

U. S. DEPARTMENT OF ENERGY
INNOVATIVE CLEAN COAL TECHNOLOGY
DEMONSTRATION PROJECT

PASSAMAQUODDY TECHNOLOGY
RECOVERY SCRUBBER™
FINAL REPORT, VOLUME 2 OF 2
APPENDICES A - M

Project Title: Passamaquoddy Innovative Clean
Coal Technology Program

Report Designation: Final Report

Project Sponsor: Passamaquoddy Technology, L.P.

Cooperative Agreement Number: DE-AC22-90PC89657

Issue Date: December 20, 1989

Portland, Maine
February, 1994

APPENDIX A.

List of Feasibility Studies

PASSAMAGUOBBY TECHNOLOGY LP - FEASIBILITY STUDIES

To December 1993

Numerous contacts have been made with companies, plants and consultants. Following is a list of plants where feasibility studies have been made and applicability has been established.

CEMENT	U.S.	Lafarge	Albena, MI	(2)
			Paulding, OH	(2)
			Fredonia, KS	(1)
		Holnam	Dundee, MI	(2)
		Medusa	Charlevoix, MI	(3)
		Cal Portland	Colton, CA	(2)
		Southdown	Fairborn, OH	(2)
			Kosmosdale, KY	(3)
			Victorville, CA	(3)
		Phoenix	Clarksdale, AZ	(3)
		Blue Circle	Pavona, NY	(2)
		TXI	Midlothian, TX	(3)
		National	Lebec, CA	(2)
		Allentown	Blandon, PA	(1)
		Continental	Hannibal, MO	(2)
		Capital	San Antonio, TX	(3)
		North Texas	Midlothian, TX	(3)
		Riverside	Orto Grande, CA	(3)
		River	Pactus, MO	(2)
		Giant	Harleyville, SC	(3)
		Essroc	Nazareth, PA	(3)
		Len Grove	Chanute, KS	(1)
		PMC Lonestar	Davenport, IA	(3)
	CANADA	St Lawrence	Joliette, Quebec	(1)
			Mississauga, Ontario	(2)
			Beauport, Quebec	(3)
		St Marys	Bowmanville, Ontario	(2)
		Lafarge	Brookfield, N. Scotia	(3)
	AUSTRALIA	Adelaide Brighton	Birkenhead	(3)
	NEW ZEALAND	Milburn		(3)
	MALAWI	MPOC	Changalumi	(4)
	SOUTH AFRICA	PPC	Jupiter	(3)

	EGYPT	Helwan National Tourism		(1) (4) (1)
	SAUDI	Gassim Yanbu Yamama Arabian		(1) (1) (1) (4)
	ABU DHABI	Al Ain		(4)
	U.K.	Rugby Castle	Rugby Padeswood Riboledale	(3) (3) (3)
	SWEDEN	Cemeta	Slite	(3)
	VENEZUELA	Venezolana	Pertigalete Maracaibo	(3) (3)
PULP & PAPER	U.S.	Lincoln I.P.	Lincoln, ME Jav. ME	(3) (2)
INCINERATION	U.S.	Davis County PERC MMWAC	JD Dorington, ME Auburn, ME	(2) (3) (3)
POWER	US	OMP	wyman, ME	(3)
	CANADA	Hydroquebec	Tracy, PG	(1)

Summary of Feasibility Studies:

	<u>Total</u>	<u>Status</u>			
		<u>(1)</u>	<u>(2)</u>	<u>(3)</u>	<u>(4)</u>
Cement	46	3	12	21	9
Pulp & Paper	2		1	1	
Incineration	3		1	2	
Power	2	1		1	
Total	<u>53</u>	<u>4</u>	<u>14</u>	<u>25</u>	<u>9</u>

- Status (1) Presently undergoing preliminary design and commercial negotiations.
- (2) Awaiting clarification of regulations, company decisions on alternative strategies, or further operating and test data on previous installations. Need for action acknowledged and serious interest in Recovery Scrubber expressed.
- (3) As (2) but with lower level of urgency and imminent action is not expected.
- (4) Overseas plants with serious pollution problems which could be addressed, but where there is presently no regulation and no available aid funding.
-

APPENDIX B

Typical Dragon Plant Coal Analyses



TANOMA COAL SALES, INC.

P.O. Box 682
Latrobe, PA 15650

Office: 412-537-5731
Fax: 412-537-5820

*Copy to: J. BINGEMAN
T. BATTY
H. O'LEARY
S. WALLACE
J. PENCKETON
ORIGINAL TO J*

DATE: July 15, 1993

ATTN: Mr. James Jaffray
Dragon

FROM: Mary Walker
Tanoma

RE: Analyses for 3rd Dragon Shipment

Attached you will find Noone Assoc. results for the 3rd Dragon shipment. I will forward invoice for same on Monday, July 19, 1993.

Sincerely yours,

Mary Walker
Mary Walker

#3

3450 tons
rec'd week of 7/19/93
used + 7/21/93 - 8/8/93



NOONE

ASSOCIATES, INC.

Box 9, Stanard, West Virginia 25927

304/252-7321

Tanoma Coal Sales, Inc.
 P.O. Box 682
 Latrobe, Pa.
 15650

Date: 07/08/93

Kind of sample reported to us: **CALC. COMP. 3451.85 TONS**
BARGE A-8402 ON 6/19/93, HBL-7513 ON 6/30/93, ING-1194 ON 7/07/93

Sample taken at:
 --

Date sampled

Sample identification

Date received **SAME**

by: **NOONE ASSOCIATES**

P. O. No.

Sample taken by:
SAME

Analysis Certificate No. **69698 C00000**

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>	<u>MAF</u>
% Moisture	5.25		
% Ash	7.84	8.27	
% Vol. Matter	35.48	37.45	40.83
% Fixed Carbon	51.43	54.28	
Total	100.00	100.00	
% Sulfur	2.70	2.85	
Btu/lb.	13168	13898	15151

Hardgrove Grindability

Chlorine

Oxidation

SCREEN ANALYSIS	
+ 2	= 1.06 .
2 X 1 1/4	= 6.95 .
1 1/4 X 1/4	= 46.04 .
1/4 X 0	= 45.95 .
TOTAL	= 100.00 .

FSI

FUSION TEMPERATURE OF ASH

	<u>Reducing</u>	<u>Oxidizing</u>
Initial Deformation	*F	*F
Softening (H = W)	*F	*F
Softening (H = 1/2 W)	*F	*F
Fluid	*F	*F

Respectfully submitted,
 NOONE ASSOCIATES



NOONE ASSOCIATES, INC.

Box 9, Stanford, West Virginia 25927

304252-7321

Tanoma Coal Sales, Inc.
P.O. Box 582
Latrobe, Pa.
15650

3rd DRAGON SHIPMENT

Date: 07/14/93

Kind of sample reported to us: COMPOSITE BARGES A-8402/HBL-7513/
ING-1194 (6/19, 30, & 7/7/93)

Sample taken at:

Date sampled

Sample identification

Date received: SAME

by: NOONE ASSOCIATES

P. O. No.

Sample taken by:
SAME

Analysis Certificate No. 69714 205455

MINERAL ANALYSIS

SILICON DIOXIDE	43.10	%
ALUMINUM OXIDE	21.32	%
IRON OXIDE	24.74	%
CALCIUM OXIDE	2.86	%
MAGNESIUM OXIDE	0.76	%
SODIUM OXIDE	0.51	%
POTASSIUM OXIDE	1.38	%
TITANIUM DIOXIDE	1.02	%
MANGANESE DIOXIDE	0.22	%
PHOSPHORUS PENTOXIDE	1.32	%
SULFUR TRIOXIDE	2.26	%
UNDETERMINED	0.51	%
TOTAL	100.00	%

HARDGROVE GRINDABILITY = 54

Respectfully submitted,
NOONE ASSOCIATES

Sunday

AMCI EXPORT CORPORATION FACSIMILE TRANSMISSION

*#2
Need 2 barges 6/29 2207 tons
Burned 1st week in July*

DATE: JUNE 18, 1993
TO: DRAGON PRODUCTS
ATTN: JIM JAFFRAY
FROM: ERNIE THRASHER
RE: COAL SHIPMENTS

TOTAL NUMBER OF PAGES 1 (INCLUDING COVER)
IF THERE ARE ANY PROBLEMS WITH THIS TRANSMISSION,
PLEASE CALL 412-537-5731

The 2 barges loaded last week will arrive at Duquesne Wharf on Sunday, June 20. Rail cars are scheduled to be loaded on Monday evening. The composite result of the two barges is as follows:

TONNAGE:	2206.65 (Barge Weights)		
MOISTURE:	5.00		
ASH:	7.91	8.32	
VOLATILES:	<u>37.97</u>	39.96	(SPECIFIED 35% MAXIMUM)
SULFUR:	2.71	2.85	
BTU:	13064	13752	15000
 SIZING:	 		
	+2"		0.47%
	2" x 1 1/4"		6.82%
	1 1/4" x 1/4"		55.19%
	1/4 " x 0		37.52%

The Ultimate, Mineral Ash, and Grindability analyses will be completed early next week.

In addition to the two barges detailed above, we have scheduled two additional barges to be loaded on Monday/Tuesday, June 21/22.

6/22 HAVE BEEN LOADED.

If you have any questions, please call me at 412-537-5731.

Best regards,

Ernie Thrasher



NOONE

ASSOCIATES, INC.

Box 9, Stanaford, West Virginia 25927

304252-7324

DRAWN SHIPMENTS
#2

Tanoma Coal Sales, Inc.
P.O. Box 682
Latrobe, Pa.
15650

Date: 06/24/93

Kind of sample reported to us: BARGE COMPOSITE *CTC-7803 & CHL-8417
SAMPLED 6/*15 & 17/93

Sample taken at:

Date sampled:

Sample identification

Date received: SAME

by: NOONE ASSOCIATES

P. O. No.

Sample taken by:

Analysis Certificate No. 69589 205000

MINERAL ANALYSIS

SILICON DIOXIDE	43.05	%
ALUMINUM OXIDE	22.10	%
IRON OXIDE	24.17	%
CALCIUM OXIDE	2.97	%
MAGNESIUM OXIDE	0.88	%
SODIUM OXIDE	0.43	%
POTASSIUM OXIDE	1.27	%
TITANIUM DIOXIDE	0.96	%
MANGANESE DIOXIDE	0.03	%
PHOSPHORUS PENTOXIDE	1.55	%
SULFUR TRIOXIDE	2.53	%
UNDETERMINED	0.06	%
TOTAL	100.00	%

HARDGROVE GRINDABILITY = 51

Respectfully submitted,
NOONE ASSOCIATES



TANOMA COAL SALES, INC.

P.O. Box 682
Latrobe, PA 15650

Office: 412-537-5731
Fax: 412-537-5820

Post-It™ brand fax transmittal memo 7671 # of pages = 3

To: JAS JAFFRAY	From: MARY WALKER
Co: DRAGON	Co: TANOMA
Dept:	Phone #
Fax #	Fax #

DATE: June 25, 1993

ATTN: Mr. James F. Jaffray
Dragon Products

FROM: Mary Walker
Tanoma Coal Sales, Inc.

Attached are the independent lab analyses for our initial shipment to Dragon. Ash Mineral analyses will follow.

If you should have any questions, please feel free to call me at (412) 537-5731.

Sincerely yours,

Mary Walker
Mary Walker

Attachments

*Coal direct to Dragon
by rail
~~1950~~ tons total
1975.7*

*± 1000 tons/boize offloaded
into railcars.*

*mid early June 1993
used = 6/7 - 6/11*

*COPY TO: R. GILHOOLY
T. BARNY
S. WALLACE
A. D'LINA*

ORIGINAL TO JT

$$\frac{(993.9)(2.44) + (981.8)(2.37)}{1995.7} = 2.405$$

#1



COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1519 SOUTH HIGHLAND AVE., SUITE 710-B, LOMBARD, ILLINOIS 60148 • (708) 963-8300

Member of the SGS Group (Societe Generale de Surveillance)

PLEASE ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 908, CLARKSBURG, WV 26301
TELEPHONE: (204) 625-3328
FAX: (204) 625-4287

June 25, 1993

TANOMA COAL SALES
PO BOX 682
LATROBE PA 15650

Sample identification by
TANOMA COAL SALES

BARGE 1730

Kind of sample
reported to us COAL

BARGE DRAFT BY CT&E
DRAFTED TONNAGE: 993.90

Sample taken at HUMPHREY

SAMPLE OBSERVATION BY CT&E

Sample taken by CONSOL

5.59% MOISTURE, AS DETERMINED BY
CONSOL LAB

Date sampled May 24, 1993

CONSOL LAB NO. 5677

Data received May 25, 1993

60 MESH SAMPLE

Analysis Report No. 65-88542

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>		
% Moisture	5.59	XXXXX		
% Ash	7.41	7.85		
% Volatile	35.25	37.34		
% Fixed Carbon	51.75	54.81		
	100.00	100.00		
Btu/lb	13285	14072	NAP	15271
% Sulfur	2.30	2.44		
Alkalies as Sodium Oxide	XXXXX	XXXXX		

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Richard Miller
1993
Manager, Clarksburg Laboratory

OVER 40 BRANCH LABORATORIES STRATEGICALLY LOCATED IN PRINCIPAL COAL MINING AREAS, TIDEWATER AND GREAT LAKES PORTS, AND RIVER LOADING FACILITIES

Original Watermarked For Your Protection

TERMS AND CONDITIONS ON REVERSE



COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 2100, LOMBARD, ILLINOIS 60148 • (708) 263-0300

Member of the SGS Group (Sandoz, Ciba, and Sandoz)

PLEASE ADDRESS ALL CORRESPONDENCE TO
P.O. BOX 909, CLARKSBURG, WV 26307
TELEPHONE: (304) 623-3322
FAX: (304) 622-3228

June 25, 1993

TANOMA COAL SALES
PO BOX 682
LATROBE PA 15650

Sample identification by
TANOMA COAL SALES

BARGE 1677

Kind of sample
reported to us COAL

BARGE DRAFT BY CT&E
DRAFTED TONNAGE: 981.80

Sample taken at HUMPHREY

SAMPLE OBSERVATION BY CT&E

Sample taken by CONSOL

5.46% MOISTURE, AS DETERMINED BY
CONSOL LAB

Date sampled May 24, 1993

CONSOL LAB NO. 5676

Date received May 25, 1993

60 MESH SAMPLE

Analysis Report No. 65-88541

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>		
% Moisture	5.46	XXXXX		
% Ash	7.47	7.90		
% Volatile	35.34	37.38		
% Fixed Carbon	51.73	54.72		
	100.00	100.00		
Btu/lb	13250	14015	NAF	15217
% Sulfur	2.24	2.37		
Alkalies as Sodium Oxide	XXXXX	XXXXX		

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

John Miller
1993
Manager, Clarksville Laboratory

OVER 40 BRANCH LABORATORIES STRATEGICALLY LOCATED IN PRINCIPAL COAL MINING AREAS, TIDEWATER AND GREAT LAKES PORTS, AND RIVER LOADING FACILITIES



TANOMA COAL SALES, INC.

P.O. Box 882
Latrobe, PA 15650

Office: 412-537-5731
Fax: 412-537-5820

DATE: July 13, 1993

ATTN: Mr. Jim Jaffray
Dragon Products

FROM: Mary Walker
Tanoma Coal Sales, Inc.

4 pages

Please find attached the mineral analyses for the first two Dragon shipments.

I should have results for the third Dragon shipment late this afternoon or early tomorrow morning.

If you have any questions or require additional information, please do not hesitate to call me at (412) 537-5731 or fax me at (412) 537-5820.

Sincerely yours,

Mary Walker
Attachments

*COPY TO: S. WALKER
J. BANGERT
T. BATTY
H. D'LIMA*

ORIGINAL TO J.J.



COMMERCIAL TESTING & ENGINEERING CO.
GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 219-B, LOMBARD, ILLINOIS 60148 - (708) 863-8300

Member of The SGS Group (Solid's Software or Surveillance)

July 6, 1993

PLEASE ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 909, CLARKSBURG, WV 26301
TELEPHONE: (800) 623-8323
FAX: (800) 623-4227

TANOMA COAL SALES
PO BOX 682
LATROBE PA 15650

DRAGON SHIPMENT
#1

Sample identification by
TANOMA COAL SALES

BARGE 1730

Kind of sample reported to us COAL

BARGE DRAFT BY CT&E
DRAFTED TONNAGE: 991.90

Sample taken at

SAMPLE OBSERVATION BY CT&E

Sample taken by

Date sampled May 24, 1993

Date received May 25, 1993

60-MESH SAMPLE

Analysis Report No. 65-88542

ANALYSIS OF ASH

WEIGHT %, IGNITED BASIS

Silicon dioxide	47.48
Aluminum oxide	24.71
Titanium dioxide	1.16
Iron oxide	16.13
Calcium oxide	4.08
Magnesium oxide	0.85
Potassium oxide	1.35
Sodium oxide	0.61
Sulfur trioxide	3.00
Phosphorus pentoxide	0.25
Strontium oxide	0.17
Barium oxide	0.13
Manganese oxide	0.10
Undetermined	0.00
	<u>100.00</u>

Silica Value = 69.26
Base:Acid Ratio = 0.31
True Temperature = 2525 °F

Type of Ash = BITUMINOUS
Fouling Index = 0.19
Slagging Index = 0.76

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

John Miller
Manager, Testing Laboratory



COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1080 COUNTRY WICKLAND AVE., SUITE 200A, LAWRENCE, ILLINOIS 62424 • (708) 957-9300

Member of the SGS Group (Société Générale de Surveillance)

July 6, 1993

PLEASE ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 308, CLARK COUNTY, WY 82001
TELEPHONE: (304) 623-3329
FAX: (304) 623-4227

TANOMA COAL SALES
PO BOX 682
LATROBE PA 15650

*Dragon Shipant
#1*

Sample identification by
TANOMA COAL SALES

BARGE 1677

Kind of sample
reported to us COAL

BARGE DRAFT BY CT&E
DRAFTED TONNAGE: 981.80

Sample taken at

SAMPLE OBSERVATION BY CT&E

Sample taken by

Date sampled May 24, 1993

Date received May 25, 1993

60 MESH SAMPLE

Analysis Report No. 65-88541

<u>ANALYSIS OF ASH</u>	<u>WEIGHT %, IGNITED BASIS</u>
Silicon dioxide	48.70
Aluminum oxide	24.95
Titanium dioxide	1.16
Iron oxide	14.96
Calcium oxide	3.89
Magnesium oxide	0.93
Potassium oxide	1.37
Sodium oxide	0.56
Sulfur trioxide	2.84
Phosphorus pentoxide	0.25
Strontium oxide	0.17
Barium oxide	0.12
Manganese oxide	0.10
Undetermined	0.00
	<u>100.00</u>

Silica Value = 71.13
Base:Acid Ratio = 0.29
Tare Temperature = 2561 °F

Type of Ash = BITUMINOUS
Fouling Index = 0.15
Slagging Index = 0.69

PROFESSIONALLY ENGINEERED
COMMERCIAL TESTING & ENGINEERING CO.

*John Miller
ES*



SPRAGUE ENERGY

C. H. SPRAGUE & SON CO.

One Parade Mall, Portsmouth, N.H. 03801 Tel: (603) 431-1000
Fax: (603) 431-6371

*S. WALLACE ✓
J. BANGEMAN
T. BATTY
J. PENNILETON (THIS PAGE ONLY)
ORIGINAL TO JT.*

November 10, 1992

Mr. James Jaffray
Purchasing Manager
Dragon Products Company
P.O. Box 191, Route 1
Thomaston, ME 04861

92-2 Rail

Dear Jim:

Attached is the analysis regarding the Dragon coal shipment delivered via rail to your Thomaston plant recently.

As you can see, the as received btu's/lb did not meet our expectations of 12,750 minimum. Sprague has arranged with the coal producer to credit Dragon \$.36 per net ton for the btu shortfall.

Call us with any questions or comments regarding your order.

Sincerely,

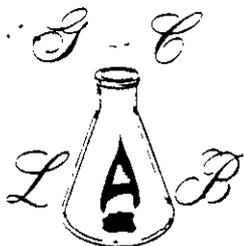
GJS
Gary J. Smith
Manager,
Coal Marketing and Supply

GJS/lml

cc: T. Flaherty
D. Butler
L. Derrick - C&K Coal Company

*All used in Thomaston 92
2000 T coal
+ 800 T wire*

*1/3000 = 2/3 +
+ = 800*



G and C COAL ANALYSIS LAB., INC.

R.D. 1, BOX 324
SUMMERVILLE, PA 15864
(814) 849-2559

RECEIVED FROM:

C.H. Sprague & Son Co.
One Parade Mall
Portsmouth, NH 03801

LAB NO. Composite
SAMPLED 10-27, 30-92
RECEIVED 10-27, 30-92
REPORTED 11-04-92

SAMPLE MARKED:

Dragon Cement Order
Taken at: C&K Coal Co. - Shannon Tipple & Piney Tipple
Car Top & Flow Sampled by Dennis Butler
Mathematical Composite, 20 Cars Total
14 Cars - Piney Tipple, 10-27-92
6 Cars - Shannon Tipple, 10-30-92

ANALYSIS REPORT

	AS RECEIVED	DRY BASIS
% Moisture.....	6.18	
% Ash.....	9.49	10.12
% Sulfur.....	2.64	2.81
B.T.U.....	12,657	13,491
B.T.U. (Moisture-Ash Free).....	15,010	
% Volatile Matter.....	36.39	38.79
% Fixed Carbon.....	47.94	51.09

RECEIVED / APPROVED

Dragon Oct 92-2 A 11/10

G. SMITH - SPRAGUE

PAY BILL: _____

REBILL: _____

RETURN FOR MY REVIEW: _____

G & C COAL ANALYSIS LAB., INC.

Dennis S. Wagner

THE ABOVE ANALYTICAL RESULTS WERE OBTAINED FOLLOWING ASTM PROCEDURES.

APPROVED BY



SPRAGUE ENERGY

C. H. SPRAGUE & SON CO.

One Parade Mall, Portsmouth, N.H. 03801 Tel: (603) 431-1000
Fax: (603) 431-6371

T. BATTY
J. BANGEMAN
S. WALLACE
ORIGINAL TO JT

Rec'd 10/2/92

October 6, 1992

Mr. James Jaffray
Purchasing Manager
Dragon Products Company
P.O. Box 191, Route 1
Thomaston, ME 04861

Dear Jim:

Attached is the analysis regarding the Dragon coal shipment delivered via rail to your Thomaston plant recently.

Call us with any questions or comments regarding your order.

Sincerely,

Gary J. Smith
Manager,
Coal Marketing and Supply

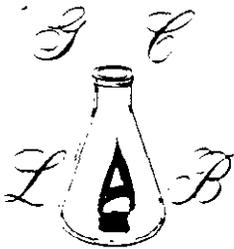
GJS/lml

cc: T. Flaherty
D. Butler

Rail 92-1
all used in
early October
@ 2000 T case

2000/5
4/2

AN AXEL JOHNSON INC. COMPANY



G and C COAL ANALYSIS LAB., INC.

R.D. 1, BOX 324
SUMMERVILLE, PA 15864
(814) 849-2559

RECEIVED FROM:

C.H. Sprague & Son Co.
One Parade Mall
Portsmouth, NH 03801

LAB NO. Composite
SAMPLED 09-14,16-92
RECEIVED 09-14,16-92
REPORTED 09-25-92

SAMPLE MARKED:

Flow & Car Top Sampled By Dennis Butler - Dragon Cement Order
Taken at: C&K Shannon & Piney Tipple - Composite Sample - 20 Cars

Screens:	+2"	16.01 lbs.	6.27 %
	2 x 1 1/4"	42.06 lbs.	16.47 %
	1 1/4 x 1/4"	158.58 lbs.	62.09 %
	1/4" x 0	38.75 lbs.	15.17 %

ANALYSIS REPORT

	AS RECEIVED	DRY BASIS
% Moisture.....	5.58	
% Ash.....	9.14	9.68
% Sulfur.....	2.70	2.86
B.T.U.....	12,790	13,546
B.T.U. (Moisture-Ash Free).....	14,998	
% Volatile Matter.....	36.59	38.75
% Fixed Carbon.....	48.69	51.57

RECEIVED
921 DRAGON RAIL 10/5
GARY J. SMITH
SPRAGUE COAL DEPT.

THE ABOVE ANALYTICAL RESULTS WERE
OBTAINED FOLLOWING ASTM PROCEDURES.

APPROVED BY

G & C COAL ANALYSIS LAB., INC.
Dennis J. Sprague



NOONE

ASSOCIATES, INC.

Box-9, Stanford, West Virginia 25927

*Start
use in October 92*

304262-7324

EASTERN ASSOCIATED COAL CORP.
RESEARCH & TECHNICAL CENTER
P.O. BOX 850
SOPHIA, WV 25921

*Seaspeak
92-3
Coal*

Date: 09/25/92

Kind of sample reported to us: CALCULATED COMPOSITE 14,546.2 TONS
C.H. SPRAGUE UT #UCG-64B & #UCG-66B

Sample taken at:
FEDERAL #2

Date sampled: 9/19/92

Sample identification by: EASTERN ASSOC.

Date received: -----

Sample taken by:
SAME

P. O. No.

Analysis Certificate No. 00000 000000

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>	<u>MAF</u>
% Moisture	7.19		
% Ash	6.12	6.59	
% Vol. Matter			
% Fixed Carbon			
Total			
% Sulfur	2.50	2.69	
Btu/lb.	13256	14283	15291
FSI			

RECEIVED
DRAGON 92-3
GARY J. SMITH
SPRAGUE COAL DEPT.

FUSION TEMPERATURE OF ASH

	<u>Reducing</u>	<u>Oxidizing</u>
Initial Deformation	*F	*F
Softening (H = W)	*F	*F
Softening (H = 1/2 W)	*F	*F
Fluid	*F	*F

COPY

Respectfully submitted:
NOONE ASSOCIATES



NOONE

ASSOCIATES, INC.

Box 9, Stanford, West Virginia 25927

92-2 coal

304/252-7321

EASTERN ASSOCIATED COAL CORP.
RESEARCH & TECHNICAL CENTER
P.O. BOX 850
SOPHIA, WV 25921

Date: 06/25/92

Kind of sample reported to us: 75 CARS 6250 TONS
UT #UXC-10 C.H. SPRAGUE

used? July - Sept '92

Sample taken at:
FEDERAL #2

Date sampled: 6/24/92

Sample identification by:
EASTERN ASSOC.

Date received: SAME

Sample taken by:
SAME

P. O. No.

Analysis Certificate No. 65877 C36524

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>	<u>MAF</u>
% Moisture	6.60		
% Ash	6.02	6.44	
% Vol. Matter			
% Fixed Carbon			
Total			
% Sulfur	2.09	2.24	

Hardgrove Grindability
Chlorine
Oxidation

COMPOSITE
 $2.24(6250) + 2.33(727)$

13523
2.29

Btu/lb. 13327 14269 15251

FSI

FUSION TEMPERATURE OF ASH

	<u>Reducing</u>	<u>Oxidizing</u>
Initial Deformation	*F	*F
Softening (H = W)	*F	*F
Softening (H = 1/2 W)	*F	*F
Fluid	*F	*F

COPY

Respectfully submitted,
NOONE ASSOCIATES



NOONE

ASSOCIATES, INC.

Box 9, Stanford, West Virginia 25927

SOA/252-7321

EASTERN ASSOCIATED COAL CORP.
RESEARCH & TECHNICAL CENTER
P.O. BOX 850
SOPHIA, WV 25921

Date: 06/24/92

Kind of sample reported to us 77 CARS 7273 TONS
UT #UCG-50B C.H. SPRAGUE

Sample taken at:
FEDERAL #2

Date sampled 6/23/92

Sample identification by: EASTERN ASSOC.

Date received SAME

Sample taken by:
SAME

P. O. No.

Analysis Certificate No. 65860 C36515

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>	<u>MAF</u>
% Moisture	5.92		
% Ash	6.76	7.19	
% Vol. Matter			
% Fixed Carbon			
Total			
% Sulfur	2.19	2.33	
Btu/lb.	13307	14144	15240

Hardgrove Grindability
Chlorine
Oxidation

Fst

FUSION TEMPERATURE OF ASH

	Reducing	Oxidizing
Initial Deformation	*F	*F
Softening (H = W)	*F	*F
Softening (H = 1/2 W)	*F	*F
Fluid	*F	*F

COPY

RECEIVED
Dixon 92-2 7/6/92
GARY J. SMITH
SPRAGUE COAL DEPT.

Respectfully submitted,
NOONE ASSOCIATES



COPIES TO M. WALTON, T BARRY
ORIGINAL TO J P.1
Hampton Roads Testing Laboratories, Inc.
611 Howmet Drive, Hampton, Virginia 23661-1390
Tel: (804) 826-5340 Fax: (804) 827-1398

Laboratory Report No. 279238 Date of Report April 15, 1992

CERTIFICATE OF ANALYSIS

Sample of: COALS, SUBMITTED SAMPLE
(14620 Net Tons)

Mark: Composite sample of BITUMINOUS COAL
for Total Cargo loaded aboard BARGE
SOMERSET, Mechanically/Belt Sampled
at CCSC, Baltimore, Maryland

From: C. H. Sprague & Son Co.
Portsmouth, New Hampshire

Date Sampled: April 12, 1992

Sampled By: Sampling Associates International

RECEIVED
DRAGON 92-1
GARY J. SMITH
SPRAGUE COAL DEPT.
ETA 4/16

PROXIMATE ANALYSIS

	AS RECEIVED	DRY COAL
TOTAL MOISTURE	6.29	XXXXX
VOLATILE MATTER	37.86	40.40
FIXED CARBON	49.60	52.93
ASH	6.25	6.67
Total (100%)	100.00	100.00
SULPHUR	2.71	2.89
B.T.U. PER LB.	13344	14240
CALORIES PER GRAM	7413	7917

Used file
end of July
June 92

FREE SWELLING INDEX A.S.T.M. 7.0
MOISTURE/ASH FREE B.T.U. 15258

Hampton Roads Testing Laboratories, Inc

By [Signature]
[Name]

Post-it[®] brand fax transmittal memo 7671 # of pages 2

To: J. JAFFRAY	From: FLATTERY
Ca: 4/24/92	Ca:
Dept: OUTBOUND ANALYSIS	PROB:
Fax: 804-827-5339	Fax:
ATTN: ANALYSIS TO FOLLOW	

APR-15-1992 15:26 FROM HAMPTON ROADS TESTING LAB. TO P.02



Hampton Roads Testing Laboratories, Inc.
611 Howcroft Drive, Hampton, Virginia 23661
Tel: (804) 826-5370 Fax: (804) 827-1366 Tbc 5106012734

Laboratory Report No. 279238 Date of Report April 15, 1992

CERTIFICATE OF ANALYSIS

Sample of: COALS: SUBMITTED SAMPLE
(14620 Net Tons)

Mark: Composite sample of BITUMINOUS COAL
for Total Cargo loaded aboard BARGE
SOHERSET, Mechanically/Belt Sampled
at CCSC, Baltimore, Maryland

From: C. H. Sprague & Son Co.
Portsmouth, New Hampshire

Date Sampled: April 12, 1992

Sampled By: Sampling Associates International

SCREEN ANALYSIS

<u>SIZE</u>	<u>PERCENT</u>
+ 2"	4.4
2" X 1"	15.4
1" X 1/4"	41.0
1/4" X 0	39.2

	100.0

Hampton Roads Testing Laboratories, Inc.

By

Chemist

[Handwritten Signature]

APR-15-1992 15:27 FROM HAMPTON ROADS TESTING LAB TO 16034313018 P.03

TOTAL P.03

*Sprague ran out
of one coal so
used this during
January '92*



**SPRAGUE ENERGY
C. H. SPRAGUE & SON CO.**

One Parade Mall, Portsmouth, N.H. 03801 Tel: (603) 431-1000
Fax: (603) 431-6371

GARY J. SMITH
MANAGER
COAL SALES ADMINISTRATION

January 3, 1992

Mr. Dave Harrison
Project Manager
Champion International Corporation
P.O. Box 1200
Bucksport, ME 04416

Dear Dave:

Attached is the laboratory analysis regarding Sprague shipment
91-9 for Champion's Bucksport mill.

Please call us with any questions or comments regarding this
shipment.

Sincerely,

Gary J. Smith

cc: Tom Flaherty

analysis.ltr/csl

WESTMORELAND COAL SALES CO. - BANNER LABORATORY

P.O. BOX 63
 BANNER, KY. 41603 (606) 874-8231

PRODUCER KENTUCKY CRITERION COAL CO.
 ADDRESS P.O. BOX 25
 DEANE, KY 41812

Lab No.
 Date Rec'd. 12-02 THRU 12-16-91
 Date Sampled 12-02 THRU 12-16-91
 Sampled By At DEANE, KENTUCKY
 Customer CHAMPION BARGE 91-9
 N/S X Stoker Size 5" X 0"
 Seam(s) VARIOUS
 Weather Temp. F.P.

Sample Identification

COMPOSITE ANALYSIS OF 97 CARS
 CHAMPION BARGE 91-9

PROPERTIES

	% Volatile	% Fixed Carbon	% Moisture	% Ash	% Sulfur	% BTU
As Rec'd.	34.54	51.77	6.04	7.65	0.70	12,992
Dry Basis	36.76	55.10		8.14	0.74	13,827
V-M-Free						15,052

	SPECS	Fusion Temperature of Ash	SPECS
Free Swelling Index No.	5.00	Initial	2800+ °F
Grindability Index No.	44	Softening	2800+ °F
Chlorine		Hemispherical	2800+ °F
		Fluid	2800+ °F

SCREEN ANALYSIS

SIZE	WT. (IN LBS.)	PERCENTAGE	CUMULATIVE PERCENT
+ 5		9.72	9.72
5 X 2		22.73	32.45
2 X 1 1/4		13.57	46.02
1 1/4 X 3/4		15.65	61.67
3/4 X 3/8		16.31	77.98
3/8 X 1/4		6.54	84.52
1/4 X 0		15.48	100.00

RECEIVED / APPROVED
 12/27 Champion 91-9
 GARY J. SMITH
 SPRAGUE COAL DEPT.

