60, Appendix A - Reference Methods.

Each analyzer was set up and calibrated internally by introduction of calibration gas standards directly to the analyzer from a calibration manifold. The calibration gas was supplied in excess; the excess gas was released to the atmosphere to maintain calibration at ambient pressure. After internal calibration, a system bias check was conducted for each analyzer. The zero gas and one upscale calibration gas was sequentially introduced into the sample system at the valve at the end of the probe. Calibration gas injection rate was monitored to maintain the sample system pressure at the same level observed during actual stack sampling. The internal and bias check instrument responses agreed to within 3% full scale. All calibration gases were NBS standards with a guaranteed accuracy of ± 2% or EPA Protocol One gases.

6.1.1 Carbon Monoxide

Carbon monoxide (CO) concentrations were determined using EPA Method 10 procedures. The carbon monoxide analyzer was a Thermo-Environmental Model 48, gas phase correlation filter nondispersive infrared analyzer which is not affected by carbon dioxide in the sample gas. Therefore, no CO_2 scrubber was necessary.

6.1.2 Sulfur Dioxide

Sulfur dioxide (SO_2) concentrations were determined using EPA Method 6C procedures. A Western Research Model 721AT analyzer was used to measure the SO_2 concentrations. The analyzer measures the SO_2 concentration continuously using a non-dispersive ultraviolet light detection procedure.

6.1.3 Oxides of Nitrogen

Oxides of nitrogen (NO_x) concentrations were determined using EPA Method 7E procedures. A Thermo-Environmental Model 10A chemiluminescent reaction analyzer was used to continuously measure NO_x concentrations. The analyzer's built in response time is approximately 1.5 seconds.

6.1.4 Particulate

Preliminary test data were obtained on the sampling locations for nozzle sizing and sampling rate determinations for isokinetic sampling procedures. Stack geometric measurements were recorded, and traverse point distances calculated. A preliminary velocity traverse was performed utilizing a calibrated "S" type pitot tube and a Dwyer inclined manometer to determine velocity profiles. Flue gas temperatures were observed with a calibrated direct readout pyrometer equipped with a chromel-alumel thermocouple. Water vapor was determined from wet bulb/dry bulb measurements utilizing a psychrometric chart.

A check for the presence or absence of cyclonic flow was conducted at the test location prior to formal testing. All cyclonic flow checks proved to be negative (α <20°) thus verifying the suitability of the test site for obtaining representative samples.

Calibration of probe nozzles, pitot tubes, metering systems, probe heaters and temperature gauges was performed as specified in the Environmental Protection Agency Test Method procedures (see Appendix D).

6.1.4.1 Description Of Particulate Sampling Train

The sampling train utilized to perform the particulate sampling was EPA Reference Method 5 train (see Figure 6-2).

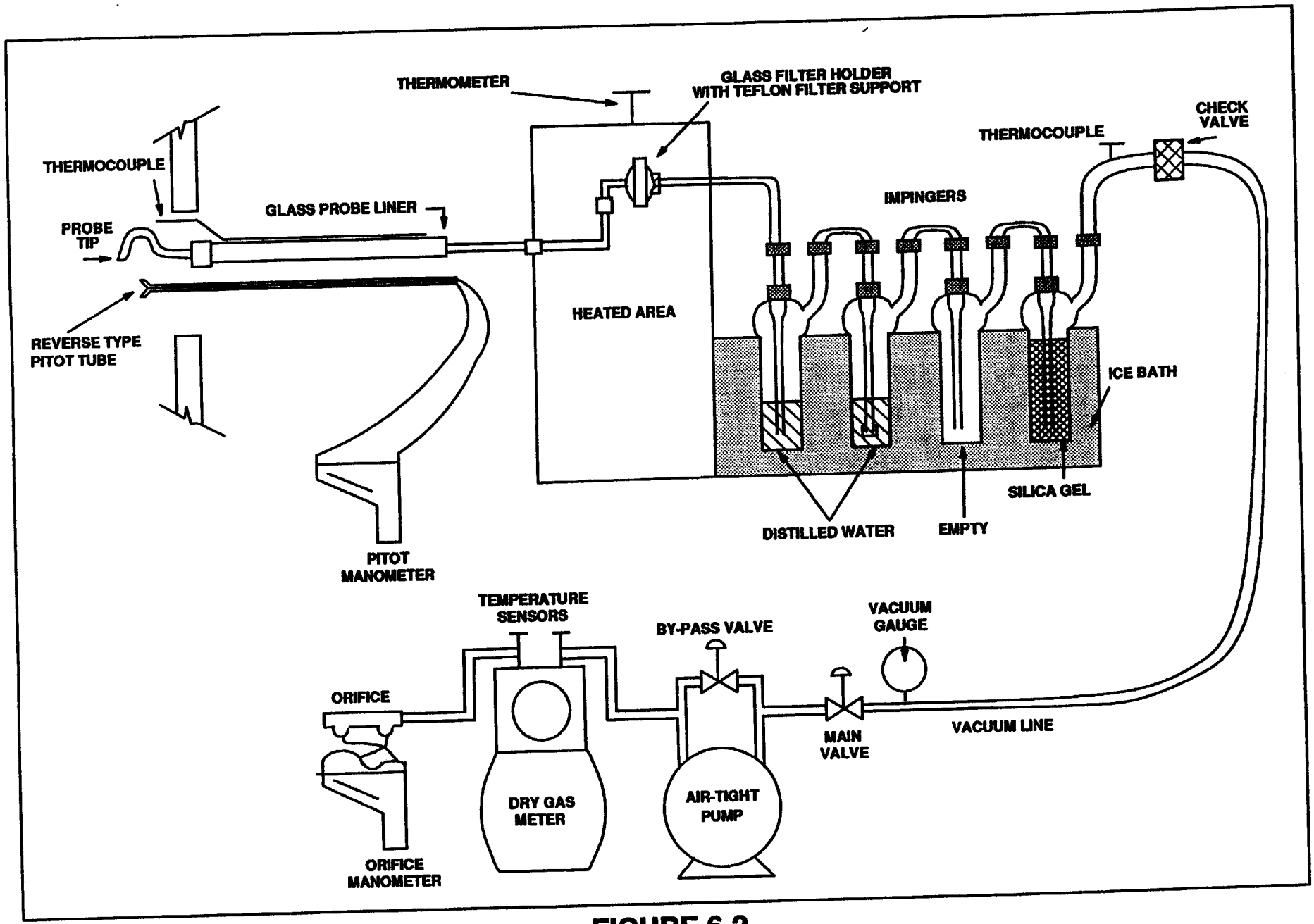


FIGURE 6-2
EPA METHOD 5
PARTICULATE SAMPLING TRAIN

A calibrated stainless steel nozzle was attached to a heated (~250°F) borosilicate probe of appropriate length. The probe was connected to a heated (~250°F) borosilicate filter holder containing a 9-cm 2,500-QAT-UP quartz fiber filter (preweighed to a constant 0.1 mg weight). The first and second impingers each contained 100 ml of distilled water, the third impinger was dry, and the fourth impinger contained 300 grams of dry preweighed silica gel. The second impinger was a standard Greenburg-Smith type; the first, third, and fourth were of a modified design. All impingers were maintained in a crushed ice bath. A Nutech control console with a leakless vacuum pump, a calibrated dry gas meter, a calibrated orifice, and inclined manometers was connected to the final impinger via an umbilical cord to complete the train.

Flue gas velocity was measured with a calibrated "S" type pitot tube (provided with extensions) fastened alongside the sampling probe. Flue gas temperature was monitored with a calibrated direct readout pyrometer equipped with a chromel-alumel thermocouple positioned near the sampling nozzle. Filter box and impinger exit gas temperatures were monitored with a calibrated direct readout pyrometer equipped with chromel-alumel thermocouples positioned in the heated filter chamber and in the sample gas stream after the last impinger. Stack gas stream composition (carbon dioxide and oxygen content) was determined utilizing an Orsat apparatus to analyze multi-point integrated samples of the flue gas obtained for each test period.

6.1.4.2 Particulate Sample Recovery

At the conclusion of each test, the sampling train was dismantled, openings sealed, and the components transported to the field laboratory. Sample integrity was assured by maintaining chain-of-custody records.

A consistent procedure was employed for sample recovery as follows:

- The quartz fiber filter was removed from its holder with tweezers and placed in its original container (petri dish), along with any loose particulate and filter fragments (Sample 1).

- The probe and nozzle were separated and the particulate rinsed with acetone into a borosilicate container fitted with a Teflon-lined closure while brushing a minimum of three times. Particulate adhering to the brush was rinsed with acetone into the same container. The front-half of the filter holder and connecting glassware were also rinsed with acetone while brushing a minimum of three times. The rinses were combined (Sample 2).

- The total liquid contents of impingers one, two and three were measured volumetrically to the nearest milliliter (ml) and the liquid discarded.

- The silica gel was removed from the last impinger and immediately weighed to the nearest 0.1 gram (g).

- Samples of acetone and a quartz fiber filter were retained for blank analysis.

Each sample bottle was labeled to clearly identify it's contents. The height of the fluid was marked on each bottle. The samples were then placed in a locked shipping crate prior to transport to the WESTON Analytics laboratory.

6.1.4.3 Particulate Analysis

The particulate analysis proceeded as follows:

- The filters (Sample 1) and any loose fragments were desiccated for 24 hours and weighed to the nearest 0.1 milligram (mg) to a constant (± 0.5 mg) weight.

- The front-half acetone wash samples (Sample 2) and an acetone blank were evaporated at ambient temperature and pressure in tared beakers, then desiccated to constant 0.1 mg weight.

The total weight of material measured in the front-half acetone-rinse fraction plus the weight of material collected on the glass fiber filter represents the particulate catch for each train. Blank corrections were made where appropriate for all sample weights.

APPENDIX A

RAW TEST DATA

W.S. FREY COMPANY
Clear Brook, VA
Lime Kiln Stack
Run One

DATE	TIME	SO2 (ppmv)	CO (ppmv)	NOx (ppmv)
19 May 1992	08:58	520.83	2.59	661.29
19 May 1992	08:59	541.55	2.96	641.66
19 May 1992	09:00	576.45	3.10	638.18
19 May 1992	09:01	587.32	4.29	584.83
19 May 1992	09:02	633.35	6.20	589.69
19 May 1992	09:03	682.45	6.62	572.09
19 May 1992	09:04	696.76	9.32	502.56
19 May 1992	09:05	684.81	21.83	425.43
19 May 1992	09:06	633.45	31.68	349.37
19 May 1992	09:07	543.91	45.00	239.98
19 May 1992	09:08	202.22	45.68	286.14
19 May 1992	09:09	14.43	22.21	305.94
19 May 1992	09:10	3.89	23.36	228.42
19 May 1992	09:11	8.26	28.34	317.32
19 May 1992	09:12	622.34	14.35	564.57
19 May 1992	09:13	768.18	7.83	569.10
19 May 1992	09:14	885.74	32.33	356.22
19 May 1992	09:15	1232.13	36.68	503.32
19 May 1992	09:16	1076.02	14.21	560.26
19 May 1992	09:17	912.66	8.50	562.32
19 May 1992	09:18	830.43	30.31	401.39
19 May 1992	09:19	848.42	217.92	296.84
19 May 1992	09:20	946.59	88.60	234.77
19 May 1992	09:21	594.85	751.14	96.31
19 May 1992	09:22	83.67	353.04	251.67
19 May 1992	09:23	11.96	251.35	312.48
19 May 1992	09:24	5.99	47.37	277.98
19 May 1992	09:25	396.39	31.18	573.13
19 May 1992	09:26	668.58	11.88	617.84
19 May 1992	09:27	682.17	7.77	616.06
19 May 1992	09:28	915.90	36.84	318.65
19 May 1992	09:29	1443.58	588.03	129.50
19 May 1992	09:30	1092.98	943.17	563.37
19 May 1992	09:31	766.04	84.72	585.68
19 May 1992	09:32	630.30	13.08	637.19
19 May 1992	09:33	538.33	8.11	630.95
19 May 1992	09:34	524.35	5.87	646.37
19 May 1992	09:35	510.47	14.45	496.65
19 May 1992	09:36	681.93	31.84	557.00
19 May 1992	09:37	904.64	10.03	641.44
19 May 1992	09:38	768.44	5.58	675.53
19 May 1992	09:39	610.14	4.28	677.03
19 May 1992	09:40	528.02	4.10	678.13
19 May 1992	09:41	501.45	4.10	670.77
19 May 1992	09:42	507.91	3.26	677.77
19 May 1992	09:43	457.69	4.10	696.81
19 May 1992	09:44	523.57	3.24	696.23
19 May 1992	09:45	517.35	3.28	680.05
19 May 1992	09:46	619.85	4.10	665.55
19 May 1992	09:47	694.28	6.28	602.42
19 May 1992	09:48	958.19	16.84	511.23
19 May 1992	09:49	1048.05	26.90	466.51
19 May 1992	09:50	1147.11	43.86	353.58
19 May 1992	09:51	1313.98	59.79	335.83
19 May 1992	09:52	1178.31	47.01	435.53
19 May 1992	09:53	1053.86	32.91	492.53
19 May 1992	09:54	1031.13	31.16	492.18
19 May 1992	09:55	1048.89	32.78	505.15
19 May 1992	09:56	1054.46	36.15	464.42
19 May 1992	09:57	1097.00	38.83	476.90
19 May 1992	09:58	1090.70	39.15	437.16
19 May 1992	09:59	1110.32	199.10	240.26
19 May 1992	10:00	1281.52	595.82	287.20
19 May 1992	10:01	1272.00	94.50	340.72
	AVG	723.7	81.7	482.9
	Bias Corrected	726.7	85.3	494.6

