AP42 Section:	11.3
Background Chapter	4
Reference:	19
Title:	*Stationary Source Sampling Report: Lee Brick And Tile Company, Sanford, NC, Compliance Testing, Tunnel Kiln, Entropy Environmentalists, Inc., Research Triangle Park, NC, February 1978.*

BRICKS AND RELATED CLAY PRODUCTS
AP-42 Section 8.3
Reference Number
14

CH 4 Ref 19

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CENTRAL OFFICE

ENTROPY ENVIRONMENTALISTS, INC

SPECIALISTS IN SOURCE SAMPLING

Final

STATIONARY SOURCE SAMPLING REPORT

LEE BRICK AND TILE COMPANY
SANFORD, NORTH CAROLINA
COMPLIANCE TESTING
TUNNEL KILN

FEBRUARY 1978

PERFORMED FOR
PULLMAN-SWINDELL, INC.

This Report was Reviewed
by: V. Copeland
Date: 4/3/78
and found to be
Satisfactory: ☒
Unsatisfactory: ☐
Remarks: Failed

P.O. Box 12291, Research Triangle Park, North Carolina 27709
Phone 919-781-3550

REPORT CERTIFICATION

The sampling and analysis performed for this report was carried out under my direction and supervision.

Date February 17, 1978 Signature _____

Roy N. Doster

I have reviewed all testing details and results in this test report and hereby certify that the test report is authentic and accurate.

Date February 17, 1978 Signature _____

D. James Grove, P.E.

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INTRODUCTION

Stationary source sampling was performed at Lee Brick and Tile Company, Sanford, North Carolina to determine the particulate emissions from a coal-fired tunnel kiln. Three sets of simultaneous particulate tests were made on each of the two kiln stacks on February 9, 1978. In addition, a particulate sizing test was performed on each stack.

Observing the testing were Paul Sieffert and Scott Frame of Pullman-Swindell, Inc., and Sammy Amerson of the North Carolina Department of Natural Resources and Community Development.

The measurements made for stack gas flow rate and particulate emissions were made according to North Carolina Department of Natural Resources and Community Development recommendations.

The following sections of this report treat the summary of results, a brief description of the process and its operation, and the sampling and analytical procedures used.

SUMMARY OF RESULTS

Presented in Table 1 below are the emission rates as determined by the six particulate emission tests performed on the tunnel kiln outlets. The values shown are reasonably consistent and reflect the non-changing nature of the process.

Table 1

Particulate Emissions

Test Set No.	Pounds Per Hour		
	South	North	Total
1	24.0	2.01	26.0
2	22.5	1.89	24.4
3*	19.4	1.71	21.1
Avg.	22.0	1.87	23.8

*During the third set of tests, the kiln doors were not opened.

According to North Carolina Regulation 2D.0515, the maximum allowable emission rate is 17.7 pounds per hour. This is based on a process weight rate of 8.90 tons per hour and includes an estimate of the coal being combusted.

Table 2 and 3 on the following pages give the individual test summaries for the tests performed at stack #1 (south) and stack #2 (north), respectively. Table 4 presents the results from the two particle sizing tests performed. In

TABLE 2

SUMMARY OF RESULTS, PARTICULATE EMISSIONS

KILN STACK #1, SOUTH

RUN NUMBER	1	2	3
DATE	2/ 9/78	2/ 9/78	2/ 9/78
STACK TEMPERATURE, DEG. F	306.	303.	308.
PERCENT EXCESS AIR	565.	565.	565.
PERCENT ISOKINETIC	96.8	96.1	99.5
STACK FLOW RATE SCFM* DRY	20905.	21714.	21012.
STACK FLOW RATE ACFM,WET	31560.	32827.	31912.
VOLUME OF GAS SAMPLED SCF* DRY	60.89	70.21	63.42
PARTICULATES, EPA METHOD 5:			
CATCH - MGRAMS	528.7	550.0	443.2
CONCENTRATION - GR/DSCF*	0.1337	0.1206	0.1076
EMISSION RATE - LBS/HR	23.96	22.45	19.38

* 68 DEG F, 29.92 IN. HG

TABLE 3

SUMMARY OF RESULTS, PARTICULATE EMISSIONS

KILN STACK #2, NORTH

RUN NUMBER	4	5	6
DATE	2/ 9/78	2/ 9/78	2/ 9/78
STACK TEMPERATURE, DEG. F	336.	336.	335.
PERCENT EXCESS AIR	565.	565.	565.
PERCENT ISOKINETIC	98.7	97.6	95.4
STACK FLOW RATE SCFM* DRY	1522.	1422.	1461.
STACK FLOW RATE ACFM,WET	2376.	2226.	2281.
VOLUME OF GAS SAMPLED SCF* DRY	19.05	17.83	17.90
PARTICULATES, EPA METHOD 5:			
CATCH - MGRAMS	190.6	179.9	158.9
CONCENTRATION - GR/DSCF*	0.1541	0.1554	0.1367
EMISSION RATE - LBS/HR	2.01	1.89	1.71

* 68 DEG F, 29.92 IN. HG

Table 4

Particle Size Summary

----Stack #1 (South)------		----Stack #2 (North)-------	
Aerodynamic Diameter (microns)	Cumulative % Less Than Stated Size	Aerodynamic Diameter (microns)	Cumulative % Less Than Stated Size
10.7	93.0	15.7	97.6
6.72	80.6	9.79	96.1
4.48	63.2	6.55	88.6
3.11	43.5	4.55	80.6
1.96	29.2	2.85	71.6
1.01	10.1	1.48	56.7
0.61	2.5	0.91	48.2
0.41	1.7	0.63	36.3
Median Size: approx. 3.3 microns		Median Size: approx. 1.3 microns	

addition to the Andersen tests, the first set of simultaneous tests used cyclones ahead of the filter. No large particles were caught, although some small particles did adhere to the cyclone's surface due to static electricity.

PROCESS DESCRIPTION

Lee Brick and Tile Company in Sanford, North Carolina manufactures bricks, which involves the screening and blending of the raw materials, and the drying and firing of the final, shaped, product.

The firing of the bricks takes place in a tunnel kiln, with the bricks traveling on cars on rails through the kiln. After a set time, a car leaves the kiln at the same time a car is entering the kiln at the other end. At this time, doors at the end of the kiln are opened, allowing ambient air to enter uncontrolled.

Firing takes place in six steps: evaporation of free water, dehydration, oxidation, vitrification, flashing, and cooling. The actual fire zone is located near the middle of the kiln, with the 2000°F temperature provided by the combustion of coal. As shown in Figure 1, ambient air is used to cool the bricks and conversely preheat the air for the firing zone. Also some of the preheated air is ducted to the brick dryer for drying the bricks. The kiln is exhausted by two fans at opposite ends of the kiln.

Potential emissions from the kiln consists mainly of particulate matter in the form of dust generated by the handling of the bricks, and of combustion products from the coal. No emission control equipment is presently in use.

