AP42 Section:	11.20
Background Chapter	4
Reference:	17
Title:	Source Tests Conducted on Number 1 and Number 2 Kilns at Tombigbee Lightweight Aggregate, Livingston, Alabama on June 5 and 6, 1979, Resource Consultants, Inc., Brentwood, TN, June 22, 1979.

RECEIVED APR 29 1983

AP-42 Section 11.20
Reference
Report Sect. 4
Reference 17

ADEM

ALABAMA
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

A-82-39
II-D-141

April 26, 1983

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3263 Demetropolis Rd.
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Mobile, AL
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Ms. Amy J. Nelson
Midwest Research Institute
4505 Creedmoore Road
Raleigh, NC 27612

Dear Ms. Nelson:

Enclosed is a test report of the No. 1 and No. 2 kilns at Tombigbee Lightweight Aggregate Corporation in Livingston, Alabama. The report includes particulate and sulfur dioxide emission data and particle size analysis.

This data consists of 56 pages. A charge of $14.00 is assessed for duplication. The check should be made payable to Department of Environmental Management, Air Program. It should be sent to the following address: Alabama Department of Environmental Management, State Capitol, Montgomery, Alabama 36130.

If I may be of further assistance, please write or call me at 834-6570.

Sincerely,

Freddie B. Thomas

Freddie B. Thomas, Jr.
Pollution Control Specialist
Engineering Services Section
Air Program

FBT:sp
Enc.

RESOURCE
CONSULTANTS
environmental engineers and scientists

August 9, 1979

Mr. Freddie B. Thomas, Jr.
Alabama Air Pollution Control Commission
645 South McDonough Street
Montgomery, AL 36130

Dear Freddie:

As requested, enclosed is a copy of the source tests conducted on the No. 1 kiln at Tombigbee Lightweight Aggregate Corporation, Livingston, Alabama.

Since our last conversation, Resource Consultants, Inc. has performed additional source tests on the No. 1 and No. 2 kilns at Tombigbee Lightweight Aggregate. These tests were performed after the installation of air seals at the outlet of the kiln which changed the air flow characteristics somewhat. A report on these findings is being prepared, and a copy will be forwarded to you as soon as possible.

In an effort to speed up the process of equipment selection, the results of these tests have already been phoned to the prospective vendors. A resubmittal of their proposals is forthcoming. A compliance schedule will be submitted as soon as these new proposals have been received and evaluated.

Thank you for your understanding in this matter. If you have any questions or if I may be of any assistance, please let me know.

Sincerely,

RESOURCE CONSULTANTS, INC.

Billy Nichols

Billy R. Nichols
Pollution Control Specialist

BRN/dl

Enclosure

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A[illegible]ion
Control Comm[illegible]on

P.O. Box 498 • Two Maryland Farms • Suite 340 • Brentwood, Tennessee 37027 • 615-373-5040
a tennessee corporation

RESOURCE
CONSULTANTS
environmental engineers and scientists

June 22, 1979

Mr. Clem Blackburn
Tombigbee Lightweight Aggregate
P. O. Drawer V
Livingston, AL 35470

Dear Mr. Blackburn:

This report contains the results from the test series conducted on the Number 1 Kiln exhaust gases and the sulfur dioxide test conducted on the Number 2 Kiln. A summary of the results for the Number 1 Kiln follows:

Temperature, ^{o}F	329
Moisture, % by volume	20.3
Volumetric Flow Rate, acfm	65,300
Volumetric Flow Rate, sdcfm	36,800
Particulate Concentration, gr/dscf	13.6
Particulate Mass Rate, lbs/hr	4,320
SO_2 Concentration, lbs/dscf	1.82×10^{-4}
SO_2 Mass Rate, lbs/hr	403

The results for the sulfur dioxide test conducted on the Number 2 Kiln are as follows:

Temperature, ^{o}F	295
Moisture, % by Volume	18.3
Volumetric Flow Rate, acfm	110,000
Volumetric Flow Rate, sdcfm	63,700
SO_2 Mass Rate, lbs/hr	619
SO_2 Concentration	1.62×10^{-4}

In addition, Electrozone and Bahco particle size analysis tests were conducted on a sample from the Number 1 Kiln. As before, there is a large variation in the two methods of analysis; therefore, it is suggested that the electrozone analysis be used in specifying scrubber performance.

Please let me know if you have any questions regarding this data.

Sincerely,

RESOURCE CONSULTANTS, INC.

Billy R. Nichols
Pollution Control Specialist

BRN/dl

SOURCE TESTS CONDUCTED

ON

NUMBER 1 AND NUMBER 2 KILNS

AT

TOMBIGBEE LIGHTWEIGHT AGGREGATE
Livingston, Alabama

on

June 5 and 6, 1979

By

RESOURCE CONSULTANTS, INC.
Two Maryland Farms
Brentwood, Tennessee 37027

Table of Contents

RESOURCE
CONSULTANTS

INTRODUCTION

This report presents the results of two isokinetic particulate emission tests and two sulfur dioxide emission tests conducted on June 5 and 6, 1979, at Tombigbee Lightweight Aggregate, Livingston, Alabama. The tests were conducted to determine particulate and sulfur dioxide concentrations and air flow characteristics from the Number 1 Kiln. In addition, sulfur dioxide emission rates were measured for the Number 2 Kiln.

Mr. James Colburn and Mr. David Fulton arranged testing facilities and programmed desired operating conditions for Tombigbee Lightweight Aggregate. Messrs. Al Farmer and Ed Corby performed the sampling for Resource Consultants, Inc.; Mrs. Betty Warfield performed the analysis of the samples.

The following sections of this report contain a discussion of sampling, and analytical techniques used, a statement of results, a tabulation of test data with calculations, and a particle size analysis of the sample.

RESULTS

The results of the sulfur dioxide test conducted on June 5, 1979 on the Number 2 Kiln exhaust gases are presented on the following table.

	Test No. 1
Stack Temperature (°F)	295
Moisture Content (% Volume)	18.3
Volumetric Flow Rate (acfm)	110,000
Volumetric Flow Rate (sdcfm)	63,700
SO_2 Concentration (lb/dscf)	1.62×10^{-4}
SO_2 Mass Rate (lb/hr)	619

The results from the series of tests conducted on the Number 1 Kiln on June 5 and 6, 1979, are presented as follows:

	Test No. 2	Test No. 3	Average
Stack Temperature (°F)	328	330	329
Moisture Content (% Volume)	19.6	21.0	20.3
Volumetric Flow Rate (acfm)	65,300	65,300	65,300
Volumetric Flow Rate (sdcfm)	2,229,000	2,190,000	2,210,000
SO_2 Concentration (lb/dscf)	1.69×10^{-4}	1.96×10^{-4}	1.82×10^{-4}
SO_2 Mass Rate (lb/hr)	377	429	403
Particulate Concentration (gr/dscf)	17.4	9.85	13.6
Particulate Mass Rate (lb/hr)	5,550	3,080	4,320

The particulate collected may be gravimetrically differentiated with respect to point of collection within the sampling train as follows:

Test No.	Particulate Collected in Probe, Cyclone and Front Half of Filter Holder, mg	Particulate Collected on Filter, mg	Total Particulate Collected, mg
2	21,539	1,030	22,569
3	12,301	811	13,112

DISCUSSION OF SAMPLING AND ANALYTICAL PROCEDURES

All sampling was performed using procedures described in the Federal Register, Volume 42, Number 160, dated August 18, 1977, with modifications as discussed below.

Three, four-inch sampling ports were evenly spaced vertically along the side of the horizontal ductwork connecting the kiln outlets and the multiclone inlets. Due to the duct configurations, the sampling ports were located approximately two feet from the kiln outlets and two feet from the multiclone inlet on both kilns. This resulted in erratic flow across the sampling planes, especially for the Number 1 Kiln. Therefore, flow rates for the Number 1 Kiln were measured on a straight run of 42-inch diameter duct downstream of the multiclone outlet. Particulate mass rate and sulfur dioxide emission rate calculations were made using flow data from this traverse location instead of flow rates calculated from velocity traverses conducted at the sampling location.

Sample run number one was taken on the Number 2 Kiln for sulfur dioxide concentrations only; therefore, there are no calculations for isokinetic sampling rates. Run numbers two and three were performed on the Number 1 Kiln according to EPA Method Five procedures for particulate mass rates. In addition, sulfur dioxide concentrations were measured simultaneously by replacing the deionized water in the first and second impingers with a 3% hydrogen peroxide solution. Run number four was performed so that a particulate sample could be obtained for particle size analysis without being subjected to acetone. This was accomplished by dry brushing the probe and filter holder.

Due to the erratic flow and high grain loadings encountered, several problems occurred during the test runs. During the second test run, high vacuums due to filter pluggage caused difficulties in obtaining desired sampling rates at several points and reduced sampling time. Also, the erratic flow conditions caused negative velocity pressure readings on the lower traverse of the Number 1 Kiln, variations of flow rates at any given point, and thus resulted in wide variations in the isokinetic sampling rates. For the third and fourth runs, the middle traverse was sampled twice, so that a sufficient air volume would be obtained.

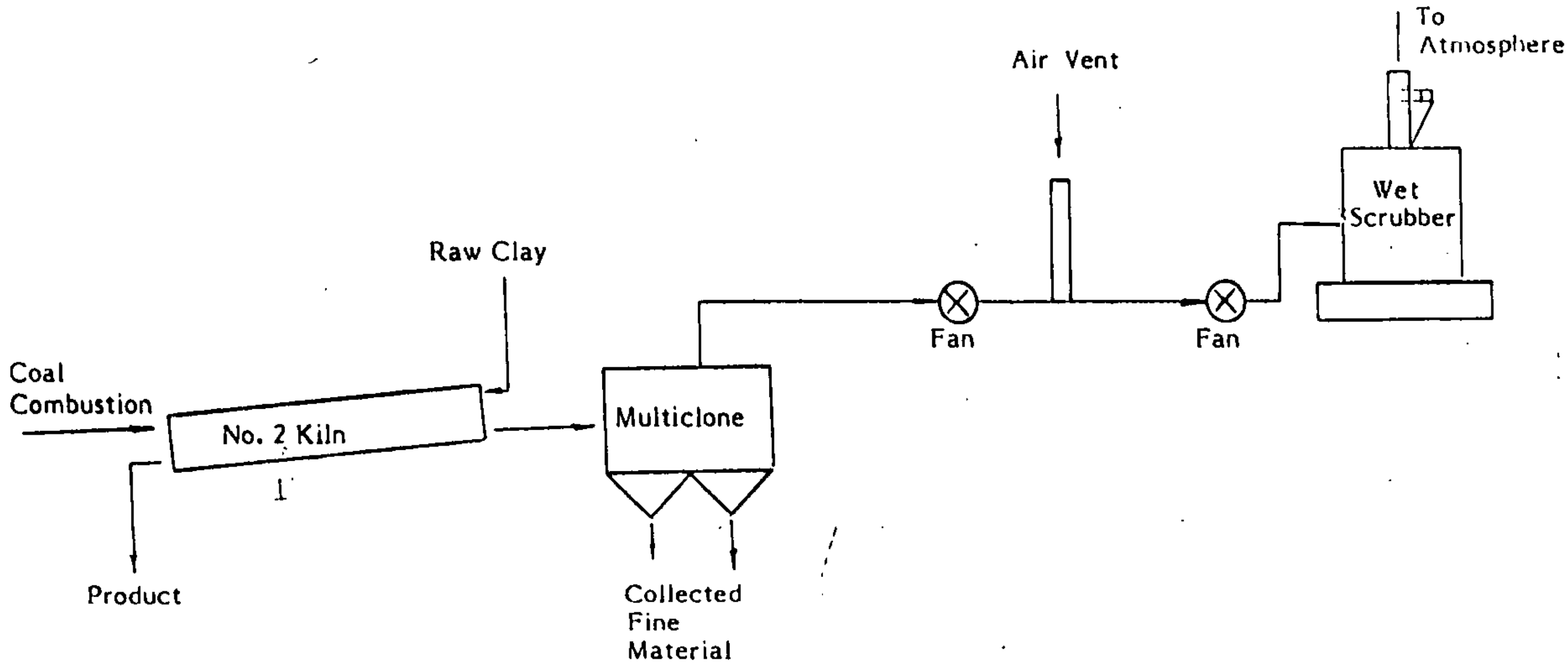

Figure 1
PROCESS FLOW DIAGRAM
TOMBIGBEE LIGHTWEIGHT AGGREGRATE
Livingston, Alabama