TOTAL WEIGHT

Submitted By:

Larry Stapleton Chem



SPRAGUE ENERGY

C. H. SPRAGUE & SON CO.

One Parade Mall, Portsmouth, N.H. 03801 Tel: (603) 431-1000
Fax: (603) 431-6371

GARY J. SMITH
MANAGER
COAL SALES ADMINISTRATION

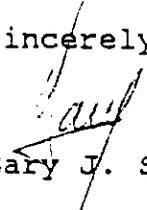
August 23, 1991

Mr. James Jaffray
Purchasing Manager
Dragon Products
P. O. Box 191, Route 1
Thomaston, ME 04861

Dear Jim:

Attached is the laboratory analysis regarding Dragon coal shipment 91-3.

Sincerely,


Gary J. Smith

Attachment

cc: J. Bangeman
T. Batty
T. Flaherty
S. Wallace
M. Walton

dragon01.ltr/csl



G and C COAL ANALYSIS LAB., INC.

R.D. 1, BOX 324
SUMMERVILLE, PA 15864
(814) 849-2559

RECEIVED FROM:

C.H. Sprague & Son Co.
One Parade Mall
Portsmouth, NH 03801

LAB NO. Composite
SAMPLED 08-12,14-91
RECEIVED 08-12,14-91
REPORTED 08-21-91

SAMPLE MARKED:

Dragon Cement Order Car Top Sampled by Dennis Butler
Taken at: C&K Coal Co. - Piney Tipple & Shannon Tipple
* Mathematical Composite * 116 Cars Total
Screens: +2" 3.35 %
2" x 1" 18.27 %
1" x 1/4" 52.02 %
1/4" x 0 26.36 %

ANALYSIS REPORT

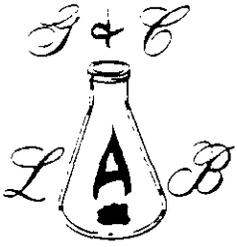
	AS RECEIVED	DRY BASIS
% Moisture.....	5.93	
% Ash.....	8.76 ✓	9.31
% Sulfur.....	2.18 ✓	2.32
B.T.U.....	12,800 ✓	13,607
B.T.U. (Moisture-Ash Free).....	15,004	
% Volatile Matter.....	35.74 ✓	37.99
% Fixed Carbon.....	49.57	52.70
Coke Button Index.....	8	
Fusing Temperature.....	ID: 2338	ST: 2394
	HT: 2458	FT: 2520

RECEIVED/APPROVED
DRAGON 91-3 4 8/23
GARY J. SMITH
SPRAGUE COAL DEPT.

G & C COAL ANALYSIS LAB., INC.

THE ABOVE ANALYTICAL RESULTS WERE
OBTAINED FOLLOWING ASTM PROCEDURES.

APPROVED BY



G and C Coal Analysis Lab., Inc.

R.D. 1, Box 324
Summerville, PA 15864
814-849-2559

C.H Sprague & Son Co.
One Parade Mall
Portsmouth, NH 03801

Dragon Cement Order
Taken at: C&K Coal Co. - Piney & Shannon
Tipples
Car Top Sampled by Dennis Butler
Composite Sample, 116 Cars Total

Date Sampled : 08-12,14-91
Date Received : 08-12,14-91
Date Reported : 08-21-91

QUALITY EVALUATION FORM

<u>ULTIMATE ANALYSIS</u>		<u>MINERAL ANALYSIS OF ASH</u>	
Carbon	<u>74.99</u>	SiO ₂	<u>46.27</u>
Hydrogen	<u>5.05</u>	Al ₂ O ₃	<u>24.71</u>
Nitrogen	<u>1.72</u>	TiO ₂	<u>1.16</u>
Chlorine	<u>0.16</u>	Fe ₂ O ₃	<u>21.96</u>
Sulfur	<u>2.32</u>	CaO	<u>1.53</u>
Ash	<u>9.31</u>	MgO	<u>0.67</u>
Oxygen(diff)	<u>6.45</u>	Na ₂ O	<u>0.43</u>
		K ₂ O	<u>1.42</u>
		P ₂ O ₅	<u>1.17</u>
		SO ₃	<u>0.61</u>
		Und.	<u>0.07</u>

The above analytical results were obtained following ASTM procedures.

G & C COAL ANALYSIS LAB., INC.

Approved By _____

APPENDIX C

Continuous Emission Monitor Proposal from Enviroplan

COPY

**ENVIROPLAN PROPOSAL
#P43-7021-3096B**

Exclusively Prepared For:

DRAGON PRODUCTS CO.

Thomaston, ME

January 18, 1990

 **ENVIROPLAN**

CEMEX
Continuous Emission Monitoring
Extractive System

Prepared For:

DRAGON PRODUCTS COMPANY
P.O. Box 191
Route 1
Thomaston, Maine 04861

Telephone: (207) 594-5555

P43-7021-3096B
January 18, 1990

January 18, 1990
P43-7021-3096B

Mr. Steven Wallace
Dragon Products Co.
P.O. Box 191
Rt. One
Thomaston, ME 04861

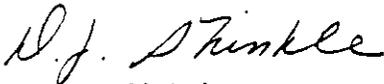
Dear Mr. Wallace:

Enviroplan is pleased to submit revised pricing for our CEMEX System.

Should you have any questions regarding our proposal, do not hesitate to call at your earliest convenience.

Sincerely,

ENVIROPLAN, INC.



D.J. Shinkle
Mid-West Regional Manager

DJS/ma

cc: B. Fournier

TABLE OF CONTENTS

	Page
1. Pricing and Submittals	1-1
1.1 Pricing - CEMEX	1-2
1.2 Recommended Spare Parts	1-4
1.3 Submittals	1-5
1.3.1 Enviroplan Engineering Standards/ Enviroplan Standard Drawing Package	1-5-1
1.3.2 Miscellaneous Enviroplan Standards	1-5-2
1.3.3 Preventive Maintenance Schedule/CEMEX	1-5-3
1.4 Required Utilities	1-6
1.5 System Specifications	1-7
1.6 Representative Drawings	1-8
1.7 Clarifications	1-9
2. Product Description - CEMEX	2-1
2.1 Specific System Description - None	2-1
2.2 General Cemex Product Description	2-1
2.2.1 Dilution Probe Sampling System	2-2
2.2.2 Pumpless Source Sample Extraction	2-3
2.2.3 True Dynamic Calibration	2-3
2.2.4 Installation	2-4
2.2.5 Sequence/Controller	2-4
2.2.6 Rack Mounting	2-4
2.2.7 Environmental Enclosure (OPTION)	2-5
3. Services	3-1
3.1 Start-up Supervision	3-1
3.2 Client Responsibility For CEM Certification	3-3
3.3 Guaranteed System Certification	3-4
3.4 Maintenance Service Contracts	3-5
3.4 Training Program	3-5
4. Limited Warranty	4-1
5. User's List	5-1
Product Brochures:	
CEMEX	
Teco 43A	
Teco 42	

1. PRICING AND SUBMITTALS

1.1 PRICING - CEMEX

ITEM	QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL PRICE
1.	1	CEMEX System for SO ₂ and NO _x measurement. Two point system. o heated dilution probes o air clean-up system o dilution control panels o timer/sequencer o auto calibration o auto purge o UV fluorescent SO ₂ monitor o chemiluminescent NO _x monitor o standard cabinet for controlled environment. Nema 1A equivalent. o sample and hold for outputs o 4-20 ma outputs o estimated weight 600 lbs.	\$ 62,500	\$ 62,500
2.	1 lot	Calibration gases and regulators		To be supplied by owner (EP will specify concentrations and packaging)
3.	1 lot	Freeze-protected umbilical for item 1 - CEMEX system.	19.50 per foot	
4.	2	Flow measurement devices o EMRC monitor o 100 ft. of connecting cable o Δ P and temperature provided outputs (4-20 ma) allow calculation of velocity	7,300	14,600

5.	1 lot	System documentation o drawings (2 sepias and 2 print sets) o service manuals (4 copies) o test documentation	950
6.	1 lot	Guaranteed certification for SO ₂ and NO (inlet ² & outlet ^x) Results provided: 3 copies of all appropriate reports. 2 copies - protocol.	20,500

OPTIONS:

A.	1 lot	Start-up supervision (estimated at 2 mandays)	1,200 + T & E*
B.	1 lot	Training program (estimated at 1 manday)	600 + T & E*

Pricing exclusive of all sales taxes.

Shipping prepaid and added, FOB Indianapolis, Indiana.

Delivery: 16 weeks ARO and design engineering information
including facility drawings.

Terms of Payment: NET 30 days from date of shipment from
Enviroplan Factory.

Start-up supervision and/or training is planned for 3-4 weeks following date of shipment. If client is not ready for start-up supervision and/or training during this time period, they must contact Enviroplan field services at (317) 271-6039 to arrange for another date.

*Travel & Expenses (T & E): The costs associated with travel to the site, travel expenses onsite, and per diem costs are excluded from prices quoted. These costs will be billed at actual costs plus 10 percent handling.

1.2 RECOMMENDED SPARE PARTS PACKAGE

CEMEX SYSTEM

ITEM	PRICE
Critical Orifice (2)	
Graphite Ferrules (2 box)	
Miscellaneous Small Component Parts	
Solenoid (3)	
NO _x Spare Parts Kit (1 Lot)	
SO ₂ Spare Parts Kit (1 Lot)	
TOTAL	\$ 5,610



1.3 SUBMITTALS



1.3.1 Enviroplan Engineering Standards/
Enviroplan Standard Drawing Package

ENVIROPLAN ENGINEERING STANDARDS/
ENVIROPLAN STANDARD DRAWING PACKAGE

The following information is in reference to Enviroplan's standard drawing submittal.

1. One (1) set of sepia paper reproducibles of all drawings will be supplied.
2. Three (3) sets of bluelines of all drawings will be supplied.
3. A 4-square inch area will be available on right side of paper for client stamps, blocks, etc...
4. One set of the above mentioned items 1 and 2 will be supplied upon initial preliminary drawing submittal. Changes made by client that do not effect pre-construction on site do not require a new set of submittals.
5. One set of the above mentioned items 1 and 2 will be supplied "as built" after the equipment is shipped. If any major changes occur on site during installation, a new set of prints will be supplied.
6. Enviroplan drawings will indicate specific size (H x W x D) of all equipment.
7. Enviroplan drawings will contain title blocks which consist of manufacturer's name, address, date of approval, and responsible person.
8. The following drawings shall be submitted to client approximately four weeks after receipt of purchase order and clarification of any technical questions. In cases where standard Enviroplan pipe flange connections are used, drawings may be submitted within one week of purchase order.
 - a. Equipment installation and mounting details
 - b. Piping and instrumentation diagram
 - c. Wiring (terminal block arrangements)
 - d. Electric interconnect drawings
 - e. Cabinet/rack drawings
 - f. Cabinet - junction box sizes and layouts
 - g. Specifications for sample tubing and electrically-fabricated cable
 - h. Equipment, water, air and power connection drawings

9. Enviroplan shall use its standard transmittal form. Please see following page for example.
10. No sepia mylar reproducibles or sepia vellum reproducibles will be supplied as a standard, yet can be provided at additional cost.
11. Microfilm will not be supplied. All sepia paper reproducibles will be of microfilm quality.
12. Xerox (blackline) will not be supplied as a standard, yet can be provided at additional cost.
13. Any changes or revisions to drawings requested by client after installation can be provided at additional cost.
14. Any deviation from Enviroplan Engineering Standards will be at additional cost.



DOCUMENT TRANSMITTAL

Enviroplan, Inc.
Indianapolis Facility
8212 Country Club Place
Indianapolis, IN 46214

Date: _____
No. of Sheets: _____

To: _____

Attention: _____

Project Name: _____

Purchase Order No. _____

Enviroplan Project Authorization No. _____

Enclosed: _____ set(s) of sepias
_____ set(s) of bluelines

COMMENTS: _____

Very Truly Yours,

Phone No. (317) 271-6039
FAX No. (317) 271-2804



1.3.2 Miscellaneous Enviroplan Standards

MISCELLANEOUS ENVIROPLAN STANDARDS

1. Standard wire is a pvc-jacketed insulation.
2. Enviroplan typically requests individual circuit drops to our system. Enviroplan can provide a power distribution panel as an option.
3. Standard flanges are:
 - a. CEMEX - 4" 150 lb. RF carbon steel.
 - b. O₂ - .4 meter comes with a standard mounting plate
 - c. O₂ - 1 meter probe comes with standard mounting plate
 - d. Opacity - comes with a 3-1/2" pipe flange adaptor.
4. Any alterations in adaptation to material will be at additional cost.
5. Enviroplan requires 80-100 psi instrument grade air dew point -40°F dirt and oil free.
6. All wiring external to rack assembly and interconnecting to sample points or other locations is by client.
7. Enviroplan standard outputs are 4-20 mA non-isolated. Isolated outputs can be purchased as an option.
8. If power source is unstable or susceptible to spiking client is responsible for suppressors or transformers. This option can be purchased.
9. Lightning protection can be purchased as an option. This is not a standard option.
10. Standard pipe arrangements for opacity blowers are capable of overcoming +3" w.c. Higher positive pressure or larger pipe diameters will require a larger blower motor.
11. Enviroplan Operation and Maintenance Manuals consist of:
 - a. Soft cover containing name of client and project.
 - b. Spiral binding
 - c. Table of Contents arranged in systematic order.
 - d. 8-1/2" x 11" paper.
 - e. C.E.M. Appendix constructed as above.

1-5-3



1.3.3 Preventive Maintenance Schedule/CEMEX

PREVENTIVE MAINTENANCE SCHEDULE/CEMEX

A maintenance schedule is determined by the following factors:

- a. Plant load
- b. Plant process
- c. Plant environment

Preventive Maintenance includes:

1. Probe:
 - o Remove probe from process
 - o Clean coarse filter
 - o Inspect and replace fine filter (quartz wool)
 - o Ensure cal/purge line clean
 - o Apply anti-seize compound and return mantle
2. Air system: Inspect and replace, if necessary, all reagents
3. Analyzers:
 - o Inspect and replace analyzer filters
 - o Clean fan screens
 - o Inspect and replace any reagents if necessary

Enviroplan initially recommends maintenance on a quarterly basis.

1.4 REQUIRED UTILITIES (General)

1.4.1 CEMEX

A. Instrument Air

Four SCFM per probe at 85 psig
 + 5 psig delivered to control room rack.
 Air at dewpoint of -40°F
 (oil/dirt free is anticipated).

B. CEMEX rack (optional) Nema-(x)

115 VAC, 30A air conditioning/heating control.
 Qty. -1.

C. 115 VAC Circuits

1.	20A circuit instrumentation	Qty.- <u>2</u>
2.	15A circuit utilities	Qty.- <u>1</u>
3.	(Optional) 15A circuit probe heater	Qty.- <u>1</u>
4.	(Optional) 20A circuit dual probe heaters	Qty.- <u>1</u>
5.	(Optional) 30A, <u>220 VAC</u> for each freeze-protected umbilical	

D. 220 VAC power (See C-5)

One circuit at control room rack.
 30-amp for freeze protected umbilical.

*Note: Client must supply effective power grounds for all equipment.

1.5 SYSTEM SPECIFICATIONS (GENERAL)

Pollutant Ranges:	Maximum	Minimum
SO ₂	0-3000 ppm	0-25 ppm
NO ₂	0-1500 ppm	0-25 ppm
CO ^x	0-15,000 ppm	0-200 ppm
O ₂	0-21%	0-5%
HCl	0-15,000 ppm	0-250 ppm
CO ₂	As required	

Flue Gas temp. max: 750° (standard probe) 1050° (high temp. probe)

Output: 4-20 ma or 0-10%-5 vdc

Calibration error: Less than 5% of gas value

Response time: Less than 5 minutes

Zero span drift: Less than 2% full scale
24 hour

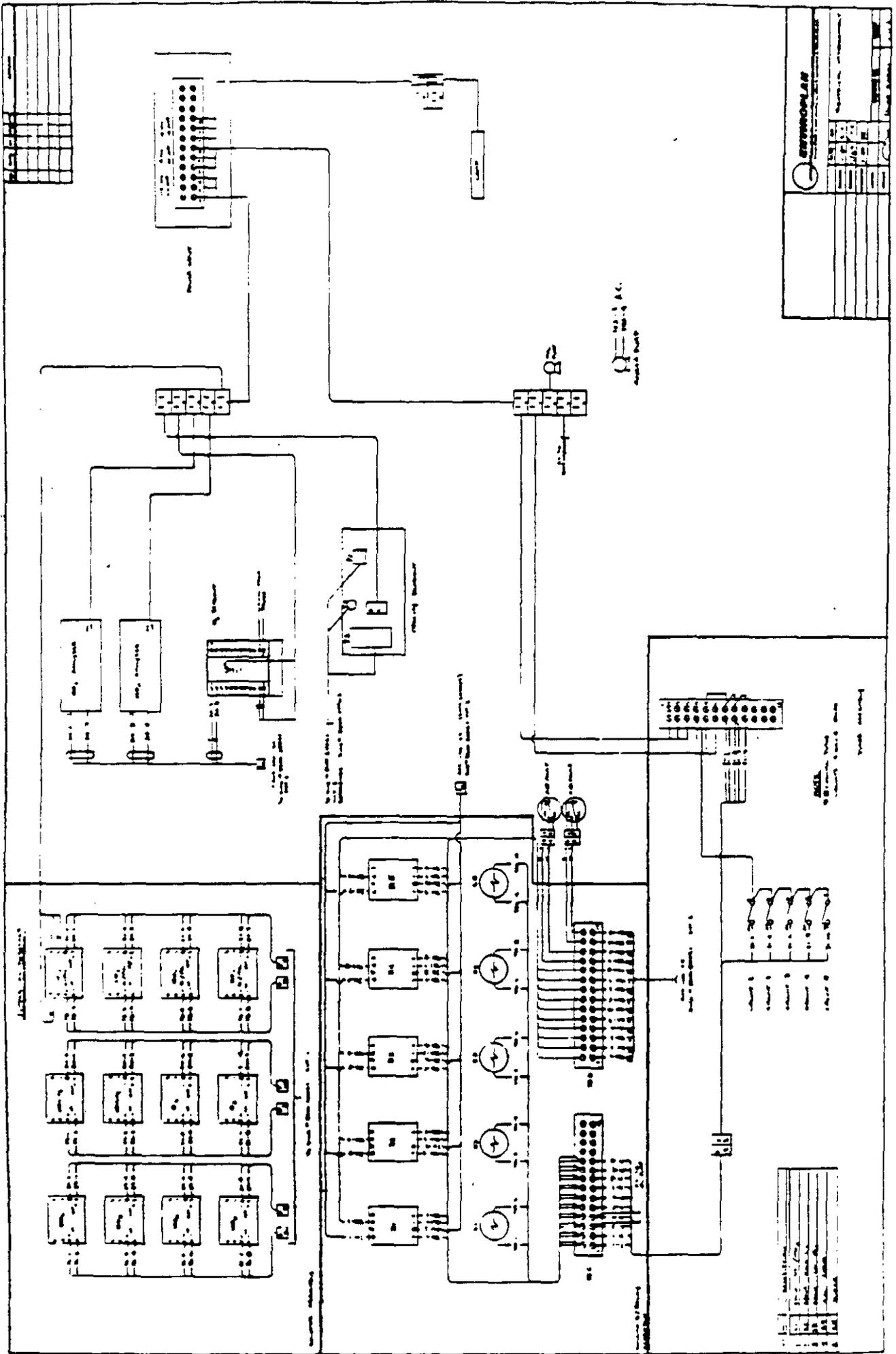
Relative accuracy: Less than 20% for applications at-5" H₂O or greater stack /duct pressure

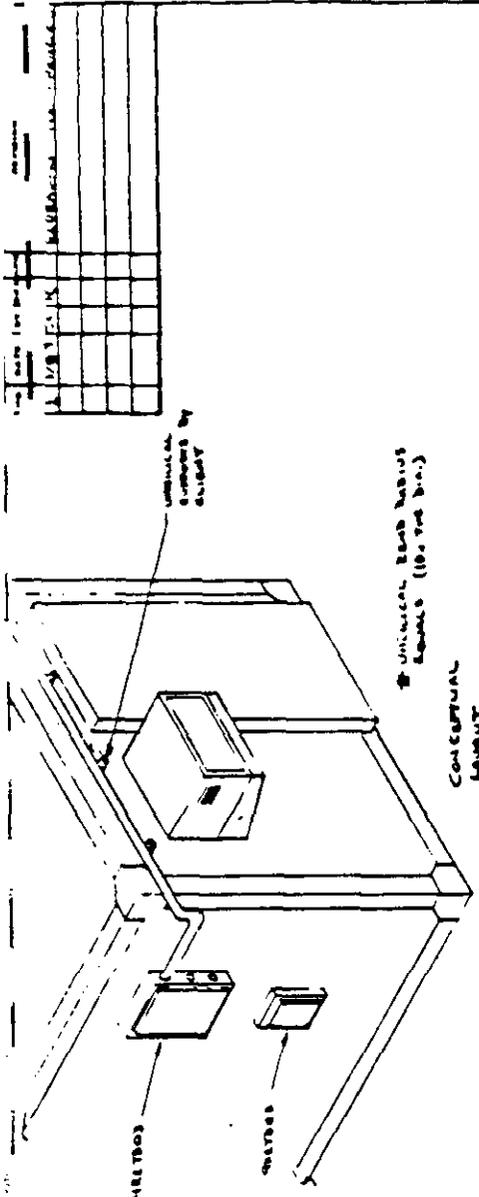
Cycle time: 10 to 30 minutes

*All cabinets/racks supplied by Enviroplan require dual access (front and rear).

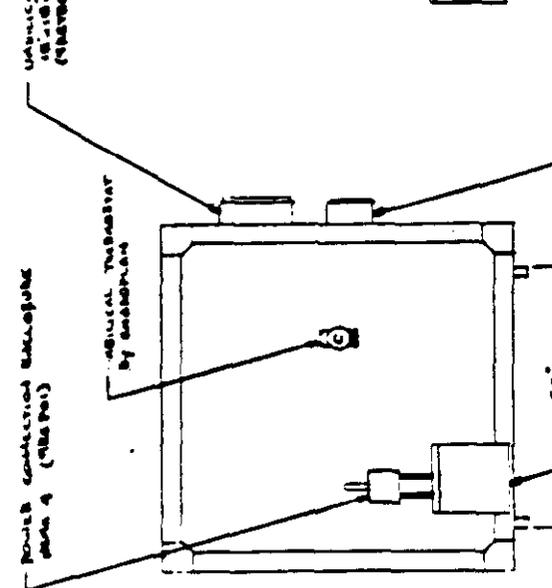
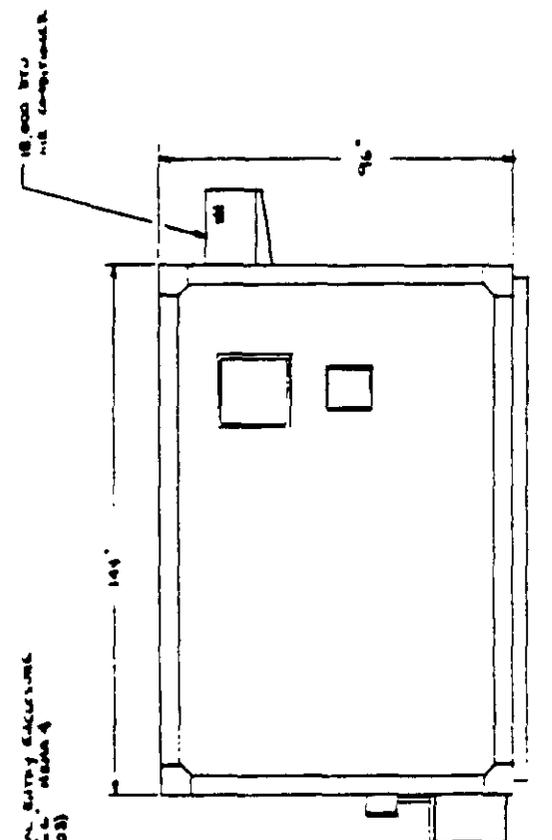
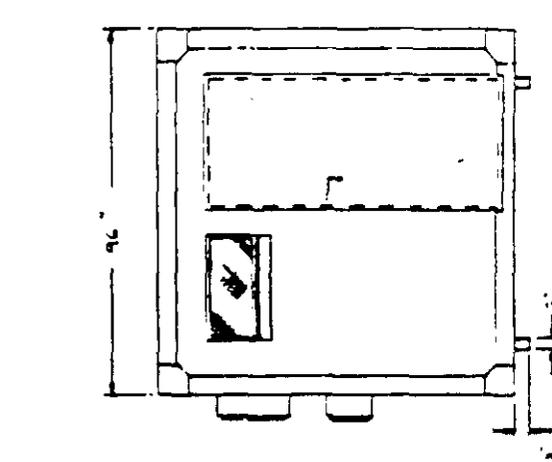
1.6 REPRESENTATIVE DRAWINGS

The following drawings are of a typical CEMEX System, and are not related to the specific project quoted. Project specific drawings will be provided if contract awarded.





NO.	DESCRIPTION	QTY	UNIT
1
2
3
4
5
6
7
8
9
10



UNITS, ENTRY STRUCTURE 18" x 18" x 4" (181803)

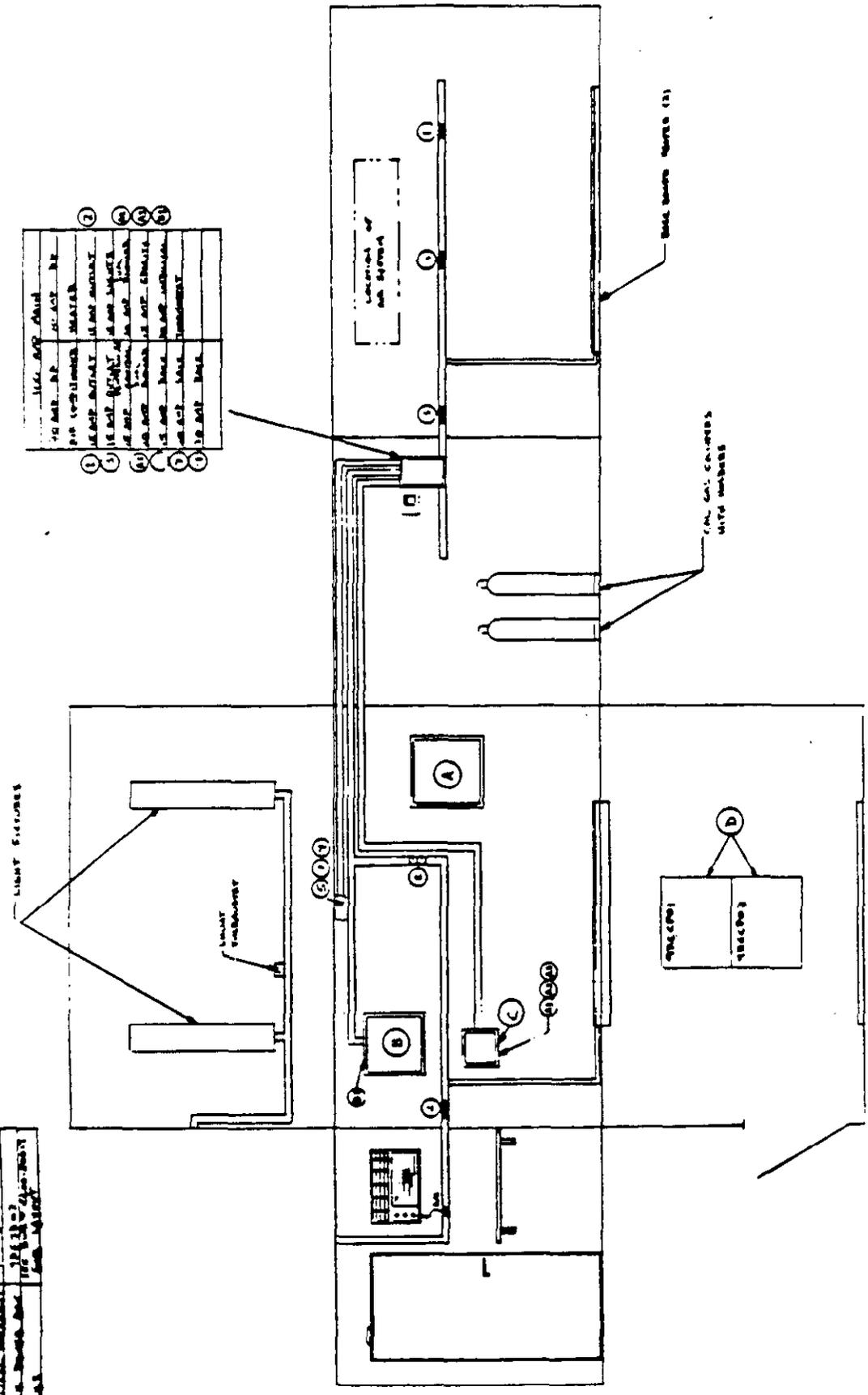
UNITS, ENTRY STRUCTURE 18" x 18" x 4" (181803)

ENVIROPLAN		UNITS, ENTRY STRUCTURE 18" x 18" x 4" (181803)	
NO.	DESCRIPTION	QTY	UNIT
1
2
3
4
5
6
7
8
9
10

NO	DATE	BY	REVISION
1	7/87	SL	INITIAL PLAN

NO	DESCRIPTION	INVESTIGATION
A	WATER METER	7/87/81
B	WATER METER	7/87/81
C	WATER METER	7/87/81
D	WATER METER	7/87/81

1	100 GAL. GAL. COVER
2	100 GAL. GAL. COVER
3	100 GAL. GAL. COVER
4	100 GAL. GAL. COVER
5	100 GAL. GAL. COVER
6	100 GAL. GAL. COVER
7	100 GAL. GAL. COVER
8	100 GAL. GAL. COVER
9	100 GAL. GAL. COVER
10	100 GAL. GAL. COVER



ENVIROPLAN	
DATE	7/87
BY	SL
PROJECT	INITIAL PLAN
NO.	1
SCALE	1" = 10'
DRAWN BY	SL
CHECKED BY	SL
DATE	7/87
PROJECT NO.	100
SCALE	1" = 10'

1.7 CLARIFICATIONS

Enviroplan has based this proposal upon its standard system and practices which fully meet the requirements of a reliable and certifiable continuous emission monitoring system.

Enviroplan will be more than happy to discuss our specific system and practices in further detail at your convenience.

Although Enviroplan considers this quotation applicable to its standard system and practices, we have attempted to outline a few differences, exceptions and/or clarifications within this section. (Please also refer to the submittals section of this proposal for more specific information).

a.) Enviroplan shall adhere to its standard drawing package. Details of these drawings have been developed in conjunction with various architect/engineering companies and customers. These drawings meet all normal requirements. Specifics of Enviroplan drawing package can be found within the submittals section of this proposal. Enviroplan would be happy to discuss variations to its standard package.

b.) If contract is awarded, Enviroplan reserves the right to have P.O./contract reviewed by its attorneys and/or contract administrator prior to acceptance by Enviroplan.

c.) Enviroplan will consider any exception or clarification stated within these exceptions and clarifications also applicable toward any other items within specifications to which exception was not specifically taken; yet, item was the same in nature.

2. PRODUCT DESCRIPTION - CEMEX

2.1 SPECIFIC SYSTEM DESCRIPTION - NONE

2.2 GENERAL CEMEX PRODUCT DESCRIPTION

The CEMEX System is not just one system. CEMEX is a family name for Enviroplan's Continuous Emission Gas Monitoring Extractive Systems, which are made up of various components and features. These components are made available in such a manner as to provide you, the user, the option of selecting the sampling system and monitor combinations most suitable for your unique applications.

Enviroplan is not a manufacturer of gas measuring equipment. Each instrument manufacturer utilized by Enviroplan has given its equipment unique features, sensitivities and ranges. After careful analysis of your application, and based on our in-depth knowledge derived from long-term use of these instruments, Enviroplan is able to select the equipment from manufacturers around the world which best suits your needs.

Through selection of the best sampling system and the most applicable monitoring instruments, (and with the addition of associated hardware engineered by Enviroplan), together with its assembly and testing expertise, Enviroplan can provide you the best, most cost effective solution to your monitoring problems.

2.2.1 Dilution Probe Sampling System

The Sampling System described here and in the attached literature has been found to best suit your application's unique needs.

The dilution probe sampling system has been in use in the U.S.A. for more than five years, and it has been widely accepted overseas for more than a decade in applications similar to yours.

The 12-inch probe tip (the only foreign component) is designed in such a manner as to effectively extract a sample at a pressure of approximately 17 feet of water at a rate which varies by application but lies within ranges of one to five cubic feet per day. Low sample volume means less maintenance of filters. High pressure extraction prevents probe plugging. The sample is mixed in the probe tip with clean, dry air at ratios varying from 10:1 to 500:1. This dilution ratio is selected to prevent any possibility of condensates in the sample line and to provide the ideal range of gas for the gas analysis equipment. The probe tip is manufactured of non-corrosive materials such as Hastelloy, Inconel and Pyrex.

The sample is delivered under pressure through sample lines (not heat traced) to the ambient level EPA approved instruments for measurement.

2.2.2 Pumpless Source Sample Extraction

Low volume, high pressure extraction is accomplished by means of clean, dry air. The air, delivered through the umbilical sample line, drives a highly efficient venturi which extracts the sample through a coarse screen, then a fine quartz filter, and finally through a sonic orifice metering device.

After mixing the sample with air in the dilution chamber, the pressured air carries the diluted sample under pressure to the analyzer. Because the sample is always under pressure, sample integrity is guaranteed.

2.2.3 True Dynamic Calibration

Calibration gas is delivered through the sample umbilical line to the probe tip. The entire extractive chamber is flooded with calibration gas which then checks the fine filters, sonic orifice, mixing chambers (and so on) back all the way to the analyzer.