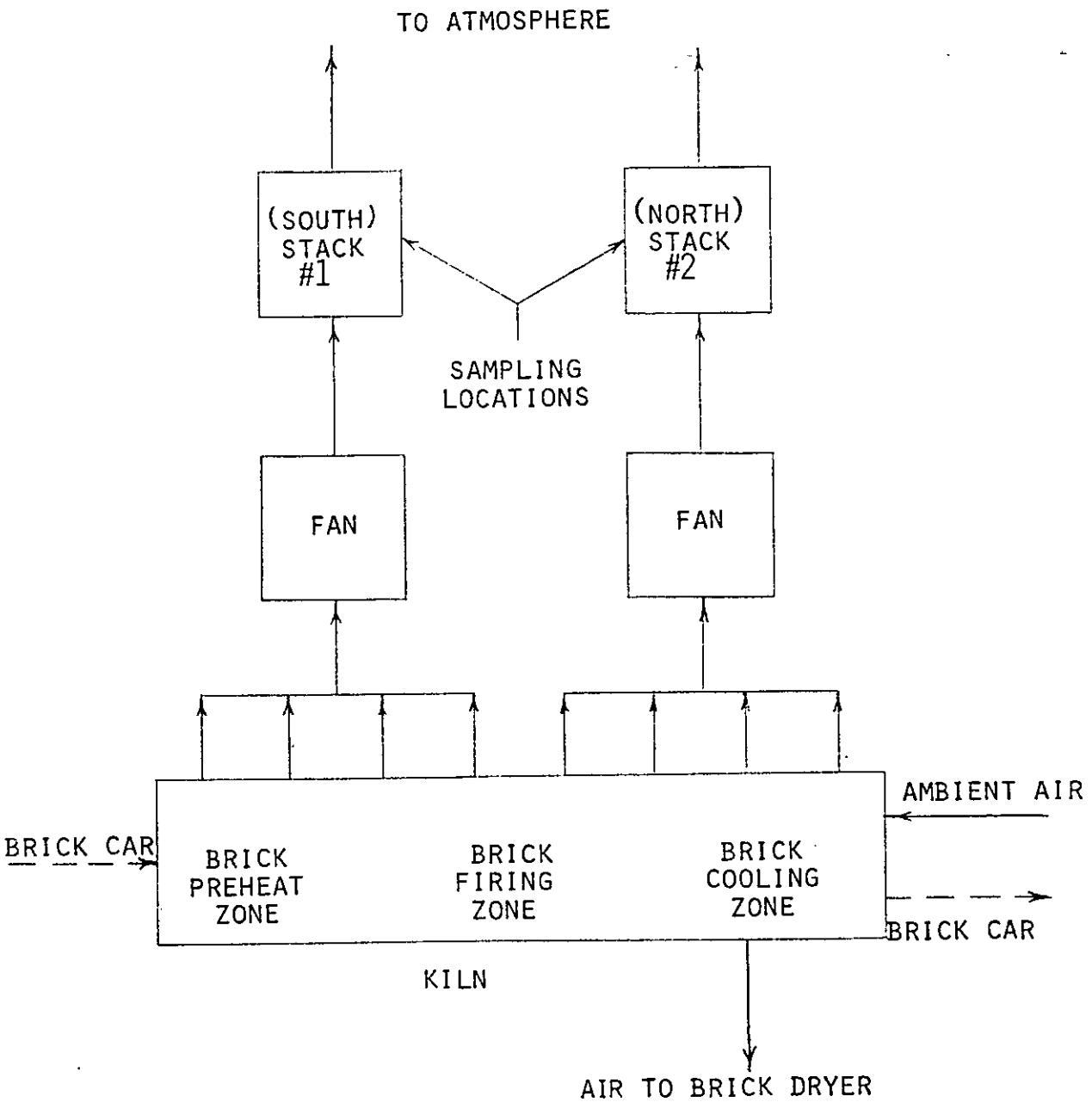


FIGURE 1. PROCESS SCHEMATIC AND SAMPLING LOCATIONS

During the testing performed at the outlet of the two kiln exhaust fans, the kiln was firing a carload of 8064 type #320 bricks every 100 minutes. With an average brick weight of 3.43 pounds, this converts to a process rate of 8.3 tons of bricks per hour. When the estimated coal usage rate of 0.60 tons per hour is added, the total process weight rate is 8.90 tons per hour.

It is suspected that the opening of the kiln doors increases the emissions; therefore, the last of the three sets of tests performed was made without a door opening occurring. As shown in Table 1 in the Summary of Results, the particulate tests did show a decrease in the emissions.

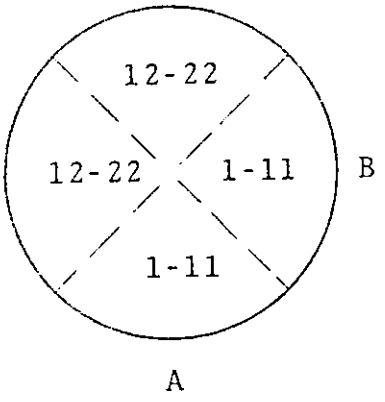
SAMPLING AND ANALYTICAL PROCEDURES

All sampling and analytical procedures used were those recommended by the U. S. Environmental Protection Agency and the North Carolina Department of Natural Resources and Community Development. Complete details of the equipment and procedures used are described in Appendix E, which is extracted from the Federal Register, August 18, 1977. Also included in Appendix E is a writeup of the Andersen particle sizing equipment and how to use it.

Method 1 was used to determine the number and location of the sampling points. The two kiln exhaust stacks are identical, with each stack cross section divided into 44 equal areas. Two ports labeled A and B, as shown in Figure 2, access the traverse axes, with each axis having 22 points. Every point was sampled for one and a half minutes, giving a total testing time of 66 minutes for each run on a stack.

Velocity measurements were in accordance with Method 2. Molecular weights for the stack gases were determined by Method 3 procedures. Particulate emissions were found using Method 5 analytical and sampling procedures. The particle sizing tests were made using Andersen Mark III Stack Samplers.

All sampling equipment used was manufactured by Nutech Corporation, Entropy Environmentalists, Inc., or Andersen 2000, Inc.



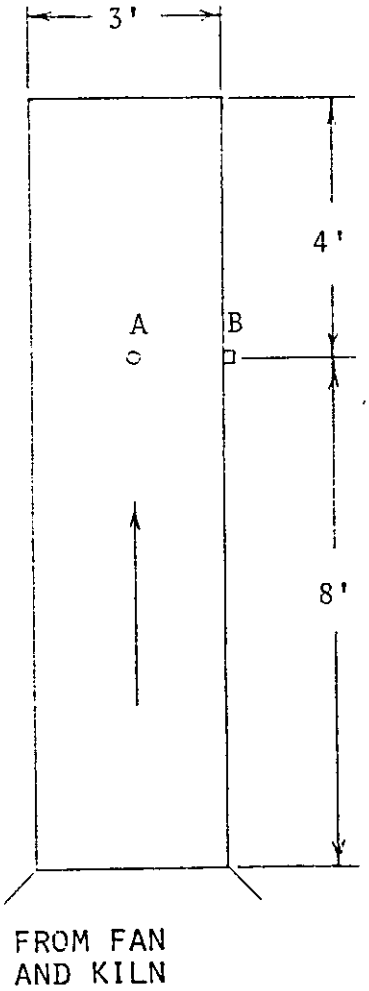


FIGURE 2. STACK DIMENSIONS AND SAMPLING POINT LOCATIONS, KILN EXHAUST STACKS (1 AND 2)

APPENDICES

APPENDIX A

RESULTS PREPARED BY

**ENTROPY ENVIRONMENTALISTS,INC. **

PARTICULATE FIELD DATA & RESULTS TABULATION

PLANT: LEE BRICK & TILE COMPANY, SANFORD, N.C.

TEST TEAM LEADER: WILLIS NESBIT

TEST 1 KILN STACK #1, SOUTH

TEST 2 KILN STACK #1, SOUTH

TEST 3 KILN STACK #1, SOUTH

RUN NUMBER		1	2	3
TEST DATE		2/ 9/78	2/ 9/78	2/ 9/78
TB	TIME-START	1022	1215	1411
TF	TIME-FINISH	1137	1325	1623
TT	NET TIME OF TEST,MIN.	66.0	66.0	66.0
FNP	NET SAMPLING POINTS	44.	44.	44.
DN	SAMPLING NOZZLE DIA., IN.	0.243	0.257	0.244
CP	PITOT TUBE COEFFICIENT	0.84	0.84	0.84
PM	AVERAGE ORIFICE PRESSURE DROP, IN. H2O	2.85	3.88	2.88
VM	VOLUME OF DRY GAS SAMPLED CU. FT. AT METER CONDITIONS	61.509	71.815	65.390
TM	AVERAGE GAS METER TEMP DEGREES F	69.	77.	80.
VMSTD	VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS*,SCF	60.889	70.211	63.417
VW	TOTAL H2O COLLECTED IN IMPINGERS & SILICA GEL,ML.	32.0	45.0	38.0
VWV	VOLUME OF WATER VAPOR AT STANDARD CONDITIONS*, SCF	1.51	2.12	1.79
PMV	PERCENT MOISTURE BY VOL.	2.4	2.9	2.8
MD	MOLE FRACTION DRY GAS	0.976	0.971	0.972
PCO2	PERCENT CO2 BY VOL.,DRY	2.3	2.3	2.3
PO2	PERCENT O2 BY VOL.,DRY	17.9	17.9	17.9
PCO	PERCENT CO BY VOL.,DRY	0.0	0.0	0.0
PN2	PERCENT N2 BY VOL.,DRY	79.8	79.8	79.8

MWD	MOLECULAR WT-DRY STACK GAS	29.08	29.08	29.08
MW	MOLECULAR WT-STACK GAS	28.82	28.76	28.78
PB	BAROMETRIC PRESSURE,IN. HG.	29.46	29.46	29.46
PSI	STATIC PRES OF STACK GAS IN. H2O	0.0	0.0	0.0
PS	STACK PRES,ABS., IN. HG.	29.46	29.46	29.46
TS	AVERAGE STACK TEMP. DEG. F	306.	303.	308.
DPS	AVERAGE VELOCITY HEAD OF STACK GAS,IN. H2O	1.190	1.290	1.212
VS	AVE STACK GAS VELOCITY, FPS	74.4	77.4	75.2
AS	STACK AREA, SQUARE INCHES	1018.	1018.	1018.
QS	STACK FLOW RATE,DRY,SCFM*	20905.	21714.	21012.
QA	ACTUAL STACK FLOW RATE,ACFM	31560.	32827.	31912.
PERI	PERCENT ISOKINETIC	96.8	96.1	99.5
FMF	PARTICULATE,MG, EPA 5	528.7	550.0	443.2
CAN	PARTICULATE,GR/DSCF* EPA 5	0.1337	0.1206	0.1076
CAW	PARTICULATE,LBS/HR EPA 5	23.96	22.45	19.38
PEA	PERCENT EXCESS AIR	565.	565.	565.

* 68 DEG F, 29.92 IN. HG

PARTICULATE FIELD DATA & RESULTS TABULATION

PLANT: LEE BRICK & TILE COMPANY, SANFORD, N.C.

