Background Report Reference

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Background Chapter: 4

Reference Number: 1

Title: Source Emissions Compliance Test Report

Roy F. Weston, Inc.

October 1989

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BR #1

SOURCE EMISSIONS COMPLIANCE TEST REPORT NUMBER ONE CALCINER

Sep 1989
Part 502

SCM CHEMICALS
BALTIMORE, MD

September 1989

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WESTON Project No. 2373-01-02-0082

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SCM007c.rpt

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October 9, 1989

Mr. Ronald E. Lipinski
Administrator Enforcement Program
Department of the Environment
2500 Broening Highway
Baltimore, MD 21224

Subject: SCM Chemicals
Number One Calciner
Compliance Test Report

Dear Mr. Lipinski:

Enclosed are three (3) copies of the above-referenced report.

As you requested, these copies were sent to you simultaneously with the report copies sent to Mr. James Wilkerson of SCM Chemicals.

Please contact Mr. Wilkerson should you have any questions.

Very truly yours,

ROY F. WESTON, INC.

Jeffrey D. O'Neill
Section Manager

JDO:dd
Enclosures

cc: B. L. Jackson, WESTON
J. Wilkerson, SCM

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WESTON

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SUMMARY

SCM Chemicals ("SCM") contracted Roy F. Weston, Inc. ("WESTON") to conduct a source testing and analysis program at its Baltimore, Maryland facility.

The primary objective of the survey was to determine the particulate, sulfuric acid mist and sulfur dioxide emissions compliance status of the No. 1 Calciner with the State of Maryland Department of the Environment ("DOE") allowable limits.

Testing procedures conformed to the specifications of the DOE.[1] A representative of DOE was present during all test periods.

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

[1]"Stack Test Methods for Stationary Sources, "Air Quality Control Administration - Technical Memorandum, Revised: June 1983.

SCM CHEMICALS
BALTIMORE, MARYLAND

TABLE 1

SUMMARY OF COMPLIANCE TEST RESULTS

NO. 1 CALCINER

Test Run No.	Test Date	Test Period	Particulate Emission Concentration		Sulfuric Acid Emission Concentration		Sulfuric Dioxide Emission Concentration	
			Measured gr/dscf(2)	Allowable gr/dscf	Measured mg/m^3	Allowable mg/m^3	Measured ppm	Allowable ppm
1	9/7/89	1334-1528	0.0152	0.03	47.	70	635.	2,000
2	9/8/89	0805-1011	0.0129	0.03	151.	70	863.	2,000
3	9/8/89	1207-1410	0.0120	0.03	42.	70	440.	2,000
Series Average	-	-	0.0134	-	80.	-	646.	-

(1) Particulate emission concentration shown are based on the Maryland front half catch weights listed in Table 2.

(2) gr/dscf - grains per dry standard cubic foot at standard conditions of 77°F and 29.92 inches Hg.

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SECTION 2

INTRODUCTION

SCM retained WESTON to conduct a source testing and analysis program on the stack serving Calciner No. 1 at its Baltimore, Maryland titanium dioxide production facility.

The primary objective of the survey was to determine the emissions compliance status of the No. 1 Calciner with Maryland DOE limits. Particulates, sulfuric acid mist (H_2SO_4) and sulfur dioxide (SO_2) were measured at the No. 1 Calciner Stack.

Maryland DOE approved test methods were used throughout the program. All tests were performed during the period 7-8 September 1989 by WESTON Air Quality Testing Services personnel.

Detailed test data and test results summaries are presented in Tables 2 and 3 of this report. Descriptions of the process, test location, test equipment, test procedures, sample recovery techniques and analytical methods used during the survey are also included herein. Raw test data, laboratory reports, sample calculations, equipment calibration records and a list of WESTON project participants are provided in Appendices A through E, respectively.

SECTION 3

DESCRIPTION OF PROCESS OPERATIONS

3.1 NO. 1 CALCINER

A titanium hydrated sulfate paste is extruded into one end of each 15' diameter by 165' long calciner. Each calciner is a steel shell, lined with acid brick, which rotates about once every 10-11 minutes and has a slight slope. The calciner or kiln, because of the rotation and slope, causes the paste to move down the inside and discharge at the far end 12-15 hours later. The kiln has a primary burner at the discharge end to furnish the bulk of heat but also has internal burners to provide additional heat. Exhaust gas from the kiln flow in one of two directions. During normal operations the gas flow proceeds through gas cleaning steps, but in an emergency (i.e., power failure), a powered damper opens and the gases vent to a natural gravity stack.

The paste enters the calciner and begins to dry. Further into the kiln the acid hydrolysate decomposes and gives up water, sulfur dioxide and sulfur trioxide. Next, as the dry cake tumbles, it produces titanium dioxide dust. Natural gas and/or oil is used as a fuel source producing normal products of combustion.

The carrier gas, when it reaches the separator contains sulfur oxides, particulate pollutants, and the oxygen depleted air. From the separator the gases go past a draft damper to a cyclone to remove most of the dust, and the remainder goes through a gas cleaning process. The first step is a low energy venturi scrubber using recycle water that cools the gases from about 700^{o} to 200^{o}F. This also removes dust and some acid mist. Next the gases go to a humidifying and cooling section called a conditioner, which reduces the temperature further to less than 195^{o}F. From here, the gas goes to a variable-throat venturi which utilizes recycle scrubbing water containing a scrubbing alkali. From here gases go to a separator to remove excess water using a Chevron type mist eliminator, and then through the I.D. fan to the stack.

The calciners operate between 50 and 82 TPD per kiln, (i.e., one kiln at 80 TPD rather than two kilns at 40 TPD and two kilns at 80 TPD rather than three kilns at 53 TPD each). Rates for most of the operating time have been between 50 and 75 TPD, although operating rates have ranged up to 82 TPD, the upper limit specified in the current operating permits for several of the calciners. Most of the testing has taken place at the higher operating rates. Some testing has taken place at rates up to 90 TPD.

See Figure 1 for a process schematic.

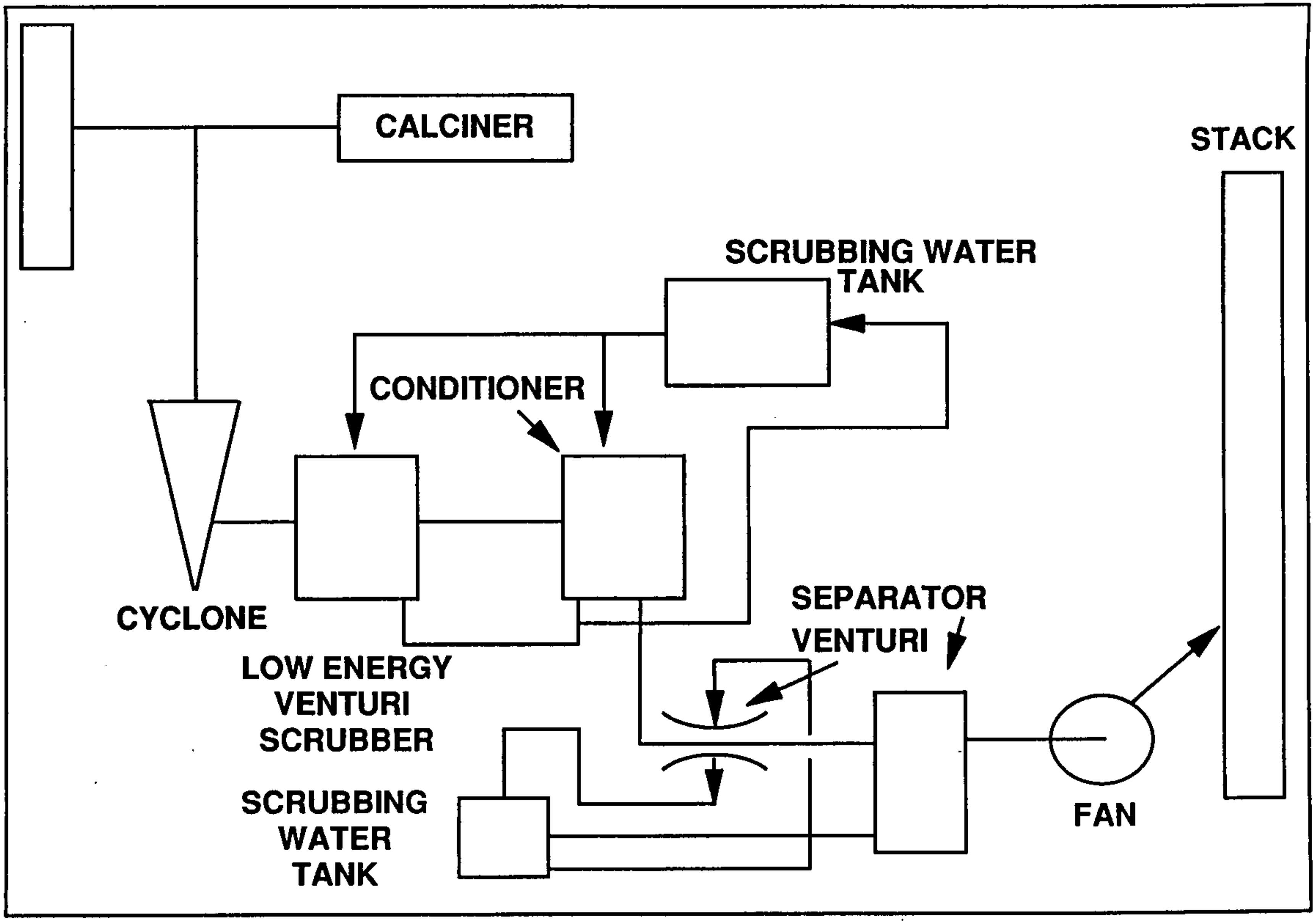

FIGURE 1
CALCINER PROCESS SCHEMATIC

SECTION 4

DESCRIPTION OF TEST LOCATION

4.0 NO. 1 CALCINER

Two test ports, 90° apart, were installed on a straight section of the fiberglass stack (60"ID) at a site which was 8 stack diameters downstream from the end of the taper above the fan breeching. The test ports were >10 stack diameters from the nearest downstream flow disturbance (stack discharge point). Traverse point selection criteria dictated by EPA Method 1 required a minimum of 16 points, per port axis, for this stack configuration. Figure 2 illustrates test port placement and traverse point locations.

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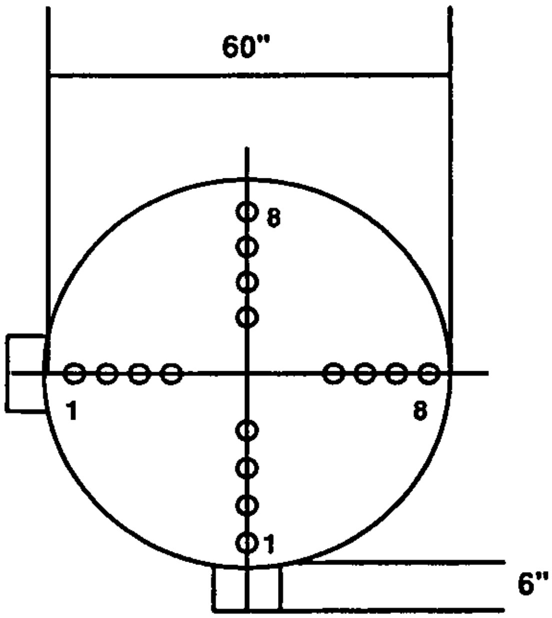
Baltimore, Maryland



TRAVERSE POINT NUMBER	DISTANCE FROM INSIDE WALL, IN.
1	2
2	6-1/4
3	11-5/8
4	19-3/8
5	40-5/8
6	48-3/8
7	53-3/4
8	58

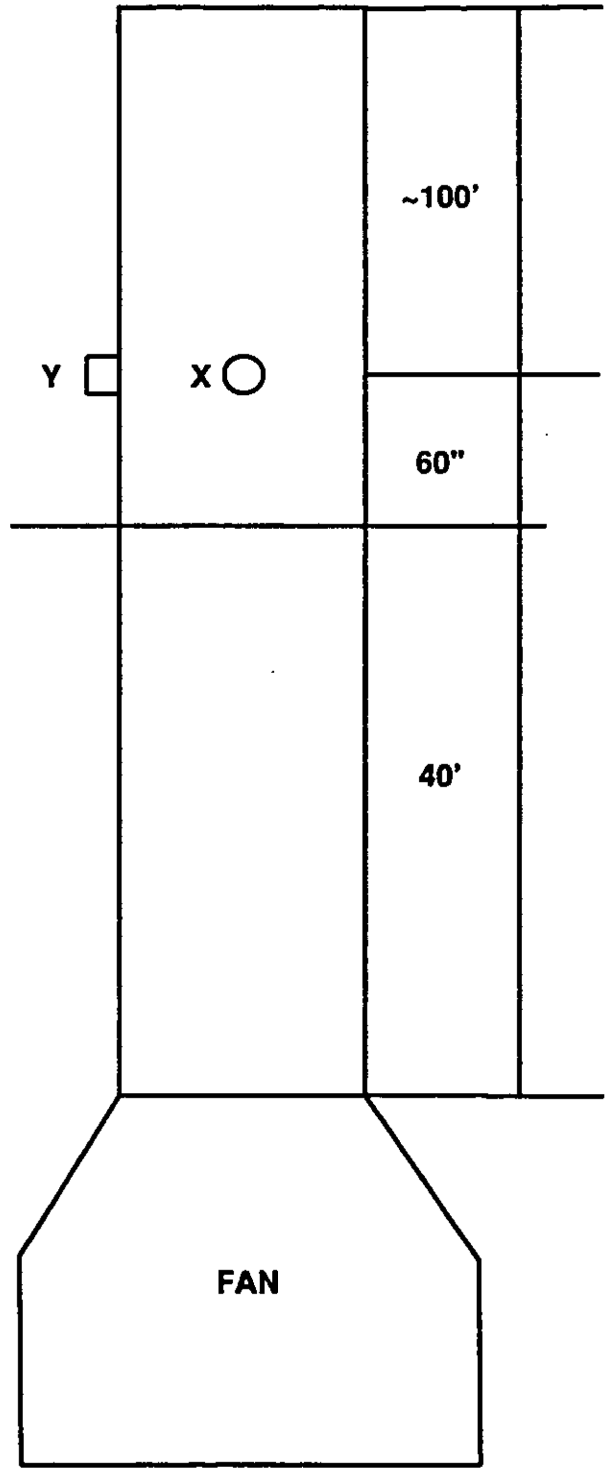


FIGURE 2: STACK SERVING CALCINER #1 PORT AND TRAVERSE POINT LOCATIONS

SECTION 5

DESCRIPTION OF SAMPLING TRAINS

5.1 PARTICULATE

The sampling train utilized to perform the particulate sampling was a DOE Method 1005 train (see Figure 3).

A calibrated stainless steel nozzle was attached to a heated (250°F) 6 ft. borosilicate probe. The probe was connected to a heated (250°F) borosilicate filter holder containing a 9-cm Reeve Angel 934 AH glass fiber filter (preweighed to a constant 0.1 mg weight). The first and second impingers contained 100 ml of distilled water each, 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 and impinger exit gas temperatures were monitored with a calibrated direct readout pyrometer equipped with chromel-alumel thermocouples positioned near the filter holder and after the last impinger, respectively.