Continuous functional checking is accomplished by means of a vacuum line in the umbilical line which checks the efficiency of the venturi chamber continuously.

2.2.4 Installation

The equipment is mounted through a standard 4-inch port and held in place by the 4-inch flange. These are mounted to the two inches outside diameter tube extension which supports the probe tip.

Because the sample line is not heat traced, service loops are provided for periodic maintenance. That is, the sample line need not be detached for removal of the probe tip. In fact, the system can be kept on and functional through the entire maintenance process.

2.2.5 Sequence/Controller

The Enviroplan-engineered and built-sequence controller is located at (or near) the analyzers at ground level for easy access.

Air supply and calibration gases are attached to the controller, and the sample gas is delivered to the analyzer from the sequencer.

The sequencer can be used to provide sample gas from up to six probes to a single set of analyzers.

2.2.6 Rack Mounting

The sequencer and analyzers are mounted in a standard rack. When rack mounting is used, a stable environment must be provided. i.e., 50°F to 95°F and 95 percent humidity maximum (a circulation fan is provided for heat dissipation).

2.2.7 Environmental Enclosure (OPTION)

The equipment, other than the probe and sample line, will be mounted in an insulated, heated/air-conditioned enclosure with a walk-in door.

The equipment is mounted in permanent racks which have been pre-wired and piped.

All that need be supplied is a support pad, 220 VAC 60 Hz power, and an air supply.

3. SERVICES

3.1 START-UP SUPERVISION *

Enviroplan will provide start-up supervision for the supplied CEM equipment. This service includes telephone consultation, as major equipment items are physically located and installed, sample and signal lines are installed and terminated, and plumbing/electrical services provided. An Enviroplan engineer(s) will arrive on site to inspect and check the physical installation, turn on systems, correct minor problems, and initially calibrate the systems.

Enviroplan expects that the following conditions will be met prior to arrival of Enviroplan engineers for start-up supervision:

1. Instrument air has been supplied to the instrument cabinet where required.
2. Calibration gases for project are mounted for use. Regulators are available.
3. Any periferal equipment that Enviroplan will install or make connections for are available for use.
4. All cable and umbilicals are installed.
5. Equipment should be positioned for start-up.
6. All flanges to be mounted on stack and duct locations.
7. Electrical power should be supplied to instrument cabinet or shelter and for CEMDAS system if supplied.
8. One technician to be available to assist engineer in start-up of system.
9. Radios available on site for start-up use.

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10. Phone line for data transmission at DAS System.
11. Adequate temperature control of instrument environment.

If any of the above requirements have not been met upon arrival of Enviroplan engineer, additional charges will be required caused by delay.

Upon the completion of installation supervision, Enviroplan will not be responsible for system maintenance operation. Warranty repair will become effective.

3.2 CLIENT RESPONSIBILITY FOR CEM CERTIFICATION

Client will be responsible for the following:

- a. Steady state boiler load conditions. Variations limited to $\pm 25\%$ of average load value.
- b. Greater than 50% boiler load conditions for all RA and CD test periods.
- c. Sufficient plant fuel and calibration gas supply to prevent interruptions during these periods.
- d. Minimum of three weeks' notice to schedule relative accuracy tests.
- e. Must decide whether reporting units for relative accuracy tests will be in ppm or lbs./MMbtu.
- f. Collection and analysis of fuel samples if necessary for relative accuracy test completion.
- g. Collection and provision of plant operating data during the time of relative accuracy and calibration drift tests.
- h. If relative accuracy is calculated in PPMbtu, client is responsible for supplying the appropriate fuel factors for use.

3.3 GUARANTEED SYSTEM CERTIFICATION *

Enviroplan, in conjunction with plant personnel, assigned to the equipment maintenance will carry out full certification of the systems provided. This will include all testing prescribed by Federal Register or appropriate Performance Test Specifications. An Enviroplan selected stack testing team will carry out appropriate relative accuracy testing. Plant personnel will be required to terminate calibration error drift, zero drift, and other long period automatic testing procedures and to provide the data to Enviroplan. Enviroplan will prepare the final certification report. Enviroplan guarantees that the system provided will pass certification testing and will make equipment corrections/adjustments and repeat testing if necessary to assure certification. A plant employee is to be assigned to record and evaluate zero/span data with Enviroplan Engineers by phone.

3.4 MAINTENANCE SERVICE CONTRACTS *

Enviroplan can provide various levels of maintenance support if necessary to help plant technical personnel smoothly operate the CEM system provided.

The contract proposed includes quarterly preventative maintenance and system calibration as well as providing for emergency maintenance. A fixed cost is provided that includes the expected number of emergency calls for the system. Additional emergency service will be available on a preferred customer basis at discounted rates. Enviroplan will provide for all normal expendable parts in conjunction with the service provided. The service for this system will originate from the Indianapolis, Indiana service center. The customer will be responsible for all spare/replacement parts (except for warranty coverage during year one) and calibration gases.

3.5 TRAINING PROGRAM *

Enviroplan can offer a tailored, custom training program to customer technical personnel. Training will normally be carried out on site after system installation, and will consist of classroom and hands-on training. The amount of and level of training can be adjusted to customer requirements.

*The costs associated with travel to the site are excluded from prices quoted. These costs will be billed at actual costs plus 10 percent handling.

4. LIMITED WARRANTY

Enviroplan, Inc. guarantees that all goods sold hereunder are free from harmful defects in material and workmanship, and conform to the specifications agreed upon in writing, signed by Purchaser and Enviroplan, or in the absence of such specifications, to Enviroplan's catalogue description of the goods.

This limited warranty is valid for a period of twelve (12) months from date of shipment or twelve (12) months from installation whichever comes first. Enviroplan agrees to rework or replace, at its option, goods found to contain harmful defects in material or workmanship, provided Enviroplan is notified of such defects within seven (7) days of discovery of such defects, or such other period as may mutually be agreed upon in writing; and provided further that such goods have been maintained and/or operated in accordance with Enviroplan's recommendations and/or standard industry practice. Such reworking or replacement will be performed, at Enviroplan's option, either at (a) Enviroplan's factory, provided that the purchaser shall pay all charges for and associated with the removal, transportation, and reinstallation of the goods, or (b) a location designated by the Purchaser. In the event Purchaser elects, pursuant to subparagraph (b) above, to have the goods repaired or replaced at a location other than Enviroplan's factory, then Purchaser agrees to pay Enviroplan an amount equal to all additional costs and expenses (such as travel, lodging, per diem, and excess labor costs arising from the performance of services at the location designated by Purchaser) incurred by Enviroplan in performing the repairs and/or replacements at the location designated by Purchaser. Correction of any nonconformity in the manner and for the period of time provided above shall constitute complete fulfillment of all liabilities of Enviroplan under the foregoing warranty.

ENVIROPLAN PARTIAL USERS LIST

	CEMEX	CEMDAS	CEMOP	CEMOX
1. BOC/GM Flint Operations, Michigan Stephen Kelly (313) 236-4085		1		
2. Wisconsin Pub. Serv. Co. Rothchild, WI Dan Schneider (715) 359-3351		1	2-281	
3. Cincinnati Gas & Electric Co. Eastbend Station, Ohio Denny McGrath (606) 586-5600		1		
4. City of Lakeland, Dept. of Electric and Water Utilities C.D. McIntosh Power Plant Farazie Shelton (813) 666-5575 ext. 3642		1		
5. Muscatine Power & Water Cliff Scherrer (319) 263-2631 x583			4-281	
6. Wheatland Foundry Chatanooga, TN Harvey Rice (615) 265-3181			3-216	
7. Alcoa Cleveland, Ohio Richard King (216) 641-4190			1-281	
8. Ensco El Dorado, Arkansas Jerry Misenheimer (501) 863-7173			3-281	
9. Platte River Power Rawhide Station Doug Carlson (303) 482-2000			2-216	

	CEMEX	CEMDAS	CEMOP	CEMOX
10. Diamond Crystal/Intl. Chimney Dave Stevenson (216) 745-0031			1-281 4-216	
11. International Chimney Corp./ Cogentrix Kittanning, PA Mike Krapf (412) 543-3043			7-281	
A. Cogentrix Carolina Leasing Corporation Roxboro, NC 27573				1-1pt. NO _x
B. Cogentrix Carolina Leasing Corporation Southport, NC 28461				2-2pt. NO _x
C. James River Cogeneration Corporation Hopewell, VA 23860				2-2pt. NO _x
D. Cogentrix Virginia Leasing Corporation Portsmouth, VA 23703				2-2pt. NO _x
12. Southern California Edison Biff Horvitan (818) 302-1522			7-281	
13. Babcock & Wilcox Ohio Edison Barberton, OH Robert Monteith (216) 860-6517				1-2 pt. H ₂ O, CO ₂ , CO

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	CEMEX	CEMDAS	CEMOP	CEMOX
4. ANR Pipeline Co. Detroit, MI Ed Mizgaiski (313) 496-5792	1-2 pt. SO ₂ NO _x CO ₂		2-281	
5. County Sanitation District Los Angeles, California Joe Smisco (213) 721-1278			1-281	
6. Skagitt County Resource Recovery Facility Seattle, WA Don King (206) 424-3551	1-2 pt. SO ₂ CO ₂	1	2-281	2-O ₂
7. Greenville Steam Co Greenville, ME Scott Hershey (207) 695-2125			1-281	
18. Niagara Mohawk Power Corp. Syracuse, NY Carl Griebno (315) 349-2232			2-281	
9. Denison University Granville, OH Larry Layton (614) 587-6264			1-281	
20. Packaging Corporation of America Rittman, OH Brian Taylor (216) 925-0222			3-281	
1. Central Maine Power Co. Yarmouth, ME Jamie Cough (207) 846-9055			4-281	

	CEMEX	CEMDAS	CEMOP	CEMOX
22. Hilton Davis Cincinnati, OH Randy Calhoun (513) 841-4000			1-281	
23. Nekoosa Packaging Tomahawk, WI Brian Hansen (715) 453-2131		1		
24. Dairyland Power Cooperative Lacrosse, WI Harold Frank (608) 788-4000	2-1 pt. SO ₂ , NO _x , CO ₂	2	2-281	
25. Bechtel-Semass Waste to Energy Cape Cod, MA Greg Wilson (508) 291-1813	2-2 pt. SO ₂ , NO _x , HCl	1	2-281	4-O ₂
26. Maxwell House Coffee General Foods Corp. Jacksonville, FL Michael George (904) 366-3228			1-281	
27. Hempstead Resource Recovery Facility Garden City, Long Island American Ref-Fuel Don Olson (713) 531-4233	3-1 pt. CO ₂ , SO ₂ 1-3 pt. CO, SO ₂ , CO ₂ , H ₂ O	1	3-281	
28. Essex County Resource Recovery Facility Newark, NJ American Ref-Fuel Don Olson (713) 531-4233	3-1 pt. CO, SO ₂ , NO _x , 1-3 pt. H ₂ O, SO ₂ , CO ₂	1	3-281	9-O ₂

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	CEMEX	CEMDAS	CEMOP	CEMOX
29. CRRA Southeast Resource Recovery Facility Preston, CT American Ref-Fuel Don Olson (713) 531-4233	1-2 pt. CO ₂ , VOC, SO NO _x	1	1-281	2-O ₂
	1-2 pt. SO ₂ , CO, CO ₂ , H ₂ O			
30. Medical College of Ohio Toledo, OH John Brenner (419) 381-3906			1-281	
31. Monarch Cement Humboldt, KS Jack Green (316) 473-2223			4-281	
32. Metropolitan Edison Portland and Titus Stations Gary Magno (215) 921-6725		1		
33. LFC Power Hillman Project Hillman, MI Greg Ritzlaff (503) 697-0263	1-1 pt. CO, NO _x			
34. Babcock & Wilcox Lauhoff Grain R. Anderson (216) 753-4511	1-1 pt. SO ₂ , NO ₂ , CO _x	1	1-281	1-O ₂
35. General Electric Schnectady, NY Cairo, Egypt Ellen Smith (518) 385-0828	3-1 pt. NO _x			3-O ₂

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CEMOX

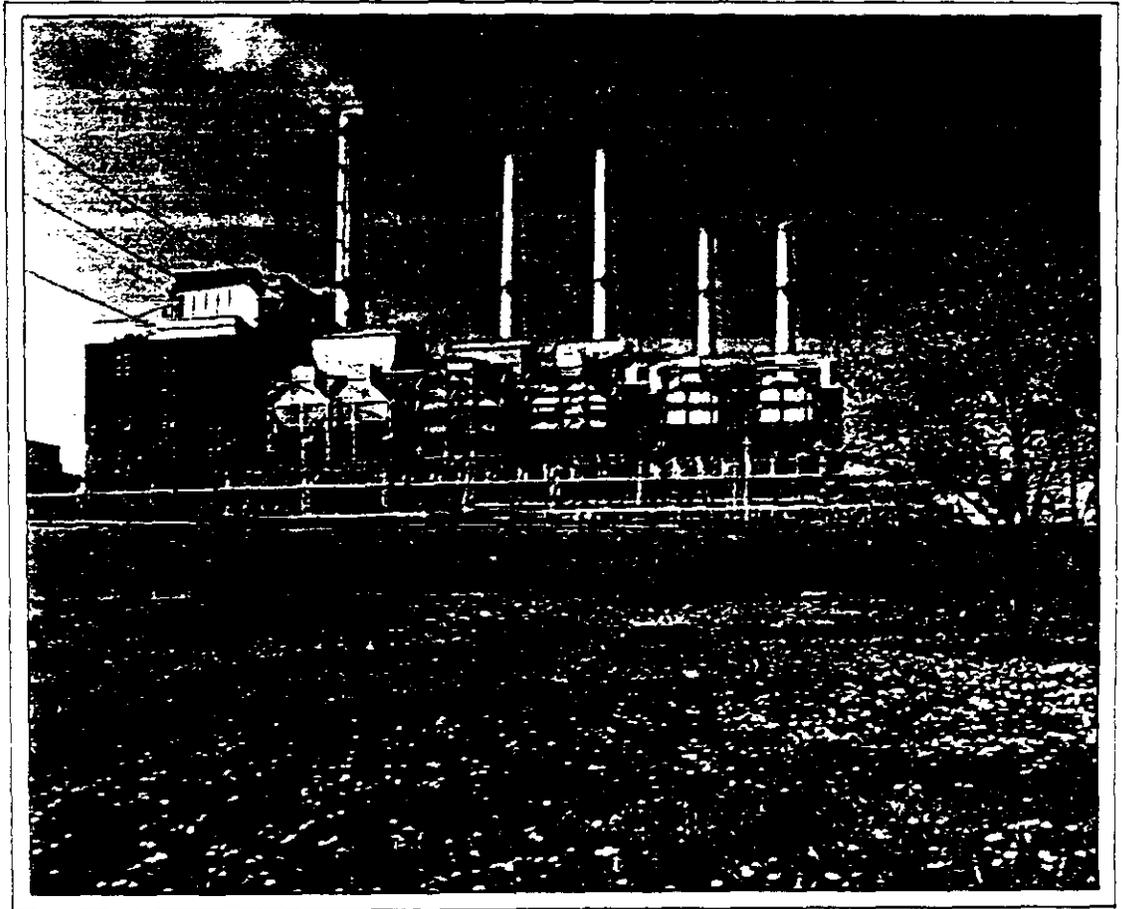
36. Exxon Company
Houston, TX
Ray Mansfield
(713) 656-7363

1-1 pt.
CO,
NO_x
CO₂

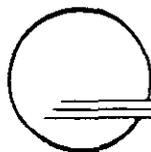
1-1 pt.
SO₂,
NO_x,
CO₂

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continuous
emission monitoring
extractive system



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ENVIROPLAN[®]

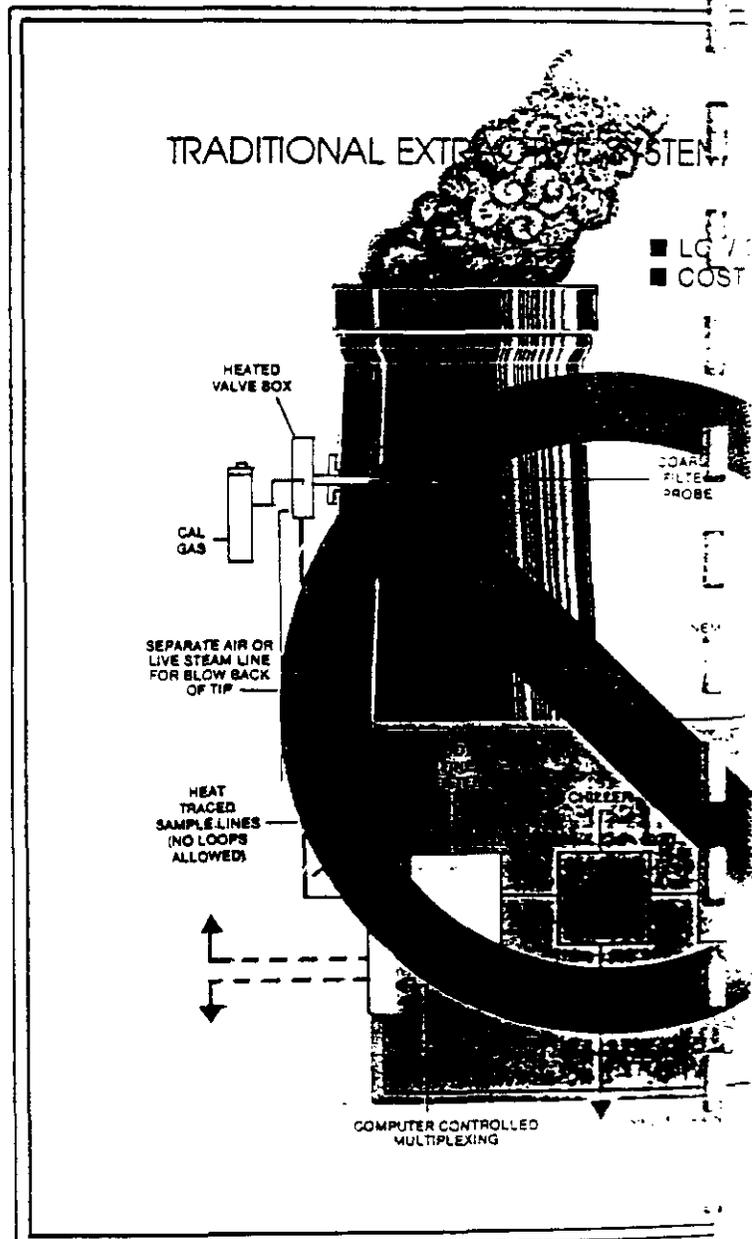
CEMEX[®] Continuous

A new solution to an old problem

Stack gas emissions are difficult to monitor continuously. The traditional extractive system must draw out over 200 cubic feet per day of dirty, wet, corrosive gas. This sample passes through heat traced sample lines to cleaners, dryers, and pumps to provide a clean dry sample. The sample is then sent to gas measuring instrumentation originally designed to measure parts per billion and modified to measure parts per million. These systems frequently have low data capture rates and high maintenance requirements.

Traditional in-situ gas monitoring instruments have much higher data capture rates. However, they are installed in hard-to-reach places — making maintenance difficult. Maintenance has become ever more costly, and the instruments work only in very narrowly defined and limited applications.

Based on more than a decade of experience as one of the nation's leading suppliers of air pollution measurement systems and services, Enviroplan's CEMEX is a stack gas monitoring system which provides maximum data capture with minimum maintenance.



CEMEX FEATURES

Instack Automatic Inline Calibration

Calibration zero and span gas is introduced directly into the probe tip, doing away with cumbersome stack mounted valve enclosures and providing a truly complete system check.

Simple Sample Lines

No heat trace is ever necessary.

EPA Approved Instruments

CEMEX uses only U.S. EPA Equivalent Method instruments for SO₂, CO, and NO_x.

Non-criteria Pollutant Monitoring Capability

TRS, H₂S, and many other non-criteria air pollutants can be measured with CEMEX.

Multiplexing

One system can be multiplexed to monitor any number of sample points.

Field Expandable

CEMEX is field expandable. In most cases mounting the additional equipment in the existing rack, and installing wiring and plumbing, can be done in less than one day.

Pre-Built and Tested

CEMEX is a complete system, delivered ready to operate at your site. You are welcome to see and test your own system during the assembly process.

Reliability and Maintainability

CEMEX uses only equipment and instruments which have proven their reliability over many years of actual field use. We have found simple systems preferable to more complex micro-electrical equipment for ease of maintenance.

Parts Availability

Enviroplan maintains an extensive parts inventory for CEMEX.

CEMDAS

CEMEX can be used with Enviroplan's Continuous Emission Monitoring Data Acquisition System (CEMDAS) to automatically prepare reports in EPA approved formats.

Dilution Is The Solution

The problem with extractive monitors has always been all that *dirty, wet, corrosive* gas.

The problem is: how do you make clean, dry non-corrosive gas out of stack gas?

Dilution Is The Solution: The sample gas in the probe tip is diluted 50 to 200 times with clean dry gas.

The result is: clean, dry gas which does not require heat traced sample lines, pumps, filters, or dryers.

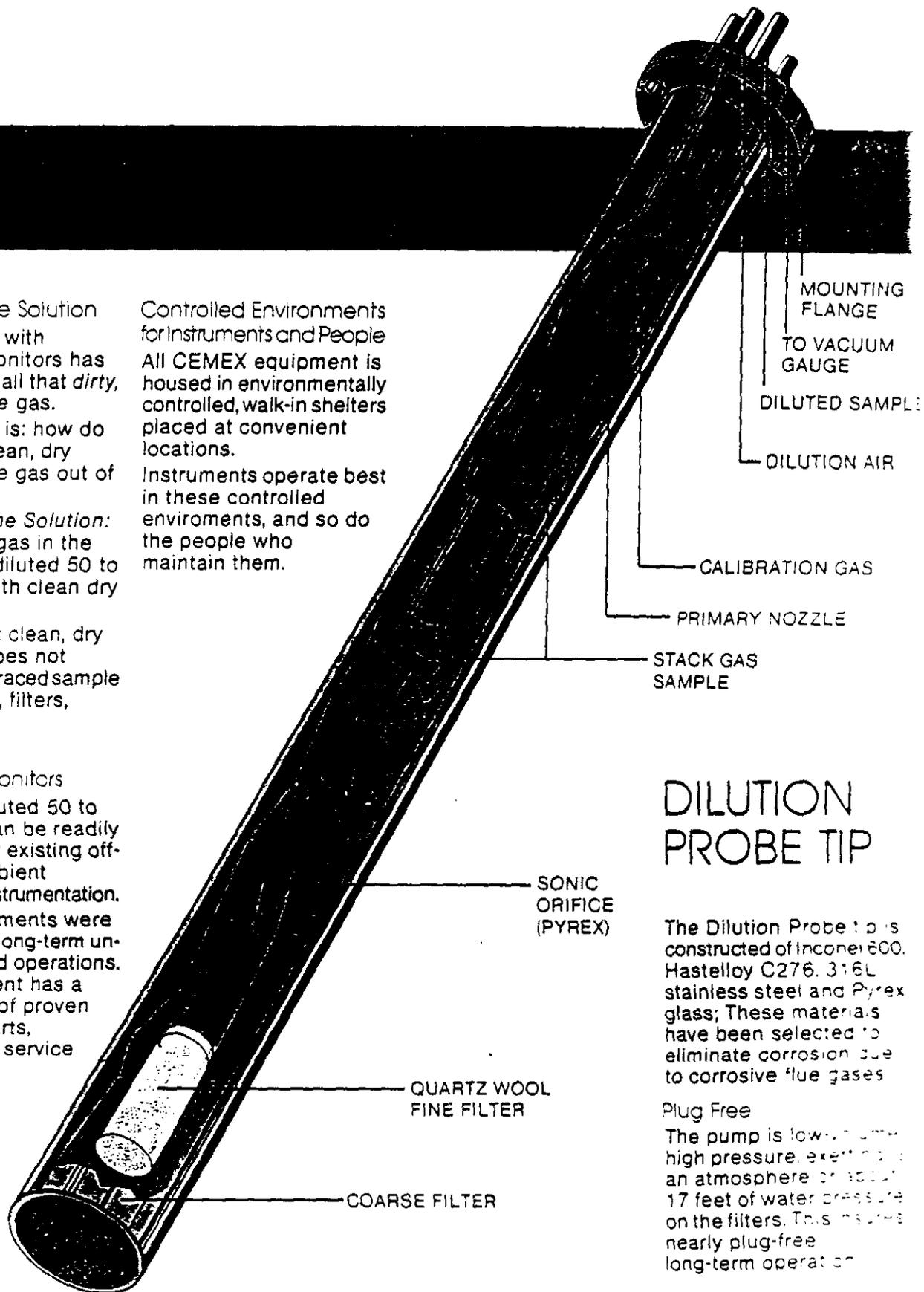
Reliable EPA Approved Monitors

A sample diluted 50 to 200 times can be readily measured by existing off-the-shelf ambient monitoring instrumentation. These instruments were designed for long-term unattended field operations. The equipment has a long history of proven reliability. Parts, training, and service are readily available.

Controlled Environments for Instruments and People

All CEMEX equipment is housed in environmentally controlled, walk-in shelters placed at convenient locations.

Instruments operate best in these controlled environments, and so do the people who maintain them.



MOUNTING FLANGE

TO VACUUM GAUGE

DILUTED SAMPLE

DILUTION AIR

CALIBRATION GAS

PRIMARY NOZZLE

STACK GAS SAMPLE

SONIC ORIFICE (PYREX)

QUARTZ WOOL FINE FILTER

COARSE FILTER

DILUTION PROBE TIP

The Dilution Probe tip is constructed of Inconel 600, Hastelloy C276, 316L stainless steel and Pyrex glass; These materials have been selected to eliminate corrosion due to corrosive flue gases

Plug Free

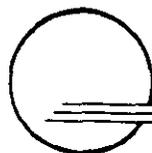
The pump is low volume, high pressure, exerting an atmosphere of about 17 feet of water pressure on the filters. This insures nearly plug-free long-term operation

SPECIFICATIONS

Parameter	Specifications	Parameter	Specifications
Flue Gas Temperature	Up to 750° F (optional to 1100° F)	Relative Accuracy*	Less than 20%
Probe Length	Standard - 2 to 10 feet Optional - greater than 10 feet	Weight and Size	
Utilities at Analyzer Shelter		- Probe Assembly	30 pounds total (dependent on length)
- Electrical	208-230 VAC, 0, 60 Hz, 15A	- Probe body	2-inch diameter x length required
- Instrument Air	2 SCFM/probe dry instrument air	- Analyzer Shelter	1400 to 1600 pounds (depending on analyzers included)
Utilities at Probe	None	- Sample Line	1-inch diameter 350 feet maximum length
Data Interface		Probe Materials	Hastelloy C276, Inconel 600, Pyrex glass, 316L stainless steel.
- Analog Output	4-20 mA or 0-10 Vdc for each gas measured		
- Discrete Signals	Normal/service status, zero cal indicator, span cal indicator.		
Calibration Error*	Less than 5% of reading		
Response Time	Less than 5 minutes		
Drifts* 2 and 24 hours for zero and span	Less than 2% of full scale		

*Expressed as the sum of the absolute mean value plus 95% confidence interval of a series of tests (see CFR Title 40, Part 60, Appendix B)

For more information about CEMEX, and Enviroplan's other environmental systems and services, contact:



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CEMEX FEATURES

Instack Automatic Inline Calibration

Calibration zero and span gas is introduced directly into the probe tip, doing away with cumbersome stack mounted valve enclosures and providing a truly complete system check.

Simple Sample Lines

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Non-criteria Pollutant Monitoring Capability

TRS, H₂S, and many other non-criteria air pollutants can be measured with CEMEX.

Multiplexing

One system can be multiplexed to monitor any number of sample points.

Field Expandable

CEMEX is field expandable. In most cases mounting the additional equipment in the existing rack, and installing wiring and plumbing, can be done in less than one day.

Pre-Built and Tested

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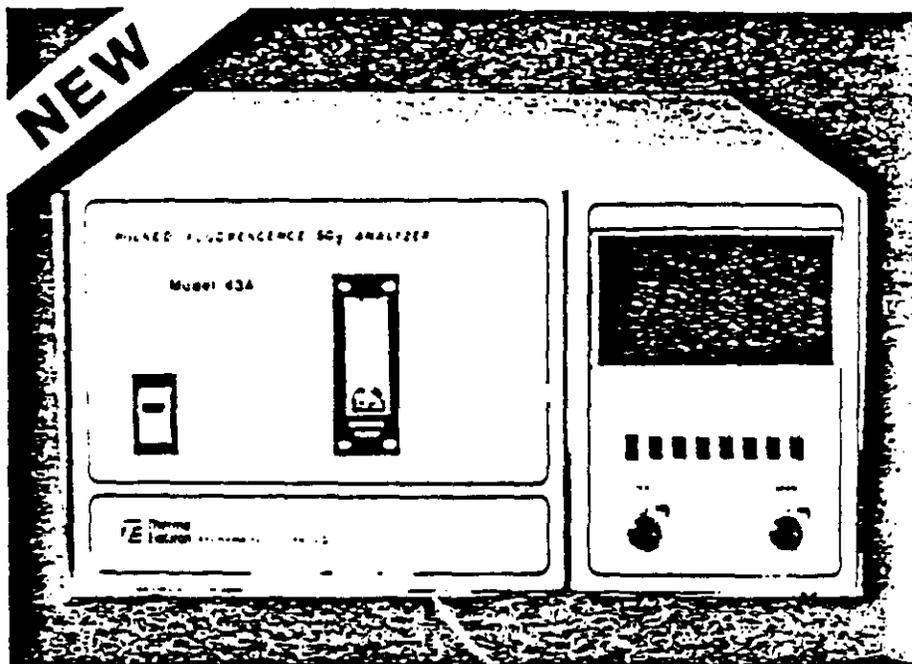
CEMDAS

CEMEX can be used with Enviroplan's Continuous Emission Monitoring Data Acquisition System (CEMDAS) to automatically prepare reports in EPA approved formats.

PULSED FLUORESCENCE SO₂ Analyzer

Model 43A For Continuous Ambient Air Monitoring

Thermo Electron's Model 43A Pulsed Fluorescence SO₂ Analyzer provides unequalled ease of operation, reliability, precision and specificity. This unique, patented, field-proven Pulsed Fluorescence method offers significant advantages for measuring ambient SO₂ by eliminating the need for expensive and time-consuming maintenance and replacement of consumables.



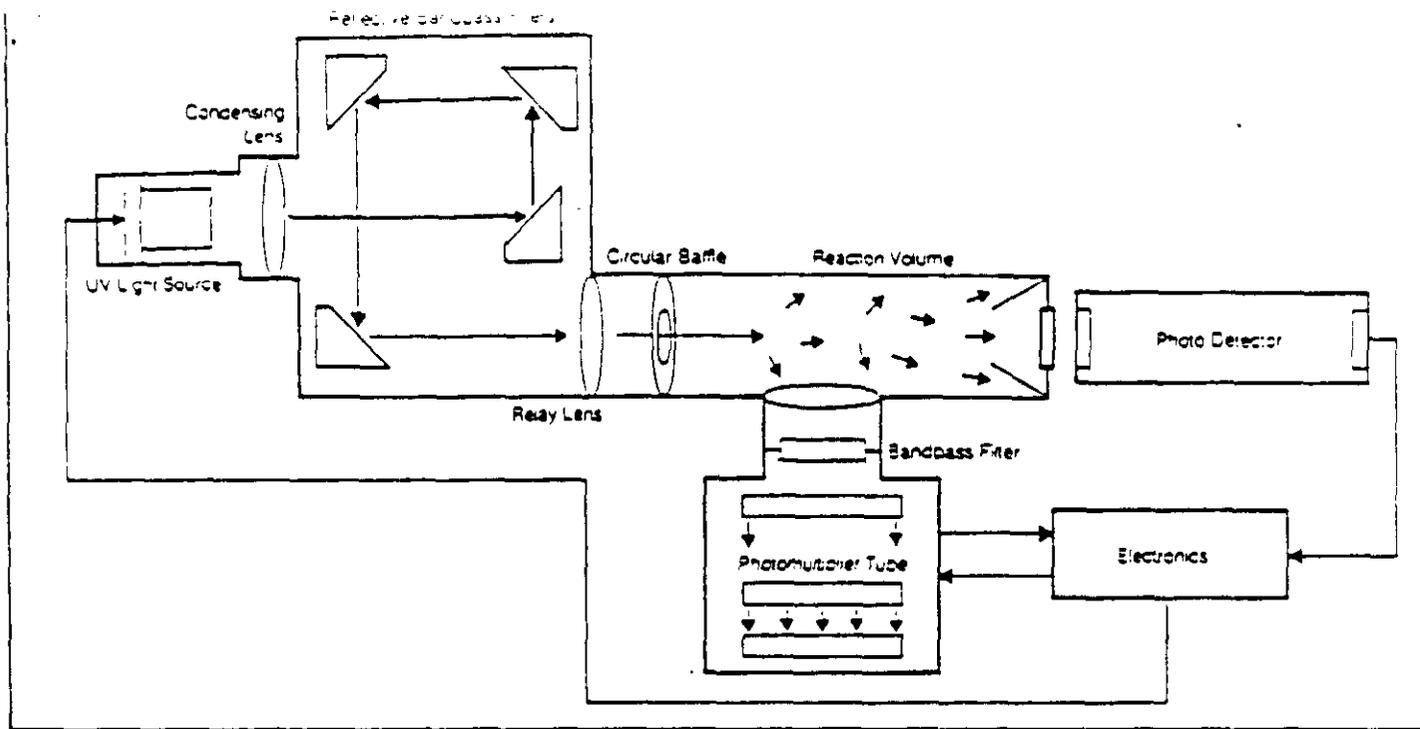
Key Features

- EPA approved (EQSA-0486-060)*
- High sensitivity, low noise
- No consumable gases or wet chemicals required
- Longterm zero and span stability
- Field proven reliability
- Insensitive to change in flow and temperature
- Specific to SO₂
- Linear response through all ranges
- Totally self-contained
- Longterm unattended operation
- Maintenance free
- Digital display
- Reflective U.V. filtering (patent applied for)
- U.V. excitation stabilized by closed loop control
- Hermetically sealed U.V. lamp

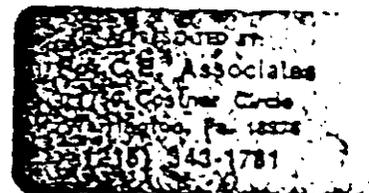
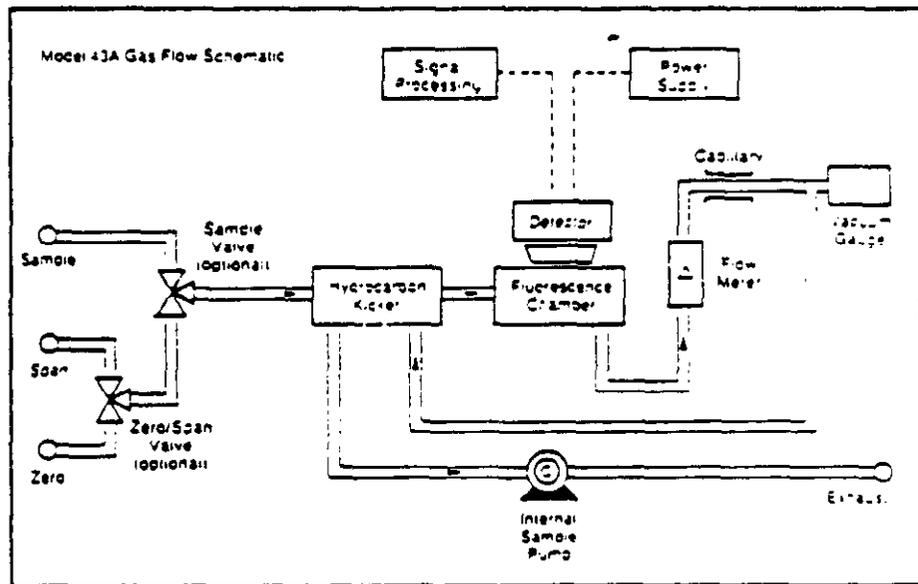
*See Federal Register, Thursday April 10, 1986, Volume 51, No. 69, for definitions and federal specifications.

