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

The file name refers to the file number, the AP42 chapter and then the section. The file name "rel01_c01s02.pdf" would mean the file relates to AP42 chapter 1 section 2. The document may be out of date and related to a previous version of the section. The document has been saved for archival and historical purposes. The primary source should always be checked. If current related information is available, it will be posted on the AP42 webpage with the current version of the section.

These are the source test reports for AP 42 section 11.17 Lime Manufacturing.
They are referenced in the database as a group, Lime Manufacturing source tests.

SUMMARY

The particulate and sulfur dioxide emissions from the coal-fired rotary lime kiln at the Western Lime & Cement Company plant in Eden, Wisconsin were measured on October 10, 1991. The particulate emissions were found to be well below the New Source Performance Standard (NSPS) of 0.30 pounds of particulate per ton of limestone feed set by the U.S. EPA. The numerical particulate results are presented below:

Test	Emissions	% of Allowable
1	0.027	9
2	0.033	11
3	0.018	6
AVG	0.026 lb/ton of feed	9

The sulfur dioxide emissions were also measured as a provision of the permit issued by the State of Wisconsin DNR. These sulfur dioxide numerical results are presented below:

Test	Emissions
1	46.9
2	44.1
3	50.1
AVG	47.0 lb/hr

1.0 GENERAL

On Thursday, October 10, 1991, Environmental Technology and Engineering Corporation personnel performed a stack emission test on the coal-fired rotary lime kiln at the Western Lime & Cement Company plant located in Eden, Wisconsin. The purpose of the testing was to determine the compliance status of the particulate emissions with the permit conditions established by the State of Wisconsin DNR and with the New Source Performance Standard (NSPS) established by the U.S. EPA for lime kilns of this type.

The kiln tested was equipped with a baghouse for particulate control. The limestone input, lime output, coal firing rate and baghouse conditions were monitored by Western Lime personnel under the direction of Lloyd Soley. At the request of the DNR, a coal sample was collected and an ultimate analysis was performed by Commercial Testing & Engineering. A copy of this report is included in the APPENDIX. The field test, laboratory analysis, and report preparation were performed by Mike Huenink and Bill Dick. The test procedures, plant operating conditions, and stack opacity were observed by Dave Sellers of the DNR Southern District Office.

The following sections of this report document the activities and results of the test program. The report presents all of the relevant data collected and discussions on the interpretation of the data are provided where appropriate. The report, therefore, includes much necessary detail. The results, however, have been summarized in the SUMMARY section at the beginning of this report for those readers not wishing to be burdened by the details.

2.0 RESULTS

2.1 PARTICULATE MATTER

Isokinetic sampling for particulate matter was performed in accordance with the procedures outlined in EPA Method 5 - "Determination of Particulate Emissions from Stationary Sources" - as published in the Federal Register. A brief summary of this method is included in section 3.0 of this report. The tests were performed in the final discharge stack at the location shown in Figure 2-1. This same figure also depicts the location of the exact test points relative to the stack wall. The stack flow parameters recorded during testing and the weights of particulate collected were used to compute the emissions for each test of the three-test sequence. These data were then entered into a computer and printouts showing detailed results are included as Tables 2-1, 2-2, and 2-3.

The results of the three individual tests as well as the average of the three show the emissions to be above the NSPS limit of 0.30 pounds of particulate per ton of limestone feed as set by the U.S. EPA. The numerical test results are summarized below:

Test	Emissions	% of Allowable
1	0.027	9
2	0.033	11
3	0.018	6
AVG	0.026 lb/ton	9

FIGURE 2-1

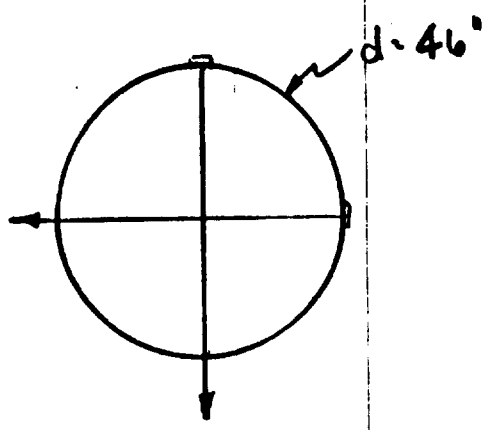
PLANT WESTERN LIME

LOCATION EDEN

SOURCE COAL-FIRED KILN

DIMENSIONS 46" Ø

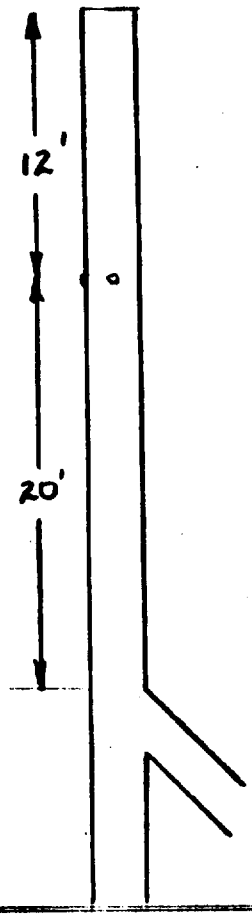
COMMENTS



TEST SECTION

POINT	DISTANCE FROM STACK WALL
1	1.1"
2	3.8
3	6.7
4	10.4
5	15.7
6	30.3
7	35.6
8	39.3
9	42.2
10	44.9

SAMPLING LOCATION



13020 WEST BLUEMOUND ROAD • ELM GROVE, WISCONSIN 53122 • TELEPHONE (414) 784-2434

WESTERN LIME EDEN KILN TEST 1 TABLE 2-1 10-10-91

BAROMETRIC PRESSURE, in Hg = 29.400
TIP DIAMETER, in .3040
STACK AREA, sq ft = 11.511
SAMPLING TIME PER POINT, min = 3.00
NUMBER OF POINTS = 20
GAS METER VOLUME, acf = 59.44
WATER COLLECTED, ml = 42.00
PARTICULATE COLLECTED, grams = 0.0106
LIMESTONE FEED, tph = 20.0
CO2 = 23.00 O2 = 5.50 CO = 0.00 N2 = 71.50

SAMPLING POINT	STACK TEMP deg F	PITOT DEL P inches	ORIFICE METER inches	GAS METER OUTLET T deg F	GAS VELOCITY fps
1	325	0.620	3.70	62	52.62
2	325	0.620	3.70	63	52.62
3	325	0.640	3.80	63	53.46
4	330	0.650	3.85	64	54.05
5	330	0.640	3.80	66	53.63
6	325	0.600	3.60	67	51.77
7	325	0.580	3.45	68	50.90
8	325	0.560	3.40	70	50.01
9	320	0.540	3.20	71	48.95
10	320	0.500	2.95	71	47.11
11	320	0.580	3.45	75	50.73
12	325	0.580	3.45	76	50.90
13	330	0.600	3.60	77	51.93
14	330	0.600	3.60	78	51.93
15	325	0.580	3.45	79	50.90
16	325	0.580	3.45	80	50.90
17	330	0.650	3.85	81	54.05
18	330	0.650	3.85	81	54.05
19	325	0.640	3.80	82	53.46
20	325	0.620	3.70	82	52.62
AVG VALUES	326		3.583	73	51.83

TOTAL GAS WITHDRAWN, scf = 61.52
DRY GAS WITHDRAWN, scf = 59.54
WATER VAPOR WITHDRAWN, scf = 1.98
PERCENT WATER VAPOR = 3.21
ACTUAL WET FLOW RATE, acfm = 35,796.88
STANDARD DRY FLOW RATE, scfm = 22,859.60
, m3/hr = 38,843.02
PARTICULATE CONCENTRATION, grains/dscf = 0.003
PARTICULATE EMISSIONS, lb/1000 lb wet gas = 0.005
PARTICULATE EMISSIONS, lb/ton feed = 0.027
PARTICULATE EMISSION RATE, lb/hr = 0.54
SULFUR DIOXIDE CONCENTRATION, mg/m3 = 547.3
SULFUR DIOXIDE EMISSION RATE, lb/hr = 46.9
PERCENT OF ISOKINETIC SAMPLING = 99.15

WESTERN LIME EDEN KILN TEST 2 TABLE 2-2 10-10-91

BAROMETRIC PRESSURE, in Hg = 29.400
TIP DIAMETER, in .2450
STACK AREA, sq ft = 11.511
SAMPLING TIME PER POINT, min = 3.00
NUMBER OF POINTS = 20
GAS METER VOLUME, acf = 37.86
WATER COLLECTED, ml = 25.00
PARTICULATE COLLECTED, grams = 0.0085
LIMESTONE FEED, tph = 20.0
CO2 = 23.00 O2 = 5.60 CO = 0.00 N2 = 71.40

SAMPLING POINT	STACK TEMP deg F	PITOT DEL P inches	ORIFICE METER inches	GAS METER OUTLET T deg F	GAS VELOCITY fps
1	325	0.620	1.50	84	52.60
2	330	0.620	1.50	85	52.76
3	330	0.640	1.55	85	53.61
4	330	0.640	1.55	85	53.61
5	330	0.640	1.55	85	53.61
6	330	0.600	1.45	85	51.91
7	330	0.560	1.35	85	50.15
8	330	0.560	1.35	85	50.15
9	325	0.540	1.30	86	49.09
10	325	0.540	1.30	86	49.09
11	325	0.540	1.30	90	49.09
12	330	0.520	1.25	91	48.32
13	330	0.560	1.35	91	50.15
14	330	0.560	1.35	91	50.15
15	325	0.580	1.40	91	50.87
16	325	0.640	1.55	91	53.44
17	330	0.640	1.55	92	53.61
18	330	0.640	1.55	92	53.61
19	325	0.600	1.45	92	51.74
20	325	0.520	1.25	92	48.17
AVG VALUES	328		1.420	88	51.28

