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 The document may be out of date and related to a previous version of the section.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.

Commonwealth of Pennsylvania
Environmental Resources
July 5, 1988

Subject: Source Test Review

To: Data File
Bellefonte Lime Company
Spring Township, Centre County

From: John S. Pitulski J. S. P.
Air Quality Program Specialist
Division of Technical Services and Monitoring
Bureau of Air Quality Control

Through: Chief, Source Testing and Monitoring Section

The No. 5 Kiln at Bellefonte Lime Co. is a Traylor Company manufactured limestone production kiln with a rated feed capacity of approximately 37.5 tons per hour. Gaseous effluent from the unit is controlled by a Chemico S-F venturi wet scrubber in combination with a cyclonic seperator.

Two particulate compliance tests were conducted on March 23, 1988 by Mease Engineering Associates at the exhaust stack servicing the kiln. Both tests appear to have been conducted in accordance with the applicable test methods and are acceptable to the Department.

The following information was extracted from the test report:

Test Run No.	1	2
Kiln Production Rate (tons/hr)	19.24	19.02
Volumetric Flowrate (dscfm)	53400	53000
Particulate Concentration (gr/dscf)	0.079	0.083
Particulate Emission Rate (lb/hr)	36.0	37.7
Allowable Emission Rate (lb/hr)	24.4	24.2

COMMONWEALTH OF PENNSYLVANIA

June 8, 1988

14-309-033A

SUBJECT: Source Test Report Review

TO: L. Blaine DeHaven
Chief, Source Testing & Monitoring Section

FROM: Richard L. Maxwell, Jr.
Chief, Engineering Services
Bureau of Air Quality Control
Williamsport Regional Office

Attached is a test report for particulate source testing performed on 3/23/88 by Nease Engineering Associates on the #5 lime kiln at Bellefonte Lime's Bellefonte Plant. Would you please have someone on your staff review this report for conformance with Chapter 139 procedures, etc.

Also attached are copies of inspection memos by Alan Bigatel and myself.

Tim Brooks observed the first test and a portion of the second.

This is the same kiln tested by the Source Testing and Monitoring Section on 8/20/87 (Test 00887).

RLM/skb

Attachments

cc: File

COMMONWEALTH OF PENNSYLVANIA

April 11, 1988

SUBJECT: Bellefonte Lime Company
Bellefonte, Centre County

THROUGH: Richard L. Maxwell, Jr.
Chief, Engineering Services
Williamsport Region

TO: File #14-022

FROM: Alan J. Bigatel,
Air Pollution Control Engineer
Hawk Run District

John E. Archambault,
District Supervisor
Hawk Run District

On March 23, 1988, I observed a stack test at Bellefonte Lime Company, Bellefonte, Centre County. The test was performed on #5 Lime Kiln exhaust by Michael J. Nease Associates. Two tests were performed on the kiln. Tim Brooks of the Division of Technical Services and Monitoring observed the test procedures, while Rich Maxwell and I observed the operating parameters of the kiln and the scrubber system.

I recorded the following parameters every fifteen minutes: stone feed pulley count, coal feed pulley count, kiln feed end temperature, kiln discharge end temperature, optical lime temperature, fan amps, kiln amps, coal mill amps, scrubber pump amps, % oxygen, kiln speed, kiln feed, end draft, kiln discharge end draft, and pressure drop across the scrubber. A copy of the original data sheet is included with this memo.

I observed the pre-test leak check for Test No. 1 at 8:30 AM. It was performed at 15 inches of mercury and was acceptable. The first test started at 8:55 AM with the kiln running smoothly on BC stone. According to Bob Woodring, of Bellefonte Lime, straight C stone is no longer run in the kilns. Rather, BC stone is used which is everything between 1 1/2" and 1/4". This stone is the smallest stone sizing now run through the kilns. The kiln ran smoothly throughout the first test with the only notable adjustment being a decrease in the coal feed at approximately 9:35 AM. This kiln is run with the induced draft fan running as hard as possible and with the coal feed being adjusted to achieve the proper temperatures throughout the kiln.

Scrubber draft was read from a mercury manometer measuring the pressure drop across the scrubber and demister. At first, there were some problems with the vacuum line seal near the scrubber inlet, but this was corrected early in the test and pressure drop remained steady at around 1.9 inches of Mercury which is equivalent to 25.8 inches of water. The ameter on the scrubber pump varied between 45 and 46 amps. The first test was over at 11:03 AM. Tim Brooks observed the final leak check for this test, and it was acceptable.

Test #2 started at 11:55 AM, with Tim Brooks observing the pre-test leak check. As before, the kiln ran very consistently on the BC stone. Between the two tests, however, the kiln had been slowed down to allow part of it to heat up to get the final lime temperature into the correct range. During the test, the kiln ran at a steady 88 r.p.h. The second test concluded at 2:06 PM. No one from DER observed the final leak check, but Mr. Nease reported that it was acceptable.

Lime production which determines the allowable particulate emission, was determined using Bellefonte Lime Company's methods which they claim are accurate to within approximately 3%. A counter on the stone feed belt has been calibrated to determine pounds of stone per revolution. Also, with the BC stone, they know that .525 tons of lime are produced for each ton of stone fed. Therefore, by multiplying the counter revolutions x the conversion factor, dividing by 2000 to obtain tons and multiplying by .525, the lime production during the test can be obtained. For example;

TEST #1

(995, 376 - 994, 089) x 121.49 ÷ 2,000 x 0.525 = 41.044 T

41.044 T ÷ 2.133 hr. = 19.240 t/hr.

TEST #2

(997, 121 - 996, 127) x 121.49 ÷ 2,000 x 0.525 = 31.700 T

31.700 T ÷ 1.666 hr. = 19.020 t/hr.

There were several items of note during these tests. The first was the obvious rain out problem downwind from the stack. At a distance of approximately 100 yards from the stack, water droplets were falling to the ground although the day was sunny and cloudless. These droplets when they dried left behind a brown stain indicating that the water had made good contact with the lime dust and clay dust, but that this droplet was not being removed from the gas stream by the demister. Since the particulate in these droplets is going up the stack, it is being counted as particulate emission by the sampling train. Mike Nease, Rich Maxwell, and I spoke to Bob Woodring about this problem, but he did not seem to understand its importance to the compliance/non-compliance situation. From the amount of build-up on my car and my clipboard, this problem appears to be significant to me.

The stone entering the feed end of the kiln was obviously coated with a brownish red clay dust. This stone is coming from the Gentzel Quarry and is considerably dirtier than the pure limestone previously quarried from the deep mine near the plant. This additional particulate loading to the scrubber may be enough to have put this source into non-compliance.

The company has stated since this scrubber was re-built that there is more water going to the scrubber than the design engineers called for. They would like to perform some tests at lower water flow rates to see whether scrubbing improves or deteriorates. It is conceivable that the scrubber is being flooded, causing channeling, but this would need to be demonstrated before our permit conditions could be changed. Overall, these tests were conducted with the source operating in a normal fashion on the dirtiest stone which could be expected to be used and should provide meaningful test results.

AJB/car

cc: Alan Bigatel
Williamsport Case File
Hawk Run Case File
~~Williamsport Permit File #14-309-033~~
Hawk Run Permit File #14-309-033

COMMONWEALTH OF PENNSYLVANIA

March 28, 1988

SUBJECT: Bellefonte Lime Company
Spring Township, Centre County
14-309-033

TO: Files

FROM: Richard L. Maxwell, Jr.
Chief, Engineering Services
Bureau of Air Quality Control
Williamsport Regional Office

On 3/23/88 particulate stack testing was performed on the #5 lime kiln by Mike Mease and Associates. Two tests were performed on 3/23/88 and a third, to be conducted at a lower scrubber water flow rate, was scheduled for the 24th. I arrived approximately 1/2 hour after the commencement of the first test but Alan Bigatel was present at the beginning. Tim Brooks from the Division of Technical Services and Monitoring was also present throughout the first test and for a portion of the second.