TEST TEAM LEADER: ROY N. DOSTER

TEST 4 KILN STACK #2, NORTH

TEST 5 KILN STACK #2, NORTH

TEST - 6 KILN STACK #2, NORTH

RUN NUMBER		4	5	6
TEST DATE		2/ 9/78	2/ 9/78	2/ 9/78
TB	TIME-START	1025	1218	1411
TF	TIME-FINISH	1135	1327	1623
TT	NET TIME OF TEST,MIN.	66.0	66.0	66.0
FNP	NET SAMPLING POINTS	44.	44.	44.
DN	SAMPLING NOZZLE DIA., IN.	0.499	0.502	0.502
CP	PITOT TUBE COEFFICIENT	0.84	0.84	0.84
PM	AVERAGE ORIFICE PRESSURE DROP, IN. H2O	0.27	0.23	0.25
VM	VOLUME OF DRY GAS SAMPLED CU. FT. AT METER CONDITIONS	18.745	17.853	18.128
TM	AVERAGE GAS METER TEMP DEGREES F	52.	61.	67.
VMSTD	VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS*,SCF	19.050	17.828	17.897
VW	TOTAL H2O COLLECTED IN IMPINGERS & SILICA GEL,ML.	8.0	8.5	8.0
VWV	VOLUME OF WATER VAPOR AT STANDARD CONDITIONS*, SCF	0.378	0.401	0.378
PMV	PERCENT MOISTURE BY VOL.	1.9	2.2	2.1
MD	MOLE FRACTION DRY GAS	0.981	0.978	0.979
PCO2	PERCENT CO2 BY VOL.,DRY	2.3	2.3	2.3
PO2	PERCENT O2 BY VOL.,DRY	17.9	17.9	17.9
PCO	PERCENT CO BY VOL.,DRY	0.0	0.0	0.0
PN2	PERCENT N2 BY VOL.,DRY	79.8	79.8	79.8

MWD	MOLECULAR WT-DRY STACK GAS	29.08	29.08	29.08
MW	MOLECULAR WT-STACK GAS	28.87	28.84	28.85
PB	BAROMETRIC PRESSURE,IN. HG.	29.46	29.46	29.46
PSI	STATIC PRES OF STACK GAS IN. H2O	0.0	0.0	0.0
PS	STACK PRES,ABS., IN. HG.	29.46	29.46	29.46
TS	AVERAGE STACK TEMP. DEG. F	336.	336.	335.
DPS	AVERAGE VELOCITY HEAD OF STACK GAS,IN. H2O	0.006	0.006	0.006
VS	AVE STACK GAS VELOCITY, FPS	5.60	5.25	5.38
AS	STACK AREA, SQUARE INCHES	1018.	1018.	1018.
QS	STACK FLOW RATE,DRY,SCFM*	1522.	1422.	1461.
QA	ACTUAL STACK FLOW RATE,ACFM	2376.	2226.	2281.
PERI	PERCENT ISOKINETIC	98.7	97.6	95.4
FMF	PARTICULATE,MG, EPA 5	190.6	179.9	158.9
CAN	PARTICULATE,GR/DSCF* EPA 5	0.1541	0.1554	0.1367
CAW	PARTICULATE,LBS/HR EPA 5	2.01	1.89	1.71
PEA	PERCENT EXCESS AIR	565.	565.	565.

* 68 DEG F, 29.92 IN. HG

EXAMPLE PARTICULATE CALCULATIONS TEST NO. 4

KILN STACK #2, NORTH

VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS

VMSTD = (17.65*VM*(PB+PM/13.6))/(TM+460)

$$VMSTD = \frac{17.65 * 18.745 * (29.46+0.270/13.6)}{512.0} = 19.050 \text{ DSCF}$$

VOLUME OF WATER VAPOR AT STANDARD CONDITIONS

VWV = .0472 * VW

VWV = .0472 * 8.0 = 0.378 SCF

PERCENT MOISTURE IN STACK GAS

PMV = (100*VWV)/(VMSTD+VWV)

$$PMV = \frac{100.* 0.38}{19.050+ 0.38} = 1.9 \text{ PERCENT}$$

MOLE FRACTION OF DRY STACK GAS

MD = (100.-PMV)/100.

$$MD = \frac{100.- 1.9}{100.} = 0.981$$

AVERAGE MOLECULAR WEIGHT OF DRY STACK GAS

MWD = (PCO2*.44)+(PO2*.32)+(PN2+PCO)*.28

MWD = (2.3*0.44)+(17.9*0.32)+((79.8+0.0)*0.28) = 29.08 LB/LB MOLE

MOLECULAR WEIGHT OF STACK GAS

MW = MWD*MD + 18*(1-MD)

MW = 29.08*0.981 + 18*(1-0.981) = 28.87 LB/LB MOLE

STACK GAS VELOCITY AT STACK CONDITIONS

VS = 85.48*CP*SQRT((DPS*(TS+460))/(PS*MW))

VS = 85.48*.84*SQRT((0.006* 796.) / (29.46*28.87)) = 5.6 FPS

STACK GAS VOLUMETRIC FLOW AT STACK CONDITIONS

QA = VS * AS * 60 / 144

QA = 5.6 * 1018. * 60 / 144 = 2376. ACFM

STACK GAS VOLUMETRIC FLOW AT STANDARD CONDITIONS

QS = (17.65*QA*PS*MD) / (TS+460)

$$QS = \frac{17.65 * 2376. * 29.46 * 0.981}{796.0} = 1522.\ SCFM$$

PERCENT ISOKINETIC

PERI = (17.3*(TS+460)*VMSTD)/(VS*TT*PS*MD*DN*DN)

$$PERI = \frac{17.3 * 796.0 * 19.05}{5.6 * 66.0 * 29.46 * 0.981 * 0.499 * 0.499} = 98.7\ PERCENT$$

PARTICULATE LOADING -- EPA METHOD 5
(AT STANDARD CONDITIONS)

CAN = 0.0154*FMF/VMSTD

CAN = 0.0154*(190.6/ 19.05) = 0.1541 GR/DSCF

PARTICULATE LBS/HR--EPA METHOD 5

CAW = 0.00857*CAN*QS

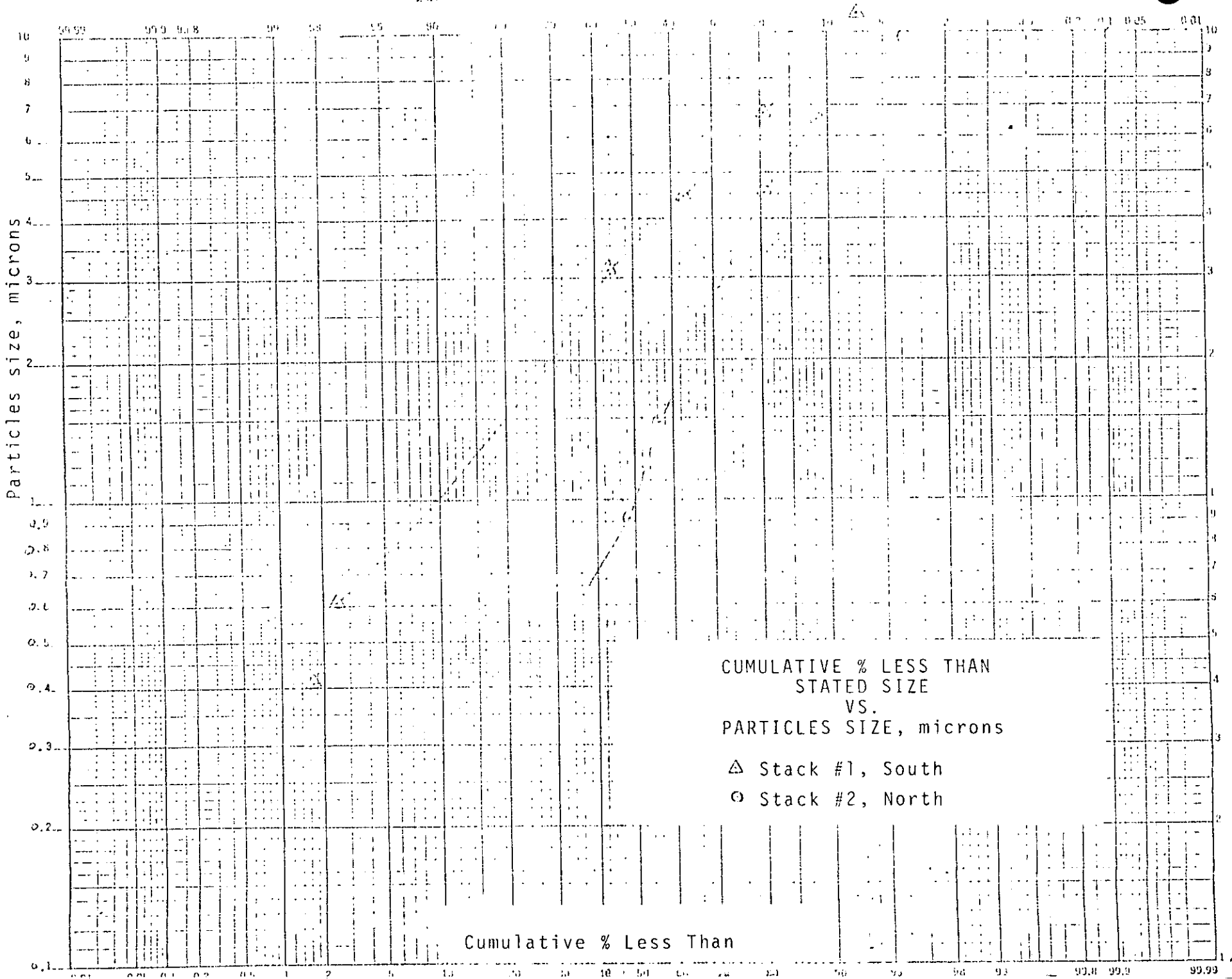
CAW = 0.00857* 0.154* 1522. = 2.01 LBS/HR

PERCENT EXCESS AIR

$$PEA = \frac{(PO2-0.5*PCO)}{0.264*PN2-PO2+0.5*PCO} * 100$$

$$PEA = \frac{17.9-(0.5*0.0}{(0.264*79.8)-(17.9+0.5*0.0} * 100 = 565.2\ PERCENT$$

APPENDIX B


Particles size, microns
Cumulative % Less Than
CUMULATIVE % LESS THAN
STATED SIZE
VS.
PARTICLES SIZE, microns
Δ Stack #1, South
O Stack #2, North

1-1

CALCULATIONS - ANDERSEN SAMPLING HEAD

PLANT NAME [illegible] Brick & Tile

SAMPLING LOCATION Kiln Stack #1 (South)

TEST DATE 2-9-77

STACK TEMPERATURE 300 °F

METER TEMPERATURE 72 ° F.