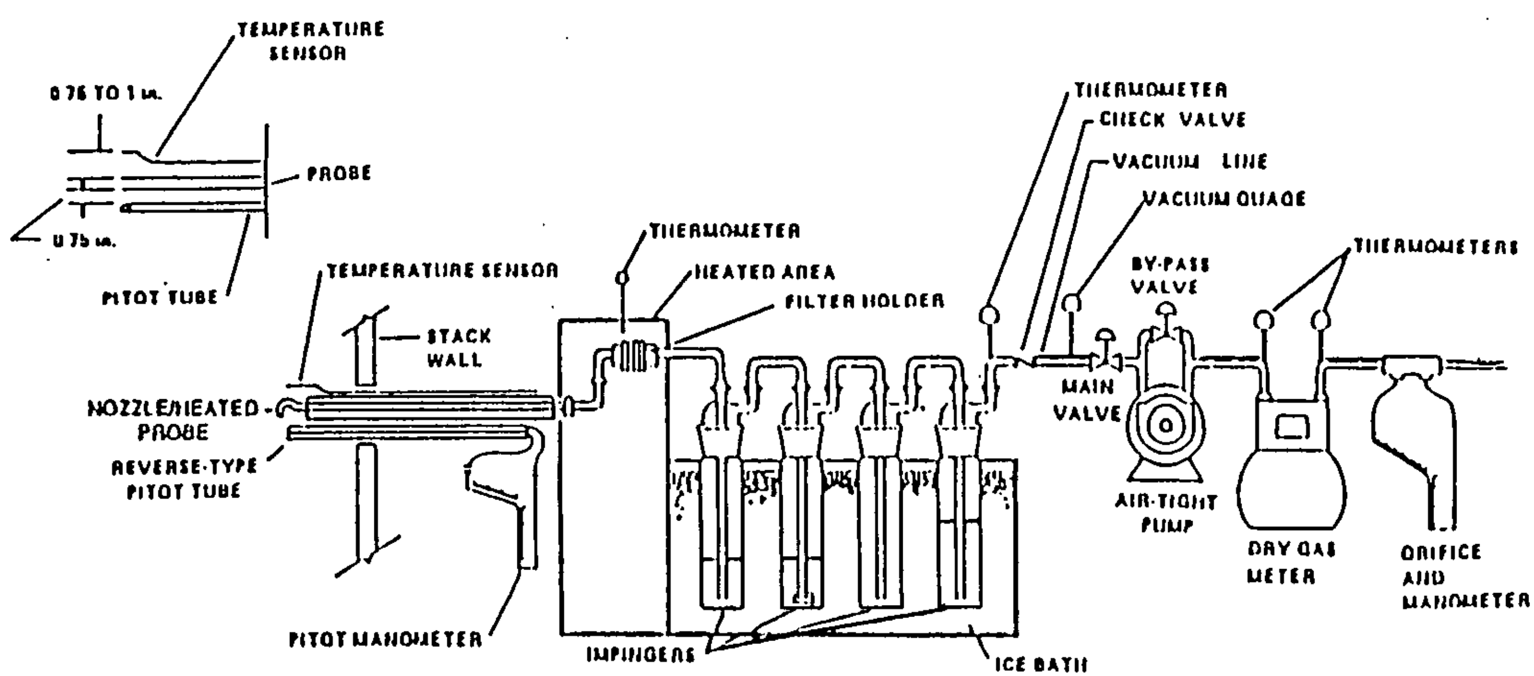


FIGURE 3 PARTICULATE SAMPLING TRAIN- DOE : Method 1005

Stack dry gas stream composition (carbon dioxide, oxygen, and carbon monoxide contents) was determined utilizing a EPA Method 3 Tedlar bag sampler and an Orsat apparatus to analyze integrated samples of the flue gases for each test. The integrated samples of the flue gases were collected at a constant rate of 0.8 liter per minute at each sample point in conjunction with each particulate test run. Triplicate Orsat analyses were performed on each gas sample.

5.2 SULFURIC ACID MIST/SULFUR DIOXIDE

The sampling train utilized to perform the combined H_2SO_4/SO_2 sampling was a DOE Method 1008 train, modified with the addition of an extra impinger to increase the capacity of the train to collect condensate, as described below:

A calibrated stainless steel nozzle was attached to a heated (250°F) borosilicate probe 6 feet in length. The probe was connected to the first impinger by means of rigid glass connectors. The probe to impinger glass connectors were inside a heated chamber (250°F) to prevent condensation prior to the first impinger. The first impinger contained 200 ml of 80 percent isopropyl alcohol. Impinger No. 2 was dry and was separated from the third impinger by an unheated filter holder containing an unweighed 934 AH glass fiber filter. The third and fourth impingers each contained 100 ml of 3% hydrogen peroxide, and the fifth impinger contained 300 grams of dry silica gel. The first and fourth impingers were standard Greenburg-Smith types; the second, third and fifth were of a modified design. All impingers were maintained in an ice bath. A Nutech control console with a leakless vacuum pump, a calibrated dry gas meter, a calibrated orifice, and inclined manometers completed the sampling train (see Figure 4).

Flue gas velocity was measured with a calibrated "S" type pitot tube (provided with extensions) fastened alongside the sampling

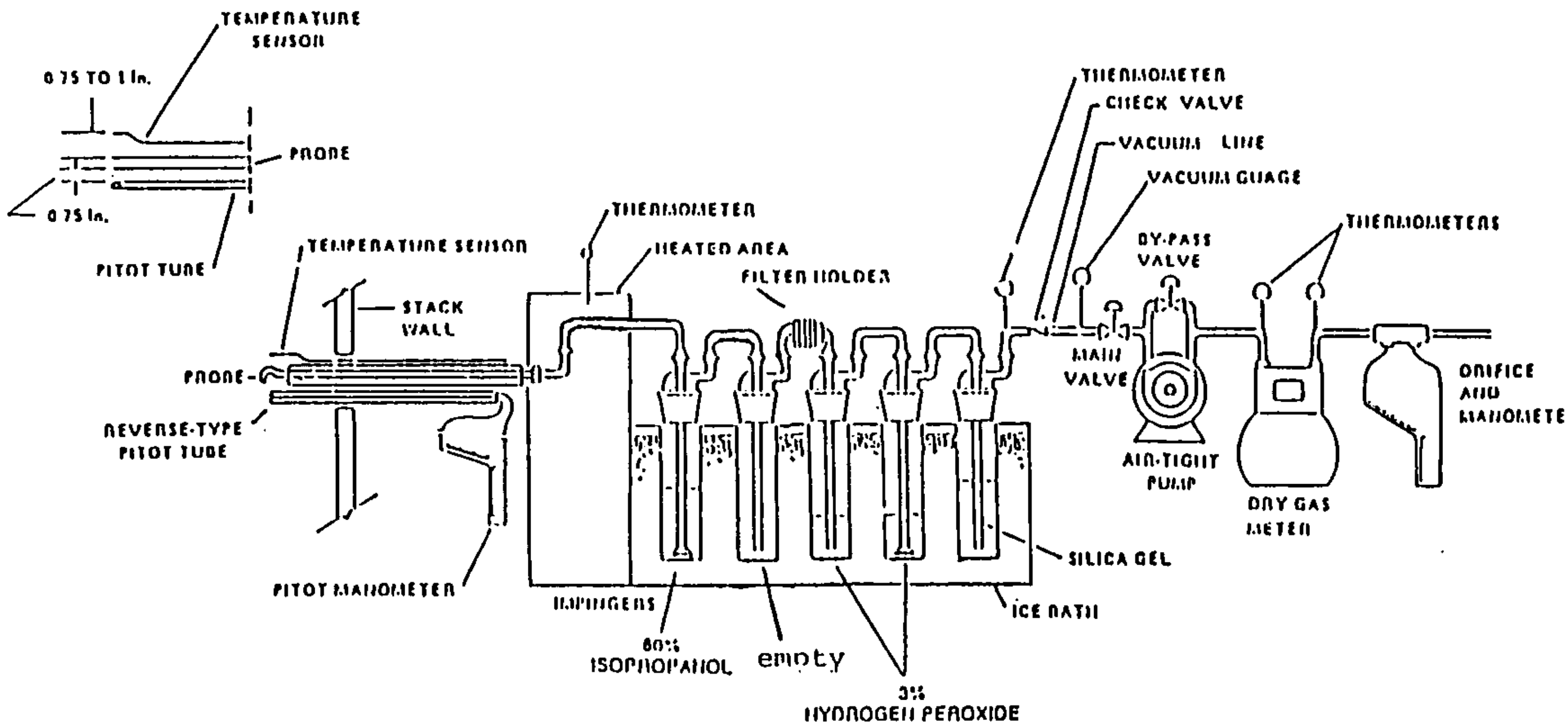


FIGURE 4 H_2SO_4/SO_2 SAMPLING TRAIN

Modified DOE Method 1008*

* Modified with the addition of an empty impinger preceeding the filter.

probe. Flue gas temperature was monitored with a calibrated direct readout pyrometer equipped with a chromel-alumel thermocouple positioned near the sampling nozzle. Filter and impinger exit gas temperatures were monitored with a calibrated direct readout pyrometer equipped with chromel-alumel thermocouples positioned near the filter holder and after the last impinger respectively.

SECTION 6

TEST PROCEDURES

6.1 PRELIMINARY TESTS

Preliminary test data were obtained at the No. 1 Calciner Stack. Stack geometry 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 content was estimated from a psychometric chart at the saturation temperature.

A check for the presence or absence of cyclonic flow was conducted at the stack prior to formal testing. The cyclonic flow check proved to be negative ($\bar{\alpha}<10^{\circ}$) thus verifying the suitability of the test site for obtaining representative samples.

Preliminary test data was used for nozzle sizing and nomagraph set-up for isokinetic sampling procedures.

Calibration of probe nozzles, pitot tubes, metering systems, probe heaters and temperature gauges was performed as specified in Section 5 of DOE Method 1005 test procedures (see Appendix D for calibration records).

6.2 FORMAL TESTS

A series of three particulate and H_2SO_4/SO_2 test runs were conducted on the No. 1 Calciner Stack location.

Test period length for particulate test run one was 96 minutes (16 total traverse points with readings taken every 6 minutes). Particulate test runs two and three were each 112 minutes in length (16 total traverse points with readings taken every 7 minutes).

Test period length for each acid mist and sulfur dioxide test was 80 minutes (16 total traverse points at 5 minutes each).

During particulate and H_2SO_4/SO_2 sampling, gas stream velocities were measured by inserting a calibrated "S"-type pitot tube into the gas stream adjacent to the sampling nozzle. The velocity pressure differential was observed immediately after positioning the nozzle at each traverse point, and the sampling rate was adjusted to maintain isokineticity. Flue gas temperature was monitored at each point with the pyrometer and thermocouple. Temperature measurements were made at the heated filter box, final impinger and at the center of the dry gas meter. During sampling the heated filter chamber was maintained at approximately 250 ^{o}F as required by DOE. Test data were recorded at each point during all test periods.

Leak checks were preformed on each apparatus according to DOE method instructions, prior to and following each run. In addition, leak checks were conducted before and after each traverse change over.

A constant rate integrated sampling technique was employed to collect flue gas samples at each particulate traverse point for the molecular weight determination using an Orsat analysis. The sampling train was operated for 5 minutes with the tedlar bag disconnected to purge extraneous gases prior to each test. The flue gas sample train was leak checked before and after each test run.

Following completion of the H_2SO_4/SO_2 test run, the impingers were purged with cleaned ambient air for 15 minutes. The purge air was passed through a 3% H_2O_2 solution, prior to the test impingers, to remove any SO_2 present in the ambient air.

SECTION 7

ANALYTICAL PROCEDURES

Sample integrity was assured through the maintenance of strict chain-of-custody procedures.

7.1 PARTICULATE SAMPLE RECOVERY

At the conclusion of each particulate test, the sampling train was dismantled, the openings sealed, and the components transported to the field laboratory.

A consistent procedure was employed for sample recovery:

1. The preweighed glass 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 type 1).

2. The particulate adhering to the internal surfaces of the nozzle, probe and front-half of the filter holder was rinsed with acetone into a borosilicate container while brushing a minimum of three times until no visible particulate remained. Particulate adhering to the brush was rinsed with acetone into the same container. The container was sealed with a Teflon-lined closure (sample type 2).

3. The total volume of liquid in impingers 1, 2 and 3 was measured to the nearest milliliter and the value recorded. The liquid was then placed in a borosilicate container along with a distilled water rinse of the impingers, connectors, and back-half of the filter holder. The container was sealed with a lid fitted with

a Teflon liner (sample type 3).

4. An acetone rinse of impingers 1, 2 and 3 was placed into a borosilicate container and sealed with a lid fitted with a teflon liner (sample type 4).

5. The silica gel was removed from the last impinger and immediately weighed to the nearest one tenth gram. The weight gain was recorded.

6. Acetone and distilled water blank samples were placed into borosilicate containers and sealed with teflon lined caps for gravimetric analysis. A blank filter sealed in its original petri dish container was also retained for gravimetric analysis.

Each container was labeled to clearly identify its contents. The height of the fluid level was marked on the container of each liquid sample to determine whether or not leakage occurred during transport. All samples were placed into a locked shipping crate, then transported to the WESTON laboratories for analysis.

7.2 PARTICULATE ANALYSIS

Gravimetric analysis of the particulate samples was performed as follows:

1. The filters (sample type 1) and any loose fragments were desiccated at ambient temperature and pressure for 24 hours and weighed to the nearest 0.1 milligram to a constant ($\pm$ 0.5 mg) weight.

2. The front-half acetone wash samples (sample type 2) and an acetone blank were transferred (after a volume measurement) to tared 250-ml beakers, and evaporated to

dryness at ambient temperature and pressure. The samples were then desiccated for 24 hours and weighed to the nearest 0.1 milligram to a constant weight.

Final front-half wash residue weights were determined by correcting for the acetone blank factor.

3. The back-half water and wash samples (sample type 3) were extracted (after volume measurement) with 3 separate 25-ml portions of chloroform followed by 3 25-ml additions of ethyl ether. The extracts were combined in a tared 250-ml beaker, evaporated to dryness at ambient temperature and pressure, then desiccated for 24 hours to a constant 0.1-mg weight. An ether/chloroform extraction was performed on the distilled water blank sample to obtain a blank correction value.

4. The resulting extracted water sample from Step 3 was poured into a tared beaker, evaporated to dryness at 100°C, then desiccated at ambient temperature and pressure to a constant 0.1 mg weight. The residue weights of the dried water samples were corrected for the water blank factor.

5. The back-half acetone wash sample (sample type 4) was transferred to a tared 250-ml beaker, and evaporated to dryness at ambient temperature and pressure. The samples were then desiccated for 24 hours and weighed to the nearest 0.1 milligram to a constant weight.

6. Acetone, distilled water, and ether/chloroform blank samples were analyzed to obtain blank correction factors.

The weight of the material collected on the glass fiber filter plus the residue weight of the front-half acetone wash sample yields the DOE catch weight which was used to calculate the particulate emission results. See Summary of Test Results tables for catch fraction breakdowns and Appendix B for complete laboratory reports.

7.3 SULFURIC ACID MIST/SULFUR DIOXIDE SAMPLE RECOVERY

For each test the sample recovery procedure was the same:

1. The internal surfaces of the nozzle, probe, and probe to impinger connectors were rinsed with 80% isopropyl alcohol while brushing and the rinses poured into a plastic container (sample type 1).

2. The contents of the first and second impingers were weighed to the nearest 0.1 gram and the value recorded. The liquid was added to the nozzle/probe wash (sample type 1) along with an 80% isopropyl alcohol rinse of the impingers, glass connectors and front-half of the unheated filter holder. The unheated filter was added to the 80% isopropyl alcohol nozzle/probe wash and impinger contents and wash.

3. The total liquid in the third and fourth impingers was weighed to the nearest 0.1 gram and the value recorded. The liquid was placed in a plastic container along with a distilled water rinse of the impingers and connectors (sample type 3).

4. The silica gel was removed from the last impinger and immediately weighed to the nearest 0.1 gram. The weight gain was recorded.

5. Blank samples of the 80% isopropyl alcohol and 3%

hydrogen peroxide solutions were placed into plastic containers.

Following sample recovery, each sample type 1 and 2 was taken up to a constant volume, the fluid levels were marked and the volumes recorded. The samples were thoroughly mixed and an aliquot of each sample was given to SCM personnel.

Each container was labeled to clearly identify its contents. The fluid level in each container was remarked to determine whether or not leakage occurred during transport to WESTON laboratories. All samples were placed in a locked crate for shipment.

7.4 SULFURIC ACID MIST/SULFUR DIOXIDE SAMPLE ANALYSIS

Following a volume measurement an aliquot of sample type 1 was pipetted into a 250 ml Erlenmeyer flask and diluted to 100 ml with 80% isopropyl alcohol. Two to four drops of thorin indicator were added and the solution titrated to a pink end point with 0.01 N barium perchlorate. The titration was repeated on a second aliquot and the titrant volumes averaged. A reagent blank was analyzed in like fashion.