TOTAL GAS WITHDRAWN, scf = 38.97
DRY GAS WITHDRAWN, scf = 37.79
WATER VAPOR WITHDRAWN, scf = 1.18
PERCENT WATER VAPOR = 3.02
ACTUAL WET FLOW RATE, acfm = 35,419.97
STANDARD DRY FLOW RATE, scfm = 22,599.46
, m3/hr = 38,400.99
PARTICULATE CONCENTRATION, grains/dscf = 0.003
PARTICULATE EMISSIONS, lb/1000 lb wet gas = 0.006
PARTICULATE EMISSIONS, lb/ton feed = 0.033
PARTICULATE EMISSION RATE, lb/hr = 0.67
SULFUR DIOXIDE CONCENTRATION, mg/m3 = 521.5
SULFUR DIOXIDE EMISSION RATE, lb/hr = 44.1
PERCENT OF ISOKINETIC SAMPLING = 98.00

WESTERN LIME EDEN KILN TEST 3 TABLE 2-3 10-10-91

BAROMETRIC PRESSURE, in Hg = 29.400
TIP DIAMETER, in .2450
STACK AREA, sq ft = 11.511
SAMPLING TIME PER POINT, min = 3.00
NUMBER OF POINTS = 20
GAS METER VOLUME, acf = 37.75
WATER COLLECTED, ml = 21.00
PARTICULATE COLLECTED, grams = 0.0045
LIMESTONE FEED, tph = 20.0
CO2 = 23.00 O2 = 5.40 CO = 0.00 N2 = 71.60

SAMPLING POINT	STACK TEMP deg F	PITOT DEL P inches	ORIFICE METER inches	GAS METER OUTLET T deg F	GAS VELOCITY fps
1	325	0.620	1.50	90	52.55
2	330	0.620	1.50	91	52.72
3	330	0.660	1.60	91	54.39
4	325	0.640	1.55	91	53.39
5	325	0.640	1.55	91	53.39
6	325	0.600	1.45	91	51.69
7	325	0.600	1.45	91	51.69
8	330	0.560	1.35	90	50.10
9	330	0.540	1.30	90	49.20
10	325	0.500	1.20	89	47.19
11	325	0.520	1.25	89	48.12
12	330	0.560	1.35	90	50.10
13	330	0.560	1.35	90	50.10
14	330	0.600	1.45	90	51.86
15	330	0.600	1.45	90	51.86
16	330	0.640	1.55	90	53.56
17	325	0.640	1.55	92	53.39
18	330	0.640	1.55	92	53.56
19	330	0.600	1.45	92	51.86
20	325	0.540	1.30	93	49.04
AVG VALUES	328		1.435	91	51.49

TOTAL GAS WITHDRAWN, scf = 38.68
DRY GAS WITHDRAWN, scf = 37.69
WATER VAPOR WITHDRAWN, scf = 0.99
PERCENT WATER VAPOR = 2.56
ACTUAL WET FLOW RATE, acfm = 35,560.42
STANDARD DRY FLOW RATE, scfm = 22,804.96
, m3/hr = 38,750.19
PARTICULATE CONCENTRATION, grains/dscf = 0.002
PARTICULATE EMISSIONS, lb/1000 lb wet gas = 0.003
PARTICULATE EMISSIONS, lb/ton feed = 0.018
PARTICULATE EMISSION RATE, lb/hr = 0.35
SULFUR DIOXIDE CONCENTRATION, mg/m3 = 586.1
SULFUR DIOXIDE EMISSION RATE, lb/hr = 50.1
PERCENT OF ISOKINETIC SAMPLING = 96.87

2.2 SULFUR DIOXIDE

Sampling for sulfur oxides was performed simultaneously with the particulate sampling in accordance with the procedures outlined in EPA Method 8 -"Determination of Sulfuric Acid Mist and Sulfur Dioxide Emissions from Stationary Sources" - as published in the Federal Register. A brief summary of this method is included in section 3.0 of this report. The stack flow parameters recorded during testing and the weights of sulfur dioxide collected were used to compute the emissions for each test of the three-test sequence. These data were then entered into a computer and printouts showing detailed results are included as Tables 2-1, 2-2, and 2-3.

The numerical test results are summarized below:

Test	Emissions
1	46.9
2	44.1
3	50.1
AVG	47.0 lb/hr

3.0 METHOD OF TEST

The equipment used to sample was the Western Precipitation Division of the Joy Manufacturing Company Emission Parameter Analyzer. Samples were collected and analyzed in accordance with procedures outlined in the Federal Register, Volume 42, Number 160, August 18, 1977, Method 5 (Particulate Matter) and Method 8 (Sulfur Dioxide).