APPENDIX A

SUMMARY OF TEST DATA

SUMMARY OF TEST DATA

Source Name: Tombigbee Lightweight Aggregate

Location: Kiln # 2

Run No.: 1 Date: 6/5/79

Particulate Sampling Train

Sampling nozzle diameter, in.	D_n	-
Sampling nozzle cross-sectional area, ft.^{2}	A_n	-
Sampling time, min.	θ	36
Sample gas volume-meter conditions, ft.^{3}	V_m	26.23
Average meter temperature, ^oR	T_m	558
Average orifice pressure drop, in. H_2O	ΔH	1.8
Particulate collected, mg.	M_n	-
Sample gas volume @ standard conditions, ft.^{3} (dry)	V_{mstd}	24.92

Velocity Traverse

Stack area, ft.^{2}	A	22.5
Average stack pressure, in. Hg absolute	P_s	30.21
Average stack temperature, ^oR	T_s	755
Static pressure in stack, in. H_2O	P_g	-0.55
Average $\sqrt{\text{velocity head}}$	$(\sqrt{\Delta p})$ @	1.20
Molecular weight of stack gas	M_s	27.7
Barometric pressure, in. Hg	P_{bar}	30.25
Stack gas velocity, ft./sec. @ stack conditions	V_s	81.8

Stack Moisture Content

Total water collected by train, ml	V_{lc}	118.8
Volume of water vapor @ standard conditions, ft^3	V_{wstd}	5.57
Moisture in stack gas, %	M_{pc}	18.3

Emission Data

Stack gas flow rate, acfm	Q_s	110,000
Stack gas flow rate, scfh	Q_{sstd}	3,824,000
Total particulate concentration, gr/dscf	C'_s	-
Particulate mass rate, lbs/hr	PMR	-
Percent isokinetic of test	I	-

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CORRECTION OF DRY GAS SAMPLE VOLUME TO STANDARD CONDITIONS

Date 6/5/79 Run 1

θ	=	36	Sampling time, min.
V_m	=	26.23	Sample gas volume, meter conditions, ft.^{3}
P_{bar}	=	30.25	Barometric pressure, in. Hg.
ΔH	=	1.8	Average orifice pressure drop, in H_2O
T_{ad}	=	105	Average meter temperature, inlet, ^oF
T_{ae}	=	92	Average meter temperature, outlet, ^oF
T_m	=	558	Average meter temperature, ^oR
V_{mstd}	=	24.92	Sample gas volume @ standard conditions, ft^3 (dry)
Y	=	0.99	Dry gas meter calibration factor (dimensionless)

(1) $$T_m = \frac{T_{ad} + T_{ae}}{2} + 460$$

T_m = 558

(2) $$V_{mstd} = \left(17.64 \frac{^oR}{\text{in. Hg}}\right) Y \; V_m \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}\right)$$

V_{mstd} = 24.92

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DETERMINATION OF MOISTURE IN STACK GAS (Method 5)

Date 6/5/79 Run No. 1

Total volume of water collected in impingers and silica gel (V_{lc}) ml = 118.8

Volume of water vapor (V_{wstd}) $ft.^3$

$$V_{wstd} = (0.0474\ ft.^3/ml)\ (V_{lc})$$

V_{wstd} = 5.57

Proportion by volume of water vapor in the gas stream (B_{wo})

$$B_{wo} = \frac{V_{wstd}}{V_{wstd} + V_{mstd}}$$

B_{wo} = 0.183

Percent moisture in stack gas (M_{pc}) %

$$M_{pc} = 100 \times B_{wo}$$

M_{pc} = 18.3 %

RESOURCE CONSULTANTS

GAS ANALYSIS FOR DRY MOLECULAR WEIGHT (Method 3)

Date 6/5/79 Run No. 1

Component	% Volume Dry Basis	Molecular Weight
CO_2	9.0	44
O_2	12.0	32
$CO + N_2$	79.0	28

Dry Molecular Weight of Stack Gas (M_d)

M_d = (0.44) (9.0) + 0.32 (12.0) + 0.28 (79.0)

M_d = 29.9

Molecular Weight of Stack Gas (wet basis) (M_s)

$M_s = M_d\ (1 - B_{wo}) + 18\ B_{wo}$

M_s = 27.7

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DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE
(Method 2)

Date 6/5/79 Run No. 1

P_g = -0.55 Static pressure in stack, in. H_2O

P_{bar} = 30.25 Barometric pressure, in. Hg

C_p = 0.84 Pitot tube coefficient, dimensionless

K_p = 85.48 ft./sec. $\left(\frac{lb}{lb\ mole\ \ {}^oR}\right)$

$\left(\sqrt{\Delta p}\right)$ @ = 1.20 Average $\sqrt{\text{velocity head}}$

T_s = 755 Average stack temperature, ^oR

M_s = 27.7 Molecular weight of stack gas

T_{std} = 528 ^oR Absolute temperature @ standard conditions

P_{std} = 29.92 Absolute pressure @ standard conditions, in. Hg.

A = 22.5 Stack area, ft^2

P_s = 30.21 Average stack pressure, in. Hg, absolute

V_s = 81.8 Stack gas velocity, ft/sec, @ stack conditions

Q_s = 110,000 Stack gas volumetric flow rate, actual ft^3/min.

Q_{sstd} = 3,824,000 Stack gas volumetric flow rate, std ft^3/hr (dry)

(1) $$P_s = \frac{P_g}{13.6} + P_{bar}$$

P_s = 30.21

(2) $$V_s = Kp\ Cp\left(\sqrt{\Delta p}\right) @ \cdot \sqrt{\frac{T_s}{P_s\ M_s}}$$

V_s = 81.8

(3) $$Q_s = 60\ A\ V_s$$

110,000 Q_s = 110,000

(4) $$Q_{sstd} = 3600\,(1 - B_{wo})\ V_s\ A\left(\frac{T_{std}}{T_s}\right)\left(\frac{P_s}{P_{std}}\right)$$

Q_{sstd} = 3,824,000

RESOURCE CONSULTANTS

SO_2 CALCULATIONS

$$C_{SO_2} = \frac{(7.06 \times 10^{-5})(V_t - V_b)(N)(V_{SOLN}/V_a)}{V_{m(std)}}$$

$$PMR = C_{SO_2} \times \text{Volumetric Flow Rate}$$

Where:

7.06×10^{-5}	=	lb/meq.
V_t	=	Volume of titrant, ml
V_{tb}	=	Volume of titrant used for blank, ml
N	=	Normality of barium perchlorate
V_{SOLN}	=	Volume of sample, ml
V_a	=	Volume of aliquot, ml
$V_{m(std)}$	=	Volume of air sampled, dscf
C_{SO_2}	=	Concentration of SO_2, lb/dscf
PMR	=	Pollutant mass rate, lb/hr

Run No. 1

$$C_{SO_2} = \frac{(7.06 \times 10^{-5})(14.5 - 0.1)(.0097)(409/1)}{24.92}$$

$$= 1.62 \times 10^{-4}$$

$$PMR = (1.62 \times 10^{-4})(3,824,000)$$

$$= 619$$

RESOURCE CONSULTANTS inc

SUMMARY OF LABORATORY DATA

CLIENT Tombigbee Lightweight Aggregate DATE 6/5/79

SOURCE # 2 Kiln BOX NO. 8 RUN NO. 1

SO_2 Analysis Only

CONDENSATE

IMPINGER NO.	FINAL VOLUME, ml	INITIAL VOLUME, ml	NET GAIN, ml
1.	233	150	83
2.	176	150	26
3.		0	
4.	209.8 ,g	200 ,g	9.8 ,g
TOTAL	618.8	500	118.8

PARTICULATE

COMPONENT	ID NO.	FINAL WT., g	INITIAL WT., g	NET WT., g
PROBE WASH				
ACETONE BLANK				-
PROBE WASH (-BLK)				
CYCLONE				
FILTER				
IMPINGER H_2O (100 ml ALIQUOT)				
IMPINGER H_2O - CORRECTED TO TOTAL IMPINGER VOLUME		$\frac{(\quad)(\quad)}{100}$ =		

PARTICULATE COLLECTED (EXCLUDING IMPINGER CATCH) =	,g
PARTICULATE COLLECTED (INCLUDING IMPINGER CATCH) =	,g

COMMENTS: SO_2 Analysis

A 2 ml Sample - 28.8 ml 0.0097N $BaClO_4$

B 1 ml " - 14.7 ml "

C 1 ml " - 14.5 ml "

Blank 0.1 ml "

ORSAT ANALYSIS

CO_2	
O_2	
N_2 + CO	

RESOURCE CONSULTANTS

SIGNED

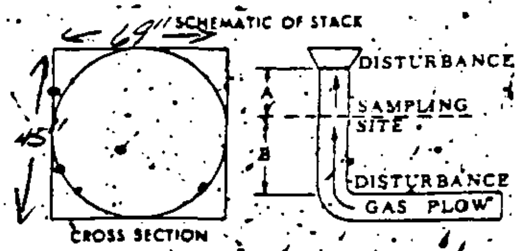
PARTICULATE FIELD DATA

PLANT Tombigbee Lt. Wt. DATE 4/5/79

LOCATION #2 Kiln outlet
OPERATOR Tomok & Cooley
STACK NO. 1
RUN NO. 1
SAMPLE BOX NO. 4 Filter #1334
METER BOX NO. 3
AMBIENT TEMPERATURE 85
BAROMETRIC PRESSURE 30.25

ASSUMED MOISTURE, % 15
PROBE LENGTH, in. 60
NOZZLE DIAMETER, in. .25
STACK DIAMETER, in. 29x45
PROBE HEATER SETTING 290
HEATER BOX SETTING 250
C FACTOR 1.0
PROCESS WEIGHT RATE

SCHEMATIC OF STACK



TRAVERSE POINT NUMBER	SAMPLING TIME CLOCK	SAMPLING TIME SAMPLE TIME	STACK TEMP. (T_s) °F	VELOCITY HEAD (ΔP_s)	VELOCITY HEAD ($\sqrt{\Delta P_s}$)	ORIFICE METER (ΔH) in. H_2O ACTUAL	ORIFICE METER DESIRED	GAS SAMPLE VOLUME (Vm), Ft³	GAS SAMPLE TEMP. AT DRY GAS METER INLET (Tm_{in}) °F	OUTLET (Tm_{out}) °F	SAMPLE BOX TEMP. °F	TEMP. OF GAS LEAVING LAST IMPINGER °F	PUMP VACUUM in. Hg GUAGE
								484.94					
1		2	380	2.2		2.0	5.8	486.4	88	90	225	72	23
2		4	381	2.1		2.0	5.8	487.9	91	91	255	73	23
3		6	342	1.8		2.0	5.0	489.4	93	90	280	73	23
4		8	320	1.3		1.9	3.7	490.8	96	90	290	78	23.5
5		10	284	1.1		1.8	3.0	492.3	100	90	266	82	23.5
6		12	241	.96		1.7	2.8	493.67	102	90	275	89	23.5
1		2	378	2.3		1.8	6.2	494.9	94	90	250	86	23.5
2		4	336	2.1		1.8	5.8	496.2	98	90	240	86	24.0
3		6	291	1.9		1.8	5.4	497.6	102	90	230	84	24.0
4		8	262	1.9		1.75	5.6	499.1	108	90	220	82	24.0
5		10	258	2.0		1.7	5.9	500.5	112	92	254	84	24.0
6		12	230	.14		1.7	.43	501.9	114	92	245	80	24.0
1		2	335	2.3		1.75	6.2	503.3	106	92	260	78	24.0
2		4	305	2.1		1.75	5.8	504.7	108	94	262	71	24.0
3		6	271	1.5		1.75	4.2	506.1	112	95	250	71	24.0
4		8	260	1.6		1.75	4.3	507.5	116	96	255	71	24.0
5		10	240	.48		1.75	1.35	509.0	122	96	240	71	24.0
X 6		12	195	.15		1.75	.45	511.17	124	96	299	71	24.0
TOTAL								26.23					
AVERAGE													