W.S. FREY COMPANY
Clear Brook, VA
Lime Kiln Stack
Run Two

DATE	TIME	SO2 (ppmv)	CO (ppmv)	NOx (ppmv)
19 May 1992	11:58	785.47	40.75	669.76
19 May 1992	11:59	623.56	12.39	685.28
19 May 1992	12:00	759.74	19.26	503.49
19 May 1992	12:01	1117.74	35.43	633.68
19 May 1992	12:02	848.61	25.24	408.02
19 May 1992	12:03	1126.16	351.79	195.47
19 May 1992	12:04	1299.62	821.98	182.07
19 May 1992	12:05	1281.97	1036.01	178.58
19 May 1992	12:06	1317.35	1036.09	170.96
19 May 1992	12:07	1358.06	1036.17	180.67
19 May 1992	12:08	1335.03	847.13	317.76
19 May 1992	12:09	1302.99	174.08	311.94
19 May 1992	12:10	1338.89	661.41	138.67
19 May 1992	12:11	1333.69	670.42	123.70
19 May 1992	12:12	1302.35	1035.24	126.27
19 May 1992	12:13	1330.43	677.98	141.29
19 May 1992	12:14	1305.97	1036.11	163.84
19 May 1992	12:15	1344.28	756.41	487.27
19 May 1992	12:16	1323.26	56.75	438.08
19 May 1992	12:17	1330.76	46.49	544.23
19 May 1992	12:18	951.09	20.12	662.74
19 May 1992	12:19	701.49	11.76	699.24
19 May 1992	12:20	568.13	8.90	692.79
19 May 1992	12:21	611.12	10.32	604.53
19 May 1992	12:22	760.57	12.78	676.84
19 May 1992	12:23	741.56	8.48	700.26
19 May 1992	12:24	629.68	8.25	698.64
19 May 1992	12:25	603.83	7.95	653.52
19 May 1992	12:26	590.99	11.03	635.41
19 May 1992	12:27	573.16	8.38	642.75
19 May 1992	12:28	568.70	7.35	629.60
19 May 1992	12:29	572.24	6.98	618.29
19 May 1992	12:30	580.75	6.25	592.54
19 May 1992	12:31	580.52	6.61	571.17
19 May 1992	12:32	572.45	7.50	560.98
19 May 1992	12:33	524.33	22.30	365.18
19 May 1992	12:34	286.79	37.95	426.78
19 May 1992	12:35	80.47	12.44	493.15
19 May 1992	12:36	18.87	26.84	281.24
19 May 1992	12:37	503.33	56.45	220.28
19 May 1992	12:38	1261.96	101.66	259.92
19 May 1992	12:39	1151.70	60.43	474.15
19 May 1992	12:40	982.23	43.74	321.04
19 May 1992	12:41	1114.54	41.18	580.23
19 May 1992	12:42	975.77	43.23	275.86
19 May 1992	12:43	1231.50	73.47	277.94
19 May 1992	12:44	1174.86	40.08	587.57
19 May 1992	12:45	903.27	15.67	545.29
19 May 1992	12:46	820.70	33.81	532.64
19 May 1992	12:47	951.46	19.38	631.93
19 May 1992	12:48	782.37	13.47	536.74
19 May 1992	12:49	1198.94	54.12	372.35
19 May 1992	12:50	1050.68	35.81	524.10
19 May 1992	12:51	1003.64	31.64	602.83
19 May 1992	12:52	772.21	11.70	667.57
19 May 1992	12:53	672.65	6.07	701.61
19 May 1992	12:54	657.77	4.66	694.93
19 May 1992	12:55	615.52	4.05	690.46
19 May 1992	12:56	636.62	4.45	668.61
19 May 1992	12:57	697.14	5.25	648.70
19 May 1992	12:58	734.65	5.25	627.78
19 May 1992	12:59	723.12	4.85	620.17
19 May 1992	13:00	699.17	4.05	643.27
19 May 1992	13:01	676.21	20.75	423.54
	AVG	879.3	177.4	483.4
	Bias Corrected	891.1	180.5	479.8

W.S. FREY COMPANY
Clear Brook, VA
Lime Kiln Stack
Run Three

DATE	TIME	SO2 (ppmv)	CO (ppmv)	NOx (ppmv)
19 May 1992	15:15	1487.21	254.75	626.76
19 May 1992	15:16	762.70	53.89	599.22
19 May 1992	15:17	423.90	31.01	592.13
19 May 1992	15:18	336.15	21.39	528.84
19 May 1992	15:19	238.28	17.71	445.69
19 May 1992	15:20	179.85	15.57	433.08
19 May 1992	15:21	166.75	12.88	561.33
19 May 1992	15:22	279.42	10.70	616.20
19 May 1992	15:23	473.71	9.27	636.90
19 May 1992	15:24	535.83	8.25	676.87
19 May 1992	15:25	889.01	10.38	664.73
19 May 1992	15:26	1206.85	19.76	598.71
19 May 1992	15:27	1306.58	31.19	575.76
19 May 1992	15:28	1235.75	31.27	519.50
19 May 1992	15:29	1293.37	46.40	476.74
19 May 1992	15:30	1231.36	43.05	425.90
19 May 1992	15:31	1436.55	630.38	91.17
19 May 1992	15:32	1381.13	755.05	274.66
19 May 1992	15:33	959.57	389.22	642.66
19 May 1992	15:34	582.44	26.65	651.85
19 May 1992	15:35	484.17	12.31	646.07
19 May 1992	15:36	484.75	8.17	641.05
19 May 1992	15:37	467.21	6.72	644.59
19 May 1992	15:38	461.88	5.41	645.46
19 May 1992	15:39	453.44	4.86	638.54
19 May 1992	15:40	443.41	4.05	633.97
19 May 1992	15:41	466.95	4.05	621.86
19 May 1992	15:42	455.65	4.05	633.88
19 May 1992	15:43	638.52	9.34	516.91
19 May 1992	15:44	1342.54	39.52	556.91
19 May 1992	15:45	625.39	10.01	637.68
19 May 1992	15:46	566.79	4.86	629.30
19 May 1992	15:47	824.36	9.59	539.07
19 May 1992	15:48	852.32	12.85	619.51
19 May 1992	15:49	613.54	4.84	654.05
19 May 1992	15:50	621.30	4.05	646.33
19 May 1992	15:51	928.15	12.40	517.10
19 May 1992	15:52	1005.67	18.61	593.64
19 May 1992	15:53	794.77	7.47	602.83
19 May 1992	15:54	1238.37	32.24	349.64
19 May 1992	15:55	1656.60	83.62	348.55
19 May 1992	15:56	866.46	32.14	685.05
19 May 1992	15:57	704.49	9.77	678.46
19 May 1992	15:58	611.42	5.73	669.27
19 May 1992	15:59	584.88	4.05	658.45
19 May 1992	16:00	536.08	3.23	652.28
19 May 1992	16:01	593.64	3.37	642.06
19 May 1992	16:02	694.10	4.05	635.83
19 May 1992	16:03	683.01	4.05	653.83
19 May 1992	16:04	692.89	4.05	648.14
19 May 1992	16:05	688.28	4.05	626.61
19 May 1992	16:06	706.82	4.05	626.65
19 May 1992	16:07	652.08	3.39	596.65
19 May 1992	16:08	679.14	4.04	625.69
19 May 1992	16:09	705.55	4.22	623.68
19 May 1992	16:10	722.56	5.84	617.35
19 May 1992	16:11	763.29	7.53	618.33
19 May 1992	16:12	742.91	8.06	637.49
19 May 1992	16:13	780.00	10.50	576.73
19 May 1992	16:14	889.84	14.82	621.60
19 May 1992	16:15	762.86	10.18	642.14
19 May 1992	16:16	767.15	9.94	634.52
19 May 1992	16:17	781.07	10.13	666.93
	AVG	753.0	45.8	587.2
	Bias Corrected	768.3	50.9	598.0

Test Data			
Run number	1	2	3
Location		SCRUBBER STACK	
Date	05-19-92	05-19-92	05-19-92
Time period	0854-1024	1154-1329	1455-1624
Operator	MILLS	WILLIAMS	MILLS
Inputs For Calcs.			
Sq. rt. delta P	1.520619	1.52291	1.51041
Delta H	1.087917	1.18458	1.19375
Stack temp. (deg.F)	147.75	147.79	148.17
Meter temp. (deg.F)	73.02	78.81	91.27
Sample volume (act.)	35.428	37.647	38.038
Barometric press. (in.Hg)	30.35	30.38	30.41
Volume H2O imp. (ml)	224.0	228.0	234.0
Weight chnge sil. gel (g)	14.0	16.0	13.0
% CO2	20.9	20.7	18.9
% O2	4.8	5.0	5.8
% CO			
% N	74.2	74.3	75.3
Area of stack (sq.ft.)	6.250	6.250	6.250
Sample time (min.)	60	60	60
Static pressure (in.H_2O)	-0.90	-0.91	-0.97
Nozzle dia. (in.)	0.175	0.175	0.175
Meter box cal.	0.9915	0.9915	0.9915
Cp of pitot tube	0.84	0.84	0.84
Particulate Laboratory Report Data			
Frt half acetone rinse, g	0.0293	0.0218	0.0335
Filter, g	0.0818	0.0808	0.1346
Total filterable catch weight, g	0.1111	0.1026	0.1681

W.S.FREY-CLEARBROOK, VA
SUMMARY OF PARTICULATE TEST DATA AND TEST RESULTS
TABLE 1

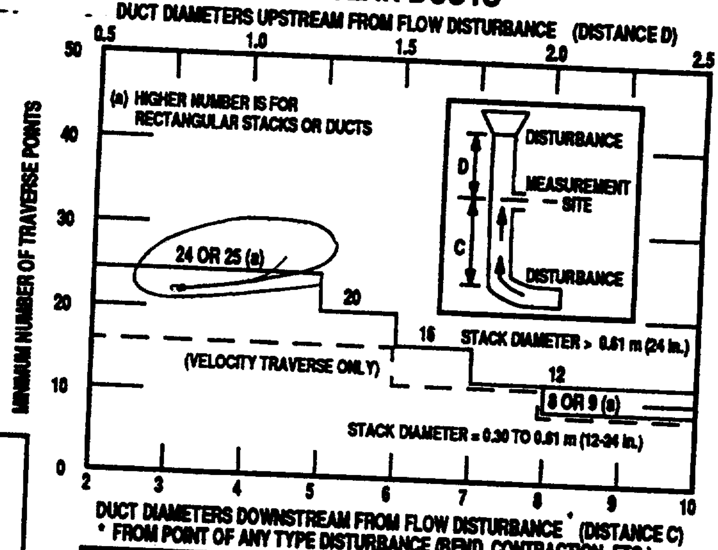
TEST DATA:			
Test run number	1	2	3
Test location		SCRUBBER STACK	
Test date	05-19-92	05-19-92	05-19-92
Test time period	0854-1024	1154-1329	1455-1624
SAMPLING DATA:			
Sampling duration, min.	60.0	60.0	60.0
Nozzle diameter, in.	0.175	0.175	0.175
Cross sectional nozzle area, sq.ft.	0.000167	0.000167	0.000167
Barometric pressure, in. Hg	30.35	30.38	30.41
Avg. orifice press. diff., in H_2O	1.09	1.18	1.19
Avg. dry gas meter temp., deg F	73	79	91
Avg. abs. dry gas meter temp., deg. R	533	539	551
Total liquid collected by train, ml	238.0	244.0	247.0
Std. vol. of H2O vapor coll., cu.ft.	11.204	11.486	11.627
Dry gas meter calibration factor	0.9915	0.9915	0.9915
Sample vol. at meter cond., dcf	35.428	37.647	38.038
Sample vol. at std. cond., dscf (1)	35.375	37.232	36.805
Percent of isokinetic sampling	95.8	100.1	99.9
GAS STREAM COMPOSITION DATA:			
CO2, % by volume, dry basis	20.9	20.7	18.9
O2, % by volume, dry basis	4.8	5.0	5.8
CO, % by volume, dry basis	0.0	0.0	0.0
N2, % by volume, dry basis	74.2	74.3	75.3
Molecular wt. of dry gas, lb/lb mole	31.54	31.51	31.25
H2O vapor in gas stream, prop. by vol.	0.241	0.236	0.240
Mole fraction of dry gas	0.759	0.764	0.760
Molecular wt. of wet gas, lb/lb mole	28.29	28.32	28.07
GAS STREAM VELOCITY AND VOLUMETRIC FLOW DATA:			
Static pressure, in. H_2O	-0.90	-0.91	-0.97
Static pressure, in. Hg	-0.066	-0.067	-0.071
Absolute pressure, in. Hg	30.28	30.31	30.34
Avg. temperature, deg. F	148	148	148
Avg. absolute temperature, deg.R	608	608	608
Pitot tube coefficient	0.84	0.84	0.84
Total number of traverse points	24	24	24
Avg. gas stream velocity, ft./sec.	92.0	92.0	91.7
Stack/duct cross sectional area, sq.ft.	6.25	6.25	6.25
Avg. gas stream volumetric flow, wacf/min.	34500	34500	34400
Avg. gas stream volumetric flow, dscf/min.	23000	23200	23000
PARTICULATE LABORATORY REPORT:			
Frt half acetone catch, g	0.0293	0.0218	0.0335
Filter catch, g	0.0818	0.0808	0.1346
Total filterable catch weight, g	0.1111	0.1026	0.1681
PARTICULATE EMISSIONS:			
Concentration, gr/dscf	0.0485	0.0425	0.0705
Particulate mass rate, lb/hr	9.57	8.46	13.89