BAROMETRIC PRESS. 29.46 in. Hg

METER VOLUME [illegible] ACF

STACK STATIC PRESS. 0 in. H_2O

WATER COLLECTED 2.5 mls

AVERAGE ΔH 1.20 in. H_2O

METER VOLUME @ STP = $\frac{17.65 \times 6.60 \times (29.46 + \frac{1.20}{13.6})}{(460 + 72)}$ = 6.470 SCF

WATER VOLUME(VAPOR) @ STP: 0.0472 x 2.5 = 0.118 SCF

TOTAL SAMPLE VOLUME @ STP: 6.47 + .118 = [illegible] SCF

TOTAL SAMPLE VOLUME(ACF): $\frac{6.588 \times (460 + 300)}{17.65\ (29.40 + \frac{0}{13.6})}$ = [illegible] ACF

SAMPLING RATE: 9.627 ACF / 12 min. = [illegible] ACFM

VISCOSITY CORRECTION FACTOR @ ______ °F = ______

SPECIFIC GRAVITY CORRECTION FACTOR @ ______ g/cm^3 = ______

COMBINED CORRECTION FACTOR ______

STAGE	AERODYNAMIC DIAMETER, μ	PHYSICAL DIAMETER, μ	CATCH mgs	%	CUMULATIVE %
[illegible]	10.7	—	2.5	7.0	100
1	6.72	-	4.4	12.4	93.0
2	4.78		6.2	17.4	80.6
3	3.11	—	7.0	19.7	63.2
4	1.96		5.1	14.3	43.5
5	1.01		6.8	19.1	29.2
6	0.61		2.7	7.6	10.1
-	0.41		0.3	0.8	2.5
BACKUP FILTER	-	-	0.6	1.7	1.7
TOTAL CATCH			35.6	-	-

A-2

CALCULATIONS - ANDERSEN SAMPLING HEAD

PLANT NAME Lee Brick #7 Lg — SAMPLING LOCATION Inlet Duct #2 (Unit)

TEST DATE 2-4-78 — STACK TEMPERATURE 331 °F

METER TEMPERATURE 70 ° F. — BAROMETRIC PRESS. 29.76 in. Hg

METER VOLUME 4.011 ACF — STACK STATIC PRESS. 0 in. H_2O

WATER COLLECTED 2 mls — AVERAGE ΔH 0.19 in. H_2O

$$\text{METER VOLUME @ STP} = \frac{17.65 \times 4.011 \times (29.76 + \frac{0.19}{13.6})}{(460 + 70)} = 3.927 \text{ SCF}$$

WATER VOLUME(VAPOR) @ STP: 0.0472 x 2 = .094 SCF

TOTAL SAMPLE VOLUME @ STP: 3.927 + .094 = 4.021 SCF

$$\text{TOTAL SAMPLE VOLUME(ACF)} = \frac{4.021 \times (460 + 331)}{17.65 (29.76 + \frac{0}{13.6})} = 6.132 \text{ ACF}$$

SAMPLING RATE: 0.132 ACF / 16 min. = 0.383 ACFM

VISCOSITY CORRECTION FACTOR @ _____ °F = _____

SPECIFIC GRAVITY CORRECTION FACTOR @ _____ g/cm^3 = _____

COMBINED CORRECTION FACTOR _____

STAGE	AERODYNAMIC DIAMETER, μ	PHYSICAL DIAMETER, μ	CATCH mgs	%	CUMULATIVE %
0	15.7	-	0.5	2.5	100
1	9.79	-	0.3	1.5	97.6
2	6.55	-	1.5	7.5	96.1
3	4.55	-	1.6	8.0	88.6
4	2.85	-	1.5	7.0	80.6
5	1.48	-	3.0	14.9	73.6
6	0.91	-	1.7	8.5	58.7
7	0.63	-	2.4	11.9	48.2
BACKUP FILTER	-	-	7.3	36.3	36.3
TOTAL CATCH			20.1	-	-

APPENDIX C

PRELIMINARY FIELD DATA

Stack Geometry

Plant Name LEE BRICK & TILE

Plant Location SANFORD

Sampling Location KILN STACKS 1 & 2

Date(s) 2-9-78

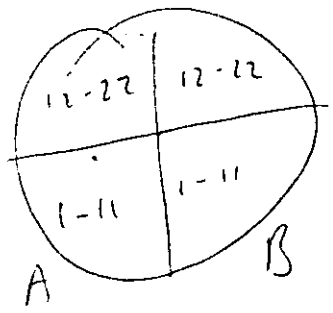
A. Dist. from inside of far wall to outside of near wall: 38 3/4 inches

B. Wall thickness: 2 3/4 inches

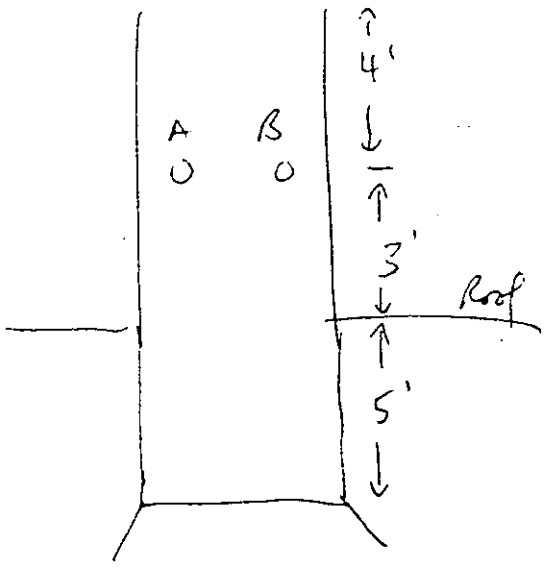
Inside diameter of stack (A-B): 36" inches

Stack Area: 1018 square inches

Comments: #1 Stack is South Stack
#2 is North Stack



Sketch of stack cross section showing sampling ports.



Sketch of stack dimensions and location of sampling ports.

2 3/4"

Point	% of Diameter	Distance from inside wall	Distance from outside of port
1	1.1	3/8"	3 1/8
2	3.5	1 1/4"	4
3	6.0	2 1/8"	4 7/8
4	8.7	3 1/8"	5 7/8
5	11.6	4 1/8"	6 7/8
6	14.6	5 1/4"	8
7	18.0	6 1/2"	9 1/4
8	21.8	7 7/8"	10 5/8
9	26.2	9 1/2"	12 1/4
10	31.5	11 3/8"	14 1/8
11	39.3	14 1/8"	16 7/8
12	60.7	21 7/8"	24 5/8

2 3/4"

Point	% of Diameter	Distance from inside wall	Distance from out-side of port
13	68.5	24 5/8"	27 3/8
14	73.8	26 1/2"	29 1/4
15	78.2	28 1/8"	30 7/8
16	82.0	29 1/2"	32 1/4
17	85.4	30 3/4"	33 1/2
18	88.4	31 7/8"	34 5/8
19	91.3	32 7/8"	35 5/8
20	94.0	33 7/8"	36 5/8
21	96.5	34 3/4"	37 1/2
22	98.9	35 5/8	38 3/8
			

ENTROPY ENVIRONMENTALISTS, INC.
SPECIALISTS IN SOURCE SAMPLING

ORSAT FIELD DATA

Plant Name Lee Brick Date 2-9-28

Sampling Location Stack #1 (South Stack) Operator RD

Time of Sample Collection	Time of Analysis	CO_2 Reading A	O_2 Reading B	CO Reading C	$\%O_2$ B-A	%CO C-B	$\%N_2$ 100-C
1415 & 1620	1900	2.3	20.2	20.2	17.9	0	79.8

PROCESS DESCRIPTION

FUEL TYPE

Wood: bark, chips, shavings, sawdust

Oil: #1, #2, #3, #4, #5, #6

Coal: coke, anthracite, ✓ bituminous, pulverized?

Nat. Gas Other _____

BOILER TYPE

Feeding Location: overfeed, underfeed

Mechanism: manual, steam, flipper, screw, vibrator, gravity, chain, air, ram

Grating type: solid, traveling, stationary, vibrating

Control Equipment? None

Combustion Air Configuration: overfire jets

PROCESS OPERATION

RATE TYPE	Rated	Normal	Actual
Feed Rate (lbs/hr, gals/hr, cu. ft./hr			
Steam Rate (lbs/hr)			
KW produced (power boilers only)			
MBTU/hr produced			
H.P. produced			

PARTICULATE FIELD DATA

ENTROPY ENVIRONMENTALISTS, INC. — SPECIALISTS IN SOURCE SAMPLING

Company Lee Brick

Plant Location Sanford, NC

Run No. 1

Sampling Location Stack 1 (2nd)

Date 2/9/78

Operator WW

Sample Box No. 6

Meter Box No. N-3

Meter $\Delta H_@$ 1.74

C Factor .92

Start: 10:22

Finish: 11:37

Filter # 2809

Tare Weight: .3932

REMARKS:

PRE LEAK : 0.00 @ 15"

POST LEAK : 0.00 @ 7"

Ambient Temp., °F 35°

Bar. Press., in. Hg 29.46

Assumed Moisture, % 5 %

Heater Box Setting, °F H1

Probe Heater Setting H1

Probe Tip Dia., in. .243 (304)