Model 43A Specifications*

Ranges	0-100* ppb, 200* ppb, 500* ppb, 1000* ppb, and 2000 ppb
Linearity	1% of Range
Noise (At Zero)	0.5 ppb (Fast Time Response) 0.3 ppb (Slow Time Response)
Response Time (0-95%)	2 minutes (Fast Time Response) 4 minutes (Slow Time Response)
Lower Detectable Limit	1 ppb (Fast Time Response) 0.6 ppb (Slow Time Response)
Precision	1% of Reading or 1 ppb
Zero Drift	Less than 1 ppb per day
Span Drift	± 0.5%/week
Interferences per EPA Levels	Less than LDL except for the following
NO	Less than 3 ppb
M-Xylene	Less than 2 ppb
H ₂ O	Less than 2% of reading (as quenching)
Temperature Dependence	
Zero	± 0.05%/°C
Span	± 0.1%/°C
Power	100 Watts
Voltage	115/220 Volts 50/60 Hz
Size and Weight	17"W x 8-3/4"H x 23"D 43 lbs.
Output	Dual: Selectable Voltage or Current (optional)
Flow	0.5 L/M (standard) 1 L/M (optional)



As illustrated in the above diagram, pulsed ultraviolet light passes through a reflection mode optical filter system to a measurement chamber where it excites SO_2 molecules. As these molecules return to the ground state they emit a characteristic fluorescence with intensity linearly proportional to the concentration of SO_2 molecules in the sample. The fluoresced light then passes through a second filter to illuminate the sensitive surface of a photomultiplier tube. Electronic amplification of the output of the photomultiplier tube provides a meter reading and an electronic analog signal for recorder output. A second U.V. detector senses lamp intensity and maintains a constant U.V. excitation level by a closed loop feedback control of the lamp power supply. This assures long-term span stability. The reflective filter optics result in a very low and unvarying level of scattered light. This assures long-term zero stability.



TE Thermo Electron
Instruments

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Chemiluminescence NO-NO₂-NO_x Analyzer

Model 42 For Continuous Ambient Air Monitoring

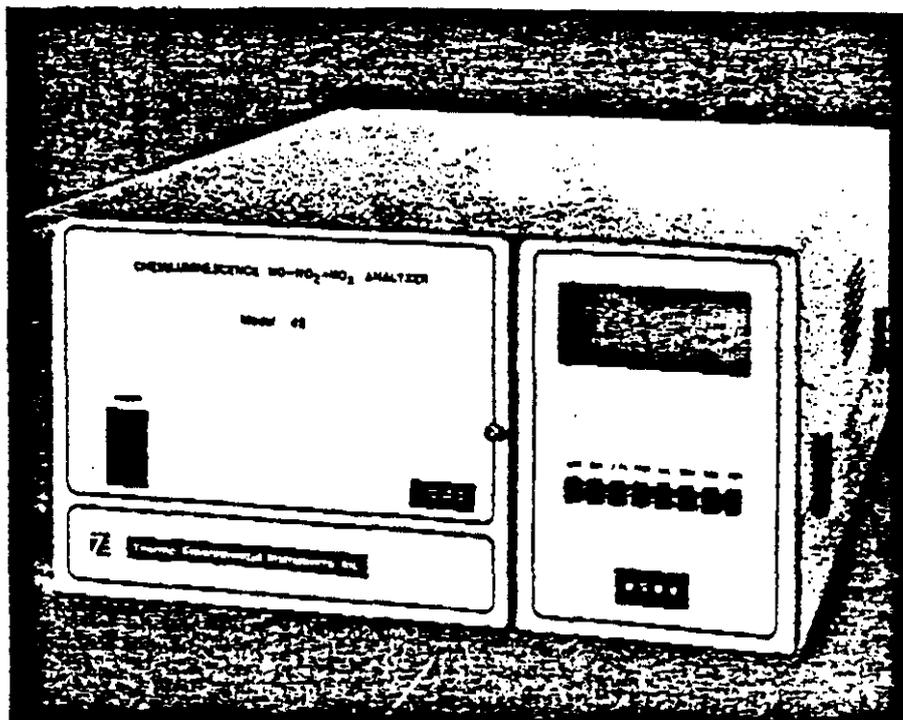
Thermo Environmental Instrument's Model 42 Chemiluminescence NO-NO₂-NO_x Analyzer is a second generation analytical instrument capable of measuring oxides of nitrogen at levels from sub parts per billion to 20 parts per million. The Model 42 utilizes one small diameter (28mm) photomultiplier tube and one reaction chamber which are time-multiplexed for NO and NO₂ measurements. The difference between the two measurements allows the generation of three continuous signals of NO, NO₂ (NO₂-NO), and NO_x.

Compared to other types of chemiluminescence analyzers, the Model 42 offers the following significant advantages:

Key Features

- EPA APPROVED (RFNA-1289-074)
- Microprocessor controlled
- Increased sensitivity
- Faster response time
- Linear on all ranges
- Thermally stabilized flow system and reaction chamber
- Long life/easily replaceable NO₂ converter cartridge
- User friendly diagnostics
- Measurement ranges for NO, NO₂, NO_x independently selectable
- Time Setting selectable from 10 to 300 sec.
- Internally mounted pump
- Integral sample filter

The microcomputer circuitry upon which the Model 42 is based, eliminates many disadvantages inherent in analog systems and provides for increased stability, accuracy, and flexibility. Digital computations are insensitive to drift with time or temperature, therefore sources of instrument drift or error due to the electronics are minimized.

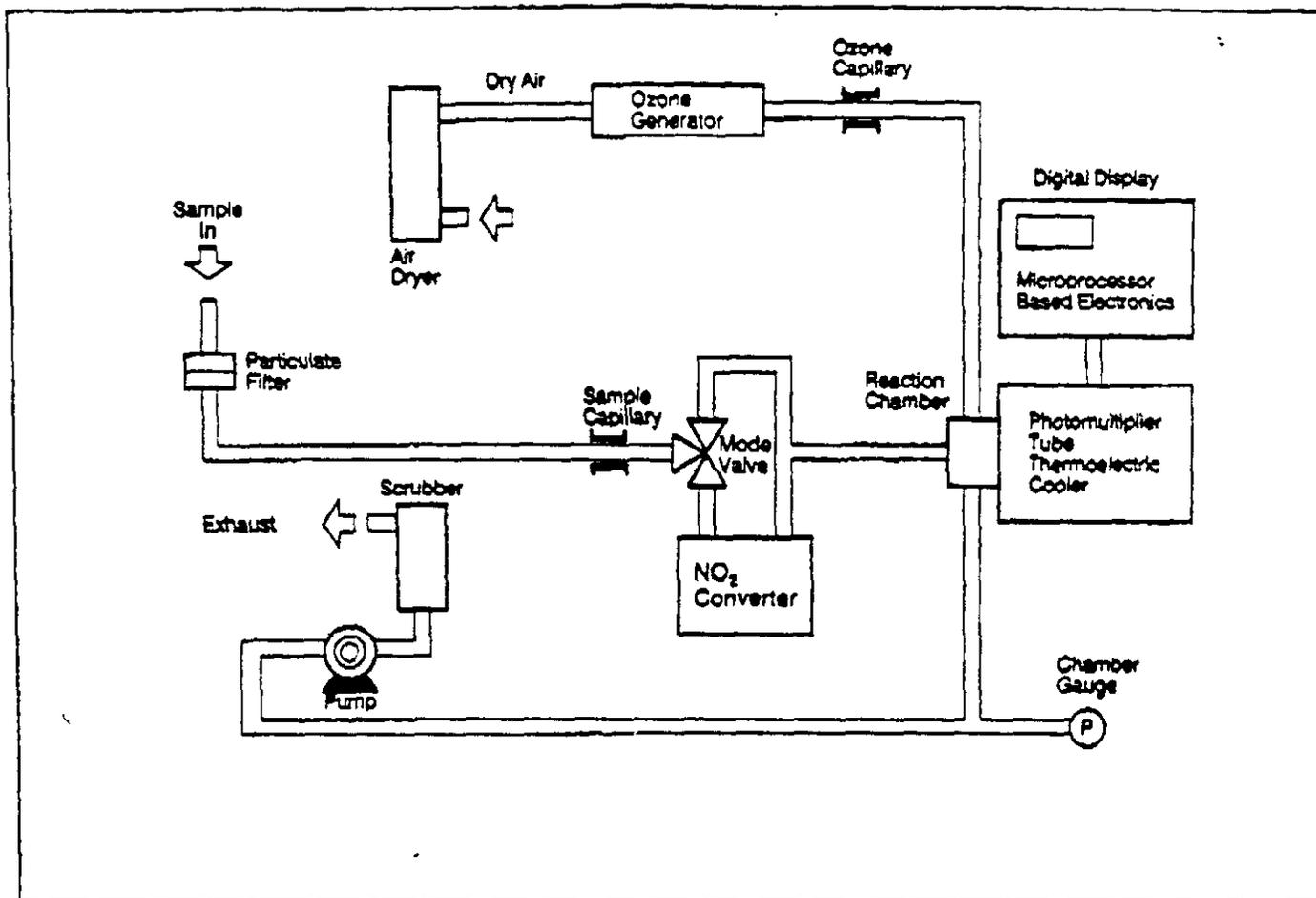


Model 42 Specifications

Ranges:	0-50* ppb, 100* ppb, 200* ppb, 500* ppb, 1* ppm, 2 ppm, 5 ppm, 10 ppm, 20 ppm (Independently selectable for NO, NO ₂ , NO _x)
Zero Noise:	0.25 ppb RMS 60 sec time constant
Lower Detectable Limit:	0.5 ppb 60 sec time constant
Zero Drift (24 Hours):	0.5 ppb
Span Drift (24 Hours):	± 1% of F/S
Response Time:	* 10 sec average 40 sec * 60 sec average 80 sec * 300 sec average 300 sec
Precision:	± 0.5 ppb
Linearity:	± 1%
Flow Rate:	0.7 L pm
Operating Temperature:	15° - 35°C EPA APPROVED* 5° - 40°C Safe Operating Temperature
Power Requirements:	300 watt 115/220V 50/60Hz
Physical Dimensions:	17" wide x 8 3/4" high x 23" deep
Weight:	53 pounds
Output (3): NO-NO ₂ -NO _x	Selectable 0-10mv, 100mv, 1v, 5v, 10v digital display 4-20MA isolated (optional)

* Denotes EPA APPROVED Parameters

Model 42 Flow Scheme



As illustrated in the above diagram, sample gas enters the Model 42, flows through the sample capillary and then either flows through the mode valve ("NO" or "NO₂") and the NO₂ to NO Converter to the reaction chamber. There the NO reacts with ozone to produce a characteristic chemiluminescence. Reacted gas is drawn from the reaction chamber through the internal pump. The pump exhaust is fed through a charcoal trap where any residual ozone is removed and vented.

The Model 42 is of a single chamber, single photomultiplier tube design and automatically cycles between the NO and NO₂ modes. Signals from the photomultiplier tube are conditioned and then fed to the microprocessor where a sophisticated mathematical algorithm is utilized to calculate three independent outputs: NO, NO₂, and NO_x. With this algorithm more accurate NO/NO₂ measurements are possible in varying NO/NO₂ samples.

Options

- 42-002 Rack Mounts
- 42-003 Internal Zero/Span and Sample Valves with Remote Activation
- 42-004 Sample/Ozone Flowmeters
- 42-005 4-20 mA Current Output
- 42-006 Pressure Transducer
- 42-007 Ozone Particulate Filter
- 42-008 RS232 Interface
- 42-009 Permeation Dryer

TE Thermo Environmental
Instruments Inc.

8 West Forge Parkway
Franklin, MA 02038

(508) 520-0430
Telex: 200205 THERMO UR

FAX: (508) 520-1460

ENVIRONMENTAL MEASUREMENT RESEARCH CORPORATION'S GAS FLOW MONITORING SYSTEM

The EMRC Gas Flow Monitoring System is both a portable and permanent instrument for measuring gas flows of 2 to 100 fps.

The gas flow system includes an insitu sensor, signal conditioning module, pneumatic transducer, zero pot, analog and digital display, recorder output, and built in span calibration module. The components are contained within an independent weather resistant housing or incorporated into existing cabinetry for industry.

The advantages of the EMRC gas flow monitor are obvious for industry requiring simplicity of operation and regulatory compatibility.

- 1 The insitu sensor is a stack or duct mounted heavy duty S-type pitot. This pitot is manufactured of any desired material to withstand corrosion, high temperatures, and other hostile conditions. Plugging is avoided via backpurging, if necessary.

Advantages: Sensor replacement cost is minimal.

Methodology is EPA method #2.

Only the sensory unit is mounted on the stack or duct, therefore maintenance is minimized at the stack.

- 2 All instrumental equipment is located at convenient locations.

Advantages: Maintenance is minimized, and is conducted under more ideal conditions.

The gas flow monitor can be located with other gas monitoring equipment.

Operation and daily calibration is thus simplified.

- 3 The EMRC gas flow monitor can be calibrated directly by built in EPA methodology (method #2).

Advantages: The signal output is easily verified against standard EPA #2 methods via an electric or standard micromanometer.

There is no need to remove the monitor to a wind tunnel for calibration.

The built in calibration capability meets EPA quality assurance standards. This is especially important if the gas flow monitor is interfaced with a gas concentration monitor.

- 4 The sample conditioning module allows for the determination of gas flow at less than 5 fps.

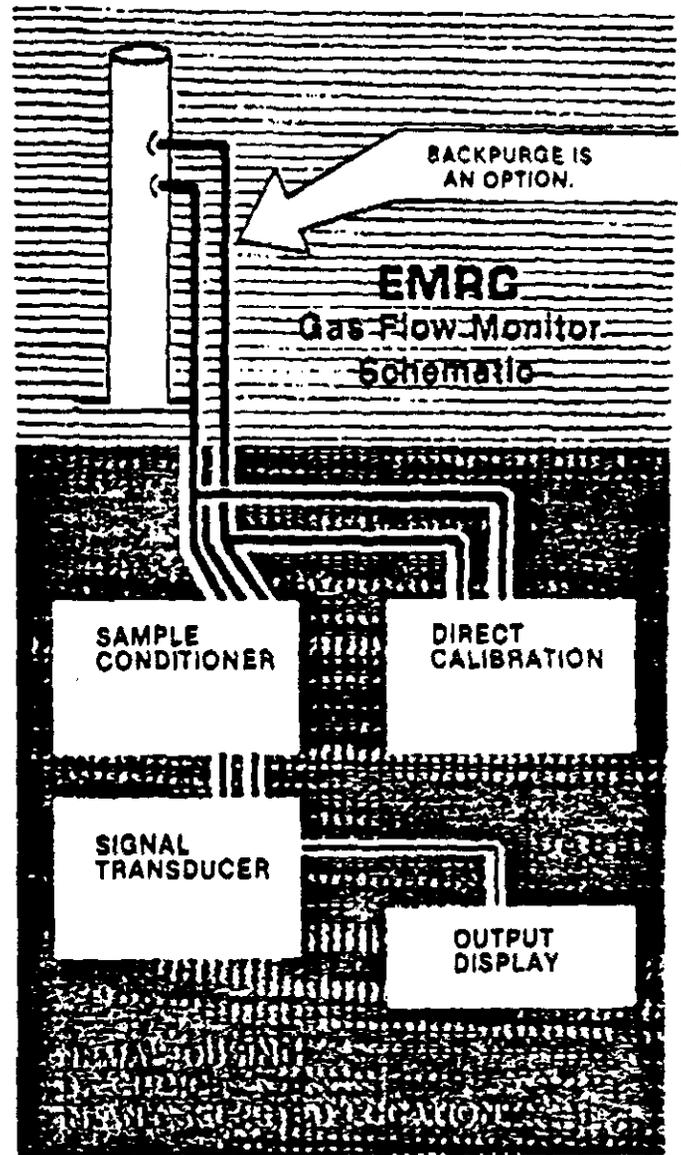
Advantages: Sources with a high level of static variation can be monitored with a minimum of interference.

High corrosion source can be monitored without endangering the expensive instrument package.

- 5 The gas flow system's output is linear with dynamic pressure. (with interface)

Advantages: The EMRC system can be interfaced with other monitors with a minimum of electronics.

A variety of outputs can be selected.



**ENVIRONMENTAL
MEASUREMENT
RESEARCH CORP.**

1744 MULLOWNEY LN.
BILLINGS, MT 59101
(406) 252-1450

PHYSICAL SPECIFICATIONS

Size: Dependent on specific requirements ranging from 2'H x 1'D x 1' W to any required dimension(s).

Weight: Portable @ ~ 20 lbs.
Stationary @ ~ 100 lbs.

Power: 115v, 60hz

Operating Temperature: 0°-140 °F

*Some units have internal heaters.

Recorder outputs: 0-5v standard, all others upon request.

PERFORMANCE SPECIFICATIONS

Sensitivity: ~ 2 fps

Response Time: ~ 1-2 seconds to 100% of final reading

Linearity: ~ ± 2% of full scale

Repeatability: < 1%

Zero Drift: ~ 2% of full scale

Span Drift: ~ 2% of full scale

Accuracy: ~ 2% of full scale

HOW TO ORDER AN EMRC GAS FLOW MONITOR

Portable Stationary

Gas Flow Conditions Anticipated: _____ fpm

Gas Temperatures Anticipated: _____ °F

Gas Density Anticipated: _____ lb/moles

Static Pressure Anticipated: _____ "Hg (ab)

Particulates

Type of Process: _____

Particulate Loading: _____ gr/acf

Duct or Stack Diameter: _____ ft.

Desired Location of Instrument Package

Distance from Stack or Duct: _____

Inside or Outside Location: _____

Heated or Unheated Location: _____

EMRC personnel are available to supply a stationary or portable unit and electronic interfacing system so that mass flow requirements can be met on a consistent and verifiable basis.

THE EMRC GAS FLOW MONITOR IS THE MOST RELIABLE SYSTEM AVAILABLE.



ENVIRONMENTAL MEASUREMENT RESEARCH CORP.

1744 MULLOWNEY LN.
BILLINGS, MT 59101

APPENDIX D

Enviroplan Certification Tests (Field Certifications and
Factory System Test Documentation)



**MOSTARDI-PLATT
ASSOCIATES, INC.**

Environmental
Consultants

1077 Entry Drive
Bensenville, IL 60106
(708) 860-5900

CONTINUOUS EMISSION MONITOR
RELATIVE ACCURACY AUDIT
PERFORMED FOR
ENVIROPLAN
AT THE
DRAGON PRODUCTS COMPANY
SCRUBBER INLET AND OUTLET
THOMASTON, MAINE
DECEMBER 19 AND 20, 1991

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Mostardi-Platt Associates, Inc.
1077 Entry Drive, Bensenville, IL 60106
(708) 860-5900

PROJECT NO.: 13811
DATE SUBMITTED: MARCH 3, 1992



TABLE OF CONTENTS

	Page
Certification Sheet	i
Introduction	1
Results Summary	1
Discussion of Results	2
Process Description	2
Test Procedures	3
Quality Assurance Procedures	5
Acknowledgments	6
Accuracy Determination Results	7
 APPENDIX	
Test Section Diagram	18
Sampling Train Diagrams	19
Calculation and Formulae	22
Reference Method Test Data	23
CEMS Data	41
Plant Operating Data	68
Calibration Data Summary	84
Calibration Gas Certification Sheets	163
SO ₂ Analyzer Interference Test	170
NO _x Analyzer Interference Test	184
NO _x to NO Conversion Efficiency Test	194
Field Data Sheets	197



MOSTARDI-PLATT
ASSOCIATES, INC.

CERTIFICATION SHEET

Having supervised and worked on this test program described in this report, and having written this report, I hereby certify the data, information and results in this report to be accurate and true according to the methods and procedures used.

MOSTARDI-PLATT ASSOCIATES, INC.

Thomas D. Mostardi

Thomas D. Mostardi, PE
Project Supervisor

CONTINUOUS EMISSION MONITOR
RELATIVE ACCURACY AUDIT

Performed For
ENVIROPLAN

At The
Dragon Products Company
Scrubber Inlet and Outlet
Thomaston, Maine
December 19 and 20, 1991

INTRODUCTION

MOSTARDI-PLATT ASSOCIATES, INC. (MPA) was retained by Enviroplan to evaluate the relative accuracy of the continuous emission monitor system (CEMS) for sulfur dioxide and nitrogen oxide emission rate outputs expressed in ppm and lbs/hr located on the Recovery Scrubber inlet and outlet stack of the Dragon Products Company in Thomaston, Maine on December 19 and 20, 1991.

This relative accuracy audit was performed by Messrs. T. Mostardi, M. Peterson, T. Kalisz and G. Trzupsek of MPA. Mr. Steve Wallace of Dragon Products Company and Mr. Gary Yarber of Enviroplan provided assistance and coordinated plant operations during the test.

RESULTS SUMMARY

The test results from this program are tabulated on pages 7 through 16. The relative accuracies of the CEMS were as follows:

CEMS Location	Parameter	Performance Standard	Actual Performance
Scrubber Inlet	SO ₂ , ppm	±20%	11.9%
	NO _x , ppm	±20%	17.2%
Scrubber Outlet	SO ₂ , lbs/hr	±10%	0.5%
	NO, lbs/hr	±10%	11.4%

Note: SO₂ lbs/hr performance is in terms of the applicable standard of 600 lbs/hr. NO lbs/hr performance is in terms of the applicable standard of 800 lbs/hr.

DISCUSSION OF RESULTS

The test results from this program indicate the CEMS for SO₂ met the USEPA performance specification for relative accuracy as published in the Federal Register, Volume 48, No. 102, May 25, 1983, 23608-23616. "The RA of the CEMS must be no greater than 10 percent of the mean value of the RM test data in terms of the units of the emission standard." The CEMS for NO did not meet the performance standard.

The tests at the scrubber inlet consisted of ten sulfur dioxide Reference Method 6C sampling runs, and ten NO_x Reference Method 7E sampling runs, with simultaneous CO₂ determinations. The tests at the scrubber outlet consisted of ten sulfur dioxide and nitrogen oxide Reference Methods 6C and 7E sampling runs, with simultaneous CO₂ determinations.

Source operation appeared normal and the process was operated at greater than 50 percent of normal load during the test program. No problems were encountered with the testing apparatus. Volumetric flowrate for the CEMS at the inlet was not measured directly but was based on fan curves.

PROCESS DESCRIPTION

Dragon Products Company currently operates a wet process, coal fired Portland cement plant with a rated production capacity of 57.6 tons clinker/hour. Limestone rock, obtained from quarries adjacent to the plant, passes through primary and secondary rock crushers and is then conveyed to storage silos. From here, the rock is conveyed, as needed, to the raw mill where it is ground with sand, iron ore, and water to make a slurry with a water content of 30%. The resulting slurry then becomes the raw feed to the cement kiln.

In the kiln, the raw feed undergoes drying, preheating, calcining (decarbonation), and finally, a series of chemical reactions resulting in clinker formation. Fresh clinker exits the kiln at over 2300°F, and enters the clinker cooler where it is cooled by ambient air.

Cooled clinker is sent either to interim storage or finish grinding, where it is ground with gypsum to make cement. Finished cement is then conveyed to the packhouse for bagging or bulk loadout. The cement kiln is equipped with an experimental recovery scrubber that uses waste emissions (CO₂ and SO₂) and waste heat to reclaim waste cement kiln dust.

TEST PROCEDURES

All testing, sampling, analytical and calibration procedures used for this test program were performed as described in the Code of Federal Regulations, Title 40, Part 60, Appendix A, Methods 2, 3, 4, 6C, and 7E and the latest revisions thereof. Where applicable, the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods, EPA 600/4-77-027b was used to determine the precise procedures.

Nitrogen Oxide Determination

Method 7E was used for determining nitrogen oxides (NO_x) emissions from the stack or duct. A gas sample was continuously extracted from the gas stream through a heated sampling probe. A portion of the sample stream was conveyed via a sampling line to a gas analyzer for determination of NO_x content. Prior to emissions sampling, the NO/NO_x analyzer was zeroed and calibrated. High-level, mid-level, and zero gases were introduced into the NO_x sampling system.

The sample gas manifold was then adjusted for emissions sampling. In the course of the testing, the zeroes were checked and mid-level NO_x gas was introduced into the sampling system to check calibration. A full calibration using all levels of calibration gas was performed again after the last sample run.

The chemiluminescent reaction of NO and O₃ provides the basis for this instrument operation. Specifically:



Light emission results when electronically excited NO₂ molecules revert to their ground state.

To measure NO concentrations, the gas sample to be analyzed is blended with O₂ in a reaction chamber. The resulting chemiluminescence is monitored through an optical filter by a high-sensitivity photomultiplier positioned at one end of the chamber. The filter/photomultiplier combination responds to light in a narrow-wavelength band unique to the above reaction (hence, no interference). The output from the photomultiplier is linearly proportional to the NO concentration.

To measure NO_x concentrations (i.e., NO plus NO₂), the sample gas flow is diverted through an NO₂-to-NO converter. The chemiluminescent response in the reaction chamber to the converted effluent is linearly proportional to the NO_x concentration entering the converter. The instrument is operated in the NO_x mode during all test and calibration.

Sulfur Dioxide Determination

Method 6C was used to determine sulfur dioxide emissions from the source. A gas sample was continuously extracted from the stream through a heated probe and gas conditioning system to remove the moisture. A portion of the gas stream was conveyed to the gas analyzer for determination of SO₂ content.

Prior to sampling, the SO₂ analyzer was zeroed and calibrated with high-level, mid-level, and zero gases. Between each test run, a zero and mid-level calibration gas was introduced to check calibration. A full calibration using all levels of calibration gas is performed again after the last test run at each location.

CO₂ Determination

A carbon dioxide (CO₂) was used to determine CO₂ concentrations in the stack gas in accordance with Method 3A, 40CFR60. These instruments have nondispersive infrared based detectors and operate in a range of 0-25% CO₂. A high and mid level calibration was performed using certified standard gases, and ambient air or non-CO₂ containing gas mixtures were used for the CO₂ zero.

H₂O Determination

An Alternative Method for Stack Gas Moisture Determination, written by John Stanley and Peter Westlin, August 1978, Emission Measurement Branch, USEPA is utilized to determine H₂O content of the exhaust gas. The sampling equipment is the same as specified for the moisture approximation method in Reference Method 4 except for the addition of two impingers, one containing silica gel.

Approximately 15 mls of water is added to each of the first two impingers and the third is left empty. An impinger containing approximately 15 grams of silica gel and a glass wool packed outlet is attached following the third impinger. The entire impinger train, excluding the inlet and outlet connectors, is weighed to the nearest 0.5 gram. The impingers are placed in an ice bath to maintain the sampled gas passed through the silica gel impinger outlet below 68°F in order to increase the accuracy of the sampled dry gas volume measurement. Each sample is extracted through a stainless-steel probe at a constant sample rate of between one and four liters per minute which is maintained during the course of the other simultaneous reference method sampling. An adequate volume is drawn to assure accuracy. A minimum of the equivalent to one gram of moisture must be collected to acquire that accuracy. After each run, a leak check of the sampling train is performed at a vacuum greater than the sampling vacuum to determine if any leakage had occurred during sampling. Following the leak check, the impingers are removed from the ice bath and allowed to warm. Any condensed moisture on the exterior was removed and the train is reweighed.

Volumetric Flowrate Determination

In order to determine the emission rate on a lbs/hr basis, the stack gas velocity and volumetric flowrate was determined using reference Method 2.

Velocity pressures were determined by traversing the test location with an S-type pitot tube. Temperatures were measured using a K-type thermocouple with a calibrated digital LED temperature device. The molecular weight and moisture content of the gases were determined to permit the calculation of the volumetric flowrate. Sampling points utilized were determined using Method 1, 40CFR60.

QUALITY ASSURANCE PROCEDURES

MPA recognizes the previously described reference methods to be very technique-oriented and attempts to minimize all factors which can increase error by implementing its Quality Assurance Program into every segment of its testing activities.

Shelf life of chemical reagents prepared at the MPA laboratory or at the jobsite does not exceed those specified in the above mentioned methods; and, those reagents having a shelf life of one week are prepared daily at the jobsite. When on-site analyses are required, all reagent standardizations are performed daily by the same person performing the analysis.

Dry test meters and wet test meters are calibrated according to methods described in the Quality Assurance Handbook, Sections 3.3.2., 3.4.2 and 3.5.2. Percent error for the wet test meter according to the methods is less than the allowable error of 1.0 percent. The dry test meters measured the test sample volumes to within 2 percent at the flowrate and conditions encountered during sampling.

Calculations are performed by hand held calculator and an explanation of the nomenclature and calculations along with the complete test results are appended. Also to be appended are calibration data and copies of the raw field data sheets.

Raw data is kept on file at the MPA offices in Bensenville, Illinois. All samples from the test program will be retained for 60 days after the submittal of the report, after which they will be discarded unless MPA is advised otherwise.

Calibration gases are either Protocol 1 standard gases or certified standard gases which have been verified in accordance with alternative Number 2, Section 6.1.2 of Method 6C, 40CFR60.



MOSTARDI-PLATT
ASSOCIATES, INC.

ACKNOWLEDGMENTS

MOSTARDI-PLATT ASSOCIATES, INC. would like to thank Mr. Steve Wallace and Mr. Gary Yarber for their assistance in completing this test program.

Respectfully submitted,

MOSTARDI-PLATT ASSOCIATES, INC.