(1) Standard conditions = 68 deg. F. (20 deg. C.) and 29.92 in Hg (760 mm Hg)

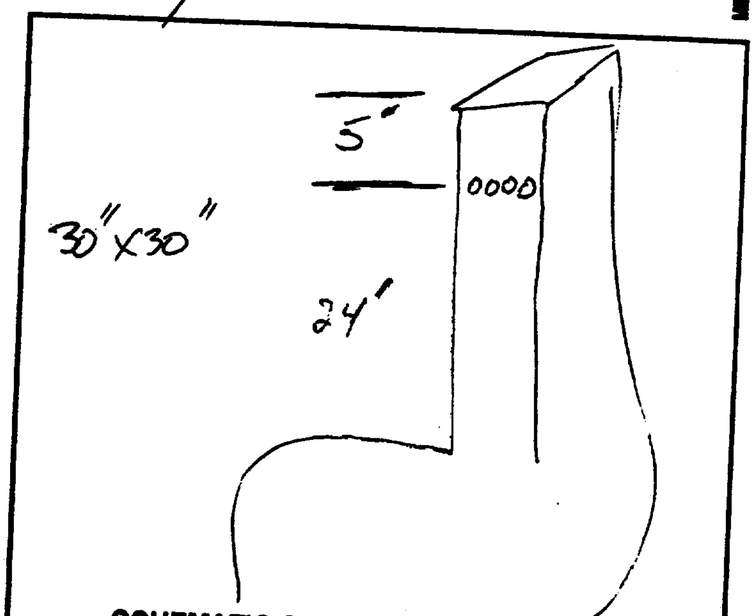
WESTON

TRAVERSE POINT LOCATION FOR CIRCULAR AND RECTANGULAR DUCTS

PLANT: WS Frey
DATE: 5/18/92
SAMPLING LOCATION: Scrubber Outlet
INSIDE OF FAR WALL TO OUTSIDE OF PORT (DISTANCE A): 33"
INSIDE OF NEAR WALL TO OUTSIDE OF PORT (DISTANCE B): 3"
STACK I.D. (DISTANCE A - DISTANCE B): 30"
NEAREST UPSTREAM DISTURBANCE (C): 24'
NEAREST DOWNSTREAM DISTURBANCE (D): 5'
CALCULATOR: [illegible signature]



RECTANGULAR DUCT EQUIVALENT DIAMETER DETERMINATION FOR THE MINIMUM NUMBER OF TRAVERSE POINTS $= \frac{2L*W}{L+W}$



SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	1 FRACTION OF STACK I.D.	2 STACK I.D.	3 PRODUCT OF COLUMNS 1 AND 2 (TO NEAREST 1/8 INCH)	4 DISTANCE B (PORT DEPTH)	5 TRAVERSE POINT LOCATION FROM OUTSIDE OF PORT (SUM OF COLUMNS 3 AND 4)	
		30"		3"		
1	.083	↓	2.490	↓	5.49 [?]	5 1/2
2	.250		7.500		10.500	10 1/2
3	.417		12.510		15.510	15 1/2
4	.583		17.490		20.490	20 1/2
5	.750		22.500		25.500	25 1/2
6	.917		27.510		30.51	30 1/2
7						
8						
9						
10						
11						
12						

LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS

	4	6	8	10	12	14	16	18	20	22	24
1	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3	75.0	29.6	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4	93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5		85.4	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6		95.6	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7			89.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8			96.8	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9				91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10				97.4	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11					93.3	85.4	78.0	70.4	61.2	39.3	32.3
12					97.9	90.1	83.1	76.4	69.4	60.7	39.8
13						94.3	87.5	81.2	75.0	68.5	60.2
14						98.2	91.5	85.4	79.6	73.8	67.7
15							95.1	89.1	83.5	78.2	72.8
16							98.4	92.5	87.1	82.0	77.0
17								95.6	90.3	85.4	80.6
18								98.6	93.3	88.4	83.9
19									96.1	91.3	86.8
20									98.7	94.0	89.5
21										96.5	92.1
22										98.9	94.5
23											96.8
24											98.9

LOCATION OF TRAVERSE POINTS IN RECTANGULAR STACKS

	2	3	4	5	6	7	8	9	10	11	12
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3		83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4			87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5				90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6					91.7	78.6	68.8	61.1	55.0	50.0	45.8
7						92.9	81.3	72.2	65.0	59.1	54.2
8							93.8	83.3	75.0	68.2	62.5
9								94.4	85.0	77.3	70.8
10									95.0	86.4	79.2
11										95.5	87.5
12											95.8

g:\shared\airteam\forms\epa1.drw

WESTON

GAS VELOCITY AND VOLUME DATA FORM

Company: W. S. Frey
Plant: Clear Brook / Virginia
Location: Scrubber Stack
Date: 5/18/92 Run No.: Pulmi
Operators: Williams
Barometric Pressure, in. Hg:

Stack Diameter, in.: 30" x 30"
Cross Sectional Area (AS), ft²:
Pitot Tube ID No.: P4 Cp: 0.84
Pitot Tube Leak Check: Good
Notes:

24-Hour Clock Time	Traverse Point Number	Velocity Head (Δp), in. H_2O	Stack Temperature (T_s), °F	Static Pressure (P_{static}), in. H_2O	Cyclonic Flow Determination	
					Δp at 0° Reference	Angle (∝) which yields a null Δp
	A 1	2.5	153		.02	<5
	2	2.8	154			
1624	3	2.9	154	-1.5		
	4	2.7	154		0	
	5	2.2	154			
	6	2.2	154			
					0	
	B 1	2.3	154			
	2	2.5	154		0	—
	3	2.5	154	-1.0		
	4	2.3	154		0	—
	5	1.5	154			
	6	1.8	154			
					-.04	<5
	C 1	2.2	154			
	2	2.7	154		.02	<5
	3	2.9	154			
	4	2.9	154	-1.2		
	5	2.7	155		0	—
	6	2.1	154			
					0	—
	D 1	2.00	154			
	2	2.75	154		0	—
	3	2.90	154			
	4	30	154	-1.6		
	5	2.7	154		0	—
	6	2.3	154			
					0	—
		Avg. $\sqrt{\Delta p}$	Avg. T_s	Avg. P_{static}		Avg. ∝[a]

[a] Avg. ∝ must be < 20° to be acceptable

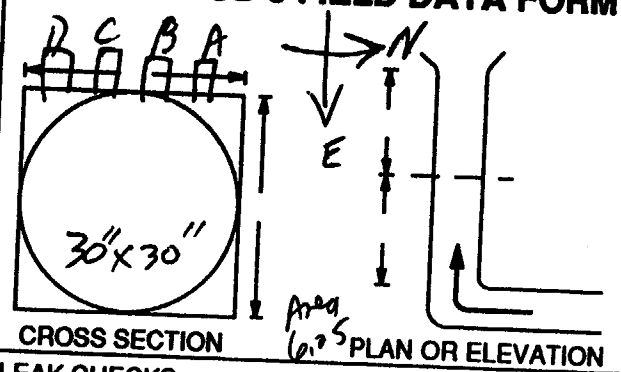
g:\shared\airteam\forms\epa2.drw

WESTON

EPA METHOD 5 FIELD DATA FORM

SHEET 1 OF 2

CLIENT: W.S. Frey
PLANT: Clear Brook Virginia
LOCATION: Scrubber outlet
OPERATOR: Mills/Williams
RUN NO.: ONE DATE: 5/19/92
AMBIENT TEMP. (deg F): 60
BARO. PRESS. (in Hg): 30.35
METER BOX NO.: NuTech 8
METER BOX ΔH@: 1.619
METER BOX CAL. (Y): .9915
PROBE LENGTH (ft): 4 Ft
PROBE LINER MATERIAL: Borosilicate
PROBE HEATER SETTING:
K FACTOR: 0.46 Mtemp 70 Stemp 155



PITOT TUBE IDENTIFICATION NO.: P4
PITOT TUBE CAL. FACTOR (C_p): 0.84
NOZZLE IDENTIFICATION NO.: 11
AVG. NOZZLE DIAMETER (D), in.: .175
PYROMETER IDENTIFICATION NO.: 8
THERMOCOUPLE IDENTIFICATION NO.: —
ASSUMED MOISTURE, %: 28
ASSUMED TEMPERATURE, deg F: 150
STATIC PRESSURE (P_{static}), in H_2O: −0.90
INITIAL LEAK RATE: .016 @ 15 in Hg
MID-POINT LEAK RATE: .006 @ 8 in Hg
FINAL LEAK RATE: .008 @ 12 in Hg
FILTER NO.: 274

LEAK CHECKS
PITOT TUBE: INITIAL Good FINAL Good
METHOD THREE: INITIAL Good FINAL Good

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	24-HOUR CLOCK TIME	VELOCITY HEAD (delta P) (in. H_2O)	ORIFICE METER PRESSURE DIFFERENTIAL (delta H) (in. H2O)	GAS METER READING (cubic ft.)	DRY GAS METER TEMPERATURE INLET (deg F)	DRY GAS METER TEMPERATURE OUTLET (deg F)	SOURCE TEMP. (deg F)	PUMP VACUUM (in. Hg gauge)	IMPINGER EXIT GAS TEMP. (deg F)	FILTER BOX TEMP. (deg F)
A	0				229.868						
1	2.5	0854	2.00	0.92	231.3	69	69	145	6.0	58	253
2	5.0		2.35	1.08	232.7	70	69	147	6.0	54	252
3	7.5		2.45	1.13	234.3	71	69	146	6.5	53	253
4	10		2.5	1.15	235.8	74	69	148	6.5	54	251
5	12.5		2.5	1.15	237.4	75	69	147	6.5	54	252
6	15	0909	2.30	1.06	238.758	75	69	147	6.5	55	253
	0		Leak check — .012 cfm @ 8 in vac		238.826						
B 1	2.5	0920	2.2	1.01	240.2	72	70	147	6.0	57	252
2	5.0		2.35	1.08	241.8	73	70	147	6.5	56	252
3	7.5		2.40	1.10	243.2	76	71	148	7.0	56	252
4	10		2.60	1.20	244.8	77	71	147	7.5	57	251
5	12.5		2.50	1.15	246.2	79	71	146	7.5	57	252
6	15	0935	2.15	0.99	247.625	78	71	146	7.0	58	252
	TOTAL θ		AVG. $\sqrt{\Delta p}$	AVG. ΔH	TOTAL V_m	AVG. T_m		AVG. T_s	MAX. VAC.	MAX. TEMP.	MIN. MAX.