Alan recorded pertinent operating data every 15 minutes throughout both tests. Scrubber pressure drop, as measured via a U tube manometer located at the scrubber, appeared to be consistent at 1.9-2.0 inches of Hg (25.8-27.2 inches of water) throughout the two tests. This value represents the pressure drop across the venturi and the demister. The scrubber pressure drop recorded in the control room is slightly higher than this. Scrubber pump motor amperage was consistent at 45-46 amps throughout the two tests.

The plant was running B size stone for both tests and supposedly had been doing so for several days. This is supposedly the smallest size now run. They used to split -1 1/4 stone into two fractions, B and C. they now screen out the -1/4 fraction and run the 1 1/4 x 1/4 as the smallest size. There was some problem (gap or broken wires) with the screen, however, as some larger material was showing up in the -1/4 reject. This would tend to bias the feed size higher during the tests than would typically be run as B but it did not appear that a significant amout of reject was being generated so any bias was probably not significant.

The stone being fed to the kiln was observed to be heavily coated with clay or dirt. Additionally, John Bish was overheard to complain about the dirty stone now being run since the deep mine closed and the kilns were dependent upon the stone quarried from the company's surface mine.

Although legitimate opacity readings could not be made from anywhere on the plant site, there did not appear to be any significant trailoff at the point of scrubber plume steam dissipation. The plume looked as it normally does.

Considering the generally "good" appearance of the plume, it is probable that the high particulate values found during the previous test can be attributed to excessive moisture carryover from the demister. Dirty rainout was observed from both #5 and #4 scrubbers. Alan's car, in fact, which was parked downwind of the #4 scrubber, became so covered with dirt from rainout that it was impossible to see through the windshield and difficult to identify the color of the paint in a matter of only several hours. Credence for the theory that the excessive particulate emissions can be attributed to rainout is also given by the fact that it appears that occasions when excessive trailoff is observed occur on days with relatively low humidity.

Both tests appeared to go quite smoothly.

We missed the final leak check of the second test.

RLM/skb

SOURCE TEST REPORT

Particulate Emissions

Bellefonte Lime Company
Bellefonte, Pennsylvania
March, 1988

Client:	Bellefonte Lime Company P.O. Box 448 Bellefonte, Pennsylvania
Testing Firm:	Mease Engineering Associates P.O. Box 721 State College, Pennsylvania

CONTENTS

SECTION 1.0

Summary of Results

CLIENT:	Bellefonte Lime Company P.O. Box 448 Bellefonte, Pennsylvania 16823
TEST LOCATION:	Bellefonte Lime Company P.O. Box 448 Bellefonte, Pennsylvania 16823
UNIT TESTED:	Lime Kiln No. 5/Scrubber
TEST PURPOSE:	Determine the particulate emission rate as requested by the Commonwealth of Pennsylvania Department of Environmental Resources.
TEST EQUIPMENT:	Research Appliance Company "STAKSAMPLR" Portable Gas Sampler, Model #2343.
TEST METHODS:	Particulates: EPA Method 5; and as modified to conform with D.E.R. Source Testing Manual requirements
TEST PERSONNEL:	Michael J. Mease Timothy J. Lockard
TEST OBSERVERS:	Timothy R. Brooks Richard Maxwell Allan Bigatell PA Dept. Environmental Resources
TESTING FIRM:	Mease Engineering Associates P.O. Box 721 State College, PA 16804 814-692-4225
TEST ENGINEER:	Michael J. Mease Pennsylvania Professional Engineer No. 26809-E

TEST DATA SUMMARY

Process: Lime Kiln No. 5/Scrubber

	Run #1	Run #2	Average
Test Date and Times	3-23-88 8:55-11:03 am	3-23-88 11:56am-2:07 pm	
Stack Diameter, Inches	60.25	60.25	60.25
Test Duration, Minutes	120	120	120
Sampling Nozzle Diameter, In.	0.188	0.188	0.188
Stack Gas Volume Sampled, ACF	62.352	62.903	62.628
Stack Gas Volume Sampled, SCF @ 70 deg. F., 29.92 in.Hg.,dry	62.9	62.8	62.8
Stack Gas Temperature, deg. F.	162	162	162
Stack Gas Moisture Content, %	32.9	32.4	32.7
Stack Gas Composition,			
%CO2	22.0	22.6	22.3
%O2	6.97	7.27	7.12
Stack Gas Molecular Weight	27.3	27.4	27.3
Stack Gas Flowrate, ACFM	92,900	91,400	92,200
Stack Gas Flowrate, SCFM @ 70 deg. F., 29.92 in.Hg.,dry	53,400	53,000	53,200
Percent Isokinetic of Test	101	101	101

TEST DATA SUMMARY: EMISSIONS SUMMARY

Process: Lime Kiln No. 5/Scrubber

	Run #1	Run #2	Average
Test Date and Times	3-23-88 8:55-11:03 am	3-23-88 11:56 am-2:07 pm	
Particulates Captured, Grams			
Front Half; Soluble	0.0261	0.0305	
Front Half; Insoluble	0.0073	0.0047	
Front Half; Acetone Wash	0.0041	0.0052	
Filter	0.2813	0.2962	
Back Half; Soluble	0.0541	0.0590	
Back Half; Insoluble	0.0022	0.0019	
Back Half; Acetone Wash	0.0034	0.0032	
Particulate Concentration; Grains/SCF (Front half & Back Insol.)	0.079	0.083	0.081
Particulate Emission Rate, Lb./Hr. (Front half & Back Insol.)	36.0	37.7	36.9
Process Weight Rate, Tons/Hour	19.24	19.02	19.13
Allowable Emission Rate, Lb./Hr.	24.4	24.2	24.3

TEST PROCEDURE SUMMARY

The sampling ports on the 60.25 inch diameter stack were located approximately 20 feet downstream (3.98 diameters) from a flow disturbance. Two separate traverses of twelve points each were sampled for a total of twenty-four sampling points. The sampling points were located at the following distances, in inches, from the inside stack walls: 1.27, 4.04, 7.11, 10.66, 15.06, 21.45, 38.80, 45.19, 49.59, 53.14, 56.21, and 58.98.

The tests followed the EPA Method 5 procedures and those procedures as required by the Pennsylvania Department of Environmental Resources. These included washing the probe with both distilled water and acetone and the analysis of impinger solutions as outlined in Section 3.0 of this report. One test was required. However, we performed two tests to insure better test reliability.

Test No. 1:

The test began at 8:55 am and concluded at 11:03 am. The test was conducted without interruption.

Test No. 2:

The test began at 11:56 am and concluded at 2:07 pm. The test was conducted without interruption.

PROCESS WEIGHT DETERMINATION

Process Weight rates were determined by taking stone integrator readings over the test time period. Then, using a ratio of product to limestone feed (Ø.525), the lime production rate, in tons per hour was calculated. The allowable emission rate is then determined by the formula:

$$A = (Ø.76)(F \times W)^{Ø.42}$$

Where:

A = Allowable particulate emission rate in lbs./hr.
F = Process factor (2ØØ lbs./ton product)
W = Production Rate

Process weight rates were monitored by Department of Environmental Resources personnel.

SAMPLE RESULTS SUMMARY

Process emissions were calculated by using the front half of the sampling train and the insoluble portion of the rear half of the sampling train. The captured particulate was a light brown color. Visible particles were observed in the probe wash.

The average particulate concentration was determined to be Ø.Ø81 grains per standard cubic foot. The average particulate emission rate was determined to be 36.9 pounds per hour.