Each SO_2 sample (sample Type 2) was analyzed as follows:

Following a volume measurement an aliquot was pipetted into a 250 ml Erlenmeyer flask and diluted with four parts 80% isopropanol. Two to four drops of thorin indicator were added and the mixture was titrated to a pink end point with 0.01 N barium perchlorate. The titration was repeated on a second aliquot and on a reagent blank.

SECTION 8

TEST RESULTS AND DISCUSSION

A summary of compliance test results is presented in Table 1, page 2 of this report. Detailed test data and test results summaries are included in Tables 2 and 3 of this section.

All test data and test results shown herein are believed to be representative of process emissions encountered during the survey periods. No sampling analytical or process problems were noted. A representative of MD DOE was present during all test periods.

During all test periods, the measured particulate concentration for the No. 1 Calciner was below the state allowable limit of 0.03 grains per dry standard cubic foot (gr/dscf). The average particulate concentration measured during the three test runs was 0.0134 gr/dscf.

During test runs one and three, the measured sulfuric acid mist concentration was below the state allowable limit of 70 mg/m^3. The sulfuric acid mist concentration measured during test run two was 151 mg/m^3. The average sulfuric acid concentration measured for the three tests was 80 mg/m^3.

The average sulfur dioxide concentration measured during the three test runs at the No. 1 Calciner was 646 ppm/v which was below the state allowable limit of 2000 ppm/v.

It should be noted that the sulfuric acid mist concentration for test run two was originally determined based on titration of a 50 milliliter sample aliquot. The titration was repeated using a 100 milliliter aliquot volume as required by DOE Method 1008. The results reported herein are based on the titration obtained using the 100 milliliter aliquot. Both titration values for the 50 and

100 milliliter aliquots are reported in the laboratory report provided in Appendix B. The concentrations derived from these two values are essentailly the same (±3%).

Process operations data was monitored by SCM personnel during all test periods.

S.C.M. CHEMICALS
BALTIMORE, MD
TABLE 2
SUMMARY OF PARTICULATE TEST RESULTS

TEST DATA:			
Test run number	1	2	3
Test location	#1 Calciner	#1 Calciner	#1 Calciner
Test date	9-7-89	9-8-89	9-8-89
Test time period	1334-1528	0805-1011	1207-1410
SAMPLING DATA:			
Sampling duration, min.	96.0	112.0	112.0
Nozzle diameter, in.	0.552	0.506	0.506
Cross sectional nozzle area, sq.ft.	0.001662	0.001396	0.001396
Barometric pressure, in. Hg	29.95	29.92	29.92
Avg. orifice press. diff., in H2O	1.56	1.08	1.10
Avg. dry gas meter temp., deg F	93	93	93
Avg. abs. dry gas meter temp., deg. R	553	553	553
Total liquid collected by train, ml	564.0	607.0	596.0
Std. vol. of H2O vapor coll., cu.ft.	26.98	29.04	28.51
Dry gas meter calibration factor	1.000	1.000	1.000
Sample vol. at meter cond., dcf	65.253	65.095	64.512
Sample vol. at std. cond., dscf (1)	63.6	63.4	62.8
Percent of isokinetic sampling	97.0	101.2	99.1
GAS STREAM COMPOSITION DATA:			
CO2, % by volume, dry basis	6.5	7.2	7.2
O2, % by volume, dry basis	8.7	7.4	7.6
CO, % by volume, dry basis	0.0	0.0	0.0
N2, % by volume, dry basis	84.7	85.4	85.2
Molecular wt. of dry gas, lb/lb mole	29.383	29.448	29.456
H2O vapor in gas stream, prop. by vol.	0.298	0.314	0.312
Mole fraction of dry gas	0.702	0.686	0.688
Molecular wt. of wet gas, lb/lb mole	25.99	25.85	25.88
GAS STREAM VELOCITY AND VOLUMETRIC FLOW DATA:			
Static pressure, in. H2O	-0.02	-0.02	-0.03
Static pressure, in. Hg	-0.001	-0.001	-0.002
Absolute pressure, in. Hg	29.949	29.919	29.918
Avg. temperature, deg. F	158	160	160
Avg. absolute temperature, deg.R	618	620	620
Pitot tube coefficient	0.84	0.84	0.84
Total number of traverse points	16	16	16
Avg. gas stream velocity, ft./sec.	11.22	11.24	11.33
Stack/duct cross sectional area, sq.ft.	19.64	19.64	19.64
Avg. gas stream volumetric flow, wacf/min.	13200	13200	13400
Avg. gas stream volumetric flow, dscf/min.	8100	7900	8000
LABORATORY PARTICULATE REPORT:			
Front half acetone rinse, g	0.0205	0.0107	0.0076
Filter catch fraction, g	0.0424	0.0421	0.0414
Maryland front-half catch, g	0.0629	0.0528	0.0490
Ether-chloroform extract, g	0.0020	0.0018	0.0017
Back-half contents and H2O wash residue, g	0.0019	0.0016	0.0047
Back-half acetone wash residue,g	0.0024	0.0020	0.0027
Total catch, g	0.0692	0.0582	0.0581
PARTICULATE EMISSIONS:			
Concentration, gr/dscf	0.0152	0.0129	0.0120
Mass rate, lbs/hr	1.0551	0.8666	0.8206

(1) Standard Conditions = 77 deg. F. (25 deg. C.) and 29.92 inches (760 mm) mercury, dry basis

S.C.M. CHEMICALS
BALTIMORE, MD
TABLE 3
SUMMARY OF H2SO4/SO2 TEST RESULTS

TEST DATA:			
Test run number	1	2	3
Test location	#1 Calciner	#1 Calciner	#1 Calciner
Test date	9-7-89	9-8-89	9-8-89
Test time period	1345-1528	0822-1008	1221-1404
SAMPLING DATA:			
Sampling duration, min.	80.0	80.0	80.0
Nozzle diameter. in.	0.506	0.496	0.496
Cross sectional nozzle area, sq.ft.	0.001396	0.001342	0.001342
Barometric pressure, in. Hg	29.95	29.92	29.92
Avg. orifice press. diff., in H2O	1.18	1.16	1.11
Avg. dry gas meter temp., deg F	86	89	88
Avg. abs. dry gas meter temp., deg. R	546	549	548
Total liquid collected by train, ml	388.0	413.3	400.0
Std. vol. of H2O vapor coll., cu.ft.	18.56	19.77	19.14
Dry gas meter calibration factor	1.002	1.002	1.002
Sample vol. at meter cond., dcf	44.949	43.993	43.558
Sample vol. at std. cond., dscf (1)	44.502	43.255	42.886
Percent of isokinetic sampling	100.2	99.7	100.5
GAS STREAM COMPOSITION DATA:			
CO2, % by volume, dry basis	6.5	7.2	7.2
O2, % by volume, dry basis	8.7	7.4	7.6
CO, % by volume, dry basis	0.0	0.0	0.0
N2, % by volume, dry basis	84.7	85.4	85.2
Molecular wt. of dry gas, lb/lb mole	29.394	29.448	29.456
H2O vapor in gas stream, prop. by vol.	0.294	0.314	0.309
Mole fraction of dry gas	0.706	0.686	0.691
Molecular wt. of wet gas, lb/lb mole	26.04	25.86	25.92
GAS STREAM VELOCITY AND VOLUMETRIC FLOW DATA:			
Static pressure, in. H2O	-0.02	-0.02	-0.03
Static pressure, in. Hg	-0.001	-0.001	-0.002
Absolute pressure, in. Hg	29.949	29.919	29.918
Avg. temperature, deg. F	159	162	162
Avg. absolute temperature, deg.R	619	622	622
Pitot tube coefficient	0.84	0.84	0.84
Total number of traverse points	16	16	16
Avg. gas stream velocity, ft./sec.	10.82	11.37	11.09
Stack/duct cross sectional area, sq.ft.	19.64	19.64	19.64
Avg. gas stream volumetric flow, wacf/min.	12700	13400	13100
Avg. gas stream volumetric flow, dscf/min.	7800	7900	7800
SULFURIC ACID EMISSIONS:			
Average concentration, lb/dscf x 10-6	2.96	9.44	2.60
Average concentration, ppm/v	11.83	37.68	10.37
Average concentration, mg/cu.m	47.45	151.13	41.61
Mass emission rate, lbs/hr	1.39	4.49	1.22
SULFUR DIOXIDE EMISSIONS:			
Average concentration, lb/dscf x 10-6	103.9	141.2	72.0
Average concentration, ppm/v	635	863	440
Average concentration, mg/cu.m	1665	2262	1154
Mass emission rate, lbs/hr	49	67	34

(1) Standard Conditions = 77 deg. F. (25 deg. C.) and 29.92 inches (760 mm) mercury, dry basis

APPENDIX A

RAW TEST DATA

S.C.M.
BALTIMORE, MD

Test Data			
Run number	1	2	3
Location	#1 Calciner	#1 Calciner	#1 Calcin
Date	9-7-89	9-8-89	9-8-89
Time period	1334-1528	0805-1011	1207-1410
Operator	O'NEILL	O'NEILL	O'NEILL
Inputs For Calcs.			
Sq. rt. delta P	0.175416	0.174769	0.176438
Delta H	1.56250	1.07500	1.09750
Stack temp. (deg.F)	158.25	160.44	159.63
Meter temp. (deg.F)	93.20	93.11	92.89
Sample volume (act.)	65.253	65.095	64.512
Barometric press. (in.Hg)	29.95	29.92	29.92
Volume H2O imp. (ml)	530.00	586	572
Weight chnge sil. gel (g)	34.00	21	24
% CO2	6.530	7.200	7.200
% O2	8.730	7.400	7.600
% CO	0.000	0.000	0.000
% N	84.700	85.400	85.200
Area of stack (sq.ft.)	19.64	19.64	19.64
Sample time (min.)	96	112	112
Static pressure (in.H2O)	-0.020	-0.020	-0.030
Nozzle dia. (in.)	0.5520	0.5060	0.5060
Meter box cal.	0.9997	0.9997	0.9997
Cp of pitot tube	0.84	0.84	0.84
Laboratory Report Data			
Frt half acetone rinse, g	0.0205	0.0107	0.0076
Filter catch fraction, g	0.0424	0.0421	0.0414
Maryland FH catch, g	0.0629	0.0528	0.0490
Ether-chloroform extract residue, g	0.0020	0.0018	0.0017
Back-half contents and H2O wash residue, g	0.0019	0.0016	0.0047
Bach-half acetone wash residue, g	0.0024	0.0020	0.0027
Total catch, g	0.0692	0.0582	0.0581

S.C.M.
BALTIMORE, MD

Test Data			
Run number	1	2	3
Location	#1 Calciner	#1 Calciner	#1 Calciner
Date	9-7-89	9-8-89	9-8-89
Time period	1345-1528	0822-1008	1221-1404
Operator	O'NEILL	O'NEILL	O'NEILL
Inputs For Calcs.			
Sq. rt. delta P	0.169079	0.176534	0.172562
Delta H	1.17690	1.16080	1.11250
Stack temp. (deg.F)	159.19	161.90	161.81
Meter temp. (deg.F)	85.66	88.88	88.06
Sample volume (act.)	44.949	43.993	43.558
Barometric press. (in.Hg)	29.95	29.92	29.92
Volume H2O imp. (ml)	365.00	388.30	374.00
Weight chnge sil. gel (g)	23.00	25.00	26.00
% CO2	6.530	7.200	7.200
% O2	8.730	7.400	7.600
% CO	0.000	0.000	0.000
% N	84.740	85.400	85.200
Area of stack (sq.ft.)	19.64	19.64	19.64
Sample time (min.)	80	80	80
Static pressure (in.H2O)	-0.020	-0.020	-0.030
Nozzle dia. (in.)	0.5060	0.4960	0.4960
Meter box cal.	1.0020	1.0020	1.0020
Cp of pitot tube	0.84	0.84	0.84
Laboratory Report Data			
Acid mist as H2SO4			
vol. of titrate, ml(cor)	13.55	41.95	11.45
nor. of titrate, g-eq/l	0.01	0.01	0.01
vol. of acid mist sample (first two impingers, washes, probe and front half filter wash, filter),ml	900	900	900
vol. of sample aliquot titrated, ml	100.00	100.00	100.00
dilution factor	1.00	1.00	1.00
Sulfur dioxide as SO2			
vol. of titrate, ml(cor)	13.10	17.30	8.75
nor. of titrate, g-eq/l	0.01	0.01	0.01
vol. of acid mist sample (first two impingers, washes, probe and front half filter wash, filter),ml	500.00	500.00	500.00
vol. of sample aliquot titrated, ml	10.00	10.00	10.00
dilution factor	10.00	10.00	10.00

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT: SCM CHEMICALS
DATE: 9/7/77
SAMPLING LOCATION: No. 1 Calciner Stack
INSIDE OF FAR WALL TO OUTSIDE OF PORT, (DISTANCE A): 66"
INSIDE OF NEAR WALL TO OUTSIDE OF PORT, (DISTANCE B): 6"
STACK I.D., (DISTANCE A - DISTANCE B): 60"
NEAREST UPSTREAM DISTURBANCE: > 8 dia
NEAREST DOWNSTREAM DISTURBANCE: > 2 dia
CALCULATOR: O'Neil

SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF PORT (SUM OF COLUMNS 4 & 5)
XY 1	.032	60"	2"	6"	8
2	.105	↓	6 1/4	↓	12 1/4
3	.194	↓	11 5/8	↓	17 5/8
4	.323	↓	19 3/8	↓	25 3/8
5	.677	↓	40 5/8	↓	46 5/8
6	.806	↓	48 3/8	↓	54 3/8
7	.895	↓	53 3/4	↓	59 3/4
8	.968	↓	58	↓	64

GAS VELOCITY AND VOLUME DATA FORM

Plant SCM Location Calciner #1
Date 9/7/89 Run no. Prelim 24-hr. clock time 1040 – 11
Operators Meeker/Baylis Stack diameter or dimensions, in.
Barometric pressure, in. Hg 29.95 Cross sectional area, $ft.^2$ 60"
Pitot tube identification no. P6 Cp .84

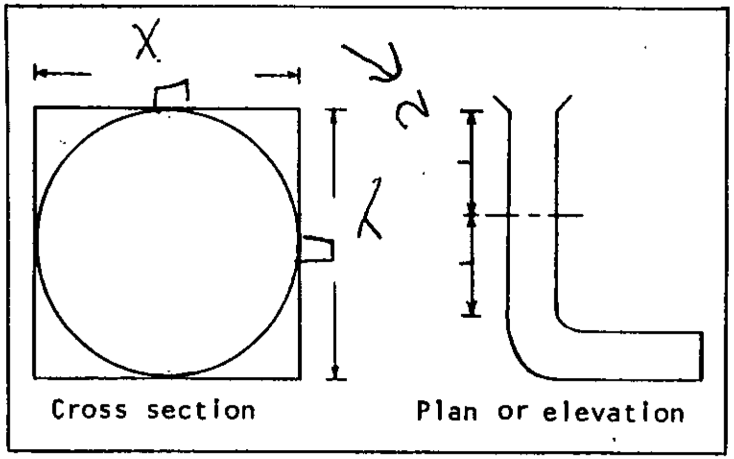
Traverse Point Number	Velocity head (Δp), in. H_2O	Stack Temperature (T_s), °F.	Static pressure (P_{static}) in. H_2O	Cyclonic flow determination: Δp at 0° reference	Cyclonic flow determination: Angle (α) which yields a null Δp
X 1	.025	158			
2	.036	159			
3	.038	159			
4	.038	159			
5	.038	159			
6	.039	159			
7	.036	159			
8	.035	159			
9	.033	159	+.06		
10	.031	159			
11	.028	159			
12	.026	159			
Y 1	.033	160			
2	.036	160			
3	.038	160			
4	.038	160			
5	.038	160			
6	.036	160			
7	.034	160			
8	.032	160			
9	.032	160			
10	.029	159	+.06		
11	.029	160			
12	.026	160			
	Avg. √Δp	Avg. Ts	Avg. P static		Avg. α [a]

[a] Must be <10 degrees to be acceptable.