Margin notes: static −0.85; −0.91

COMMENTS:

g:\share\airteam\forms\EPA5FDF1.DRW

WESTON

EPA METHOD 5 FIELD DATA FORM

CLIENT: W.S. Frey
PLANT: Clear Brook Virginia
LOCATION: Venturi Scrubber

OPERATOR: Mills/Williams
RUN NO.: ONE
K FACTOR:
SHEET 2 OF 2
DATE: 5/19/92

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	24-HOUR CLOCK TIME	VELOCITY HEAD (delta P) (in. H_2O)	ORIFICE METER PRESSURE DIFFERENTIAL (delta H) (in. H2O)	GAS METER READING (cubic ft.)	DRY GAS METER TEMPERATURE INLET (deg F)	DRY GAS METER TEMPERATURE OUTLET (deg F)	SOURCE TEMP. (deg F)	PUMP VACUUM (in. Hg gauge)	IMPINGER EXIT GAS TEMP. (deg F)	FILTER BOX TEMP. (deg F)
	0				247.677						
C 1	2.5	0943	2.25	1.03	249.2	72	71	145	7.5	59	252
2	5		2.40	1.10	250.6	75	71	148	7.5	58	251
3	7.5		2.60	1.19	252.0	76	71	147	7.5	59	251
4	10		2.70	1.24	253.8	78	71	147	7.5	58	252
5	12.5	*	~~2.3~~ 2.5	~~1.15~~ 1.25	255.1	78	71	147	8.5	59	253
6	15	0958	2.20	1.08	256.644	80	72	149	8.5	60	252
			Leak Check - .005 cfm @ 10 in VAC								
	0				256.730						
D 1	2.5	1009	1.8	0.88	258.1	73	71	152	8.0	60	252
2	5		2.10	1.03	259.6	75	72	153	8.5	61	252
3	7.5		2.40	1.18	261.2	76	72	149	9.0	61	253
4	10		2.35	1.15	262.7	78	73	148	9.0	60	252
5	12.5		2.30	1.13	264.2	79	72	148	9.0	61	250
6	15	1024	1.7	0.83	265.502	79	72	152	7.5	61	250
TOTAL θ			AVG. $\sqrt{\Delta p}$ 1.520619	AVG. ΔH 1.087917	TOTAL V_m 35.428	AVG. T_m 73.02		AVG. T_s 147.750	MAX. VAC.	MAX. TEMP.	MIN. / MAX.

Static (filter box column margin): -.93; -.90

COMMENTS:

* [illegible] 49

g:\shared\airteam\forms\EPSFDF2.DRW

PARTICULATE
SAMPLE RECOVERY ~~AND~~ INTEGRITY DATA FORM

Plant W. S. Frey
Sample Location Scrubber Stack
Sample Recovery Person Mills
Filter Number(s) 274

Sample Date 5/19/92
Run Number One
Recovery Date 5/19/92

MOISTURE

220
204
424

Impingers			Silica Gel	
Final volume (wt)	ml	ml	Final wt 314 g	g
Initial volume (wt)	200 ml	ml	Initial wt 300 g	g
Net volume (wt)	224 ml	ml	Net wt 14 g	g
Total moisture	224 + 14			

Color of silica gel ½ Blue ½ orange
Description of impinger water Clear Colorless

RECOVERED SAMPLE

Blank Filter container number Frey - Blank - Filter #252 Sealed ✓
Filter container number Frey - R1 - PART - Filter #274 Sealed ✓
Filter container number _____ Sealed _____
Filter container number _____ Sealed _____
Filter container number _____ Sealed _____
Description of particulate on filter Very Fine Light Grey
Front-half acetone rinse container number Frey - R1 - PART - FHA Liquid level marked? ✓
Back-half water rinse container number N/A Liquid level marked? _____
Back-half acetone rinse container number N/A Liquid level marked? _____
Water blank container number N/A Liquid level marked? _____
Acetone blank container number Frey - Blank - Acetone Liquid level marked? ✓
Samples stored and locked _____
Remarks: _____

Date of laboratory custody 5/20/92

Laboratory personnel taking custody _____

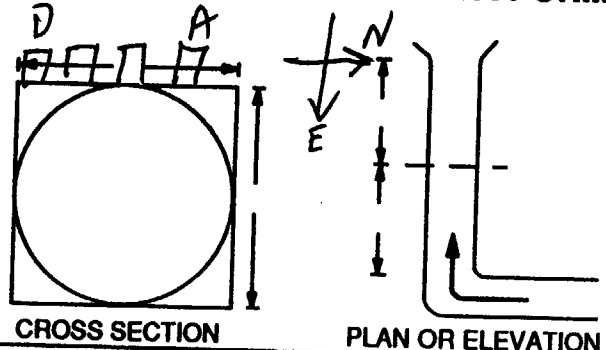
Remarks:

WESTON

SHEET 1 OF 2

EPA METHOD 5 FIELD DATA FORM

CLIENT W.S. Frey
PLANT Clear Brook Virginia
LOCATION Scrubber
OPERATOR Mills / Williams
RUN NO. TWO DATE 5/19/92
AMBIENT TEMP. (deg F) 65
BARO. PRESS. (in Hg) 30.38
METER BOX NO. MTech 8
METER BOX ΔH@ 1.619
METER BOX CAL. (Y) .9915
PROBE LENGTH (ft) 4 FT
PROBE LINER MATERIAL Borosilicate
PROBE HEATER SETTING
K FACTOR ~~0.84~~ 0.51



PITOT TUBE IDENTIFICATION NO. P4
PITOT TUBE CAL. FACTOR (C_p) 0.84
NOZZLE IDENTIFICATION NO. 11
AVG. NOZZLE DIAMETER (D), in 0.175
PYROMETER IDENTIFICATION NO. MTech 8
THERMOCOUPLE IDENTIFICATION NO. —
ASSUMED MOISTURE, % 24
ASSUMED TEMPERATURE, deg F 150
STATIC PRESSURE (P_{static}), in H_2O -0.97
INITIAL LEAK RATE .018 @ 15 in Hg
MID-POINT LEAK RATE .012 @ 11 in Hg
FINAL LEAK RATE .016 @ 12 in Hg
FILTER NO. 214

LEAK CHECKS
PITOT TUBE: INITIAL Good FINAL Good
METHOD THREE: INITIAL Good FINAL Good

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	24-HOUR CLOCK TIME	VELOCITY HEAD (delta P) (in. H_2O)	ORIFICE METER PRESSURE DIFFERENTIAL (delta H) (in. H2O)	GAS METER READING (cubic ft.)	DRY GAS METER TEMPERATURE INLET (deg F)	DRY GAS METER TEMPERATURE OUTLET (deg F)	SOURCE TEMP. (deg F)	PUMP VACUUM (in. Hg gauge)	IMPINGER EXIT GAS TEMP. (deg F)	FILTER BOX TEMP. (deg F)
A	0	1154			266.245						
1	2.5		.9	0.97	267.7	73	72	148	5.0	63	228
2	5		2.2	1.12	269.3	75	73	148	5.0	64	245
3	7.5		2.35	1.20	271.0	77	73	149	5.5	65	254
4	10		2.40	1.22	272.4	78	73	156	5.5	65	265
5	12.5		2.45	1.25	274.1	79	73	156	6.0	65	271
6	15	1209	2.25	1.15	275.525	80	73	157	6.0	67	267
				leak check	.012 CFM @ 10 IN VAC						
	0	1217			275.608						
D 1	2.5		2.2	1.12	277.1	75	73	147	6.0	67	237
2	5		2.3	1.17	278.8	77	74	147	6.0	67	234
3	7.5		2.4	1.22	280.2	80	73	146	6.0	65	244
4	10		2.55	1.30	281.8	81	73	145	6.5	62	249
5	12.5		2.45	1.25	283.5	83	74	145	6.5	60	252
6	15	1232	2.3	1.17	285.205	83	74	146	6.0	59	253
	TOTAL θ		AVG. $\sqrt{\Delta p}$	AVG. ΔH	TOTAL V_m	AVG. T_m		AVG. T_s	MAX. VAC.	MAX. TEMP.	MIN. MAX.

STATIC -.90 -.88

COMMENTS:

A-11

CLIENT W.S. Frey
PLANT Clear Brook Virginia
LOCATION Venturi Scrubber

EPA METHOD 5 FIELD DATA FORM

OPERATOR Mills/Williams —SHEET 2 OF 2
RUN NO. Two DATE 5/19/92
K FACTOR

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	24-HOUR CLOCK TIME	VELOCITY HEAD (delta P) (in. H_2O)	ORIFICE METER PRESSURE DIFFERENTIAL (delta H) (in. H2O)	GAS METER READING (cubic ft.)	DRY GAS METER TEMPERATURE INLET (deg F)	DRY GAS METER TEMPERATURE OUTLET (deg F)	SOURCE TEMP. (deg F)	PUMP VACUUM (in. Hg gauge)	IMPINGER EXIT GAS TEMP. (deg F)	FILTER BOX TEMP. (deg F)
	0	1241			285.267						
C 1	2.5		2.40	1.22	286.9	77	75	147	7.0	62	250
2	5		2.65	1.35	288.5	80	75	146	7.5	57	252
3	7.5		2.60	1.33	290.2	83	76	147	7.5	55	253
4	10		2.55	1.30	291.8	84	76	146	7.5	55	253 -.94
5	12.5		2.50	1.27	293.5	86	77	146	7.5	55	253
6	15	1256	2.10	1.07	294.922	87	77	146	7.0	57	253
				Leak check - .016 cfm @ 12 in VAC							
	0				295.000						
D 1	2.5	1314	1.9	0.97	296.4	82	80	146	6.5	67	252
2	5		1.9	0.97	297.8	85	79	146	7.0	62	252
3	7.5		2.55	1.30	299.6	86	80	146	8.0	60	254
4	10		2.45	1.25	301.2	90	81	147	8.0	58	254
5	12.5		2.50	1.27	302.7	92	81	147	8.0	58	255
6	15	1329	1.95	0.99	304.115	93	82	147	7.5	60	254 -.92
	TOTAL θ		AVG. $\sqrt{\Delta p}$ 1.522914	AVG. ΔH 1.184583	TOTAL V_m ~~36.159~~ 37.647	AVG. T_m 78.812		AVG. T_s 147.92	MAX. VAC.	MAX. TEMP.	MIN. MAX.

COMMENTS: Gas ~~O2~~ 25.8
CO2 - 20.5
Into 5.3

A-12

g:\shared\airteam\forms\EPSFDF2.DRW

PARTICULATE
SAMPLE RECOVERY ~~AND~~ INTEGRITY DATA FORM

Plant W. S. Frey
Sample Location Scrubber Stack
Sample Recovery Person Mills
Filter Number(s) 214

Sample Date 5/19/92
Run Number TWO
Recovery Date 5/19/92

MOISTURE

	210	218	Silica Gel	
Impingers				
Final volume (wt)	428 ml	ml	Final wt 316 g	g
Initial volume (wt)	200 ml	ml	Initial wt 300 g	g
Net volume (wt)	228 ml	ml	Net wt 16 g	g

Total moisture 228 + 16
Color of silica gel 1/2 Blue 1/2 orange
Description of impinger water Clear colorless

RECOVERED SAMPLE

Blank Filter container number Frey - Blank - Filter #252 Sealed ✓
Filter container number Frey - R2 - Part - Filter #214 Sealed ✓
Filter container number _____ Sealed _____
Filter container number _____ Sealed _____
Filter container number _____ Sealed _____
Description of particulate on filter Very Fine Light Grey-TAN
Front-half acetone rinse container number Frey - R2 - Part - FHA Liquid level marked? ✓
Back-half water rinse container number N/A Liquid level marked? _____
Back-half acetone rinse container number N/A Liquid level marked? _____
Water blank container number N/A Liquid level marked? _____
Acetone blank container number Frey - Blank - Acetone Liquid level marked? ✓
Samples stored and locked _____
Remarks: _____

Date of laboratory custody 5/20/92

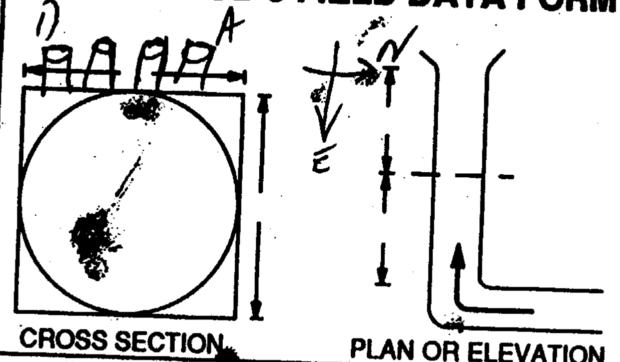
Laboratory personnel taking custody _____

Remarks:

WESTON

CLIENT	W.S. Frey
PLANT	Clen Brook Virginia
LOCATION	Venturi scrubber
OPERATOR	Mills / Williams
RUN NO.	Three
DATE	5/19/92
AMBIENT TEMP. (deg.F)	75
BARO. PRESS. (in Hg)	30.41
METER BOX NO.	Mtech B
METER BOX ΔH@	1.619
METER BOX CAL. (Y)	.9915
PROBE LENGTH (ft)	4 FT
PROBE LINER MATERIAL	Borosilicate
PROBE HEATER SETTING	
K FACTOR	0.512

EPA METHOD 5 FIELD DATA FORM



LEAK CHECKS
PITOT TUBE: INITIAL Good FINAL Good
METHOD THREE: INITIAL Good FINAL Good

SHEET 1 OF 2

PITOT TUBE IDENTIFICATION NO.	P4
PITOT TUBE CAL. FACTOR (C_p)	0.84
NOZZLE IDENTIFICATION NO.	11
AVG. NOZZLE DIAMETER (D), in.	~~.147~~ 0.175
PYROMETER IDENTIFICATION NO.	Mtech 8
THERMOCOUPLE IDENTIFICATION NO.	—
ASSUMED MOISTURE, %	~~14.8~~ 24
ASSUMED TEMPERATURE, deg F	148
STATIC PRESSURE (P_{static}), in H_2O	-0.97
INITIAL LEAK RATE	.010 @ 15 in Hg
MID-POINT LEAK RATE	.008 @ 14 in Hg
FINAL LEAK RATE	.006 @ 14 in Hg
FILTER NO.	251