Thomas D. Mostardi, PE
Project Supervisor

TDM/abl



ACCURACY DETERMINATION

Project: Dragon Products Company, Scrubber Inlet

Outlet Enviroplan CEMS, Model 43, S/N ASM-10147-114

Test Run No.	Date	Time	Reference Method Sample	CEMS Output	Difference (d)
			SO ₂ ppm dry	SO ₂ ppm dry	
1	12/19/91	0837-0858	135.2	148	-12.8
2	12/19/91	0917-0938	154.5	158	-3.5
3	12/19/91	1142-1203	192.9	211	-18.1
4	12/19/91	1225-1246	206.2	177	29.2
5	12/19/91	1318-1339	150.3	169	-18.7
6	12/19/91	1401-1422	240.7	205	35.7
7	12/19/91	1456-1517	160.7	153	7.7
8	12/19/91	1542-1603	217.3	213	4.3
9	12/19/91	1624-1645	(267.7)	(212)	(54.7)
10	12/19/91	1715-1736	218.1	189	29.1
11	12/19/91	1756-1817	(235.7)	(199)	(36.7)
Mean Reference Method Value = 186.21				Σd _i =	52.9
n = 9	t _{0.975} = 2.306	Standard Deviation (S _d) = 21.196		d̄ =	5.88
2.5 % Error confidence coefficient (one-tailed) = 16.29 ppm SO ₂				Σd _i ² =	3905.11
Relative Accuracy = 11.9% of mean reference method value					

Tests 9 and 11 not included in the calculations.

$$\bar{d} = \frac{1}{n} \sum_{i=1}^n d_i$$

$$s_d = \left(\frac{\sum_{i=1}^n d_i^2 - \frac{\left(\sum_{i=1}^n d_i\right)^2}{n}}{n-1} \right)^{1/2}$$

$$CC = t_{0.975} \frac{s_d}{\sqrt{n}}$$

$$RA = \frac{|\bar{d}| + |CC|}{RM} \times 100$$



ACCURACY DETERMINATION

Project: Dragon Products Company, Scrubber Inlet

Enviroplan CEMS, Model 43, S/N ASM-10147-114

Test Run No.	Date	Time	Reference Method Samples				CEMS Output		Difference (d)
			SO ₂ ppm dry	SO ₂ lbs/dscf	Volumetric Flowrate dscfm	SO ₂ lbs/hr	SO ₂ lbs/hr		
1	12/19/91	0837-0858	135.2	2.25x10 ⁻⁵	122,816	166	150	-16	
2	12/19/91	0917-0938	154.5	2.57x10 ⁻⁵	122,816	189	160	-29	
3	12/19/91	1142-1203	192.9	3.21x10 ⁻⁵	122,816	236	222	-14	
4	12/19/91	1225-1246	206.2	3.43x10 ⁻⁵	122,478	252	184	-68	
5	12/19/91	1318-1339	150.3	2.50x10 ⁻⁵	122,478	184	174	-10	
6	12/19/91	1401-1422	240.07	4.00x10 ⁻⁵	121,830	293	212	-81	
7	12/19/91	1456-1517	160.7	2.67x10 ⁻⁵	121,830	195	156	-39	
8	12/19/91	1542-1603	217.3	3.61x10 ⁻⁵	121,830	264	217	-47	
9	12/19/91	1624-1645	267.3	4.45x10 ⁻⁵	121,830	(325)	217	(-108)	
10	12/19/91	1715-1736	267.7	3.19x10 ⁻⁵	121,830	233	199	-34	
11	12/19/91	1756-1817	191.72	---	121,830	---	210	---	
Mean Reference Method Value = 223.6							Σd = -338		
n = 9	t _{0.975} = 2.306		Standard Deviation (S _d) = 24.42			d̄ = 37.56			
2.5 % Error confidence coefficient (one-tailed) = 18.77 lbs SO/hr							Σd ² = 17464		
Relative Accuracy = 25.2% of mean reference method value									

Tests 9 and 11 not used in calculations.

$$\bar{d} = \frac{1}{n} \sum_{i=1}^n d_i$$

$$s_d = \left(\frac{\sum_{i=1}^n d_i^2 - \frac{\left(\sum_{i=1}^n d_i\right)^2}{n}}{n-1} \right)^{1/2}$$

$$CC = t_{0.975} \frac{s_d}{\sqrt{n}}$$

$$RA = \frac{|\bar{d}| + |CC|}{RM} \times 100$$



ACCURACY DETERMINATION

Project: Dragon Products Company, Scrubber Inlet

Inlet - Enviroplan CEMS, Model 42, S/N 42-27859-230

Test Run No.	Date	Time	Reference Method Samples			CEMS Output	Difference (d _i)	
			NO _x ppm dry	Bws	NO _x ppm wet	NO _x ppm wet		
1	12/19/91	0837-0858	544.9	24.2	413.0	462	-49	
2	12/19/91	0917-0938	527.9	24.2	400	489	-89	
3	12/19/91	1142-1203	442.6	24.2	(335)	(488)	(-153)	
4	12/19/91	1225-1246	568	24.2	431	499	-68	
5	12/19/91	1318-1339	564.5	24.2	428	471	-43	
6	12/19/91	1401-1422	515	24.2	390	450	-60	
7	12/19/91	1456-1517	631.9	24.2	479	514	-35	
8	12/19/91	1542-1603	472.2	24.2	(358)	(457)	(-99)	
9	12/19/91	1624-1645	490	24.2	371	449	-78	
10	12/19/91	1715-1736	546	24.2	414	469	-55	
11	12/19/91	1756-1817	527	24.2	399	437	-38	
			Mean Reference Method Value =		413.9	Σd _i =	-515	
n =	9	t _{0.975} =	2.306	Standard Deviation (S _d) =		18.38	d̄ =	57.22
			2.5 % Error confidence coefficient (one-tailed) =		14.13 ppm/NO _x	Σd _i ² =	32173	
Relative Accuracy = 17.24% of mean reference method value								

Tests 3 and 8 not included in calculations.

$$\bar{d} = \frac{1}{n} \sum_{i=1}^n d_i$$

$$s_d = \sqrt{\frac{\sum_{i=1}^n d_i^2 - \frac{(\sum_{i=1}^n d_i)^2}{n}}{n-1}}$$

$$CC = t_{0.975} \frac{s_d}{\sqrt{n}}$$

$$RA = \frac{|\bar{d}| + |CC|}{EM}$$



ACCURACY DETERMINATION

Project: Dragon Products Company, Scrubber Inlet

Enviroplan CEMS, Model 42, S/N 42-27859-230

Test Run No.	Date	Time	Reference Method Samples				CEMS Output		Difference (d)
			NO _x ppm dry	NO _x lbs/dscf	Volumetric Flowrate dscfm	NO lbs/hr	NO lbs/hr		
1	12/19/91	0837-0858	544.9	4.24x10 ⁻⁵	122,816	312	296	16	
2	12/19/91	0917-0938	527.9	4.11x10 ⁻⁵	122,816	303	313	-10	
3	12/19/91	1142-1203	442.6	3.45x10 ⁻⁵	122,816	(254)	324	(-70)	
4	12/19/91	1225-1246	568.0	4.42x10 ⁻⁵	122,478	325	327	-2	
5	12/19/91	1318-1339	564.5	4.39x10 ⁻⁵	122,478	323	305	18	
6	12/19/91	1401-1422	515.0	4.01x10 ⁻⁵	121,830	293	294	-1	
7	12/19/91	1456-1517	631.9	4.92x10 ⁻⁵	121,830	360	333	27	
8	12/19/91	1542-1603	472.2	3.68x10 ⁻⁵	121,830	(269)	295	(-26)	
9	12/19/91	1624-1645	490	3.81x10 ⁻⁵	121,830	278	291	-17	
10	12/19/91	1715-1736	546	4.25x10 ⁻⁵	121,830	311	313	-2	
11	12/19/91	1756-1817	527	4.10x10 ⁻⁵	121,830	300	291	9	
Mean Reference Method Value = 311.7							Σd _i = 38		
n = 9	t _{0.975} = 2.306	Standard Deviation (S _d) = 14.26				d̄ = 4.22			
2.5 % Error confidence coefficient (one-tailed) = 10.96 lbs NO/hr							Σd _i ² = 1788		
Relative Accuracy = 4.87% of mean reference method value									

Tests 3 and 8 not included in calculations.

$$\bar{d} = \frac{1}{n} \sum_{i=1}^n d_i$$

$$s_d = \sqrt{\frac{\sum_{i=1}^n d_i^2 - \frac{(\sum_{i=1}^n d_i)^2}{n}}{n-1}}$$

$$CC = t_{0.975} \cdot \frac{s_d}{\sqrt{n}}$$

$$RA = \frac{|\bar{d}| + |CC|}{RM} \times 100$$



ACCURACY DETERMINATION

Project: Dragon Products, Scrubber Inlet

Volumetric Flowrate of CEMS from fan curves.

Test Run No.	Date	Time	Reference Method Samples			CEMS Output	Difference (d)
			dscfm	Bws	wscfm	wscfm	
1	12/19/91	0837-0858	122,816	24.2	(162,026)	(137,000)	(25,026)
2	12/19/91	0917-0938	122,816	24.2	(162,026)	(137,000)	(25,026)
3	12/19/91	1142-1203	122,816	24.2	162,026	142,000	20,026
4	12/19/91	1225-1246	122,478	24.2	161,580	140,000	21,580
5	12/19/91	1318-1339	122,478	24.2	161,580	139,000	22,580
6	12/19/91	1401-1422	121,830	24.2	160,726	140,000	20,726
7	12/19/91	1456-1517	121,830	24.2	160,726	139,000	21,726
8	12/19/91	1542-1603	121,830	24.2	160,726	138,000	22,726
9	12/19/91	1624-1645	121,830	24.2	160,726	139,000	21,726
10	12/19/91	1715-1736	121,830	24.2	160,726	143,000	17,726
11	12/19/91	1756-1817	121,830	24.2	160,726	143,000	17,726
Mean Reference Method Value = 161,060						$\Sigma d_i = 186,542$	
n = 9		$t_{0.975} = 2.306$	Standard Deviation (S_d) = 1890			$ \bar{d} = 20,727$	
2.5 % Error confidence coefficient (one-tailed) = 1453 wscfm						$\Sigma d_i^2 = 3.39 \times 10^9$	
Relative Accuracy = 13.77 % of mean reference method value							

Tests 1 and 2 not included in calculations.

$$\bar{d} = \frac{1}{n} \sum_{i=1}^n d_i$$

$$s_d = \left(\frac{\sum_{i=1}^n d_i^2 - \frac{(\sum_{i=1}^n d_i)^2}{n}}{n-1} \right)^{1/2}$$

$$CC = t_{0.975} \frac{s_d}{\sqrt{n}}$$

$$RA = \frac{|\bar{d}| + |CC|}{RM} \times 100$$



ACCURACY DETERMINATION

Project: Dragon Products Company, Scrubber Outlet

Outlet Enviroplan CEMS, Model 43, S/N ASM-10153-114

Test Run No.	Date	Time	Reference Method Sample	CEMS Output	Difference (d _i)
			SO ₂ ppm dry	SO ₂ ppm dry	
1	12/20/91	1222-1243	17.5	22	-4.5
2	12/20/91	1300-1321	13.0	13	0.0
3	12/20/91	1337-1358	23.9	28	-4.1
4	12/20/91	1414-1435	4.7	14	-9.3
5	12/20/91	1505-1526	(5.0)	(16)	(-11.0)
6	12/20/91	1543-1604	14.6	26	-11.4
7	12/20/91	1621-1644	5.0	7	-2.0
8	12/20/91	1807-1828	5.0	6	-1.0
9	12/20/91	1844-1905	(4.0)	(15)	(-11.0)
10	12/20/91	1916-1937	4.0	8	-4.0
11	12/20/91	2000-2021	6.0	9	-3.0
Mean Reference Method Value = 10.411			Σd _i =		-39.3
n = 9	t _{2,975} = 2.306	Standard Deviation (S _d) = 3.74	d̄ =		4.367
2.5 % Error confidence coefficient (one-tailed) = 2.875 ppm SO ₂			Σd _i ² =		283.51
Relative Accuracy = 69.6% of mean reference method value					

Tests 5 and 9 not included in the calculations.

$$\bar{d} = \frac{1}{n} \sum_{i=1}^n d_i$$

$$s_d = \sqrt{\frac{\sum_{i=1}^n d_i^2 - \frac{(\sum_{i=1}^n d_i)^2}{n}}{n-1}}$$

$$CC = t_{2,975} \frac{s_d}{\sqrt{n}}$$

$$RA = \frac{(|\bar{d}| + CC)}{RM} \times 100$$



ACCURACY DETERMINATION

Project: Dragon Products Company, Scrubber Outlet

Enviroplan CEMS, Model 43, S/N ASM-10153-114

Test Run No.	Date	Time	Reference Method Samples				CEMS Output		Difference (d)
			SO ₂ ppm dry	SO ₂ lbs/dscf	Volumetric Flowrate dscfm	SO ₂ lbs/hr	SO ₂ lbs/hr		
1	12/20/91	1222-1243	17.5	0.29x10 ⁻⁵	109,558	19.1	17	2.1	
2	12/20/91	1300-1321	13.0	0.22x10 ⁻⁵	109,847	14.5	10	4.5	
3	12/20/91	1337-1358	23.9	0.40x10 ⁻⁵	115,934	27.8	22	5.8	
4	12/20/91	1414-1435	4.7	0.08x10 ⁻⁵	107,239	5.1	9	-3.9	
5	12/20/91	1505-1526	5.0	0.08x10 ⁻⁵	105,925	(5.3)	11	(-5.7)	
6	12/20/91	1543-1604	14.6	0.24x10 ⁻⁵	110,046	16.0	19	-3.0	
7	12/20/91	1621-1644	5.0	0.08x10 ⁻⁵	99,875	5.0	6	-1.0	
8	12/20/91	1807-1828	5.0	0.08x10 ⁻⁵	107,150	5.3	5	0.3	
9	12/20/91	1844-1905	4.0	0.07x10 ⁻⁵	118,635	(4.7)	13	(-3.3)	
10	12/20/91	1916-1937	4.0	0.07x10 ⁻⁵	109,115	4.4	6	-1.6	
11	12/20/91	2000-2021	6.0	0.10x10 ⁻⁵	109,115	6.5	7	-0.5	
Mean Reference Method Value = 11.52							Σd _i =	2.7	
n = 9	t _{0.975} = 2.306	Standard Deviation (S _d) = 3.27				d̄ =	0.30		
2.5 % Error confidence coefficient (one-tailed) = 2.51 lbs SO ₂ /hr							Σd _i ² =	36.41	
Relative Accuracy = 0.47% of the applicable standard of 600 lbs/hr									

Tests 5 and 9 not included in calculation.

$$\bar{d} = \frac{1}{n} \sum_{i=1}^n d_i$$

$$s_d = \sqrt{\frac{\sum_{i=1}^n d_i^2 - \frac{\left(\sum_{i=1}^n d_i\right)^2}{n}}{n-1}}$$

$$CC = t_{0.975} \frac{s_d}{\sqrt{n}}$$

$$RA = \frac{|\bar{d}| + |CC|}{RM} \times 100$$



ACCURACY DETERMINATION

Project: Dragon Products Company, Scrubber Outlet

Outlet - Enviroplan CEMS, Model 42, S/N 42-27835-230

Test Run No.	Date	Time	Reference Method Samples			CEMS Output	Difference (d)
			NO _x ppm dry	Bws	NO _x ppm wet	NO _x ppm wet	
1	12/20/91	1222-1243	487.5	20	390	328	62
2	12/20/91	1300-1321	542	20	(434)	(355)	(79)
3	12/20/91	1337-1358	517	20	414	352	62
4	12/20/91	1414-1435	631.5	20	505	452	53
5	12/20/91	1505-1526	586	20	469	424	45
6	12/20/91	1543-1604	434	20	347	291	56
7	12/20/91	1621-1644	566	20	453	385	68
8	12/20/91	1807-1828	562	20	(450)	(345)	(105)
9	12/20/91	1844-1905	431	20	345	368	-23
10	12/20/91	1916-1937	528	20	422	457	-35
11	12/20/91	2000-2021	482	20	386	398	-10
			Mean Reference Method Value = 414.6		Σd _i = 278		
n = 9	t _{0.975} = 2.306	Standard Deviation (S _d) = 41.15		d̄ = 30.9			
2.5 % Error confidence coefficient (one-tailed) = 31.63 ppm NO _x				Σd _i ² = 22,136			
Relative Accuracy = 15.08 of mean reference method value							

Tests 2 and 8 not included in calculations.

$$\bar{d} = \frac{1}{n} \sum_{i=1}^n d_i$$

$$s_d = \sqrt{\frac{\sum_{i=1}^n d_i^2 - \frac{(\sum_{i=1}^n d_i)^2}{n}}{n-1}}$$

$$CC = t_{0.975} \frac{s_d}{\sqrt{n}}$$

$$RA = \frac{|\bar{d}| + |CC|}{RM} \leq 1.00$$



ACCURACY DETERMINATION

Project: Dragon Products Company, Scrubber Outlet

Enviroplan CEMS, Model 42, S/N 42-27835-230

Test Run No.	Date	Time	Reference Method Samples				CEMS Output		Difference (d)
			NO _x ppm dry	NO lbs/dscf	Volumetric Flowrate dscfm	Emission Rate lbs NO/hr	Emission Rate lbs NO/hr		
1	12/20/91	1222-1243	487.5	3.79x10 ⁻⁵	109,558	249	169	+80	
2	12/20/91	1300-1321	542	4.22x10 ⁻⁵	109,847	(278)	177	(+101)	
3	12/20/91	1337-1358	517	4.02x10 ⁻⁵	115,934	280	182	+98	
4	12/20/91	1414-1435	631.5	4.92x10 ⁻⁵	107,239	317	208	+109	
5	12/20/91	1505-1526	586	4.56x10 ⁻⁵	105,925	290	203	+87	
6	12/20/91	1543-1604	434	3.38x10 ⁻⁵	110,046	223	143	+80	
7	12/20/91	1621-1644	566	4.41x10 ⁻⁵	99,875	264	205	59	
8	12/20/91	1807-1828	562	4.37x10 ⁻⁵	107,150	(281)	175	(-106)	
9	12/20/91	1844-1905	431	3.36x10 ⁻⁵	118,635	239	195	-44	
10	12/20/91	1916-1937	528	4.11x10 ⁻⁵	109,115	269	254	15	
11	12/20/91	2000-2021	482	3.75x10 ⁻⁵	109,115	246	213	33	
Mean Reference Method Value = 264						Σd _i = 605			
n = 9	t _{0.975} = 2.306	Standard Deviation (S _d) = 31.46				d̄ = 67			
2.5 % Error confidence coefficient (one-tailed) = 24.18 lbs NO/hr						Σd _i ² = 48,585			
Relative Accuracy = 11.40% of applicable standard of 800 lbs NO/hr									

Tests 2 and 8 not included in calculations.

$$\bar{d} = \frac{1}{n} \sum_{i=1}^n d_i$$

$$s_d = \sqrt{\frac{\sum_{i=1}^n d_i^2 - \frac{\left(\sum_{i=1}^n d_i\right)^2}{n}}{n-1}}$$

$$CC = t_{0.975} \frac{s_d}{\sqrt{n}}$$

$$RA = \frac{|\bar{d}| + |CC|}{RM} \times 100$$



ACCURACY DETERMINATION

Project: Dragon Products Company, Scrubber Outlet

Outlet CEMS, Sick Optic Ultrasonic Velocity Monitor Model VMA2, S/N 9028-8058

Test Run No.	Date	Time	Reference Method Samples			CEMS Output	Difference (d)
			dscfm	Bws	wscfm	wscfm	
1	12/20/91	1222-1243	109,558	20	136,948	111,000	25,948
2	12/20/91	1300-1321	109,847	20	137,309	107,000	30,309
3	12/20/91	1337-1358	115,934	20	144,918	111,000	33,918
4	12/20/91	1414-1435	107,239	20	(134,049)	(99,000)	(35,049)
5	12/20/91	1505-1526	105,925	20	132,406	103,000	29,406
6	12/20/91	1543-1604	110,046	20	137,558	105,000	32,558
7	12/20/91	1621-1644	99,875	20	124,844	114,000	10,844
8	12/20/91	1807-1828	107,150	20	133,938	109,000	24,938
9	12/20/91	1844-1905	118,635	20	(148,294)	113,000	(35,294)
10	12/20/91	1916-1937	109,115	20	136,394	119,000	17,394
11	12/20/91	2000-2021	109,115	20	136,394	114,000	22,394
Mean Reference Method Value = 135,634						$\Sigma d_i =$	227,709
n = 9	$t_{0.975} = 2.306$	Standard Deviation (S_d) = 7494				$ \bar{d} =$	25,301
2.5 % Error confidence coefficient (one-tailed) = 5761 wscfm						$\Sigma d_i^2 =$	6.2106 x 10 ⁹
Relative Accuracy = 22.90% of mean reference method value							

Tests 4 and 9 not included in calculations

$$\bar{d} = \frac{1}{n} \sum_{i=1}^n d_i$$

$$s_d = \left(\frac{\sum_{i=1}^n d_i^2 - \frac{(\sum_{i=1}^n d_i)^2}{n}}{n-1} \right)^{1/2}$$

$$CC = t_{0.975} \frac{s_d}{\sqrt{n}}$$

$$RA = \frac{|\bar{d}| + |CC|}{RM} \times 100$$

COPY

CEMEX

Test Documentation

For:

DRAGON PRODUCTS COMPANY

Ref. No. 43-7021-114

 **ENVIROPLAN**

Ref. No. 43-7021-114
October 17, 1990

Mr. Steven Wallace
Dragon Products Co.
P.O. Box 191
Thomaston, ME 04861

Re: Dragon Co.
CEMEX System Test Documentation

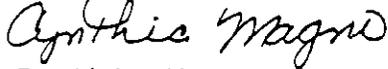
Dear Mr. Wallace:

Enclosed please find three copies of the CEMEX System Test Documentation. I understand you did not receive these with your system manuals. We regret any inconvenience this has caused.

If you have any questions regarding this documentation, or if I can be of further assistance, please do not hesitate to call me.

Sincerely,

ENVIROPLAN, INC.



Cynthia Magno
Administrative Assistant
CEM Products and Services

Enc.

CEMEX
TEST DOCUMENTATION

For:
DRAGON PRODUCTS CO.

Ref. NO. 43-7021-114

TABLE OF CONTENTS

	<u>Page</u>
1. Calibration Error Test Procedures - Outlet	1
2. Calibration Error Test No _x outlet S/N 42-27835-230	2
3. Calibration Error Test SO ₂ outlet S/N ASM-10153-114	3
4. Calibration Error Test Procedures - Inlet	4
5. Calibration Error Test NO _x Inlet S/N 42-27859-230	5
6. Calibration Error Test SO ₂ Inlet S/N ASM-10147-114	6
7. Support Data	7



CALIBRATION ERROR TEST PROCEDURES

The Calibration Error test is conducted on the completely assembled continuous emission monitoring system. Fill out completely the following information:

Probe # Dut SN _____ Orifice size 20ml
 Probe # _____ SN _____ Orifice size _____
 Probe # _____ SN _____ Orifice size _____
 Probe # _____ SN _____ Orifice size _____

Client: Dragon
 Job No: _____

<u>Analyzers</u>	<u>SN</u>	<u>Range</u>	<u>Zero pot</u>	<u>Span pot</u>
<u>SO2</u>	<u>ASM-10193-114</u>	<u>0-0.5 0-0-100</u>	<u>9.50</u>	<u>8.18</u>
<u>NOx</u>	<u>4227836-230</u>	<u>0-1 = 0-200</u>	<u>Background 4.2</u>	<u>Span Factor 1.131</u>
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

Umbilical Lengths #1 _____ #2 _____ #3 _____ #4 _____

Probe lengths #1 5' #2 _____ #3 _____ #4 _____

Inlet air setting: NA psi

Dilution air settings: #1 49 psi #2 _____ #3 _____ #4 _____

Vacuum air settings: #1 21.3 inHg #2 _____ #3 _____ #4 _____

Dilution air alarms: #1 28 psi #2 _____ #3 _____ #4 _____

Vacuum air alarms: #1 _____ #2 _____ #3 _____ #4 _____

Rotometers settings: purge #1 _____ purge #2 _____

cal #1 1 L cal #2 _____ cal #3 _____ cal #4 _____

Calibration Error Test Customer Dragon Industries

Date 6-6-90 Person Conducting Test L. Myers Analyzer SN ^{Nox} 42-27935-730

Orifice Size 20ml Approx Dil. Ratio 250:1 Diluted Sam. Flow Rate _____

Analyzer Range 0-1 ppm System Range 0-200 ppm

Inlet Air (PSI) N.A. Dilution Air (PSI) 49 psi Vacuum (HG") 21.3 inHg

Mid Cylinder Gas/SN ALM2257 / 52.3 Nox High Cylinder Gas/SN ALM08640 / 102.2 Nox

Zero Pot: Background No: 11.2 Span Pot: Span Factor: 1.131
Background Nox: 11.4 Balance Factor: 1.001

Run #	Cylinder Gas (ppm/%)	Measured % FS	Actual	Difference (Known-Actual)
1	102.2 ppm	51%	102.0 ppm	0.2 ppm
	52.3 ppm	26%	52.0 ppm	0.3 ppm
	0.0 ppm	0.0%	0 ppm	0 ppm
2	102.2 ppm	51%	102.0 ppm	0.2 ppm
	52.3 ppm	26%	52.0 ppm	0.3 ppm
	0.0 ppm	0.0	0 ppm	0 ppm
3	102.2 ppm	51%	102.0 ppm	0.2 ppm
	52.3 ppm	26%	52.0 ppm	0.3 ppm
	0.0 ppm	0.0	0 ppm	0 ppm
4	102.2 ppm	51%	102.0 ppm	0.2 ppm
	52.3 ppm	26%	52.0 ppm	0.3 ppm
	0.0 ppm	0.0	0 ppm	0 ppm
5	102.2 ppm	51%	102.0 ppm	0.2 ppm
	52.3 ppm	26%	52.0 ppm	0.3 ppm
	0.0 ppm	0.0	0 ppm	0 ppm
6	102.2 ppm	51%	102.0 ppm	0.2 ppm
	52.3 ppm	26%	52.0 ppm	0.3 ppm
	0.0 ppm	0.0	0 ppm	0 ppm

	Mid	High
Mean Difference	<u>0.3</u>	<u>0.2</u>
Confidence Interval	<u>0.0</u>	<u>0.0</u>
Calibration Error	<u>.57%</u>	<u>.19%</u>

Calibration Error Test Customer Dragon Industries

Date 10-6-90 Person Conducting Test J. Taylor Analyzer SN ⁵⁰² ASM-10157-714

Sample Size 20 ml Approx Dil. Ratio 250:1 Diluted Sam. Flow Rate _____

Analyzer Range 0-5 ppm System Range 0-1 ppm

Inlet Air (PSI) N.A. Dilution Air (PSI) 49 psi Vacuum (HG") 21.3 in/Hg

Low Cylinder Gas/SN 27.72 ppm / ALM003440 High Cylinder Gas/SN 51.5 ppm / ALM2252

Zero Pot 9.56 Span Pot 8.19

Run #	Cylinder Gas (ppm/%)	Measured % FS	Actual	Difference (Known-Actual)
	51.5 ppm	51.5%	51.5 ppm	0
	27.72 ppm	28.0	28 ppm	0.28
	0.0 ppm	0.0 %	0.0 ppm	0
	51.5 ppm	51.5 %	51.5 ppm	0
	27.72 ppm	28.0	28 ppm	0.28
	0.0 ppm	0.0 %	0.0 ppm	0.0
	51.5 ppm	51.5 %	51.5 ppm	0.0
	27.72 ppm	28.0	28 ppm	0.28
	0.0 ppm	0.0 %	0.0 ppm	0.0
	51.5 ppm	51.5 %	51.5 ppm	0.0
	27.72 ppm	28.0	28 ppm	0.28
	0.0 ppm	0.0 %	0.0 ppm	0.0
	51.5 ppm	51.5 %	51.5 ppm	0.0
	27.72 ppm	28.0	28 ppm	0.28
	0.0 ppm	0.0 %	0.0 ppm	0.0

	Mid	High
Mean Difference	<u>0.28</u>	<u>0</u>
Confidence Interval	<u>0</u>	<u>0</u>
Calibration Error	<u>1.01</u>	<u>0</u>



CALIBRATION ERROR TEST PROCEDURES

The Calibration Error test is conducted on the completely assembled continuous emission monitoring system. Fill out completely the following information:

Probe # _____ SN _____ Orifice size 20m¹
Probe # _____ SN _____ Orifice size _____
Probe # _____ SN _____ Orifice size _____
Probe # _____ SN _____ Orifice size _____

Client: DRAGON *w/let to crewman*
Job No: 43-7021-116

	<u>Analyzers</u>	<u>SN</u>	<u>Range</u>	<u>Zero pot</u>	<u>Span pot</u>
<u>O₂</u>	<u>TECO 42*</u>	<u>ASM10147-114</u>	<u>0-5 = 0-1000</u>	<u>712</u>	<u>463</u>
	<u>TECO 42</u>	<u>42-27859-230</u>	<u>0-10 = 0-2000</u>	<u>NA</u>	<u>NA</u>
	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____

* USED - from Client

Umbilical Lengths #1 _____ #2 _____ #3 _____ #4 _____

Probe lengths #1 _____ #2 _____ #3 _____ #4 _____

Inlet air setting: 100 psi

Dilution air settings: #1 49.2 #2 _____ #3 _____ #4 _____

Vacuum air settings: #1 -23.2 #2 _____ #3 _____ #4 _____

Dilution air alarms: #1 _____ #2 _____ #3 _____ #4 _____

Vacuum air alarms: #1 _____ #2 _____ #3 _____ #4 _____

Rotometers settings: purge #1 5.0 purge #2 _____

cal #1 1.0 cal #2 _____ cal#3 _____ cal#4 _____

Calibration Error Test Customer DRAGON
 Date 6-12-90 Person Conducting Test CAC Analyzer SN 42-27859-23C
 Orifice Size 25 ml Approx Dil. Ratio 250:1 Diluted Sam. Flow Rate _____
 Analyzer Range 0-10 ppm System Range 0-2000 ppm
 Inlet Air (PSI) 100 Dilution Air (PSI) 49.2 Vacuum (HG") -23.2
 Low Cylinder Gas/SNALM012941 / 398.8 High Cylinder Gas/SNALM012983 / 1585.1
 Zero Pot NA Span Pot NA

Run #	Cylinder Gas (ppm/%)	Measured % FS.	Actual	Difference (Known-Actual)
1	1585.1	79.2	1584.0	+1.1
	398.8	20.0	400.0	+1.2
	0	0.0	0.0	0.0
4	1585.1	79.0	1580.0	-5.1
	398.8	20.0	400.0	+1.2
	0	0.0	0.0	0.0
6	1585.1	79.0	1580.0	-5.1
	398.8	20.0	400.0	+1.2
	0	0.0	0.0	0.0
9	1585.1	78.8	1576	-9.1
	398.8	20.0	400	+1.2
	0	0.0	0.0	0.0
1	1585.1	78.8	1576	-9.1
	398.8	20.0	400	+1.2
	0	0.0	0.0	0.0
4	1585.1	78.8	1576	-9.1
	398.8	20.0	400	+1.2
	0	0.0	0.0	0.0

	Mid	High
Mean Difference	<u>1.2</u>	<u>-5.46</u>
Confidence Interval	<u>0.0</u>	<u>5.18</u>
Calibration Error	<u>0.30</u>	<u>0.67</u>

Calibration Error Test Customer DRAGON

Date 6-13-90 Person Conducting Test CAC Analyzer SN ASMA10147-114

Orifice Size 25 ml Approx Dil. Ratio 250:1 Diluted Sam. Flow Rate _____

Analyzer Range 0-5 = 0-1000 System Range 0-1000

Inlet Air (PSI) 100 psf Dilution Air (PSI) 49.2 Vacuum (HG") 10.0

Mid Cylinder Gas/SN AlM 012941 / 196.1 ppm High Cylinder Gas/SN AlM 012983 / ~~1500~~ 792.0

Zero Pot 463 Span Pot 712

Run #	Cylinder Gas (ppm/%)	Measured % FS	Actual	Difference (Known-Actual)
1	792.0	79.2	792.0	0.0
	196.1	20.0	200.0	3.9
	0.0	0.0	0.0	0.0
4	792.0	78.6	786.0	-6.0
	196.1	19.9	199.0	2.9
	0.0	0.0	0.0	0.0
5	792.0	78.6	786.0	-6.0
	196.1	19.9	199.0	2.9
	0.0	0.0	0.0	0.0
9	792.0	78.2	782.0	-10.0
	196.1	19.9	199.0	2.9
	0.0	0.0	0.0	0.0
1	792.0	78.2	782.0	-10.0
	196.1	19.9	199.0	2.9
	0.0	0.0	0.0	0.0
4	792.0	78.2	782.0	-10.0
	196.1	19.9	199.0	2.9
	0.0	0.0	0.0	0.0

	Mid	High
Mean Difference	<u>3.1</u>	<u>-6.4</u>
Confidence Interval	<u>0.56</u>	<u>5.09</u>
Calibration Error	<u>1.86</u>	<u>1.45</u>



SUPPORT DATA

-JUN 68

FACTORY CAC ERROR

INLET

TECO NO. 43

S/N 42-27859-230

VAC - 20.0 "Hg

D.I. A.F. = 49.2 ps.