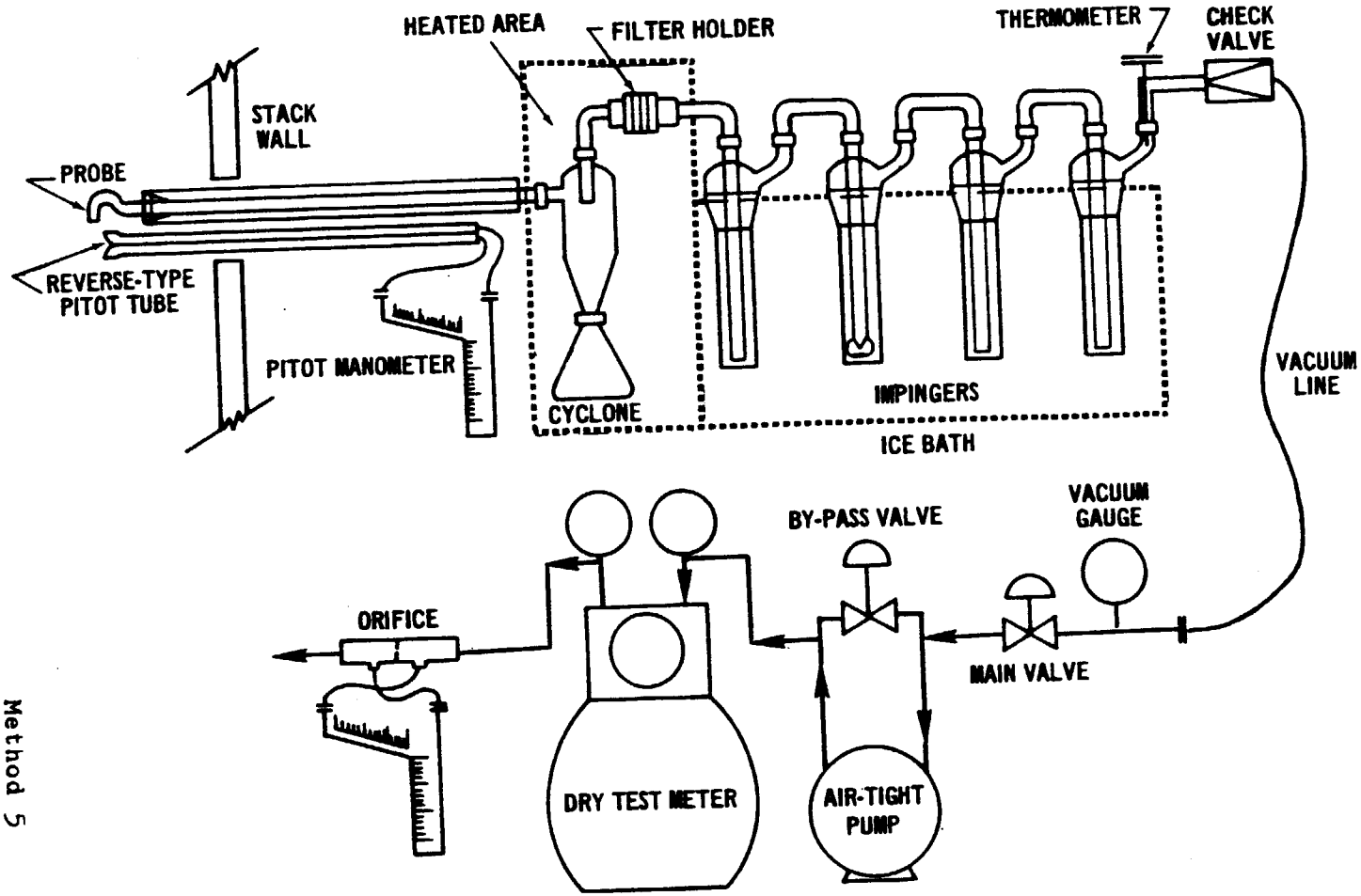
The sampling train consisted of a stainless steel probe tip, a heated stainless steel lined probe, a heated glass cyclone and flask, and a heated filter holder with a tared filter. A series of four impingers followed in an ice bath. The first was a Greenburg-Smith impinger with 150 ml of 80 % isopropyl alcohol; the second was a Greenburg-Smith impinger with 100 ml of 3 % hydrogen peroxide; the third was a modified Greenburg-Smith impinger also with 100 ml of 3 % hydrogen peroxide; the fourth was also a modified Greenburg-Smith impinger containing a tared quantity of silica gel. The gas then passed through a vacuum pump, calibrated dry gas meter, and a calibrated orifice. A schematic drawing of the sampling train is included.

The temperatures of the stack gas stream, as well as strategic locations within the sampling devices, were monitored by RTDs and read directly from a gauge on the control unit.

The initial gas stream velocity was obtained from a preliminary traverse using an "S" type pitot tube. The initial moisture was estimated from previous tests of similar processes. This data, along with the stack temperature, was used to set a nomograph so that rapid calculations of isokinetic sampling conditions could be made.

The principle of the method was to collect the sample representative of the exhaust by adjusting the sample collection velocity to match the exhaust gas stream velocity at the point of collection. The velocity at the point of collection was measured with an "S" type pitot tube attached to the probe and the collection velocity was matched to the stack gas velocity by adjusting the flow as indicated by the calibrated orifice.