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	24-HOUR CLOCK TIME	VELOCITY HEAD (delta P) (in. H_2O)	ORIFICE METER PRESSURE DIFFERENTIAL (delta H) (in. H2O)	GAS METER READING (cubic ft.)	DRY GAS METER TEMPERATURE INLET (deg F)	DRY GAS METER TEMPERATURE OUTLET (deg F)	SOURCE TEMP. (deg F)	PUMP VACUUM (in. Hg gauge)	IMPINGER EXIT GAS TEMP. (deg F)	FILTER BOX TEMP. (deg F)
	0	1455			304.394						
D 1	2.5		2.15	1.12	306.1	88	86	147	6.0	68	257
2	5		2.45	1.26	307.7	90	87	148	5.5	64	256
3	7.5		2.50	1.28	309.3	92	87	154	6.0	61	254
4	10		2.75	1.42	311.0	96	88	157	6.5	59	255
5	12.5		2.25	1.16	312.8	96	88	160	6.5	57	249
6	15	1510	1.70	0.87	313.978	95	88	158	7.5	57	252
			leak check - .008 cfm @ 12 in vac								
	0				314.040						
C 1	2.5	1524	1.4	0.72	315.4	90	89	146	6.5	71	253
2	5		2.45	1.26	316.8	92	90	155	10.0	62	253
3	7.5		2.50	1.28	318.6	94	89	147	10.0	59	252
4	10		2.40	1.24	320.1	96	90	146	10.0	57	257
5	12.5		2.50	1.28	321.8	96	89	145	10.0	56	254
6	15	1539	2.40	1.24	323.482	96	89	145	10.5	57	255
	TOTAL θ		AVG. $\sqrt{\Delta p}$	AVG. ΔH	TOTAL V_m	AVG. T_m		AVG. T_s	MAX. VAC.	MAX. TEMP.	MIN. MAX.

,95
,96

COMMENTS:
* 1505 Black Soot was coming out of stack (upset kiln condition)

g:\share\shared\EPA5FDF1.DRW

CLIENT WS Frey
PLANT Clear Brook Virginia
LOCATION Venturi Scrubber

EPA METHOD 5 FIELD DATA FORM

SHEET 2 OF 2
OPERATOR Mills/Williams
RUN NO. ~~One~~ Three
K FACTOR
DATE 5/19/9-

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	24-HOUR CLOCK TIME	VELOCITY HEAD (delta P) (in. H_2O)	ORIFICE METER PRESSURE DIFFERENTIAL (delta H) (in. H2O)	GAS METER READING (cubic ft.)	DRY GAS METER TEMPERATURE INLET (deg F)	DRY GAS METER TEMPERATURE OUTLET (deg F)	SOURCE TEMP. (deg F)	PUMP VACUUM (in. Hg gauge)	IMPINGER EXIT GAS TEMP. (deg F)	FILTER BOX TEMP. (deg F)	
B	0	1545			323.541							
1	2.5		2.00	1.03	325.1	91	89	145	9.0	65	232	
2	5		1.95	1.00	326.5	94	89	146	9.5	60	230	
3	7.5		2.25	1.19	328.1	95	89	146	11.0	60	233	
4	10		2.55	1.35	329.8	96	89	146	11.5	58	243	
5	12.5		2.60	1.38	331.6	98	90	145	12.10	58	247	-1.0
6	15	1600	2.35	1.25	333.153	98	89	145	11.5	59	245	
			Leak check - .006 cfm @ 14 in Vac									
	0											
A	2.5	1609	2.1	1.11	333.228							
1	5		2.4	1.27	334.7	90	89	145	8.0	68	247	
2	7.5		2.4	1.27	336.2	92	89	145	11.0	63	247	
3	10		2.35	1.24	337.8	94	89	146	11.0	62	247	
4	12.5		2.4	1.27	339.4	94	89	148	11.5	62	244	-.98
5	15	1624	2.2	1.16	341.0	95	89	146	11.5	63	245	
6					342.578	95	88	145	11.5	65	245	
	TOTAL θ		AVG. $\sqrt{\Delta p}$ 1.510409	AVG. ΔH 1.19375	TOTAL V_m 38.038	AVG. T_m 91.27		AVG. T_s 148.167	MAX. VAC.	MAX. TEMP.	MIN. MAX.	

COMMENTS:

g:\shared\airteam\forms\EPSFDF2.DRW

PARTICULATE
SAMPLE RECOVERY AND INTEGRITY DATA FORM

Plant W.S. Frey
Sample Location Scrubber Stack
Sample Recovery Person Mills
Filter Number(s) 251

Sample Date 5/19/92
Run Number Three
Recovery Date 5/19/92

MOISTURE

	Impingers		Silica Gel	
Final volume (wt)	310 / 224 / ~~434~~ ml	ml	Final wt 313 g	g
Initial volume (wt)	200 ml	ml	Initial wt 300 g	g
Net volume (wt)	234 ml	ml	Net wt 13 g	g

Total moisture 234 + 13
Color of silica gel 1/2 Blue 1/2 orange
Description of impinger water Clear colorless

RECOVERED SAMPLE

Blank Filter container number Frey - Blank - Filter #252 Sealed ✓
Filter container number Frey - R3 - PART - Filter #251 Sealed ✓
Filter container number _____ Sealed _____
Filter container number _____ Sealed _____
Filter container number _____ Sealed _____
Description of particulate on filter Very Fine TAN - Light Grey - with a black layer underneath
Front-half acetone rinse container number Frey - R3 - PART - FHA Liquid level marked? ✓
Back-half water rinse container number N/A Liquid level marked? _____
Back-half acetone rinse container number N/A Liquid level marked? _____
Water blank container number N/A Liquid level marked? _____
Acetone blank container number Frey - Blank - Acetone Liquid level marked? ✓
Samples stored and locked _____
Remarks: _____

Date of laboratory custody 5/20/92

Laboratory personnel taking custody _____

Remarks:

GAS ANALYSIS DATA FORM

Plant: WS Frey
Date: 5/19/92
Sample Location: Scrubber
Operator: M. Mills
Sample Type: SINGLE POINT or MULTIPOINT: GRAB or INTEGRATED
Analytical Method: ORsat
Orsat Leak Check: Good

Run Number	Sample Location/Train ID	% CO2 Reading 1	%O2 Reading 2	%O2 Net (1)	%N2 100 - Reading 2
ONE		21.0	26.0	5.0	
ONE		21.0	25.7	4.7	
ONE		20.8	25.6	4.8	
		20.933		4.833	
TWO		20.5	25.5	5.0	
TWO		20.8	25.7	4.9	
TWO		20.7	25.8	5.1	
		20.667		5.000	
Three		18.8	24.6	5.8	
Three		18.8	24.6	5.8	
Three		19.0	24.9	5.9	
		18.867		5.833	
AVERAGES					

%N2 = 100 - (%CO2 + % O2 + %CO)
MWd = 0.440(%CO2) + 0.320(%O2) + 0.280(%N2 + %CO)

(1) Net %O2 = Reading 1 - Reading 2

Integrated Bag Limits
CO2 > 4% - 0.3% by vol
<=4% - 0.2% by vol
O2 >= 15% - 0.2% by vol
< 15% - 0.3% by vol

APPENDIX B

LABORATORY REPORT

to Jeff O'Neill 6-23

ROY F. WESTON, INC.
Lionville Laboratory

CLIENT: W.S. FREY
RFW #: 9205L356
W.O. #: 6845-01-02

SAMPLE(S) RECEIVED: 05-20-92

INORGANIC NARRATIVE

The following is a summary of the quality control results and a description of any problems encountered during the analysis of this batch of samples:

1. The analytical methods applied by the laboratory in the analysis of air samples contained in this batch were derived from the Federal Register, 40 CRF, Part 60, Revised July 1, 1988, The Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA - 600/4-84-041, May 1987 and NIOSH Manual of Analytical Methods, 2nd & 3rd Editions.

Jack R. Tuschall, Ph.D.
Laboratory Manager
Lionville Analytical Laboratory

06.08.92
Date

kls/i05-356

ROY F. WESTON, INC.
GLOSSARY OF TERMS - INORGANIC REPORTS

DATA QUALIFIERS

U - Indicates that the parameter was not detected at or above the reported limit. The associated numerical value is the sample detection limit.

* - Indicates that the original sample result is greater than 4x the spike amount added. The USEPA-CLP has determined that spike results on samples where this occurs may be unreliable and therefore, the control limits are not applicable.

ABBREVIATIONS

MB - Method or preparation blank.
MS - Matrix Spike.
MSD - Matrix Spike Duplicate.
REP - Sample Replicate.
LC - Indicates a method LCS or Blank Spike.
NC - Not calculable, result below the detection limit.

A suffix of -R or -S following these codes indicates a replicate or spike analysis respectively.

ANALYTICAL METAL METHODS

As : EPA 206.2	SE	:	EPA 270.2
Pb : EPA 239.2	ICP Scan	:	EPA 200.7
Hg : EPA 245.1	All Others	:	EPA 200.7
Tl : EPA 279.2	EP Leachates	(except Hg)	200.7

The analytical methods applied by the laboratory for the determination of drinking water are found in 5.2.1.

NOTES

The laboratory prepares a matrix spike at one per 20 frequency for TCLP samples. The Federal Register recommends that all matrix spikes be prepared at greater than 50% of the indigenous analyte concentration.

Holding times for soil samples have not been promulgated by the USEPA.

For solid samples, all results are reported on a dry weight basis.

The range for mercury solid laboratory control standards is 66.9% to 133.8%.

ROY F. WESTON INC.

INORGANIC DATA SUMMARY REPORT 06/03/92

CLIENT: W.S. FREY
WORK ORDER: 6845-01-02-0000

WESTON BATCH #: 9205L356

SAMPLE	SITE ID	ANALYTE	RESULT	UNITS	REPORTING LIMIT
-001	FREY-R1-PART-FHA	Particulate	29.5	MG	0.10
-002	FREY-R1-PRT-FLT 274	Particulate	82.1	MG	0.10
-003	FREY-R2-PART-FHA	Particulate	22.0	MG	0.10
-004	FREY-R2-PRT-FLT 214	Particulate	81.1	MG	0.10
-005	FREY-R3-PART-FHA	Particulate	33.8	MG	0.10
-006	FREY-R3-PRT-FLT 251	Particulate	135	MG	0.10
-007	FREY-BLANK-ACETONE	Particulate	0.20	MG	0.10
-008	FREY-BLANK-FLT 252	Particulate	0.30	MG	0.10

Roy F. Weston, Inc. - Lionville Laboratory
INORGANIC ANALYTICAL DATA PACKAGE FOR
W.S. FREY

DATE RECEIVED: 05/20/92

RFW LOT # :9205L356

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTION	EXTR/PREP	ANALYSIS
FREY-R1-PART-FHA						
PARTICULATE-RESIDUE	001	AI	92LPT019	05/19/92	05/20/92	06/01/92
FREY-R1-PRT-FLT 274						
PARTICULATE-FILTER	002	AI	92LPT019	05/19/92	05/20/92	06/01/92
FREY-R2-PART-FHA						
PARTICULATE-RESIDUE	003	AI	92LPT019	05/19/92	05/20/92	06/01/92
FREY-R2-PRT-FLT 214						
PARTICULATE-FILTER	004	AI	92LPT019	05/19/92	05/20/92	06/01/92
FREY-R3-PART-FHA						
PARTICULATE-RESIDUE	005	AI	92LPT019	05/19/92	05/20/92	06/01/92
FREY-R3-PRT-FLT 251						
PARTICULATE-FILTER	006	AI	92LPT019	05/19/92	05/20/92	06/01/92
FREY-BLANK-ACETONE						
PARTICULATE-RESIDUE	007	AI	92LPT019	05/18/92	05/20/92	06/01/92
FREY-BLANK-FLT 252						
PARTICULATE-FILTER	008	AI	92LPT019	05/18/92	05/20/92	06/01/92

WESTON Analytics Use Only
9205L356

Custody Transfer Record/Lab Work Request

WESTON

Page 1 of 1

Client W.S. Frey
Est. Final Proj. Sampling Date 5/19/92
Work Order # 6875-01-02
Project Contact/Phone # Jeff O'Neill/Jack Mills
AD Project Manager Josie King
QC SH Del SH TAT 30 days
Date Rec'd 5/20/92 Date Due 6/19/92
Account # WSFREYSTD

Refrigerator #
#/Type Container: Liquid / Solid
Volume: Liquid / Solid
Preservatives

ANALYSES REQUESTED →

ORGANIC: VOA, BNA, Pest/PCB, Herb | INORG: Metal, CN

Air samples

WESTON Analytics Use Only

MATRIX CODES:
S - Soil
SE - Sediment
SO - Solid
SL - Sludge
W - Water
O - Oil
A - Air
DS - Drum Solids
DL - Drum Liquids
L - EP/TCLP Leachate
WI - Wipe
X - Other
F - Fish

Lab ID	Client ID/Description	MS	MSD	Matrix	Date Collected	Time Collected	Part Particulate	TPRTF
001	Frey-R1-PART-FHA			Air	5/19/92		X	
002	Frey-R1-PART-FILTER 274					1330	(X)	✓
003	Frey-R2-PART-FHA						X	
004	Frey-R2-PART-FILTER 214					1330	(X)	✓
005	Frey-R3-PART-FHA						X	
006	Frey-R3-PART-FILTER 251					1330	(X)	✓
007	Frey-Blank-Acetone				5/8/92		X	
008	Frey-Blank-Filter 252						(X)	✓

FIELD PERSONNEL: COMPLETE ONLY SHADED AREAS

Special Instructions:

DATE/REVISIONS:
6-8-92 1. add matrix to C.O.C as Air
2.
3.
4.
5.
6.