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

H_2O

VOLUME OF LIQUID WATER COLLECTED			
Impinger	Final	— Initial	= Liquid Collected
1	233	150	
2	176	150	
3	—	—	
4			
SILICA GEL			
Total Volume Collected			

ORSAT MEASUREMENT					
Test	Time	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS: Pre test leak check ok
Post test leak check 6.8 cc @ 24"

X Probe liner broke on last point

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environmental engineers and scientists

SUMMARY OF TEST DATA

Source Name: Tombigbee Lightweight Aggregate

Location: Kiln # 1

Run No.: 2 Date: 6/5/79

Particulate Sampling Train

Sampling nozzle diameter, in.	D_n	0.187
Sampling nozzle cross-sectional area, ft.^{2}	A_n	0.000191
Sampling time, min.	θ	42
Sample gas volume-meter conditions, ft.^{3}	V_m	21.30
Average meter temperature, ^oR	T_m	564
Average orifice pressure drop, in. H_2O	ΔH	0.73
Particulate collected, mg.	M_n	22,569.0
Sample gas volume @ standard conditions, ft.^{3} (dry)	V_{mstd}	19.99

Velocity Traverse

Stack area, ft.^{2}	A	12.25
Average stack pressure, in. Hg absolute	P_s	30.24
Average stack temperature, ^oR	T_s	788
Static pressure in stack, in. H_2O	P_g	-0.17
Average $\sqrt{\text{velocity head}}$	$(\sqrt{\Delta p})$ @	1.22
Molecular weight of stack gas	M_s	27.7
Barometric pressure, in. Hg	P_{bar}	30.25
Stack gas velocity, ft./sec. @ stack conditions	V_s	85.0

Stack Moisture Content

Total water collected by train, ml	V_{lc}	103.2
Volume of water vapor @ standard conditions, ft^3	V_{wstd}	4.86
Moisture in stack gas, %	M_{pc}	19.6

Emission Data

Stack gas flow rate, acfm	* Q_s	65,300
Stack gas flow rate, scfh	* Q_{sstd}	2,229,000
Total particulate concentration, gr/dscf	C'_s	17.4
Particulate mass rate, lbs/hr	PMR	5550
Percent isokinetic of test	I	91

Q_s & Q_{sstd} calculated from velocity traverse taken downstream from multiclone outlet.

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CORRECTION OF DRY GAS SAMPLE
VOLUME TO STANDARD CONDITIONS

Date 6/5/79 Run 2

θ	=	42	Sampling time, min.
V_m	=	21.30	Sample gas volume, meter conditions, $ft.^3$
P_{bar}	=	30.25	Barometric pressure, in. Hg.
ΔH	=	0.73	Average orifice pressure drop, in H_2O
T_{ad}	=	109	Average meter temperature, inlet, ^oF
T_{ae}	=	98.6	Average meter temperature, outlet, ^oF
T_m	=	564	Average meter temperature, ^oR
V_{mstd}	=	19.99	Sample gas volume @ standard conditions, ft^3 (dry)
Y	=	0.99	Dry gas meter calibration factor (dimensionless)

(1) $$T_m = \frac{T_{ad} + T_{ae}}{2} + 460$$

T_m = 564

(2) $$V_{mstd} = \left(17.64 \frac{^oR}{\text{in. Hg}}\right) Y \quad V_m \quad \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}\right)$$

V_{mstd} = 19.99

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DETERMINATION OF MOISTURE IN STACK GAS (Method 5)

Date 6/5/79 Run No. 2

Total volume of water collected in impingers and silica gel (V_{lc}) ml = 103.2

Volume of water vapor (V_{wstd}) $ft.^3$

$$V_{wstd} = (0.0474\ ft.^3/ml)\ (V_{lc})$$

V_{wstd} = 4.86

Proportion by volume of water vapor in the gas stream (B_{wo})

$$B_{wo} = \frac{V_{wstd}}{V_{wstd} + V_{mstd}}$$

B_{wo} = 0.196

Percent moisture in stack gas (M_{pc}) %

$$M_{pc} = 100 \times B_{wo}$$

M_{pc} = 19.6 %

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GAS ANALYSIS FOR DRY MOLECULAR WEIGHT (Method 3)

Date 6/5/79 Run No. 2

Component	% Volume Dry Basis	Molecular Weight
CO_2	9.0	44
O_2	14.0	32
$CO + N_2$	77.0	28

Dry Molecular Weight of Stack Gas (M_d)

$$M_d = (0.44)\ (9.0) + 0.32\ (14.0) + 0.28\ (77.0)$$

M_d = 30.0

Molecular Weight of Stack Gas (wet basis) (M_s)

$$M_s = M_d\ (1 - B_{wo}) + 18\ B_{wo}$$

M_s = 27.7

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DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE (Method 2)

Date 6/5/79 Run No. 2

P_g	=	-0.17	Static pressure in stack, in. H_2O
P_{bar}	=	30.25	Barometric pressure, in. Hg
C_p	=	0.84	Pitot tube coefficient, dimensionless
K_p	=	85.48	ft./sec. $\left(\frac{lb}{lb\ mole\ ^{o}R}\right)$
$\left(\sqrt{\Delta p}\right)$ @	=	1.22	Average $\sqrt{\text{velocity head}}$
T_s	=	788	Average stack temperature, ^{o}R
M_s	=	27.7	Molecular weight of stack gas
T_{std}	=	528 ^{o}R	Absolute temperature @ standard conditions
P_{std}	=	29.92	Absolute pressure @ standard conditions, in. Hg.
A	=	12.25	Stack area, ft^2
P_s	=	30.24	Average stack pressure, in. Hg, absolute
V_s	=	85.0	Stack gas velocity, ft/sec, @ stack conditions
Q_s	=	65,300	Stack gas volumetric flow rate, actual ft^3/min.
Q_{sstd}	=	2,229,000	Stack gas volumetric flow rate, std ft^3/hr (dry)

(1) $P_s = \frac{P_g}{13.6} \bullet P_{bar}$

P_s = 30.24

(2) $V_s = K_p C_p \left(\sqrt{\Delta p}\right) @ \sqrt{\frac{T_s}{P_s M_s}}$

V_s = 85.0

(3) $Q_s = 60\ A\ V_s$

Q_s = 65,300

(4) $Q_{sstd} = 3600\,(1 - B_{wo})\ V_s\ A \left(\frac{T_{std}}{T_s}\right) \left(\frac{P_s}{P_{std}}\right)$

Q_{sstd} = 2,229,000

RESOURCE CONSULTANTS

DETERMINATION OF PARTICULATE EMISSIONS (Method 5)

Date 6/5/79 Run No. 2

Particulate concentration (C'_s), gr/dscf

$$C'_s = \left(0.0154\ \frac{gr}{mg}\right)\left(\frac{M_n}{V_{mstd}}\right)$$

C'_s = 17.4

Where M_n = Particulate collected in mg

Particulate mass rate(PMR), lbs/hour

$$PMR = (0.000143)\ (C'_s)\ (Q_{sstd})$$

PMR = 5,550

Isokinetic Variation

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

I = 91 %

RESOURCE CONSULTANTS

SO_2 CALCULATIONS

$$C_{SO_2} = \frac{(7.06 \times 10^{-5})(V_t - V_b)(N)(V_{SOLN}/V_a)}{V_{m(std)}}$$

PMR = C_{SO_2} x Volumetric Flow Rate

Where:

7.06×10^{-5}	=	lb/meq.
V_t	=	Volume of titrant, ml
V_{tb}	=	Volume of titrant used for blank, ml
N	=	Normality of barium perchlorate
V_{SOLN}	=	Volume of sample, ml
V_a	=	Volume of aliquot, ml
$V_{m(std)}$	=	Volume of air sampled, dscf
C_{SO_2}	=	Concentration of SO_2, lb/dscf
PMR	=	Pollutant mass rate, lb/hr

Run No. 2

$$C_{SO_2} = \frac{(7.06 \times 10^{-5})(12.5 - 0.1)(.0097)(398/1)}{19.99}$$

$$= 1.69 \times 10^{-4}$$

$$\text{PMR} = (1.69 \times 10^{-4})(2{,}229{,}000)$$

$$= 337$$

RESOURCE CONSULTANTS INC

SUMMARY OF LABORATORY DATA

CLIENT Tombigbee Lightweight Aggregate DATE 6/5/79

SOURCE # 1 Kiln BOX NO. 7 RUN NO. 2

CONDENSATE

IMPINGER NO.	FINAL VOLUME, ml	INITIAL VOLUME, ml	NET GAIN, ml
1.	236	150	86
2.	162	150	12
3.		0	
4.	205.2 ,g	200 ,g	5.2 ,g
TOTAL		400	103.2

PARTICULATE

COMPONENT	ID NO.	FINAL WT., g	INITIAL WT., g	NET WT., g
PROBE WASH	314	129.3050	107.7658	21.5392
ACETONE BLANK	310	106.6670	106.6670	- 0.0000
PROBE WASH (-BLK)				21.5392
CYCLONE				
FILTER	1344 ~~1348~~	1.3824 ~~1.1165~~	0.7389 ~~0.7302~~	0.6435 ~~0.3863~~
IMPINGER H_2O (100 ml ALIQUOT)				
IMPINGER H_2O - CORRECTED TO TOTAL IMPINGER VOLUME		$\frac{(\quad)(\quad)}{100}$ =		

PARTICULATE COLLECTED (EXCLUDING IMPINGER CATCH) =	22.5690 ,g
PARTICULATE COLLECTED (INCLUDING IMPINGER CATCH) =	,g

COMMENTS: SO_2 Analysis

A 1ml Sample - 12.6ml 0.0097N $BaClO_4$

B 1ml " - 12.6ml "

C 1ml " - 12.3ml "

ORSAT ANALYSIS

CO_2	
O_2	
N_2 + CO	

RESOURCE CONSULTANTS

SIGNED

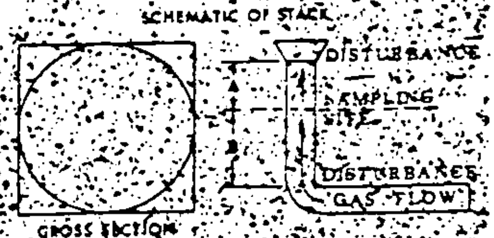
PARTICULATE FIELD DATA

PLANT Tombigbee St. #4 DATE 8/5/79

LOCATION [illegible]
OPERATOR [illegible]
STACK NO. 2
RUN NO. 2
SAMPLE BOX NO. 7, [illegible] #2
METER BOX NO. 3
AMBIENT TEMPERATURE 70
BAROMETRIC PRESSURE 29.95

ASSUMED MOISTURE, % [illegible]
PROBE LENGTH, in. 60
NOZZLE DIAMETER, in. .127
STACK DIAMETER, in. 7442
PROBE HEATER SETTING 2.2
HEATER BOX SETTING 250
C FACTOR 1.0
PROCESS WEIGHT RATE

SCHEMATIC OF STACK



TRAVERSE POINT NUMBER	SAMPLING TIME CLOCK	SAMPLING TIME SAMPLE TIME	STACK TEMP. (T_s) °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m) ft³	GAS SAMPLE TEMP. AT DRY GAS METER INLET ($T_{m_{in}}$) °F	OUTLET ($T_{m_{out}}$) °F	SAMPLE BOX TEMP. °F	TEMP. OF GAS LEAVING LAST IMPINGER °F	PUMP VACUUM in. Hg GUAGE
								512.3					
1		2		<.0									
2		4		<.0									
3		6	393	.15		.15		512.6	96	92	245	89	2.0
4		8	300	.17		.17		514.1	97	94	270	86	2.5
5		10	396	.20		.20		514.5	97	94	200	84	2.2
6		12		0									
7		14	338	.30		.29		515.0	100	94	270	87	4.0
8		16	324	.15		.14		516.6	105	94	275	97	6.0
1		2	390	3.3		1.10	3.0	511.9	108	96	280	80	22.5
2		4	390	3.4		1.27	3.2	518.9	110	96	290	75	25.0
3		6	367	3.6		1.1	3.3	520.1	112	98	260	75	25
4		8	348	3.3		1.7	4.0	521.2	115	98	267	78	25
5		10	343	3.0		1.0	2.7	522.4	118	99	247	80	25
6		12	351	2.5		.96	2.2	523.5	120	100	276	83	25
7		14	343	2.5		.94	2.2	524.5	122	102	236	84	25
8		16	314	1.2		.98	1.1	525.76	108	102	225	82	25
1		2	317	3.6		.96	3.4	527.0	105	100	224	86	25
2		4	327	1.9		.97	2.6	528.1	105	102	225	82	25
3		6	290	3.0		.97	2.7	529.2	108	100	248	82	25
4		8	290	2.7		.93	2.6	530.3	110	100	244	85	25
5		10	224	2.7		.89	1.95	531.4	112	100	260	85	25
6		12	287	.50		.83	.55	533.5	115	102	225	89	25
7		14	223	.13		.42		533.2	115	104	240	106	20
8		16	220	.08		.21		533.6					
TOTAL													
AVERAGE													