PARTICULATE FIELD DATA FORM

Sheet 1 of 2

Plant SCM
City Bell MO
Location Calciner #1
Operator O'Neill
Run No. ONE Date 9/7/84
Ambient temp., °F 80
Baro. press. (P_b), in. Hg. 29.45
Sample box no. #1
Meter box no. #9
Meter box ΔH@ 1.818
Meter box cal. (Y) .9997
Probe length, ft. 6'
Probe liner material Boro
Probe heater setting 30



Test point schematic

Pitot tube identification no. P6
Pitot tube cal. factor (C_p) .840
Nozzle identification no.
Avg. nozzle diameter (D_n), in. ~~.506~~ .552
Pyrometer identification no. #9
Thermocouple identification no. –
Assumed moisture, % 30
Assumed temperature, °F. 160
Static pressure (P_{static}), in. H_2O – .02
K factor 5.20 Reference Δp –
Initial leak rate .009 cfm @ 15 in. Hg
Final leak rate .006 cfm @ 6 in. Hg
Filter no. 20080

Pitot L.C. = Good Orifice L.C. = Good

MID PT L.C. = .004 at 6" Hg

Traverse point number	Sampling time, min.	24-hr. clock time	Velocity head (ΔP), in. H_2O	Orifice meter pressure differential (ΔH), in. H_2O	Gas meter reading, ft.^{3}	Dry gas meter temperature (T_m) Inlet °F.	Outlet °F.	Source temperature (T_s), °F	Pump vacuum, in.Hg. gauge	Impinger exit gas temp., °F.	Filter box temp., °F.
	0	1334			606.127						
1	3		.028	1.4	608.1	78	78	156	4	67	231
1	6		.028	1.4	610.4	85	80	158	4	67	231
2	9		.030	1.53	612.5	81	89	158	5	67	238
2	12		.030	1.53	614.1	92	82	157	5	68	238
3	15		.033	1.65	617.0	94	84	157	5	62	238
3	18		.035	1.75	618.9	97	85	158	5	64	232
4	21		.035	1.75	620.7	98	85	159	5	67	239
4	24		.035	1.75	623.7	99	85	159	5	65	237
5	27		.035	1.75	625.9	98	86	160	5	66	236
5	30		.035	1.75	627.9	99	88	158	5	66	239
6	33		.030	1.53	629.0	99	88	159	5	66	238
6	36		.030	1.53	632.0	100	88	160	5	66	238
7	39		.030	1.53	633.9	100	89	159	5	66	238
7	42		.030	1.53	635.1	101	90	155	5	67	235
8	45		.028	1.40	637.1	101	90	155	4	66	235
8	48	1422	.025	1.25	638.778	100	90	156	4	66	238
	Total θ		Avg. $\sqrt{\Delta P}$	Avg. ΔH	Total V_m 32.651	Avg. T_m		Avg. T_s	Max. vac	Max. temp.	Min. Max.

Comments:

51. Run 1 9/7/89 SCM Fonthodite Calciner # 1

Traverse point number	Sampling time, min.	24-hr. clock time	Velocity head (ΔP), in. H_2O	Orifice meter pressure differential (ΔH), in. H_2O	Gas meter reading, ft.^{3}	Dry gas meter temperature (T_m) Inlet °F.	Dry gas meter temperature (T_m) Outlet °F.	Source temperature (T_s), °F	Pump vacuum, in.Hg. gauge	Impinger exit gas temp., °F.	Filter box temp., °F.
	0	1440			638.938						
1	3		.028	1.43	641.1	94	90	162	4	65	235
1	6		.028	1.43	643.3	94	90	159	4	60	237
2	9		.030	1.53	645.8	98	91	159	4	59	236
2	12		.030	1.53	646.7	98	91	159	4	58	232
3	15		.034	1.70	649.6	100	91	158	5	60	234
3	18		.034	1.70	652.0	100	91	158	5	59	237
4	21		.036	1.84	653.1	100	91	160	5	59	241
4	24		.036	1.84	656.3	101	91	159	5	59	239
5	27		.033	1.68	657.6	101	92	159	5	58	236
5	30		.033	1.68	659.6	101	92	156	5	59	247
6	33		.033	1.68	661.8	101	92	158	5	59	244
6	36		.033	1.68	664.7	102	92	158	5	60	244
7	39		.029	1.48	666.4	101	93	158	5	59	242
7	42		.029	1.43	667.9	103	93	159	5	61	246
8	45		.023	1.17	669.6	102	93	159	4	60	241
8	48	1528	.023	1.17	671.540	102	93	159	4	62	243
					32.602						
							Q ACFM = 13300				
							Q SCFM = 7900				
					%M = 29.99						
—	Total θ 96	—	Avg. √ΔP .175416	Avg. ΔH 1.5625	Total V_m 65.253	Avg. T_m 93.203		Avg. T_s 159.25	Max. vac. 5	Max. temp. 69	Min. 231 Max. 246

Comments:

SAMPLE RECOVERY AND INTEGRITY DATA FORM

Plant SCM Balt. Md. Sample date 9-7-89

Sample location Calciner #1 Run number ONE

Sample recovery person JPO/TB Recovery date 9-7-89

Filter/thimble number(s) 200 BO

250 + 250 + 230 =

MOISTURE

Impingers			Silica gel		
Final volume (wt)	730 ml	(g)	Final wt	334 g	— g
Initial volume (wt)	200 ml	(g)	Initial wt	300 g	— g
Net volume (wt)	530 ml	(g)	Net wt	34 g	— g
Total moisture	564 ✓	(g)			

Color of silica gel pink 75%

Description of impinger water Clean all

RECOVERED SAMPLE

Blank filter container number	007-SCM-FILT-Blk	Sealed	✓
Blank thimble container number		Sealed	
Filter/thimble container number	001-SCM-FILT-1	Sealed	✓
Filter/thimble container number		Sealed	
Filter/thimble container number		Sealed	
Filter/thimble container number		Sealed	

Description of particulate

Front-half water rinse container number(s)		Liquid level marked ?	
Front-half acetone rinse container number(s)	002-SCM-FHA-1	Liquid level marked ?	✓
Impinger contents and back-half water rinse container number(s)	003-SCM-BHW-1	Liquid level marked ?	✓
Back-half acetone rinse container number	004-SCM-BHA-1	Liquid level marked ?	✓
Water blank container number	006-SCM-WATER-Blk	Liquid level marked ?	✓
Acetone blank container number	005-SCM-Acetone-Blk	Liquid level marked ?	

Samples stored and locked 9/8/89 JPO

Remarks

Date of laboratory custody 9/9/89

Laboratory personnel taking custody MT

Remarks all arrived safely

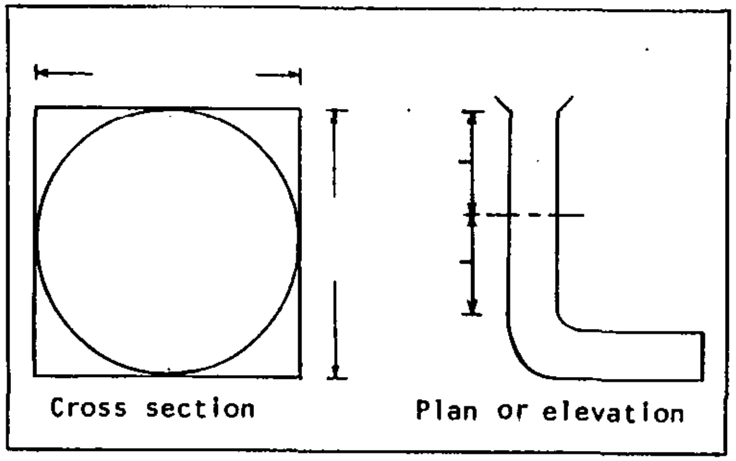
M ~~~~

SO_x

~~PARTICULATE~~-FIELD DATA FORM

Sheet 1 of 2

Plant SCM
City Balt, MD
Location #1 Calciner
Operator DADOIT
Run No. ONE Date 9-7-89
Ambient temp., °F 80
Baro. press. (P_b), in. Hg. 29.45
Sample box no. #10
Meter box no. #10
Meter box ΔH@ 2.10
Meter box cal. (Y) 1.002
Probe length, ft. 6'
Probe liner material BORO.
Probe heater setting 30



Pitot tube identification no. P18
Pitot tube cal. factor (C_p) .840
Nozzle identification no. –
Avg. nozzle diameter (D_n), in. .506
Pyrometer identification no. #10
Thermocouple identification no. –
Assumed moisture, % 30
Assumed temperature, °F. 160
Static pressure (P_{static}), in. H_2O –.02
C factor – Reference ΔP –
Initial leak rate .006 cfm @ 15 in. Hg
Final leak rate .002 cfm @ 5 in. Hg
Filter no. N/A

Pitot L.C. = good

MID PT L.C. = .002 at 4" Hg Test point schematic K = 40.6

Traverse point number	Sampling time, min.	24-hr. clock time	Velocity head (ΔP), in. H_2O	Orifice meter pressure differential (ΔH), in. H_2O	Gas meter reading, $ft.^3$	Dry gas meter temperature (T_m) Inlet °F.	Dry gas meter temperature (T_m) Outlet °F.	Source temperature (T_s), °F	Pump vacuum, in.Hg. gauge	Impinger exit gas temp., °F.	Filter box temp., °F.
	0	1345			953.267						
1	5		.021	.86	955.6	86	82	158	1	65	226
2	10		.022	.90	958.6	85	82	158	1	64	224
3	15		.028	1.14	960.7	88	82	159	2	63	224
4	20		.033	1.35	963.4	89	83	158	2	63	224
5	25		.033	1.35	964.6	88	81	159	3	64	222
6	30		.033	1.35	969.6	89	80	159	3	64	220
7	35		.030	1.22	973.1	91	82	159	3	64	220
8	40	1425	.025	1.02	975.348	89	79	159	2	63	230
~~ ~~	~~0~~										
~~1~~	~~5~~										
~~2~~	~~10~~										
~~3~~	~~15~~										
~~4~~	~~20~~										
~~5~~	~~25~~										
~~6~~											
	Total θ		Avg. $\sqrt{\Delta P}$	Avg. ΔH	Total V_m 22.081	Avg. T_m		Avg. T_s	Max. vac.	Max. temp.	Min. Max.

Comments:

M1008 Run One 9/7/77 Sheet 2 of 2

12
5
60

Traverse point number	Sampling time, min.	24-hr. clock time	Velocity head (ΔP), in. H_2O	Orifice meter pressure differential (ΔH), in. H_2O	Gas meter reading, $ft.^3$	Dry gas meter temperature (T_m) Inlet °F.	Outlet °F.	Source temperature (T_s), °F	Pump vacuum, in.Hg. gauge	Impinger exit gas temp., °F.	Filter box temp., °F.
	0	1448			975.564						
1	5		.026	1.07	978.5	86	81	157	2	66	234
2	10		.028	1.15	980.7	87	81	160	2	57	236
3	13		.032	1.31	983.8	88	81	160	2	57	235
4	20		.035	1.44	987.1	90	81	160	2	55	230
5	25		.033	1.33	991.2	93	85	160	2	58	231
6	30		.036	1.23	993.0	92	85	161	2	57	227
7	35		.023	1.15	996.1	93	85	160	2	60	226
8	40	1528	.023	.94	998.432	93	84	160	2	6.2	227
					22.868 ✓						
				$V_{m\,std}$ = 43.81			12800 ACFM 7700 dscfm				
					29.5% m						
				Purged train for		15 min at		1.2 ΔH			
	Total θ		Avg. $\sqrt{\Delta P}$ ✓ .1690791	Avg. ΔH ✓ 1.1769	Total V_m ✓ 44.949	Avg. T_m ✓ 85.66		Avg. T_s ✓ 159.19	Max. vac 3	Max. temp. 66	Min. 220 Max. 236

Comments:

385.5 + 158

SAMPLE RECOVERY AND INTEGRITY DATA FORM

Plant SCM Sample date 9-7-89

Sample location #1 Calciner Run number ONE

Sample recovery person JDD Recovery date 9-7-89

Filter(s) number — N/A

ISO I = 251.5
F = 543.5
292.

H_2O_2 I = 285
F = 28 300 358
73

MOISTURE

Impingers

Final volume (wt) ______ ml (g)

Initial volume (wt) ______ ml (g)

Net volume (wt) 365 ml (g)

Total moisture 388 g

Silica gel

Final wt ~~318~~ g 323 g

Initial wt ~~300~~ g 300 g

Net wt 18 g 23 g

Color of silica gel pink 60%

Description of impinger water All clean

ISO = 008-SCM-H_2SO_4-1 ✓

H_2O_2 = 009-SCM-SO_2-1 ✓

RECOVERED SAMPLE

Blank filter container number ______ Sealed ______

Filter container number ______ Sealed ______

Description of particulate on filter ______

H_2O_2-BLANK- 011-SCM-H_2O_2-BLANK ✓

Acetone rinse container number ______ Liquid level marked? ______

~~Acetone~~ ISO blank container number 010-SCM-ISO-Blank Liquid level marked? ✓

Samples stored and locked ______

Remarks ______

Date of laboratory custody ______

Laboratory personnel taking custody 9/9/89

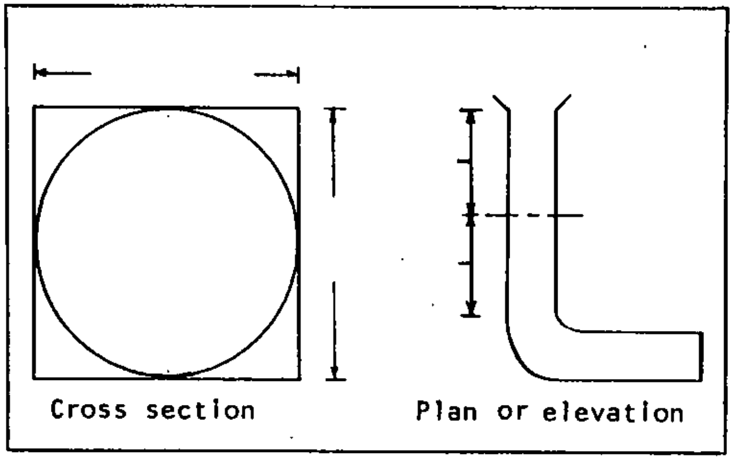
Remarks H_2SO_4 taken to TSV of 900 ml all corrected safety

244.
1 86.
158
385.5
543.5

PARTICULATE FIELD DATA FORM

Sheet 1 of 2

Plant: SCM
City: BALT. MD
Location: Calcin #1
Operator: O'Neill
Run No. RW0 Date 4-8-87
Ambient temp., °F: 80
Baro. press. (P_b), in. Hg.: 29.92
Sample box no.: #1
Meter box no.: #4
Meter box ΔH@: 1.818
Meter box cal. (Y): .9997
Probe length, ft.: 6'
Probe liner material: BORO.
Probe heater setting: 30



Test point schematic

Pitot tube identification no. P6
Pitot tube cal. factor (C_p): .840
Nozzle identification no. -
Avg. nozzle diameter (D_n), in.: .506
Pyrometer identification no. #9
Thermocouple identification no. -
Assumed moisture, %: 29%
Assumed temperature, °F.: 160
Static pressure (P_{static}), in. H_2O: -.020
C factor - Reference Δp -
Initial leak rate .015 cfm @ 15 in. Hg
Final leak rate .002 cfm @ 5 in. Hg
Filter no. 97040
Pitot LC = Good Orsat LC = Good

MIN PT LC = .006 @ 15" t = 35.0

Traverse point number	Sampling time, min.	24-hr. clock time	Velocity head (ΔP), in. H_2O	Orifice meter pressure differential (ΔH), in. H_2O	Gas meter reading, ft.^{3}	Dry gas meter temperature (T_m) Inlet °F.	Outlet °F.	Source temperature (T_s), °F	Pump vacuum, in.Hg. gauge	Impinger exit gas temp., °F.	Filter box temp., °F.
	0	0805			671.853						
Y 1	3.5		.031	1.09	674.6	79	77	162	3	68	237
1	6 7		.030	1.05	676.5	86	78	161	3	56	236
2	9 10.5		.030	1.05	678.1	87	78	164	3	55	235
2	12 14		.030	1.05	680.8	90	80	162	3	56	236
3	15 17.5		.033	1.16	682.5	92	81	161	3	55	236
3	18 21		.033	1.16	684.0	94	82	162	3	54	236
4	21 24.5		.033	1.16	687.2	94	82	161	3	53	237
4	24 28		.033	1.16	688.9	96	85	161	3	54	237
5	27 31.5		.033	1.16	690.4	96	84	161	3	55	240
5	30 35		.030	1.05	692.9	98	85	161	3	54	236
6	33 38.5		.030	1.05	694.9	97	88	160	3	54	235
6	36 42		.029	1.02	696.9	98	88	161	3	55	237
7	39 45.5		.028	.98	698.5	98	88	161	3	55	234
7	42 49		.028	.98	700.7	99	89	161	3	53	235
8	45 52.5		.025	.88	703.1	100	90	161	3	55	235
8	48 56	0901	.025	.88	704.647	100	90	160	3	53	236
	Total θ 56		Avg. √ΔP	Avg. ΔH	Total V_m	Avg. T_m		Avg. T_s	Max. vac.	Max. temp.	Min. Max.