Relinquished by	Received by	Date	Time
Jack Mills	B. Duffy	5-20-92	8:10 am

Relinquished by	Received by	Date	Time
	5-20-92		

WESTON Analytics Use Only

Samples were:
1) Shipped ___ or Hand Delivered X
Airbill #
2) (Ambient) or Chilled
3) Received in Good Condition (Y) or N
4) Labels Indicate Properly Preserved (Y) or N
5) Received Within Holding Times (Y) or N

COC Tape was:
1) Present on Outer Package Y or (N)
2) Unbroken on Outer Package Y or (N)
3) Present on Sample Y or (N)
4) Unbroken on Sample Y or (N)
COC Record Present Upon Sample Rec't (Y) or N

Discrepancies Between Samples Labels and COC Record? Y or (N)
NOTES:

RFW 21-21-001/A-7/91 ___ L372 ___ L373 ___ L375 ___ L377 ___ L378 Ref# NA Cooler# NA 381-596a

APPENDIX C

SAMPLE CALCULATIONS

SAMPLE CALCULATIONS FOR PARTICULATE TEST (EPA METHOD 5)

Client: W.S. FREY
Test Number: Run 1
Test Location: SCRUBBER STACK

Plant: CLEARBROOK, VA
Test Date: 05-19-92
Test Period: 0854-1024

1. Volume of dry gas sampled at standard conditions (68 deg F, 29.92 in. Hg), dscf.

$$Vm(std) = \frac{17.64 \times Y \times Vm \times \left(Pb + \frac{delt\ H}{13.6} \right)}{(Tm + 460)}$$

$$Vm(std) = \frac{17.64 \times 0.9915 \times 35.428 \times \left(30.35 + \frac{1.088}{13.6} \right)}{73.02 + 460} = 35.375$$

Where:

Vm(std)	=	Volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscf.
Vm	=	Volume of gas sample measured by the dry gas meter at meter conditions, dcf.
Pb	=	Barometric Pressure, in Hg.
delt H	=	Average pressure drop across the orifice meter, in H_20.
Tm	=	Average dry gas meter temperature , deg F.
Y	=	Dry gas meter calibration factor.
17.64	=	Factor that includes ratio of standard temperature (528 deg R) to standard pressure (29.92 in. Hg), deg R/in. Hg.
13.6	=	Specific gravity of mercury.

2. Volume of water vapor in the gas sample corrected to standard conditions, scf.

$$V_{w(std)} = (0.04707 \times V_{wc}) + (0.04715 \times W_{wsg})$$

$$V_{w(std)} = (0.04707 \times 224.0) + (0.04715 \times 14.0) = 11.204$$

Where:

$V_{w(std)}$ = Volume of water vapor in the gas sample corrected to standard conditions, scf.

V_{wc} = Volume of liquid condensed in impingers, ml.

W_{wsg} = Weight of water vapor collected in silica gel, g.

0.04707 = Factor which includes the density of water (0.002201 lb/ml), the molecular weight of water (18.0 lb/lb-mole), the ideal gas constant 21.85 (in. Hg) (ft^3)/lb-mole)(deg R); absolute temperature at standard conditions (528 deg R), absolute pressure at standard conditions (29.92 in. Hg), ft^3/ml.

0.04715 = Factor which includes the molecular weight of water (18.0 lb/lb-mole), the ideal gas constant 21.85 (in. Hg) (ft^3)/lb-mole)(deg R); absolute temperature at standard conditions (528 deg R), absolute pressure at standard conditions (29.92 in. Hg), and 453.6 g/lb, ft^3/g.

3. Moisture content

$$B_{ws} = \frac{V_{w(std)}}{V_{w(std)} + V_{m(std)}}$$

$$B_{ws} = \frac{11.204}{11.204 + 35.375} = 0.241$$

Where:

B_{ws} = Proportion of water vapor, by volume, in the gas stream, dimensionless.

4. Mole fraction of dry gas.

$Md = 1 - Bws$

$Md = 1 - 0.241 = 0.759$

Where:

Md = Mole fraction of dry gas, dimensionless.

5. Dry molecular weight of gas stream, lb/lb-mole.

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

$MWd = (0.440 \times 20.90) + (0.320 \times 4.80) + (0.280 \times (74.30 + 0.00))$

$= 31.54$

Where:

MWd = Dry molecular weight , lb/lb-mole.

$\%\ CO_2$ = Percent carbon dioxide by volume, dry basis.

$\%\ O_2$ = Percent oxygen by volume, dry basis.

$\%\ N_2$ = Percent nitrogen by volume, dry basis.

% CO = Percent carbon monoxide by volume, dry basis.

0.440 = Molecular weight of carbon dioxide, divided by 100.

0.320 = Molecular weight of oxygen, divided by 100.

0.280 = Molecular weight of nitrogen or carbon monoxide, divided by 100.

6. Actual molecular weight of gas stream (wet basis), lb/lb-mole.

$$MWs = (MWd \times Md) + (18 \times (1 - Md))$$

$$MWs = (31.54 \times 0.759) + 18(1 - 0.759)) = 28.28$$

Where:

MWs = Molecular weight of wet gas, lb/lb-mole.

18 = Molecular weight of water, lb/lb-mole.

7. Average velocity of gas stream at actual conditions, ft/sec.

$$Vs = 85.49 \times Cp \times ((delt\ p)^{1/2})avg \times \left(\frac{Ts\ (avg)}{Ps \times MWs}\right)^{1/2}$$

$$Vs = 85.49 \times 0.84 \times 1.520619 \times \left(\frac{608}{30.28 \times 28.28}\right)^{1/2} = 91.99$$

Where:

Vs = Average gas stream velocity, ft/sec.

85.49 = Pitot tube constant, ft/sec $\times$ $\frac{(lb/lb\text{-}mole)(in.\ Hg)^{1/2}}{(deg\ R)(in\ H2O)}$

Cp = Pitot tube coefficient, dimensionless.

Ts = Absolute gas stream temperature, deg R = Ts, deg F + 460.

Ps = Absolute gas stack pressure, in. Hg. = $Pb + \frac{P(static)}{13.6}$

delt p = Velocity head of stack, in. H_2O.

8. Average gas stream volumetric flowrate at actual conditions, wacf/hr.

$$Qs(act) = 3{,}600 \times Vs \times As$$

$$Qs(act) = 3{,}600 \times 91.99 \times 6.25 = 2069731$$

Where:

Qs(act) = Volumetric flowrate of wet stack gas at actual conditions, wacf/hr.

As = Cross-sectional area of stack, ft^2.

9. Average gas stream dry volumetric flowrate at standard conditions, dscf/hr.

$$Qs(std) = 17.64 \times Md \times \frac{Ps}{Ts} \times Qs(act)$$

$$Qs(std) = 17.64 \times 0.759 \times \frac{30.28}{608} \times 2069731$$

$$= 1381677$$

Where:

Qs(std) = Volumetric flowrate of dry stack gas at standard conditions, dscf/hr.

10. Isokinetic variation calculated from intermediate values, percent.

$$I = \frac{17.327 \times Ts \times Vm(std)}{Vs \times O \times Ps \times Md \times (Dn)^2}$$

$$I = \frac{17.327 \times 608 \times 35.375}{91.99 \times 60 \times 30.28 \times 0.759 \times (0.175)^2} = 95.82$$

Where:

I = Percent of isokinetic sampling.

O = Total sampling time, minutes.

Dn = Diameter of nozzle, inches.

17.327 = Factor which includes standard temperature (528 deg R), standard pressure (29.92 in. Hg), the formula for calculating area of circle D^2/4, conversion of square feet to square inches (144), conversion of seconds to minutes (60), and conversion to percent (100), $\frac{(\text{in. Hg})(\text{in}^2)(\text{min})}{(\text{deg R})(\text{ft}^2)(\text{sec})}$

11. Particulate Concentration, gr/dscf.

$$C1 = 15.432 \times \frac{Mt}{Vm(std)}$$

$$C1 = 15.432 \times \frac{0.11110}{35.375}$$

$$= 0.0485$$

Where:

C1 = Particulate concentration, lb/dscf.

Mt = Total weight of particulate caught by train minus the particulate caught by the blank train, gms.

15.432 = Conversion factor from gms to gr.

12. Particulate mass emission rate, lbs/hr.

PMRt = 0.008571 x C1 x Qs(std)

PMRt = 0.008571 x 0.04847 x 23028

= 9.57

Where:

PMRt = Particulate mass emission rate, lbs/hr.

0.008571 = Conversion factor relating grains to pounds (7,000) and minutes to hours.

SAMPLE CALCULATIONS FOR BIAS CORRECTION AND MASS EMISSION RATE OF CARBON MONOXIDE

Client:	W.S. FREY COMPANY	**Plant:**	CLEAR BROOK, VA
Test Run No.:	RUN 1	**Test Date:**	05-19-92
Test Location:	LIME KILN SCRUBBER STACK	**Test Period:**	0845-1024

1. Bias corrected value of carbon monoxide.

$$C(corr) = \frac{AVG - ZERO}{BIAS - ZERO} \times SPAN\ GAS$$

$$C(corr) = \frac{81.70 - 4.70}{506.00 - 4.70} \times 504.0$$

$$C(corr) = 85.266$$

Where:

AVG = Average CO concentration for the test run as reported by the analyzer.

ZERO = The average of pre and post test zero bias check of the complete system with "zero" air.

BIAS = The average of pre and post test bias check of the complete system with the calibration span gas.

SPAN GAS = The calibration gas closest to the gas stream concentration, which was used for a BIAS check.

C(corr) = Bias corrected value of carbon monoxide.

2. Carbon monoxide mass emission rate, lbs/hr.

$$PMR(CO) = \frac{C(corr) \times Qs(std) \times 28.01 \times 60\ min/hr}{385.35 \times 10^{\wedge}6}$$

$$PMR(CO) = \frac{85 \times 23000.00 \times 28.01 \times 60\ min/hr}{385.35 \times 10^{\wedge}6}$$

PMR(CO) = 8.55

Where:

PMR(CO)	=	Carbon monoxide mass emission rate, lbs/hr.
Qs(std)	=	Avg. volumetric gas stream flow rate at std. conditions, dscf/min.
28.01	=	Molecular weight of CO.
385.35x10^6	=	Conversion factor from ppm to lbs.

APPENDIX D

EQUIPMENT CALIBRATION RECORDS

CEM CALIBRATION DATA SHEET

RUN NO. ONE SITE: WS FREY LIME KILN STACK DATE: 5/19/92 OPERATOR: L.S.