21.022

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

VOLUME OF LIQUID WATER COLLECTED			
Impinger	Final	Initial	Liquid Collected
1	236	150	
2	162	150	
3			
4			
SILICA GEL			
Total Volume Collected			

ORSAT MEASUREMENT					
Test	Time	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS [illegible]

RESOURCE CONSULTANTS
environmental engineers and scientists

SUMMARY OF TEST DATA

Source Name: Tombigbee Lightweight Aggregate

Location: Kiln # 1

Run No.: 3 Date: 6/6/79

Particulate Sampling Train

Sampling nozzle diameter, in.	D_n	0.187
Sampling nozzle cross-sectional area, ft.^{2}	A_n	0.000191
Sampling time, min.	θ	32
Sample gas volume-meter conditions, ft.^{3}	V_m	21.89
Average meter temperature, ^oR	T_m	567
Average orifice pressure drop, in. H_2O	ΔH	1.92
Particulate collected, mg.	M_n	13,112.4
Sample gas volume @ standard conditions, ft.^{3} (dry)	V_{mstd}	20.49

Velocity Traverse

Stack area, ft.^{2}	A	12.25
Average stack pressure, in. Hg absolute	P_s	30.24
Average stack temperature, ^oR	T_s	790
Static pressure in stack, in. H_2O	P_g	-0.17
Average $\sqrt{\text{velocity head}}$	$(\sqrt{\Delta p})$ @	1.27
Molecular weight of stack gas	M_s	27.5
Barometric pressure, in. Hg	P_{bar}	30.25
Stack gas velocity, ft./sec. @ stack conditions	V_s	88.9

Stack Moisture Content

Total water collected by train, ml	V_{lc}	115.7
Volume of water vapor @ standard conditions, ft^3	V_{wstd}	5.45
Moisture in stack gas, %	M_{pc}	21.0

Emission Data

Stack gas flow rate, acfm	* Q_s	65,300
Stack gas flow rate, scfh	* Q_{sstd}	2,190,000
Total particulate concentration, gr/dscf	C'_s	9.85
Particulate mass rate, lbs/hr	PMR	3,080
Percent isokinetic of test	I	118

* Q_s and Q_{sstd} calculated from velocity traverse taken downstream from multiclone outlet.

RESOURCE CONSULTANTS

CORRECTION OF DRY GAS SAMPLE VOLUME TO STANDARD CONDITIONS

Date 6/6/79 Run 3

θ	=	32	Sampling time, min.
V_m	=	21.89	Sample gas volume, meter conditions, $ft.^3$
P_{bar}	=	30.25	Barometric pressure, in. Hg.
ΔH	=	1.92	Average orifice pressure drop, in H_2O
T_{ad}	=	117	Average meter temperature, inlet, ^oF
T_{ae}	=	97	Average meter temperature, outlet, ^oF
T_m	=	567	Average meter temperature, ^oR
V_{mstd}	=	20.49	Sample gas volume @ standard conditions, ft^3 (dry)
Y	=	0.99	Dry gas meter calibration factor (dimensionless)

(1) $$T_m = \frac{T_{ad} + T_{ae}}{2} + 460$$

T_m = 567

(2) $$V_{mstd} = \left(17.64 \frac{^oR}{\text{in. Hg}}\right) Y \quad V_m \quad \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}\right)$$

V_{mstd} = 20.49

RESOURCE CONSULTANTS

DETERMINATION OF MOISTURE IN STACK GAS (Method 5)

Date 6/6/79 Run No. 3

Total volume of water collected in impingers and silica gel (V_{lc}) ml = 115.7

Volume of water vapor (V_{wstd}) $ft.^3$

V_{wstd} = ($0.0474\ ft.^3/ml$) (V_{lc})

V_{wstd} = 5.45

Proportion by volume of water vapor in the gas stream (B_{wo})

$$B_{wo} = \frac{V_{wstd}}{V_{wstd} + V_{mstd}}$$

B_{wo} = 0.210

Percent moisture in stack gas (M_{pc}) %

M_{pc} = $100 \times B_{wo}$

M_{pc} = 21.0 %

RESOURCE CONSULTANTS

GAS ANALYSIS FOR DRY MOLECULAR WEIGHT (Method 3)

Date 6/6/79 Run No. 3

Component	% Volume Dry Basis	Molecular Weight
CO_2	9.0	44
O_2	14.0	32
$CO + N_2$	77.0	28

Dry Molecular Weight of Stack Gas (M_d)

$$M_d = (0.44)\ (9.0) + 0.32\ (14.0) + 0.28\ (77.0)$$

M_d = 30.0

Molecular Weight of Stack Gas (wet basis) (M_s)

$$M_s = M_d\ (1 - B_{wo}) + 18\ B_{wo}$$

M_s = 27.5

RESOURCE CONSULTANTS

DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE (Method 2)

Date 6/6/79 Run No. 3

P_g	=	-0.17	Static pressure in stack, in. H_2O
P_{bar}	=	30.25	Barometric pressure, in. Hg
C_p	=	0.84	Pitot tube coefficient, dimensionless
K_p	=	85.48	ft./sec. $\left(\frac{lb}{lb\ mole\ \ ^oR}\right)$
$\left(\sqrt{\Delta P}\right)$ @	=	1.27	Average $\sqrt{\text{velocity head}}$
T_s	=	790	Average stack temperature, ^oR
M_s	=	27.5	Molecular weight of stack gas
T_{std}	=	528 ^oR	Absolute temperature @ standard conditions
P_{std}	=	29.92	Absolute pressure @ standard conditions, in. Hg.
A	=	12.25	Stack area, ft^2
P_s	=	30.24	Average stack pressure, in. Hg, absolute.
V_s	=	88.9	Stack gas velocity, ft/sec, @ stack conditions
Q_s	=	65,$\overset{3}{4}$00	Stack gas volumetric flow rate, actual ft^3/min.
Q_{sstd}	=	2,$\overset{1,}{0}$9$\overset{6}{3}$,000	Stack gas volumetric flow rate, std ft^3/hr (dry)

(1) $P_s = \dfrac{P_g}{13.6} + P_{bar}$

P_s = 30.24

(2) $V_s = K_p C_p \left(\sqrt{\Delta p}\right) @ \sqrt{\dfrac{T_s}{P_s M_s}}$

V_s = 88.9

(3) $Q_s = 60\ A\ V_s$

Q_s = 65,300

(4) $Q_{sstd} = 3600\,(1 - B_{wo})\ V_s\ A \left(\dfrac{T_{std}}{T_s}\right) \left(\dfrac{P_s}{P_{std}}\right)$

Q_{sstd} = 2,190,000

RESOURCE CONSULTANTS

DETERMINATION OF PARTICULATE EMISSIONS (Method 5)

Date 6/6/79 Run No. 3

Particulate concentration (C'_s), gr/dscf

$$C'_s = \left(0.0154 \ \frac{gr}{mg}\right) \left(\frac{M_n}{V_{mstd}}\right)$$

C'_s = 9.85

Where M_n = Particulate collected in mg

Particulate mass rate(PMR) , lbs/hour

$$PMR = (0.000143)\ (C'_s)\ (Q_{sstd})$$

PMR = 3080

Isokinetic Variation

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

I = 118 %

RESOURCE CONSULTANTS

SO_2 CALCULATIONS

$$C_{SO_2} = \frac{(7.06 \times 10^{-5})(V_t - V_b)(N)(V_{SOLN}/V_a)}{V_{m(std)}}$$

$$PMR = C_{SO_2} \times \text{Volumetric Flow Rate}$$

Where:

7.06×10^{-5} = lb/meq.

V_t = Volume of titrant, ml

V_{tb} = Volume of titrant used for blank, ml

N = Normality of barium perchlorate

V_{SOLN} = Volume of sample, ml

V_a = Volume of aliquot, ml

$V_{m(std)}$ = Volume of air sampled, dscf

C_{SO_2} = Concentration of SO_2, lb/dscf

PMR = Pollutant mass rate, lb/hr

Run No. 3

$$C_{SO_2} = \frac{(7.06 \times 10^{-5})(14.6 - 0.1)(.0097)(405/1)}{20.49}$$

$$= 1.96 \times 10^{-4}$$

$$PMR = (1.96 \times 10^{-4})(2,190,000)$$

$$= 429$$

RESOURCE CONSULTANTS INC

SUMMARY OF LABORATORY DATA

CLIENT Tombigbee Lightweight Aggregate DATE 6/6/79

SOURCE # 1 Kiln BOX NO. 9 RUN NO. 3

CONDENSATE

IMPINGER NO.	FINAL VOLUME, ml	INITIAL VOLUME, ml	NET GAIN, ml
1.	225	150	75
2.	180	150	30
3.		0	
4.	210.7 ,g	200 ,g	10.7 ,g
TOTAL		400	115.7

PARTICULATE

COMPONENT	ID NO.	FINAL WT., g	INITIAL WT., g	NET WT., g
PROBE WASH	319	116.8790	104.5778	12.3012
ACETONE BLANK	310	106.6670	106.6670	- 0.0000
PROBE WASH (-BLK)				12.3012
CYCLONE				
FILTER	1350	1.5360	0.7248	0.8112
IMPINGER H_2O (100 ml ALIQUOT)				
IMPINGER H_2O - CORRECTED TO TOTAL IMPINGER VOLUME			$\frac{(\quad)(\quad)}{100}$ =	

PARTICULATE COLLECTED (EXCLUDING IMPINGER CATCH) =	13.1124	,g
PARTICULATE COLLECTED (INCLUDING IMPINGER CATCH) =		,g

COMMENTS: SO_2 Analysis

A 1ml Sample - 14.6ml 0.0097N BaClO

B 1ml " - 14.6ml "

C 1ml " - 14.6ml "

ORSAT ANALYSIS

CO_2	
O_2	
N_2 + CO	

RESOURCE CONSULTANTS

SIGNED ______

PARTICULATE FIELD DATA

PLANT Tom bu kee Ld. wt

DATE 6/6/79

LOCATION #1 Kiln

OPERATOR Jameson Corley

STACK NO. 2

RUN NO. 2

SAMPLE BOX NO. 9, 7 Str. H1 Gr #3

METER BOX NO. 3

AMBIENT TEMPERATURE 86

BAROMETRIC PRESSURE 30.25

ASSUMED MOISTURE, %

PROBE LENGTH, in. 60

NOZZLE DIAMETER, in. .187

STACK DIAMETER, in. 42 X 42

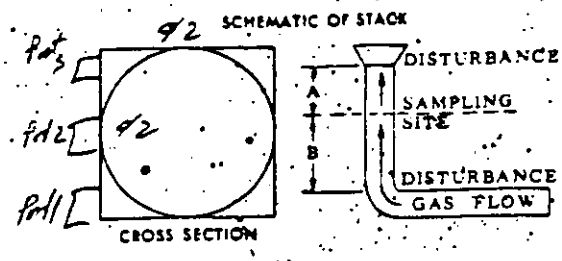
PROBE HEATER SETTING 80

HEATER BOX SETTING 250

C FACTOR 1.0

PROCESS WEIGHT RATE

SCHEMATIC OF STACK



Port	TRAVERSE POINT NUMBER	SAMPLING TIME CLOCK	SAMPLING TIME SAMPLE TIME	STACK TEMP. (T_s) °F	VELOCITY HEAD (ΔP_s)	VELOCITY HEAD $(\sqrt{\Delta P_s})$	ORIFICE METER (ΔH) in. H_2O ACTUAL	ORIFICE METER DESIRED	GAS SAMPLE VOLUME (Vm), Ft³	GAS SAMPLE TEMP. AT DRY GAS METER INLET (Tm_{in}) °F	OUTLET (Tm_{out}) °F	SAMPLE BOX TEMP. °F	TEMP. OF GAS LEAVING LAST IMPINGER °F	PUMP VACUUM in. Hg GUAGE
									536.21					
	1		2	378	.09		.09		536.5	94	86	225	88	<2
	2		4		<0									
	3		6		<0					96	88	250	90	<2
	4		8	391	<0		.09		537.6					
Port #1	1		2	400	3.1		3.0		539.4	105	92	260	70	11.0
	2		4	352	3.0		2.9		541.2	110	92	270	64	13.0
	3		6	330	2.8		2.7		542.9	115	95	274	72	14.0
	4		8	295	2.0		2.0		544.5	120	95	236	72	10.0
#2 Port	1		2	400	3.1		3.0		546.3	116	96	256	76	14.0
	2		4	335	3.9		3.0		548.2	125	96	262	82	17.0
	3		6	320	2.9		2.8		549.9	128	98	225	90	16.5
	4		8	289	1.9		1.9		551.48	130	98	245	90	12.5
#3	1		2	318	2.5		2.5		553.2	120	102	276	76	10.0
	2		4	294	2.9		2.8		555.0	125	104	254	74	12.0
	3		6	278	2.7		2.6		556.7	128	105	240	79	12.0
	4		8	235	1.1		1.1		558.1	128	106	260	82	13.0
	TOTAL													
	AVERAGE													

