Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

AP-42 Section 12.2
Reference
Report Sect. 4
Reference 115

PARTICULATE EMISSION MEASUREMENT ON #2 COKE OVEN BATTERY AT UNITED STATES STEEL CORPORATION FAIRFIELD, ALABAMA

Prepared for
United States Steel Corporation
Fairfield, Alabama

Prepared by
CH2M HILL
807 South McDonough Street
Montgomery, Alabama 36104

October 1979

Project No. MG63304.90

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Chapter 1

INTRODUCTION

The purpose of this study was to measure the concentration of particulate matter in the exhaust gases from the underfiring stack serving the #2 coke oven battery at U. S. Steel in Fairfield, Alabama. The underfiring stack receives the combustion products of the by-product gas which is burned to supply heat for the coking process. Dry coal was used in the ovens during this test series. (See our report dated March 1979, for test results using wet coal.)

Since the purpose of this test was to determine whether this source is in compliance with regulatory standards, the U. S. Environmental Protection Agency (EPA), the Alabama Air Pollution Control Comission (AAPCC), and the Jefferson County Health Department were contacted prior to the test. Representatives of these agencies were present during the test series and monitored process operation and testing procedures.

The particulate samples were collected October 10 and 11, 1979. Jim Long of U. S. Steel's Engineering Department coordinated the sampling with process operation. Bill Morgan and Alan Todd of CH2M HILL conducted the tests.

Chapter 2

SUMMARY OF RESULTS

Table 2-1 is a summary of the various parameters measured during the three particulate runs conducted on the under-firing stack serving the #2 coke battery. As shown in this table, the average grain loading measured for this test series was 0.0297 gr/sdcf.

Table 2-1 U. S. Steel - Summary of Test Results, #2 Coke Underfire Stack

Parameter	Run 1	Run 2	Run 3	Average
Date of Test	10/10/79	10/10/79	10/11/79	
Sampling Period (Time of Day)	1112-1420	1556-1840	0847-1151	
Stack Gas Temperature (°F)	379	373	376	376
Moisture Content (% Vol.)	11.0	11.3	11.6	11.3
Stack Gas Velocity (fps)	9.8	9.9	10.0	9.9
Gas Volumetric Flow Rate (SDCFH)[a]	6,135,557	6,234,105	6,194,470	6,188,044
Particulate Emissions (grains/SDCF)	.0298	.0288	.0304	.0297
Particulate Emissions (lbs/hr)	26.1	25.7	26.9	26.4
Percent of Isokinetic Sampling	104	105	105	

[a] Dry basis, standard conditions of 70°F and 29.92 in. of Hg.

Chapter 3

DESCRIPTION OF INSTALLATION

The coke oven facility of U. S. Steel Corporation in Fairfield, Alabama, generates coke for use in blast furnaces. Coke is produced by the distillation of a mixture of two or more low, medium and high volatile coals in a chemical retort or oven. The coal mixture is charged through holes in the top of the oven. The lids are then sealed with a wet clay mixture. Heat for the coking operation is supplied by a flue system located between the ovens. The regenerators serve as pre-heaters for the combustion air that enters the flues. Distilled volatiles are withdrawn to a duct system to be stripped of by-product chemicals. These gases are fed through scrubbers to remove such chemicals as ammonia, naphthalene, and light and heavy oil. The hot combustion gases after heating the regenerators are discharged through the underfiring stack. Typically, 12.5 hours are required to produce blast furnace coke. Coking time is determined by the coal mixture, moisture control, rate of underfiring, and desired properties of the coke. The oven doors are removed after the desired coking time is achieved. The hot coke is then pushed into a rail car and quenched with water.

Coke battery #2 discharges its combustion gases to the underfiring stack that was tested during this sampling program. There are 57 ovens in the #2 battery. Each oven has a capacity of 3.3 tons of coal. Figure 1 is a schematic of the coke oven operation. U. S. Steel collected the required process data during the test periods and supplied that data to regulatory agency representatives.

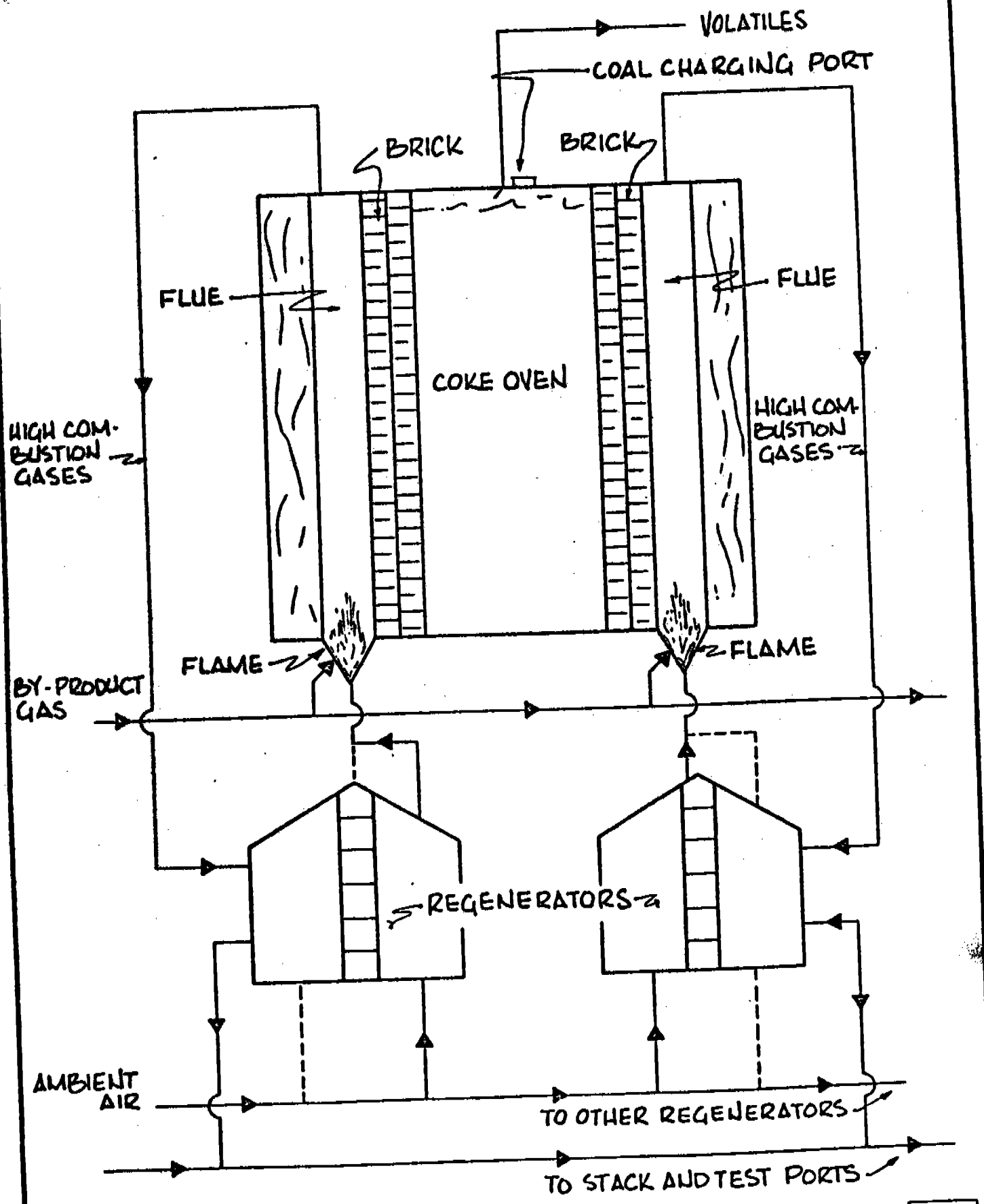


Figure 3-1
PROCESS FLOW DIAGRAM

Chapter 4

SAMPLING AND ANALYTICAL PROCEDURES

Sampling Location and Procedures

An EPA sampling train as described in the Air Pollution Control Office publication, APTD-0581, was used for collecting the particulate samples. Figure 4-1 shows a schematic of this sampling equipment.

Layout of the sampling ports in relation to flow disturbances for the stack is shown by Figure 4-2. Based on the stack diameter and the upstream and downstream distances of the sampling ports from the closest flow disturbances, the required number of sampling points according to Figure 1-1 and Method 1 of the August 18, 1977, Federal Register, Volume 42, was determined to be 44. Sampling was conducted through four ports at these 44 points for three minutes per point. Table 4-1 shows the dimensions from the stack wall to each sampling point as directed by the previously mentioned Federal Register.