VAC = -23.2

25 ml orifice

250:1

0 - 10 ppm

0 - 2000 ppm

CEMEX 145

TANKS

MID: ALCM 012941

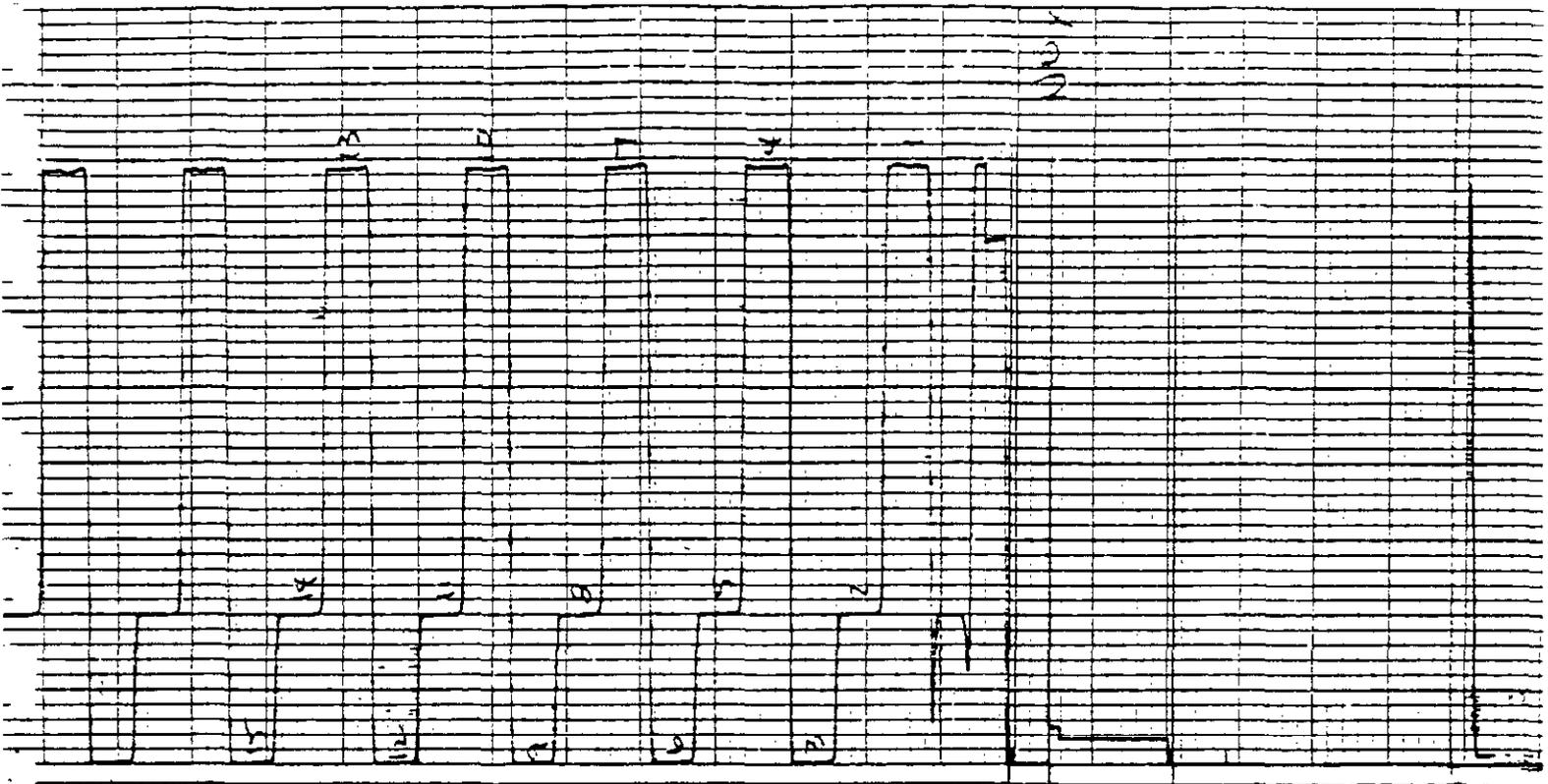
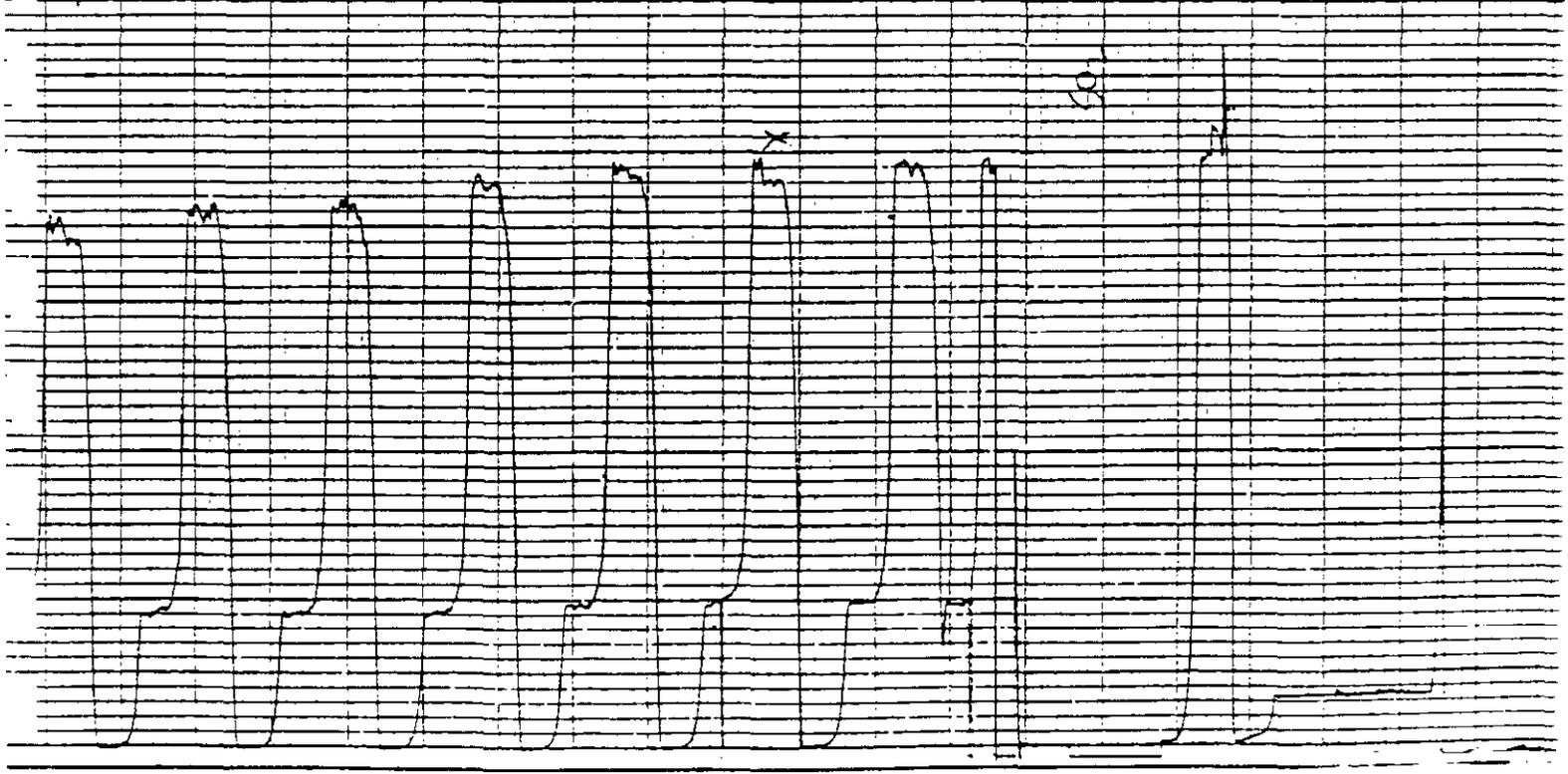
398.8 ppm

HIGH: ALCM 012983

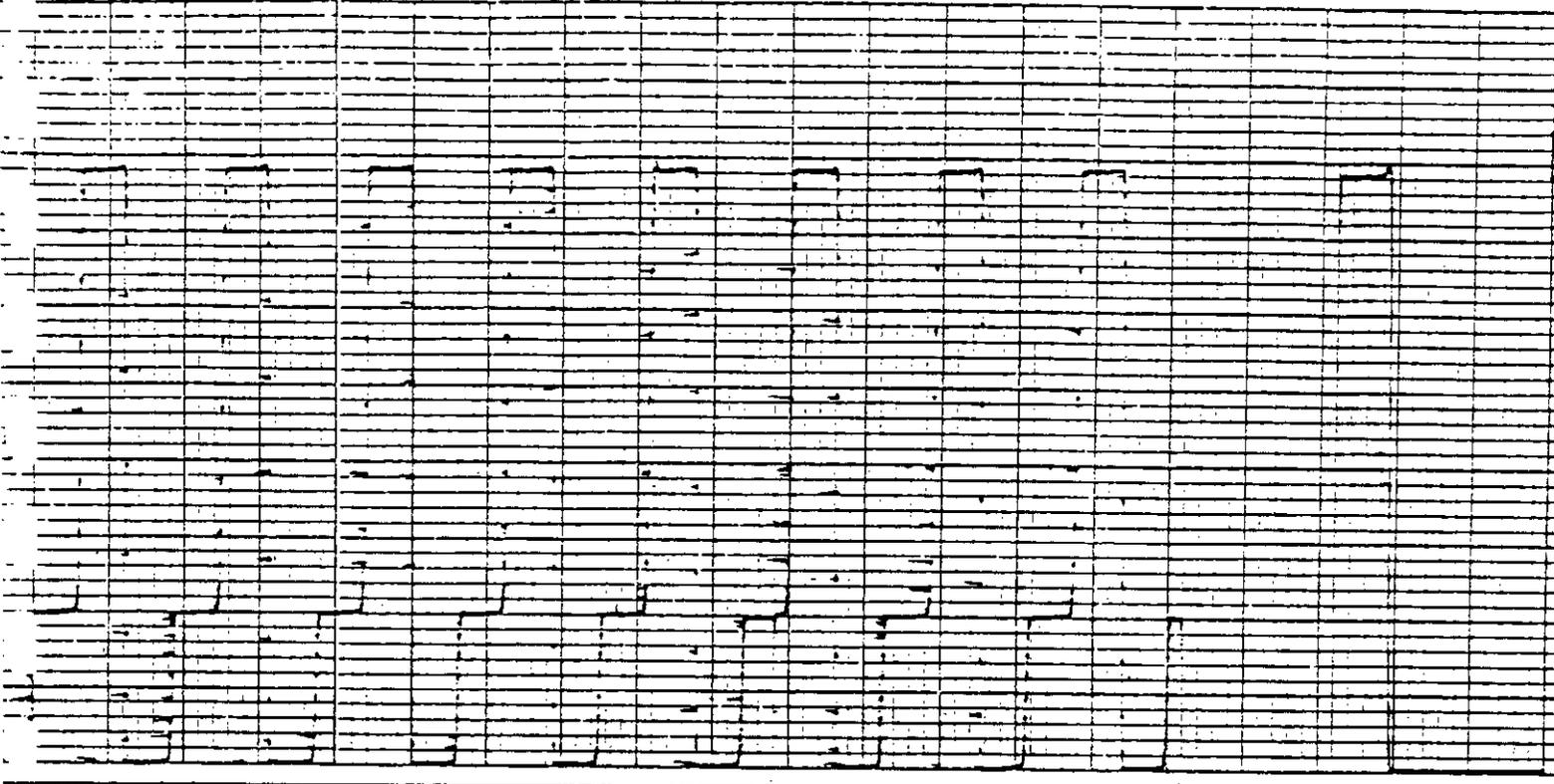
1585.1 ppm

6-12-90

CAC



...AC...
 Envisoplan
 Factor Cal. Error
 INLET
 TCO 502 43
 S/N ASM 10147.114
 VAL = -10.0" H₂O
 flow = ~2.0
 Z pot = 712
 Sp. Pot = 463
 D.I. A.r = 49.2 psi
 VAL. = -23.2
 25 ml orifice
 250:1
 0-5 PPM =
 0-1000 PPM
 Inlet a.r 100psi.
 CEMEX 145
 TANKS:
 M.D: ALM 012941
 196.1 PPM
 High: ALM 012983
 792 PPM
 6-13-90
 GAC



Model 12

Gas Spas 118

G-10-90

2000 070

Dragon

Outlet

Range 0.4 = 0.1030E

0.1 = 0.0200 NOX

Oil Air 47psi

Model 17

VAC 21.31014

Background 11.2

Moisture Factor 1.151

Balance Factor 11.0017

Mo

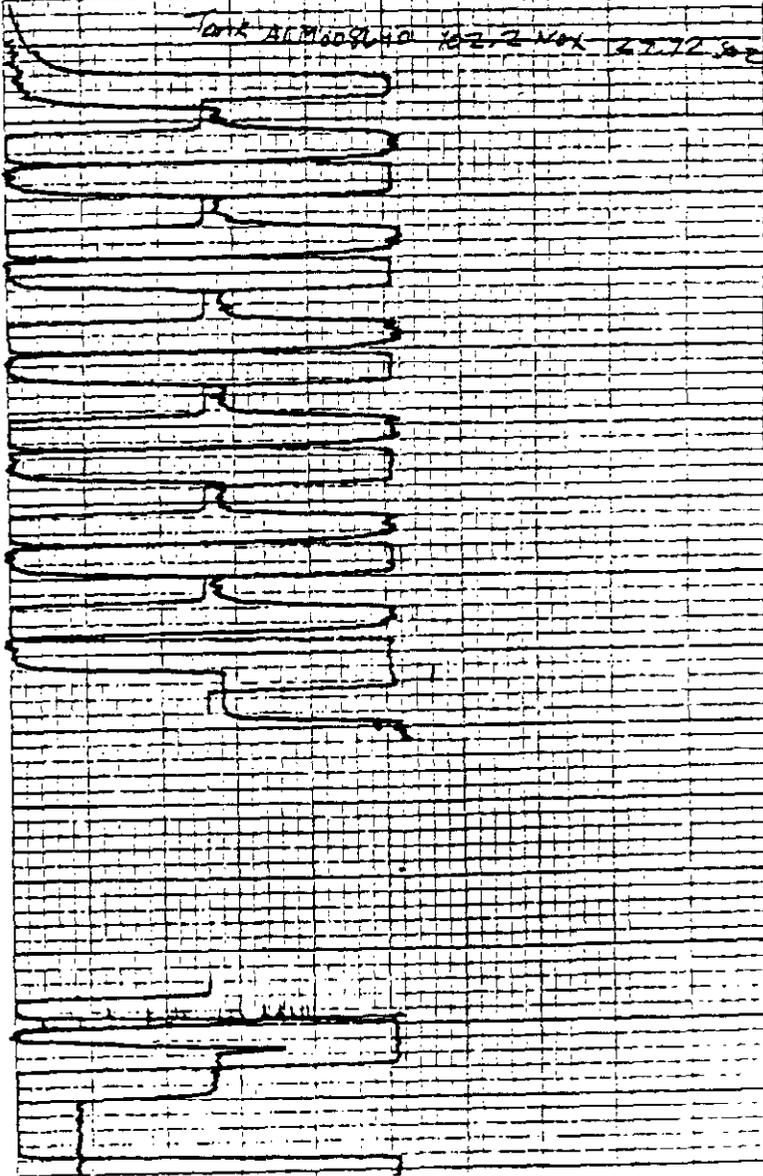
Background 11.2

Oil Non

Black 500

Tank ALA 2257 52.5 NOX 315.502L

Tank ALM09140 102.2 NOX 2272.502L



APPENDIX E

CEM Calibration Gas Certifications



559926

Airco Special Gases
 Union Landing & River Roads
 P.O. Drawer No. 272
 Riverton
 New Jersey 08077
 Telephones: Marketing: 609-829-7878
 Prod. & Admin.: 609-829-7914
 International: 609-829-7917

in use 7-2-93 JC

CERTIFICATE OF ANALYSIS - EPA PROTOCOL GAS MIX

CUSTOMER: ASG - 024 Acton MA
 CYLINDER #: CC-1274 CERTIFICATION DATE: 6-2-93
 CYLINDER PRESSURE: 2000 psig EXPIRATION DATE: 12-2-93 (6 months)
 LABORATORY: Riverton NJ REFERENCE #: 32280

MIXTURE COMPONENTS	ACTUAL MIXTURE CONCENTRATION	AIRCO INTERMEDIATE STANDARD		
		CYLINDER #	CONC.	NIST SRM#
Sulfur Dioxide	45.8 ppm	CC-72396	50.4 ppm	1693A
Nitric Oxide	499 ppm	CC-13164	512 ppm	1686B

BALANCE GAS: Nitrogen

COMPONENT 1 GAS ANALYSIS PROCEDURE Non-Dispersive Infrared
 MAKE/MODEL/SER#: Beckman 865 0103986
 LAST MULTIPOINT CALIBRATION DATE: 6-1-93

COMPONENT 2 GAS ANALYSIS PROCEDURE Chemiluminescence
 MAKE/MODEL/SER#: Beckman 952 0100204
 LAST MULTIPOINT CALIBRATION DATE: 6-1-93
 R=REFERENCE STANDARD Z=ZERO GAS S=SAMPLE GAS

1ST COMPONENT Sulfur Dioxide
 1ST ANALYSIS: DATE 5-26-93 ANALYST A. Lattanze
 1) Z 0000 R 5410 S 4920 CONC (1) 45.8 ppm
 2) R 5410 Z 0000 S 4920 CONC (2) 45.8 ppm
 3) R 5410 S 4920 Z 0000 CONC (3) 45.8 ppm
 AVE CONC 45.8 ppm

2ND ANALYSIS: DATE 6-2-93 ANALYST A. Lattanze
 1) Z 0000 R 5450 S 4950 CONC (1) 45.8 ppm
 2) R 5450 Z 0000 S 4950 CONC (2) 45.8 ppm
 3) R 5450 S 4950 Z 0000 CONC (3) 45.8 ppm
 AVE CONC 45.8 ppm

2ND COMPONENT Nitric Oxide
 1ST ANALYSIS: DATE 5-26-93 ANALYST A. Lattanze
 1) Z 0000 R 3960 S 3860 CONC (1) 499 ppm
 2) R 3960 Z 0000 S 3860 CONC (2) 499 ppm
 3) R 3960 S 3860 Z 0000 CONC (3) 499 ppm
 AVE CONC 499 ppm

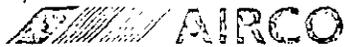
2ND ANALYSIS: DATE 6-2-93 ANALYST A. Lattanze
 1) Z 0000 R 3950 S 3840 CONC (1) 498 ppm
 2) R 3950 Z 0000 S 3840 CONC (2) 498 ppm
 3) R 3950 S 3840 Z 0000 CONC (3) 498 ppm
 AVE CONC 498 ppm

THIS CALIBRATION STANDARD HAS BEEN CERTIFIED VERSUS EPA TRACEABILITY
 PROTOCOL NO. 1, PROCEDURE G1, AND ANALYSES PERFORMED PER SECTION 3.0.4.

CERTIFIED CONCENTRATION: Nitric Oxide = 499 ppm, Sulfur Dioxide = 45.8 ppm, Nitrogen =

Balance

APPROVED BY J. Lattanze
 LABORATORY MANAGER



Recertification

Airco Special Gases
Union Landing & River Roads
P.O. Drawer No. 272
Riverton
New Jersey 08077
Telephones: Marketing: 609-829-7878
Prod. & Admin.: 609-829-7914
International: 609-829-7917

CERTIFICATE OF ANALYSIS - EPA PROTOCOL GAS MIX

CUSTOMER: AIG Acton
CYLINDER #: CC-17379
CYLINDER PRESSURE: 1200 psig
LABORATORY: Riverton, NJ
CERTIFICATION DATE: 4/23/92
EXPIRATION DATE: 10/23/93
REFERENCE #: 21661

Table with 5 columns: MIXTURE COMPONENTS, ACTUAL MIXTURE CONCENTRATION, AIRCO INTERMEDIATE STANDARD CYLINDER #, CONC., NIST SRM#. Rows include Sulfur Dioxide (50.4 ppm) and Nitric Oxide (181 ppm).

BALANCE GAS: Nitrogen

COMPONENT 1 GAS ANALYSIS PROCEDURE Non-Dispersive Infrared
MAKE/MODEL/SER#: Beckman, 865, 0103986
LAST MULTIPOINT CALIBRATION DATE: 4/1/92

COMPONENT 2 GAS ANALYSIS PROCEDURE Chemiluminescence
MAKE/MODEL/SER#: Beckman, 952, 0100204
LAST MULTIPOINT CALIBRATION DATE: 4/1/92
R=REFERENCE STANDARD Z=ZERO GAS S=SAMPLE GAS

1ST COMPONENT Sulfur Dioxide
1ST ANALYSIS: DATE 4/22/92 ANALYST A. Lattanze
1) Z 0000 R 6940 S 6900 CONC (1) 50.1 ppm
2) R 6880 Z 0000 S 6910 CONC (2) 50.6 ppm
3) R 6880 S 6900 Z 0000 CONC (3) 50.5 ppm
AVE CONC 50.4 ppm

2ND ANALYSIS: DATE ANALYST
1) Z R S CONC (1)
2) R Z S CONC (2)
3) R S Z CONC (3)
AVE CONC

2ND COMPONENT Nitric Oxide
1ST ANALYSIS: DATE 4/22/92 ANALYST A. Lattanze
1) Z 0001 R 8560 S 6420 CONC (1) 182 ppm
2) R 8565 Z 0000 S 6420 CONC (2) 181 ppm
3) R 8565 S 6420 Z 0000 CONC (3) 181 ppm
AVE CONC 181 ppm

2ND ANALYSIS: DATE ANALYST
1) Z R S CONC (1)
2) R Z S CONC (2)
3) R S Z CONC (3)
AVE CONC

THIS CALIBRATION STANDARD HAS BEEN CERTIFIED VERSUS EPA TRACEABILITY
PROTOCOL NO. 1, PROCEDURE G1, AND ANALYSES PERFORMED PER SECTION 3.0.4.
CERTIFIED CONCENTRATION: Recertification Values Nitric Oxide = 181ppm;
Sulfur Dioxide = 50.4 ppm; Nitrogen = Balance

APPROVED BY J. Long LABORATORY MANAGER
A member of The BOC Group





After Scrubber
Protocol I

AIRCO Special Gases
 An operating unit of The BOC Group, Inc.
 Union Landing & River Roads
 P.O. Drawer No. 272
 Riverton
 New Jersey 08077
 Telephone: Marketing: 609-829-7878
 Prod. & Admin.: 609-829-7914
 International: 609-829-7917

CERTIFICATION OF ANALYSIS

CUSTOMER AIG Acton REFERENCE NO. 04519
 DATE 8/12/90 EXP. DATE 2/12/92

CYLINDER NO. CC-17379 CYLINDER PRESSURE 2000 psig BALANCE GAS N2

REFERENCE STANDARD

SRM NO. 1686B CYLINDER NO. FF-144 CONCENTRATION 214 ppm
470 ppm NO/N2 GMIS NO/N2

INSTRUMENT

MAKE Beckman MODEL 952 SERIAL NO. 0100204

PRINCIPLE Chemiluminescence LAST MULTIPOINT CALIBRATION DATE 6/1/90

COMPONENT NO

ANALYSIS

DATE	ZERO GAS	STD	SAMPLE
8/7/90			
TRIAL 1	0000	10011	8420
TRIAL 2	0001	10009	8466
TRIAL 3	0000	10015	8517
8/12/90			
TRIAL 1	0001	9923	8439
TRIAL 2	0002	9959	8470
TRIAL 3	0000	9968	8477

FIRST ANALYSIS CONCENTRATION 181 ppm SECOND ANALYSIS CONCENTRATION 182 ppm
 EAN CONCENTRATION 182 ppm CHRONOLOGY 2/12/92
 TRACEABLE TO NBS PER EPA PROTOCOL - REV. JUNE 9, 1987
 PERFORMED ACCORDING TO SECTION 3.0.4

ANALYZED BY: _____ (LAB MANAGER)

DATE: _____

This report states and certifies the results of the analysis performed under the conditions stated on this Analytical Certificate. The data entry has been computerized. See the user's manual for details.

Union Landing & River Roads
 P.O. Drawer No. 272
 Riverton
 N/w Jersey 08077
 Telephone: Marketing: 609-829-7878
 Prod. & Admin.: 609-829-7914
 International: 609-829-7917

Customer: AIG Acton
 Test No: 04519
 Cyl. No: CC-17379
 Standard: 214ppm NO/N2

CALCULATIONS

DATE: 8/7/90
 INSTRUMENT: Beckman

SAMPLE: CC-17379

<u>STD</u>	<u>SAMPLE</u>				
10011	8420	$\frac{8420}{10011}$	x 214 ppm	STD =	180 ppm NO
10009	8466	$\frac{8466}{10009}$	x 214 ppm	STD =	181 ppm NO
10015	8517	$\frac{8517}{10015}$	x 214 ppm	STD =	182 ppm NO
				AVG =	181 ppm NO/N2

DATE: 8/12/90
 INSTRUMENT: Beckman

SAMPLE: CC-17379

<u>STD</u>	<u>SAMPLE</u>				
9923	8439	$\frac{8439}{9923}$	x 214 ppm	STD =	182 ppm NO
9959	8470	$\frac{8470}{9959}$	x 214 ppm	STD =	182 ppm NO
9968	8477	$\frac{8477}{9968}$	x 214 ppm	STD =	182 ppm NO
				AVG =	182 ppm NO/N2

Overall AVG = 182ppm NO/N2

By J. Long
 Authorized Signature

This report is the property of the manufacturer and is loaned to the user. It is to be used for the purpose stated and is not to be distributed outside the user's organization. The user is responsible for the safekeeping of this report and for its return to the manufacturer upon completion of the analysis. The manufacturer shall not be held responsible for any damage to the user's equipment or for any loss of data or information. The manufacturer shall not be held responsible for any damage to the user's equipment or for any loss of data or information. The manufacturer shall not be held responsible for any damage to the user's equipment or for any loss of data or information.

An operating unit of The EOC Group, Inc.

Union Landing & River Roads
 P.O. Drawer No. 272
 Riverton
 New Jersey 08077
 Telephone: Marketing: 609-829-7878
 Prod. & Admin: 609-829-7914
 International: 609-829-7917

CERTIFICATION OF ANALYSIS

CUSTOMER AIG Acton REFERENCE NO. 04519

DATE 8/14/90 EXP. DATE 2/14/92

CYLINDER NO. CC-11379 CYLINDER PRESSURE 2000 PSI/g BALANCE GAS N2

REFERENCE STANDARD

SRM NO. 1694A CYLINDER NO. FT-26690 CONCENTRATION 94.3

INSTRUMENT

MAKE DuPont MODEL 411 SERIAL NO. 310059

PRINCIPLE UV Photometric LAST MULTIPOINT CALIBRATION DATE 8/8/90

COMPONENT SO2

ANALYSIS

DATE	ZERO GAS	STD	SAMPLE
8/8/90			
TRIAL 1	0001	0138	072
TRIAL 2	0001	0136	072
TRIAL 3	0001	0136	073
8/14/90			
TRIAL 1	0001	133	071
TRIAL 2	0001	134	070
TRIAL 3	0001	134	071

FIRST ANALYSIS CONCENTRATION 49.9 ppm SECOND ANALYSIS CONCENTRATION 49.8 ppm
 MEAN CONCENTRATION 49.9 ppm CHRONOLOGY 2/14/92
 TRACEABLE TO NBS PER EPA PROTOCOL - REV. JUNE 9, 1987
 PERFORMED ACCORDING TO SECTION 3.0.4

By _____
 Authorized Representative of AIRCO

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UNION CARBIDE CORPORATION
 P.O. Drawer No. 272
 Ridgely
 New Jersey 08077
 Telephone: Marketing: 609-829-7878
 Prod. & Admin.: 609-829-7814
 International: 609-829-7917

Customer: AIG Acton
 Test No: 04519
 Cyl. No: CC-17379
 Standard: 94.3 ppm SO2/N2

CALCULATIONS

DATE: 8/8/90
 INSTRUMENT: Beckman

SAMPLE: CC-17379

<u>STD</u>	<u>SAMPLE</u>				
		$\frac{072}{138}$	x 94.3 ppm	STD =	49.2 ppm
138	072				
136	072				
136	073				
		$\frac{072}{136}$	x 94.3 ppm	STD =	49.9 ppm
		$\frac{073}{136}$	x 94.3 ppm	STD =	50.6 ppm
				AVG =	49.9 ppm

DATE: 8/14/90
 INSTRUMENT: Beckman

SAMPLE: CC-17379

<u>STD</u>	<u>SAMPLE</u>				
		$\frac{071}{133}$	x 94.3 ppm	STD =	50.3 ppm
133	071				
134	070				
134	071				
		$\frac{070}{134}$	x 94.3 ppm	STD =	49.3 ppm
		$\frac{071}{134}$	x 94.3 ppm	STD =	49.7 ppm
				AVG =	49.8 ppm

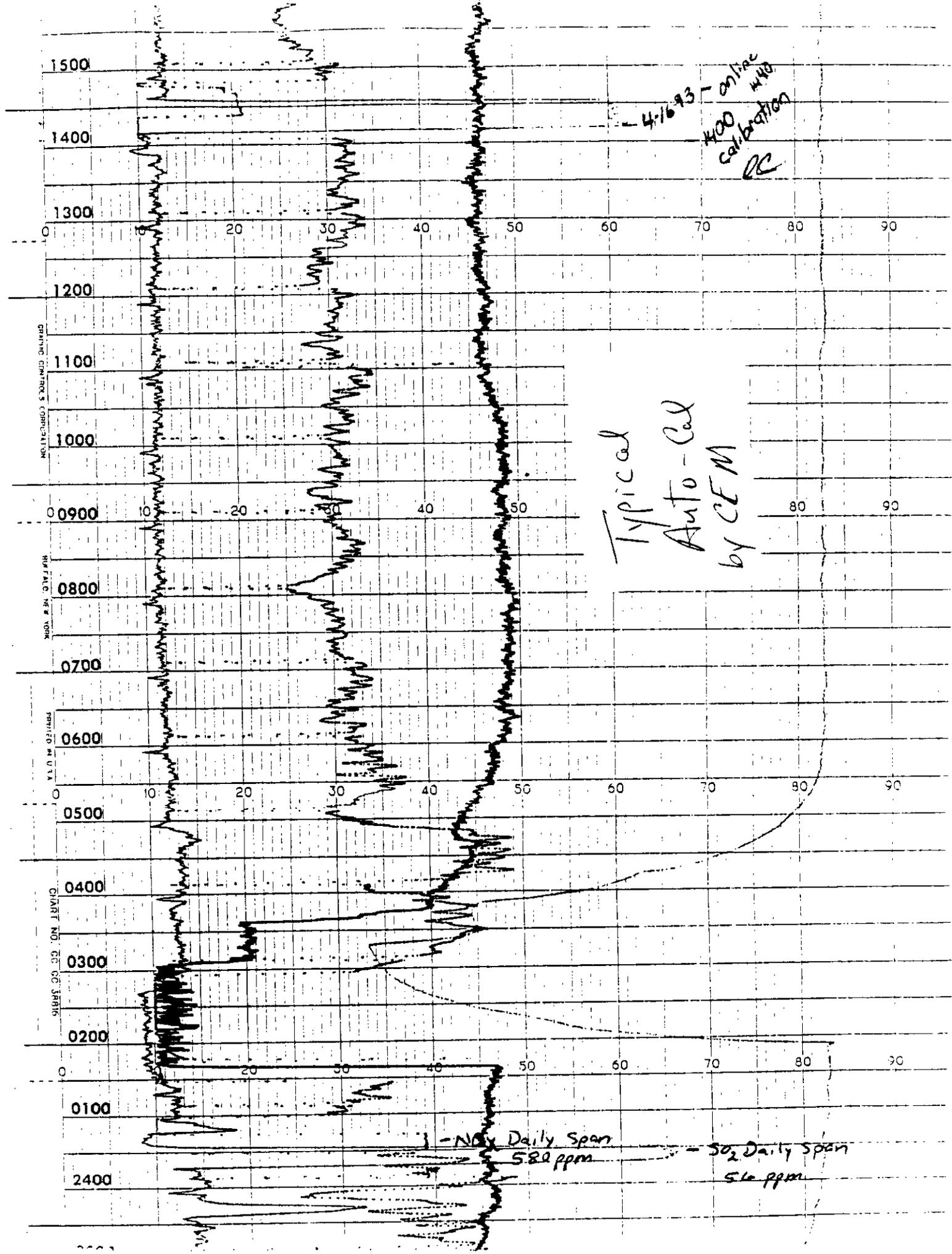
Overall AVG = 49.9 ppm SO2/N2

By J. Long
 Authorized Signature

This report states accurately the results of the investigation made upon the materials submitted to the Analytical Laboratory. The Laboratory has endeavored to follow the proper procedures to determine, and to present, the information requested. However, the user is responsible for the accuracy of the information submitted and the results reported. The user is also responsible for the accuracy of the information submitted and the results reported. The user is also responsible for the accuracy of the information submitted and the results reported.

APPENDIX F

Examples of Completed Dragon Daily CEM Inspection Checklists



4-16-93 - online
H₂O calibration
RC

Typical
Auto-Cal
by CEM

NOx Daily Span
580 ppm

SO₂ Daily Span
510 ppm

AFTER SCRUBBER STACK SO₂-NO_x DAILY LOG

Enviroplan CEMEX System 20 ml Dilution Probe = 250:1 TECO Model 43 SO ₂ Analyzer S/N ASM-10153-114 Range 0-100 ppm SO ₂ (65 ppm Setting) TECO Model 42 NO _x Analyzer S/N 42-27835-230 Range 0-2000 ppm NO _x (10 ppm Setting) ZERO Offset 10% OF Full Scale		Span Gas Cyl. # 1737 Lab Ref. # 13530 Vendor A.F.C.O. Certified SO ₂ /NO _x Conc. 49 / 52.6 ppm Conc. vs. Prot I Stnd. /		Protocol I Stnd. Cyl. # 1737 Lab Ref. # 2116, Vendor A.F.C.O. Certified SO ₂ /NO _x Conc. 50.4 / 18.1 ppm							
Date	Equipment Operator	Room Temp. °C	Max/Min	4-18-93	4-19-93	4-20-93	4-21-93	4-22-93	4-23-93	4-24-93	
D	Dilution Air Press	50 PSI	± 0.5								
L	Sample Vac. >	14.6 in. Hg									
U	Probe Heater										
I	Plant Air Supply >	50 PSI									
B											
E											
I											
E											
O											
N											
D	Parameter	SO ₂	NO _x	SO ₂	NO _x	SO ₂	NO _x	SO ₂	NO _x	SO ₂	NO _x
A	Unadj. Zero ppm (less offset)	0	0	0.5	0	0	0	1.5	0	1.5	0
I	Unadj. Span ppm (less unadj. zero)	175	180	50	180	50	180	50	180	50	180
L	Span Drift % (Computer)	44	164	54	173	42	168	47	164	47	164
T	Adjusted Zero ppm (less offset)										
Y	Adjusted Span ppm (less adj. zero)										
S	New Pot. Setting										
S	Sample Flowmeter (MOB)			2.75			7.70			2.75	
O	Adjusted Zero ppm (less offset)										
2	Adjusted Span ppm (less adj. zero)										
N	ma Output Recorder Display Chart										
O	ma Output Recorder Display Chart										
X	Digital Disp. Rndg. Before Calib.										
	Digital Disp. Rndg. After Calib.										
	NO _x Converter Temp.										

Comments 4-18-93 scrubber on line also
ALL SPANS PROTOCOL I

*ppm = (ma Output - 4) (Full Scale)
16

Zero Limits	Span Limits	Corrective Action
0 ± 25 ppm	0 ± 10%	No Adjustment Needed. Data Acceptable.
+ 25 - ± 50 ppm	± 10% - ± 25%	Adjust Analyzer. Data Acceptable If Corrected.
> 50 ppm	> 25%	Invalidate Data. Troubleshoot/Recalibrate Analyzer.