To determine the molecular weight of the stack gas, integrated samples were collected in bags and analyzed by an Orsat analyzer for percentage CO2, O2, and N2.



Particulate sampling train.

At the completion of the test, the impinger contents were measured and weighed for determination of the actual moisture content of the exhaust gas stream and then saved for subsequent titration for sulfur oxide content. The quantity of titrant (barium perchlorate) was used to calculate the sulfur oxide weights in the samples. The probe tip, probe, and glassware preceding the filter were washed with acetone and placed in a tared beaker and evaporated at room temperature. The filter and beaker were then desiccated to the tared humidity conditions and weighed. The combined weight of the filter catch and the washing residue was used for the determination of particulate emission rates and emission concentrations.

A computer was used to calculate the stack velocities, emission concentrations, emission rates and volumetric flow rates using the field and laboratory data.

4.0 CALIBRATIONS

The probe tip, pitot tube, dry gas meter, and orifice were calibrated prior to the test according to procedures outlined in the Maintenance, Calibration, and Operation of Isokinetic Source-Sampling Equipment as published by the EPA. The values obtained were:

Probe tip diameters	d =	0.304", 0.245"
Pitot tube coeff.	Cp =	0.85
Orifice coeff.	*d*H@ =	1.779

The dry gas meter presently installed in the control box is a temperature compensating meter. The correction factor for this dry gas meter is represented by:

$$\text{Gama} = 1.010 + (Td - 70) \times .00012$$

where: Td = Dry Gas Meter Temperature

The most recent calibration was performed October 9, 1991.

APPENDIX A

SAMPLE CALCULATIONS

SAMPLE CALCULATIONS

1. **DRY MOLECULAR WEIGHT (Md)** lb/lb-mole

   Md = .44*% CO2 + .32*%O2 + .282*%N2 + .28*%CO

2. **WATER VAPOR PERCENT (%H2O)**

   Vw std = 0.04707*(Vf - Vi)

   where: Vw std = standard cubic feet of water vapor
   Vf = Final volume of impingers, ml
   Vi = Initial volume of impingers, ml

   %H2O = Vw std * 100/(Vm std + Vw std)

   where Vm std = standard cubic feet of gas sampled

3. **WET MOLECULAR WEIGHT (Ms)** lb/lb-mole

   Ms = Md*(1 - %H2O/100) + 18*%H2O/100

4. **STACK PRESSURE (Ps)** in. Hg

   Ps = Pb + Pg/13.6

   where: Pb = barometric pressure (uncorrected), in. Hg
   Pg = stack gauge pressure, in. H2O
   13.6 = specific gravity of mercury (Hg)

5. **AVERAGE STACK VELOCITY (Vs)** feet per second

   Vs = Kp*Cp* (DELP) Tsavg/(Ps*Ms)

   where: Kp = 85.49 unit conversion
   Cp = 0.85, pitot tube calibration factor
   DELP = square root of velocity head, in. H2O
   Tsavg = average stack temperature, deg R (460+F)
   Ps = stack pressure
   Ms = wet molecular weight

6. **STACK GAS FLOW RATE (Qs)** std cubic feet per minute

   Qs = 60*(1 - %H2O/100)*Vs*A*(528*Ps/Tsavg/29.92)

   where: A = stack area, ft2
   528 = std temperature, deg R
   29.92 = std pressure, in. Hg

7. **DRY GAS VOLUME (Vm std)** std cubic feet

Vm std = GAMA*(Vm-(AL-.02)t)*(Pb+DELH/13.6)/29.92

where: GAMA = dry gas meter calibration factor
Vm = volume of dry gas metered, cubic feet
AL = post test leak rate, cubic feet per minute
t = total time of test, minutes
DELH = average orifice pressure drop, in.H2O

8. **PARTICULATE CONCENTRATION (Cs)** grains/dry std cubic foot

Cs = Mn * 15.43/Vm std

where: Mn = particulate captured, grams
15.43 = grains per gram

9. **EMISSION RATE (ER)** pounds per hour

PMRA = Mn*A*60/(t*An*453.6) AREA METHOD lb/hr

PMRC = Cs*Qs*60/(15.43*453.6) CONC. METHOD lb/hr

ER = (PMRA + PMRC)/2

where: An = area of sampling nozzle, square feet

10. **EMISSION CONCENTRATION (EC)** lb/1000 lb exhaust gas

EC = ER * 386700 * (1-%H2O/100)/(Qs*60*Ms)

where: 386700 = cubic feet per lb mole * 1000

11. **ISOKINETIC SAMPLING PERCENTAGE (I)** %

I = PMRA/PMRC

SAMPLE CALCULATION

BAROMETRIC PRESSURE, in Hg (Pb) = 29.200
STACK PRESSURE, in Hg (Pb + Pg/13.6) = 29.178
TIP DIAMETER, in (An = PI*D^2/576) = .2450
STACK AREA, sq ft (A) = 10.560
SAMPLING TIME PER POINT, min = 2.50
NUMBER OF POINTS = 24
GAS METER VOLUME, acf (Vm) = 66.06
WATER COLLECTED, ml (Vf - Vi) = 86.00
PARTICULATE COLLECTED, grams (Mn) = 0.0755
CO2 = 0.60 O2 = 21.00 CO = 0.00 N2 = 78.40
WET MOLECULAR WEIGHT, lb/mole (Ms) = 28.45