Prior to the start of the first particulate sampling run, stack temperature was measured and a velocity traverse was made. Moisture was estimated based on previous sampling data. Using the above data, the nomograph was set up to utilize an appropriate size nozzle. Settings for the nomograph and the exact nozzle diameter are shown on the field data sheets (Appendix).

The particulate sampling procedures followed were as outlined by Method 5 from the previously mentioned Federal Register. Sampling data for each run is a part of the Appendix. Acceptable isokinetic sampling rates were achieved during all test runs as indicated by the data summary sheet of Chapter 2. Calculations for the isokinetic rates are also a part of the Appendix.

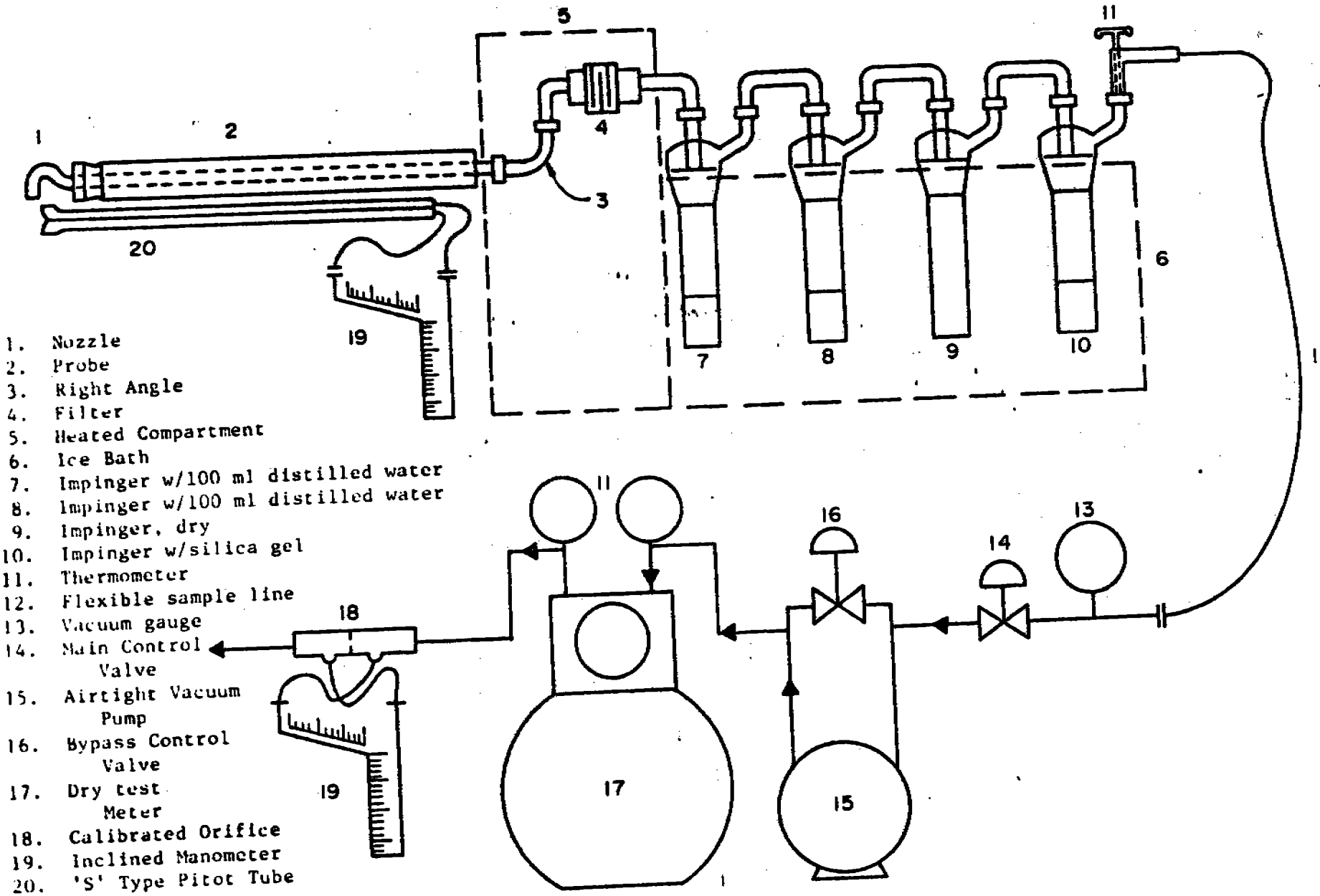


FIGURE 4-1. PARTICULATE SAMPLING TRAIN

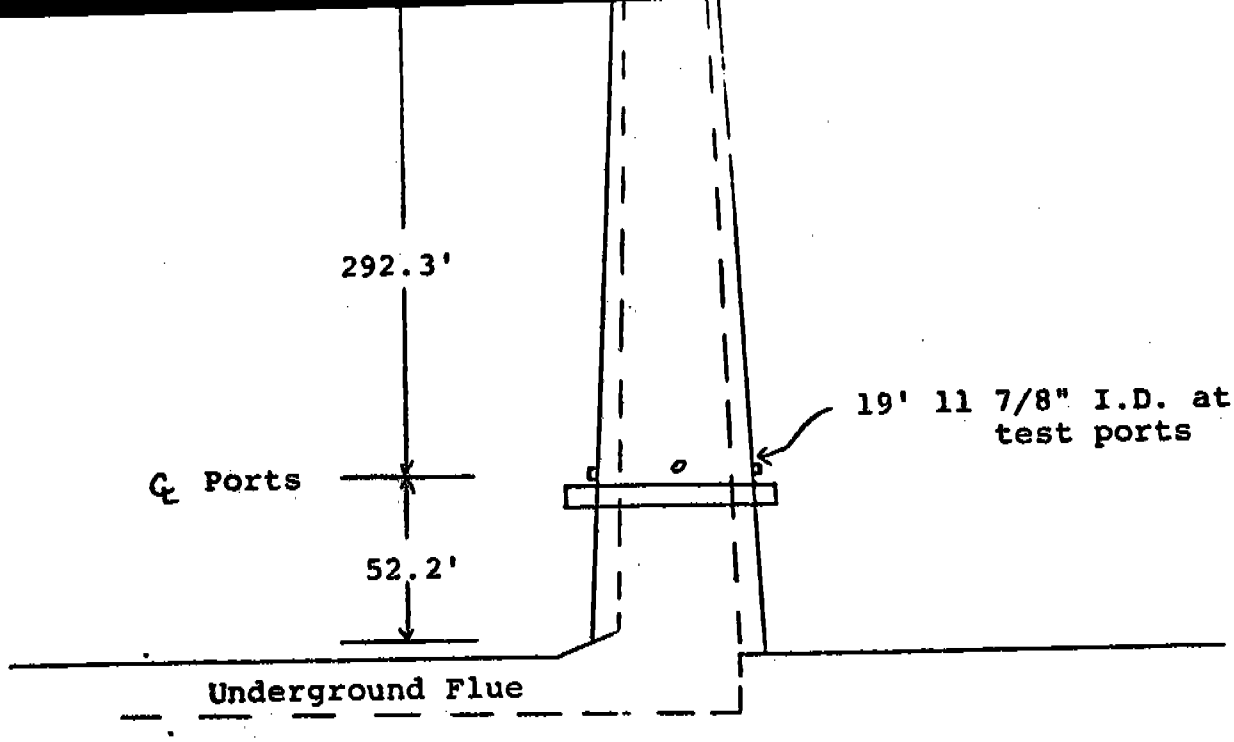


Figure 4-2
Location of Sampling Ports

Table 4-1
Location of Sampling Points

Point	% of Stack I.D.	x	Stack I.D. (Inches)	=	Distance to Sampling Point (Inches)
1	1.1		239.88		2.64
2	3.5		239.88		8.40
3	6.0		239.88		14.39
4	8.7		239.88		20.87
5	11.6		239.88		27.83
6	14.6		239.88		35.02
7	18.0		239.88		43.18
8	21.8		239.88		52.29
9	26.2		239.88		62.85
10	31.5		239.88		75.56
11	39.3		239.88		94.27
12	60.7		239.88		145.61
13	68.5		239.88		164.32
14	73.8		239.88		177.03
15	78.2		239.88		187.59
16	82.0		239.88		196.70
17	85.4		239.88		204.86
18	88.4		239.88		212.05
19	91.3		239.88		219.01
20	94.0		239.88		225.49
21	96.5		239.88		231.48
22	98.9		239.88		237.24

Analytical Procedures

Particulate sample recovery procedures were as outlined in Method 5 of the Federal Register. Acetone was used to wash down all parts of the sampling train prior to the glass fiber filter. A probe brush was utilized to ensure that the probe was properly cleansed following each run, and the nozzle was removed at the conclusion of each run and cleaned with a nozzle brush. Laboratory data for all runs are a part of the Appendix.