WEIGHT OF PARTICULATE COLLECTED, mg

	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
FILTER			
PROBE WASH			
TOTAL WEIGHT GAIN			

VOLUME OF LIQUID WATER COLLECTED

Impinger	Final	Initial	Liquid Collected
1	225	150	
2	180	150	
3	—	—	
4	—	—	
SILICA GEL			
Total Volume Collected			

Fyrite ORSAT MEASUREMENT

Test	Time	CO_2	O_2	CO	N_2
1		9	14		
2					
3					
4					

COMMENTS Pitot Leak Check #2
Pitot Leak [illegible]

RESOURCE CONSULTANTS
environmental engineers and scientists

SUMMARY OF TEST DATA

Source Name Tombigbee Lightweight Aggregate

Location Kiln # 1

Run No. 4 Date 6/6/79

Particulate Sampling Train

Sampling nozzle diameter, in.	D_n	0.187
Sampling nozzle cross-sectional area, ft.^{2}	A_n	0.000191
Sampling time, min.	θ	24
Sample gas volume-meter conditions, ft.^{3}	V_m	20.61
Average meter temperature, ^oR	T_m	576
Average orifice pressure drop, in. H_2O	ΔH	2.5
Particulate collected, mg.	M_n	--
Sample gas volume @ standard conditions, ft.^{3} (dry)	V_{mstd}	19.02

Velocity Traverse

Stack area, ft.^{2}	A	12.25
Average stack pressure, in. Hg absolute	P_s	30.24
Average stack temperature, ^oR	T_s	788
Static pressure in stack, in. H_2O	P_g	-0.17
Average $\sqrt{\text{velocity head}}$	$(\sqrt{\Delta p})$ @	1.62
Molecular weight of stack gas	M_s	27.7
Barometric pressure, in. Hg	P_{bar}	30.25
Stack gas velocity, ft./sec. @ stack conditions	V_s	112.8

Stack Moisture Content

Total water collected by train, ml	V_{lc}	94.5
Volume of water vapor @ standard conditions. ft^3	V_{wstd}	4.45
Moisture in stack gas, %	M_{pc}	0.190

Emission Data

Stack gas flow rate, acfm	Q_s	--
Stack gas flow rate, scfh	Q_{sstd}	--
Total particulate concentration, gr/dscf	C'_s	--
Particulate mass rate . lbs/hr	PMR	--
Percent isokinetic of test	I	112

RESOURCE CONSULTANTS

CORRECTION OF DRY GAS SAMPLE
VOLUME TO STANDARD CONDITIONS

Date 6/6/79 Run 4

θ	=	24	Sampling time, min.
V_m	=	20.61	Sample gas volume, meter conditions, $ft.^3$
P_{bar}	=	30.25	Barometric pressure, in. Hg.
ΔH	=	1.62	Average orifice pressure drop, in H_2O
T_{ad}	=	125	Average meter temperature, inlet, ^oF
T_{ae}	=	107	Average meter temperature, outlet, ^oF
T_m	=	576	Average meter temperature, ^oR
V_{mstd}	=	19.02	Sample gas volume @ standard conditions, ft^3 (dry)
Y	=	0.99	Dry gas meter calibration factor (dimensionless)

(1) $$T_m = \frac{T_{ad} + T_{ae}}{2} + 460$$

T_m = 576

(2) $$V_{mstd} = \left(17.64 \frac{^oR}{in.\ Hg}\right) Y \ V_m \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}\right)$$

V_{mstd} = 19.02

RESOURCE CONSULTANTS

DETERMINATION OF MOISTURE IN STACK GAS (Method 5)

Date 6/6/79 Run No. 4

Total volume of water collected in impingers and silica gel (V_{lc}) ml = 94.5

Volume of water vapor (V_{wstd}) $ft.^3$

$$V_{wstd} = (0.0474\ ft.^3/ml)\ (V_{lc})$$

V_{wstd} = 4.45

Proportion by volume of water vapor in the gas stream (B_{wo})

$$B_{wo} = \frac{V_{wstd}}{V_{wstd} + V_{mstd}}$$

B_{wo} = 0.190

Percent moisture in stack gas (M_{pc}) %

$$M_{pc} = 100 \times B_{wo}$$

M_{pc} = 19.0 %

RESOURCE CONSULTANTS

GAS ANALYSIS FOR DRY MOLECULAR WEIGHT (Method 3)

Date 6/6/79 Run No. 4

Component	% Volume Dry Basis	Molecular Weight
CO_2	9.0	44
O_2	14.0	32
$CO + N_2$	77.0	28

Dry Molecular Weight of Stack Gas (M_d)

$$M_d = (0.44)\ (9.0) + 0.32\ (14.0) + 0.28\ (77.0)$$

M_d = 30.0

Molecular Weight of Stack Gas (wet basis) (M_s)

$$M_s = M_d\ (1 - B_{wo}) + 18\ B_{wo}$$

M_s = 27.7

RESOURCE CONSULTANTS

DETERMINATION OF STACK GAS VELOCITY AND ISOKINETIC VARIATION

Date 6/6/79 Run No. 4

P_g	=	-0.17	Static pressure in stack, in. H_2O
P_{bar}	=	30.25	Barometric pressure, in. Hg
C_p	=	0.84	Pitot tube coefficient, dimensionless
K_p	=	85.48	ft./sec. $\left(\frac{lb}{lb\ mole\ {}^{o}R}\right)$
$\left(\sqrt{\Delta P}\right)$ @	=	1.67	Average $\sqrt{\text{velocity head}}$
T_s	=	788	Average stack temperature, ^{o}R
M_s	=	27.7	Molecular weight of stack gas
T_{std}	=	528 ^{o}R	Absolute temperature @ standard conditions
P_{std}	=	29.92	Absolute pressure @ standard conditions, in. Hg.
A	=	12.25	Stack area, ft^2
P_s	=	30.24	Average stack pressure, in. Hg, absolute
V_s	=	113	Stack gas velocity, ft/sec, @ stack conditions
Q_s	=	--	Stack gas volumetric flow rate, actual ft^3/min.
Q_{sstd}	=	--	Stack gas volumetric flow rate, std ft^3/hr (dry)

(1) $$P_s = \frac{P_g}{13.6} + P_{bar}$$

P_s = 30.24

(2) $$V_s = K_p C_p \left(\sqrt{\Delta p}\right) @ \sqrt{\frac{T_s}{P_s M_s}} = 113$$

Isokinetic Variation

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

I = 112 %

RESOURCE CONSULTANTS

PARTICULATE FIELD DATA

PLANT Ison Lingbec

DATE 1/6/79

LOCATION #1 Kiln

OPERATOR Farrar Curley

STACK NO. 2

RUN NO. 4

SAMPLE BOX NO. 10, [illegible]

METER BOX NO. 9

AMBIENT TEMPERATURE 40

BAROMETRIC PRESSURE 30.25

ASSUMED MOISTURE, % 15%

PROBE LENGTH, in. 60

NOZZLE DIAMETER, in. .187

STACK DIAMETER, in. 42x42

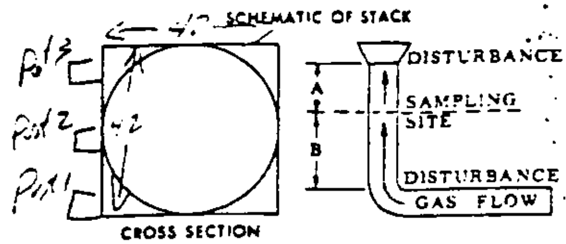
PROBE HEATER SETTING 50

HEATER BOX SETTING 75

C FACTOR 1.0

PROCESS WEIGHT RATE

SCHEMATIC OF STACK



	TRAVERSE POINT NUMBER	SAMPLING TIME CLOCK	SAMPLE TIME	STACK TEMP. (T_s) °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	ORIFICE METER (ΔH) in., H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), Ft.³	GAS SAMPLE TEMP. AT DRY GAS METER INLET (Tm_{in}) °F	OUTLET (Tm_{out}) °F	SAMPLE BOX TEMP. °F	TEMP. OF GAS LEAVING LAST IMPINGER °F	PUMP VACUUM in. Hg GUAGE
									558.22					
Port 2	1		4	390	3.2		3.0		561.9	105	102	200	65	10.0
	2		8	354	3.2		3.0		565.6	115	105	225	73	14.0
	3		12	340	2.9		2.6		569.2	130	105	275	100	12.0
	4	"	16	316	1.7		1.6		572.11	134	108	275	118	7.0
Port 3	1		2	315	3.4		3.2		574.0	126	109	254	98	13.0
	2		4	312	3.2		2.9		575.9	132	110	264	96	11.0
	3		6	272	2.6		2.3		577.6	134	110	251	94	9.0
	4		8	232	1.2		1.1		578.83	135	112	260	92	5.0
	TOTAL													
	AVERAGE													

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

VOLUME OF LIQUID WATER COLLECTED			
Impinger	Final	— Initial	= Liquid Collected
1			
2			
3			
4			
SILICA GEL			
Total Volume Collected			

ORSAT MEASUREMENT					
Test	Time	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS: Pre test leak check ok
Post test leak check ok

RESOURCE CONSULTANTS
environmental engineers and scientists

APPENDIX B

PARTICLE SIZE ANALYSES

PARTICLE DATA LABORATORIES, LTD.

115 Hahn Street • Elmhurst, Illinois 60126 • (312) 832-5658

June 18, 1979

Resource Consultants
P.O. Box 498
Maryland Farms
Suite 340
Brentwood, Tennessee 37027

Attn: Mr. Billy R. Nichols

Subj: Bahco Analysis
PDL Project I-5775

Gentlemen:

Two samples submitted for a Bahco analysis were oven dried to determine volatiles and then given a sieve analysis to remove particles greater than 100 mesh (149µ). The material passing the 100 mesh sieve was given a standard Bahco analysis. The results of the test series are as follows:

Volatiles at 100°C	% By Weight
Clay Kiln	Nil

Sieve Analysis

Sample	Mesh Size	Microns	% Retained
Clay Kiln	100	149	59.1%

Your samples will be returned to you under separate cover for your examination.

Bahco Analysis

The results of this test series are shown in the following data groupings. Each group consists of a terminal settling velocity and a micron size distribution by weight performed in accordance with the American Society of Mechanical Engineers Power Test Code 28.

Electrozone Analysis

The sample was given a standard Electrozone Analysis (brochure included) and in both cases, the data was extrapolated back below 1.2 microns. We encourage you to call us, and we will discuss your data on a one-to-one basis as we have an exact duplicate copy on file.

Conclusion

The sample was analyzed on a Bahco classifier using the ASME Power Test Code 28. In addition, the material was given a sieve analysis for material greater than 100 mesh and the specific gravity of a composite sample was determined as per ASTM method C135.