Actual Probe Length, Ft. 4'-1

Static Pressure, in. H_2O 0

Average Δp 0.75

Average ΔH 1.85

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in. H_2O	Orifice Manometer (ΔH) in. H_2O Desired	Orifice Manometer (ΔH) in. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F
A 1	0	976.090	0.95	2.25	2.25	62	4	220	50	310
2	1½	977.690	1.00	2.40	2.40	62	4	220	50	310
3	3	978.970	1.15	2.75	2.75	62	5	220	50	310
4	4½	979.970	1.20	2.90	2.90	62	5	220	50	310
5	6	981.200	1.20	2.90	2.90	62	5	220	50	310
6	7½	982.580	1.25	3.00	3.00	63	6	220	50	310
7	9	983.980	1.25	3.00	3.00	63	6	220	50	310
8	10½	985.510	1.25	3.00	3.00	64	6	220	50	310
9	12	987.300	1.20	2.90	2.90	65	6	220	50	310
10	13½	988.520	1.20	2.90	2.90	66	6	220	50	310
11	15	989.680	1.15	2.75	2.75	67	6	220	50	310
12	16½	991.085	1.10	2.60	2.60	67	6	220	50	310
13	3	992.450	1.15	2.75	2.75	68	6	220	50	310
14	4½	993.830	1.50	3.50	3.50	68	7	220	50	310
15	6	995.295	1.50	3.50	3.50	69	7	220	50	240
16	7½	996.845	1.30	3.10	3.10	69	6½	220	50	250
17	9	998.350	1.30	3.10	3.10	70	6½	220	50	270
18	10½	999.850	1.30	3.10	3.10	70	6½	220	50	280
19	12	1001.380	1.30	3.10	3.10	70	7	220	50	295

Company Lee Brick Run # 1

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in. H_2O	Orifice Manometer (ΔH) in. H_2O Desired	Orifice Manometer (ΔH) in. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F
20	13½	1002.795	1.30	3.10	3.10	70	7	220	50	300
21	15	1004.250	1.30	3.10	3.10	70	7	220	50	300
22	1½	1005.745	1.20	2.90	2.90	71	6	220	50	305
A 1	3	1007.150	1.20	2.90	2.90	71	6	220	50	305
2	4½	1008.685	0.95	2.25	2.25	67	5	220	50	310
3	6	1009.875	0.95	2.25	2.25	68	5	220	50	310
4	7½	1011.140	1.10	2.60	2.60	70	5	220	52	310
5	9	1012.460	1.20	2.90	2.90	70	6	220	52	310
6	10½	1013.970	1.20	2.90	2.90	70	6	220	53	310
7	12	1015.255	1.15	2.75	2.75	70	6	220	53	310
8	13½	1016.675	1.10	2.60	2.60	70	6	220	54	315
9	15	1018.150	1.10	2.60	2.60	70	6	220	55	318
10	1½	1019.410	1.05	2.55	2.55	70	6	220	56	320
11	3	1020.745	1.05	2.55	2.55	70	6	220	56	320
12	4½	1022.080	1.10	2.60	2.60	70	6	220	57	320
13	6	1023.450	1.15	2.75	2.75	71	6	220	57	320
14	7½	1024.820	1.15	2.75	2.75	71	6	220	57	320
15	9	1026.185	1.20	2.90	2.90	72	6	220	58	320
16	10½	1027.600	1.25	3.00	3.00	72	6	220	58	325
17	12	1029.095	1.30	3.10	3.10	73	7	220	58	325
18	13½	1030.520	1.25	3.00	3.00	73	7	220	58	325
19	15	1032.050	1.25	3.00	3.00	73	7	220	58	320
20	1½	1033.535	1.20	2.90	2.90	74	7	220	57	320
21	3	1034.935	1.25	3.00	3.00	74	7	220	57	320
22	4½	1036.350	1.15	2.75	2.75	74	7	220	57	305
		1037.599								
	DIFF.	61.509								
	AVE.		1.19 (1.09)		2.85	69				306

PARTICULATE FIELD DATA

ENTROPY ENVIRONMENTALISTS, INC
SPECIALISTS IN SOURCE SAMPLING

Company Lee Brick
Plant Location Sanford, NC
Run No. 2
Sampling Location Stack 1 (South)
Date 2/9/78
Operator WW
Sample Box No. 6
Meter Box No. N-3
Meter ΔH@ 1.74
C Factor .92

Start: 12:15
Finish: 13:25
Filter # 2806
Tare Weight: .3915

REMARKS:
Pre lk. test, .015 @ 15"
Post " " .001 @ 8"

Ambient Temp., °F 40
Bar. Press., in. Hg 29.46
Assumed Moisture, % 5.0
Heater Box Setting, °F H1
Probe Heater Setting H1
Probe Tip Dia., in. .257 (316)
Actual Probe Length, Ft. 4'-2
Static Pressure, in. H_2O 0
Average Δp 0.64
Average ΔH 1.85

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in. H_2O	Orifice Manometer (ΔH) in. H_2O Desired	Orifice Manometer (ΔH) in. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F
A 1	0	1038.340	1.00	3.50	3.10	66	4	220	50	310
2	1½	1039.095	1.00	3.50	3.00	66	4	220	50	310
3	3	1041.395	1.20	3.60	3.60	66	5	220	50	310
4	4½	1042.950	1.10	3.30	3.30	68	5	220	50	310
5	6	1044.450	1.25	3.75	3.75	68	5	220	50	310
6	7½	1045.995	1.25	3.75	3.75	69	5½	220	50	310
7	9	1047.580	1.25	3.75	3.75	70	6	220	50	310
8	10½	49.200	1.50	4.50	4.50	71	7	220	50	310
9	12	51.010	1.50	4.50	4.50	72	7	220	50	310
10	13½	52.650	1.50	4.50	4.50	73	7	220	50	335
11	15	54.385	1.20	3.60	3.60	74	6	220	50	250
12	16½	55.975	1.20	3.60	3.60	75	6	220	50	275
13	18	57.550	1.25	3.75	3.75	76	6	220	50	285
14	19½	59.150	1.25	3.75	3.75	77	6	220	50	295
15	21	60.765	1.25	3.75	3.75	78	6	220	50	300
16	22½	62.350	1.25	3.75	3.75	78	6	220	50	300
17	24	63.950	1.25	3.75	3.75	78	6	220	52	305
18	25½	65.560	1.30	3.85	3.85	78	6	220	54	310
19	27	67.885	1.30	3.85	3.85	78	6	220	56	310

Company Lee Brick Run # 2

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in. H_2O	Orifice Manometer (ΔH) in. H_2O Desired	Orifice Manometer (ΔH) in. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F
20	13½	69.685	1.30	3.85	3.85	78	6	220	58	310
21	15	71.095	1.25	3.75	3.75	78	6	220	58	310
22	1½	72.590	1.30	3.85	3.85	78	8	220	58	310
D 1	3-0	74.335	1.15	3.50	3.50	77	8	220	58	310
2	4½	75.870	1.41	4.15	4.15	77	8	220	59	310
3	6	77.290	1.45	4.35	4.35	78	8	220	60	315
4	7½	78.795	1.35	4.10	4.10	78	7	220	61	315
5	9	80.500	1.35	4.10	4.10	79	7	220	61	315
6	10½	82.055	1.40	4.15	4.15	79	7	220	62	320
7	12	83.770	1.40	4.15	4.15	79	7	220	63	320
8	13½	85.355	1.40	4.15	4.15	79	7	220	64	325
9	15	87.035	1.40	4.15	4.15	80	7	220	65	330
10	1½	88.741	1.35	4.10	4.10	81	7	220	65	305
11	3	90.415	1.30	3.85	3.85	81	7	220	65	300
12	4½	92.075	1.25	3.75	3.75	81	7	220	65	300
13	6	93.715	1.30	3.85	3.85	81	7	220	65	300
14	7½	95.335	1.30	3.85	3.85	81	7	220	65	300
15	9	97.001	1.30	3.85	3.85	81	7	220	65	300
16	10½	98.595	1.30	3.85	3.85	81	7	220	65	300
17	12	1100.015	1.30	3.85	3.85	81	7	220	65	300
18	13½	1101.755	1.35	4.10	4.10	82	7	220	65	300
19	15	1103.520	1.35	4.10	4.10	82	7	220	65	300
20	1½	1105.195	1.35	4.10	4.10	82	7	220	65	300
21	3	1106.875	1.30	3.85	3.85	82	7	220	65	300
22	4½	1105.150	1.30	3.85	3.85	82	7	220	65	300
	6	1110.155								
	DIFF.	41.815								
	AVE.		1.29 (1.14)		3.88	77				303

CO_2 .05 1½ .10 1½ .05 ½ .20 1½

PARTICULATE FIELD DATA

Company/Location Lee Brick
Sanford, NC
Sampling Location: Stack 1 (South)
Date 2/7/18 Test Participants DM, RD, UW, DG
Bar. Press., in. Hg 29.46 Meter Box # N-3
Static Press., in. H_2O 0 ΔH@ 1.74
Ambient Temp, °F 40° C Factor .92
Est. Moisture, % 5% Temp. Device ~~Fisher~~ Palmer

Run # 3
Start: 14:11
Finish: 16:23

Filter #	Tare Wt.
2850	.4008

Sample Box # 6 @ Heat Setting 7
Probe # 4-3 @ Heat Setting 7
Nozzle # 305 with Dia., inches .244
Pitot Leak Tests: Before 0 After 0
Sampling Train Leak Test (from nozzle)
Before @ ≥ 15 in. Hg = 0.01 cfm
After @ 15 in. Hg = 0.01 cfm
Avg. Δp 0.74 at ΔH of 1.84