Using the field data taken during each sample run along with corresponding laboratory data, calculations were made to determine various exhaust gas parameters and particulate emissions. A summary of these is found in Chapter 2, Table 2-1. Calculation sheets showing all parameters used for each run are also a part of the Appendix. Fyrite readings taken during the study for calculating gas densities are shown on the field data sheets.

APPENDIX A

LAB DATA

CH2M HILL

MONTGOMERY OFFICE
807 SOUTH McDONOUGH STREET
MONTGOMERY, ALABAMA 36104
TELEPHONE 205/834-2870

Client U.S. STEEL
Date 10/15/79 Weighings By A. TODD
Sampling Location #2 COKE UNDERFIRE STAC
Remarks:

LABORATORY DATA

PARTICULATE SOURCE	RUN # 1			RUN # 2			RUN # 3			BLANKS		
	Final Wt (g)	Initial Wt (g)	Diff. (g)	Final Wt (g)	Initial Wt (g)	Diff. (g)	Final Wt (g)	Initial Wt (g)	Diff. (g)	Final Wt (g)	Initial Wt (g)	Diff (g)
PROBE & CYCLONE WASH	116.8380 g / 240 ml	D 116.7955	.0425	115.7739 / 117.0809 g / 350 ml	m-10 115.7285 / m-8 117.0651	.0312	117.9986 g / 250 ml	D 117.9592	.0394	106.1256 g / 200 ml	42 106.1242	.0014
FILTER	.5682	180 .4254	.1428	.5964	238 .4437	.1527	.6070	235 .4544	.1526			
IMPINGERS ACETONE WASH												
IMPINGERS H_2O												
	Gross Weight		.1853	Gross Weight		.1839	Gross Weight		.1920	Total Blank Wt.		.0007 / 100 ml
	Less Blank Wt.		.0017	Less Blank Wt.		.0025	Less Blank Wt.		.0018			
	Net Weight		.1836	Net Weight		.1814	Net Weight		.1902			

NOTE: The weight of the probe and cyclone wash blank for each sample is in direct proportion to the weight of the actual blank based on volume.

SILICA GEL	Final Wt (g)	Initial Wt (g)	Diff. (g)	Final Wt (g)	Initial Wt (g)	Diff. (g)	Final Wt (g)	Initial Wt (g)	Diff. (g)	Final Wt (g)	Initial Wt (g)	Di (g)

APPENDIX B

FIELD DATA AND CALCULATIONS

CH2M HILL

MO[illegible]MER [illegible]FICE
807 SOUTH McDONOUGH STREET
MONTGOMERY, ALABAMA 36104
205/834-2870

PLANT U.S. [illegible]EE
DATE 10/10/79 RUN NUMBER 1
TIME START [illegible]:12 TIME END 2:20 PM
MATERIAL PROCESSING RATE
SAMPLING LOCATION #2 COAL UNDERFIRE STACK
WEATHER P.C. & COOL
AMBIENT TEMP. 60 °F STACK PRESS. 29.40 "H
BAROMETRIC PRESS. 29.50 "Hg WET BULB °
DRY BULB °F MOISTURE
DEW POINT °F

TEST CONDUCTED BY: MORGAN / TODD

NOZZLE DIA. .625 in.
PITOT CORR. FACTOR .84
ORIFICE CORR. FACTOR 1.78
FILTER NUMBER
SILICA GEL NUMBER

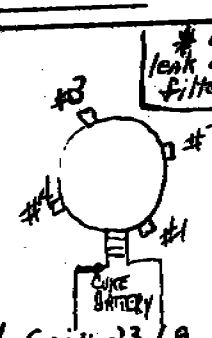
READING	GAS METER	IMPINGER COND.
FINAL	690.526	224
INITIAL	595.415	200
NET	95.111	224

ORSAT READING

% CO_2	4.0		
% O_2	10.5		
% CO			
% N_2			

REMARKS: Ts = 380, Tm = 65, %H_2O = 12, C = .85, ΔP = .022

SKETCH:
NOZZLE:
.625
.625
.624



* NOTE: Post leak checks from filter only / pre-checks showed probe leak free.

FINAL LEAK CHECK *
SAMPLE TRAIN AT 7 in.Hg
FINAL
INITIAL
LEAK 0 /min.
PITOT checked on 10" manometer prior to test. No leakage.
IMPACT at in.
STATIC at in.

Silica Gel Wt. Gain: 23.9
DIA. 239.88 in.
AREA 313.84 ft²

STACK INFORMATION
DISTANCE FROM DOWNSTREAM 52.2 ft
DISTURBANCE: UPSTREAM 292.3 ft

PORT # / POINT #	DISTANCE FROM PORT (in.)	TIME	GAS METER VOLUME (ft^3)	STACK VELOCITY HEAD-Δp (in. H_2O)	$\sqrt{\Delta p}$	ORIFICE VELOCITY HEAD-Δp (in. H_2O)	GAS METER TEMP. T_m (°F) INLET	GAS METER TEMP. T_m (°F) OUTLET	STACK TEMP.-T_s (°F)	IMPINGER TEMP. (°F)	BOX TEMP. (°F)	VACUUM (in. Hg)
2/1		0	595.4	.015	.122	1.25	50	51	370	55	250	4.0
2		3	597.3	.015	.122	1.25	52	51	373	55	250	4.0
3		6	599.2	.02	.141	1.70	55	51	373	50	270	5.0
4		9	601.5	.02	.141	1.70	58	51	377	50	270	5.0
5		12	603.7	.02	.141	1.70	62	51	382	50	270	5.0
6		15	606.0	.02	.141	1.70	62	52	383	50	270	5.0
7		3	608.2	.015	.122	1.25	64	52	368	50	260	4.0
8		6	610.2	.02	.141	1.70	63	52	368	50	275	5.0
9		9	612.6	.02	.141	1.70	65	52	369	50	270	5.0

PORT # / POINT #	DISTANCE FROM PORT (in.)	TIME	GAS METER VOLUME (ft^3)	STACK VELOCITY HEAD- p (in. H_2O)	$\sqrt{\Delta p}$	ORIFICE VELOCITY HEAD- H (in. H_2O)	GAS METER TEMP. T_m (°F) INLET	GAS METER TEMP. T_m (°F) OUTLET	STACK TEMP.-T_s (°F)	IMPINGER TEMP. (°F)	BOX TEMP. (°F)	VACUUM (in. Hg)
2/10	[illegible] 11:41 ON 11:45	12	614.7	.015	.122	1.25	66	50	370	50	270	4.0
11		15	616.6	.01	.100	0.84	62	53	370	50	250	3.0
1/1		12:09 0	618.1	.02	.141	1.70	58	53	370	50	245	4.5
2		3	620.3	.015	.122	1.25	58	54	370	50	250	4.0
3		6	622.4	.015	.122	1.25	60	54	370	50	250	4.0
4		9	624.3	.02	.141	1.70	62	54	372	50	260	5.0
5		12	626.5	.015	.122	1.25	64	54	372	50	260	4.0
6		15	628.5	.015	.122	1.25	65	54	370	50	260	4.0
7		3	630.4	.015	.122	1.25	67	55	370	50	265	4.0
8		6	632.4	.02	.141	1.70	66	55	370	50	265	5.0
9		9	634.6	.02	.141	1.70	69	56	370	50	265	5.0
10		12	636.9	.02	.141	1.70	69	56	375	50	270	5.0
11		15	639.1	.02	.141	1.70	70	56	375	50	270	5.0
4/1		12:59 0	641.3	.02	.141	1.70	60	56	377	50	250	4.5
2		3	643.5	.02	.141	1.70	64	57	378	50	250	5.0
3		6	645.8	.02	.141	1.70	66	58	379	50	260	5.0
4		9	648.0	.025	.158	2.10	70	58	369	50	275	6.0
5		12	650.5	.01	.100	0.84	72	59	370	55	275	3.0
6		15	652.2	.01	.100	0.84	73	60	377	55	275	3.0
7		3	653.8	.02	.141	1.70	76	60	377	55	270	5.0