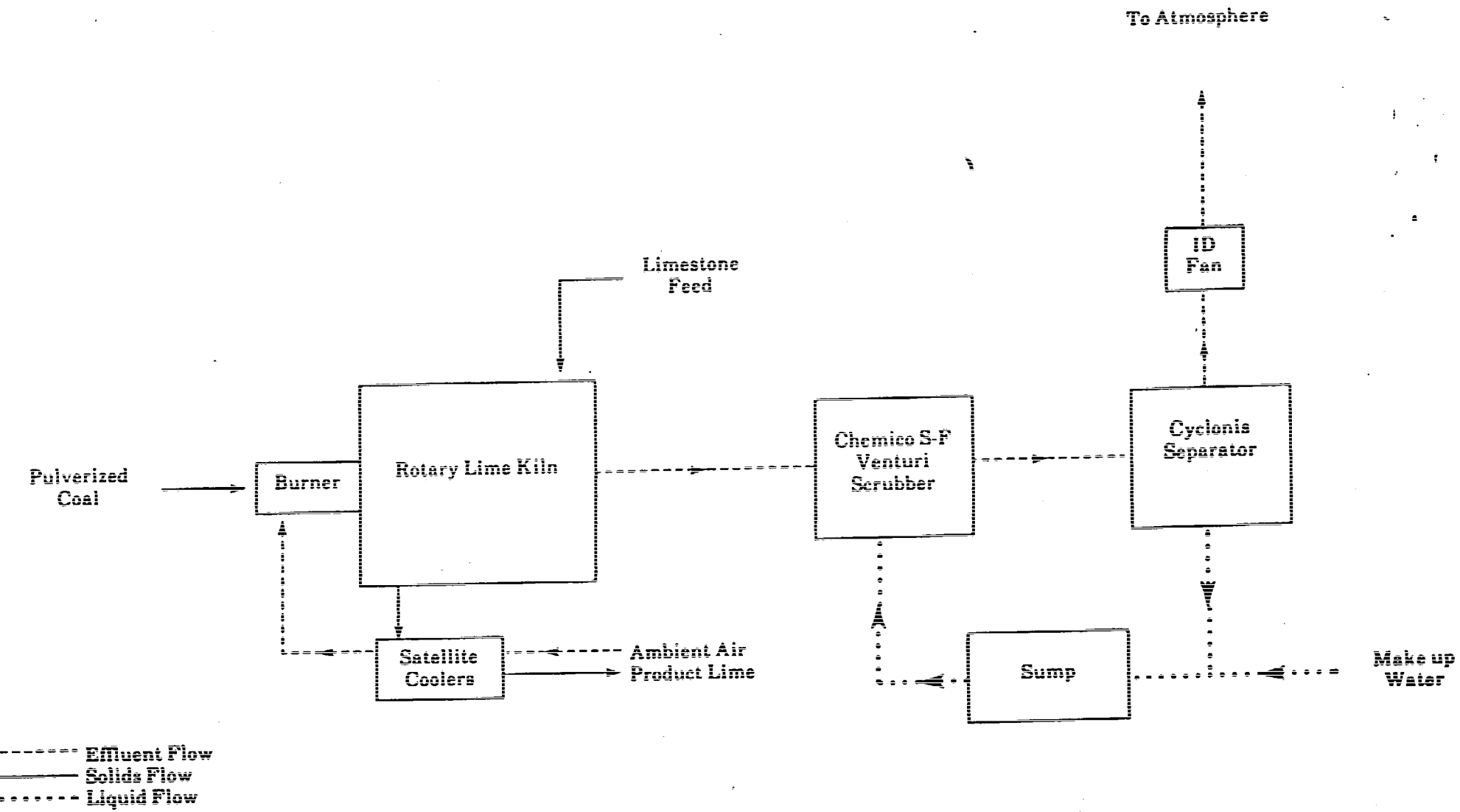


FIGURE 1
PROCESS FLOW DIAGRAM

ROTARY KILN LOG
BELLEFONTE LIME COMPANY

PLANT 1 KILN No. 5 Beginning Date 3-23 1987

Shift Log

OPERATOR	KILN OR STONE COUNTER	COAL COUNTER	COAL PER FOOT	KIND OF COAL
7-3 [illegible]	992658	923466	24.39	[illegible]
3-11 Fetzer	997447	925135		
11-7 [illegible]	002311	926926		
	007134	928656		

Daily Report of Kiln Superintendent

A STONE COUNTER	007134	E COAL COUNTER	28656	L LIME – TONS	461.66
B PREVIOUS DAY	992658	F PREVIOUS DAY	23466	J COAL – TONS	171.77
C NET FOR DAY	14476	G NET FOR DAY	5190	K RATION	2.68
D STONE WT./REV.	121.49	H COAL PER FOOT	66.27	SIGNED – SUPT.	[illegible]

Hourly Log

TIME	Temp: Hot Air to Mill	Temp: Fuel Pipe	Temp: Fan	Temp: Kiln Feed End	Temp: Optical	Temp: Disch Dam	Amps: Fan	Amps: Kiln	Amps: Mill	Kiln Speed :00	Kiln Speed :30	Controller Point :00	Controller Point :30	Draft 1 Fan	Draft 2 Kiln	Draft 3 Hood	Draft 4 Thru Kiln	Vent Diff	Cyclone Sec	Stone Feed Size	T/Hr Coal Per Foot	O2	Stone T/Hr	Kiln Heavy Hot Medium Average Cool	Lime Quality	TROUBLES–BAD COAL OR STONE–DELAYS
7	390	115	180	1520	1250	920	165	192	77	90	90	6	6	29/45	2.1	.45	.16	–	81	B	5.7	.00	415	A	5.0	TOB; Lime on Belt to #5 Bin
8	410	135	180	1560	1240	900	165	197	78	90	89	6	6	29/45	2.1	.40	.16	–	81	B	5.6	.01	415	A	4.0	
9	420	135	180	1560	1240	900	165	190	78	89	89	6	6	29/45	2.1	.40	.16	–	81	B	5.6	.00	415	A	4.0	
10	420	135	180	1550	1240	1150	165	192	76	89	89	6	6	29/45	2.1	.42	.16	–	81	B	5.6	.01	410	A	4.0	
11	420	135	180	1520	1240	870	165	190	74	97	97	6	5	29/45	2.1	.43	.16	–	81	B	5.4	.09	400/410	A	6.0	
12	400	135	180	1550	1630	900	165	190	74	88	89	4	6	29/45	2.1	.40	.16	–	81	B	5.6	.05	410/400	A	5.0	Lime on "A" pan to #4 [illegible]
1	410	135	180	1560	1600	980	165	189	72	89	89	6	6	29/45	2.1	.42	.16	–	81	B	5.4	.06	410	A	3.0	
2	400	135	180	1530	1620	910	165	196	72	89	89	6	6	29/45	2.1	.42	.16	–	81	B	5.4	.04	400	A	6.0	TOB
3	410	135	180	1560	1720	960	161	186	72	89	89	6	6	30	2.1	.40	.16	–	81	B	5.4	.02	415	A	4.0	T.O.B. Stone off [illegible]
4	420	135	180	1590	1750	1000	160	187	72	89	89	6	6	30	2.1	.36	.15	–	82	B	5.4	.02	415	A	5.0	T.O.B. B.S.
5	490	135	180	1550	1770	[illegible]	160	186	72	89	89	6	6	30	2.1	.40	.16	–	82	B	5.4	.03	415	A	5.0	T.O.B.
6	480	140	180	1520	1770	1200	160	189	72	88	84	6	5	30	2.1	.42	.14	–	82	B	5.4	.02	425	A	4.0	T.O.B.
7	480	140	180	1540	1740	960	160	187	73	84	77	5	6	30	2.1	.41	.16	–	82	B	5.6	.10	415	A	3.5	T.O.B.
8	430	140	180	1560	1720	1000	160	186	72	88	88	6	6	30	2.1	.40	.14	–	82	B	5.7	.08	415	A	3.5	T.O.B.
9	430	140	180	1540	1800	1000	160	187	72	88	88	6	6	30	2.1	.42	.16	–	82	B	5.6	.08	415	A	4.0	T.O.B.
10	440	140	180	1560	1800	1020	160	187	73	88	85	6	5	30	2.1	.41	.16	–	82	B	5.6	.02	415	A	4.5	T.O.B.
11	430	140	180	1540	1800	970	160	190	73	82	82	4	4	28	2.1	.41	.16	–	82	B	5.6	.03	356	A	4.0	BS
12	410	140	180	1530	1830	990	160	[illegible]	71	88	87	6	6	28	2.1	.39	.16	–	82	B	5.6	.04	415	A	3.5	BS TOB Added Lime
1	430	140	180	1540	1910	930	159	185	71	89	89	6	6	28	2.1	.41	.14	–	82	B	5.4	.03	415	A	4.0	BS TOB
2	430	140	180	1540	1850	1050	151	186	71	88	88	6	6	28	2.1	.39	.14	–	82	B	5.5	.01	415	A	4.5	BS TOB
3	440	140	180	1540	1900	1040	155	186	71	88	88	6	6	28	2.1	.41	.14	–	82	B	5.4	.01	415	A	3.0	BS
4	435	140	180	1530	1900	1010	160	194	72	86	86	5	5	27	2.1	.41	.12	–	82	B	5.4	.01	385	A	3.0	BS
5	410	140	180	1530	1910	980	160	187	71	86	89	5	6	27	2.1	.41	.12	–	82	B	5.5	.01	385	A	3.5	BS
6	410	140	180	1540	1830	1010	160	185	70	89	89	6	6	27	2.1	.45	.14	–	82	B	5.4	.01	420	A	3.5	BS