Comments:

7/3/89 Run Two Calciner #1

Traverse point number	Sampling time, min.	24-hr. clock time	Velocity head (ΔP), in. H_2O	Orifice meter pressure differential (ΔH), in. H_2O	Gas meter reading, $ft.^3$	Dry gas meter temperature (T_m) Inlet °F.	Outlet °F.	Source temperature (T_s), °F	Pump vacuum, in.Hg. gauge	Impinger exit gas temp., °F.	Filter box temp., °F.
	0	0915			704.732						
~~1~~	3 3.7		.026	.91	707.0	95	91	159	2.5	67	235
1	6 7		.026	.91	708.9	98	91	159	3	53	235
2	9 10.5		.030	1.05	710.3	98	92	160	3	52	230
2	12 14		.03	1.05	712.4	100	92	159	3	52	234
3	15 17.5		.031	1.09	715.0	101	92	160	3	54	231
3	18 21		.034	1.15	717.2	101	93	159	3	57	232
4	21 24.5		.035	1.23	718.5	101	93	159	3	56	234
4	24 28		.035	1.23	720.9	102	94	160	3	56	232
5	27 31.5		.035	1.23	723.3	102	94	160	3	55	231
5	30 35		.035	1.23	724.6	102	94	159	3	54	233
6	33 38.5		.035	1.23	726.7	103	95	160	3	55	232
6	36 42		.034	1.19	729.5	103	94	159	3	55	233
7	39 45.5		.030	1.05	731.6	103	94	161	3	56	232
7	42 49		.030	1.05	733.0	102	95	160	3	57	235
8	45 52.5		.029	.98	735.3	102	95	162	3	59	233
8	48 56	1011	.023	.90	737.033	102	95	158	3	60	237
					32.301						
					100.98 92 I						
					62.102 m 31.690						
—	Total θ ~~48~~ 112	—	Avg. $\sqrt{\Delta P}$ .1741686	Avg. ΔH 1.075	Total V_m 65.095	Avg. T_m 93.1094		Avg. T_s 160.44	Max. vac 3	Max. temp. 68	Min. 231 Max. 240

Comments:

SAMPLE RECOVERY AND INTEGRITY DATA FORM

Plant SCM Sample date 9-8-89

Sample location Calciner #1 Run number TWO

Sample recovery person JDC / TB Recovery date 9-8-89

Filter/thimble number(s) 97040

MOISTURE

Impingers				Silica gel				
Final volume (wt)	786	ml	(g)	Final wt	321	g	—	g
Initial volume (wt)	200	ml	(g)	Initial wt	300	g	—	g
Net volume (wt)	586	ml	(g)	Net wt	21	g	—	g

Total moisture 607 (g).

Color of silica gel 60% pink

Description of impinger water all clear

RECOVERED SAMPLE

Blank filter container number		Sealed	
Blank thimble container number		Sealed	
Filter/thimble container number	013-SCM-FILT-2	Sealed	✓
Filter/thimble container number		Sealed	
Filter/thimble container number		Sealed	
Filter/thimble container number		Sealed	

Description of particulate

Front-half water rinse container number(s)	—	Liquid level marked ?	
Front-half acetone rinse container number(s)	012-SCM-FHA-2	Liquid level marked ?	✓
Impinger contents and back-half water rinse container number(s)	014-SCM-BHW-2	Liquid level marked ?	✓
Back-half acetone rinse container number	015-SCM-BHA-2	Liquid level marked ?	✓
Water blank container number		Liquid level marked ?	
Acetone blank container number		Liquid level marked ?	

Samples stored and locked ✓ JDC/PMM 9/8/89

Remarks

Date of laboratory custody 9/9/89

Laboratory personnel taking custody M. T.

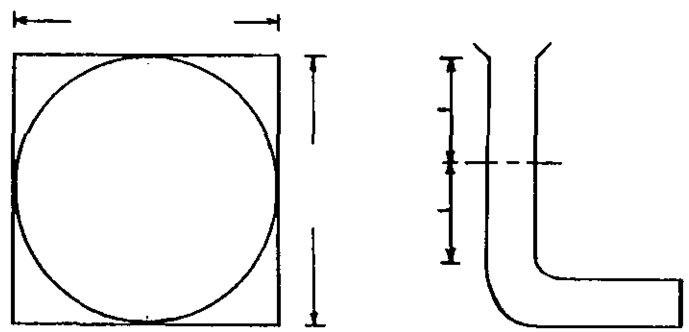
Remarks all arrived safely

SOX

~~PARTICULATE~~ FIELD DATA FORM

Sheet 1 of 2

Plant SCM
City BALT . MD
Location Calciner #1
Operator O'Neill
Run No. RW3
Date 9-8-87
Ambient temp., °F
Baro. press. (P_b), in. Hg. 29.92
Sample box no. #2
Meter box no. #16
Meter box ΔH@ 2.10
Meter box cal. (Y) 1.002
Probe length, ft. 6'
Probe liner material BORO
Probe heater setting 50



Cross section

Plan or elevation

Test point schematic

Pitot tube identification no. P 18
Pitot tube cal. factor (C_p) .840
Nozzle identification no. 21 V
Avg. nozzle diameter (D_n), in. .496
Pyrometer identification no. #10
Thermocouple identification no.
Assumed moisture, % 29
Assumed temperature, °F. 160
Static pressure (P_{static}), in. H_2O — .02
C factor — Reference Δp ~
Initial leak rate .002 cfm @ 15 in. Hg
Final leak rate .002 cfm @ 5 in. Hg
Filter no. N/A

Pitot LC = 500cl

MID PT LC = .004 at 4" 37.1

Traverse point number	Sampling time, min.	24-hr. clock time	Velocity head (ΔP), in. H_2O	Orifice meter pressure differential (ΔH), in. H_2O	Gas meter reading, $ft.^3$	Dry gas meter temperature (T_m) Inlet °F.	Dry gas meter temperature (T_m) Outlet °F.	Source temperature (T_s), °F	Pump vacuum, in.Hg. gauge	Impinger exit gas temp., °F.	Filter box temp., °F.
	0	0822			6.157						
X 1	5		.03	1.113	8.9	84	85	163	1.5	67	231
2	10		.031	1.16	12.5	89	87	163	1.5	62	217
3	15		.034	1.26	14.3	93	88	163	2	62	223
4	20		.034	1.26	17.7	94	87	163	2	60	220
5	25		.034	1.26	19.9	96	88	162	2	59	226
6	30		.031	1.16	22.6	97	89	161	2	60	218
7	35		.030	1.11	25.6	98	89	162	2	59	221
8	40	0902	.025	0.93	28.202	96	88	162	2	59	220
	Total θ		Avg. $\sqrt{\Delta P}$	Avg. ΔH	Total V_m 22.045	Avg. T_m		Avg. T_s	Max. vac.	Max. temp.	Min. Max.

Comments:

Ri

SOx Calciner #1 9/8/89

Sheet 2 of 2

Traverse point number	Sampling time, min.	24-hr. clock time	Velocity head (ΔP), in. H_2O	Orifice meter pressure differential (ΔH), in. H_2O	Gas meter reading, ft.^{3}	Dry gas meter temperature (T_m) Inlet °F.	Dry gas meter temperature (T_m) Outlet °F.	Source temperature (T_s), °F	Pump vacuum, in.Hg. gauge	Impinger exit gas temp., °F.	Filter box temp., °F.
	0	0927			28.296						
1	5		.025	.93	30.9	83	80	160	2	65	219
2	10		.029	1.07	33.9	89	83	161	2	57	219
3	15		.031	1.15	37.0	87	91	162	2	57	217
4	20		.035	1.30	38.8	92	81	162	2	57	217
5	25		.035	1.30	41.9	91	79	161	2	57	217
6	30		.035	1.30	44.9	93	80	162	3	59	217
7	35		.033	1.22	47.9	94	83	162	3	60	218
8	40	1008	.028	1.05	50.244	94	84	162	3	66	218
				Purged	for 15 min	at 1.2	6 H				
					21.948						
							ACFM = 13400.				
							SCFM = 7800.				
					31.5% 1M						
					42.622						
					99.99% I						
	Total θ		Avg. $\sqrt{\Delta P}$ ~~.20453~~	Avg. ΔH 1.1608	Total V_m 43.993	Avg. T_m 88.875		Avg. T_s 161.9	Max. vac 3	Max. temp. 67	Min. 217 Max. 231

Comments: .1765343

SAMPLE RECOVERY AND INTEGRITY DATA FORM

Plant SCM Cal. #1 Sample date 9-8-89

Sample location BAIST MD Run number TWO

Sample recovery person JDD Recovery date 9-8-89

Filter(s) number N/A

ISO I = 251.5 grs. H_2O_2 I = 286.5 grs.

F = F =

MOISTURE

Impingers 306.5

Final volume (wt) ______ ml (g)

Initial volume (wt) ______ ml (g)

Net volume (wt) 388.3 ml (g)

Total moisture 413.3 g

Silica gel 81.8

Final wt 325 g — g

Initial wt 300 g — g

Net wt 25 g — g

Color of silica gel Pink = 50%

Description of impinger water all clear

016-SCM-H_2SO_4-2 ✓

017-SCM-SO_2-2 ✓

RECOVERED SAMPLE

Blank filter container number ______ Sealed ______

Filter container number ______ Sealed ______

Description of particulate on filter ______

Acetone rinse container number ______ Liquid level marked? ______

Acetone blank container number ______ Liquid level marked? ______

Samples stored and locked ✓ JDD 9/8/87

Remarks ______

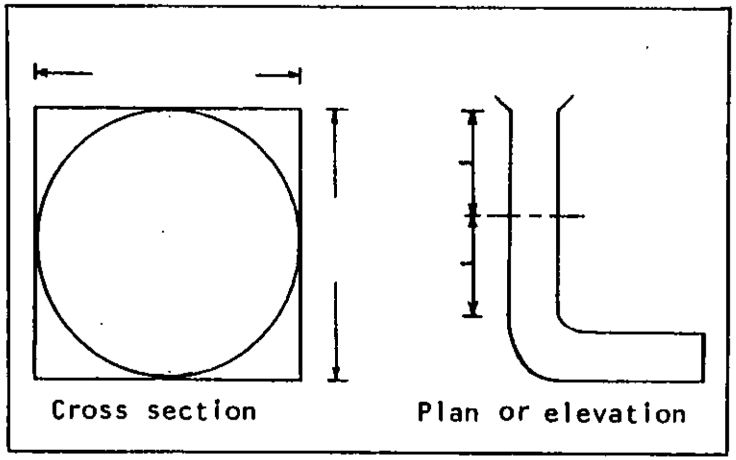
Date of laboratory custody 9/9/87

Laboratory personnel taking custody M.T.

Remarks all arrived safely

PARTICULATE FIELD DATA FORM

Plant SCM
City BALT MD
Location Calciner #1
Operator O'Neill
Run No. Three Date 9-8-89
Ambient temp., °F 80
Baro. press. (P_b), in. Hg. 29.92
Sample box no. # 1
Meter box no. # 9
Meter box ΔH@ 1.810
Meter box cal. (Y) .9997
Probe length, ft. 6'
Probe liner material BORO
Probe heater setting 30



Test point schematic

Pitot tube identification no. P6
Pitot tube cal. factor (C_p) .840
Nozzle identification no.
Avg. nozzle diameter (D_n), in. .506
Pyrometer identification no. #9
Thermocouple identification no.
Assumed moisture, % 24
Assumed temperature, °F. 160
Static pressure (P_{static}), in. H_2O -.030
C factor — Reference Δp —
Initial leak rate .006 cfm @ 15 in. Hg
Final leak rate .002 cfm @ 5 in. Hg
Filter no. 97041
Pitot LC = OK
Orsat LC = OK

MID PT LC = .004 at 5" 35.1

Traverse point number	Sampling time, min.	24-hr. clock time	Velocity head (ΔP), in. H_2O	Orifice meter pressure differential (ΔH), in. H_2O	Gas meter reading, ft.^{3}	Dry gas meter temperature (T_m) Inlet °F.	Outlet °F.	Source temperature (T_s), °F	Pump vacuum, in.Hg. gauge	Impinger exit gas temp., °F.	Filter box temp., °F.
	0	1207			737.195						
X 1	3 .5		.029	1.02	739.2	76	80	160	3	68	250
1	6 7		.029	1.02	741.6	75	81	163	3	66	240
2	9 10.5		.031	1.09	743.3	87	81	161	3	64	237
2	12 14		.031	1.09	744.9	90	82	161	3	64	236
3	15 17.5		.033	1.16	747.0	92	91	160	3	66	236
3	18 21		.034	1.18	749.4	92	93	161	3	66	233
4	21 24.5		.035	1.23	751.4	91	84	161	3	66	238
4	24 28		.035	1.23	753.3	95	84	161	3	66	238
5	27 31.5		.035	1.23	754.8	96	85	160	3	66	238
5	30 35		.035	1.23	757.6	97	86	161	3	64	241
6	33 38.5		.035	1.23	761.0	98	86	161	3	57	236
6	36 42		.035	1.23	762.4	97	98	160	3	56	237
7	39 45.5		.033	1.16	763.1	97	98	161	3	56	236
7	42 49		.033	1.16	765.7	89	100	160	3	57	236
8	45 52.5		.028	1.00	768.0	89	100	161	3	58	236
8	48 56	1303	.028	1.00	769.903	90	99	160	3	59	235
	Total θ 56		Avg. $\sqrt{\Delta P}$	Avg. ΔH	Total V_m	Avg. T_m		Avg. T_s	Max. vac.	Max. temp.	Min. Max.