SAMPLING POINT	STACK TEMP deg F	PITOT DEL P inches	ORIFICE DEL H inches	GAS METER OUTLET T deg F	GAS VELOCITY fps
1	110	1.450	4.05	32	72.51
2	110	1.350	3.75	32	69.97
3	110	1.350	3.75	32	69.97
4	110	1.300	3.70	32	68.66
5	110	1.250	3.60	32	67.33
6	110	1.250	3.60	32	67.33
7	110	1.050	2.95	32	61.71
8	110	1.000	2.85	32	60.22
9	110	1.000	2.85	34	60.22
10	110	1.050	2.95	34	61.71
11	110	0.950	2.75	38	58.69
12	115	0.950	2.75	38	58.95
13	115	1.300	3.70	42	68.96
14	115	1.250	3.60	42	67.62
15	115	1.200	3.40	42	66.26
16	115	1.200	3.40	42	66.26
17	115	1.150	3.30	44	64.86
18	115	1.150	3.30	46	64.86
19	115	1.050	2.95	48	61.98
20	115	1.150	3.30	48	64.86
21	115	1.000	2.85	50	60.48
22	115	1.100	3.15	50	63.43
23	115	1.050	2.95	50	61.98
24	115	0.900	2.55	50	57.38
AVG VALUES	113		3.250	40	64.42

TOTAL GAS WITHDRAWN, scf = 69.39
DRY GAS WITHDRAWN, scf (Vmstd) = 65.35
WATER VAPOR WITHDRAWN, scf (Vwstd) = 4.05
PERCENT WATER VAPOR (%H2O) = 5.83
ACTUAL WET FLOW RATE, acfm = 40,819.39
STANDARD DRY FLOW RATE, scfm (Qs) = 34,558.69
PARTICULATE CONCENTRATION, grains/dscf (Cs) = 0.018
PARTICULATE EMISSION RATE, lb/hr (ER) = 5.325
PARTICULATE EMISSIONS, lb/1000 lb (EC) = 0.033
PERCENT OF ISOKINETIC SAMPLING (I) = 101.67

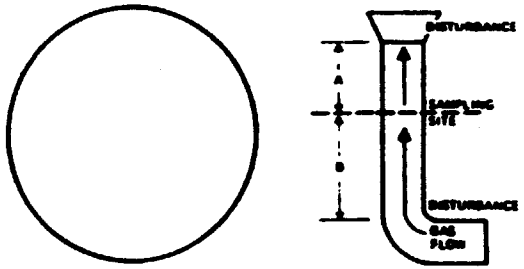
APPENDIX B

FIELD & LABORATORY DATA SHEETS

Technology &
Engineering Corp.

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Western Lime
DATE 10-10-91
LOCATION EDEN
OPERATOR WJD
STACK NO. KILN
RUN NO. 1
SAMPLE BOX NO. 1
METER BOX NO. 1

AMBIENT TEMPERATURE 50
BAROMETRIC PRESSURE 29.40
ASSUMED MOISTURE, % 5
PROBE LENGTH, in. 5'5 5
NOZZLE DIAMETER, in. 5/16
STACK DIAMETER, in. 66
PROBE HEATER SETTING 250
HEATER BOX SETTING 250

Cp: 0.85
ΔP: 1.010
10-9-91
METER ΔH 1.779
C FACTOR
LIMESTONE
PROCESS WEIGHT RATE ~20 TPH FEED
~2.2 TPH COAL

ORSAT RESULTS
CO_2 23.0
O_2 5.5
CO 0.
N_2 71.5

PRE LK ON
POST LK ON
C.01@29"

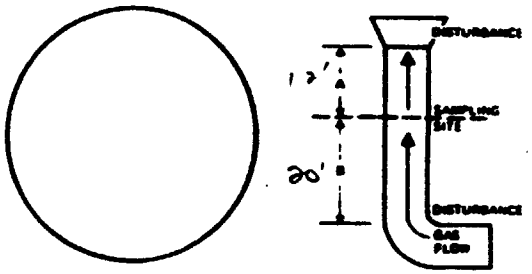
TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY fps
A 1	0920000	-0.3	325	.62	3.70		8950.00		60			7	
2	23		325	.62	3.70		53.2		63				
3	26		325	.64	3.80		56.3		63				
4	29	-0.3	330	.65	3.85		59.4		64				
5	32		330	.64	3.80		62.4		66				
6	35		325	.60	3.60		65.5		67				
7	38	-0.3	325	.58	3.45		68.5		68				
8	41		325	.56	3.40		71.4		70				
9	44		320	.54	3.20		74.3		71				
10	47	-0.3	320	.50	2.95		77.2		71				
B 11	50/56		320	.58	3.45		79.9		75				
12	01		325	.58	3.45		83.0		76				
13	05		330	.60	3.60		85.7		77				
14	07	-0.3	320	.60	3.60		88.6		78				
15	10		325	.58	3.45		91.6		79				
16	13		325	.58	3.45		94.1		80				
17	16	-0.3	330	.65	3.85		97.4		81				
18	19		330	.65	3.85		00.5		81				
19	22		325	.64	3.80		03.4		82				
20	25		325	.62	3.70		06.4		82				
	1028 EU						9509.44						
							(59.44)						

Technology & Engineering Corp.