SECTION 2.0

Lab & Field Data

Mease Engineering Associates

Environmental Consultants

LABORATORY WORKSHEET

Client: [redacted] LIME Run No. & Date: 1 3-29-88

Process: LIME KILN Sample Box No.: 1

Filter Analysis:
- Filter Wt.,grams 0.9167
- Filter Tare,gms 0.7304
- Part.Increase,gm. 0.2813

Impinger Water Increase:
- Silica Gel Impinger (#4):
  - Final Wt.,gms 816.3
  - Tare Wt.,gms 797.9
  - H_2O Increase 18.4
- Total Water Volume Increase: 144 192 204 154
  - Impinger #1 336 ml
  - Impinger #2 773 ml
  - Impinger #3 3 ml
  - Impinger #4 18.4 ml
  - TOTAL INCREASE 6554 ml

Impinger Analysis:
- Wash Bottle No. 2,3
- Filter Wt.,gms 0.0183
- Filter Tare,gms 0.0161
- Total Insoluble 0.0022
- Final Beaker Wt. 156.6814
- Tare Wt. (No.) 156.6273
- Total Soluble 0.0541

Particulate Weight Summary:
- Filter 0.2813
- Probe Wash 0.0375
- Impingers (Sol.)
- Impingers (Insol.) 0.0022
- Total (w/imp.) 0.3210 grams
- Total (w/o imp.) grams

Signature: [redacted]

Date: 3-30-88

Probe Wash Analysis:
- Wash Volume,ml.
- Acetone Density,mg/ml
- Blank Volume,ml
- Insoluble Residue-Water Rinse
  - Final Wt. 0.0240
  - Filter Tare Wt. 0.0167
  - Insol. Part.Wt. 0.0073
- Water Wash Analysis, Bottle No. 1/1
  - Beaker Wt.,gms 155.7453
  - Tare Wt.(No.31) 155.7192
  - Soluble Part.Wt.,gms 0.0261

Acetone/Front Half/Soluble 3
- Wash Bottle No.
- Beaker Wt.,Gms. 156.3188
- Tare Wt., Gms. 156.3147
- Soluble Wt.Gms. 0.0041

NOT INCLUDED

Acetone/Back Half/Soluble
- Wash Bottle No.
- Beaker Wt.,Gms. 157.2114
- Tare Wt., Gms. 157.2080
- Soluble Wt,Gms. 0.0034

Mease Engineering Associates

Environmental Consultants

LABORATORY WORKSHEET

Client: BELLEFONTE LIME — Run No. & Date: 2 — 3-23-88

Process: LIME KILN — Sample Box No.: 2/4

Filter Analysis:

Filter Wt., grams	0.9268
Filter Tare, gms	0.6306
Part. Increase, gm.	(0.2962)

Impinger Water Increase:

Silica Gel Impinger (#4):

Final Wt., gms	819.2
Tare Wt., gms	800.3
H_2O Increase	18.9

Total Water Volume Increase:

Impinger #1	335	ml
Impinger #2	278	ml
Impinger #3	7	ml
Impinger #4	18.9	ml
TOTAL INCREASE	638.9	ml

Impinger Analysis:

Wash Bottle No.	D.I.
Filter Wt., gms	0.0177
Filter Tare, gms	0.0158
Total Insoluble	(0.0019)
Final Beaker Wt.	150.2597
Tare Wt. (No. ___)	150.2007
Total Soluble	0.0590

Particulate Weight Summary:

Filter	0.2962
Probe Wash	0.0404
Impingers (Sol.)	
Impingers (Insol.)	0.0019
Total (w/Imp.)	0.3385 grams
Total (w/o Imp.)	____ grams

Signature: Michael C. Mease

Date: 3-30-88

Probe Wash Analysis:

Wash Volume, ml.	
Acetone Density, mg/ml	
Blank Volume, ml	

Insoluble Residue-Water Rinse

Final Wt.	0.0207
Filter Tare Wt.	0.0160
Insol. Part. Wt.	(0.0047)

Water Wash Analysis, Bottle No. 2

Beaker Wt., gms	158.2151
Tare Wt. (No. 33)	158.1826
Soluble Part. Wt., gms	(0.0305)

Acetone/Front Half/Soluble

Wash Bottle No.	6
Beaker Wt., Gms.	155.7165
Tare Wt., Gms.	155.7113
Soluble Wt. Gms.	(0.0052)

NOT INCLUDED

Acetone/Back Half/Soluble

Wash Bottle No.	
Beaker Wt., Gms.	153.7706
Tare Wt., Gms.	153.7674
Soluble Wt, Gms.	0.0032

MEASE ENGINEERING ASSOCIATES

FIELD DATA

Run no. 1
Location BEULEFOUTE LIME
Date 3-23-88
Operator MEASE / LOCKARD
Sample box no. 1

K Factor 0.75
C_P 0.84
C_M 1.01
Stack dimen. 60.25" ϕ
Stack press., in. H_2O -0.72
Gas composition, % O_2 7.0 7.1 6.8
% CO_2 22.0 21.8 22.1
% N_2
Time, start 8:55
Time, finish 11:03

Ambient Temp., °F 60
Bar. press., in. hg. 30.14
Assumed moisture, % 34
Probe tip diameter, in. 3/16
Probe length 6'
Probe heater setting 65
Box heater setting 225
Leak checks, pre : 0.003 cfm @ 14" Hg vacuum
post : 0.004 cfm @ 14" Hg vacuum
Wash bottle no. H_2O 1/1 ACE: 3 0

Initial dry gas meter reading 173.077

Notes :

Point	Clock time	Dry gas meter	Pitot in. H_2O ΔP	Orifice in. H_2O ΔH	Dry gas temp. °F Inlet	Dry gas temp. °F Outlet	Stack temp. °F	Pump vacuum in. Hg.	Impinger temp. °F	Box temp. °F
1	5	175.763	1.60	1.02	69	69	163	7.0	<50	230
2	5	178.450	1.72	1.11	77	73	163	7.5	<50	225
3	5	181.196	1.80	1.17	81	74	161	8.0	<50	230
4	5	183.928	1.77	1.15	81	73	162	8.0	<50	225
5	5	186.683	1.79	1.16	82	73	162	8.0	<50	230
6	5	189.376	1.70	1.10	81	73	162	8.0	<50	225
7	5	191.996	1.64	1.06	81	73	162	8.0	<50	230
8	5	194.621	1.64	1.06	81	73	162	8.0	<50	235
9	5	197.164	1.45	0.94	81	73	162	7.5	<50	240
10	5	199.564	1.30	0.84	81	73	162	7.5	<50	225
11	5	201.928	1.29	0.83	80	73	162	7.5	<50	230
12	5	207.973	0.91	0.59	79	73	159	7.0	<50	225
13	5	206.653	1.79	1.14	71	67	162	10.0	<50	225
14	5	209.386	1.69	1.08	77	71	163	10.0	<50	230
15	5	212	1.80	1.16	79	72	164	11.5	<50	225
16	5	214.946	1.78	1.15	80	73	164	11.5	<50	230
17	5	217.738	1.80	1.16	80	72	163	12.0	<50	215
18	5	220.5	1.82	1.16	81	72	163	12.0	<50	225
19	5	223.162	1.70	1.10	82	72	163	12.0	<50	225
20	5	225.673	1.55	1.00	81	72	162	12.0	<50	225
21	5	228.316	1.49	0.96	82	72	162	12.0	<50	230
22	5	230.900	1.38	0.89	81	73	163	12.0	<50	231
23	5	233.201	1.28	0.83	81	73	163	11.5	<50	220
24	5	235.469	1.10	0.71	81	73	163	11.0	<50	225
			1.4509	1.016	536.94	75.94	622.375	162.375		