Comments:

Calciner #1 9/8/84 9-8-3

Test Run 3

Traverse point number	Sampling time, min.	24-hr. clock time	Velocity head (ΔP), in. H_2O	Orifice meter pressure differential (ΔH), in. H_2O	Gas meter reading, ft.^{3}	Dry gas meter temperature (T_m) Inlet °F.	Dry gas meter temperature (T_m) Outlet °F.	Source temperature (T_s), °F	Pump vacuum, in.Hg. gauge	Impinger exit gas temp., °F.	Filter box temp., °F.
	0	1314			769.973						
1	3 / 3.5		.030	1.05	772.0	92	89	159	3	68	237
1	6 / 7		.030	1.05	774.1	97	90	158	3	62	236
2	9 / 10.5		.033	1.16	776.0	98	91	160	3	59	243
2	12 / 14		.033	1.16	777.9	99	92	160	3	56	243
3	15 / 17.5		.036	1.26	780.1	100	92	157	3	60	245
3	18 / 21		.036	1.26	782.4	101	92	159	4	61	240
4	21 / 24.5		.036	1.26	784.7	101	93	158	4	61	246
4	24 / 28		.035	1.24	787.1	101	93	158	4	64	239
5	27 / 31.5		.030	1.05	789.0	102	93	159	4	65	245
5	30 / 35		.030	1.05	791.1	102	93	160	4	66	246
6	33 / 38.5		.028	.98	792.3	102	93	159	4	66	247
6	36 / 42		.028	.98	794.5	101	94	159	4	66	248
7	39 / 45.5		.024	.84	796.1	102	94	158	4	66	247
7	42 / 49		.024	.84	797.8	102	94	158	4	65	241
8	45 / 52.5		.024	.84	800.0	102	94	158	4	66	240
8	48 / 56	1410	.024	.84	801.777	102	95	156	3	66	241
									3		245
					31.804						
—	Total θ 112	—	Avg. $\sqrt{\Delta P}$ .1764383	Avg. ΔH 1.0975	Total V_m 64.512	Avg. T_m 92.891		Avg. T_s 159.63	Max. vac. 4	Max. temp. 68	Min. 237 Max. 248

Comments:

SAMPLE RECOVERY AND INTEGRITY DATA FORM

Plant SCM Sample date 9-8-89

Sample location Calciner #1 Run number Three

Sample recovery person JDO/ TB Recovery date 9-8-89

Filter/thimble number(s) 97041

MOISTURE

Impingers			Silica gel		
Final volume (wt)	ml	(g)	Final wt	324 g	— g
Initial volume (wt)	200 ml	(g)	Initial wt	300 g	— g
Net volume (wt)	572 ml	(g)	Net wt	24 g	g
Total moisture	596	(g)			

Color of silica gel 1/2 Blue 1/2 Orange/Pink

Description of impinger water Clear

RECOVERED SAMPLE

Blank filter container number		Sealed	
Blank thimble container number		Sealed	
Filter/thimble container number	019-SCM-FILT-3	Sealed	✓
Filter/thimble container number		Sealed	
Filter/thimble container number		Sealed	
Filter/thimble container number		Sealed	

Description of particulate very very light loading

Front-half water rinse container number(s)		Liquid level marked ?	
Front-half acetone rinse container number(s)	018-SCM-FHA-3	Liquid level marked ?	
Impinger contents and back-half water rinse container number(s)	020-SCM-BHW-3	Liquid level marked ?	
Back-half acetone rinse container number	021-SCM-BHA-3	Liquid level marked ?	
Water blank container number		Liquid level marked ?	
Acetone blank container number		Liquid level marked ?	

Samples stored and locked OK JDO 9/8/89

Remarks

Date of laboratory custody 9/9/89

Laboratory personnel taking custody M. T.

Remarks all arrived safely

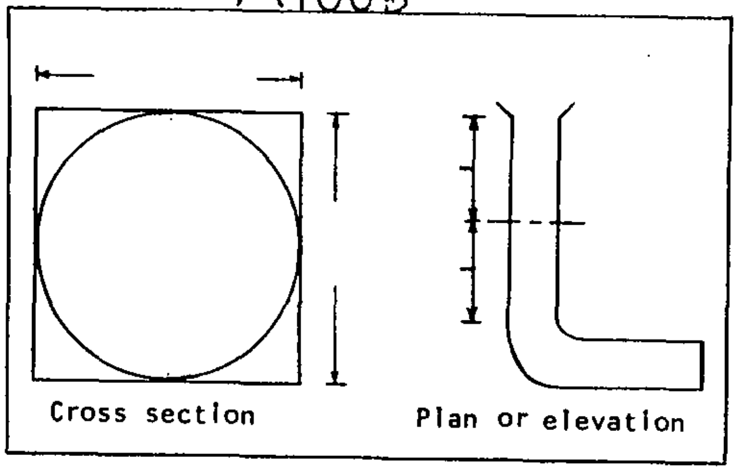
SOx

~~PARTICULATE~~ FIELD DATA FORM

M1008

Sheet 1 of 2

Plant SCM
City BALT. MD
Location Calcine #1
Operator O'Neill
Run No. Three Date 9-8-99
Ambient temp., °F 80
Baro. press. (P_b), in. Hg. 29.42
Sample box no. #2
Meter box no. #10
Meter box ΔH@ 2.10
Meter box cal. (Y) 1.0002
Probe length, ft. 6'
Probe liner material BORO
Probe heater setting 50



Test point schematic

Pitot tube identification no. P 18
Pitot tube cal. factor (C_p) .840
Nozzle identification no.
Avg. nozzle diameter (D_n), in. .496
Pyrometer identification no. #10
Thermocouple identification no.
Assumed moisture, % 29
Assumed temperature, °F. 160
Static pressure (Pstatic), in. H_2O -.030
C factor ___ Reference Δp —
Initial leak rate .014 cfm @ 15 in. Hg
Final leak rate .006 cfm @ 4.5 in. Hg
Filter no. N/A

Pitot I = OK
F = OK

min pt .006 at 4" K=37

Traverse point number	Sampling time, min.	24-hr. clock time	Velocity head (ΔP), in. H_2O	Orifice meter pressure differential (ΔH), in. H_2O	Gas meter reading, ft.^{3}	Dry gas meter temperature (T_m) Inlet °F.	Dry gas meter temperature (T_m) Outlet °F.	Source temperature (T_s), °F	Pump vacuum, in.Hg. gauge	Impinger exit gas temp., °F.	Filter box temp., °F.
	0	1221			057.821						
Y 1	5		.025	.93	60.9	83	82	162	2	67	219
2	10		.028	1.04	63.1	85	94	162	2	58	220
3	15		.029	1.08	65.6	90	87	162	2	58	222
4	20		.032	1.18	68.7	91	87	163	2	57	218
5	25		.035	1.30	71.0	93	88	162	2	58	221
6	30		.035	1.30	75.1	91	94	162	2	68	221
7	35		.032	1.18	76.9	96	92	162	2	67	218
8	40	1301	.028	1.04	79.888	90	94	160	2	60	219
					22.067						
—	Total θ	—	Avg. √ΔP	Avg. ΔH	Total V_m	Avg. T_m		Avg. T_s	Max. vac.	Max. temp.	Min. Max.

Comments:

SC... Rich. MP 9/8/89 Run 3 37. SOx

Traverse point number	Sampling time, min.	24-hr. clock time	Velocity head (ΔP), in. H_2O	Orifice meter pressure differential (ΔH), in. H20	Gas meter reading, ft.^{3}	Dry gas meter temperature (T_m) Inlet °F.	Dry gas meter temperature (T_m) Outlet °F.	Source temperature (T_s), °F	Pump vacuum, in.Hg. gauge	Impinger exit gas temp., °F.	Filter box temp., °F.
	0	1324			80.000						
1	5		.026	.96	82.9	87	82	161	1.5	66	225
2	10		.031	1.15	84.9	89	82	161	1.5	59	227
3	15		.032	1.22	88.4	90	82	162	2	59	225
4	20		.033	1.25	91.7	91	82	163	2	61	226
5	25		.032	1.23	94.1	91	82	162	2	64	227
6	30		.029	1.07	96.5	93	84	161	2	65	227
7	35		.026	.96	98.9	93	85	162	2	65	228
8	40	1404	.024	.89	101.491	93	85	162	2	66	228
				Purged for 15 min							
					21.491						
					Vm std =	43.001			23566.98 / 548.06		
—	Total θ 80	—	Avg. √ΔP 0.1725615	Avg. ΔH 1.1125	Total V_m 43.558	Avg. T_m 88.063		Avg. T_s 161.81	Max. vac 2	Max. temp. 67	Min. 218 Max. 228

Comments:

SOx

SAMPLE RECOVERY AND INTEGRITY DATA FORM

Plant SCM Sample date 9-8-89

Sample location Calciner #1 Run number Three

Sample recovery person JDO / TB Recovery date 9-8-89

Filter(s) number —

ISO I = 251.5 H_2O_2 I = 286.5

ISO F = 558 MOISTURE H_2O_2 F = 354

306.5 67.5

Impingers		Silica gel		
Final volume (wt)	ml (g)	Final wt	— g	326 g
Initial volume (wt)	ml (g)	Initial wt	— g	300 g
Net volume (wt)	374 ml (g)	Net wt	— g	26 g

Total moisture 400 g

Color of silica gel 50% pink

Description of impinger water all clear ✓

022 - SCM - H_2SO_4 - 3 ✓

023 - SCM - SO_2 - 3 ✓

RECOVERED SAMPLE

Blank filter container number ____ Sealed ____

Filter container number ____ Sealed ____

Description of particulate on filter ____

Acetone rinse container number ____ Liquid level marked? ____

Acetone blank container number ____ Liquid level marked? ____

Samples stored and locked ✓ on JDO

Remarks ____

Date of laboratory custody 9/9/89

Laboratory personnel taking custody M.T.

Remarks all arrived safely

355
203
558

GAS ANALYSIS DATA FORM

Plant SCM Sample location Calciner #1

Date 9/8/89 Run no. Three Operator Baylis

Sample type: single-point or (multipoint); grab or (integrated)

Analytical method Orsat Comments Leak V = OK

Sample point	24-hour clock time	% CO2	% O2		% CO	
		Reading 1	Reading 2	Net[a]	Reading 3	Net[b]
1-1	Bag	6.4	15.2	8.8	12.2	0
1-2	Bag	6.6	15.2	8.8	15.2	0
1-3	Bag	6.6	15.4	9.0	15.4	0
Ave	—					0
2-1	Bag	7.2	14.6	7.4	14.6	0
2-2	Bag	7.2	14.6	7.4	14.6	0
2-3	Bag	7.2	14.6	7.4	14.6	0
Ave	—	7.2	14.6	7.4	14.6	0
3-1	Bag	7.2	14.8	7.6	14.8	0
3-2	Bag	7.2	14.8	7.6	14.8	0
3-3	Bag	7.2	14.8	7.6	14.8	0
Ave	—	7.2	14.8	7.6	14.8	0
Averages			----		----	

$\% N_2 = 100 - (\% CO_2 + \% O_2 + \% CO) =$

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

[a] Net % O_2 = Reading 2 - Reading 1

[b] Net % CO = Reading 3 - Reading 2

APPENDIX B

LABORATORY REPORTS

ROY F. WESTON INC.
LIONVILLE LABORATORY

CLIENT: SCM BALT MD
RFW #: 8909L657
W.O. #: 2373-01-02

SAMPLES RECEIVED: 9-9-89

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 Maryland Dept. of the Enviroment Procedures.

Debra K. White — Date
Inorganic Section Manager
Lionville Analytical Laboratory

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.

LABORATORY CHRONOLOGY AND HOLDTIME REPORT

The test code listed indicates the specific analysis or preparation procedure employed. The codes may be interpreted as follows:

MAAW - Metals prep test for AA digestion, water matrix.
MAAS - Metals prep test for AA digestion, soil matrix.
MICW - Metals prep test for ICP digestion, water matrix.
MICS - Metals prep test for ICP digestion, soil matrix.

M**TO- This type of code indicates a total metal analysis (eg. MAGTO indicates an analysis for total silver).

M**SO- This type of code indicates a soluble metal analysis. (eg. MAGSO indicates an analysis for soluble silver).

M**EP- This type of code indicates an EPTOXICITY metals analysis (eg. MAGEP indicates an analysis for eptox silver).

I**TO- This type of code indicates a non-metallic total analysis. There is also a complimentary soluble analysis for each of these codes (eg. ICNTO indicates an analysis for total cyanide).

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

ROY F. WESTON INC.

INORGANICS DATA SUMMARY REPORT 10/04/89

CLIENT: SCM BALT MD

WORK ORDER: 2373-01-02-0000

WESTON BATCH #: 8909L657

SAMPLE	SITE ID	ANALYTE	RESULT	UNITS	REPORTING LIMIT
-001	001-SCM-FILT-1	PARTICULATE	0.0424	grams	0.0000
-002	002-SCM-FHA-1	PARTICULATE	0.0227	grams	0.0000
-003	003-SCM-BHW-1	PARTICULATE	0.0055	grams	0.0000
-004	004-SCM-BHA-1	PARTICULATE	0.0030	grams	0.0000
-005	005-SCM-ACETONE-BLK	PARTICULATE	0.0007	grams	0.0000
-006	006-SCM-WATER-BLK	PARTICULATE	0.0010	grams	0.0000
-007	007-SCM-FILT-BLK	PARTICULATE	0.0000	grams	0.0000
-008	008-SCM-H2SO4-1	SULFURIC ACID	13.6	ML TITR	0.00
-009	009-SCM-SO2-1	SULFUR DIOXIDE	13.0	ML TITR	0.00
-010	010-SCM-ISO-BLK	SULFURIC ACID	0.050	ML TITR	0.00
-011	011-SCM-H2O2-BLK	SULFUR DIOXIDE	0.10	ML TITR	0.00
-012	012-SCM-FHA-2	PARTICULATE	0.0123	grams	0.0000
-013	013-SCM-FILT-2	PARTICULATE	0.0421	grams	0.0000
-014	014-SCM-BHW-2	PARTICULATE	0.0053	grams	0.0000
-015	015-SCM-BHA-2	PARTICULATE	0.0027	grams	0.0000
-016	016-SCM-H2SO4-2	SULFURIC ACID	42.0	ML TITR	0.00
-017	017-CON-SO2-2	SULFUR DIOXIDE	17.4	ML TITR	0.00
-018	018-SCM-FHA-3	PARTICULATE	0.0088	grams	0.0000
-019	019-SCM-FILT-3	PARTICULATE	0.0414	grams	0.0000
-020	020-SCM-BHW-3	PARTICULATE	0.0087	grams	0.0000
-021	021-SCM-BHA-3	PARTICULATE	0.0035	grams	0.0000

ROY F. WESTON INC.

INORGANICS DATA SUMMARY REPORT 10/04/89

CLIENT: SCM BALT MD

WORK ORDER: 2373-01-02-0000

WESTON BATCH #: 8909L657

SAMPLE	SITE ID	ANALYTE	RESULT	UNITS	REPORTING LIMIT
-022	022-SCM-H2SO4-3	SULFURIC ACID	11.5	ML TITR	0.00
-023	023-SCM-S02-3	SULFUR DIOXIDE	8.8	ML TITR	0.00

INORGANICS DATA SUMMARY REPORT CONTINUED:
Analytical results for extractable particulates.
RfW batch #89091657:

Calciner #1,	Run 1	back	half	water	extract	= 2.0 mg.
" "	Run 2	"	"	"	"	= 1.8 mg.
" "	Run 3	"	"	"	"	= 1.7 mg.
" "	Water blank				"	= 0.0 mg.