It has been a pleasure serving Resource Consultants, and we look forward to the pleasure of serving you again in the future.

Respectfully submitted,

PARTICLE DATA LABORATORIES, LTD.

Kirk A Evans

Kirk Evans
Technical Staff

KE/jh

PARTICLE SIZE ANALYSIS BY PARTICLE DATA LABS. - ELZONE METHOD
115 HAHN STREET, ELMHURST, IL 60126
TELEPHONE: 312/832-5658

FOR: RESOURCE CONSULTANTS
ON SAMPLE: CLAY KILN
DATE: 18 JUN 79

STATISTICS FOR VOLUME DISTRIBUTION:

INDICES

VOLUME MODE = 1.22 MEDIAN = 1.50 MICRONS AND LARGER

GEOMETRIC VOLUME MEAN = 1.59 +/- 2.35 (147.84%) SKEWNESS = .16

ARITHMETIC VOLUME MEAN = 2.62 +/- 4.14 (157.90%) SKEWNESS = .34

PERCENTILE:	0.48	MICRONS AND LARGER HAS	93.03%	OF VOLUME
PERCENTILE:	0.60	MICRONS AND LARGER HAS	88.18%	OF VOLUME
PERCENTILE:	0.76	MICRONS AND LARGER HAS	81.54%	OF VOLUME
PERCENTILE:	0.95	MICRONS AND LARGER HAS	73.21%	OF VOLUME
PERCENTILE:	1.20	MICRONS AND LARGER HAS	60.24%	OF VOLUME
PERCENTILE:	1.50	MICRONS AND LARGER HAS	50.16%	OF VOLUME
PERCENTILE:	1.90	MICRONS AND LARGER HAS	40.55%	OF VOLUME
PERCENTILE:	2.40	MICRONS AND LARGER HAS	28.99%	OF VOLUME
PERCENTILE:	3.80	MICRONS AND LARGER HAS	16.33%	OF VOLUME
PERCENTILE:	4.80	MICRONS AND LARGER HAS	11.51%	OF VOLUME
PERCENTILE:	10.0	MICRONS AND LARGER HAS	4.71%	OF VOLUME
PERCENTILE:	15.0	MICRONS AND LARGER HAS	2.24%	OF VOLUME
PERCENTILE:	22.0	MICRONS AND LARGER HAS	.87%	OF VOLUME
PERCENTILE:	27.0	MICRONS AND LARGER HAS	.50%	OF VOLUME
PERCENTILE:	32.0	MICRONS AND LARGER HAS	.34%	OF VOLUME
PERCENTILE:	38.0	MICRONS AND LARGER HAS	.19%	OF VOLUME
PERCENTILE:	45.0	MICRONS AND LARGER HAS	.12%	OF VOLUME
PERCENTILE:	53.0	MICRONS AND LARGER HAS	.08%	OF VOLUME
PERCENTILE:	63.0	MICRONS AND LARGER HAS	.04%	OF VOLUME
PERCENTILE:	75.0	MICRONS AND LARGER HAS	.02%	OF VOLUME
PERCENTILE:	90.0	MICRONS AND LARGER HAS	.01%	OF VOLUME
PERCENTILE:	106.	MICRONS AND LARGER HAS	.00%	OF VOLUME
PERCENTILE:	125.	MICRONS AND LARGER HAS	.00%	OF VOLUME
PERCENTILE:	150.	MICRONS AND LARGER HAS	.00%	OF VOLUME

AT 0.77 SIGMA INTERVALS ON PROBABILITY PAPER:

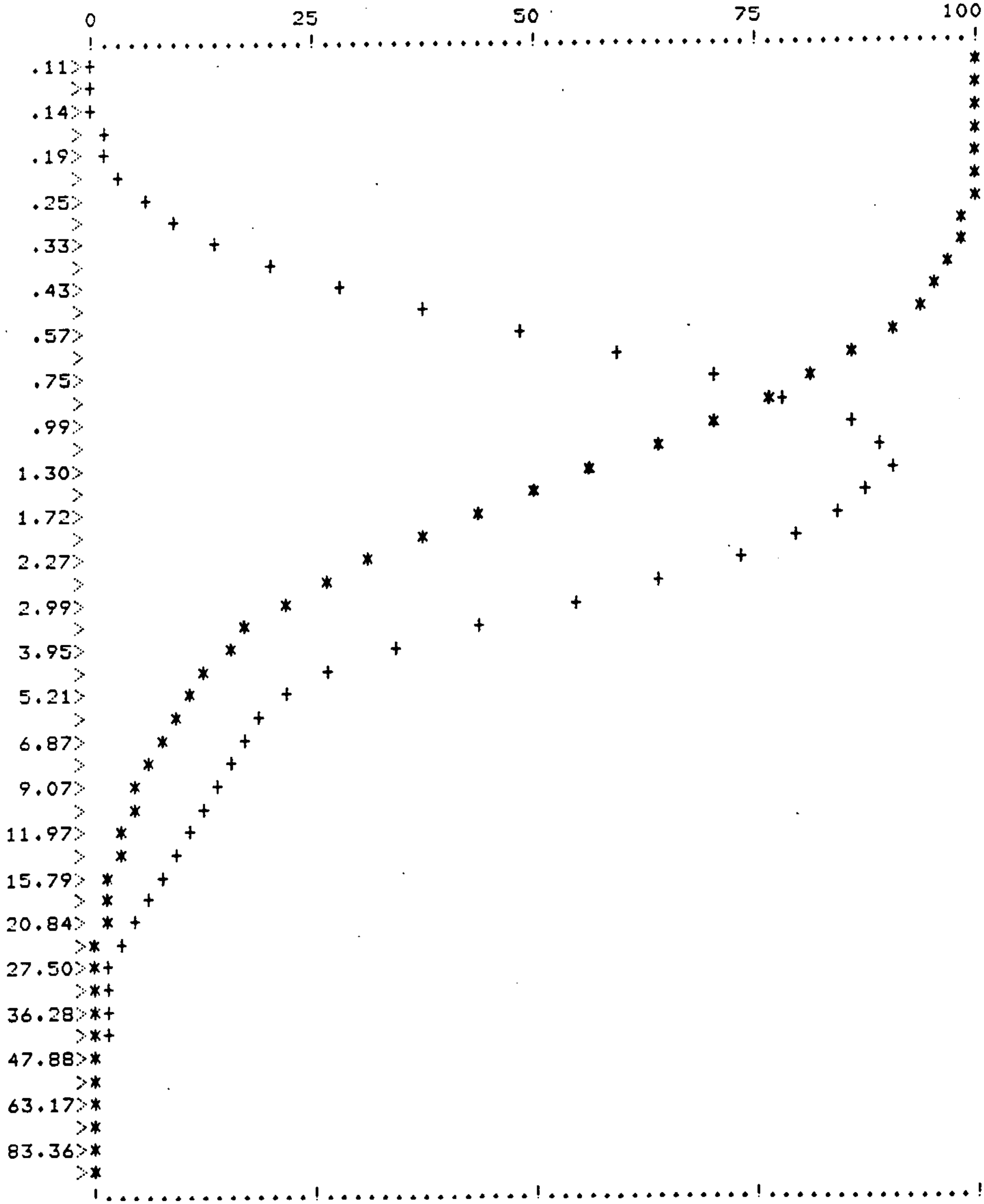
PERCENTILE:	00.1%	OF VOLUME IS AT	44.67	MICRONS AND LARGER
PERCENTILE:	01.0%	OF VOLUME IS AT	20.84	MICRONS AND LARGER
PERCENTILE:	06.0%	OF VOLUME IS AT	7.90	MICRONS AND LARGER
PERCENTILE:	22.0%	OF VOLUME IS AT	2.79	MICRONS AND LARGER
PERCENTILE:	50.0%	OF VOLUME IS AT	1.50	MICRONS AND LARGER
PERCENTILE:	78.0%	OF VOLUME IS AT	.80	MICRONS AND LARGER
PERCENTILE:	94.0%	OF VOLUME IS AT	.46	MICRONS AND LARGER
PERCENTILE:	99.0%	OF VOLUME IS AT	.26	MICRONS AND LARGER
PERCENTILE:	99.9%	OF VOLUME IS AT	.16	MICRONS AND LARGER

PARTICLE SIZE ANALYSIS BY PARTICLE DATA LABS. - ELZONE METHOD
115 HAHN STREET, ELMHURST, IL 60126
TELEPHONE: 312/832-5658

FOR: RESOURCE CONSULTANTS
ON SAMPLE: CLAY KILN
DATE: 18 JUN 79

PARTICLE SIZE VS. VOLUME (+) AND % OF VOLUME LARGER THAN SIZE (*)

GRAPH - FROM : TO : - SKIP: #1



PARTICLE SIZE ANALYSIS BY PARTICLE DATA LABS. - ELZONE METHOD
115 HAHN STREET, ELMHURST, IL 60126
TELEPHONE: 312/832-5658

FOR: RESOURCE CONSULTANTS
ON SAMPLE: CLAY KILN
DATE: 18 JUN 79

TABULATION

DATA ID 5775 DATE 18 JUN
SIZE-NORMALIZED VOLUME DISTRIBUTION
TOTAL = 1.12199E 8

CHNL	SIZE	VOLUME	CHNL	SIZE	VOLUME	CHNL	SIZE	VOLUME
6	.12	8329	39	1.13	3766430	72	11.17	481888
7	.12	11893	40	1.22	3788419	73	11.97	443840
8	.13	16804	41	1.30	3775858	74	12.83	406572
9	.14	23490	42	1.40	3735109	75	13.75	370284
10	.15	32490	43	1.50	3673754	76	14.74	335094
11	.16	44462	44	1.60	3598391	77	15.79	301148
12	.17	58241	45	1.72	3512994	78	16.93	268646
13	.19	78275	46	1.84	3418358	79	18.14	237815
14	.20	104235	47	1.97	3312278	80	19.44	208882
15	.21	137489	48	2.12	3190533	81	20.84	182047
16	.23	179541	49	2.27	3048691	82	22.34	157474
17	.25	232171	50	2.43	2884145	83	23.94	135257
18	.26	297307	51	2.60	2696942	84	25.66	115409
19	.28	376313	52	2.79	2490226	85	27.50	97878
20	.30	470671	53	2.99	2270156	86	29.47	82556
21	.33	581500	54	3.21	2044802	87	31.59	69291
22	.35	709508	55	3.44	1822903	88	33.85	57899
23	.37	854756	56	3.68	1612799	89	36.28	48186
24	.40	1017018	57	3.95	1421633	90	38.89	39954
25	.43	1195894	58	4.23	1254484	91	41.68	33014
26	.46	1389893	59	4.54	1114050	92	44.67	27191
27	.49	1596565	60	4.86	1000737	93	47.88	22313
28	.53	1812849	61	5.21	912689	94	51.31	18264
29	.57	2035330	62	5.58	846195	95	55.00	14915
30	.61	2260305	63	5.98	796382	96	58.94	12155
31	.65	2484346	64	6.41	757918	97	63.17	9888
32	.70	2704815	65	6.87	725690	98	67.71	8031
33	.75	2918638	66	7.37	695517	99	72.57	6687
34	.80	3121674	67	7.90	664595	100	77.78	5379
35	.86	3308481	68	8.46	631510	101	83.36	4311
36	.92	3472593	69	9.07	596010	102	89.34	3443
37	.99	3607127	70	9.72	558663	103	95.75	2739
38	1.06	3706122	71	10.42	520354	104	102.63	2171

CONVERT FROM VOLUME TO COUNT TOTAL= 3.77184E 8

PARTICLE SIZE ANALYSIS BY PARTICLE DATA LABS. - ELZONE METHOD
115 HAHN STREET, ELMHURST, IL 60126
TELEPHONE: 312/832-5658

FOR: RESOURCE CONSULTANTS
ON SAMPLE: CLAY KILN
DATE: 18 JUN 79

STATISTICS FOR COUNT DISTRIBUTION:

INDICES

COUNT MODE = .33 MEDIAN = .33 MICRONS AND LARGER

GEOMETRIC COUNT MEAN = .34 +/- .28 (81.38%) SKEWNESS = .06

ARITHMETIC COUNT MEAN = .41 +/- .31 (74.10%) SKEWNESS = .29

PERCENTILE:	0.48	MICRONS AND LARGER HAS	28.12%	OF COUNT
PERCENTILE:	0.60	MICRONS AND LARGER HAS	18.40%	OF COUNT
PERCENTILE:	0.76	MICRONS AND LARGER HAS	11.23%	OF COUNT
PERCENTILE:	0.95	MICRONS AND LARGER HAS	6.39%	OF COUNT
PERCENTILE:	1.20	MICRONS AND LARGER HAS	2.71%	OF COUNT
PERCENTILE:	1.50	MICRONS AND LARGER HAS	1.33%	OF COUNT
PERCENTILE:	1.90	MICRONS AND LARGER HAS	.62%	OF COUNT
PERCENTILE:	2.40	MICRONS AND LARGER HAS	.21%	OF COUNT
PERCENTILE:	3.80	MICRONS AND LARGER HAS	.03%	OF COUNT
PERCENTILE:	4.80	MICRONS AND LARGER HAS	.01%	OF COUNT
PERCENTILE:	10.0	MICRONS AND LARGER HAS	.00%	OF COUNT
PERCENTILE:	15.0	MICRONS AND LARGER HAS	.00%	OF COUNT
PERCENTILE:	22.0	MICRONS AND LARGER HAS	.00%	OF COUNT
PERCENTILE:	27.0	MICRONS AND LARGER HAS	.00%	OF COUNT
PERCENTILE:	32.0	MICRONS AND LARGER HAS	.00%	OF COUNT
PERCENTILE:	38.0	MICRONS AND LARGER HAS	.00%	OF COUNT
PERCENTILE:	45.0	MICRONS AND LARGER HAS	.00%	OF COUNT
PERCENTILE:	53.0	MICRONS AND LARGER HAS	.00%	OF COUNT
PERCENTILE:	63.0	MICRONS AND LARGER HAS	.00%	OF COUNT
PERCENTILE:	75.0	MICRONS AND LARGER HAS	.00%	OF COUNT
PERCENTILE:	90.0	MICRONS AND LARGER HAS	.00%	OF COUNT
PERCENTILE:	106.	MICRONS AND LARGER HAS	.00%	OF COUNT
PERCENTILE:	125.	MICRONS AND LARGER HAS	.00%	OF COUNT
PERCENTILE:	150.	MICRONS AND LARGER HAS	.00%	OF COUNT

AT 0.77 SIGMA INTERVALS ON PROBABILITY PAPER:

PERCENTILE:	00.1%	OF COUNT IS AT	2.79	MICRONS AND LARGER
PERCENTILE:	01.0%	OF COUNT IS AT	1.60	MICRONS AND LARGER
PERCENTILE:	06.0%	OF COUNT IS AT	.92	MICRONS AND LARGER
PERCENTILE:	22.0%	OF COUNT IS AT	.53	MICRONS AND LARGER
PERCENTILE:	50.0%	OF COUNT IS AT	.33	MICRONS AND LARGER
PERCENTILE:	78.0%	OF COUNT IS AT	.21	MICRONS AND LARGER
PERCENTILE:	94.0%	OF COUNT IS AT	.14	MICRONS AND LARGER
PERCENTILE:	99.0%	OF COUNT IS AT	.12	MICRONS AND LARGER
PERCENTILE:	99.9%	OF COUNT IS AT	.12	MICRONS AND LARGER

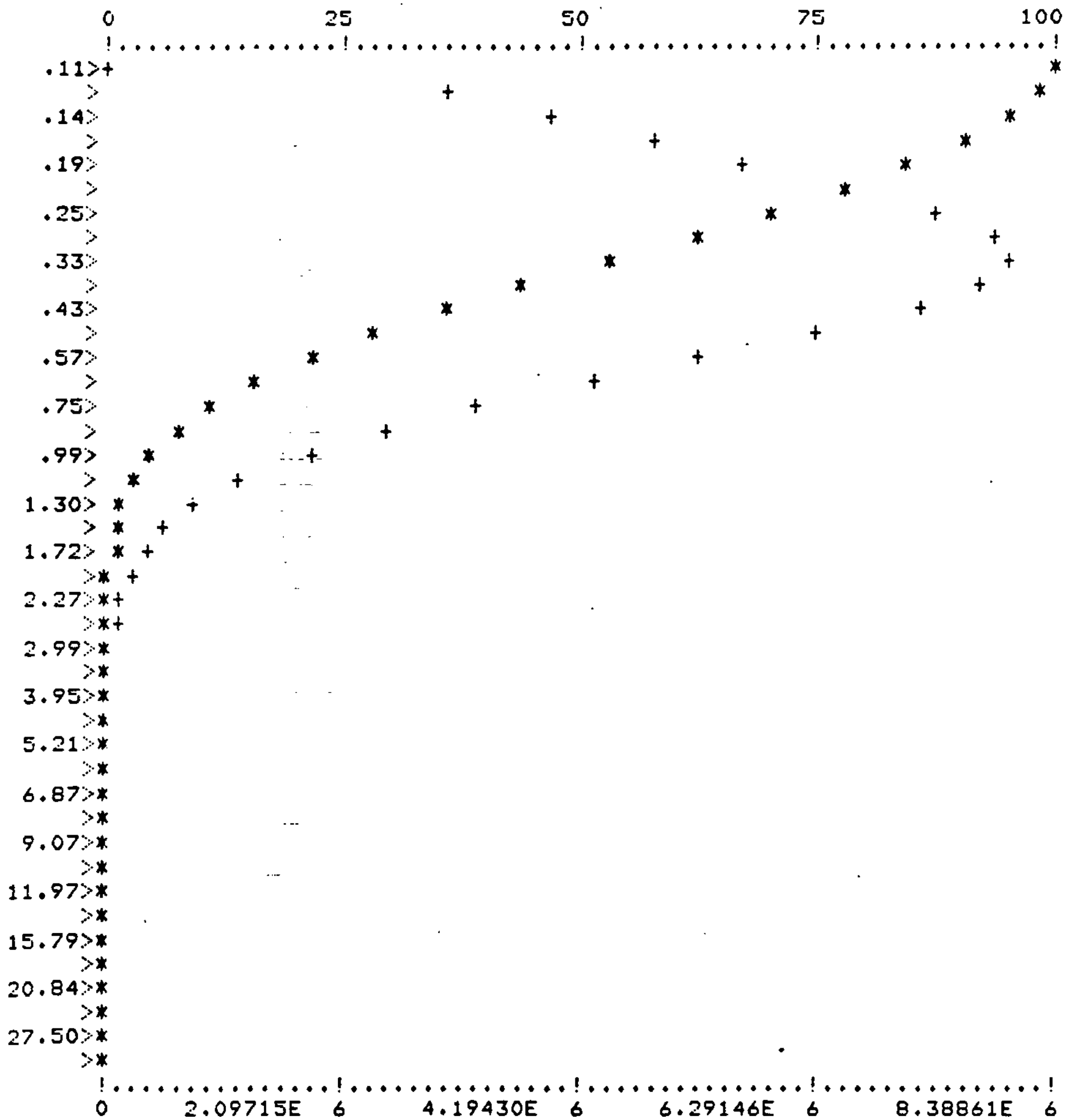
PARTICLE SIZE ANALYSIS BY PARTICLE DATA LABS. — ELZONE METHOD

115 HAHN STREET, ELMHURST, IL 60126
TELEPHONE: 312/832-5658

FOR: RESOURCE CONSULTANTS
ON SAMPLE: CLAY KILN
DATE: 18 JUN 79

PARTICLE SIZE VS. COUNT (+) AND % OF COUNT LARGER THAN SIZE (*)

GRAPH - FROM : TO : - SKIP: #1



PARTICLE SIZE ANALYSIS BY PARTICLE DATA LABS. - ELZONE METHOD

115 HAHN STREET, ELMHURST, IL 60126
TELEPHONE: 312/832-5658

FOR: RESOURCE CONSULTANTS
ON SAMPLE: CLAY KILN
DATE: 18 JUN 79

TABULATION

DATA ID 5775 DATE 18 JUN
SIZE-NORMALIZED COUNT DISTRIBUTION
TOTAL = 1.79178E 8

CHNL	SIZE	COUNT	CHNL	SIZE	COUNT	CHNL	SIZE	COUNT
6	.12	2593142	34	.80	2877198	62	5.58	2309
7	.12	3007570	35	.86	2476861	63	5.98	1765
8	.13	3450803	36	.92	2111630	64	6.41	1364
9	.14	3918768	37	.99	1781624	65	6.87	1061
10	.15	4402856	38	1.06	1486844	66	7.37	826
11	.16	4894120	39	1.13	1227344	67	7.90	641
12	.17	5207251	40	1.22	1002733	68	8.46	495
13	.19	5684520	41	1.30	811772	69	9.07	379
14	.20	6148594	42	1.40	652248	70	9.72	289
15	.21	6587502	43	1.50	521089	71	10.42	218
16	.23	6987270	44	1.60	414580	72	11.17	164
17	.25	7339094	45	1.72	328766	73	11.97	123
18	.26	7631735	46	1.84	259876	74	12.83	91
19	.28	7847404	47	1.97	204588	75	13.75	68
20	.30	7972829	48	2.12	160000	76	14.74	50
21	.33	8001025	49	2.27	124182	77	15.79	36
22	.35	7929527	50	2.43	95423	78	16.93	26
23	.37	7759314	51	2.60	72477	79	18.14	19
24	.40	7498958	52	2.79	54357	80	19.44	13
25	.43	7162352	53	2.99	40250	81	20.84	10
26	.46	6761379	54	3.21	29448	82	22.34	7
27	.49	6308574	55	3.44	21325	83	23.94	5
28	.53	5816876	56	3.68	15326	84	25.66	3
29	.57	5305443	57	3.95	10976	85	27.50	2
30	.61	4785993	58	4.23	7864	86	29.47	2
31	.65	4272857	59	4.54	5672	87	31.59	1
32	.70	3778657	60	4.86	4139	88	33.85	1
33	.75	3311858	61	5.21	3066			

PARTICLE DATA LABORATORIES, LTD.

115 Hahn Street • Elmhurst, Illinois 60126 • (312) 832-5658

PARTICLE SIZE ANALYSIS
BY BAHCO TEST METHOD
POWER TEST CODE 28

DATE: June 18, 1979

COMPANY: Resource Consultants

SAMPLE: Clay Kiln

SPECIFIC GRAVITY	2.55	grams/cc
PERCENT ABOVE 100 MESH	59.1	
PERCENT BELOW 100 MESH	40.9	
PARTICLE SIZE CURVE BASED ON SPECIFIC GRAVITY	2.55	grams/cc

The particle size distribution of your sample was determined by data obtained from the Bahco Centrifugal Classifier. Analysis was performed in accordance with the American Society of Mechanical Engineers Power Test Code 28. The particle size distribution presented in the graph is that part of the distribution which the Bahco Classifier is used for. The attached information details the principle and operation of the Bahco Centrifugal Classifier.