PORT # / POINT #	DISTANCE FROM PORT (in.)	TIME	GAS METER VOLUME (ft^3)	STACK VELOCITY HEAD- P (in. H_2O)	$\sqrt{\Delta p}$	ORIFICE VELOCITY HEAD- H (in. H_2O)	GAS METER TEMP. T_m (°F)		STACK TEMP.-T_s (°F)	IMPINGER TEMP. (°F)	BOX TEMP. (°F)	VACUUM (in. Hg)
							INLET	OUTLET				
4/8		6	656.0	.025	.158	2.10	79	60	379	55	265	6.0
9		9	658.5	.03	.173	2.50	80	62	381	55	265	7.0
10		12	661.2	.025	.158	2.10	82	62	391	55	265	6.0
11		15	663.7	.025	.158	2.10	82	63	390	55	265	6.0
3/1		1:40	666.2	.015	.122	1.25	72	64	382	60	250	4.0
2		3	668.1	.02	.141	1.70	74	66	385	60	250	5.0
3		6	670.4	.015	.122	1.25	76	67	404	60	260	4.0
4		9	672.3	.02	.141	1.70	78	67	403	60	260	5.0
5		12	674.6	.02	.141	1.70	81	68	403	60	270	5.0
6		15	676.9	.015	.122	1.25	82	69	403	60	270	4.0
7		3	678.8	.025	.158	2.10	84	69	395	60	275	6.0
8		6	681.3	.025	.158	2.10	84	70	395	60	270	6.0
9		9	683.8	.02	.141	1.70	86	70	375	60	270	5.0
10		12	686.1	.02	.141	1.70	86	71	385	60	270	5.0
11		15	688.3	.02	.141	1.70	86	72	385	60	270	5.0
				AVG.	.136	1.59		64	379			

PARTICULATE EMISSION DATA CALCULATION SHEET

CH2M HILL
MONTGOMERY OFFICE
807 SOUTH McDONOUGH STREET
MONTGOMERY, ALABAMA 36104
205/834-2870

Plant U.S. STEEL

Date 10/10/79 Run # 1

Sampling Location #2 COKE UNDERFIRE STACK

Sampling Data

$\bar{T}_s$ = 839 °R; $\bar{T}_m$ = 524 °R

C_p = .84; $(\overline{\sqrt{\Delta p}})_{avg}$ = .136

P_s = 29.40 in. Hg; M_s = 28.15 g/g-mole

A_s = 313.84 sq. ft.; V_m = 95.111 cu. ft.

H_2O (condensate) = 224 mls

H_2O (silica gel) = 23.1 gms

ΔH_{avg} = 1.59 in H_2O; P_b = 29.5 in Hg

Total particulate = .1836 grams

1. Calculate Stack gas velocity--

$$V_s = 85.48\ C_p\ (\sqrt{\Delta p})_{avg} \sqrt{\frac{T_s}{P_s M_s}}$$

$$V_s = 85.48\ (.84)\ (.136) \sqrt{\frac{839}{(29.4)(28.15)}}$$

V_s = 9.83 fps

2. Calculate volume of water vapor in gas sample--

$$V_{wstd} = (0.0474) \begin{pmatrix} \text{mls } H_2O \\ \text{condensate} \end{pmatrix} + \begin{pmatrix} \text{grams } H_2O \\ \text{silica gel} \end{pmatrix}$$

$$V_{wstd} = (0.0474)(224 + 23.1) = (0.0474)\ (247.10) = 11.71 \text{ cu.ft.}$$

3. Calculate gas sample volume at standard conditions--

$$V_{mstd} = (17.71)(V_m) \left(\frac{P_b + \frac{\Delta H}{13.6}}{T_m} \right)$$

$$V_{mstd} = (17.71)(95.111) \left(\frac{29.50 + \frac{1.59}{13.6}}{524} \right) = (1684.416)(.057) = 95.21 \text{ cu.ft.}$$

4. Calculate percent moisture in gas stream--

$$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}} = \frac{11.71}{95.21 + 11.71} = 0.110 = 11.0\%$$

5. Calculate stack gas volumetric flow rate, dry basis, std. conditions--

$$Q_{stpd} = 3600(1-B_{wo})V_s A_s \frac{530}{T_s} \frac{P_s}{29.92}$$

$$Q_{stpd} = 3600\ (1-.11)\ (9.83)\ (313.84)\ (530/839)\ (29.40/29.92) = 6,135,557 \text{ cu.ft.}$$

6. Calculate grain loading--

grains/sdcf = (15.43)(grams)/V_{mstd} = (15.43)(.1836)/(95.21) = .0298

7. Calculate mass emission rate--

$$\text{lbs/hr} = (\text{grains/stdcf})(Q_{stpd})(1.43 \times 10^{-4})$$

$$\text{lbs/hr} = (.0298)(6,135,557)(1.43 \times 10^{-4}) = 26.1$$

MONTGOMERY OFFICE

807 SOUTH McDONOUGH STREET
MONTGOMERY, ALABAMA 36104
205/834-2870

Client U S STEEL

Date 10/10/79 Run # 1

Sampling Location #2 COKE UNDERFIRE STACK

CALCULATION OF STACK GAS MOLECULAR WEIGHT (M_s)

Moisture Content = 11.0 %

Average Orsat Analysis (dry)

$\%CO_2$ = 5

$\%O_2$ = 11

%CO = —

$\%N_2$ = 84

Component	% Vol/100	X	Moisture Correction	X	Molecular Weight	=	Wt./Mole (wet base)
H_2O	.110	x	1.0	x	18.0	=	1.980
CO_2	.05	x	.89	x	44.0	=	1.958
O_2	.11	x	.89	x	32.0	=	3.133
CO	—	x		x	28.0	=	—
N_2	.84	x	.89	x	28.2	=	21.082

Average Molecular Wt., wet basis (M_s) = 28.15 lb/lb-mol

Density of gas referred to air = 28.95 =

Gas density correction factor = $\sqrt{1.00}$ = $\sqrt{}$ =

MONTGOMERY OFFICE

807 SOUTH McDONOUGH STREET
MONTGOMERY, ALABAMA 36104
205/834-2870

Client U.S. STEEL

Date 10/10/79 Run# 1

Sampling Location #2 COKE UNDERFIRE STACK

CALCULATION OF ISOKINETIC RATE

$$I = T_s \left(1.667 \frac{\text{min}}{\text{sec}}\right) \frac{\left[\left(0.00267 \frac{\text{in. Hg-cu.ft.}}{\text{ml} - {}^\circ\text{R}}\right) V_l + \frac{V_m}{T_m}\left(P_{bar} + \frac{\Delta H}{13.6}\right)\right]}{\theta V_s P_s A_n}$$

Where I = % of isokinetic sampling

T_s = Avg. stack temperature = 839 °R

V_l = Total volume of liquid collected in impingers & silica gel = 247.1 ml

V_m = Gas sample thru dry gas meter @ meter conditions = 95.111 cu.ft.

T_m = Average dry gas meter temperature = 524 °R

P_{bar} = Barometric pressure @ sampling site = 29.5 in.Hg

ΔH = Average pressure drop across orifice = 1.59 in.H_2O

θ = Total sampling time = 132 min.

V_s = Stack gas velocity = 9.83 fps

P_s = Stack gas pressure = 29.40 in.Hg

A_n = Cross-sectional area of nozzle = .00213 sq.ft.

$$I = \frac{(839)(1.667)\left[(0.00267)(247.1) + \frac{95.111}{524}\left(29.5 + \frac{1.59}{13.6}\right)\right]}{(132)(9.83)(29.40)(.00213)}$$

$$I = \frac{(1398.61)\left[(0.66) + (0.19)(29.62)\right]}{(81.256)}$$

$$I = \frac{(1398.61)(0.66 + 5.38)}{(81.256)} = \frac{(1398.61)(6.04)}{(81.256)} = \frac{8441.34}{81.256}$$

I = 103.9 = 104 % of isokinetic sampling

CH2M HILL

MONTGOMERY, ALABAMA

807 SOUTH McDONOUGH STREET
MONTGOMERY, ALABAMA 36104
205/834-2870

PLANT U.S. STEEL
DATE 10/10/79 RUN NUMBER 2
TIME START 3:56 TIME END 6:40
MATERIAL PROCESSING RATE
SAMPLING LOCATION #2 CURE UNDERFIRE STACK
WEATHER
AMBIENT TEMP. 83 °F STACK PRESS. (-1.4"H2O) 29.40 "Hg
BAROMETRIC PRESS. 29.5 "Hg WET BULB
DRY BULB °F MOISTURE
DEW POINT °F

TEST CONDUCTED BY: MORGAN / TODD

NOZZLE DIA. .625 in. FILTER NUMBER
PITOT CORR. FACTOR .84 SILICA GEL NUMBER
ORIFICE CORR. FACTOR 1.78

READING	GAS METER	IMPINGER COND.
FINAL	789.456	430
INITIAL	690.615	200
NET	98.841	230

ORSAT READING

% CO_2			
% O_2			
% CO			
% N_2			

REMARKS: Ts = 380, Tm = 88, %H2O = 11, C = 0.90, ∝ = .021

SKETCH:

NOZZLE:
.625
.624
.625
.625

Silica Gel Wt. Gain: 31.4g

DIA. 239.88 in.
AREA 313.84 ft²

FINAL LEAK CHECK
SAMPLE TRAIN AT 7.0 in.Hg
FINAL
INITIAL
LEAK 0.002 /min.
PITOT
IMPACT at in.
STATIC at in.