START TIME: 0856

STOP TIME: 1000

		INTERNAL CALIBRATION			SYSTEM BIAS PRE-TEST			SYSTEM BIAS POST-TEST				
			TIME 0815		0845			1015				
		KNOWN	ANAL. RESP.	% DIFF.	ANAL. RESP.	% DIFF.		ANAL. RESP.	% DIFF.		% DRIFT	AVG RESP.
CO ppm range	ZERO	0.0	-4.7		-4.7			-4.7				
	LOW	251	265									
	MID	504	509		507			505				
	HIGH	803	793									
CO2 % range 20	ZERO	0.0										
	LOW											
	MID											
	HIGH											
O2 % range 25	ZERO	0.0										
	LOW											
	MID											
	HIGH											
NOx ppm range	ZERO	0.0	0		0			0.1				
	LOW	84.43	84.6									
	MID	1258	1256		1256			1200				
	HIGH	2062	2048									
THC ppm range	ZERO	0.0										
	LOW											
	MID											
	HIGH											
SO2 ppm range	ZERO	0.0	1.4		1.2			3.5				
	LOW	202	201									
	MID	391	395		388			393				
	HIGH	777	778									
range	ZERO	0.0										
	LOW											
	MID											
	HIGH											

CEM CALIBRATION DATA SHEET

RUN NO. TWO SITE: WS Frey Lime Kiln Stack DATE: 5/19/92 OPERATOR: SI

START TIME: 1156

STOP TIME:

		INTERNAL CALIBRATION TIME 1050			PRE-TEST 1120		POST-TEST 1310			
		KNOWN	ANAL. RESP.	% DIFF.	ANAL. RESP.	% DIFF.	ANAL. RESP.	% DIFF.	% DRIFT	AVG RESP.
CO ppm range	ZERO	0.0	-4.7		-4.7		-4.8			
	LOW	251	266							
	MID	504	504		500		508			
	HIGH	803	796							
CO2 % range 20	ZERO	0.0								
	LOW									
	MID									
	HIGH									
O2 % range 25	ZERO	0.0								
	LOW									
	MID									
	HIGH									
NOx ppm range	ZERO	0.0	0.3		0.4		2.0			
	LOW	84.43	84							
	MID	1258	1252		1268		1263			
	HIGH	2062	2068							
THC ppm range	ZERO	0.0								
	LOW									
	MID									
	HIGH									
SO2 ppm range	ZERO	0.0	0.5		1.5		3.5			
	LOW	202	201							
	MID	391	393		393		389			
	HIGH	777	778		769		765			
range	ZERO	0.0								
	LOW									
	MID									
	HIGH									

CEM CALIBRATION DATA SHEET

RUN NO. THREE SITE: WS FREY LIME KILN STACK DATE: 5/19/92 OPERATOR: SI

START TIME: _____ INTERNAL SYSTEM BIAS

STOP TIME: _____ CALIBRATION PRE-TEST POST-TEST

TIME 1350 1500 1630

		KNOWN	ANAL. RESP.	% DIFF.	ANAL. RESP.	% DIFF.	ANAL. RESP.	% DIFF.	% DRIFT	AVG RESP.
CO ppm range	ZERO	0.0	-5.0		-5.0		-5.1			
	LOW	251	264							
	MID	504	504		497		499			
	HIGH	803	792							
CO2 % range 20	ZERO	0.0								
	LOW									
	MID									
	HIGH									
O2 % range 25	ZERO	0.0								
	LOW									
	MID									
	HIGH									
NOx ppm range	ZERO	0.0	1.2		4.3		6.0			
	LOW	84.43	87							
	MID	1258	1260		1235		1220			
	HIGH	2062	2060							
THC ppm range	ZERO	0.0								
	LOW									
	MID									
	HIGH									
SO2 ppm range	ZERO	0.0	0.3		0.3		6.5			
	LOW	202	198							
	MID	391	392							
	HIGH	777	775		765		758			
range	ZERO	0.0								
	LOW									
	MID									
	HIGH									

WESTON

Calibrator PM

POSTTEST DRY GAS METER CALIBRATION DATA FORM

Date 5/21/92 Meter box number 8 Plant WJ Frey

Barometric pressure, P_b = 29.74 in. Hg Dry gas meter number 6842672 Pretest Y .9946

Setting	Gas Volume		Temperature				Time (θ), min.	Vacuum Setting, in. Hg.	Y_i	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w + 460)}$
			Wet test meter	Dry gas meter						
Orifice Manometer (ΔH) in. H_2O	Wet test meter (V_w) ft^3	Dry gas meter (V_d) ft^3	Wet test meter (t_w) °F	Inlet (td_i) °F	Outlet (td_o) °F	Average (t_d) °F				
1.18	10	361.559 351.511	71.5	83,86,88	77,78,79	82	15.7	12	1.041	
1.18	10	371.680 361.559	71	85,88,89	79,79,80	83.5	15.7	12	1.008	
1.18	10	381.562 371.680	71	87,89,90	80,81,81	84.5	15.8	12	1.004	
									Y = 1.007	

D-4

If there is only one thermometer on the dry gas meter, record the temperature under td_o.

V_w = Gas volume passing through the wet test meter, ft^3.
V_d = Gas volume passing through the dry gas meter, ft^3.
t_w = Temperature of the gas in the wet test meter, °F.
td_i = Temperature of the inlet gas of the dry gas meter, °F.
td_o = Temperature of the outlet gas of the dry gas meter, °F.
t_d = Average temperature of the gas in the dry gas meter, $\frac{td_i + td_o}{2}$.
ΔH = Pressure differential across orifice, in. H_2O.
Y_i = Ratio of accuracy of wet test meter to dry gas meter for each run.
Y = Average ratio of accuracy of wet test meter to dry gas meter for all three runs; tolerance = pretest Y ± 0.05Y.
P_b = Barometric pressure, in. Hg.
θ = Time of calibration run, min.

$$\Delta H@_1 = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\theta}{V_w}\right]^2$$

Long calibration required? Yes _____ No ✓

WESTON

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

DATE 5/21/92
AMBIENT TEMPERATURE 70°
CALIBRATION PM

POTENTIOMETER NUMBER 2010 #8
BAROMETRIC PRESSURE 29.74
REFERENCE: THERMOCOUPLE SIMULATOR
(ACCURACY ± 1°F)

REFERENCE TEMPERATURE °C	REFERENCE TEMPERATURE °F	TEMPERATURE READING FROM THERMOCOUPLE CHANNEL INPUT NUMBER 1	2	3	4	5	AVERAGE TEMPERATURE READING ⊙	TEMPERATURE DIFFERENCE ⊙ (%)
0	32	33	33	33	33	33	33	1°-,20%
100	212	213	213	213	213	213	213	1°-,14%
500	932	931	931	931	931	931	931	1°-,07%
1000	1832	1825	1825	1825	1825	1825	1825	7°-,30%

COMMENTS

⊙ AVERAGE TEMPERATURE READING = MEAN OF THE TEMPERATURE READINGS FOR THE THERMOCOUPLE CHANNELS

⊙ THE CHANNEL READINGS MUST AGREE WITHIN ± 5°F OR 3°C

ACCEPTABLE TEMPERATURE DIFFERNCE ≤ 1.5 = $\left(\frac{(\text{REF TEMP}^{\circ}\text{F} + 460) - (\text{TEST TEMP}^{\circ}\text{F} + 460)}{(\text{REF TEMP}^{\circ}\text{F} + 460)}\right) \times 100$

POTCAL-4T

NOZZLE CALIBRATION DATA FORM

Date 5/18/92 Calibrated by Jack Mills

Nozzle Identification Number	Nozzle Diameter, Inches[1]			ΔD,[2]	D_{avg}[3]
	D_1	D_2	D_3		
11R	.185	.186	.186	.001	.186
11J	.175	.174	.176	.002	.175

Where:

[1] $D_{1,2,3}$ = Three different nozzle diameters, inches; each diameter must be measured to nearest 0.001 in.

[2] ΔD = Maximum difference between any two diameters, inches. ΔD must be $\leq$0.004 in.

[3] D_{avg} = Nozzle diameter = average of D_1, D_2, and D_3.

nozzle.frm

PITOT TUBE IDENTIFICATION NUMBER: P - 4

TYPE S PITOT TUBE INSPECTION DATA FORM

PITOT TUBE ASSEMBLY LEVEL? ✓ (YES) _____ (NO)

PITOT TUBE OPENINGS DAMAGED? _____ (YES-EXPLAIN BELOW) ✓ (NO)

α_1 = 4 ° (<10°) α_2 = 2 ° (<10°)

β_1 = 3 ° (< 5°) β_2 = 4 ° (< 5°)

γ = 4 ° θ = 1 ° A = .94 in cm (in.)

z = A sin γ = .066 cm (in.); <0.32 cm (<1/8 in.),

w = A sinθ = .016 cm (in.); <0.32 cm (<1/8 in.),

P_a .47 in cm (in.) P_b .47 in cm (in.)

D_t .38 in cm (in.)

COMMENTS _____

CALIBRATION REQUIRED? _____ (YES) ✓ (NO)

INSPECTOR Alfred R. Barber Jr. DATE 4-22-92

APPENDIX E

PROCESS OPERATIONS DATA

TABLE E-1

LIME KILN PROCESS DATA[1]
W.S. FREY COMPANY - CLEAR BROOK, VIRGINIA

Run No.	One	Two	Three
Date	5-19-92	5-19-92	5-19-92
Time	0854-1024	1154-1329	1455-1624
Coal Feed Rate, tons/hr	4.3	4.4	4.2
Lime Discharge Rate, tons/hr	9.0	9.4	9.2
Limestone Feed Rate, tons/hr	18.0	18.9	18.4
Kiln Feed End Temperature, °F	1315.1	1299.9	1332.3
Kiln Firing End Temperature, °F	2369.4	2426.2	2347.3
Kiln Speed, revolutions/hr	38.0	39.5	38.5

[1] Provided by W.S. Frey Company. These are average values for the stated time period.

APPENDIX F

CALIBRATION GAS CERTIFICATES

Scott Specialty Gases, Inc.

E. P. A. PROTOCOL RECERTIFICATION ANALYSIS

Shipped from:
Scott Specialty Gases
Route 611
Plumsteadville, PA 18949
Purchase order :
5918

Shipped to:
ROY F WESTON
1280 KING RD
WEST CHESTER PA 19380
ATTN: LARRY SI
KEYSTONE BLDG
Project No 38505

Certified per E.P.A. Protocol # 1 Procedure #G1 Section # 3.0.4
Certified accuracy +/- 1 % NIST Traceable

Cylinder number	AAL 9336	Cylinder pressure 500 psig.	Date of assay: 6/9/92
Component		Certified concentration	Expiration date: 12/9/93
CARBON MONOXIDE		803 ppm	
NITROGEN		Balance	

Standard		Analyzer	
Type	CRM 1681b	Make	: HORIBA
Concentration	968 ppm	Model	: CFA-310A
Cylinder #	CLM000330	Serial number	: 474091
		Analytical principle	: NDIR
		Date of calibration	: 5/7/92

Raw data units: VOLTS			: Concentration of Customer Cylinder
First analysis 9/18/90			
Z1=0.0000	R1=0.0000000	T1=0.00000000	: 803 ppm
R2=0.0000000	Z2=0.0000	T2=0.00000000	: 803 ppm
Z3=0.0000	T3=0.0000000	R3=0.00000000	: 803 ppm
Second analysis: 6/9/92			
Z1=0.0000	R1=0.86850	T1=0.72760	: 805 ppm
R2=0.87250	Z2=0.0000	T2=0.73040	: 804 ppm
Z3=0.0000	T3=0.72980	R3=0.87370	: 802 ppm

Analyst Christine Rust

Approved by Ted Neeme
Mark S. Sirinides/Ted Neeme

Scott Specialty Gases, Inc.

E. P. A. PROTOCOL RECERTIFICATION ANALYSIS

Shipped from:
Scott Speciality Gases
Route 611
Plumsteadville, PA 18949
Purchase order :
5918

Shipped to:
ROY F WESTON
1280 KING RD
WEST CHESTER PA 19380
ATTN: LARRY SI
KEYSTONE BLDG
Project No 38505

Certified per E.P.A. Protocol # 1 Procedure #G1 Section # 3.0.4
Certified accuracy +/- 1 % NIST Traceable

Cylinder number	AAL 14003	Cylinder pressure 600 psig.	Date of assay: 6/9/92
Component		Certified concentration	Expiration date: 12/9/93
CARBON MONOXIDE		504 ppm	
NITROGEN		Balance	

Standard
Type CRM 1681b
Concentration 968 ppm
Cylinder # CLM000330

Analyzer
Make : HORIBA
Model : CFA-310A
Serial number : 474091
Analytical principle : NDIR
Date of calibration : 5/7/92

Raw data units: VOLTS			Concentration of Customer Cylinder
First analysis 9/18/90			
Z1=0.0000	R1=0.0000000	T1=0.00000000	505 ppm
R2=0.0000000	Z2=0.0000	T2=0.00000000	505 ppm
Z3=0.0000	T3=0.0000000	R3=0.00000000	505 ppm
Second analysis: 6/9/92			
Z1=0.0000	R1=0.86510	T1=0.46230	506 ppm
R2=0.87080	Z2=0.0000	T2=0.46200	502 ppm
Z3=0.0000	T3=0.46180	R3=0.86770	503 ppm

Analyst Christine Rusk

Approved by
Mark S. Sirinides/Tec Neeme

Scott Specialty Gases, Inc.

E. P. A. PROTOCOL RECERTIFICATION ANALYSIS

Shipped from:
Scott Specialty Gases
Route 611
Plumsteadville, PA 18949
Purchase order :
5918

Shipped to:
ROY F WESTON
1280 KING RD
WEST CHESTER PA 19380
ATTN: LARRY SI
KEYSTONE BLDG
Project No 38505

Certified per E.P.A. Protocol # 1 Procedure #G1 Section # 3.0.4
Certified accuracy +/- 1 % NIST Traceable

Cylinder number AAL 934
Cylinder pressure 700 psig.
Date of assay: 6/8/92

Component
CARBON MONOXIDE
NITROGEN

Certified concentration
251 ppm
Balance

Expiration date: 12/8/93

Standard
Type CRM 2636
Concentration 243.4 ppm
Cylinder # ALM013375

Analyzer
Make : HORIBA
Model : CFA-310A
Serial number : 474091
Analytical principle : NDIR
Date of calibration : 5/6/92

Raw data units: VOLTS			: Concentration of Customer Cylinder
First analysis 9/19/90			
Z1=0.0000 R1=0.0000000	T1=0.00000000		: 252 ppm
R2=0.0000000	Z2=0.0000 T2=0.00000000		: 252 ppm
Z3=0.0000 T3=0.0000000	R3=0.00000000		: 252 ppm
Second analysis: 6/8/92			
Z1=0.0000	R1=0.61240	T1=0.63320	: 252 ppm
R2=0.61600	Z2=0.0000	T2=0.63110	: 249 ppm
Z3=0.0000	T3=0.63300	R3=0.61530	: 250 ppm

Analyst Christine Rush

Approved by
Mark S. Sirinides/Ted Heeme

F-3

Scott Specialty Gases, Inc.