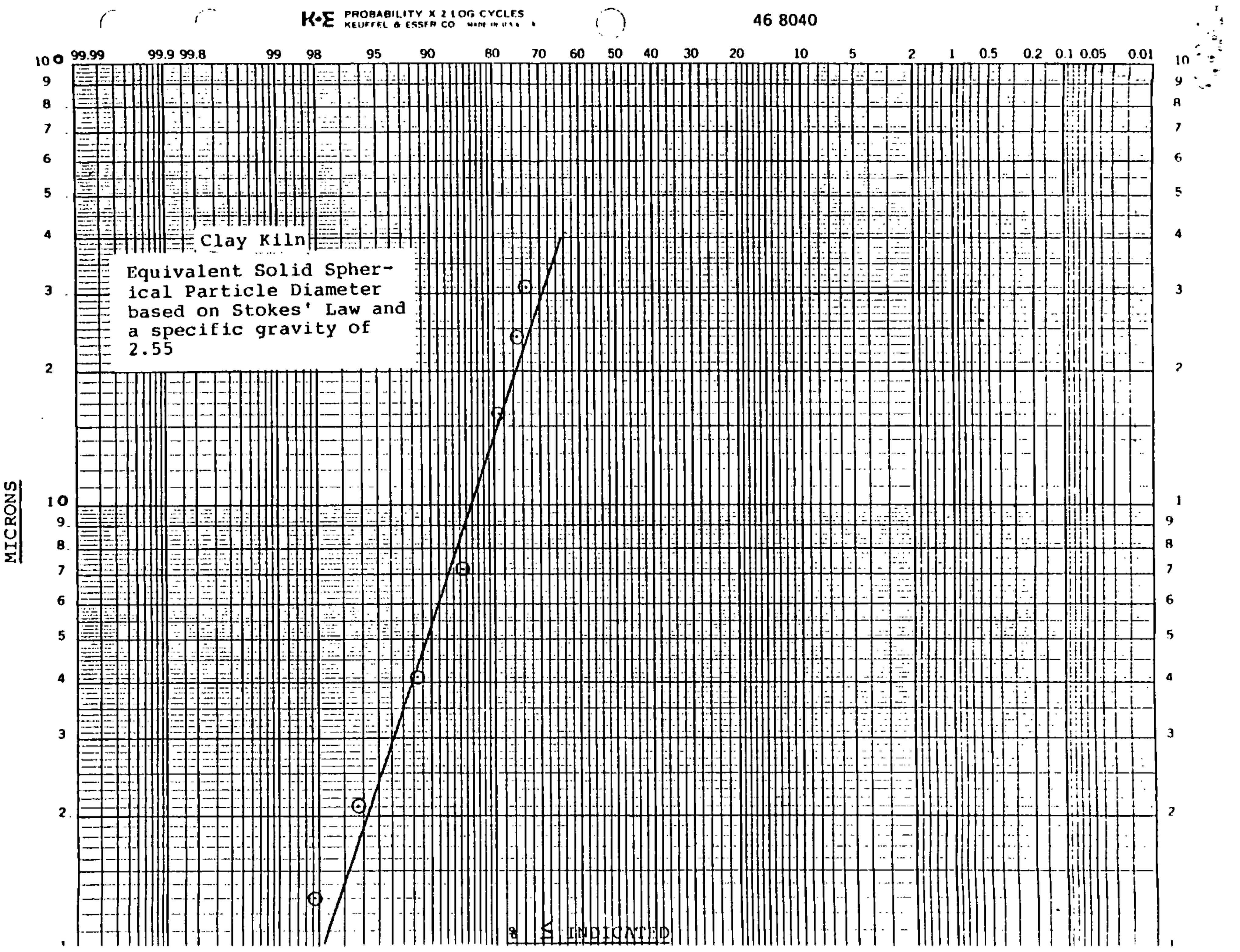
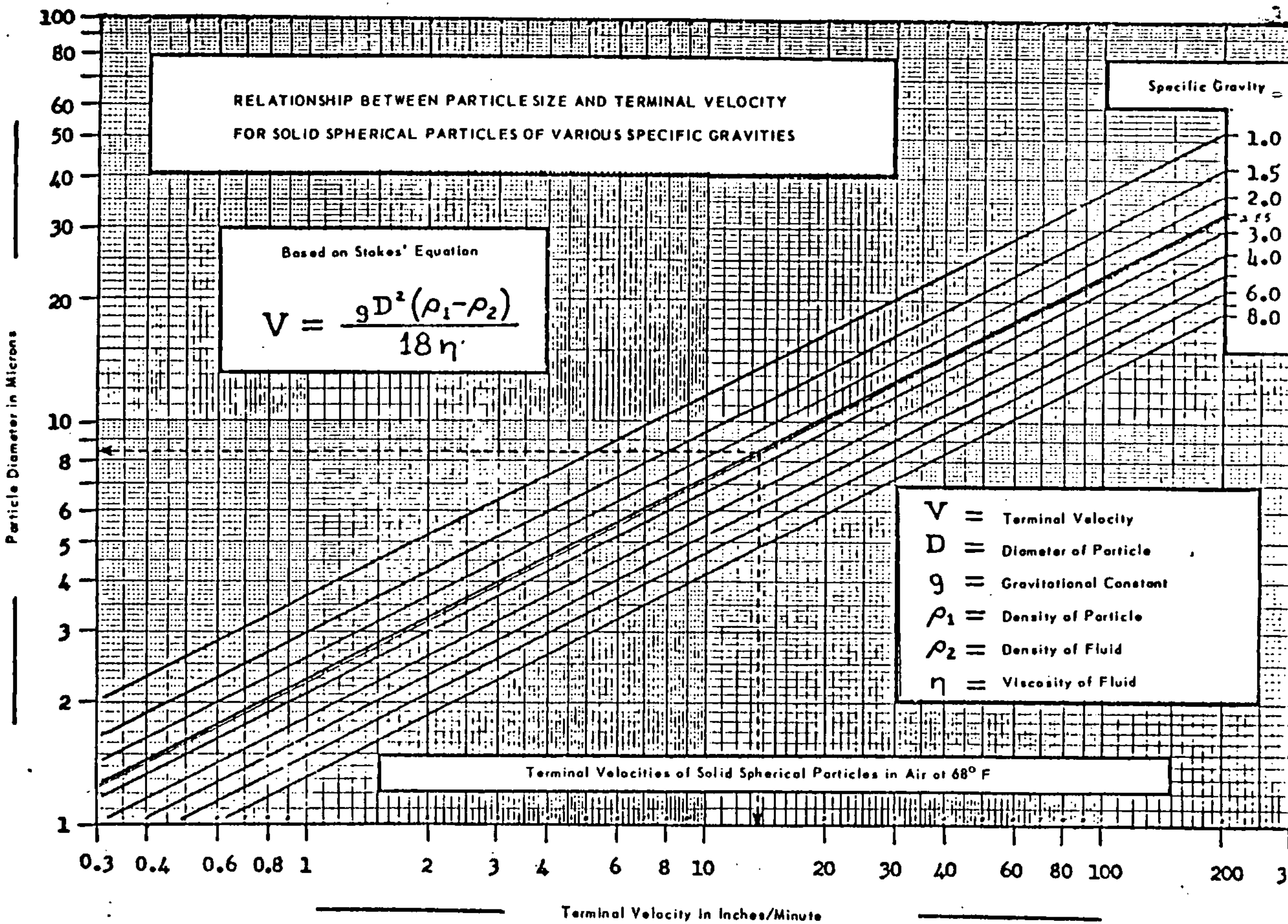

K•E PROBABILITY X 2 LOG CYCLES
KEUFFEL & ESSER CO.
46 8040
Clay Kiln
Equivalent Solid Spherical Particle Diameter based on Stokes' Law and a specific gravity of 2.55
MICRONS
% ≤ INDICATED

FIG. 6



RELATIONSHIP BETWEEN PARTICLE SIZE AND TERMINAL VELOCITY
FOR SOLID SPHERICAL PARTICLES OF VARIOUS SPECIFIC GRAVITIES
Based on Stokes' Equation
$V = \frac{g D^2 (\rho_1 - \rho_2)}{18 \eta}$
Specific Gravity =
1.0
1.5
2.0
2.65
3.0
4.0
6.0
8.0
V = Terminal Velocity
D = Diameter of Particle
g = Gravitational Constant
ρ_1 = Density of Particle
ρ_2 = Density of Fluid
η = Viscosity of Fluid
Terminal Velocities of Solid Spherical Particles in Air at 68° F
100
80
60
50
40
30
20
10
8
6
5
4
3
2
1
Particle Diameter in Microns
0.3
0.4
0.6
0.8
1
2
3
4
6
8
10
20
30
40
60
80
100
200
300
Terminal Velocity In Inches/Minute

DRAFT/WP
d3006-4/971130
03/30/92 1

NO PROCESS DATA

R OF 4 - ~~18~~ 17

Emission Test Report
Review Checklist

Reviewer: R. MARINSHAW
Review Date: 11/18/92

A. Background Information

1. Facility name: TOMBIGBEE LIGHTWEIGHT AGGREGATE CORP
   Location: LIVINGSTON, AL
2. Source category: LIGHTWEIGHT AGGREGATE
3. Test date: 6/5 - 6/6/79
4. Test sponsor: PLANT
5. Testing contractor: RESOURCE CONSULTANTS
6. Purpose of test: COMPLIANCE

7. Pollutants measured

   PM PM-10 CO SO_2 NO_x VOC Pb CO_2

   Others (list): ______

8. Process overview: On an attached page provide a block diagram of the unit operations and associated air pollution control systems at the facility. Identify process tested with letters from the beginning of the alphabet (A, B, C, etc.) and APC systems with letters from end of alphabet (V, W, X, etc.). Also identify test locations with Arabic numerals (1,2,3, ...). Using the ID symbols from that sketch complete the table below that identifies processes or unit operations tested.

Test ID	Process	Process ID	Emissions tested		APCD (controlled emissions only)
			Uncontrolled	Controlled	
	KILN (No. 1)				

B. Process Information

1. Provide a brief narrative description of the process. With as much detail as possible, (e.g., if a furnace or conveyor system is used, identify the type of unit) describe the equipment used for those operations tested. (Note: If process description provided in test report is adequate, attach copy or reproduce here.)

2. For each process tested list feedstock materials and products. Indicate if activity factors are for feed (F) rate or product (P) rate.

Process ID	Feedstock materials	Products	Basis for activity factor	F/P

Basis for data: ______________________________
(Indicate page/table Nos. in test report)

3. For each process or operation tested and each test run note process capacity and operating rate during test.

Process ID	Capacity	Units	Test run	Process rate	Units
			1		
			2		
			3		
			4		
			1		
			2		
			3		
			4		
			1		
			2		
			3		
			4		
			1		
			2		
			3		
			4		

Basis for data: ______________________________

C. Air Pollution Control Systems Tested

1. For each air pollution control system pollution control system identified in A.8, note the following

ID	Type of APCD	Manufacturer	Model No.

Note: Be as specific as possible in identifying APCD. For example, indicate "pulse jet fabric filter" rather than simply "fabric filter."

2. For each system identified above, provide a narrative description. For fugitive systems describe capture techniques as well as the removal techniques (use a separate page if necessary)

3. Using the attached parameter list for guidance complete the table below. (Use additional pages as needed.)

APCD ID	Parameter	Units	Readings			
			Run 1	Run 2	Run 3	Run 4
Type of APCD:						
Type of APCD:						
Type of APCD:						

D. Sampling and Analysis Methods

1. Complete the following table

Test location	Pollutant	S & A method	Reference/ conditional method	Deviations noted
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N
			Y/N	Y/N

2. If a method used was not a reference or conditional method, provide a narrative discussion including any data manipulation needed to make results correspond to reference or conditional method results.

3. Describe any deviations identified above.

E. Emission Data Documentation

1. Tabulate the following stack gas data from the test report. (Use additional pages as needed.)

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
	Stack temperature					
	Moisture					
	Oxygen					
	Volumetric flow, actual					
	Volumetric flow, standard					
	Percent isokinetic					
	Pollutant concentration:					
	Stack temperature					
	Moisture					
	Oxygen					
	Volumetric flow, actual					
	Volumetric flow, standard					
	Percent isokinetic					
	Pollutant concentration:					
	Stack temperature					
	Moisture					
	Oxygen					
	Volumetric flow, actual					
	Volumetric flow, standard					
	Percent isokinetic					
	Pollutant concentration:					

2. Tabulate pollutant mass flux rates

Test ID	Pollutant	Units	Mass flux rates			
			Run 1	Run 2	Run 3	Run 4

3. Present example emission factor calculations below.

4. Tabulate emission factors

Process	Pollutant	Units	Average emission factor	
			Uncontrolled	Controlled

ATTACHMENT A
APCD PARAMETERS

Type of APCD	Parameters
Fabric filter	Cleaning mechanism Bag type Cleaning frequency Air to cloth ratio (A/C) Pressure drop Inlet temperature
ESP	Type (wet or dry) Number of fields Rapping cycle (if dry) Specific Collection Area (SCA) Particulate resistivity (if known) Spark rate Current and power levels
Venturi (or other high energy) scrubber	Pressure drop Liquid/gas (L/G) ratio Mist eliminator type
Packed-bed scrubber	Packing depth L/G ratio Caustic use (Y/N) pH Mist eliminator type
Carbon absorber	Bed depth Superficial gas velocity Bed temperature Desorption mechanism (media) Flue-gas moisture Cycle length Time-on-line after breakthrough