CHANGE TO SHORTER PROBE & SMALLER NTP

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT WESTERN LIME
DATE 10-10-91
LOCATION EDEN
OPERATOR WJD
STACK NO. KILN
RUN NO. 2
SAMPLE BOX NO. 2
METER BOX NO. 1

AMBIENT TEMPERATURE 50
BAROMETRIC PRESSURE 29.40
ASSUMED MOISTURE, % 5
PROBE LENGTH, in. 52
NOZZLE DIAMETER, in. YG
STACK DIAMETER, in. 46
PROBE HEATER SETTING 250
HEATER BOX SETTING 250

METER ΔH
C FACTOR
PROCESS WEIGHT RATE

ORSAT RESULTS
CO_2 23.0
O_2 5.6
CO
N_2 71.4

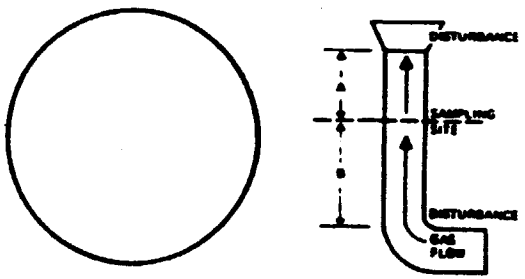
PRE LK @
POST LK @ 0.01 @ 20"

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft^3	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY fps
A 1	10 47 00		325	.62	1.50		8511.00		84				
2	50	-0.3	330	.62	1.50		13.0		85				
3	53		330	.64	1.55		15.0		85				
4	56		330	.62	1.55		16.9		85				
5	59		330	.64	1.55		19.0		85				
6	02	-0.3	330	.60	1.45		21.0		85				
7	05		330	.56	1.35		22.93		85				
8	08		330	.56	1.35		24.7		85				
9	11		325	.54	1.30		26.5		86				
10	14		325	.54	1.30		28.4		86				
B 11	17/21		325	.54	1.30		30.25		90				
12	20	-0.3	330	.52	1.25		32.0		91				
13	23		330	.56	1.35		33.8		91				
A	26		330	.56	1.35		35.6		91				
15	33	-0.3	325	.58	1.40		37.5		91				
16	36		325	.64	1.55		39.4		91				
17	39		330	.64	1.55		41.4		92				
18	42		330	.64	1.55		43.3		92				
19	45		325	.60	1.45		45.3		92				
20	48		325	.52	1.25		47.1		92				
	11 51 00						8540.86						
							(37.86)						

Technology &
Engineering Corp.

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Western Lime
DATE 10-10-91
LOCATION Eden
OPERATOR WJD
STACK NO. Kiln
RUN NO. 3
SAMPLE BOX NO. 3
METER BOX NO. 1

AMBIENT TEMPERATURE 60
BAROMETRIC PRESSURE 29.90
ASSUMED MOISTURE, % 5
PROBE LENGTH, in. 52"
NOZZLE DIAMETER, in. 1/4
STACK DIAMETER, in. 96
PROBE HEATER SETTING 250
HEATER BOX SETTING 250

METER ΔH
C FACTOR
PROCESS WEIGHT RATE
ORSAT RESULTS
CO_2 23.0
O_2 5.4
CO
N_2 71.6
PRE LEAK
POST LEAK <.01 @ 29" Hg

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
A 1	12:00:00		325	.62	1.50		8550.00		90				
2	13	-0.3	330	.62	1.50		520		91				
3	16		330	.66	1.60		54.0		91				
4	19		325	.64	1.55		56.0		91				
5	22	-0.3	325	.64	1.55		57.9		91				
6	25		325	.60	1.45		59.8		91				
7	28		325	.60	1.45		61.7		91				
8	31		330	.56	1.35		63.6		90				
9	34	-0.3	330	.54	1.30		65.6		90				
10	37		325	.50	1.20		67.4		89				
B 11	40:45		325	.52	1.25		69.2		89				
12	48		330	.56	1.35		70.8		90				
13	51	-0.3	330	.56	1.35		72.7		90				
14	55		330	.60	1.45		74.6		90				
15	59		330	.60	1.45		76.4		90				
16	00	-0.3	330	.64	1.55		78.4		90				
17	03		325	.64	1.55		80.3		92				
18	06		330	.64	1.55		82.2		92				
19	09	-0.3	330	.60	1.45		84.2		92				
20	12		325	.54	1.30		86.1		93				
	12:56						8587.75						
							(37.75)						