MEASE ENGINEERING ASSOCIATES

FIELD DATA

Run no. 2
Location BELLEFONTE LIME KILN
Date 3-23-88
Operator MEASE / LOCKARD
Sample box no. 2

K Factor 0.75
C_p 0.84
C_M 1.01
Stack dimen. 60.25" ⌀
Stack press., in. H_2O −0.72
Gas composition, % O_2 7.6 7.0 7.2
% CO_2 22.5 22.6 22.6
% N_2
Time, start 11:56 AM
Time, finish 2:07 PM

Ambient Temp., °F 65
Bar. press., in. hg. 30.14
Assumed moisture, % 35
Probe tip diameter, in. 3/16
Probe length 6' 6 1/4"
Probe heater setting 70
Box heater setting 225
Leak checks, pre: 0.003 cfm @ 15" Hg
post: 0.003 cfm @ 14" Hg
Wash bottle no. 31 ALT: 6

Initial dry gas meter reading 236.114

Notes:

Point	Clock time	Dry gas meter	Pitot in. H_2O ΔP	Orifice in. H_2O ΔH	Dry gas temp. °F Inlet	Dry gas temp. °F Outlet	Stack temp. °F	Pump vacuum in. Hg.	Impinger temp. °F	Box temp. °F
1	5	238.900	1.65	1.06	73	72	161	8.0	<50	210
2	5	241.678	1.82	1.18	81	77	162	8.5	<50	225
3	5	244.468	1.76	1.14	83	77	161	9.0	<50	230
4	5	247.243	1.75	1.14	84	77	162	9.5	<50	225
5	5	250.051	1.74	1.14	86	77	162	10.0	<50	230
6	5	252.874	1.80	1.17	85	77	162	10.0	<50	230
7	5	255.533	1.61	1.05	85	77	162	10.0	<50	235
8	5	258.194	1.60	1.04	85	77	161	10.0	<50	230
9	5	260.785	1.48	0.97	86	78	162	10.0	<50	235
10	5	263.326	1.43	0.93	86	79	162	10.0	<50	235
11	5	265.650	1.20	0.78	85	78	161	9.5	<50	240
12	5	267.930	1.12	0.77	86	78	161	9.5	<50	230
13	5	270.592	1.55	1.00	78	77	162	10.5	<50	215
14	5	273.279	1.62	1.05	82	79	162	11.0	<50	225
15	5	275.970	1.65	1.07	84	79	162	11.0	<50	230
16	5	278.743	1.74	1.13	85	79	161	12.0	<50	225
17	5	281.443	1.62	1.06	87	79	162	12.0	<50	230
18	5	284.111	1.56	1.01	87	79	162	12.0	<50	225
19	5	286.792	1.59	1.03	87	79	162	12.0	<50	220
20	5	289.413	1.49	0.97	88	79	161	12.0	<50	215
21	5	291.950	1.38	0.90	88	80	163	11.5	<50	220
22	5	294.463	1.37	0.89	87	80	162	11.5	<50	235
23	5	296.858	1.22	0.79	90	81	164	11.0	<50	230
24	5	299.017	0.98	0.64	91	83	160	10.5	<50	225

3-23
MJM
TJL

PRELIMINARY DATA

		N-S	E-W	Angles
1 -	1.27	1.50	1.55	5
2 -	4.04	1.82	1.76	4
3 -	7.11	1.70	1.80	2
4 -	10.66	1.80	1.78	6
5 -	15.06	1.70	1.80	5
6 -	21.45	1.80	1.77	2
7 -	28.30	1.77	1.65	5
8 -	35.17	1.65	1.55	5
9 -	41.59	1.55	1.35	2
10 -	52.14	1.45	1.28	0
11 -	56.21	1.40	1.30	3
12 -	59.73	1.02	1.02	2

$\Delta P_{stmc} = -0.72$

$\Delta P \sim 1.80$

$T_s = 150°F - 162°F$

$T_s =$

0.32

$\Delta \sim 0.8$

SECTION 3.0

Test Procedures

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
Post Office Box 2063
Harrisburg, Pennsylvania 17120

Bureau of Air Quality Control

717-787-6547

December 3, 1987

Mr. Michael J. Mease
President
Mease Engineering Associates
P.O. Box 721
State College, PA 16804

Dear Mr. Mease:

The test protocol submitted for particulate testing of the No. 5 rotary limestone kiln at the Bellefonte Lime Company is acceptable to the Department.

Final acceptance of the test report will be contingent upon fulfilling all of the requirements for particulate tests as stated in Chapter 139 of the Department of Environmental Resources' Rules and Regulations and the Source Testing Manual.

If you should have any questions regarding this matter, please feel free to contact me.

Sincerely yours,

Richard St. Louis, Chief
Source Testing Unit

Mease Engineering Associates
Engineers & Surveyors

November 20, 1987

Mr. Robert Woodring
Bellefonte Lime Company
P.O. Box 448
Bellefonte, PA 16823

Re: Source Test Protocol
No. 5 Kiln/Scrubber System

Dear Mr. Woodring:

We hereby propose to perform a particulate source emission test at your facility with the following test procedures:

One particulate test of approximately two hours will be conducted using the DER procedures (back half analysis of test train included) on a limestone kiln/scrubber process.

The vertical stack is approximately sixty and one-quarter inches in diameter and approximately sixty feet high. The two sampling ports are located approximately twenty feet downstream of a silencer. We anticipate sampling twenty four sampling points (twelve per traverse) at five minutes each for a total test time of one hundred twenty minutes. We anticipate a minimum sample volume of 50 DSCF.

The emission test train will use the standard Research Appliance Company "STAKSAMPLR", model #2343, with a stainless steel or glass lined probe. Should cyclonic flow be evident, the test procedures will be discussed with D.E.R. officials prior to the commencement of tests.

Sampling points will be located at the following points:

Point	% Diameter	Location (In. from stack wall)
1	2.1	1.27
2	6.7	4.04
3	11.8	7.11
4	17.7	10.66
5	25.0	15.06
6	35.6	21.45
7	64.4	38.80
8	75.0	45.19
9	82.3	49.59
10	88.2	53.14
11	93.3	56.21
12	97.9	58.98

Stack gas composition will be determined with several grab samples using a Fyrite Analyzer at the stack sampling ports.

We anticipate one test day to complete the test. We will perform test equipment preparations and flowrate checks the day before testing and begin testing early the following morning. Due to a heavy scheduling workload, we propose to schedule the tests for the week of December 14, 1987; perhaps in the middle of that week. We certainly will call with the exact test date and time.

Very truly yours,

MEASE ENGINEERING ASSOCIATES

Michael J. Mease, P.E.
President

MJM: eps

ATTACHMENT NO. 2
DER ANALYTICAL PROCEDURES

DETERMINATION OF PARTICULATE EMISSIONS FROM SOURCE TESTS

I. Introduction

This procedure determines gravimetrically the particulate captured on collection surfaces and in solutions during source testing. The sampling train should be analyzed within a maximum of 48 hours after collection.