STACK INFORMATION
DISTANCE FROM DOWNSTREAM 52.2 ft
DISTURBANCE: UPSTREAM 292.3 ft

PORT # / POINT #	DISTANCE FROM PORT (in.)	TIME	GAS METER VOLUME (ft^3)	STACK VELOCITY HEAD-Δp (in. H_2O)	$\sqrt{\Delta p}$	ORIFICE VELOCITY HEAD-Δp (in. H_2O)	GAS METER TEMP. T_m (°F) INLET	GAS METER TEMP. T_m (°F) OUTLET	STACK TEMP.-T_s (°F)	IMPINGER TEMP. (°F)	BOX TEMP. (°F)	VACUUM (in. Hg)
3/1		0	690.6	.075	.158	2.20	73	74	377	65	255	4.0
2		3	693.1	.02	.141	1.80	73	74	380	55	260	3.5
3		6	695.4	.02	.141	1.80	73	74	380	55	270	4.0
4		9	697.8	.025	.158	2.20	75	74	380	55	270	4.0
5		12	700.3	.025	.158	2.20	78	74	380	55	270	5.0
6		15	702.9	.03	.173	2.65	80	74	387	55	265	5.0
7		3	705.7	.03	.173	2.65	81	74	387	55	265	5.0
8		6	708.5	.03	.173	2.65	82	74	389	55	265	5.0
1		9	711.2	.03	.173	2.65	83	74	385	60	265	5.0

POINT # / PORT #	DISTANCE FROM PORT (in.)	TIME	GAS METER VOLUME (ft^3)	STACK VELOCITY HEAD- P (in. H_2O)	$\sqrt{\Delta p}$	ORIFICE VELOCITY HEAD- H (in. H_2O)	GAS METER TEMP. T_m (°F)		STACK TEMP.- T_s (°F)	IMPINGER TEMP. (°F)	BOX TEMP. (°F)	VACUUM (in. Hg)
							INLET	OUTLET				
3/10		12	714.1	.03	.173	2.65	84	74	380	60	270	5.0
11		15	716.8	.025	.158	2.20	84	74	380	60	270	4.5
4/1		4:30	719.4	.03	.173	2.65	78	74	390	65	275	4.5
2		3	722.1	.03	.173	2.65	78	74	390	65	255	4.5
3		6	724.9	.025	.158	2.20	78	74	390	65	260	4.5
4		9	727.6	.025	.158	2.20	80	74	380	65	260	4.5
5		12	730.0	.025	.158	2.20	80	74	365	65	265	4.5
6		15	732.6	.025	.158	2.20	82	74	365	65	270	4.5
7		3	735.1	.03	.173	2.65	83	74	368	65	270	5.0
8		6	737.9	.03	.173	2.65	84	74	365	65	275	5.0
9		9	740.7	.02	.141	1.80	84	74	360	65	275	4.0
10		12	743.1	.02	.141	1.80	84	74	360	65	275	4.0
11		15	745.5	.02	.141	1.80	84	74	360	65	275	4.0
1/1		5:31:0	747.6	.015	.122	1.30	75	72	380	50	250	3.0
2		3	749.6	.02	.141	1.80	74	72	380	50	250	4.0
3		6	752.0	.02	.141	1.80	74	72	380	50	260	4.0
4		9	754.2	.015	.122	1.30	76	72	380	50	260	3.0
5		12	756.2	.01	.100	0.89	77	72	350	50	260	2.5
6		15	757.9	.01	.100	0.89	78	71	350	50	270	2.5
7		3	759.5	.01	.100	0.89	78	71	350	50	270	2.5

POINT # / POINT #	DISTANCE FROM POINT (in.)	TIME	GAS METER VOLUME (ft^3)	STACK VELOCITY HEAD- p ($in.\ H_2O$)	$\sqrt{\Delta p}$	ORIFICE VELOCITY HEAD- H ($in.\ H_2O$)	GAS METER TEMP. T_m (°F)		STACK TEMP.-T_s (°F)	IMPINGER TEMP. (°F)	BOX TEMP. (°F)	VAGUUM (in. Hg)
							INLET	OUTLET				
1/8		6	761.2	.02	.141	1.80	78	70	360	65	255	4.0
9		9	763.5	.02	.141	1.80	80	70	380	55	255	4.0
10		12	765.8	.015	.122	1.30	79	70	380	55	255	4.0
11		15	768.1	.01	.100	0.89	78	70	380	55	255	2.5
2/1		6	769.8	.015	.122	1.30	75	68	380	55	260	3.0
2		3	771.7	.015	.122	1.30	75	68	380	55	260	3.0
3		6	773.7	.015	.122	1.30	75	68	380	55	260	3.0
4		9	775.7	.01	.100	0.89	74	68	360	55	260	3.0
5		12	777.4	.01	.100	0.89	74	68	360	55	270	2.5
6		15	778.9	.01	.100	0.89	74	68	370	55	270	2.5
7		3	780.6	.01	.100	0.89	74	66	370	55	270	2.5
8		6	782.2	.01	.100	0.89	74	66	370	55	265	2.5
9		9	784.0	.015	.122	~~1.30~~ 0.89	74	66	370	55	265	2.5
10		12	785.5	.015	.122	1.30	74	66	375	55	265	3.0
11		15	787.5	.015	.122	1.30	74	66	380	55	265	3.0
				AVG.	.138	1.75	73		373			

PARTICULATE EMISSION DATA CALCULATION SHEET

CH2M HILL
MONTGOMERY OFFICE
807 SOUTH McDONOUGH STREET
MONTGOMERY, ALABAMA 36104
205/834-2870

Plant U.S. STEEL

Date 10/10/79 Run # 2

Sampling Location #2 COKE UNDERFIRE STACK

Sampling Data

$\bar{T}_s$ = 833 °R; $\bar{T}_m$ = 533 °R

C_p = .84; $(\sqrt{\Delta p})_{avg}$ = .138

P_s = 29.4 in.Hg; M_s = 28.12 g/g-mole

A_n = 313.84 sq.ft.; V_m = 98.841 cu.ft.

H_2O (condensate) = 230 mls

H_2O (silica gel) = 31.4 gms

ΔH_{avg} = 1.75 in H_2O; P_b = 29.50 in Hg

Total particulate = .1814 grams

1. Calculate Stack gas velocity--

$$V_s = 85.48\ C_p\ (\sqrt{\Delta p})_{avg} \sqrt{\frac{T_s}{P_s M_s}}$$

$$V_s = 85.48\ (.84)\ (.138) \sqrt{\frac{833}{(29.4)(28.12)}}$$

V_s = 9.95 fps

2. Calculate volume of water vapor in gas sample--

$$V_{wstd} = (0.0474)\ \begin{pmatrix} \text{mls } H_2O \\ \text{condensate} \end{pmatrix} + \begin{pmatrix} \text{grams } H_2O \\ \text{silica gel} \end{pmatrix}$$

$$V_{wstd} = (0.0474)(230 + 31.4) = (0.0474)\ (261.4) = 12.39 \text{ cu.ft.}$$

3. Calculate gas sample volume at standard conditions--

$$V_{mstd} = (17.71)(V_m)\left(\frac{P_b + \frac{\Delta H}{13.6}}{T_m}\right)$$

$$V_{mstd} = (17.71)(98.841)\left(\frac{29.50 + \frac{1.75}{13.6}}{533}\right) = (1750.47)(.056) = 97.31 \text{ cu.ft.}$$

4. Calculate percent moisture in gas stream--

$$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}} = \frac{12.39}{97.31 + 12.39} = 0.113 = 11.3\%$$

5. Calculate stack gas volumetric flow rate, dry basis, std. conditions--

$$Q_{stpd} = 3600(1-B_{wo})V_s A_s \frac{530}{T_s} \frac{P_s}{29.92}$$

$$Q_{stpd} = 3600\ (1-.113)\ (9.95)\ (313.84)\ (530/833)\ (29.40/29.92) = 6,234,105 \text{ cu.ft.}$$