E. P. A. PROTOCOL RECERTIFICATION ANALYSIS

Shipped from:
Scott Specialty Gases
Route 611
Plumsteadville, PA 18949
Purchase order :
5918

Shipped to:
ROY F WESTON
1280 KING RD
WEST CHESTER PA 19380
ATTN: LARRY SI
KEYSTONE BLDG
Project No 38505

Certified per E.P.A. Protocol # 1 Procedure #G1 Section # 3.0.4
Certified accuracy +/- 1 % NIST Traceable

Cylinder number ALM001953
Cylinder pressure 200 psig.
Date of assay: 6/4/92

Component
SULFUR DIOXIDE
AIR

Certified concentration
777 ppm
Balance

Expiration date: 12/4/92

Standard
Type CRM 1662
Concentration 1006 ppm
Cylinder # ALM007670

Analyzer
Make : HORIBA
Model : CMA-321A
Serial number : 564-371-02
Analytical principle : NDIR
Date of calibration : 5/13/92

Raw data units: VOLTS

First analysis 9/21/90

Z1=0.0000 R1=0.0000000 T1=0.00000000
R2=0.0000000 Z2=0.0000 T2=0.00000000
Z3=0.0000 T3=0.0000000 R3=0.00000000

Second analysis: 6/4/92

Z1=0.0000 R1=1.0037 T1=0.76740
R2=1.0005 Z2=0.0000 T2=0.77110
Z3=0.0000 T3=0.77270 R3=1.0049

Concentration of Customer Cylinder	
773	ppm
773	ppm
773	ppm
778	ppm
784	ppm
782	ppm

Analyst Christine Rust

Approved by
Mark S. Sirinides/Ted Neeme

Scott Specialty Gases, Inc.

E. P. A. PROTOCOL RECERTIFICATION ANALYSIS

Shipped from:
Scott Specialty Gases
Route 611
Plumsteadville, PA 18949
Purchase order :
5918

Shipped to:
ROY F WESTON
1280 KING RD
WEST CHESTER PA 19380
ATTN: LARRY SI
KEYSTONE BLDG
Project No 38505

Certified per E.P.A. Protocol # 1 Procedure #G1 Section # 3.0.4
Certified accuracy +/- 1 % NIST Traceable

Cylinder number AL21470
Cylinder pressure 1300 psig,
Date of assay: 6/4/92

Component
SULFUR DIOXIDE
AIR

Certified concentration
391 ppm
Balance

Expiration date: 12/4/92

Standard
Type CRM 1661
Concentration 454 ppm
Cylinder # ALM005781

Analyzer
Make : HORIBA
Model : CMA-321A
Serial number : 564-371-02
Analytical principle : NDIR
Date of calibration : 5/13/92

Raw data units: VOLTS			: Concentration of Customer Cylinder
First analysis 10/29/91			
Z1=0.0000	R1=0.0000000	T1=0.00000000	: 393 ppm
R2=0.0000000	Z2=0.0000	T2=0.00000000	: 393 ppm
Z3=0.0000	T3=0.0000000	R3=0.00000000	: 393 ppm
Second analysis: 6/4/92			
Z1=0.0000	R1=0.41400	T1=0.35130	: 388 ppm
R2=0.41580	Z2=0.0000	T2=0.35500	: 390 ppm
Z3=0.0000	T3=0.35660	R3=0.41700	: 391 ppm

Analyst Christine Rusk

Approved by
Mark S. Sirinides/Ted Neeme

Scott Specialty Gases, Inc.

E. P. A. PROTOCOL RECERTIFICATION ANALYSIS

Shipped from:
Scott Specialty Gases
Route 611
Plumsteadville, PA 18949
Purchase order :
5918

Shipped to:
ROY F WESTON
1280 KING RD
WEST CHESTER PA 19380
ATTN: LARRY SI
KEYSTONE BLDG
Project No 38505

Certified per E.P.A. Protocol # 1 Procedure #G1 Section # 3.0.4
Certified accuracy +/- 1 % NIST Traceable

Cylinder number AL5352
Cylinder pressure 1500 psig.
Date of assay: 6/4/92

Component
SULFUR DIOXIDE
AIR
Certified concentration
202 ppm
Balance
Expiration date: 12/4/92

Standard
Type CRM 1661
Concentration 454 ppm
Cylinder # ALM005781

Analyzer
Make : HORIBA
Model : CMA-321A
Serial number : 564-371-02
Analytical principle : NDIR
Date of calibration : 5/13/92

Raw data units: VOLTS	: Concentration of Customer Cylinder
First analysis 10/29/91	
Z1=0.0000 R1=0.0000000 T1=0.00000000	: 201 ppm
R2=0.0000000 Z2=0.0000 T2=0.00000000	: 201 ppm
Z3=0.0000 T3=0.0000000 R3=0.00000000	: 201 ppm
Second analysis: 6/4/92	
Z1=0.0000 R1=0.047500 T1=0.038800	: 202 ppm
R2=0.047500 Z2=0.0000 T2=0.038800	: 202 ppm
Z3=0.0000 T3=0.038800 R3=0.047500	: 202 ppm

Analyst Brian Raffen

Approved by
Mark S. Sirinides/Ted Neeme

Scott Specialty Gases, Inc.

PLUMSTEADVILLE, PA 18949 PHONE: 215-766-8861 FAX: 215-766-0320

ROY F WESTON
ATTN: PETER VIRAG

Date Shipped 2-26-91
Our Project No: 26099
Your P.O. No: 25-13048
Page 3 of 3

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES*

(Concentrations are in mole % or ppm)

Cylinder Number 2L - 1042 CP = 2000 psig Certified Accuracy ±1 % NBS Traceable Analysis Dates: First 2-15-91 Last 2-26-91

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	REPLICATE CONCENTRATIONS SECOND
NITRIC OXIDE	2052 ppm	8-26-92	CHEMILUMINESCENCE	2631	2056 ppm	2065 ppm
NOX	2062 ppm				2029 ppm	2049 ppm
					2056 ppm	2053 ppm
OXYGEN FREE NITROGEN BALANCE						

F-7

Cylinder Number _____ Certified Accuracy _____ % NBS Traceable Analysis Dates: First _____ Last _____

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	REPLICATE CONCENTRATIONS SECOND

*We hereby certify the cylinder gas has been analyzed according to EPA Protocol No: 1 Procedure G1

Analyst Ted Weems Approved By MARK S. SIRINIDES

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the Company without extra cost.

Scott Specialty Gases, Inc.
PLUMSTEADVILLE, PA 18949 PHONE: 215-766-8861 FAX: 215-766-0320

ROY F WESTON

Date Shipped 2-26-91
Our Project No: 26099
Your P.O. No: 25-13048
Page 2 of 3

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES*
(Concentrations are in mole % or ppm)

Cylinder Number BAL - 843
CP = 2000 psig
Certified Accuracy ±1 % NBS Traceable
Analysis Dates: First 2-15-91 Last 2-26-91

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	REPLICATE CONCENTRATIONS SECOND
NITRIC OXIDE	1258 ppm	8-26-92	CHEMILUMINESCENCE	2631	1251 ppm	1254 ppm
NOX	1258 ppm				1281 ppm	1250 ppm
					1253 ppm	1255 ppm
OXYGEN FREE NITROGEN	BALANCE					

E-8

Cylinder Number _____ Certified Accuracy _____ % NBS Traceable
Analysis Dates: First _____ Last _____

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	REPLICATE CONCENTRATIONS SECOND

*We hereby certify the cylinder gas has been analyzed according to EPA Protocol No: 1 Procedure G1

Analyst Ted Neeme
Approved By Mark S. Sirinides
MARK S. SIRINIDES

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the Company without extra cost.

Scott Specialty Gases Scott Environmental Technology, Inc.
PLUMSTEADVILLE, PA 18949 PHONE: (215) 766-8861 TWX: 510-665-9344

ROY F WESTON

Date Shipped: 8-25-89
Our Project No.: 12641
Your P.O. No.: 54026-B-0017
Page 2 of 2

RECERTIFICATION ANALYSIS – EPA PROTOCOL GASES*

(Concentrations are in mole % or ppm)

Cylinder Number AAL 17391 Certified Accuracy ±1 % NBS Traceable ____ Analysis Dates: Last 8-15-89 New 8-23-89

cylinder pressure = 1300 psig

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS LAST	REPLICATE CONCENTRATIONS NEW
NITRIC OXIDE	84.8 ppm	2-23-91	Chemiluminescence	1685	85.10 ppm	84.86 ppm
NOx	85.4 ppm				85.00 ppm	84.73 ppm
					84.83 ppm	84.44 ppm
NITROGEN	BAL					

Cylinder Number ____ Certified Accuracy ____ % NBS Traceable Analysis Dates: Last ____ New ____

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS LAST	REPLICATE CONCENTRATIONS NEW

*We hereby certify the cylinder gas has been analyzed according to EPA Protocol No.: 1 Procedure G1

Analyst Jennifer L. Mease JENNIFER MEASE Approved By Mark S. Sirinides Mark Sirinides

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the Company without extra cost.

APPENDIX G

CHAIN OF CUSTODY

WESTON Analytics Use Only

Custody Transfer Record/Lab Work Request

WESTON

Page ____ of ____

Client W. S. Frey

Est. Final Proj. Sampling Date 5/19/92

Work Order # [illegible]

Project Contact/Phone # [illegible]

AD Project Manager ____

QC ____ Del ____ TAT ____

Date Rec'd ____ Date Due ____

Account # ____

Refrigerator # ____

#/Type Container (Liquid / Solid)

Volume (Liquid / Solid)

Preservatives

ANALYSES REQUESTED →

ORGANIC: VOA, BNA, Pest/PCB, Herb

INORG: Metal, CN

MATRIX CODES:
S - Soil
SE - Sediment
SO - Solid
SL - Sludge
W - Water
O - Oil
A - Air
DS - Drum Solids
DL - Drum Liquids
L - EP/TCLP Leachate
WI - Wipe
X - Other
F - Fish

Lab ID	Client ID/Description	Matrix QC Chosen (✓) MS	MSD	Matrix	Date Collected	Time Collected	VOA	BNA	Pest/PCB	Herb	Metal	CN
	Frey - R1 - [illegible]						X					
	Frey - R1 - [illegible]						X					
	Frey - R2 - [illegible]						X					
	Frey - R2 - [illegible]						X					
	Frey - R3 - [illegible]						X					
	Frey - R3 - [illegible]						X					
	Frey - Blank [illegible]						X					
	Frey - Blank [illegible]						X					

WESTON Analytics Use Only

FIELD PERSONNEL: COMPLETE ONLY SHADED AREAS

Special Instructions:

DATE/REVISIONS:
____ 1. ____
____ 2. ____
____ 3. ____
____ 4. ____
____ 5. ____
____ 6. ____

Relinquished by	Received by	Date	Time	Relinquished by	Received by	Date	Time
[illegible]	B. [illegible]	5-20-92	8:10 am		[illegible]		

WESTON Analytics Use Only

Samples were:
1) Shipped ____ or Hand Delivered X
Airbill # ____
2) Ambient or Chilled
3) Received in Good Condition Y or N
4) Labels Indicate Properly Preserved Y or N
5) Received Within Holding Times Y or N

COC Tape was:
1) Present on Outer Package Y or N
2) Unbroken on Outer Package Y or N
3) Present on Sample Y or N
4) Unbroken on Sample Y or N
COC Record Present Upon Sample Rec't Y or N

Discrepancies Between Samples Labels and COC Record? Y or N
NOTES:

RFW 21-21-001/A-7/91

____ L372 ____ L373 ____ L375 ____ L377 ____ L378 Ref# ____ Cooler# ____ 381-596a

APPENDIX H

WESTON PROJECT PARTICIPANTS

PROJECT PARTICIPANTS

The following WESTON employees participated in this project:

Richard Ruch Project Director	ECONENVIRONOMICS Division
Uttam Trivedi, P.E. Project Manager	ECONENVIRONOMICS Division
Kam Lo (Larry) Si Associate Project Engineer	ECONENVIRONOMICS Division
Jack Mills Project Scientist	ECONENVIRONOMICS Division
Andre Williams Technician	ECONENVIRONOMICS Division
Jack Tuschall, Ph.D. Laboratory Manager	WESTON Analytics