II. Pretest Preparation

A. Field Materials

1. Glass fiber filters, Gelman type A, or equal.
2. Alundum thimbles, Norton grades AL788, AL899, AL485, or equal.
3. Triple distilled and deionized water.
4. Acetone, reagent grade.
5. Silica gel, indicating type, 6-16 mesh.

B. Glass Fiber Filters

1. Heat the filter to 900°F for one hour then desiccate for 24 hours.
2. Identify all filters sequentially using a five-digit number. The first digit equals the diameter of the filter; e.g., "30079" signifies the 79th 3" filter weighed.
3. Weigh the filter to the nearest 0.1 mg. Record the weight, the identification number and the date.
4. Place the filter in a clean, dry container (petri dish) which is identified with the number of the enclosed filter and seal the container. DO NOT FOLD FILTERS.

C. Alundum Filters

1. Sand the lip and outside of the filter (thimble) to remove loose particles. Check the thimble to assure a proper seal in the filter holder.
2. Wash the thimble a minimum of four times in clean distilled water using an ultrasonic cleaner. Use clean water each time.
3. Air dry the thimble.
4. Identify the thimbles sequentially using Coors ceramic ink. Use an alpha numeric system of five characters. The first is the letter A; e.g., "A0079" signifies the 79th alundum filter weighed.

5. Place the thimble in a cold muffle furnace and heat to 600°F at a rate not to exceed 200°F per hour. Increase the temperature to 1200°F and hold for four hours minimum.

6. Cool in a desiccator for 24 hours and weigh to the nearest 0.1 mg. Record the weight, identification number and date.

7. Place the thimble in a clean, dry container which is identified with the number of the enclosed thimble and seal the container.

D. Distilled Water, Acetone, and Silica Gel

1. Provide triple distilled, deionized water for the collection train and cleanup procedures and acetone for cleanup.

2. Store each in a sealable, clean container.

3. Retain a sample of each for a blank determination.

4. Dry approximately 300gm of silica gel at a temperature of 105°C for approximately 12 hours. Desiccate until cool and place in an air-tight container.

III. Particulate Analysis

A. Procedure:

1. Remove the used glass fiber or alundum filters carefully to prevent loss of collected particulate or filter material and store in their original, relabeled, clean containers (separate petri dishes).

2. Measure to the nearest ml the volume of liquid in each impinger and record.

3. Place the impinger solutions in a labeled container and wash any residue in the impingers into the container using distilled water.

4. Add the washings from the back-half of the filter holder and interconnecting glassware to step 3.

5. Wash the nozzle, probe, front-half of the filter holder, and the cyclone or cyclone bypass into a labeled container using distilled water. NOTE: any dry material in the cyclone is brushed onto the glass fiber filter.

6. Wash with acetone the impingers and the components in step 4 into a labeled container.

7. Wash with acetone the components in step 5 into a labeled container.

NOTE:

Steps III.A.1 through 7 are the responsibility of the source test team leader. When multiple tests are conducted and it is necessary to clean the sampling train in the field, proceed in accordance with these steps. Store the samples in an airtight, cool or refrigerated condition.

8. Identify and desiccate for 24 hours, a sufficient number of 0.22 μ membrane filters to filter all liquid collections and washings.

9. Weigh and record the weights of the membrane filters.

10. Filter the solutions from (step 4) and (step 5) separately using preweighed and identified membrane filter(s). It may be necessary to start with an 0.8 μ filter then finally the 0.22 μ filter.

11. Measure the two filtrates from step 10 to the nearest ml and record the volumes.

12. Air dry, then desiccate for 24 hours, all membrane filters used in the above steps. Weigh to the nearest 0.1 mg and record the weights.

13. Identify and dry for two hours at 105° ± 5°C sufficient evaporating dishes to evaporate the filtrates. Desiccate until cool and weigh to the nearest 0.1 mg. Record the weights with their identification numbers.

14. Using the evaporating dishes, evaporate 300 ml of the filtrates from step 11 and 300 ml of the distilled water (blank) at a constant temperature of 105° ± 5°C. Desiccate the residue until cool, weigh until constant weights are achieved to the nearest 0.1 mg and record the final weight. THE WASHINGS FROM EACH INDIVIDUAL COLLECTION TRAIN HALF ARE TO BE KEPT SEPARATE.

15. Quantitatively transfer an equal volume of acetone washing (from steps 6 and 7) into separate preweighed evaporating dishes after measuring and recording each volume of acetone. AS ABOVE, KEEP EACH COLLECTION TRAIN HALF SEPARATE.

16. Place a measured quantity of unused acetone, equal to the transferred volume of acetone washing, into a preweighed evaporating dish for use as a blank.

17. Evaporate both the blank and the washings from steps 15 and 16 in a vacuum at 60°C.

18. Desiccate to constant weight, reweigh and record.

19. Handle the used glass fiber or alundum filters carefully to prevent loss of material.

20. Air dry the used alundum and glass fiber filters if necessary, desiccate 24 hours and weigh. Record the weights and the identification numbers.

21. Weigh and record the spent silica gel to the nearest 0.5gm.

22. Dry the spent silica gel at a temperature of 105°C for 12 hours.

23. Desiccate until cool then reweigh to the nearest 0.5gm and record.

B. Calculations

1. Front or Back-Half Water Wash

For each:

a. Insoluble Particulate

membrane filter weight - membrane filter tare weight

b. Soluble Particulate

(filtrate dish wt.-tare wt.) - (water blank wt.-tare wt.) x $\frac{\text{final wash vol.}}{\text{aliquot}}$

2. Front- or Back-Half Acetone Wash

For each:

a. Soluble Particulate

(washings dish wt.-tare wt.) - (acetone blank wt.-tare wt.) x $\frac{\text{final acetone}}{\text{aliquot}}$

3. Glass Fiber Filter or Alundum Filter

a. Insoluble Particulate

used filter weight - filter tare weight

4. Water Vapor

a. Silica gel

weight of spent silica gel - weight of dried silica gel

b. Impinger solution

final impinger volumes - initial impinger volumes

SAMPLING TRAIN COMPONENTS, METHOD OF USE, AND ANALYTICAL TECHNIQUES

A. Components

1. Stainless steel or glass probe with minimum 3/16 inch diameter opening, heated above the dew point of the gas stream to be sampled.

2. Glass cyclone efficient for removal of particles of 5 microns or greater, and cyclone collection flask. In cases of low particulate loadings, a glass cyclone eliminator may be substituted.

3. In-line filter of 0.3 micron porosity.

4. Heated chamber for maintaining glass fiber filter and cyclone above the dew point of the gas stream to be sampled.

5. Impingers placed in the following order:

   a. A 500 ml. modified Greenburg-Smith impinger filled with 100 mls. of distilled deionized water.

   b. A 500 ml. Greenburg-Smith impinger filled with 100 mls. of distilled deionized water.

   c. A 500 ml. modified Greenburg-Smith impinger left dry to act as a water trap to remove entrained water.

   d. A 500 ml. modified Greenburg-Smith impinger containing approximately 200 grams of precisely weighed silica gel.

6. An ice bath in which the impingers are partially submerged to maintain exit temperature well below the dew point of the gas to be sampled.

7. Dry gas meter equipped with a vacuum gage registering up to 30 inches of mercury, and a calibrated orifice.

B. General Sampling Procedure

1. Starting with clean equipment, a leak check is performed by drawing a vacuum of 15 inches on system as indicated on the vacuum gage. Leak checks are also performed post-test and corrections may be necessary to account for increases in the leakage rate.

2. The sample is collected at isokinetic rates based upon a velocity profile determined with the use of an "S" type pitot tube.

3. Samples are taken at multiple points across the gas stream representing equal areas of cross-sectional flow, and each point is sampled for as long a time as is feasible.

4. Moisture content of the gas stream is determined by the condensation method, using a series of cooled impingers described above (A-5).