LABORATORY CHRONOLOGY & HOLDTIME REPORT PRODUCED ON 10/04/89 AT [illegible]

SAMPLE	TEST	DAT_PREP	DAT_ANAL	HOLD_DAT	DATE_COL	DATE_REC	MATRIX	CLI_ID
09L657-00100	IPART	[illegible]/13/89	09/15/89	09/14/89	09/07/89	09/09/89	AIR	001-SCM-FILT-1
09L657-00200	IPART	09/13/89	09/15/89	09/14/89	09/07/89	09/09/89	AIR	002-SCM-FHA-1
09L657-00300	IPART	09/13/89	09/15/89	09/14/89	09/07/89	09/09/89	AIR	003-SCM-BHW-1
09L657-00400	IPART	09/13/89	09/15/89	09/14/89	09/07/89	09/09/89	AIR	004-SCM-BHA-1
09L657-00500	IPART	09/13/89	09/15/89	09/14/89	09/07/89	09/09/89	AIR	005-SCM-ACETONE-BLK
09L657-00600	IPART	09/13/89	09/15/89	09/14/89	09/07/89	09/09/89	AIR	006-SCM-WATER-BLK
09L657-00700	IPART	09/13/89	[illegible]	09/14/89	09/07/89	09/09/89	AIR	007-SCM-FILT-BLK
09L657-00800	IHSO4	09/15/89	09/15/89	10/07/89	09/07/89	09/09/89	AIR	008-SCM-H2SO4-1
09L657-00900	ISO2	09/15/89	09/15/89	09/14/89	09/07/89	09/09/89	AIR	009-SCM-SO2-1
09L657-01000	IHSO4	09/15/89	09/15/89	10/07/89	09/07/89	09/09/89	AIR	010-SCM-ISO-BLK
09L657-01100	ISO2	09/15/89	09/15/89	09/14/89	09/07/89	09/09/89	AIR	011-SCM-H2O2-BLK
09L657-01200	IPART	09/13/89	09/15/89	09/14/89	09/08/89	09/09/89	AIR	012-SCM-FHA-2
09L657-01300	IPART	09/13/89	09/15/89	09/15/89	09/08/89	09/09/89	AIR	013-SCM-FILT-2
09L657-01400	IPART	09/13/89	09/15/89	09/15/89	09/08/89	09/09/89	AIR	014-SCM-BHW-2
09L657-01500	IPART	09/13/89	09/15/89	09/15/89	09/08/89	09/09/89	AIR	015-SCM-BHA-2
09L657-01600	IHSO4	09/15/89	09/15/89	10/08/89	09/08/89	09/09/89	AIR	016-SCM-H2SO4-2
09L657-01700	ISO2	09/15/89	09/15/89	09/15/89	09/08/89	09/09/89	AIR	017-CON-SO2-2
09L657-01800	IPART	09/13/89	09/15/89	09/15/89	09/08/89	09/09/89	AIR	018-SCM-FHA-3
09L657-01900	IPART	09/13/89	09/15/89	09/15/89	09/08/89	09/09/89	AIR	019-SCM-FILT-3
09L657-02000	IPART	[illegible]/13/89	09/15/89	09/15/89	09/08/89	09/09/89	AIR	020-SCM-BHW-3
09L657-02100	IPART	09/13/89	09/15/89	09/15/89	09/08/89	09/09/89	AIR	021-SCM-BHA-3
09L657-02200	IHSO4	09/15/89	09/15/89	10/08/89	09/08/89	09/09/89	AIR	022-SCM-H2SO4-3
09L657-02300	ISO2	09/15/89	09/15/89	09/15/89	09/08/89	09/09/89	AIR	023-SCM-SO2-3

23 SELECTIONS QUALIFIED

Plant SCm — Sampling Location — Run # — Process#
Test Date 9-7-8[illegible] — Test Period — Stack #

8909L657-

	Beaker #	Volume ml	Tare(1) grams	Tare(2) grams	TARE Avg	Final(1) grams	Final(2) grams	Final Avg grams	Δ wt grams	Net wt. grams
002 FHA	G-9	475	109.2081	109.2081	109.2081	109.2307	109.2309	109.2308	.0227	.0022, .0209
001 FILTER₁ #	20080		.3931	.3929	.3930	.4353	.4354	.43535	.04235	.04235
FILTER₂ #										.06285
FH TOTAL										
003 BHW	G-15	820	112.4610	112.4608	112.4609	112.4666	112.4662	112.4664	.0055	.0036, .0019
004 FHA	G-2	125	108.9170	108.9170	108.9170	108.9200	108.9200	108.9200	.0030	.0006, .0024
Extracts	G-11	150	109.7983	109.7983	109.7983	109.8004	109.8002	109.8003	.0020	.0020

Comments: The BHW samples were extracted with 75 mls of chloroform and ethyl ether. The extracts were combined and taken to dryness.

BHT = .0063
Total: .06915

Plant SCm — Sampling Location #1 Calciner — Run # TWO — Process#
Test Date 9-8-89 — Test Period — Stack #

	Beaker #	Volume ml	Tare(1) grams	Tare(2) grams	TARE Avg	Final(1) grams	Final(2) grams	Final Avg grams	Δ wt grams	Net wt. grams
012 FHA	G-10	335	109.0417	109.0415	109.0416	109.0537	109.0541	109.0539	.0123	.0016, .0107
013 FILTER₁ #	97040		.3725	.3725	.3725	.4145	.4147	.4146	.0421	.0421
FILTER₂ #										.0528
FH TOTAL										
014 BHW	G-7	840	112.0408	112.0410	112.0409	112.0460	112.0464	112.0462	.0053	.0037, .0016
015 BHA	G-6	140	110.7168	110.7168	110.7168	110.7195	110.7195	110.7195	.0027	.0007, .0020
Extracts	G-1	150	112.0868	112.0866	112.0867	112.0884	112.0886	112.0885	.0018	.0018

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Comments: All filters were heated + desiccated to a constant weight.

BHT = .0054
Total = .0582

Plant SCm — Sampling Location #1 Calciner — Run # Three — Process#
Test Date 9-8-89 — Test Period — Stack #

	Beaker #	Volume ml	Tare(1) grams	Tare(2) grams	TARE Avg	Final(1) grams	Final(2) grams	Final Avg grams	Δ wt grams	Net wt. grams
018 FHA	G-8	260	111.0643	111.0643	111.0643	111.0731	111.0731	111.0731	.0088	.0012, .0076
019 FILTER₁ #	97041		.3720	.3721	.37205	.4134	.4134	.4134	.04135	.04135
FILTER₂ #										.04895
FH TOTAL										
020 BHW	G-14	890	111.6857	111.6857	111.6857	111.6944	111.6944	111.6944	.0087	.0040, .0047
021 BHA	G-13	175	111.4403	111.4403	111.4403	111.4438	111.4438	111.4438	.0035	.0008, .0027
Extracts	G-3	150	110.7825	110.7823	110.7824	110.7841	110.7841	110.7841	.0017	.0017
Comments										
007 FILTER BLK	20081		.3936	.3936	.3936	.3936	.3936	.3936	0.0000	
005 ACETONE BLK	G-5	150	111.7526	111.7526	111.7526	111.7533			.0007	= .0000466
006 WATER BLK	G-12	225	110.5562	110.5558	110.5560	110.5570			.0010	= .0000444
Extracts	G-4	150	112.2581	112.2583	112.2582	112.2582			.0000	

CODE: FHA=Front half acetone wash BHW=Back half water (impinger contents + water wash) BHA=Back half acetone wash FH TOTAL=Front half catch weight TOTAL=Total train catch weight

BHTotal = .009
Total = .0580

TITLE SCm SO_x 9-15-89

Project No.______

Book No.______

From Page No.__

RFW#	Run # Location	TSV ml	aliquot ml	Diln factor	Titre (1)	Titre (2)	Titre Avg	N Bal
# 1 Calciner	SO_3 H_2SO_4							
909L 657-010	Iso Blk	100	—	—	0.05	0.05	0.05	0.01
657-008	Run 1	900	100	—	13.70	13.50	13.60	0.01
* 657-016	Run 2	900	50	1x2	20.30	20.50	20.40	.01
657-022	Run 3	900	100	-	11.60	11.40	11.50	.01
657-016 rerun with 100ml sample volume					42.0	42.0	42.0	.01
	SO_2							
657-009	Run 1	500	10	1X10	13.20	13.20	13.00	.01
657-017	Run 2	500	10	1X10	17.40	17.40	17.40	.01
657-023	Run 3	500	10	1X10	8.80	8.90	8.85	.01
657-011	H_2O_2 Blk	100	10	—	0.10	0.10	0.10	.01

Custody Transfer Record/Lab Work Request

WESTON

WESTON Analytics Use Only

Client: SCM Bull. MD.
Work Order: 2373-01-02
Date Rec'd. ______ Date Due ______
RFW Contact: O'Neill / [illegible]
Client Contact/Phone ______

Refrigerator#							
#/Type Container							
Volume							
Preservative							
ANALYSES REQUESTED →				PART.	H2SO4	SO2	

WA Use Only Lab ID	Client ID/Description	Matrix	Date Collected	PART.	H2SO4	SO2
	001-SCM-FILT-1		9-7-94	X		
	002-SCM-FHA-1		↓	X		
	003-SCM-BHW-1		↓	X		
	004-SCM-BHA-1		↓	X		
	005-SCM-Acetone-BLK		↓	X		
	006-SCM-Water-BLK		↓	X		
	007-SCM-FILT-BLK		↓	X		
	008-SCM-H2SO4-1		↓		X	
	009-SCM-SO2-1		↓			X
	010-SCM-ISO-BLK		9/7/94		X	
	011-SCM-H2O2-BLK		"			X
	~~012~~ new					
	~~013~~					
	~~014~~					
	~~015~~					

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

Special Instructions: PART and SOx by MD. Methods 1005 and 1008 - See [illegible] Robertson

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time
	[illegible]	[illegible]	[illegible]	[illegible]50					

WESTON Analytics Use Only

Samples Were:
1 Shipped or Hand-Delivered
NOTES:

2 Ambient or Chilled
NOTES:

3 Received Broken/Leaking (Improperly Sealed)
Y N
NOTES:

4 Properly Preserved
Y N
NOTES:

5 Received Within Holding Times
Y N
NOTES:

COC Tape Was:
1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

COC Record Was:
1 Present Upon Receipt of Samples Y N

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

RFW 21-21-001/A-12/88

[illegible] H2SO4 samples were diluted to [illegible] and [illegible]
[illegible] samples were diluted to 500 ml [illegible]

7-115

Custody Transfer Record/Lab Work Request

WESTON

WESTON Analytics Use Only

Client: SCM - Balt MD.
Work Order: 2373-01-02-0032
Date Rec'd. ____ Date Due ____
RFW Contact: [illegible]
Client Contact/Phone ____

WA Use Only Lab ID	Client ID/Description	Matrix	Date Collected	PART.		H_2SO_4		SO_2				
Refrigerator#												
#/Type Container												
Volume												
Preservative												
	012 - SCM - EHA - 2		9/8/89	✓								
	013 - SCM - FILT - 2		↓	✓								
	014 - SCM - BHW - 2		↓	✓								
	015 - SCM - BHA - 2		↓	✓								
	016 - SCM - H_2SO_4 - 2		↓			✓						
	017 - SCM - SO_2 - 2		↓					✓				
	018 - SCM - EHA - 3		↓	✓								
	019 - SCM - FILT - 3		↓	✓								
	020 - SCM - BHW - 3		↓	✓								
	021 - SCM - BHA - 3		↓	✓								
	022 - SCM - H_2SO_4 - 3		↓			✓						
	023 - SCM - SO_2 - 3		↓					✓				
	~~024 - SCM~~ - [illegible]											
	~~[illegible]~~ - [illegible]											
	~~[illegible]~~ - [illegible]											

Matrix:
S - Soil, SE - Sediment, SO - Solid, W - Water, O - Oil, A - Air, WI - Wipe, DS - Drum Solids, DL - Drum Liquids, F - Fish, X - Other

Special Instructions: Particulate and SOx by Maryland Methods 1005 and 1008

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time
	[illegible]	[illegible]	9/1/89	[illegible]					

WESTON Analytics Use Only

Samples Were:
1 Shipped or Hand-Delivered
NOTES:

2 Ambient or Chilled
NOTES:

3 Received Broken/Leaking (Improperly Sealed) Y N
NOTES:

4 Properly Preserved Y N
NOTES:

5 Received Within Holding Times Y N
NOTES:

COC Tape Was:
1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

COC Record Was:
1 Present Upon Receipt of Samples Y N

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

7-115

RFW 21-21-001/A-7/88

APPENDIX C

SAMPLE CALCULATIONS

DHMH Method 1005
Particulate Sample Calculation

CLIENT SCM CHEMICALS | PLANT BALTIMORE MD.
TEST RUN NO. ONE | TEST DATE 9/7/89
TEST LOCATION # 1 CALCINER | TEST PERIOD 1334-1528

1. Volume of dry gas sampled at standard conditions ($77^{o}F$, 29.92 in. Hg.), dscf.

$$V_{m(std)} = \frac{17.95 \times Y \times V_m \times (P_b + \frac{\Delta H}{13.6})}{(T_m + 460)}$$

$$V_{m(std)} = \frac{17.95 \times 1.000 \times 65.25 \times (29.95 + \frac{1.56}{13.6})}{(93 + 460)} = 63.6$$

Where:

$V_{m(std)}$ = Volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscf.

V_m = Volume of gas sample measured by the dry gas meter at meter conditions, dcf.

P_b = Barometric pressure, in. Hg.

ΔH = Average pressure drop across the orifice meter, in. H_2O.

T_m = Average dry gas meter temperature, °F

Y = Dry gas meter calibration factor.

17.95 = Factor that includes ratio of standard temperature ($537^{o}R$) to standard pressure (29.92 in. Hg), ^{o}R/in. Hg.

13.6 = Specific gravity of mercury.

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

$V_{w(std)} = 0.0480 \times W_t$

$V_{w(std)} = 0.0480 \times 564. = 27.$

Where:

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

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

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

W_t = Total weight of water collected (V_{wct} + W_{wsg}) g

0.0480 = Factor which includes the molecular weight of water (18.0 lb/lb-mole), the ideal gas constant 21.8 (in. Hg) $(ft^3)/(lb\text{-}mole)(^oR)$, absolute temperature at standard conditions (537^oR), absolute pressure at standard conditions (29.92 in. Hg), and 453.6 g/lb, ft^3/g.

3. Moisture content

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

$$B_{ws} = \frac{27}{27 + 63.6} = 0.298$$

Where:

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

4. Mole fraction of dry gas.

$$M_d = 1 - B_{ws}$$

$$M_d = 1 - 0.298 = 0.702$$

Where:

M_d = Mole fraction of dry gas, dimensionless.

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

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

$$MW_d = (0.440 \times 6.5)+(0.320 \times 8.7)+(0.280)(84.7+ \quad 0.0)$$

$$= 29.38$$

Where:

MW_d = 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.

$MW_s = (MW_d \times M_d) + 18 (1 - M_d)$

$MW_s = (29.38 \times 0.702) + 18 (1 - 0.702)$

$= 25.99$

Where:

MW_s = 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.

$$V_s = 85.48 \times C_p \times (\sqrt{\Delta p})\ \text{avg.} \times \left[\frac{T_s\ \text{(avg)}}{P_s \times MW_s}\right]^{1/2}$$

$$V_s = 85.48 \times .84 \times 0.175416 \times \left[\frac{618}{29.95 \times 25.99}\right]^{1/2} = 11.22$$

Where:

V_s = Average gas stream velocity, ft/sec.

85.48 = Pitot tube constant, ft/sec x $\frac{\text{(lb/lb-mole) (in Hg)}}{(^{\circ}R)\ \text{(in. } H_2O)}$

C_p = Pitot tube coefficient, dimensionless.

T_s = Absolute gas stream temperture, $^{\circ}R. = T_s$, $^{\circ}F + 460$

P_s = Absolute gas stack pressure, in. Hg. $= P_b = \frac{P_{static}}{13.6}$

Δp = Velocity head of stack gas, in. H_2O.

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

$$Q_{s(act)} = 3{,}600 \times V_s \times A_s$$

$$= 3{,}600 \times 11.22 \times 19.64 \div 60 = 13200.\ ACFM$$

Where:

$Q_{s(act)}$ = Volumetric flow rate of wet stack gas at actual conditions, wacf/hr.

A_s = Cross-sectional area of stack, ft.^{2}

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

$$Q_{s(std)} = 17.95 \times M_d \times \frac{P_s}{T_s} \times Q_{s(act)}$$

$$= 17.95 \times 0.702 \times \frac{29.38}{618} \times 13200 = 8100$$

Where:

$Q_{s(std)}$ = Volumetric flow rate of dry stack gas at standard conditions, dscf/hr.

10. Isokinetic variation calculated from intermediate values, percent.

$$I = \frac{17.026 \times T_s \times V_{m(std)}}{V_s \times \theta \times P_s \times M_d \times (D_n)^2}$$

$$I = \frac{17.026 \times 618 \times 63.6}{0.702 \times 11.22 \times 96 \times 29.95 \times (.552)^2} = 97.0$$

Where:

I = Percent of isokinetic sampling.

θ = Total sampling time, minutes.

D_n = Diameter of nozzle, inches.

17.026 = Factor which includes standard temperature (537°R), standard pressure (28.92 in. Hg), the formula for calculating area of circle $\frac{D^2}{4}$, conversion of square feet to square inches (144), conversion of seconds to minutes (60), and conversion to percent (100), $\frac{(\text{in. Hg})\ (\text{in}^2)\ (\text{min})}{(^\circ\text{R})\ (\text{ft}^2)\ (\text{sec})}$

11. Particulate concentration, gr/dscf.

$$C_1 = 15.432 \times \frac{M_t}{V_{m(std)}}$$

$$C_1 = 15.432 \times \frac{0.06285}{63.6} = 0.0152$$

Where:

C_1 = Particulate concentration, gr/dscf.

M_t = Total weight of particulate caught by train, g.

15.432 = Conversion factor of gr/g.

12. Particulate concentration, gr/dscf.

$$C_2 = C_1 \times \frac{Q_{s(std)}}{Q_{s(act)}} = 0.0153 \times \frac{8100}{13200.} = 0.009$$

Where:

C_2 = Particulate concentration, gr/wacf.