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in. H_2O	Orifice Manometer (ΔH) in. H_2O Desired	Orifice Manometer (ΔH) in. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F
A 1	0	110.529	1.15	2.90	1.60	78	15	220	55	310
2	1½	111.560	1.15	2.90	1.60	78	15	220	55	310
3	3	112.650	1.15	2.90	1.60	78	15	220	55	310
4	4½	113.735	1.25	3.20	1.60	78	15	220	55	300
5	6	114.908	1.25	3.20	1.60	78	15	220	55	305
6	7½	115.900	1.30	3.28	1.60	79	15	220	55	305
7	9	116.98	1.35	3.45	3.45	77	10	220	59	300
8	10½	121.570	1.35	3.45	3.45	77	10	220	59	300
9	12	123.085	1.35	3.45	3.45	78	10	220	60	300
10	13½	124.63	1.30	3.28	3.28	80	10	220	60	300
11	15	126.17	1.25	3.20	3.20	80	10	220	60	300
12	1½	127.70	1.25	3.20	3.20	80	10	220	60	300
13	3	129.17	1.20	3.05	3.05	80	10	220	60	301
14	4½	130.65	1.25	3.20	3.20	81	10	220	60	300
15	6	132.15	1.20	3.05	3.05	82	10	220	60	300
16	7½	133.62	1.25	3.20	3.20	82	11	220	60	305
17	9	135.12	1.25	3.20	3.20	82	11	220	60	305
18	10½	136.58	1.30	3.28	3.28	82	12	220	60	305
19	12	138.09	1.30	3.28	3.28	82	12	220	60	310
20	13½	139.60	1.30	3.28	3.28	82	12	220	60	310
21	15	141.12	1.30	3.28	3.28	82	12	220	60	310

various problems from 116.98 to 120.03

Company Lee Brick Run # 3

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) In. H_2O	Orifice Manometer (ΔH) In. H_2O Desired	Orifice Manometer (ΔH) In. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F	
22	1½	142.61	1.30	3.28	3.28	80	12	220	60	310	← STOP FIR
B 1	3	144.14	1.00	2.50	2.50	75	9	220	60	300	15 min. DOORS OPEN IN ~~SHOT~~ KILN
2	4½	145.43	1.15	2.90	2.90	75	9	220	60	286	
3	6	146.95	1.15	2.90	2.90	78	9	220	60	298	
4	7½	148.31	1.20	3.05	3.05	78	10	220	61	303	
5	9	149.74	1.15	2.90	2.90	78	10	220	60	307	
6	10½	151.17	1.10	2.80	2.80	79	10	220	60	311	
7	12	152.62	1.15	2.90	2.90	79	10	220	60	313	
8	13½	154.05	1.15	2.90	2.90	79	11	220	60	314	
9	15	155.46	1.10	2.80	2.80	80	11	220	60	315	
10	1½	156.88	1.10	2.80	2.80	80	11	220	60	318	POINT BY POINT W/TC
11	3	158.32	1.10	2.80	2.80	80	11	220	60	318	
12	4½	159.72	1.15	2.90	2.90	80	11	220	60	318	
13	6	161.14	1.20	3.05	3.05	80	12	220	60	318	
14	7½	162.59	1.20	3.05	3.05	80	13	220	60	318	
15	9	164.08	1.25	3.20	3.20	80	14	220	60	318	
16	10½	165.56	1.25	3.20	3.20	80	14	220	60	323	
17	12	167.06	1.25	3.20	3.20	81	15	220	60	323	
18	13½	168.55	1.20	3.05	3.05	81	15	220	60	324	
19	15	170.06	1.25	3.20	3.20	81	15	220	60	323	
21	1½	171.54	1.20	3.05	3.05	81	15	220	60	323	
21	3	172.99	1.10	2.80	2.80	81	15	220	60	324	
22	4½	174.48	1.15	2.90	2.90	81	13	220	60	299	
	6	175.91									
Dif		65.390									
Average			1.212		2.88	80				308	
			(1.10)								

PARTICULATE FIELD DATA

Company/Location Lee Brick
Sanford, N.C.
Sampling Location: Stack #2 (North)
Date 2-9-22 Test Participants RD-DM-WN-JG
Bar. Press., in. Hg 29.46 Meter Box # N7
Static Press., in. H_2O 0 ΔH@ 1.84
Ambient Temp, °F 35 C Factor 1.0
Est. Moisture, % 5 Temp. Device Palmer

Run # 4
Start: 10:25
Finish: 11:35

Filter #	Tare Wt.
2807	.3950

Sample Box # 12 @ Heat Setting Hi
Probe # 4 @ Heat Setting Hi
Nozzle # 219 with Dia., inches .499
Pitot Leak Tests: Before 0.0 After 0.0
Sampling Train Leak Test (from nozzle)
Before @ ≥ 15 in. Hg = .015 cfm
After @ 4 in. Hg = .01 cfm
Avg. Δp .042 at ΔH of 1.84

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in. H_2O	Orifice Manometer (ΔH) in. H_2O Desired	Orifice Manometer (ΔH) in. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F
A 1	0	102.420	.005	.20	.20	42	1	220	50	330
2	1½	102.89	.005	.20	.20	44	1	220	50	330
3	3	103.17	.005	.20	.20	44	1	225	50	330
4	4½	103.63	.007	.30	.30	44	1	225	50	330
5	6	104.10	.005	.20	.20	44	1	230	50	330
6	7½	104.49	.005	.20	.20	44	1	230	50	335
7	9	104.87	.006	.25	.25	44	1	230	50	335
8	10½	105.30	.005	.20	.20	45	1	230	50	335
9	12	105.70	.007	.30	.30	45	1	220	50	335
10	13½	106.11	.006	.25	.25	45	1	220	50	335
11	15	106.55	.006	.25	.25	45	1	220	50	335
12	1½	106.96	.005	.20	.20	45	1	220	50	335
13	3	107.34	.005	.20	.20	45	1	220	50	335
14	4½	107.72	.005	.20	.20	45	1	220	50	335
15	6	108.12	.005	.20	.20	45	1	220	50	330
16	7½	108.41	.005	.20	.20	45	1	220	50	330
17	9	108.91	.005	.20	.20	45	1	220	50	330
18	10½	109.15	.005	.20	.20	45	1	220	50	330
19	12	109.58	.008	.35	.35	45	1	220	50	330
20	13½	110.05	.01	.44	.44	48	1	220	50	330
21	15	110.63	.01	.44	.44	48	1	220	50	330

Company Lee Brick

Run # 4

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in. H_2O	Orifice Manometer (ΔH) in. H_2O Desired	Orifice Manometer (ΔH) in. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F
22	1½	111.14	.01	.44	.44	48	1	225	50	330
1	3-0	111.68	.005	.20	.20	55	1	225	50	330
2	1½	112.11	.01	.44	.44	55	1	225	50	330
3	3	112.69	.01	.44	.44	55	1	225	50	335
4	4½	113.12	.01	.44	.44	55	1	225	50	335
5	6	113.69	.015	.65	.65	58	1	225	50	335
6	7½	114.35	.01	.44	.44	58	1	225	50	335
7	9	114.89	.01	.44	.44	58	1	225	50	340
8	10½	115.44	.005	.20	.20	58	1	225	50	345
9	12	115.85	.005	.20	.20	60	1	225	50	345
10	13½	116.22	.005	.20	.20	60	1	225	50	345
11	15	116.80	.005	.20	.20	60	1	235	50	345
12	16½	116.97	.005	.20	.20	60	1	235	50	345
13	18	117.35	.005	.20	.20	60	1	235	50	345
14	4½	117.73	.005	.20	.20	60	1	245	50	345
15	6	118.09	.005	.20	.20	60	1	250	50	345
16	7½	118.47	.005	.20	.20	60	1	250	50	345
17	9	118.85	.005	.20	.20	60	1	250	50	345
18	10½	119.23	.005	.20	.20	60	1	250	50	345
19	12	119.61	.005	.20	.20	62	1	245	50	340
20	13½	119.97	.005	.20	.20	62	1	245	50	340
21	15	120.30	.005	.20	.20	62	1	245	50	340
22	1½	120.73	.010	.44	.44	62	1	245	50	340
	6 MIN	121.165								
Average			0.0065		0.27	52				336
Δ		18.745								

PARTICULATE FIELD DATA

Company/Location Lee Brick
Sanford, NC
Sampling Location: Stack #2
Date 2-9-78 Test Participants RDM JG WN
Bar. Press., in. Hg 29.46 Meter Box # N7
Static Press., in. H_2O 0 ΔH@ 1.84
Ambient Temp, °F 40° C Factor 1.0
Est. Moisture, % 5 Temp. Device Palmer

Run # 5
Start: 12:18
Finish: 13:27

Filter # 2808 Tare Wt. .3941

Sample Box # 12 @ Heat Setting 7½
Probe # 4 @ Heat Setting 7½
Nozzle # 314 with Dia., inches .502
Pitot Leak Tests: Before 0.0 After 0.0
Sampling Train Leak Test (from nozzle)
Before @ ≥ 15 in. Hg = 0.005 cfm
After @ 3 in. Hg = 0.005 cfm
Avg. Δp .042 at ΔH of 1.84

Figures between ½ and 1

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in. H_2O	Orifice Manometer (ΔH) in. H_2O Desired	Orifice Manometer (ΔH) in. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F
1	0	121.450	.005	.20	.20	52	1	225	50	340
2	1½	121.88	.005	.20	.20	52	1	225	50	340
3	3	123.21	.005	.20	.20	52	1	225	50	340
4	4½	122.60	.005	.20	.20	52	1	225	50	340
5	6	122.97	.005	.20	.20	52	1	225	50	340
6	7½	123.28	.005	.20	.20	58	1	225	50	340
7	9	123.78	.01	.44	.44	58	1	225	50	340
8	10½	124.15	.01	.44	.44	58	1	225	50	340
9	12	124.72	.01	.44	.44	58	1	225	50	340
10	13½	125.18	.008	.35	.35	58	1	225	50	340
11	15	125.87	.008	.35	.35	58	1	235	50	340
12	1½	126.27	.005	.20	.20	60	1	235	50	335
13	3	126.64	.005	.20	.20	60	1	235	50	335
14	4½	127.05	.005	.20	.20	60	1	235	50	335
15	6	127.34	.01	.44	.44	60	1	245	50	335
16	7½	127.89	.01	.44	.44	60	1	245	50	335
17	9	128.30	.005	.20	.20	60	1	250	50	335
18	10½	128.91	.005	.20	.20	60	1	250	50	335
19	12	129.30	.005	.20	.20	60	1	250	50	340
20	13½	129.67	.005	.20	.20	60	1	250	50	340
21	15	130.05	.005	.20	.20	60	1	250	50	340