5. The duration of the test depends on the number of sample points and the time required to equally sample each point. In no case will the sample time be less than that required to collect a sufficient sample for complete analysis.

C. Analytical Techniques

1. Before use, the filter is desiccated for a period of 24 hours and weighed to the nearest 0.1 mg.

2. When processing the sample, any material deposited inside the sample probe, glass cyclone (or cyclone eliminator) and the front half of the filter holder is washed into a container using acetone, or other suitable solvent, evaporated to dryness at either ambient conditions or below the boiling point of acetone ($55^{\circ}C$), desiccated for a period of 25 hours, and weighed to the nearest 0.1 mg.

3. After sampling, the in-line glass fiber filter is desiccated for a period of 24 hours and weighed to the nearest 0.1 mg.

4. The moisture content is determined by collecting the liquid in the impingers described above and measuring. The difference between 200 ml. and the measurement is recorded as increase in water. The spent silica gel is weighed to the nearest 0.1 gram and the increase is included in the moisture content determination.

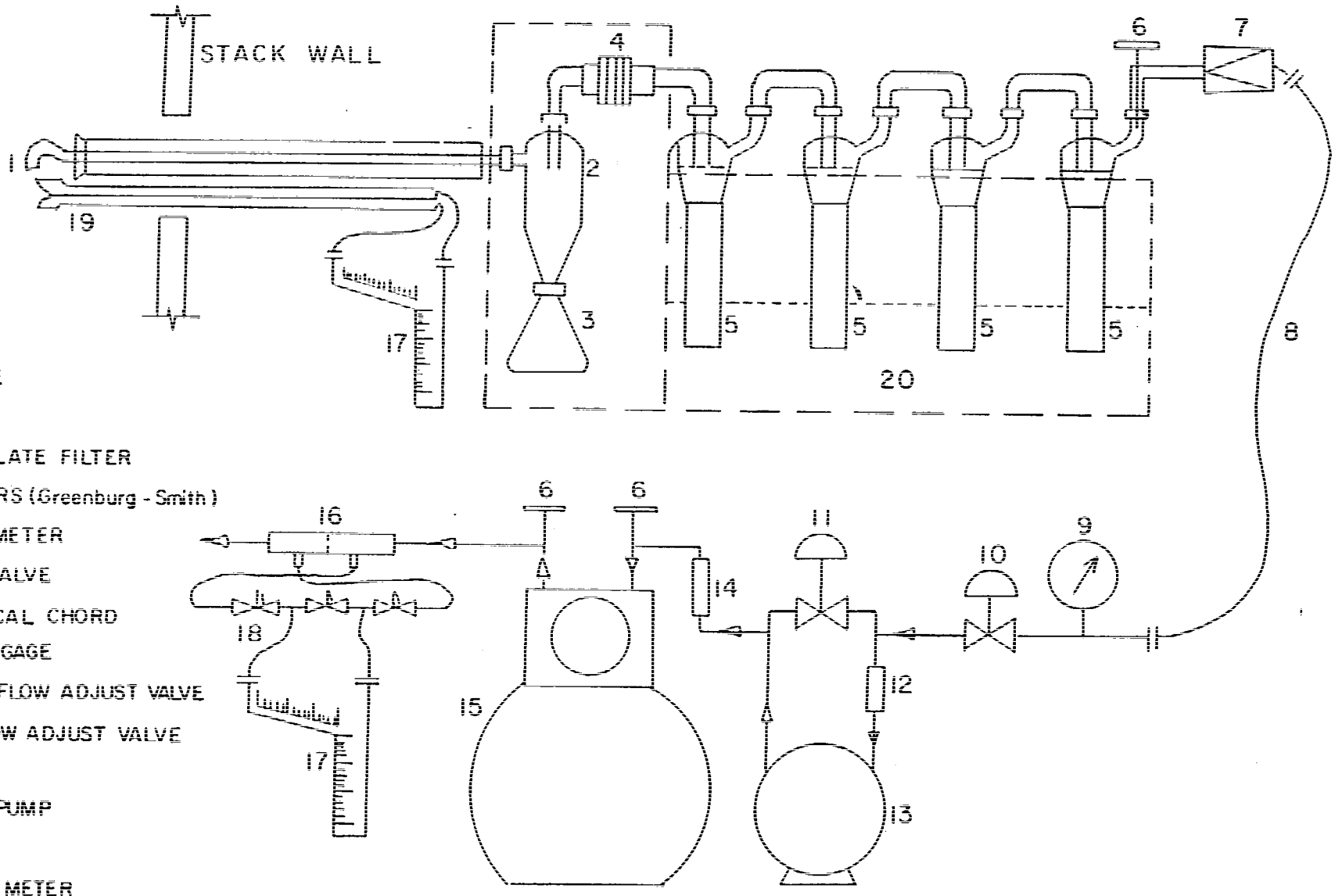
5. The liquid in the impingers may be analyzed for particulate matter and the weights may be included in the particulate catch.

6. The total particulate in the system is the sum of that collected in Nos. 2,3 and possibly 5. The contribution of each portion shall be individually identified. The inclusion of the impinger particulate catch is to be considered on an individual basis.

7. The emission rate and calculations are made from suitable measurements of gas temperature, moisture content, velocities and materials collected. In order for a test to be considered valid, isokinetic sampling rates shall be between 90% and 110%.

8. All equipment, including orifice meter, probe tip nozzles, dry gas meter, and temperature measuring devices is calibrated on a regular basis, dependent on the frequency of equipment use.

9. The stack gas content is determined by collecting a sample of stack gas and analyzing the contents with an Orsat analyzer or Fyrite analyzer.



LEGEND :

1. PROBE
2. CYCLONE
3. FLASK
4. PARTICULATE FILTER
5. IMPINGERS (Greenburg - Smith)
6. THERMOMETER
7. CHECK VALVE
8. UMBRILICAL CHORD
9. VACUUM GAGE
10. COURSE FLOW ADJUST VALVE
11. FINE FLOW ADJUST VALVE
12. OILER
13. VACUUM PUMP
14. FILTER
15. DRY GAS METER
16. ORFICE TUBE
17. INCLINE MANOMETER
18. SOLENOID VALVES
19. PITOT
20. ICE BATH

MEASE ENGINEERING ASSOC.
GENERAL ARRANGEMENT
SOURCE SAMPLING TRAIN

SECTION 4.0

Calibrations

Certificate

OF TRACEABILITY

This is to certify that the undersigned checked for Mease Engineering

Ainsworth, Model TC Balance Number 18185 on December 15, 1986

The following readings were obtained:

Sensitivity reciprocal unloaded	.8	Mg.	Readability	.1	Mg.
Sensitivity reciprocal at 100 Gm.	.73	Mg.	Optical scale	NA Gm.	NA Mg.
Arm length error	4	PPM	Reading at half scale	NA	NA Mg.
Chain weight	NA Mg.	NA Mg.	Taring device error	NA	Mg.
Rider	10 Mg.	±0 Mg.			

Traceability is through National Bureau of Standards Test No. 732/221797 and/or New Jersey Test No. NJ 82419

Dated: December 30, 1986
MATAWAN, NEW JERSEY

OMEGA BALANCE SERVICE, INC.

PITOT TUBE CALIBRATION

All pitot tubes are geometrically aligned and within the limits as prescribed in the Federal Register. Therefore, they are assigned a value of 0.84. In the event that a pitot tube tip is altered during transport, and the geometric qualifications cannot be met, the pitot tube is calibrated according to the Federal Register. In this case, the new calibration factor is listed in the report and used in the calculations.

TEMPERATURE SENSING DEVICE CALIBRATIONS

All temperature sensing devices used during a test series, including thermocouples and thermometers are calibrated after each test series, as specified in the Federal Register. In the event that these calibration factors fall within the limits as speced, no corrections are necessary. In the evnt that a device is outside the limits, as specified, the correction factor is listed and used in the calculations.