13. Particulate mass emission rate, lb/hr.

$$PMR_t = 0.000142857 \times C_1 \times Q_{s(std)}$$

$$= 0.000142857 \times 0.0152 \times 486000 = 1.06$$

Where:

PMR_t = Particulate mass emission rate, lb/hr.

0.000142857 = Conversion factor relating grains to pounds (7,000), lb/gr.

14. Conversion factors:

FROM	TO	MULTIPLY BY
in.	mm.	25.40
ft.	m.	0.3048
$ft.^2$	$m.^2$	0.092903
$ft.^3$	$m.^3$	0.028317
$gr/ft.^3$	$g/m.^3$	2.28833
lbs/hr.	g/hr.	453.59

Temperature

^oC = 5/9 (F-32)

^oR = ^oF + 460

^oK = ^oC + 273

MARYLAND METHOD

EPA METHOD 8

H_2SO_4/SO_2 SAMPLE CALCULATIONS

No. Calciner
Test Date:
Run No.:
Test Period:

15. Sulfuric Acid Mist Concentration, lb/dscf

$$C\,H_2SO_4 = \frac{1.08 \times 10^{-4} (V_t - V_{tb})\, N \left(\frac{V_{soln}}{V_a}\right) D}{V_{m(std)}}$$

$$C\,H_2SO_4 = \frac{1.081 \times 10^{-4} (13.40 - 0.05)\, 0.01 \left(\frac{900}{100}\right)}{44.5} = 2.96 \times 10^{-6}$$

WHERE:

$C\,H_2SO_4$ = Concentration of H_2SO_4 Mist at standard conditions, lb/dscf.

1.081×10^{-4} = Conversion factor including the gram equivalent weight of H_2SO_4 (49), 453.6 g/lb, and 1,000 ml/l, (lb)(l)/(g)(ml).

V_t = Volume of barium perchlorate titrate used for the sample, ml.

V_{tb} = Volume of titrate used for the blank, ml.

N = Normality of barium perchlorate titrate, g-eq./l.

V_{soln} = Total solution volume of H_2SO_4 mist sample (contents of first two impingers + washes), (probe and front half filter wash & filter), ml

V_a = Volume of sample aliquot titrated, ml.

D = Dilution Factor

16. Concentration of H_2SO_4 mist, ppm by volume.

$$C\,H_2SO_4(ppm) = 3.993 \times 10^5 \times C_{H_2SO_4}$$

$$= 3.993 \times 10^5 \times 2.97 \times 10^{-6} = 11.8$$

Concentration of H_2SO_4 mist, mg/m^3 (milligrams per cubic meter)

$$C\,H_2SO_4(mg/m^3) = C\,H_2SO_4(ppm) \times \frac{M}{24.45}$$

$$= 11.9 \times \frac{98.08}{24.45} = 47. \ mg/m^3$$

Where:

$C_{H_2SO_4}$ = Concentration of H_2SO_4, ppm by volume.

3.993×10^6 = Conversion factor including number of cubic feet/liter (0.0353, 453.6 g/lb, 24.46 l/g - mole wt, 98.0 g/g - mole wt, and 10^6 ppm, (ft^3) (ppm)/lb.

17. Mass emission rate of H_2SO_4, lb/hr.

$$PMR_{H_2SO_4} = C_{H_2SO_4} \times Q_{s(std)}$$

$$= 2.97 \times 10^{-6} \times 7800 \times 60 = 1.39$$

Where:

$PMR_{H_2SO_4}$ = H_2SO_4 mist mass emission rate, lb/hr.

18. Concentration of Sulfur Dioxide at standard conditions, dry basis, lb/dscf.

$$C_{SO_2} = \frac{7.061 \times 10^{-5} (V_t - V_{tb}) N \left(\frac{V_{soln}}{V_a}\right)}{V_{m(std)}}$$

$$= \frac{7.061 \times 10^{-5} (13.2 - .1) .01 \left(\frac{500}{10}\right) \times 10}{44.5}$$

$$= 103.9 \times 10^{-6}$$

Where:

C_{SO_2} = Concentration of sulfur dioxide at standard conditions (77°F and 29.92 in. Hg), dry basis, lb/dscf.

7.061×10^{-5} = Conversion factor including number of grams per gram equivalent of sulfur dioxide (32.0 g/g - eq), 453.6 g/lb, and 1,000 ml/l, (lb) (l)/(g) (ml).

Other terms as defined above.

19. Concentration of sulfur dioxide parts per million by volume.

$$C_{SO_2\,(ppm)} = 6.1137 \times 10^6 \times C_{SO_2}$$

$$= 6.1137 \times 10^6 \times 103.9 \times 10^{-6} = 635$$

Where:

$C_{SO_2\,(ppm)}$ = Concentration of sulfur dioxide ppm by volume

6.1137×10^6 = Coversion factor including number of cubic feet/liter (0.0353, 453.6 g/lb, 24.45 l/g - mole wt, 64.0 g/g - mole wt, and 10^6 ppm, (ft^3) (ppm)/lb.

20. Mass emission rate of sulfur dioxide lb/hr.

$$PMR_{SO_2} = C_{SO_2} \times Q_{s(std)}$$

$$= 103.9 \times 10^{-6} \times 7800 \times 60 = 49.$$

Where:

PMR_{SO_2} = sulfur dioxide mass emission rate, lb/hr.

21. Concentration of sulfur dioxide milligrams per cubic meter

$$C_{SO_2}\ (Mg/M^3) = C_{SO_2}\ (ppm) \times \frac{M}{24.45}$$

$$= 635 \times \frac{64.06}{24.45} = 1665.$$

APPENDIX D

EQUIPMENT CALIBRATION RECORDS

METER BOX CALIBRATION DATA AND CALCULATION FORM

Date 11 AUGUST 1989 Meter Box Number NUTECH #9

Barometric pressure, P_b = 30.20 in. Hg Calibrated by M. TED BARKER

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperatures: Wet test meter (t_w), °F	Temperatures: Dry gas meter Inlet (t_{d_i}), °F	Temperatures: Dry gas meter Outlet (t_{d_o}), °F	Temperatures: Dry gas meter Avg[a] (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$ in. H_2O
.5	5	400.375 395.297	73	83 84 84	80 80 80	82	13:06	1.000	1.888
.0	5	395.046 389.982	73	84 85 85	81 81 81	83	8:48	1.003	1.701
1.5	10	411.365 401.367	73	75 79 83	74 75 76	77	14:33	1.004	1.763
.0	10	422.450 412.366	73	79 83 86	76 77 78	80	12:57	.9998	1.852
.0	10	433.155 422.955	73	85 88 89	78 78 78	83	10:42	.9915	1.886
4.0	10								
							Avg	Y .9997	$\Delta H@$ 1.818

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	$\Delta H@_i = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\,\theta}{V_w}\right]^2$
0.5	0.0368	$\frac{(5)(30.2)(82+460)}{(5.078)(30.2+.0368)(73+460)}$	$\frac{(.0317)(.5)}{(30.2)(82+460)}\left[\frac{(73+460)(13.1)}{5}\right]^2 = 1.888$
0	0.0735	$\frac{(5)(30.2)(83+460)}{(5.064)(30.2+.0735)(73+460)}$	$\frac{(.0317)(1.0)}{(30.2)(83+460)}\left[\frac{(73+460)(8.8)}{5}\right]^2 = 1.701$
5	0.110	$\frac{(10)(30.2)(77+460)}{(9.998)(30.2+.110)(73+460)}$	$\frac{(.0317)(1.5)}{(30.2)(77+460)}\left[\frac{(73+460)(14.55)}{10}\right]^2 = 1.763$
2.0	0.147	$\frac{(10)(30.2)(80+460)}{(10.084)(30.2+.147)(73+460)}$	$\frac{(.0317)(2.0)}{(30.2)(80+460)}\left[\frac{(73+460)(12.95)}{10}\right]^2 = 1.852$
0	0.221	$\frac{(10)(30.2)(83+460)}{(10.20)(30.2+.221)(73+460)}$	$\frac{(.0317)(3.0)}{(30.2)(83+460)}\left[\frac{(73+460)(10.7)}{10}\right]^2 = 1.886$
4.0	0.294		

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

M. T. Barker

POSTTEST DRY GAS METER CALIBRATION DATA FORM

Test numbers 2 Date 9-16-89 Meter box number 9 Plant SCM

Barometric pressure, P_b = 30.11 in.Hg Dry gas meter number 684591.3 Pretest Y 1.004

Orifice manometer setting, (ΔH), in. H2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature: Wet test meter (t_w), °F	Temperature: Dry gas meter: Inlet (t_{d_i}), °F	Temperature: Dry gas meter: Outlet (t_{d_o}), °F	Temperature: Dry gas meter: Average (t_d), °F[a]	Time (θ), min	Vacuum setting, in. Hg.	Y_i	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6})(t_w + 460)}$
1.25	10	819.42 809.404	72	82 88 87	80 82 83	83	16	3	1.006	
1.25	10	829.529 819.42	72	82 87 88	81 83 82	83	16	3	.9977	
1.25	10	839.663 829.529	72	83 82 89	81 83 84	84	16	3	.9969	
									Y =	.9999

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

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.

t_{d_i} = Temperature of the inlet gas of the dry gas meter, °F.

t_{d_o} = Temperature of the outlet gas of the dry gas meter, °F.

t_d = Average temperature of the gas in the dry gas meter, $\frac{t_{d_i} + t_{d_o}}{2}$, °F.

ΔH = Pressure differential across orifice, in H2O.

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.

$$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$$

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

POSTTEST DRY GAS METER CALIBRATION DATA FORM

Test numbers 8 Date 8 AUG 89 Meter box number NUTECH #10 Plant [illegible]

Barometric pressure, P_b = 29.96 in.Hg Dry gas meter number 6842659 Pretest Y 1.004

Orifice manometer setting, (ΔH), in. H2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature: Wet test meter (t_w), °F	Temperature: Dry gas meter: Inlet (t_{d_i}), °F	Temperature: Dry gas meter: Outlet (t_{d_o}), °F	Temperature: Dry gas meter: Average (t_d),[a] °F	Time (θ), min	Vacuum setting, in. Hg.	Y_i	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6})(t_w + 460)}$
1.6	10	932.628 922.594	73	80 84 86	75 75 76	80	14:39	4"	1.006	
1.6	10	942.691 932.628	73	83 85 88	80 80 81	83	14:51	4"	1.008	
1.6	10	952.781 942.691	73	87 91 92	81 81 81	85	15:18	4"	1.009	
									Y =	1.008

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

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.

t_{d_i} = Temperature of the inlet gas of the dry gas meter, °F.

t_{d_o} = Temperature of the outlet gas of the dry gas meter, °F.

t_d = Average temperature of the gas in the dry gas meter, $\frac{t_{d_i} + t_{d_o}}{2}$, °F.

ΔH = Pressure differential across orifice, in H2O.

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.

$$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$$

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

M. S. Barker

Calibrator: KH

POSTTEST DRY GAS METER CALIBRATION DATA FORM

Test numbers 5 Date 9-16-89 Meter box number 10 Plant SCM

Barometric pressure, P_b = 30.11 in.Hg Dry gas meter number 6842659 Pretest Y 1.008

Orifice manometer setting, (ΔH), in. H2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature: Wet test meter (t_w), ^oF	Temperature: Dry gas meter: Inlet (t_{d_i}), ^oF	Temperature: Dry gas meter: Outlet (t_{d_o}), ^oF	Temperature: Dry gas meter: Average (t_d),[a] ^oF	Time (θ), min	Vacuum setting, in. Hg.	Y_i	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6})(t_w + 460)}$
1.1	10	120.665 110.614	76	80 90 91	79 84 86	84	18	2	1.007	
1.1	10	130.782 120.665	76	84 82 88	82 80 80	83.5	18	2	.9996	
1.1	10	140.936 130.782	76	85 88 88	80 82 81	83.5	18	2	.9959	
									Y =	1.001

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

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, ^oF.

t_{d_i} = Temperature of the inlet gas of the dry gas meter, ^oF.

t_{d_o} = Temperature of the outlet gas of the dry gas meter, ^oF.

t_d = Average temperature of the gas in the dry gas meter, $\frac{t_{d_i} + t_{d_o}}{2}$, ^oF.

ΔH = Pressure differential across orifice, in H2O.

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 $\pm$ 0.05Y

P_b = Barometric pressure, in. Hg.

θ = Time of calibration run, min.

$$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6})(t_w + 460)}$$

$$\Delta H@_i = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460) \ldots}{V_w}\right.$$

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STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 1/17/89 POTENTIOMETER [redacted] number NUTECH 9

bient temperature 67 °F Barometric pressure 29.57 in. Hg

librator [signature] Reference: mercury-in-glass YES

other ________

eference point umber	Source (specify)[a]	Reference thermometer temperature, °F	Thermocouple potentiometer temperature, °F	Temperature difference,[b] %
	ICE BATH	32°F	34°F	+ 0.41%
	AMBIENT	67 °F	67°F	0
	HOT OIL	301 °F	306 °F	+ 0.66%

ype of calibration system used.

$$\left[\frac{\text{ref temp, °F} + 459.67) - (\text{test thermom temp, °F} + 459.67)}{\text{ref temp, °F} + 459.67}\right] 100 \leq 1.5\%.$$

WESTON

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 1/17/89 POTENTIOMETER [redacted] number NUTECH/ 10

...bient temperature 68 °F Barometric pressure 29.57 in. Hg

C...librator Jeff Mills Reference: mercury-in-glass yes

other ______

Reference point number	Source[a] (specify)	Reference thermometer temperature, °F	Thermocouple potentiometer temperature, °F	Temperature difference,[b] %
	ICE BATH	32°F	+ 33°F	+ 0.20%
	AMBIENT	68°F	68°F	0
	HOT OIL	301°F	308°F	+ 0.92%

Type of calibration system used.

$$\left[\frac{(\text{ref temp, °F} + 459.67) - (\text{test thermom temp, °F} + 459.67)}{\text{ref temp, °F} + 459.67}\right] 100 \leq 1.5\%.$$

TYPE S PITOT TUBE INSPECTION DATA FORM

PITOT TUBE P6

Pitot tube assembly level? ✓ yes ______ no

Pitot tube openings damaged? ______ yes (explain below) ✓ no

α_1 = 2 ° (<10°), α_2 = 2 ° (<10°), β_1 = 1 ° (<5°),
β_2 = 2 ° (<5°)

γ = 2 °, θ = 1 °, A = 1.018 cm (in.)

z = A sin γ = .036 cm (in.); <0.32 cm (<1/8 in.),
w = A sin θ = .018 cm (in.); <.08 cm (<1/32 in.)

P_A .509 cm (in.) P_b .509 cm (in.)

D_t = .380 cm (in.)

Comments: Inspected 9/21/88 Jack Mills

Calibration required? ______ yes ✓ no

TYPE S PITOT TUBE INSPECTION DATA FORM

Pitot Tube P18

Pitot tube assembly level? ✓ yes ______ no

Pitot tube openings damaged? ______ yes (explain below) ✓ no

α_1 = 3 ° (<10°), α_2 = 2 ° (<10°), β_1 = 4 ° (<5°),
β_2 = 2 ° (<5°)

γ = 0 °, θ = 1 °, A = .766 cm (in.)

z = A sin γ = 0 cm (in.); <0.32 cm (<1/8 in.),
w = A sin θ = .013 cm (in.); <.08 cm (<1/32 in.)

P_A .383 cm (in.) P_b .383 cm (in.)

D_t = .380 cm (in.)

Comments: Inspected 9/21/88 Jack Mills

Calibration required? ______ yes ✓ no

APPENDIX E

LIST OF WESTON PARTICIPANTS

WESTON

PROJECT PARTICIPANTS

The following WESTON employees participated in this project:

Barry L. Jackson Project Director	econENVIRONomics Division
Jeffrey D. O'Neill Section Manager	econENVIRONomics Division
Paul Meeter Project Scientist	econENVIRONomics Division
Tom Baylis Technician	econENVIRONomics Division
Mike Taylor Laboratory Supervisor	WESTON Analytics
Nancy Robertson Laboratory Technician	WESTON Analytics