6. Calculate grain loading--

grains/sdcf = (15.43)(grams)/V_{mstd} = (15.43)(.1814)/(97.31) = .0288

7. Calculate mass emission rate--

lbs/hr = (grains/stdcf)$(Q_{stpd})(1.43 \times 10^{-4})$

lbs/hr = (.0288)(6,234,105)(1.43×10^{-4}) = 25.7

CH2M HILL
MONTGOMERY OFFICE
807 SOUTH McDONOUGH STREET
MONTGOMERY, ALABAMA 36104
205/834-2870

Client U.S. STEEL

Date 10/10/79 Run # 2

Sampling Location

#2 COKE UNDERFIRE STACK

CALCULATION OF STACK GAS MOLECULAR WEIGHT (M_s)

Moisture Content = 11.3 %

Average Orsat Analysis (dry)

$\%CO_2$ = 5

$\%O_2$ = 11

%CO = —

$\%N_2$ = 84

Component	% Vol/100	X	Moisture Correction	X	Molecular Weight	=	Wt./Mole (wet base)
H_2O	.113	x	1.0	x	18.0	=	2.034
CO_2	.05	x	.887	x	44.0	=	1.951
O_2	.11	x	.887	x	32.0	=	3.122
CO	—	x		x	28.0	=	—
N_2	.84	x	.887	x	28.2	=	21.011

Average Molecular Wt., wet basis (M_s) = 28.12 lb/lb-mole

Density of gas referred to air = $\frac{28.95}{}$ =

Gas density correction factor = $\sqrt{\frac{1.00}{}}$ = $\sqrt{}$ =

MONTGOMERY OFFICE

807 SOUTH McDONOUGH STREET
MONTGOMERY, ALABAMA 36104
205/834-2870

Client U.S. STEEL

Date 10/10/79 Run# 2

Sampling Location

#2 COKE UNDERFIRE STACK

CALCULATION OF ISOKINETIC RATE

$$I = T_s \left(1.667 \frac{\text{min}}{\text{sec}}\right) \frac{\left[\left(0.00267 \frac{\text{in. Hg-cu.ft.}}{\text{ml} - {}^\circ\text{R}}\right) V_l + \frac{V_m}{T_m}\left(P_{bar} + \frac{\Delta H}{13.6}\right)\right]}{\Theta V_s P_s A_n}$$

Where I = % of isokinetic sampling T_s = Avg. stack temperature = 833 °R

V_l = Total volume of liquid collected in impingers & silica gel = 261.4 ml

V_m = Gas sample thru dry gas meter @ meter conditions = 98.841 cu.ft.

T_m = Average dry gas meter temperature = 533 °R

P_{bar} = Barometric pressure @ sampling site = 29.50 in.Hg

ΔH = Average pressure drop across orifice = 1.75 in.H_2O

Θ = Total sampling time = 132 min.

V_s = Stack gas velocity = 9.95 fps

P_s = Stack gas pressure = 29.40 in.Hg

A_n = Cross-sectional area of nozzle = .00213 sq.ft.

$$I = \frac{(833)(1.667)\left[(0.00267)(261.4) + \frac{98.841}{533}\left(29.50 + \frac{1.75}{13.6}\right)\right]}{(132)(9.95)(29.40)(.00213)}$$

$$I = \frac{(1388.61)\left[(.70) + (0.185)(29.63)\right]}{(82.25)}$$

$$I = \frac{(1388.61)[.70 + 5.49]}{(82.25)} = \frac{(1388.61)[6.19]}{(82.25)} = \frac{8598.78}{82.25}$$

I= 104.5 = 105 % of isokinetic sampling

MONTGOMERY OFFICE

CH2M HILL

807 SOUTH McDONOUGH STREET
MONTGOMERY, ALABAMA 36104
205/834-2870

PLANT U.S. STEEL
DATE 10/11/79 RUN NUMBER 3
TIME START 8:47 AM TIME END 11:51
MATERIAL PROCESSING RATE
SAMPLING LOCATION #2 COKE UNDERFIRE STACK
WEATHER COOL, CLEAR, CRISP
AMBIENT TEMP. 55 °F STACK PRESS. 29.30 "Hg
BAROMETRIC PRESS. 29.40 "Hg WET BULB °F
DRY BULB °F MOISTURE %
DEW POINT °F

TEST CONDUCTED BY: McRight / TODD

NOZZLE DIA. .625 in.
PITOT CORR. FACTOR .84
ORIFICE CORR. FACTOR 1.75

FILTER NUMBER
SILICA GEL NUMBER

READING	GAS METER	IMPINGER COND.
FINAL	886.592	445
INITIAL	790.057	200
NET	96.535	245

ORSAT READING

CO_2	~~0.5~~	5.5	
O_2	11.5		
CO			
N_2			

REMARKS: T_s=380, T_m=65, %H_2O=14 C_p=.87 ΔH=.022

SKETCH:

NOZZLE:
.625
.623
.625
.626

Silica Gel wt Gain: 21.9 g

DIA. 239.88 in.
AREA 3/3.84 ft²

FINAL LEAK CHECK
SAMPLE TRAIN AT 6 in.Hg
FINAL
INITIAL
LEAK 0 /min.
PITOT
IMPACT at in.
STATIC at in.

STACK INFORMATION
DISTANCE FROM DOWNSTREAM 52.2 ft.
DISTURBANCE: UPSTREAM 292.3 ft.

PORT # / POINT #	DISTANCE FROM PORT (in.)	TIME	GAS METER VOLUME (ft^3)	STACK VELOCITY HEAD-Δp (in. H_2O)	$\sqrt{\Delta p}$	ORIFICE VELOCITY HEAD-Δp (in. H_2O)	GAS METER TEMP. T_m (°F) INLET	GAS METER TEMP. T_m (°F) OUTLET	STACK TEMP.-T_s (°F)	IMPINGER TEMP. (°F)	BOX TEMP. (°F)	VACUUM (in. Hg)
1/1		0	790.0	.03	.173	2.55	52	50	374	45	245	6.0
2		3	792.7	.015	.122	1.30	54	50	374	45	245	3.5
3		6	794.8	.015	.122	1.30	57	51	373	45	260	3.5
4		9	796.8	.018	.134	1.55	59	51	373	45	250	4.0
5		12	798.8	.025	.158	2.15	62	51	375	45	250	5.5
6		15	801.3	.018	.134	1.55	64	51	375	45	250	4.5
7		3	803.4	.02	.141	1.75	64	52	375	45	255	4.5
8		6	805.7	.015	.122	1.30	66	52	375	45	255	4.0
9		9	807.7	.02	.141	1.75	67	52	377	45	255	4.5

POINT # / POINT #	DISTANCE FROM POINT (in.)	TIME	GAS METER VOLUME (ft^3)	STACK VELOCITY HEAD- P (in. H_2O)	$\sqrt{\Delta p}$	ORIFICE VELOCITY HEAD- H (in. H_2O)	GAS METER TEMP. T_m (°F)		STACK TEMP.-T_s (°F)	IMPINGER TEMP. (°F)	BOX TEMP. (°F)	VACUUM (in. Hg)
							INLET	OUTLET				
1/10		12	809.9	.02	.141	1.75	68	52	381	45	260	4.5
11		15	812.1	.02	.141	1.75	68	53	380	45	260	4.5
2/1		9:34 6	814.4	.02	.141	1.75	60	54	368	50	245	4.5
2		3	816.6	.02	.141	1.75	60	54	370	50	250	4.5
3		6	818.9	.02	.141	1.75	62	54	372	50	255	4.5
4		9	821.2	.02	.141	1.75	64	53	375	50	255	4.5
5		12	823.4	.02	.141	1.75	66	55	376	50	255	4.5
6		15	8256	.015	.122	1.30	67	55	371	50	250	4.0
7		3	827.7	.015	.122	1.30	68	56	376	50	250	4.0
8		6	829.6	.018	.134	1.55	69	56	380	50	245	4.0
9		9	831.7	.022	.148	1.90	70	56	381	50	255	5.0
10		12	834.1	.02	.141	1.75	70	57	381	50	255	4.5
11		15	836.3	.015	.122	1.30	69	57	383	50	255	4.0
3/1		10:21 0	838.3	.02	.141	1.75	62	59	361	55	260	4.5
2		3	840.6	.02	.141	1.75	63	59	370	55	260	4.5
3		6	842.9	.02	.141	1.75	64	59	373	55	255	4.5
4		9	845.1	0.02	.141	1.75	67	59	375	55	250	4.5
5		12	847.3	0.015	.122	1.30	69	60	380	55	245	4.0
6		15	849.3	0.015	.122	1.30	70	60	384	55	260	4.0
7		3	851.3	0.010	.100	0.85	70	60	388	55	260	3.0
8		6	852.9	0.015	.122	1.30	71	60	370	55	245	4.0