SAMPLING NOZZLE CALIBRATION

The sampling nozzle used during the test series is determined after each test series using a micrometer on several diameters as specified in the Federal Ragister.

Mease Engineering Associates

Environmental Consultants

DRY GAS METER AND ORIFICE METER CALIBRATION

Model Number 2343

Serial Number 1984

Meter Box No. C

Wet Test Meter №. 4L-20 14524

Calibration Date 1-18-88

Signature Michael J. Mease

Barometric Pressure, Pb 29.84

02	03	04	05	06	07	08	09	10
Orifice Manometer ΔH in. H_2O	Gas Volume		Temperature					
	Wet	Dry	Wet	Dry				
	V_w ft^3	V_d ft^3	t_w °F	In t_{di} °F	Out t_{do} °F	Time θ Min.	Y	$\Delta H_@$
0.5	5.000	4.827	75	75	62	12.52	1.022	1.80
1.0	5.000	4.958	75	85	71	9.087	1.012	1.87
2.0	10.000	10.043	75	96	80	13.443	1.0149	2.06
3.0	10.000	10.176	75	103	81	10.913	1.011	1.96
						AVERAGE	1.01498	1.92

$$Y = \frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6} \right) (t_w + 460)} \qquad \Delta H_@ = \frac{0.0317 \; H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\, \theta}{V_w} \right]^2$$

Mease Engineering Associates

Environmental Consultants

DRY GAS METER AND ORIFICE METER CALIBRATION

Model Number 2348

Serial Number 1895

Meter Box No. D (NEW)

Wet Test Meter No. AL-20 14524

Calibration Date 1-18-08

Signature Wesley Mease

Barometric Pressure, Pb _____

01	02	04	05	06	07	08	09	10
Orifice Manometer ΔH	Gas Volume		Temperature					
	Wet	Dry	Wet	Dry		Time		
in. H_2O	V_w ft3	V_d ft3	t_w °F	In t_{di} °F	Out t_{do} °F	θ Min.	Y	$\Delta H_@$
0.5	5.000	5.002	75	83	74	12.8m	1.005	1.87
1.0	5.000	5.005	75	91	80	9.203	1.016	1.89
2.0	10.000	10.064	75	98	83	13.203	1.017	1.93
3.0	10.000	10.077	75	102	86	10.845	1.020	1.94
						AVERAGE	1.0145	1.91

$$Y = \frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w + 460)} \qquad \Delta H_@ = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\,\theta}{V_w}\right]^2$$

CARL POE CO., INC. 99 REINERMAN ST. • HOUSTON, TEXAS 77007 • 713-861-3816

December 9, 1986

Princeton Testing Lab
P.O. Box 3108
Princeton, NJ 08543
Attn: Glenn

Dear Sir/Madam:

This is to certify that your Model AL-20 American Wet Test Meter, Serial No. 14524, has been calibrated with an American 5 Ft. Bell Prover, Serial No. 1045. It is traceable to the Bureau of Standards.

Reference No. 26727, PI-TAPE.

Sincerely,

CARL POE CO., INC.

Carl W. Poe

CWP:mv

RECE
DEC 17 1986

SECTION 5.0

Calculations

SOURCE SAMPLING CALCULATIONS: NOMENCLATURE

An	=	Nozzle Area, $ft.^2$
As	=	Stack Area, $ft.^2$
Bwo	=	Water Vapor Proportion, by volume, dimensionless
Cm	=	Meter Correction Factor, dimensionless
Cp	=	Pitot Coefficient, dimensionless
Cs	=	Particulate Concentration, units specified
$\Delta H_{avg.}$	=	Average Pressure Drop Across Orifice, $in.H_2O$
$\%H_2O$	=	Water Vapor Content, dimensionless
Is	=	Percent Isokinetic of Test, dimensionless
Kp	=	85.48, unit correction
Md	=	Molecular Weight of Dry Gas
Mn	=	Total Particulate Catch, grams
Ms	=	Molecular Weight of Stack Gas
$(\sqrt{\Delta P})_{avg}$	=	Average of the Square Roots of the Velocity Head
Pbar	=	Barometric Pressure, in. Hg.
pmr	=	Pollutant Mass Rate, lb./hr.
θ	=	Time, minutes
Pstd	=	29.92 in. Hg.
Qs	=	Stack Gas Flowrate, actual cubic feet per minute
(Qs)std	=	Stack Gas Flowrate, standard cubic feet per minute
Ts	=	Stack Gas Temperature, ^{o}R
Tstd	=	$530^{o}R$
Vfc	=	Increase in Liquid Volume in Impingers, ml.
Vm	=	Volume Sampled at Meter Conditions, $ft.^3$
Vmstd	=	Volume of Air Metered at Standard Conditions
Vs	=	Stack Gas Velocity, ft./sec.
Vsstd	=	Stack Gas Velocity, standard conditions, ft./min.
Vwc	=	Volume of Liquid Collected, cubic feet

SAMPLE CALCULATIONS: Run #1

1. Volume of Water Collected

$$Vwc = (0.04707)(Vfc)$$
$$= (0.04707)(655.4)$$
$$= 30.0849$$

2. Volume of Air Metered

$$Vmstd = \frac{(Vm)(Tstd)(Pbar + \frac{\Delta H}{13.6})(Cm)}{(Tm)(Pstd)}$$
$$= \frac{(62.352)(536)(30.14 + \frac{1.01}{13.6})(1.01)}{(535.94)(29.92)}$$
$$= 62.891 \text{ scf}$$

3. Moisture Content

$$Bwo = \frac{Vwc}{(Vwc + Vmstd)}$$
$$= \frac{30.0849}{30.0849 + 62.891}$$
$$= 0.3291$$

4. Molecular Weights

$$Md = (\%CO_2 \times 0.44) + (\%O_2 \times 0.32) + ((\%N_2 + \%CO) \times 0.28)$$
$$= (11.97 \times 0.44) + (6.97 \times 0.32) + (71.06 \times 0.28)$$
$$= 31.794$$

$$Ms = Md(1 - Bwo) + 18(Bwo)$$
$$= (31.794)(1 - 0.3291) + 18(0.3291)$$
$$= 27.254$$

5. Velocity of Exit Gases

$$Vs = (Kp)(Cp)\sqrt{\frac{Ts}{(Ps)(Ms)}}\ \sqrt{(\Delta P)avg.}$$
$$= (85.48)(0.84)\sqrt{\frac{622.375}{(30.09)(27.254)}}\ (1.2504)$$
$$= 78.219 \text{ Ft./Sec.}$$

Bellefonte Lime Co.
Bellefonte, Pennsylvania

SAMPLE CALCULATIONS: Run #1, Continued

7. Flowrates

$$Qs = (Vs)(As)(60)$$
$$= (78.214)(19.799)(60)$$
$$= 92,919 \text{ ACFM}$$

$$Qs_{std} = \frac{(Qs)(Ps)(Tstd)(1-Bwo)}{(Pstd)(Ts)}$$
$$= \frac{(92,919)(30.09)(530)(1-0.3291)}{(29.92)(622.375)}$$
$$= 53,383 \text{ SCFM}$$

8. Particulate Concentration

$$Cs = \frac{(Mn)(15.43)}{Vmstd}$$
$$= \frac{(0.3210)(15.43)}{62.891}$$
$$= 0.0788 \text{ GRAINS/SCF}$$

8. Particulate Emission Rate

$$pmr = \frac{(Mn)(Qs_{std})(60)}{(Vmstd)(454)}$$
$$= \frac{(0.3210)(53,383)(60)}{(62.891)(454)}$$
$$= 36.0095 \text{ LB/HR}$$

9. Isokinetics

$$Is = \frac{Vmstd}{(An)(\theta)(Vs_{std})} \quad \text{where } Vs_{std} = \frac{Qs_{std}}{As} = \frac{53,383}{19.799} = 2,696.27$$
$$= \frac{62.891}{(0.000193)(120)(2696.27)}$$
$$= 1.005 \text{ OR } 101\%$$