LABORATORY DATA SHEET
PARTICULATE & WATER COLLECTED

JOB NAME Western Lime DATE OF TEST 10-10-91

JOB NO. 1400 TEST ENGINEER WJP

RUN NO. 1 STACK Kiln

Sample Box 1 Filter 1974 Wash Bottle —

Beaker No. 1

WATER COLLECTED

Impinger No.	Final Wt. g	Initial Wt. g	Collected grams
1 (8% IPA)	74	150	(76)
2 (3% H_2O_2)	153	100	53
3 (3% H_2O_2)	138	100	38
Silica	721	694	27
		TOTAL	42

PARTICULATE COLLECTED

	Final Wt. g	Tare Wt. g	Collected grams
Filter	0.8049	0.8031	0.0018
Washings	96.6152	96.6064	0.0088
		TOTAL	0.0106

WATER COLLECTED [42] GRAMS

PARTICULATE COLLECTED [ ] GRAMS

NOTES:

LABORATORY DATA SHEET
PARTICULATE & WATER COLLECTED

JOB NAME Western Lime — DATE OF TEST 10-10-91

JOB NO. 1400 — TEST ENGINEER WJD

RUN NO. 3 — STACK KILN

Sample Box 3 — Filter 1475 — Wash Bottle —

Beaker No. 4

WATER COLLECTED

Impinger No.	Final Wt. g	Initial Wt. g	Collected grams
1 (80% IPA)	94	150	(56)
2 (3% H_2O_2)	144	100	44
3 (3% H_2O_2)	120	100	20
Sil Gel	645	628	17
		TOTAL	25

PARTICULATE COLLECTED

	Final Wt. g	Tare Wt. g	Collected grams
Filter	0.8073	0.8060	0.0013
Washings (.0003)	95.3962	95.3887	0.0072
		TOTAL	0.0085

WATER COLLECTED [25] GRAMS

PARTICULATE COLLECTED [0.0096] GRAMS

NOTES:

LABORATORY DATA SHEET
PARTICULATE & WATER COLLECTED

JOB NAME Western Lime — DATE OF TEST 10-10-91

JOB NO. 1400 — TEST ENGINEER WJD

RUN NO. 3 — STACK Kiln

Sample Box 3 — Filter 1476 — Wash Bottle —

Beaker No. 6

WATER COLLECTED

Impinger No.	Final Wt. g	Initial Wt. g	Collected grams
1 (80% IPA)	99	150	(51)
2 (3% H_2O_2)	146	100	46
3 (3% H_2O_2)	119	100	19
Silica Gel	630	623	7
		TOTAL	21

PARTICULATE COLLECTED

	Final Wt. g	Tare Wt. g	Collected grams
Filter	0.8136	0.8124	0.0012
Washings (.0003)	97.6914	97.6878	0.0033
		TOTAL	0.0045

WATER COLLECTED [21] GRAMS

PARTICULATE COLLECTED [0.0048] GRAMS

NOTES:

COLUMN WORKSHEET
FORM 154

SO_2 Titrations

Sample No.	V_{sample}	V_0	V_f	V_{blk}	N		mg SO_2		
WL1 IPA	74	5.0	0.70	0.00	0.11				
WL1 H_2O_2	291	5.0	4.50	0.00			922.8		
			4.50						
			4.50						
WL2 IPA	94	5.0	0.45	0.00					
WL2 H_2O_2	264	5.0	3.00	0.00			558.1		
			2.95						
			3.00						
WL3 IPA	99	5.0	0.30	0.00					
WL3 H_2O_2	265	5.0	3.35	0.00			625.6		
			3.35						
			3.35						

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • (708) 953-9300

Member of the SGS Group (Société Générale de Surveillance)

PLEASE ADDRESS ALL CORRESPONDENCE TO:
16130 VAN DRUNEN RD., P.O. BOX 127
SOUTH HOLLAND, IL 60473
TELEPHONE: (708) 331-2900
FAX: (708) 333-3060

October 22, 1991

ENVIRONMENTAL TECH & ENGRG
13020 West Bluemound Road
Elm Grove, WI 53122
ATTN: William J. Dick
Vice President

Sample identification by
Environmental Tech. & Engrg.

Kind of sample reported to us	Coal
Sample taken at	Environmental Tech. & Engrg.
Sample taken by	Environmental Tech. & Engrg.
Date sampled	October 10, 1991
Date received	October 17, 1991

Sample ID: E.T.E. Coal
Date: 10/10/91
Stack Test

Analysis Report No. 71-21734

SHORT PROXIMATE - ULTIMATE ANALYSIS

	As Received	Dry Basis	
% Moisture	4.35	xxxxx	
% Carbon	74.42	77.80	
% Hydrogen	4.95	5.18	
% Nitrogen	1.49	1.56	
% Sulfur	0.72	0.75	
% Ash	7.52	7.86	
% Oxygen(diff)	6.55	6.85	
	100.00	100.00	
Btu/lb	13233	13835	MAF 15015

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Aaron Hallett
Manager, South Holland Laboratory