AFTER SCRUBBER STACK SO₂-NO_x DAILY LOG

Enviroplan CEMEX System 20 ml Dilution Probe = 250:1 TECO Model 43 SO ₂ Analyzer S/N ASM-10153-114 Range 0-100 ppm SO ₂ (.5 ppm Setting) TECO Model 42 NO _x Analyzer S/N 42-27835-230 Range 0-2000 ppm NO _x (10 ppm Setting) Zero Offset 10% of Full Scale	Span Gas Cyl. #324 Lab Ref. 13520 Vendor A, C, C Certified SO ₂ /NO _x Conc. 49/526 ppm Conc. vs. Prot I Stnd. 50/526 ppm	Protocol I Stnd. Cyl. #324 Lab Ref. 12166 Vendor A, V, C Certified SO ₂ /NO _x Conc. 50/481 ppm
--	--	---

Date	5-2-93	5-3-93	5-4-93	5-5-93	5-6-93	5-7-93	5-8-93
Equipment Operator							
Room Temp. °C. Max/Min							
Dilution Air Press 50 PSI ± 0.5							
Sample Vac. > 14.6 in. Hg							
Probe Heater							
Plant Air Supply > 50 PSI							
Parameter							
SO ₂							
NO _x							
Recorder (Zero Drift)							
Computer							
Unadj. Zero ppm (less offset)							
Unadj. Span ppm (less unadj. zero)							
Span Drift % (Computer)							
Adjusted Zero ppm (less offset)							
Adjusted Span ppm (less adj. zero)							
New Pot. Setting							
Sample Flowmeter (MOB)							
Adjusted Zero ppm (less offset)							
Adjusted Span ppm (less adj. zero)							
Digital Disp. Rdnng. Zero							
Digital Disp. Rdnng. Span							
NO _x Converter Temp.							

Comments
 5-7-93 reset zero on SO₂ Analyzer
 Sample flow in SO₂ seems to be dropping

ppm = (ma Output - A) / (Full Scale)

Zero Limits	Span Limits	Corrective Action
0 - ± 25 ppm	0 - ± 10%	No Adjustment Needed, Data Acceptable.
+ 25 - ± 50 ppm	± 10% - ± 25%	Adjust Analyzer, Data Acceptable If Corrected.
> 50 ppm	> 25%	Invalidate Data, Troubleshoot/Recalibrate Analyzer.

AFTER SCRUBBER STACK SO₂-NO_x DAILY LOG

Enviroplan CEMEX System
 20 ml Dilution Probe = 250:1
 TECO Model 43 SO₂ Analyzer S/N ASM-10153-114
 Range 0-100 ppm SO₂ (15 ppm Setting)
 TECO Model 42 NO_x Analyzer S/N 42-27835-230
 Range 0-2000 ppm NO_x (10 ppm Setting)
 Zero Offset 10% of Full Scale

Span Gas
 Cyl. #3349 Lab Ref. 113530
 Vendor ALCOD
 Certified SO₂/NO_x Conc. 49/526 ppm
 Conc. vs. Prot I Std. 50/522 ppm

Protocol I Std.
 Cyl. 113530 Lab Ref. 12111
 Vendor ALCOD
 Certified SO₂/NO_x Conc. 50.4/521 ppm

Date	Equipment Operator	Room Temp. °C	Max/Min	6-6-93	6-7-93	6-8-93	6-9-93	6-10-93	6-11-93	6-12-93
D	Dilution Air Press	50 PSI								
I	Sample Vac.	> 14.6 in. Hg								
L	Probe Heater									
R	Plant Air Supply	> 50 PSI								
U										
O										
T										
B										
I										
E										
O										
N										
D	Parameter									
S	Unadj. Zero ppm (less offset)	Recorder (Zero Drift) Computer	SO ₂	NO _x						
A	Unadj. Span ppm (less unadj. zero)	Recorder Computer	2	0	3	0	0	0	0	0
I	Span Drift % (Computer)	ma Output	3	1	3	1	0	1	0	0
T	Adjusted Zero ppm (less offset)	Recorder Display Chart	53	465	525	575	505	180	505	175
L	Adjusted Span ppm (less adj. zero)	ma Output	48	524	50	561	47	49	49	49
Y	New Pot. Setting	Span								
S	Sample Flowmeter (HOB)									
S	Adjusted Zero ppm (less offset)	Recorder Display Chart			4.20	0				
O	Adjusted Span ppm (less adj. zero)	ma Output			-1	0				
2	New Pot. Setting	Span			9.58					
N	Adjusted Zero ppm (less offset)	ma Output			2.75					
O	Adjusted Span ppm (less adj. zero)	ma Output			4.01	1.25				
X	Digital Disp. Rng. Zero	Before Calib.			0	0				
	Digital Disp. Rng. Span	After Calib.			0.002	0.000				
	NO _x Converter Temp. °C				178 (225)					

Comments 6-7-93 Scrubber on line 0700
 6-8-93 Velocity was erratic for 3-4 hrs 6-7-93 temporarily rolled ESI + Enviroplan
 6-8-93 but calmed down until 0830 c. 8-13 6/8 cleaned transmitters. This seemed to solve problem
 6-8-93 when I checked the NO_x converter temp it was 178°C - I moved the temp probe. It went back up to 325

ppm = (ma Output - 4) (Full Scale)
 16

Zero Limits	Span Limits	Corrective Action
0 - ± 25 ppm	0 - ± 10%	No Adjustment Needed. Data Acceptable.
+ 25 - ± 50 ppm	± 10% - ± 25%	Adjust Analyzer. Data Acceptable If Corrected.
> 50 ppm	> 25%	Invalidate Data. Troubleshoot/Recalibrate Analyzer.

AFTER SCRUBBER STACK SO₂-NO_x DAILY LOG

Enviroplan CEMEX System
 20 ml Dilution Probe = 250:1
 TECO Model 43 SO₂ Analyzer S/N ASM-10153-114
 Range 0-100 ppm SO₂ (15 ppm Setting)
 TECO Model 42 NO_x Analyzer S/N 42-27835-230
 Range 0-2000 ppm NO_x (10 ppm Setting)
 Zero Offset 10% of Full Scale

Span Gas
 Cyl. 10274 Lab Ref. #3330
 Vendor Airco
 Certified SO₂/NO_x Conc. 59/1526 ppm
 Conc. vs. Prot I Stnd. 50/1526 ppm

Protocol I Stnd.
 Cyl. 11274 Lab Ref. #32280
 Vendor Airco
 Certified SO₂/NO_x Conc. 458/228 ppm

Date	Equipment Operator	Room Temp. °C.	Max/Min	7-4-93		7-5-93		7-6-93		7-7-93		7-8-93		7-9-93	
				SO ₂	NO _x										
D															
I															
P															
L															
R															
U															
O															
T															
B															
I															
E															
R															
O															
N															
D															
S															
A															
I															
A															
L															
T															
Y															
U															
S															
S															
O															
2															
N															
O															
X															

Comments All Spans Protocol I Stnd

*ppm = (ma Output - 4) (Full Scale)

Zero Limits

0 - ± 25 ppm
 ± 25 - ± 50 ppm
 > 50 ppm

Span Limits

0 - ± 10%
 ± 10% - ± 25%
 > 25%

Corrective Action

No Adjustment Needed. Data Acceptable.
 Adjust Analyzer. Data Acceptable If Corrected.
 Invalidate Data. Troubleshoot/Recalibrate Analyzer.

AFTER SCRUBBER STACK SO₂-NO_x DAILY LOG

Enviroplan CEMEX System		Span Gas		Protocol I Stnd.			
20 ml Dilution Probe = 250:1		Cyl. 16329 Lab Ref. 113580		Cyl. 11774 Lab Ref. 132280			
TECO Model 43 SO ₂ Analyzer S/N ASM-10153-1114		Vendor A.C.C.O.		Vendor A.V.C.S.			
Range 0-100 ppm SO ₂ (15 ppm Setting)		Certified SO ₂ /NO Conc. 4915.6 ppm		Certified SO ₂ /NO Conc. 4581.4 ppm			
TECO Model 42 NO _x Analyzer S/N 42-27835-230		Conc. vs. Prot I Stnd. 505.2 ppm					
Range 0-2000 ppm NO _x (10 ppm Setting)							
Zero Offset 10% of Full Scale							
Date	8-1-93	8-2-93	8-3-93	8-4-93	8-5-93	8-6-93	8-7-93
Equipment Operator	/	OC	/	/	/	OC	/
Room Temp. °C		23.20				22.21	
Dilution Air Press	50 PSI	50.0				50.0	
Sample Vac. > 14.6 in. Hg		21.4				21.3	
Probe Heater		O.K.				O.K.	
Plant Air Supply > 50 PSI		60				68	
Parameter							
SO ₂	NO _x	SO ₂	NO _x	SO ₂	NO _x	SO ₂	NO _x
Recorder (Zero Drift)	Recorder (Zero Drift)	Recorder (Zero Drift)	Recorder (Zero Drift)	Recorder (Zero Drift)	Recorder (Zero Drift)	Recorder (Zero Drift)	Recorder (Zero Drift)
Computer	Computer	Computer	Computer	Computer	Computer	Computer	Computer
Unadj. Zero ppm (less offset)	Unadj. Zero ppm (less offset)	Unadj. Zero ppm (less offset)	Unadj. Zero ppm (less offset)	Unadj. Zero ppm (less offset)	Unadj. Zero ppm (less offset)	Unadj. Zero ppm (less offset)	Unadj. Zero ppm (less offset)
Unadj. Span ppm (less unadj. zero)	Unadj. Span ppm (less unadj. zero)	Unadj. Span ppm (less unadj. zero)	Unadj. Span ppm (less unadj. zero)	Unadj. Span ppm (less unadj. zero)	Unadj. Span ppm (less unadj. zero)	Unadj. Span ppm (less unadj. zero)	Unadj. Span ppm (less unadj. zero)
Span Drift % (Computer)	Span Drift % (Computer)	Span Drift % (Computer)	Span Drift % (Computer)	Span Drift % (Computer)	Span Drift % (Computer)	Span Drift % (Computer)	Span Drift % (Computer)
Adjusted Zero ppm (less offset)	Adjusted Zero ppm (less offset)	Adjusted Zero ppm (less offset)	Adjusted Zero ppm (less offset)	Adjusted Zero ppm (less offset)	Adjusted Zero ppm (less offset)	Adjusted Zero ppm (less offset)	Adjusted Zero ppm (less offset)
Adjusted Span ppm (less adj. zero)	Adjusted Span ppm (less adj. zero)	Adjusted Span ppm (less adj. zero)	Adjusted Span ppm (less adj. zero)	Adjusted Span ppm (less adj. zero)	Adjusted Span ppm (less adj. zero)	Adjusted Span ppm (less adj. zero)	Adjusted Span ppm (less adj. zero)
New Pot. Setting	New Pot. Setting	New Pot. Setting	New Pot. Setting	New Pot. Setting	New Pot. Setting	New Pot. Setting	New Pot. Setting
Sample Flowmeter (MOB)	Sample Flowmeter (MOB)	Sample Flowmeter (MOB)	Sample Flowmeter (MOB)	Sample Flowmeter (MOB)	Sample Flowmeter (MOB)	Sample Flowmeter (MOB)	Sample Flowmeter (MOB)
Adjusted Zero ppm (less offset)	Adjusted Zero ppm (less offset)	Adjusted Zero ppm (less offset)	Adjusted Zero ppm (less offset)	Adjusted Zero ppm (less offset)	Adjusted Zero ppm (less offset)	Adjusted Zero ppm (less offset)	Adjusted Zero ppm (less offset)
Adjusted Span ppm (less adj. zero)	Adjusted Span ppm (less adj. zero)	Adjusted Span ppm (less adj. zero)	Adjusted Span ppm (less adj. zero)	Adjusted Span ppm (less adj. zero)	Adjusted Span ppm (less adj. zero)	Adjusted Span ppm (less adj. zero)	Adjusted Span ppm (less adj. zero)
Digital Disp. Rng. Zero	Digital Disp. Rng. Zero	Digital Disp. Rng. Zero	Digital Disp. Rng. Zero	Digital Disp. Rng. Zero	Digital Disp. Rng. Zero	Digital Disp. Rng. Zero	Digital Disp. Rng. Zero
Before Calib.	Before Calib.	Before Calib.	Before Calib.	Before Calib.	Before Calib.	Before Calib.	Before Calib.
Digital Disp. Rng. Span	Digital Disp. Rng. Span	Digital Disp. Rng. Span	Digital Disp. Rng. Span	Digital Disp. Rng. Span	Digital Disp. Rng. Span	Digital Disp. Rng. Span	Digital Disp. Rng. Span
Before Calib.	Before Calib.	Before Calib.	Before Calib.	Before Calib.	Before Calib.	Before Calib.	Before Calib.
NO _x Converter Temp.	NO _x Converter Temp.	NO _x Converter Temp.	NO _x Converter Temp.	NO _x Converter Temp.	NO _x Converter Temp.	NO _x Converter Temp.	NO _x Converter Temp.
		324				323	
Comments: All SPAN'S PROBE/I							
Scrubber Down 1604							
8-6-93							

*ppm = (ma Output - 4) (Full Scale)

Zero Limits

Span Limits

Corrective Action

0 - ± 25 ppm
 + 25 - ± 50 ppm
 > 50 ppm

0 - ± 10%
 ± 10% - ± 25%
 > 25%

No Adjustment Needed. Data Acceptable.
 Adjust Analyzer. Data Acceptable If Corrected.
 Invalidate Data. Troubleshoot/Recalibrate Analyzer.

APPENDIX G

Tabulation of Daily Emissions by Time Period

Period 1 Operating Data - 1991

Date	Operating Hours	Inlet		Outlet		Removal Efficiency	
		SO ₂	NOx	SO ₂	NOx	SO ₂	NOx
8/20	7	33	196	5	192	84.8	2.0
8/21	24	63	336	7	332	88.9	1.2
8/22	24	48	281	6	249	87.5	11.4
8/23	22	93	347	11	287	88.2	17.3
8/24	24	143	486	18	399	87.4	17.9
8/25	11	61	251	9	236	85.2	6.0
8/26	7	33	302	3	257	90.9	14.9
8/27	24	40	276	8	229	80.0	17.0
8/28	16	51	330	8	287	84.3	13.0
8/29	8	93	312	12	269	87.1	13.8
8/30	20	106	348	14	294	86.8	15.5
8/31	24	62	245	7	220	88.7	10.2
Total	211						
Weighted average		73	320	10	279	87.0	12.8

Period 2 Operating Data - 1991

Date	Operating Hours	Inlet		Outlet		Removal Efficiency	
		SO ₂	NOx	SO ₂	NOx	SO ₂	NOx
9/1	24	43	241	4	225	90.7	6.6
9/2	24	104	296	11	285	89.4	3.7
9/3	19	67	342	10	319	85.1	6.7
9/4	24	79	250	20	208	74.7	16.8
9/5	24	47	245	5	201	89.4	18.0
9/6	24	40	323	6	303	85.0	6.2
9/7	24	37	287	5	270	86.5	5.9
9/8	24	52	248	6	226	88.5	8.9
9/9	16	58	245	7	226	87.9	7.8
9/10	18	118	315	19	258	83.9	18.1
9/11	24	53	277	9	235	83.0	15.2
9/12	24	41	315	6	283	85.4	10.2
9/13	24	53	286	7	263	86.8	8.0
9/14	24	65	260	9	261	86.2	-0.4
9/15	1	80	295	10	252	87.5	14.6
9/16	1	242	413	24	393	90.1	4.8
9/17	22	190	284	26	250	86.3	12.0
9/18	9	112	411	12	376	89.3	8.5
9/19	8	157	531	17	484	89.2	8.9
*9/20							
*9/21							
*9/22							
9/23	7	59	236	13	219	78.0	7.2
9/24	24	36	289	36	281	0.0	2.8
9/25	15	90	338	11	305	87.8	9.8
9/26	24	45	356	5	356	88.9	0.0
9/27	18	36	214	5		86.1	
9/28	18	72	290	3	253	95.8	12.8
9/29	12	189	348	18	305	90.5	12.4
*9/30							
Total	476						
Weighted average		71	284	11	260	84.6	8.6

*Periods when no data are shown represent days when the cement plant, the Recovery Scrubber, or the data collection system were not functioning.

Period 3 Operating Data - 1991

Date	Operating Hours	Inlet		Outlet		Removal Efficiency	
		SO ₂	NOx	SO ₂	NOx	SO ₂	NOx
10/1	12	74	251	10	219	86.5	12.7
10/2	14	123	545	10	383	91.9	29.7
10/3	10	34	238	3	151	91.2	36.6
*10/4							
10/5	6	34	242	5	345	85.3	-42.6
10/6	24	95	212	16	344	83.2	-62.3
10/7	24	51	296	6	310	88.2	-4.7
10/8	12	61	454	8	402	86.9	11.5
10/9	24	58	364	6	324	89.7	11.0
10/10	15	117	405	18	421	84.6	-4.0
10/11	11	126	274	24	284	81.0	-3.6
10/12	23	111	336	19	313	82.9	6.8
10/13	11	81	325	12	298	85.2	8.3
10/14	23	56	286	9	265	83.9	7.3
10/15	24	49	246	5	193	89.8	21.5
10/16	2	58	239	8	203	86.2	15.1
*10/17							
10/18	2	290	340	43	305	85.2	10.3
10/19	12	125	285	19	261	84.8	8.4
10/20	24	101	210	14	169	86.1	19.5
10/21	12	250	290	6	134	97.6	53.8
10/22	18	199	330	20	242	89.9	26.7
10/23	20	119	282	35	153	70.6	45.7
10/24	24	76	315	29	210	61.8	33.3
10/25	24	58	279	6	226	89.7	19.0
10/26	24	37	263	7	225	81.1	14.4
10/27	7	42	156	4	131	90.5	16.0
*10/28							
10/29	14	62	279	5	191	91.9	31.5
10/30	24	67	230	8	185	88.1	19.6
10/31	24	82	242	11	195	86.6	19.4
Total	464						
Weighted average		87	292	13	251	85.4	14.0

*Periods when no data are shown represent days when the cement plant, the Recovery Scrubber, or the data collection system were not functioning.

Period 4 Operating Data - 1991/1992

Date	Operating Hours	Inlet		Outlet		Removal Efficiency	
		SO ₂	NOx	SO ₂	NOx	SO ₂	NOx
11/1	16	95	186	11	130	88.4	30.1
11/2	11	154	258	15	171	90.3	33.7
*12/10							
12/11	6	48	176	9	111	81.3	36.9
*12/12							
*12/13							
12/14	8	140	259	9	179	93.6	30.9
12/15	18	186	242	15	207	91.9	14.5
12/16	7	77	201	11	166	85.7	17.4
12/17	20	76	266	7	196	90.8	26.3
12/18	20	85	250				
*12/19							
*12/20							
12/21	20	139	284	9	156	93.5	45.1
12/22	21	142	309	10	207	93.0	33.0
*12/23							
*12/24							
*12/25							
*12/26							
12/27	12	94	296	12	180	87.2	39.2
12/28	24	178	348	51	214	71.3	38.5
12/29	19	137	327	36	190	73.7	41.9
*12/30							
*12/31							
*1/1							
1/2	14	206	346	17	203	91.7	41.3
1/3	5	279	327	22	207	92.1	36.7
*1/4							
*1/5							
*1/6							
*1/7							
*1/8							
1/9	8	181	206	13	125	92.8	39.3
1/10	13	159	295	16	210	89.9	28.8
*1/11							
*1/12							
1/13	11	139	162	10	100	92.8	38.3
1/14	6	129	190	5	130	96.1	31.6
*1/15							
Total	259						
Weighted average		131	252	16	165	87.6	34.5

*Periods when no data are shown represent days when the cement plant, the Recovery Scrubber, or the data collection system were not functioning.

Period 5 Operating Data - 1992

Date	Operating Hours	Inlet		Outlet		Removal Efficiency	
		SO ₂	NOx	SO ₂	NOx	SO ₂	NOx
5/13	9	186	335	25	305	86.6	9.0
5/14	24	164	313	16	291	90.2	7.0
5/15	24	286	358	30	322	89.5	10.1
5/16	24	117	244	14	179	88.0	26.6
5/17	24	159	183	16	159	89.9	13.1
5/18	14	299	319	24	225	92.0	29.5
5/19	24	293	239	32	182	89.1	23.8
5/20	24	263	333	35	277	86.7	16.8
5/21	18	384	323	56	296	85.4	8.4
5/22	18	368	394	40	279	89.1	29.2
5/23	16	332	264	37	213	88.9	19.3
5/24	24	345	275	45	257	87.0	6.5
5/25	10	193	218	24	210	87.6	3.7
*5/26							
*5/27							
*5/28							
5/29	3	53	362	6	291	88.7	19.6
5/30	24	190	346	20	260	89.5	24.9
5/31	24	166	263	10	209	94.0	20.5
Total	304						
Weighted average		245	293	28	243	88.7	17.1

*Periods when no data are shown represent days when the cement plant, the Recovery Scrubber, or the data collection system were not functioning.

Period 6 Operating Data - 1992

Date	Operating Hours	Inlet		Outlet		Removal Efficiency	
		SO ₂	NOx	SO ₂	NOx	SO ₂	NOx
6/1	2	184	222	13	176	92.9	20.7
*6/2							
*6/10							
6/11	14	220	321	22	246	90.0	23.4
6/12	18	254	265	25	189	90.2	28.7
6/13	18	165	238	21	163	87.3	31.5
6/14	16	290	244	34	178	88.3	27.0
*6/15							
*6/16							
*6/17							
6/18	9	242	270	29	189	88.0	30.0
6/19	24	321	297	34	197	89.4	33.7
6/20	18	153	197	11	174	92.8	11.7
*6/21							
*6/22							
*6/23							
6/24	2	129	66	10	51	92.2	22.7
6/25	14	154	236	12	168	92.2	28.8
6/26	24	146	321	6	305	95.9	5.0
6/27	24	309	271	18	211	94.2	22.1
6/28	15	405	280	37	204	90.9	27.1
6/29	1	425	261	46	200	89.2	23.4
*6/30							
7/16	12	118	235	11	171	90.7	27.2
7/17	24	224	245	24	194	89.3	20.8
7/18	24	237	234	34	210	85.7	10.3
7/19	14	242	244	27	200	88.8	18.0
7/20	22	252	270	34	262	86.5	3.0
*7/21							
7/22	1	122	341	54	210	55.7	38.4
*7/23							
*7/24							
*7/25							
*7/26							
*7/27							
7/28	12	186	239	23	177	87.6	25.9
7/29	24	187	313	31	281	83.4	10.2
7/30	24	98	209	84	159	14.3	23.9
7/31	23	232	345	22	225	90.5	34.8
Total	379						
Weighted average		222	265	28	208	87.4	21.3

*Periods when no data are shown represent days when the cement plant, the Recovery Scrubber, or the data collection system were not functioning.

Period 7 Operating Data - 1992

Date	Operating Hours	Inlet		Outlet		Removal Efficiency	
		SO ₂	NOx	SO ₂	NOx	SO ₂	NOx
8/1	24	273	304	31	234	88.6	23.0
8/2	24	275	385	30	301	89.1	21.8
8/3	2	205	268	23	236	88.8	11.9
*8/4	0						
8/5	12	148	362	19	261	87.2	27.9
8/6	24	320	347	24	209	92.5	39.8
8/7	19	372	316	35	238	90.6	24.7
8/8	23	367	369	43	286	88.3	22.5
8/9	24	493	376	69	323	86.0	14.1
8/10	24	434	421	25	215	94.2	48.9
8/11	24	373	399	24	244	93.6	38.8
8/12	24	58	338	4	207	93.1	38.8
8/13	24	150	353	5	204	96.7	42.2
8/14	24	239	313	29	264	87.9	15.7
8/15	23	259	297	34	247	86.9	16.8
*8/16							
*8/17							
*8/18							
8/19	9	247	259	28	185	88.7	28.6
8/20	11	174	227	18	156	89.7	31.3
*8/21							
*8/22							
*8/23							
*8/24							
*8/25							
*8/26							
*8/27							
*8/28							
*8/29							
*8/30							
8/31	13	121	353	14	270	88.4	23.5
Total	328						
Weighted average		281	345	28	244	90.1	29.3

*Periods when no data are shown represent days when the cement plant, the Recovery Scrubber, or the data collection system were not functioning.

Period 8 Operating Data - 1992

Date	Operating Hours	Inlet		Outlet		Removal Efficiency	
		SO ₂	NOx	SO ₂	NOx	SO ₂	NOx
9/1	8	149	407	16	309	89.3	24.1
*9/2							
*9/3							
*9/4							
*9/5							
*9/6							
*9/7	10	68	345	6	163	91.2	52.8
*9/8	16	124	312	9	173	92.7	44.6
*9/9	24	193	319	11	117	94.3	63.3
9/10	6	216	348	40	118	81.5	66.1
9/11	9	169	274	11	165	93.5	39.8
9/12	24	88	307	8	244	90.9	20.5
9/13	24	108	229	10	183	90.7	20.1
9/14	17	135	245	10	182	92.6	25.7
*9/15							
*9/16							
*9/17							
9/18	14	241	320	24	242	90.0	24.4
9/19	24	112	301	8	208	92.9	30.9
9/20	24	94	261	7	177	92.6	32.2
9/21	7	171	228	7	161	95.9	29.4
*9/22							
9/23	6	93	200	9	178	90.3	11.0
*9/24							
*9/25							
*9/26							
*9/27							
9/28	16	83	228	7	158	91.6	30.7
9/29	24	88	264	8	196	90.9	25.8
9/30	24	136	258	11	195	91.9	24.4
10/1	24	98	246	7	194	92.9	21.1
Total	301						
Weighted average		124	278	10	188	91.8	32.4

*Periods when no data are shown represent days when the cement plant, the Recovery Scrubber, or the data collection system were not functioning.

Period 9 Operating Data - 1993

Date	Operating Hours	Inlet		Outlet		Removal Efficiency	
		SO ₂	NOx	SO ₂	NOx	SO ₂	NOx
4/13	9	24	275	3	267	87.5	2.9
4/14	9	10	280	2	252	80.0	10.0
4/15	24	27	244	4	223	85.2	8.6
4/16	23	21	237	3	210	85.7	11.4
*4/17							
4/18	20	24	289	4	221	83.3	23.5
4/19	24	27	305	3	224	88.9	26.6
4/20	22	53	202	4	154	92.5	23.8
4/21	16	54	211	11	168	79.6	20.4
4/22	11	52	200	20	113	61.5	43.5
4/23	6	31	142	3	87	90.3	38.7
4/24	22	27	195	4	139	85.2	28.7
4/25	16	46	210	10	153	78.3	27.1
4/26	22	56	213	11	175	80.4	17.8
4/27	24	46	221	6	202	87.0	8.6
4/28	21	77	213	7	185	90.9	13.1
4/29	21	74	271	9	216	87.8	20.3
4/30	24	104	297	11	242	89.4	18.5
Total	314						
Weighted average		47	240	7	194	85.7	19.0

*Periods when no data are shown represent days when the cement plant, the Recovery Scrubber, or the data collection system were not functioning.

Period 10 Operating Data - 1993

Date	Operating Hours	Inlet		Outlet		Removal Efficiency	
		SO ₂	NOx	SO ₂	NOx	SO ₂	NOx
5/1	24	67	306	8	231	88.1	24.5
5/2	24	19	259	4	234	78.9	9.7
5/3	24	25	244	5	237	80.0	2.9
5/4	24	42	304	7	260	83.3	14.5
5/5	23	25	222	5	190	80.0	14.4
5/6	20	19	234	4	193	78.9	17.5
5/7	18	19	241	3	200	84.2	17.0
5/8	24	70	242	9	224	87.1	7.4
5/9	24	50	246	8	220	84.0	10.6
5/10	24	28	227	2	211	92.9	7.0
5/11	17	86	224	10	188	88.4	16.1
5/12	24	31	191	5	179	83.9	6.3
5/13	17	34	186	4	170	88.2	8.6
5/14	24	32	205	4	193	87.5	5.9
5/15	24	27	227	4	207	85.2	8.8
5/16	24	65	260	8	257	87.7	1.2
5/17	6	28	248	4	238	85.7	4.0
5/18	10	122	340	14	327	88.5	3.8
*5/19							
5/20	21	40	265	5	233	87.5	12.1
5/21	6	13	251	2	240	84.6	4.4
*5/22	0						
Total	402						
Weighted average		41	244	6	218	86.1	10.5

*Periods when no data are shown represent days when the cement plant, the Recovery Scrubber, or the data collection system were not functioning.

Period 11 Operating Data - 1993

Date	Operating Hours	Inlet		Outlet		Removal Efficiency	
		SO ₂	NOx	SO ₂	NOx	SO ₂	NOx
*6/1							
*6/2							
*6/3							
6/4	10	53	261	8	236	84.9	9.6
*6/5							
*6/6							
6/7	16	58	280	9	288	84.5	-2.9
6/8	24	88	416	12	391	86.4	6.0
6/9	24	69	344	10	298	85.5	13.4
6/10	24	59	282	8	245	86.4	13.1
6/11	24	31	335	5	284	83.9	15.2
6/12	24	33	345	6	297	81.8	13.9
6/13	24	50	290	7	231	86.0	20.3
6/14	24	56	275	7	222	87.5	19.3
6/15	24	34	307	7	250	79.4	18.6
6/16	24	23	297	4	235	82.6	20.9
6/17	22	30	332	5	263	83.3	20.8
6/18	24	16	325	3	254	81.3	21.8
6/19	24	17	308	3	230	82.4	25.3
6/20	10	20	316	3	237	85.0	25.0
*6/21							
*6/22							
6/23	20	9	387	3	342	66.7	11.6
6/24	24	9	270	3	259	66.7	4.1
6/25	24	26	307	5	259	80.8	15.6
6/26	24	40	302	6	247	85.0	18.2
6/27	24	19	308	5	260	73.7	15.6
6/28	10	16	242	10	240	37.5	0.8
6/29	12	14	331	3	293	78.6	11.5
*6/30							
Total	460						
Weighted average		36	315	6	267	83.4	15.0

*Periods when no data are shown represent days when the cement plant, the Recovery Scrubber, or the data collection system were not functioning.

Period 12 Operating Data - 1993

Date	Operating Hours	Inlet		Outlet		Removal Efficiency	
		SO ₂	NOx	SO ₂	NOx	SO ₂	NOx
*7/1							
7/2	13	39	416	3	383	92.3	7.9
7/3	24	11	311	2	261	81.8	16.1
7/4	12	17	233	2	194	88.2	16.7
7/5	5	77	451	3	330	96.1	26.8
7/6	24	105	391	3	282	97.1	27.9
7/7	18	94	303	2	233	97.9	23.1
7/8	16	59	398	3	279	94.9	29.9
7/9	24	62	360	2	250	96.8	30.6
7/10	19	77	296	2	188	97.4	36.5
7/11	24	47	358	2	236	95.7	34.1
7/12	20	51	349	2	259	96.1	25.8
7/13	24	44	344	2	335	95.5	2.6
7/14	24	46	308	2	303	95.7	1.6
7/15	24	19	314	2	322	89.5	-2.5
7/16	24	11	270	2	275	81.8	-1.9
7/17	19	27	311	3	354	88.9	-13.8
7/18	24	12	271	3	254	75.0	6.3
7/19	24	46	337	2	299	95.7	11.3
7/20	13	49	302	2	263	95.9	12.9
7/21	20	108	308	2	305	98.1	1.0
7/22	20	20	315	2	278	90.0	11.7
7/23	8	106	320	3	297	97.2	7.2
*7/24							
*7/25							
7/26	12	59	385	4	349	93.2	9.4
7/27	24	61	311	2	298	96.7	4.2
7/28	18	118	365	2	330	98.3	9.6
7/29	24	101	355	3	337	97.0	5.1
7/30	24	121	425	3	393	97.5	7.5
7/31	24	60	299	3	293	95.0	2.0
Total	549						
Weighted average		57	333	2	291	95.9	12.4

*Periods when no data are shown represent days when the cement plant, the Recovery Scrubber, or the data collection system were not functioning.

Period 13 Operating Data - 1993

Date	Operating Hours	Inlet		Outlet		Removal Efficiency	
		SO ₂	NOx	SO ₂	NOx	SO ₂	NOx
8/1	24	115	252	2	248	98.3	1.6
8/2	23	158	291	2	261	98.7	10.3
8/3	8	105	326	3	286	97.1	12.3
8/4	22	163	337	3	305	98.2	9.5
8/5	24	128	302	3	300	97.7	0.7
8/6	8	69	249	2	243	97.1	2.4
*8/7							
*8/8							
8/9	10	134	335	3	352	97.8	-5.1
*8/10							
8/11	24	47	260	2	217	95.7	16.5
8/12	15	103	237	2	197	98.1	16.9
8/13	24	53	260	2	203	96.2	21.9
8/14	18	110	252	2	201	98.2	20.2
*8/15							
8/16	16	52	212	2	168	96.2	20.8
8/17	19	11	295	2	215	81.8	27.1
8/18	24	36	254	2	179	94.4	29.5
8/19	24	9	277	2	188	77.8	32.1
8/20	24	16	238	2	152	87.5	36.1
8/21	18	39	327	2	208	94.9	36.4
8/22	24	10	268	2	180	80.0	32.8
8/23	6	7	220	2	159	71.4	27.7
*8/24							
8/25	15	33	299	4	196	87.9	34.4
8/26	6	29	251	4	172	86.2	31.5
8/27	4	24	322	4	251	83.3	22.0
8/28	14	69	306	7	236	89.9	22.9
8/29	22	160	410	14	273	91.3	33.4
8/30	24	193	317	16	217	91.7	31.5
8/31	24	198	356	14	227	92.9	36.2
Total	464						
Weighted average		86	288	4	223	95.0	22.6

*Periods when no data are shown represent days when the cement plant, the Recovery Scrubber, or the data collection system were not functioning.

Period 14 Operating Data - 1993

Date	Operating Hours	Inlet		Outlet		Removal Efficiency	
		SO ₂	NOx	SO ₂	NOx	SO ₂	NOx
9/1	24	66	225	8	186	87.9	17.3
9/2	24	87	232	7	161	92.0	30.6
9/3	18	334	358	23	225	93.1	37.2
9/4	24	175	353	11	197	93.7	44.2
9/5	23	233	376	14	206	94.0	45.2
9/6	14	205	365	14	229	93.2	37.3
9/7	24	324	336	21	197	93.5	41.4
9/8	24	235	274	12	127	94.9	53.6
9/9	12	157	238	9	143	94.3	39.9
9/10	24	116	203	9	149	92.2	26.6
9/11	24	68	213	8	294	88.2	-38.0
9/12	20	78	270	3	218	96.2	19.3
*9/13							
9/14	10	68	276	7	345	89.7	-25.0
9/15	24	58	227	6	197	89.7	13.2
9/16	24	43	214	6	200	86.0	6.5
9/17	16	54	203	7	187	87.0	7.9
9/18	4	45	243	6	170	86.7	30.0
9/19	20	36	296	8	223	77.8	24.7
9/20	19	38	290	7	198	81.6	31.7
9/21	24	43	293	3	194	93.0	33.8
9/22	9	44	257	3	164	93.2	36.2
*9/23							
Total	405						
Weighted average		124	274	9	199	92.4	27.4

*Periods when no data are shown represent days when the cement plant, the Recovery Scrubber, or the data collection system were not functioning.