Company Lee Brick

Run # 5

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in. H_2O	Orifice Manometer (ΔH) in. H_2O Desired	Orifice Manometer (ΔH) in. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F
22	1½	130.43	.005	.20	.20	62	1	245	50	335
A 1	3-0	130.81	.005	.20	.20	62	1	245	50	300
2	1½	131.19	.005	.20	.20	62	1	240	50	310
3	3	131.53	.005	.20	.20	62	1	235	55	320
4	4½	131.90	.007	.30	.30	62	1	235	55	320
5	6	132.35	.005	.20	.20	62	1	235	55	330
6	7½	132.81	.005	.20	.20	62	1	235	55	330
7	9	133.11	.005	.20	.20	62	1	235	55	335
8	10½	133.50	.005	.20	.20	65	1	240	55	335
9	12	133.90	.005	.20	.20	65	1	240	55	335
10	13½	134.30	.005	.20	.20	65	1	240	55	335
11	15	134.55	.005	.20	.20	65	1	240	55	340
12	1½	135.00	.005	.20	.20	65	1	240	55	340
13	3	135.37	.007	.30	.30	65	1	240	55	340
14	4½	135.80	.007	.30	.30	65	1	240	55	340
15	6	136.29	.005	.20	.20	65	1	240	55	340
16	7½	136.67	.005	.20	.20	68	1	240	55	340
17	9	137.04	.005	.20	.20	68	1	235	60	340
18	10½	137.42	.005	.20	.20	68	1	235	60	340
19	12	137.80	.005	.20	.20	70	1	230	60	340
20	13½	138.17	.005	.20	.20	70	1	230	60	340
21	15	138.54	.005	.20	.20	70	1	230	60	345
22	1½	138.93	.005	.20	.20	70	1	230	60	345
		139.303								
Average			0.0057		0.23	61				336
D.H.		17.853								

PARTICULATE FIELD DATA

Company/Location Lee Brick
Sanford, NC
Sampling Location: Stack #2
Date 2-9-28 Test Participants RDOM
Bar. Press., in. Hg 29.46 Meter Box # N2
Static Press., in. H_2O 0 $\Delta H_@$ 1.84
Ambient Temp, °F 40 C Factor 1.0
Est. Moisture, % 5 Temp. Device Palmer

Run # 6
Start: 1411
Finish: 16:23

Filter #	Tare Wt.
2857	.3908

Sample Box # 12 @ Heat Setting 250
Probe # 4 @ Heat Setting 250
Nozzle # 315 with Dia., inches .502
Pitot Leak Tests: Before 0.0 After 0.0
Sampling Train Leak Test (from nozzle)
Before @ ≥ 15 in. Hg = 0.01 cfm
After @ 4 in. Hg = 0.005 cfm
Avg. Ap .042 at ΔH of 1.84

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in. H_2O	Orifice Manometer (ΔH) in. H_2O Desired	Orifice Manometer (ΔH) in. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F
A 1	0	139.600	.005	.20	.20	64	1	225	55	335
2	1½	140.00	.005	.20	.20	64	1	225	55	335
3	3	140.42	.005	.20	.20	64	1	225	55	335
4	4½	140.93	.005	.20	.20	64	1	230	55	335
5	6	141.10	.01	.44	.44	64	1	230	55	335
6	7½	141.58	.01	.44	.44	64	1	230	55	340
7	9	142.17	.009	.35	.35	64	1	230	55	340
8	10½	142.57	.008	.35	.35	64	1	230	55	340
9	12	142.01	.01	.44	.44	62	1	230	55	340
10	13½	143.48	.01	.44	.44	62	1	230	55	340
11	15	144.01	.008	.35	.35	64	1	235	55	340
12	1½	144.51	.005	.20	.20	64	1	235	55	340
13	3	144.92	.005	.20	.20	64	1	235	55	340
14	4½	145.28	.005	.20	.20	64	1	240	55	340
15	6	145.67	.008	.35	.35	64	1	240	55	340
16	7½	146.14	.01	.44	.44	64	1	240	55	340
17	9	146.70	.01	.44	.44	68	1	240	55	340
18	10½	147.26	.008	.35	.35	68	1	240	55	340
19	12	147.78	.005	.20	.20	68	1	245	55	340
20	13½	148.20	.005	.20	.20	68	1	245	55	340

Company Lee Brick

Run # 6

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in. H_2O	Orifice Manometer (ΔH) in. H_2O Desired	Orifice Manometer (ΔH) in. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F
22	1½	148.94	.005	.20	.20	70	1	250	55	340
01	3:0	149.29	.005	.20	.20	68	1	250	55	340
2	1½	149.68	.005	.20	.20	68	1	240	55	330
3	3	150.09	.005	.20	.20	68	1	240	55	325
4	4½	150.48	.005	.20	.20	68	1	235	55	325
5	6	150.89	.005	.20	.20	68	1	235	55	330
6	7½	151.21	.007	.30	.30	68	1	235	55	330
7	9	151.90	.008	.35	.35	68	1	235	55	330
8	10½	152.21	.005	.20	.20	68	1	230	55	330
9	12	152.60	.005	.20	.20	68	1	230	55	330
10	13½	155.00	.005	.20	.20	68	1	225	55	330
11	15	153.35	.005	.20	.20	70	1	225	55	330
12	1½	153.71	.005	.20	.20	70	1	225	60	330
13	3	154.07	.005	.20	.20	70	1	220	60	330
14	4½	154.31	.005	.20	.20	70	1	225	60	330
15	6	154.81	.005	.20	.20	70	1	225	60	330
16	7½	155.16	.005	.20	.20	70	1	230	60	330
17	9	155.55	.005	.20	.20	70	1	230	60	330
18	10½	155.95	.005	.20	.20	70	1	230	60	335
19	12	156.27	.005	.20	.20	70	1	230	60	335
20	13½	156.63	.005	.20	.20	70	1	235	60	335
21	15	156.98	.005	.20	.20	70	1	235	60	335
22	1½	157.37	.005	.20	.20	70	1	235	60	335
		157.728								
Average			0.0060		0.25	67				335
D.ff		18.128								

Down 15 min
Kiln door open

CUSTODY SHEET FOR REAGENT BOX # 0208

Date of Makeup 18 Jan 77 Individual Water Tare Volume 200 mls

Initials EES Individual Silica Gel Tare Weight 225.0 gms

Locked? ✓

Plant Name Lee Brick

Sampling Location Sanford, NC

Box/Test Number	Date Used	Initials	Locked?	Date Cleanup	S. Gel Spent?	Initials	Locked?
6/1	2/9/78	LW	✓	2/9/78	55%	LW	✓
6/2	2/9/78	LW	✓	2/9/78	80%	LW	✓
6/3	2/9/78	LW	✓	2/9/78	99%	LW	✓

	Date	Initials	Locked?
Transferred to Lab	10 Feb	EES	✓
Received in Lab	10 Feb	EES	✓

Zero & Span Balance Initials EES

Sampling Method: EPA - 5

Remarks: heavy loading

Filter #	Tare Weight (mgms)	Used on Test
2809	393.2	1
2806	391.5	2
2850	400.8	3

ENTROPY ENVIRONMENTALISTS, INC

SPECIALISTS IN SOURCE SAMPLING

PARTICULATE SAMPLING CLEANUP SHEET

Plant Name Lee Brick, Sanford, N.C.

Sampling Location _____

Reagent Box # 0208 Date Analyzed 10 Feb 78

Blank Calculations:	Acetone	Water
Blank Residue	0.6 mg	_____
Blank Volume	100 ml	_____
Concentration	.006 mg/mls	_____ mg/mls
Volume Used	259 mls	_____ mls
# 1 Blank Weight	1.6 mgms	_____ mgms
Volume Used	181 mls	_____ mls
# 2 Blank Weight	1.1 mgms	_____ mgms
Volume Used	175 mls	_____ mls
# 3 Blank Weight	1.0 mgms	_____ mgms

Analysis Method: (Zero & Span Balance EES Initials)
EPA Method 5

Description of Sample:
gray powder or dust

Remarks:
heavy loading

Date of Test	9 Feb	9 Feb	9 Feb
Test Number	1	2	3
Moisture Collected:			
Impinger water volume	212	218	210
Tared volume	200	200	200
Captured water	12 mls	18 mls	10 mls
Silica Gel weight	245.0	251.0	253.0
Tared weight	225.0	225.0	225.0
Adsorbed water	20.0 gms	26.0 gms	28.0 gms
TOTAL MOISTURE CATCH	32.0 mls	45.0 mls	38.0 mls
Front Half Analysis: (Nozzle, probe, cyclone, filter front half)			
Filter & Particulate	923.5	942.6	845.0
Filter Tare weight	393.2	391.5	400.8
Filter Particulate	530.3	551.1	444.2
Rinsings or Dry Wt.	-	-	-
Particulate catch	530.3 mgms	551.1 mgms	444.2 mgms
Acetone blank	-1.6	-1.1	-1.0
TOTAL FRONT CATCH	528.7 mgms	550.0 mgms	443.2 mgms
Back Half Analysis: (Impingers, filter back half)			
Extractables weight	_____	_____	_____
Boil Down weight	_____	_____	_____
Impingers' Catch	_____ mgms	_____ mgms	_____ mgms
Water blank	_____	_____	_____
TOTAL BACK CATCH	mgms	_____ mgms	_____ mgms
TOTAL TRAIN CATCH	_____ mgms	_____ mgms	_____ mgms

CUSTODY SHEET FOR REAGENT BOX # 0207

Date of Makeup 7 Feb 78 Individual Water Tare Volume 200 mls

Initials SSS Individual Silica Gel Tare Weight 225.0 gms

Locked? ✓

Plant Name Ley Brick

Sampling Location Sanford, NC

Box/Test Number	Date Used	Initials	Locked?	Date Cleanup	S. Gel Spent?	Initials	Locked?
4	2-9-78	WW	—	2-18-78	25%	RD	✓
5	2-15-78	WW	✓	2-19-78	35%	RD	✓
6	2-16-78	WW	—	2-19-78	25%	RD	✓

	Date	Initials	Locked?
Transferred to Lab	2-10-78	RD	✓
Received in Lab	2-10-78	SSS	✓

Zero & Span Balance Initials SSS

Sampling Method: EPA # 5

Remarks:

medium loading

Filter #	Tare Weight (mgms)	Used on Test
2807	395.0	4
2808	394.1	5
2857	390.8	6

ENTROPY ENVIRONMENTALISTS, INC.....