Ru[illegible]-a

PORT # / POINT #	DISTANCE FROM PORT (in.)	TIME	GAS METER VOLUME (ft^3)	STACK VELOCITY HEAD- p (in. H_2O)	$\sqrt{\Delta p}$	ORIFICE VELOCITY HEAD- H (in. H_2O)	GAS METER TEMP. T_m (°F) INLET	GAS METER TEMP. T_m (°F) OUTLET	STACK TEMP.-T_s (°F)	IMPINGER TEMP. (°F)	BOX TEMP. (°F)	VACUUM (in. Hg)
3/9		9	854.8	0.020	.141	1.75	72	61	378	55	260	4.8
10		12	857.1	0.020	.141	1.75	73	61	374	55	250	4.8
11		15	859.3	0.020	.141	1.75	73	62	375	55	250	4.8
4/1		0	861.6	0.020	.141	1.75	66	62	375	55	250	4.8
2		3	863.8	0.020	.141	1.75	66	62	378	55	240	4.8
3		6	866.1	.02	.141	1.75	66	63	380	55	245	4.5
4		9	868.5	.02	.141	1.75	66	63	380	55	245	4.5
5		12	870.5	.015	.122	1.30	68	63	380	50	250	4.5
6		15	872.6	.02	.141	1.75	69	63	378	50	245	4.5
7		3	874.8	.02	.141	1.75	70	63	370	50	250	4.5
8		6	877.2	.02	.141	1.75	70	63	370	50	250	4.5
9		9	879.3	.025	.158	2.10	71	63	378	50	25	5.5
10		12	881.8	.025	.158	2.10	71	63	378	50	250	5.5
11		15	884.3	.02	.141	1.75	72	63	375	50	250	5.0
				AVG	.138	1.66	62		376			

PARTICULATE EMISSION DATA CALCULATION SHEET

CH2M HILL
MONTGOMERY OFFICE
807 SOUTH McDONOUGH STREET
MONTGOMERY, ALABAMA 36104
205/834-2870

Plant 11 S STEEL

Date 10/11/79 Run # 3

Sampling Location #2 COKE UNDERFIRE STACK

Sampling Data
T_s = 836 °R; T_m = 522 °R
C_p = .84; $(\sqrt{\Delta p})_{avg}$ = .138
P_g = 29.3 in.Hg; M_s = 28.69 #/#-mole
A_s = 313.84 sq.ft.; V_m = 96.535 cu.ft.
H_2O (condensate) = 245 mls
H_2O (silica gel) = 21.9 gms
ΔH_{avg} = 1.66 in H_2O; P_b = 29.4 in Hg
Total particulate = .1902 grams

1. Calculate Stack gas velocity--

$$V_s = 85.48\ C_p\ (\sqrt{\Delta p})_{avg} \sqrt{\frac{T_s}{P_s M_s}}$$

$$V_s = 85.48\ (.84)(.138)\sqrt{\frac{836}{(29.3)(28.69)}}$$

V_s = 9.99 fps

2. Calculate volume of water vapor in gas sample--

$$V_{wstd} = (0.0474)\begin{pmatrix}\text{mls } H_2O \\ \text{condensate}\end{pmatrix} + \begin{pmatrix}\text{grams } H_2O \\ \text{silica gel}\end{pmatrix}$$

$$V_{wstd} = (0.0474)(245 + 21.9) = (0.0474)(266.9) = 12.65 \text{ cu.ft.}$$

3. Calculate gas sample volume at standard conditions--

$$V_{mstd} = (17.71)(V_m)\left(\frac{P_b + \frac{\Delta H}{13.6}}{T_m}\right)$$

$$V_{mstd} = (17.71)(96.535)\left(\frac{29.4 + \frac{1.66}{13.6}}{522}\right) = (1709635)(.057) = 96.69 \text{ cu.ft.}$$

4. Calculate percent moisture in gas stream--

$$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}} = \frac{12.65}{96.69 + 12.65} = 0.116 = 11.6\%$$

5. Calculate stack gas volumetric flow rate, dry basis, std. conditions--

$$Q_{stpd} = 3600(1-B_{wo})V_s A_s \frac{530}{T_s} \frac{P_s}{29.92}$$

$$Q_{stpd} = 3600\ (1-.116)(9.99)(313.84)(530/836)(29.3/29.92) = 6,194,470 \text{ cu.ft.}$$

6. Calculate grain loading--

grains/sdcf = (15.43)(grams)/V_{mstd} = (15.43)(.1902)/(96.69) = .0304

7. Calculate mass emission rate--

$$lbs/hr = (grains/stdcf)(Q_{stpd})(1.43 \times 10^{-4})$$

$$lbs/hr = (.0304)(6,194,470)(1.43 \times 10^{-4}) = 26.9$$

MONTGOMERY OFFICE

807 SOUTH McDONOUGH STREET
MONTGOMERY, ALABAMA 36104
205/834-2870

Client U S STEEL

Date 10/11/79 Run # 3

Sampling Location #2 COKE

CALCULATION OF STACK GAS MOLECULAR WEIGHT (M_s)

Average Orsat Analysis (dry)

Moisture Content = 11.6 %

$\%CO_2$ = 5

$\%O_2$ = 11

%CO = —

$\%N_2$ = 84

Component	% Vol/100	X	Moisture Correction	X	Molecular Weight	=	Wt./Mole (wet base)
H_2O	.116	x	1.0	x	18.0	=	2.088
CO_2	.05	x	.884	x	44.0	=	1.945
O_2	.11	x	.884	x	32.0	=	3.112
CO	—	x		x	28.0	=	—
N_2	.84	x	.884	x	28.2	=	20.940

Average Molecular Wt., wet basis (M_s) = 28.09 lb/lb-mole

Density of gas referred to air = $\overline{28.95}$ =

Gas density correction factor = $\sqrt{\overline{1.00}}$ = $\sqrt{\quad}$ =

APPENDIX C

CALIBRATIONS

MONTGOMERY OFFICE

807 SOUTH McDONOUGH STREET
MONTGOMERY, ALABAMA 36104
205/834-2870

Client U.S. STEEL

Date 10/11/79 Run# 3

Sampling Location

#2 COKE

CALCULATION OF ISOKINETIC RATE

$$I = T_s \left(1.667 \frac{\text{min}}{\text{sec}}\right) \frac{\left[\left(0.00267 \frac{\text{in. Hg-cu.ft.}}{\text{ml} - {}^\circ\text{R}}\right) V_l + \frac{V_m}{T_m}\left(P_{bar} + \frac{\Delta H}{13.6}\right)\right]}{\theta V_s P_s A_n}$$

Where I = % of isokinetic sampling T_s = Avg. stack temperature = 836 °R

V_l = Total volume of liquid collected in impingers & silica gel = 266.9 ml

V_m = Gas sample thru dry gas meter @ meter conditions = 96.535 cu.ft.

T_m = Average dry gas meter temperature = 522 °R

P_{bar} = Barometric pressure @ sampling site = 29.4 in.Hg

ΔH = Average pressure drop across orifice = 1.66 in.H_2O

θ = Total sampling time = 132 min.