SPECIALISTS IN SOURCE SAMPLING

PARTICULATE SAMPLING CLEANUP SHEET

Plant Name Lee Brick, Sanford, N.C.

Sampling Location _____

Reagent Box # 0207 Date Analyzed 10 Feb 78

Blank Calculations:	Acetone	Water
Blank Residue	0.6 mg	_____
Blank Volume	100 ml	_____
Concentration	.006 mg/mls	_____ mg/mls
Volume Used	244 mls	_____ mls
# 4 Blank Weight	1.5 mgms	_____ mgms
Volume Used	194 mls	_____ mls
# 5 Blank Weight	1.2 mgms	_____ mgms
Volume Used	178 mls	_____ mls
# 6 Blank Weight	1.1 mgms	_____ mgms

Analysis Method: (Zero & Span Balance FFS Initials)
EPA - Method 5

Description of Sample:
gray dust

Remarks:
medium loading

Date of Test	7 Feb	7 Feb	9 Feb
Test Number	4	5	6
Moisture Collected:			
Impinger water volume	205	206	203
Tared volume	200	200	200
Captured water	5 mls	6 mls	3 mls
Silica Gel weight	228.0	227.5	230.0
Tared weight	225.0	225.0	225.0
Adsorbed water	3.0 gms	2.5 gms	5.0 gms
TOTAL MOISTURE CATCH	8.0 mls	8.5 mls	8.0 mls
Front Half Analysis: (Nozzle, probe, cyclone, filter front half)			
Filter & Particulate	587.1	575.2	550.8
Filter Tare weight	395.0	394.1	390.8
Filter Particulate	192.1	181.1	160.0
Rinsings or Dry Wt.	-	-	-
Particulate catch	192.1 mgms	181.1 mgms	160.0 mgms
Acetone blank	-1.5	-1.2	-1.1
TOTAL FRONT CATCH	190.6 mgms	179.9 mgms	158.9 mgms
Back Half Analysis: (Impingers, filter back half)			
Extractables weight	_____	_____	_____
Boil Down weight			
Impingers' Catch	_____ mgms	_____ mgms	_____ mgms
Water blank			
TOTAL BACK CATCH	mgms	mgms	mgms
TOTAL TRAIN CATCH	mgms	mgms	mgms

PARTICULATE FIELD DATA

Company/Location LEE BRICK
SANFORD, NC
Sampling Location: STACK #1
Date 2-9-78 Test Participants WW, DJC, RDJM
Bar. Press., in. Hg 29.46 Meter Box # N-3
Static Press., in. H_2O 0 ΔH@ 1.74
Ambient Temp, °F 40° C Factor .92
Est. Moisture, % 5% Temp. Device Palm

Run # 1-A
Start: 16:40
Finish: 16:52

Filter # Tare Wt.

Sample Box # 6 @ Heat Setting N
Probe # A1 @ Heat Setting N
Nozzle # 303 with Dia., inches .173
Pitot Leak Tests: Before 0 After 0
Sampling Train Leak Test (from nozzle)
Before @ ≥ 15 in. Hg = 0.00 cfm
After @ 5 in. Hg = 0.00 cfm
Avg. Δp 2.75 at ΔH of 1.84

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in. H_2O	Orifice Manometer (ΔH) in. H_2O Desired	Orifice Manometer (ΔH) in. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F
B-5	0	175.99	1.20	.82	.82	72	5	220	60	300
B-5	3	177.85	1.20	.82	.82	72	5	220	60	300
B-16	6	179.48	1.20	.82	.82	72	5	220	60	300
B-16	9	181.10	1.20	.82	.82	72	5	220	60	300
	12	182.59								
	DIFF	6.60								
	AVG		1.20		0.82	72				300

PARTICULATE FIELD DATA

Company/Location LEE BRICK
SANFORD, NC
Sampling Location: STACK #1
Date 2-9-78 Test Participants WW, DJC, RDJM
Bar. Press., in. Hg 29.46 Meter Box # N-3
Static Press., in. H_2O 0 $\Delta H_@$ 1.74
Ambient Temp, °F 40° C Factor .92
Est. Moisture, % 5% Temp. Device Palm

Run # 1-A
Start: 16:40
Finish: 16:52

Filter # Tare Wt.

Sample Box # 6 @ Heat Setting N/A
Probe # A1 @ Heat Setting N/A
Nozzle # 303 with Dia., inches .173
Pitot Leak Tests: Before 0 After 0
Sampling Train Leak Test (from nozzle)
Before @ ≥ 15 in. Hg = 0.00 cfm
After @ 5 in. Hg = 0.00 cfm
Avg. Δp 2.75 at ΔH of 1.84

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in. H_2O	Orifice Manometer (ΔH) in. H_2O Desired	Orifice Manometer (ΔH) in. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F
B-5	0	175.99	1.20	.82	.82	72	5	220	60	300
B-5	3	177.85	1.20	.82	.82	72	5	220	60	300
B-16	6	179.48	1.20	.82	.82	72	5	220	60	300
B-16	9	181.10	1.20	.82	.82	72	5	220	60	300
	12	182.59								
	DIFF	6.60								
	AVG		1.20		0.82	72				300

PARTICULATE FIELD DATA

Company/Location LEE BRICK
Sanford NC
Sampling Location: STACK #2
Date 2-9-78 Test Participants RD DM
Bar. Press., in. Hg 29.46 Meter Box # #2
Static Press., in. H_2O 0 ΔH@ 1.84
Ambient Temp, °F 40 C Factor 1.0
Est. Moisture, % 5 Temp. Device Palmer

Run # 2A
Start: 1640
Finish: 16:56

Filter # Tare Wt.

Sample Box # 12 @ Heat Setting Hi
Probe # 4 @ Heat Setting Hi
Nozzle # 214 with Dia., inches 0.489
Pitot Leak Tests: Before 0 After 0
Sampling Train Leak Test (from nozzle)
Before @ ≥ 15 in. Hg = 0.015 cfm
After @ 1 in. Hg = 0.00 cfm
Avg. Δp .048 at ΔH of 1.84

Point	Clock Time	Dry Gas Meter, Cu. Ft.	Pitot Manometer (Δp) in. H_2O	Orifice Manometer (ΔH) in. H_2O Desired	Orifice Manometer (ΔH) in. H_2O Actual	Average Meter Temp. °F	Pump Vacuum in. Hg Gauge	Box Temp. °F	Impinger Temp. °F	Stack Temp. °F
B-5	0	158.202	.005	0.19	0.19	70	1	230	55	330
B-5	4	159.21	.005	0.19	0.19	70	1	230	55	330
B-16	8	160.31	.005	0.19	0.19	70	1	235	55	330
B-16	12	161.26	.005	0.19	0.19	70	1	235	55	335
	16	162.213								
	DIFF	4.011								
	AVG		.005		0.19	70				331

APPENDIX D

TEST PARTICIPANTS

ROY N. DOSTER	PROJECT DIRECTOR, TEAM LEADER
D. JAMES GROVE, P.E.	SENIOR ENGINEER
WILLIS NESBIT	TEAM LEADER
DAN MILHOLLAND	ENGINEERING TECHNICIAN

APPENDIX E

F-factor Method

For each sample run, an integrated gas sample is obtained using a stainless steel probe, moisture knockout jar, diaphragm pump, and Tedlar bag. The gas sample is collected at a minimum of 12 Method 5 traverse points and later analyzed with an orsat apparatus to determine $\%CO_2$, $\%O_2$, and %CO. An excess air correction factor is calculated based on the oxygen content in the effluent stream.

The F-factor is defined as the ratio of the theoretical quantity of dry effluent gas generated by combustion to the heat content of the fuel. Using this ratio and the excess air correction factor, the ratio of the actual volumetric flow rate to the heat input rate may be calculated. Measurement of the excess air and the flow rate thus allows determination of the heat input rate. In a similar manner, the F-factor, excess air, and pollutant concentration are used to calculate emission rates directly in terms of $lbs/10^6$ Btu.

Using stoichiometric relations, F-factors may be calculated from the ultimate analysis and heating value of the fuel. However, the values for F are constant for any given fuel category within ±3%. Average values for F ($dscf/10^4$ Btu), for some common fuels are : bituminous coal,98.2; oil, 92.2; gas,87.4; wood,92.5; and bark,97.0.

The use of the F-factor Method eliminates the inconsistencies which arise in determining heat input rates from fuel burning rates or steam production rates. The accuracy of the F-factor Method, however, is dependent on the accuracy of the excess air and volumetric flow rate measurements.