V_s = Stack gas velocity = 9.99 fps

P_s = Stack gas pressure = 29.30 in.Hg

A_n = Cross-sectional area of nozzle = .00213 sq.ft.

$$I = \frac{(836)(1.667)\left[(0.00267)(266.9) + \frac{96.535}{522}\left(29.4 + \frac{1.66}{13.6}\right)\right]}{(132)(9.99)(29.30)(.00213)}$$

$$I = \frac{(1393.61)\left[(0.71) + (0.18)(29.52)\right]}{(82.30)}$$

$$I = \frac{(1393.61)(0.71 + 5.46)}{(82.30)} = \frac{(1393.61)(6.17)}{(82.30)} = \frac{8601.69}{82.30}$$

I= 104.5 = 105 % of isokinetic sampling

EXAMPLE

METER CALIBRATION FORM

Date 6/28/79 Box No. 2

P_{bar} = 29.85 in. Hg Calibrated by A. TODD

Orifice Manometer Setting ΔH (in. H_2O)	Δ wtm (in. H_2O)	Gas Volume Wet Test Meter Initial	Gas Volume Wet Test Meter Final	Gas Volume Dry Gas Meter Initial	Gas Volume Dry Gas Meter Final	Temperature Wet Test Meter Initial	Temperature Wet Test Meter Final	Avg. Temp. Dry Gas Meter Inlet	Avg. Temp. Dry Gas Meter Outlet
0.5	0.8	0	7	588.709	595.704	86	85	91	90
1.0	1.0	0	9	579.363	588.377	86	86	88	91
1.5	1.4	0	10	~~542.306~~ ~~541.941~~	552.320	91	90	89	94
2.0	1.4	0	12	552.320	564.300	90	87	94	95
3.0	1.7	0	14	564.905	578.877	87	~~87~~ 86	80	88

Pump must be operated for at least 15 minutes at each ΔH setting (.5, 1, 1.5, 2 and 3)

T_{dgm} = average temperature of dry gas meter (inlet and outlet) + 460°F

T_{wtm} = average temperature of wet test meter + 460°F

$P_{wtm} = P_{bar} - \frac{\Delta wtm}{13.6}$

MCF = 1.00

$P_{dgm} = P_{bar} + \frac{\Delta H}{13.6}$

Δwtm = pressure on wet test meter in inches of H_2O

Y = meter calibration factor

28.316 = conversion factor when using a wet test meter calibrated in liters

Calculations

$$Y = \frac{(\text{wet final} - \text{wet initial})(T_{dgm})(P_{wtm})}{(\text{dry final} - \text{dry initial})(28.316)(T_{wtm})(P_{dgm})} \quad \text{or (1)}$$

$$\bar{Y} = \frac{\Sigma Y}{5} = \frac{4.985}{5} = 0.997$$

Meter Tolerance = 1.00 ± 0.01

If the meter calibration factor is not within the allowable tolerance, the calibration factory Y may be used to mathematically correct the gas meter dial readings to the proper values instead of physically adjusting the dry gas meter dials to correspond to the wet test meter readings.

APPENDIX F

EXAMPLE

POST METER CALIBRATION FORM - U.S. STEEL #2 COKE UNDERFIRE STACK

Date 10/12/79 Box No. 2

P_{bar} = 29.53 in. Hg Calibrated by M. TODD

Orifice Manometer Setting ΔH (in. H_2O)	Δ wtm (in. H_2O)	Gas Volume Wet Test Meter		Gas Volume Dry Gas Meter		Temperature Wet Test Meter		Avg. Temp. Dry Gas Meter	
		Initial	Final	Initial	Final	Initial	Final	Inlet	Outlet
1.67	1.6	0	11	916.702	928.188	73	73	91	91
1.67	1.6	0	10	928.188	938.584	73	73	91	91
1.67	1.6	0	10	938.584	948.975	73	73	91	90

Pump must be operated for at least 15 minutes at each ΔH setting (.5, 1, 1.5, 2 and 3)

T_{dgm} = average temperature of dry gas meter (inlet and outlet) + 460°F

T_{wtm} = average temperature of wet test meter + 460°F

$P_{wtm} = P_{bar} - \frac{\Delta wtm}{13.6}$

$P_{dgm} = P_{bar} + \frac{\Delta H}{13.6}$

MCF = 0.985 at avg. ΔH of 1.67" + 7" vacuum

Δwtm = pressure on wet test meter in inches of H_2O

Y = meter calibration factor

28.316 = conversion factor when using a wet test meter calibrated in liters

Calculations

$$Y = \frac{(\text{wet final} - \text{wet initial})(T_{dgm})(P_{wtm})}{(\text{dry final} - \text{dry initial})(28.316)(T_{wtm})(P_{dgm})}$$

or (1)

$$\bar{Y} = \frac{\Sigma Y}{5}$$

Meter Tolerance = 1.00 ± 0.01

If the meter calibration factor is not within the allowable tolerance, the calibration factory Y may be used to mathematically correct the gas meter dial readings to the proper values instead of physically adjusting the dry gas meter dials to correspond to the wet test meter readings.

Date 6/28/79 Meter Box No. 2

P_{bar} 29.85 Calibrated By A. TODD

ΔH	V_1	V_2	θ	t_1	t_2	$V_2 - V_1$	Q_m	K_m
in. H_2O	CF	CF	Sec.	°F	°F	CF		
0.5	590.3	591.3	145	96	82	1.0	.409	.731
1.0	584.0	585.0	104	96	81	1.0	.569	.721
1.5	546.0	547.0	85	100	83	1.0	.695	.718
2.0	559.0	560.0	75	104	85	1.0	.786	.702
3.0	569.0	570.0	61	83	80	1.0	.981	.720
							Average K_m	.718

V_1 = Dry gas meter reading at the start of each test

V_2 = Dry gas meter reading at the end of each test

t_1 = Dry gas meter inlet temperature

t_2 = Dry gas meter outlet temperature

OCF = 1.78

Calculations

1. Q_m = (for each ΔH) $\dfrac{V_2 - V_1}{\theta} \left[\dfrac{t_2 + 460}{\frac{t_1 + t_2}{2} + 460} \right] (60)(Y)$

2. K_m = (for each ΔH) $Q_m \sqrt{\dfrac{P_m M_m}{T_m \Delta H}}$

$M_m = 29$

$T_m = t_2 + 460$

$P_m = P_{bar} + \dfrac{\Delta H}{13.6}$

Y = meter calibration factor

3. Calculate the average K_m as follows:

$$\bar{K}_m = \frac{\Sigma K_m}{5}$$

4. Calculate ΔH_a as follows:

$$\Delta H_a = \frac{Q@^2 \; P@ \; M@}{T@} \left[\frac{1}{\bar{K}_m^2} \right] = \frac{0.921}{\bar{K}_m^2} = \frac{.921}{(718)^2} = 1.78$$

Q@ = 0.75 cfm
T@ = 528°R
P@ = 29.92 in.Hg
M@ = 29

5. Orifice Tolerance = 1.84 ± .25

CALIBRATION FORM A
(Must Be Included With Field Data Sheet)

Gauge	Average Test Condition Temperature °F	°F Gauge Reading	°F Reference Reading	°F Difference
Impinger (Pre)	65	68	67	1
Meter In (Pre)	71	67	67	—
Meter Out (Pre)	63	66	67	1
Filter Heated Area (Pre)	250	260	255	5
Stack (Post)	376	380	388	8

Post Test	Run 1	Run 2	Run 3
Train Leak Rate	0	.002	0

Pre Test (Answer Yes or No)

Pitot Leak Check: Yes - Checked on 10" manometer prior to tests

Orsat Leak Check: FYRITE USED

Metering System Leak Check: Yes

Barometer Calibrated: Yes

Sample Bag Leak Check (if used): N/A

Signature Alan Todd Title Technician Date 10/15/79

* NOTE: 13' pitot tube factor .84 by design

Calibration data for dry gas meter, orifice, nozzle, pitot, and differential pressure gauge (if other than manometer) must be available for inspection at the time of the test and must be included in the stack test report.

Title: see title page

Plant and Location: USSC, Fairfield, AL

SCC: 30300306

Test Date: 10/10 + 11/79

By Whom: CH2M Hill

Encoded By:

Date Encoded:

Completed By:

Form No.:

J. K. PETERSON
MANAGER
ENVIRONMENTAL CONTROL—SOUTH

United States Steel Corporation
FAIRFIELD WORKS
P. O. BOX 599
FAIRFIELD, ALABAMA 35064

November 2, 1979

Director, Enforcement Division
U. S. Environmental Protection Agency
345 Courtland Street, NE
Atlanta, Georgia 30308

Health Officer
Jefferson County Department of Health
P. O. Box 2646
Birmingham, Alabama 35202

Director
Alabama Air Pollution Control Commission
645 South McDonough Street
Montgomery, Alabama 36130

Gentlemen:

Attached please find a copy of the test report by CH2M Hill of the determination of particulate emissions from the combustion stack of Coke Battery No. 2, Fairfield Works, during dry coal operations. This test was performed on October 10 and 11, 1979, with representatives of all agencies present.

The averaged grain loading is 0.03 gr/SCFD; the grain loading from this source required in the Settlement Agreement of March 31, 1978, is 0.03 gr/SCFD.

Sincerely,

Attachment

bc: Dr. P. X. Masciantonio/R.Dworek - Att.
Mr. L. C. McLean
Mr. J. C. Bird
Mr. F. Burton - Att.

RECEIVED
UNITED STATES STEEL CORPORATION
NOV 05 1979
ENVIRONMENTAL CONTROL