APPENDIX H

Tabulation of Selected Inlet/Outlet SO₂ Data and
Corresponding Removal Efficiencies

RECOVERY SCRUBBER SO2 SCRUBBING EFFICIENCY 1993

Less than 100lb/H SO2 input:

IN	OUT	RECOVERY	IN	OUT	RECOVERY
22	3	96.4	20	5	75.0
12	2	83.3	9	3	62.5
72	7	90.3	28	4	85.7
63	6	90.5	14	4	71.4
16	4	75.0	14	3	78.6
15	3	80.0	18	4	77.8
74	19	74.3	43	7	83.7
34	16	52.9	12	3	75.0
17	2	88.2	22	3	86.4
5	2	60.0	6	3	50.0
23	4	82.6	14	3	78.6
14	4	71.4	9	2	77.8
10	3	70.0	13	1	92.3
27	4	85.2	98	3	96.9
99	10	89.9	94	2	97.9
29	5	82.8	13	3	76.9
50	7	86.0	14	3	78.6
23	4	82.6	9	2	77.8
15	4	73.3	13	1	92.3
32	4	87.5	98	3	96.9
29	6	79.3	94	2	97.9
28	2	92.9	13	3	76.9
92	11	88.0	27	2	92.6
16	4	75.0	27	2	92.6
57	6	89.5	74	2	97.3
53	9	83.0	8	3	62.5
35	5	85.7	16	2	87.5
34	5	85.3	16	2	87.5
49	5	89.8	7	2	71.4
29	4	86.2	57	2	96.5
28	5	82.1	6	1	83.3
83	9	89.2	56	2	96.4
6	2	66.7	11	3	72.7
8	2	75.0	90	3	96.7
30	5	83.3	69	3	95.7
80	10	87.5	42	2	95.2
76	8	89.5	43	2	95.3
37	6	83.8	55	3	94.5
39	5	87.2	5	2	60.0
6	2	66.7	16	2	87.5
25	5	80.0	4	1	75.0
31	5	83.9	12	2	83.3
13	5	61.5	4	1	75.0
9	3	62.5	9	2	77.8
			43	4	90.7
				Average	82.0%

Note: One pair of data were collected from each day of RS operation during 1993: usually the third from the last hour providing the input was less than 100lb/H.

100-200Lb/H SO2 indu

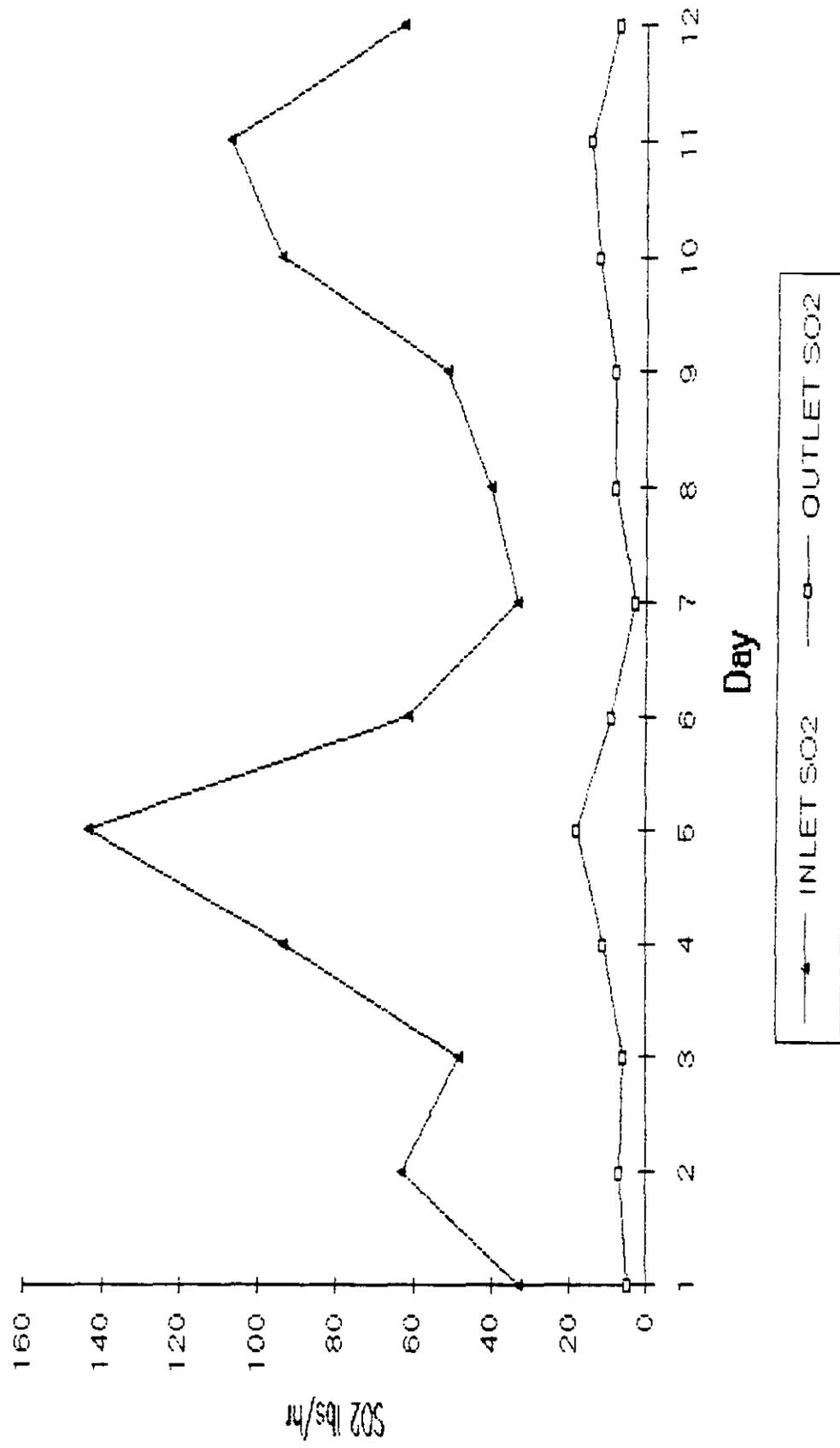
IN	OUT	RE
108	11	
177	12	
140	10	
106	25	
101	11	
156	14	
142	15	
113	12	
126	16	
114	13	
118	13	
180	19	

APPENDIX I

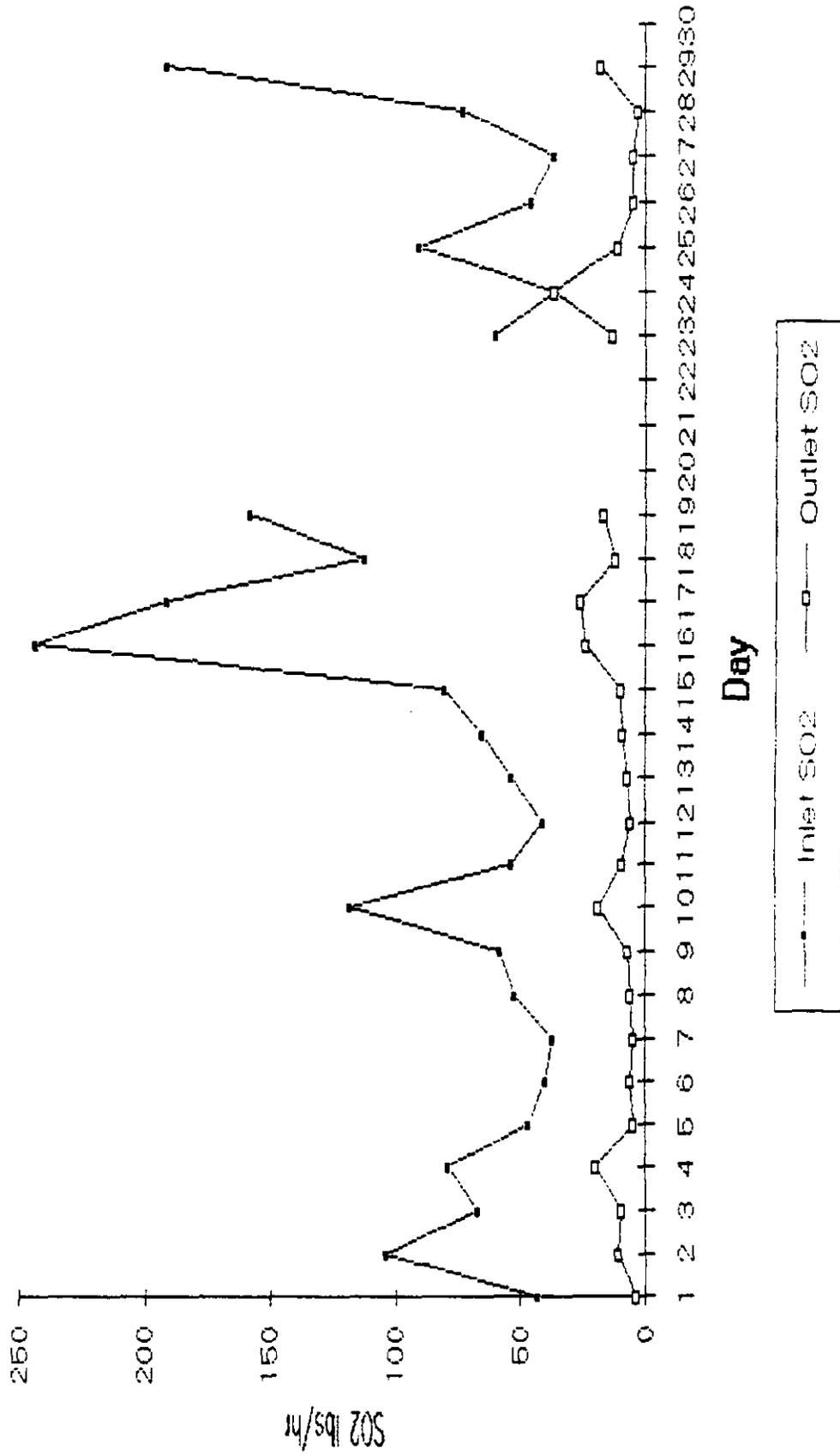
Graphs of Daily Inlet and Outlet SO₂ Emissions
versus
Time

for 14 Operational Time Periods

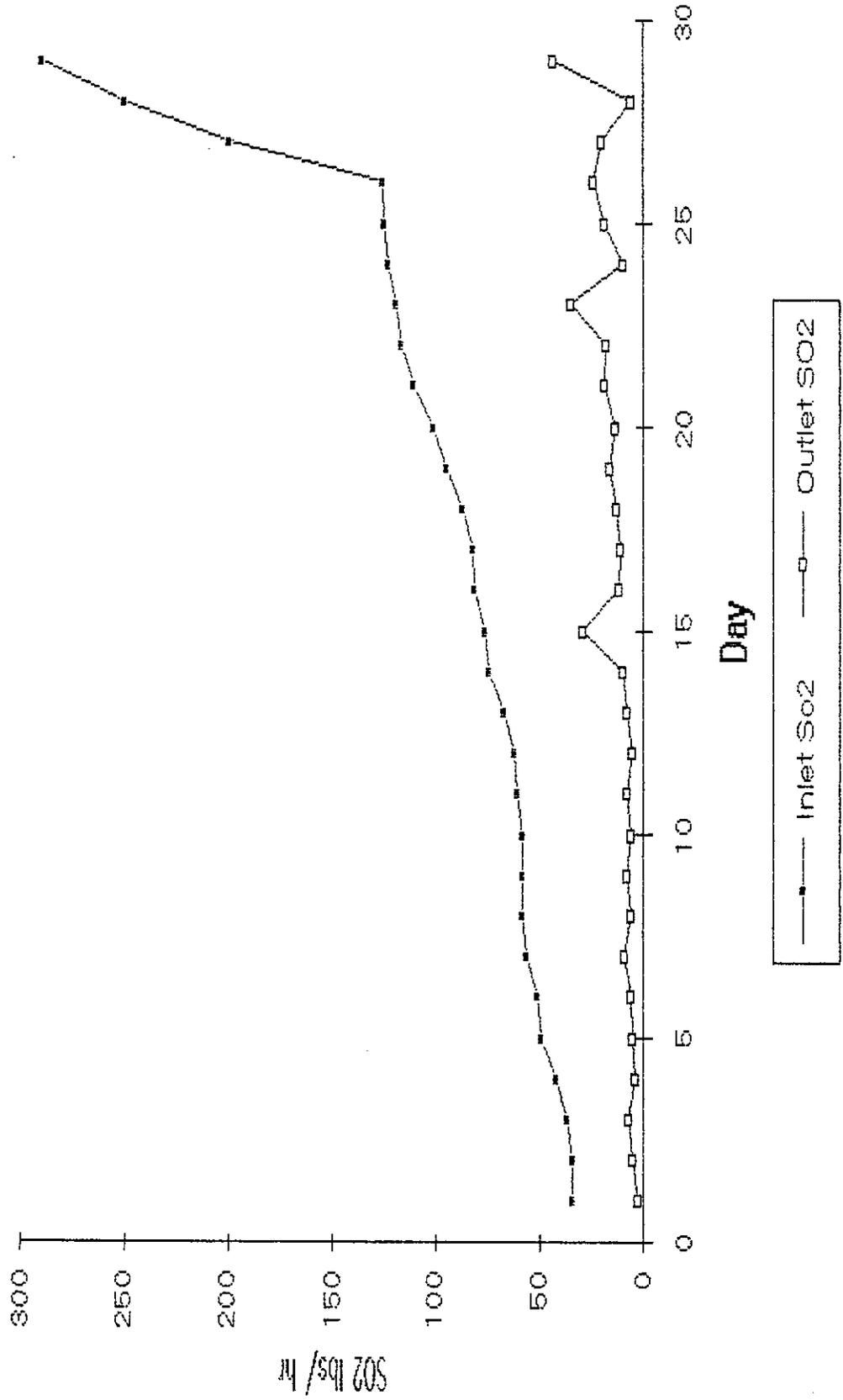
Time Period # 1 - Inlet and Outlet SO2 vs Day



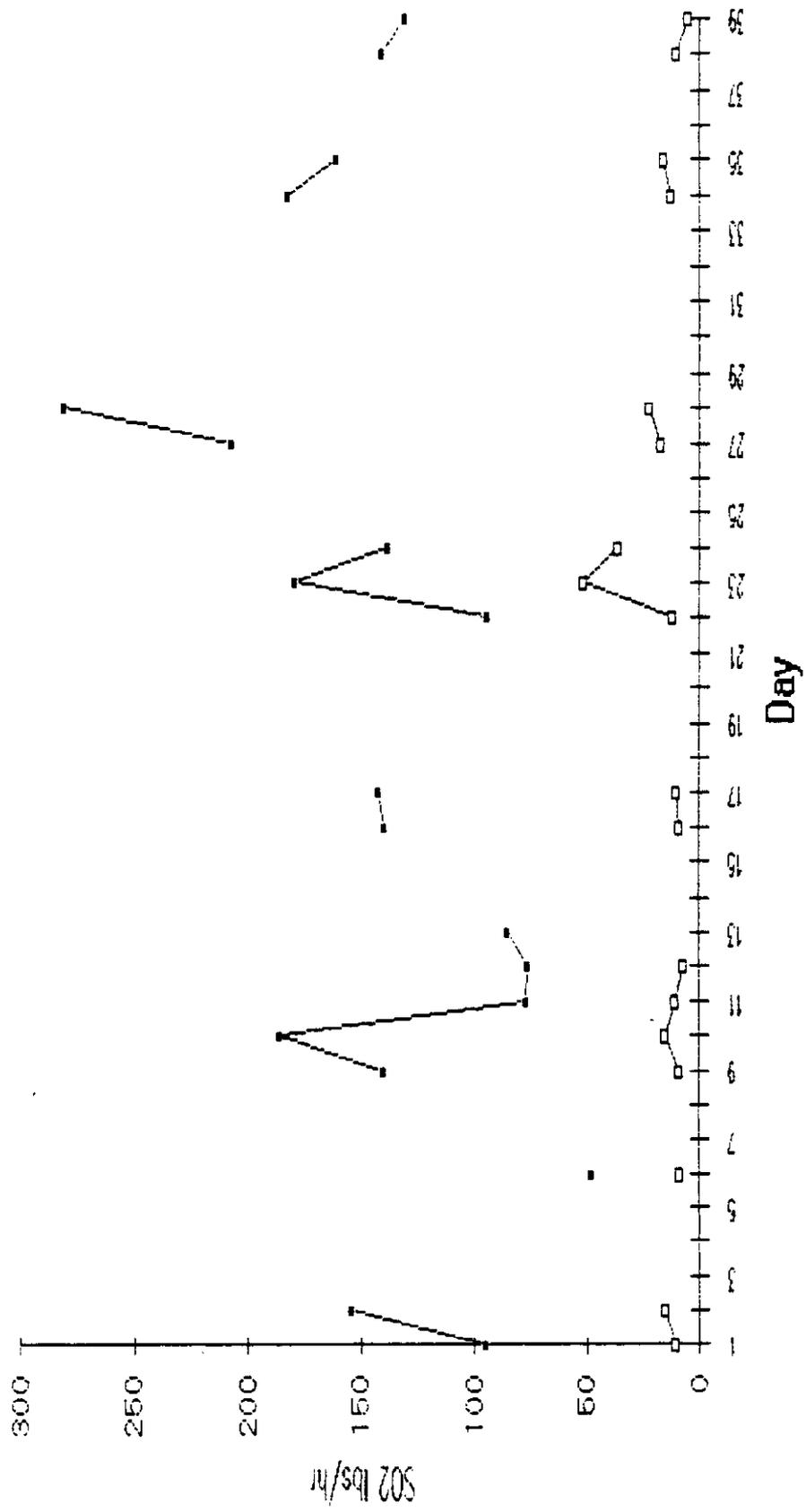
Time Period # 2 - Inlet & Outlet SO2 vs Day



Time Period # 3 - Inlet and Outlet SO2 vs Day

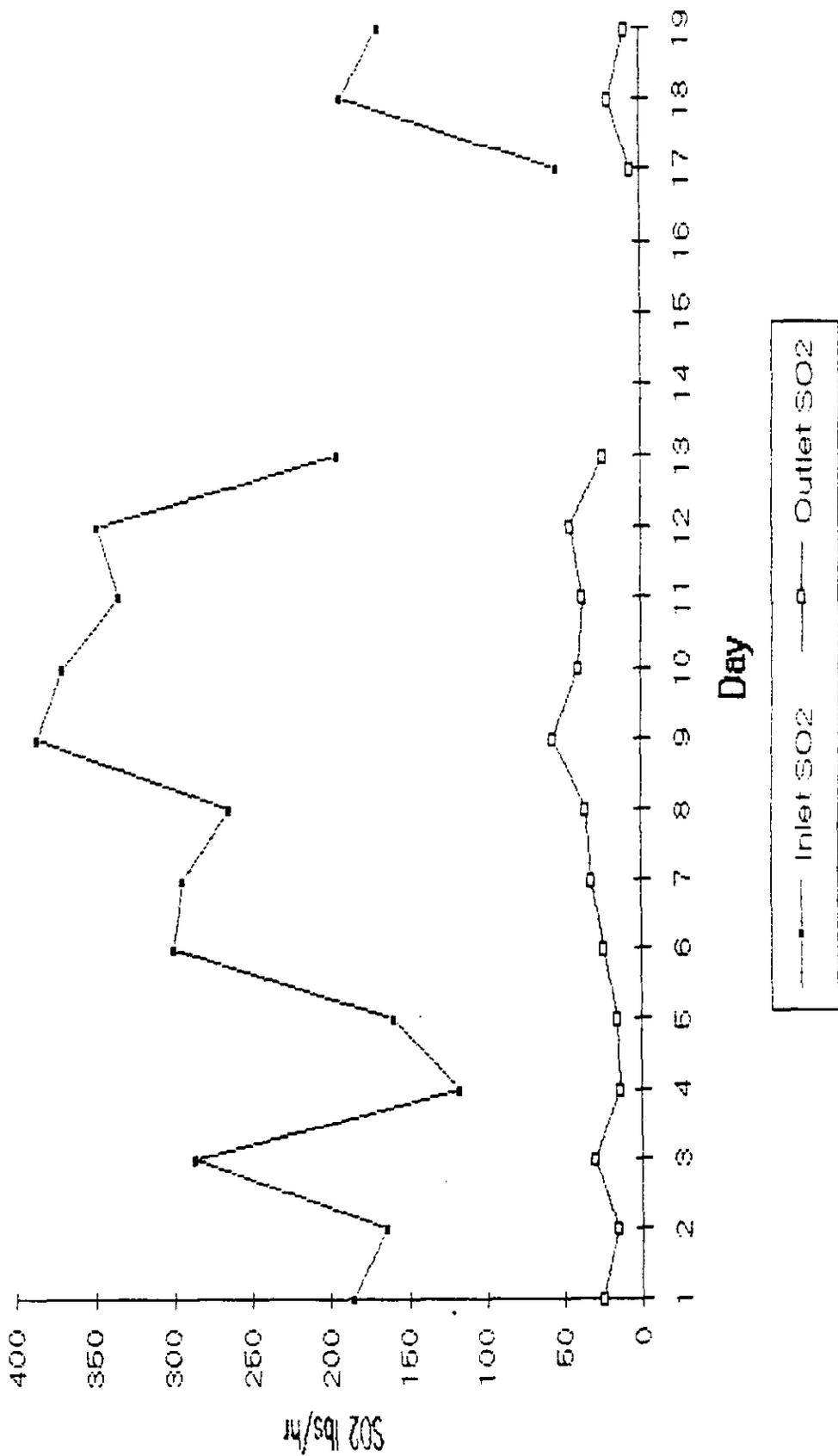


Time Period # 4 - Inlet and Outlet SO2 vs Day

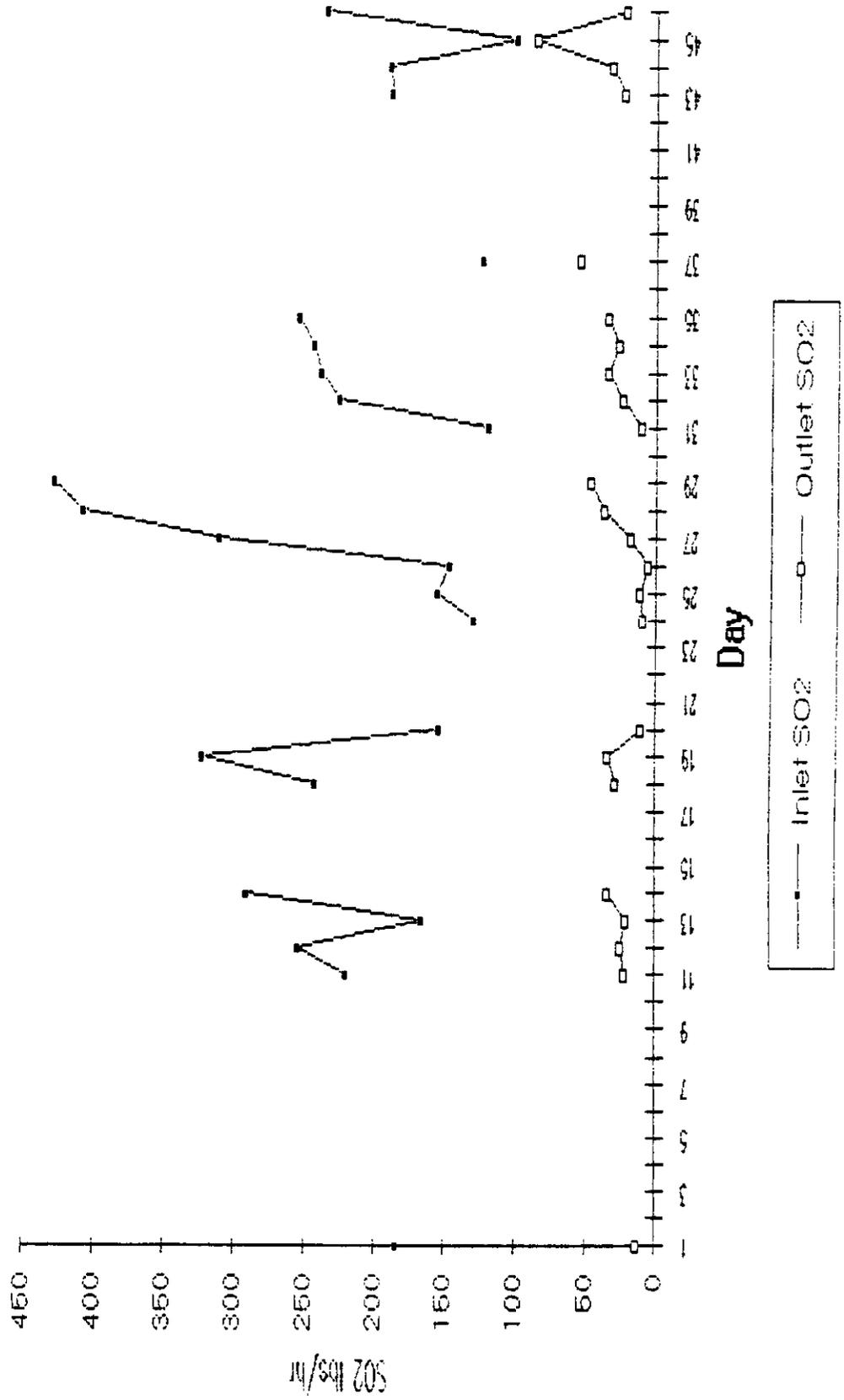


Legend:
- Inlet SO2
- Outlet SO2

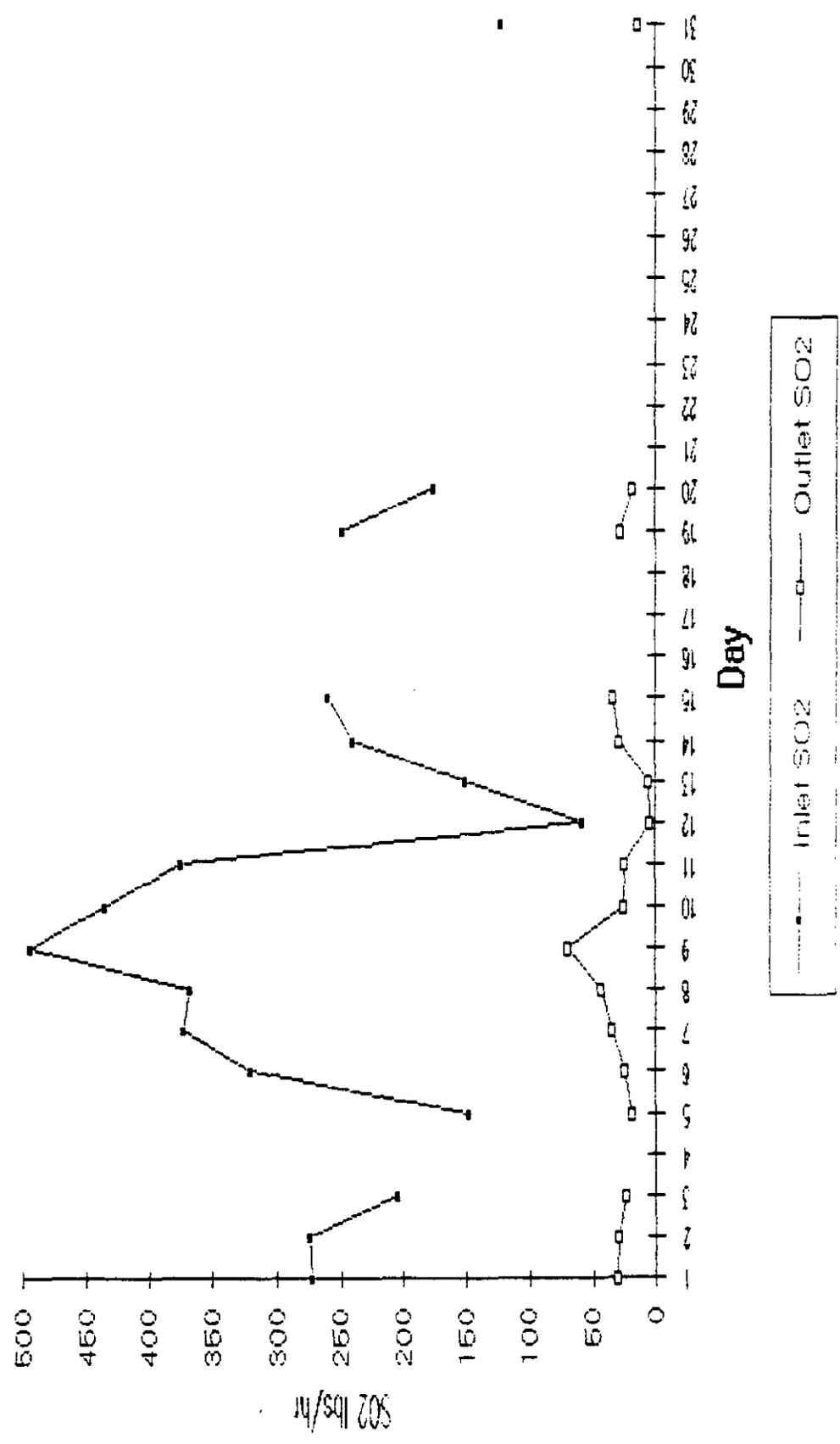
Time Period # 5 - Inlet and Outlet SO2 vs Day



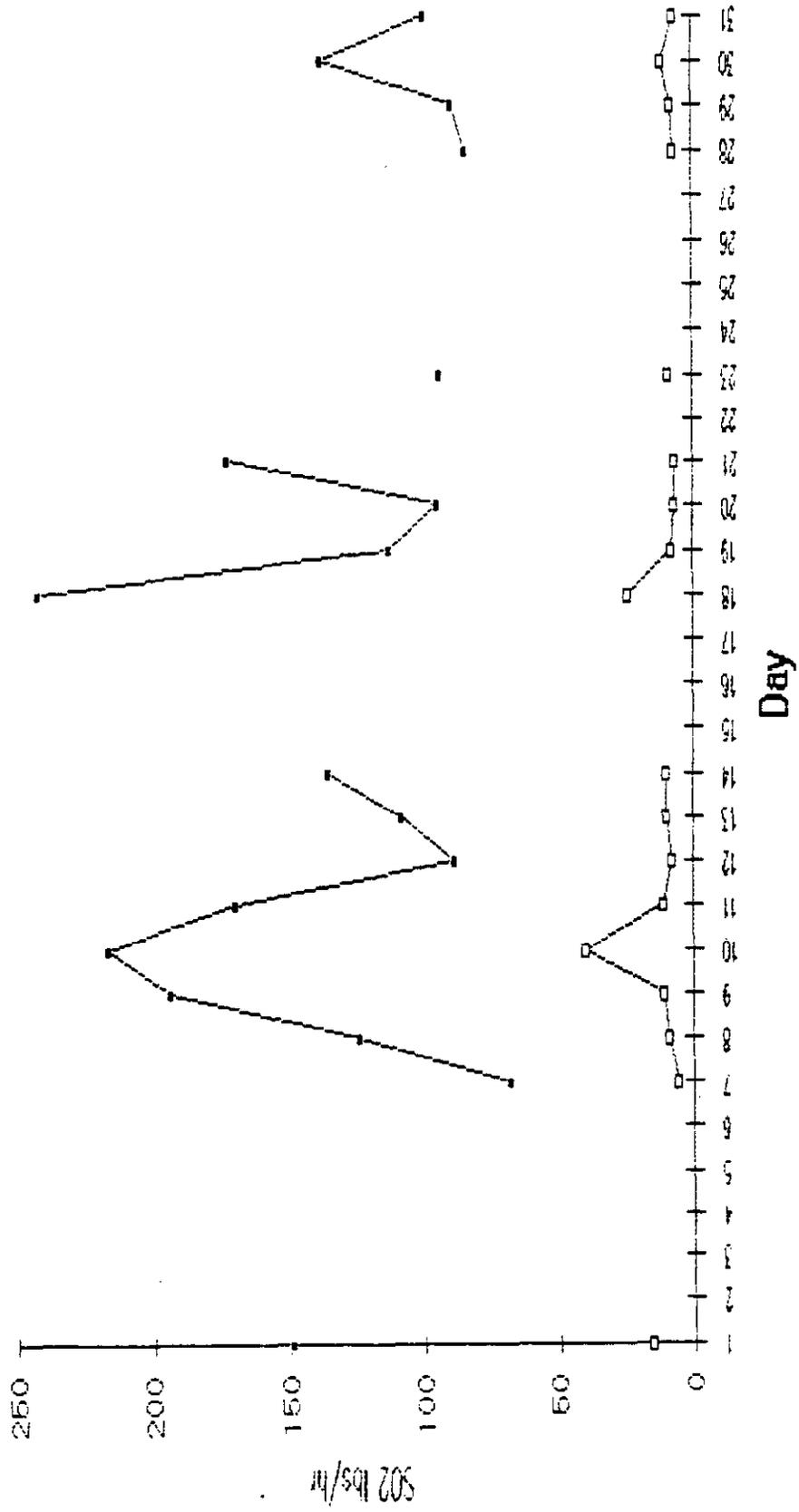
Time Period # 6 - Inlet and Outlet SO2 vs Day



Time Period # 7 - Inlet & Outlet SO2 vs Day

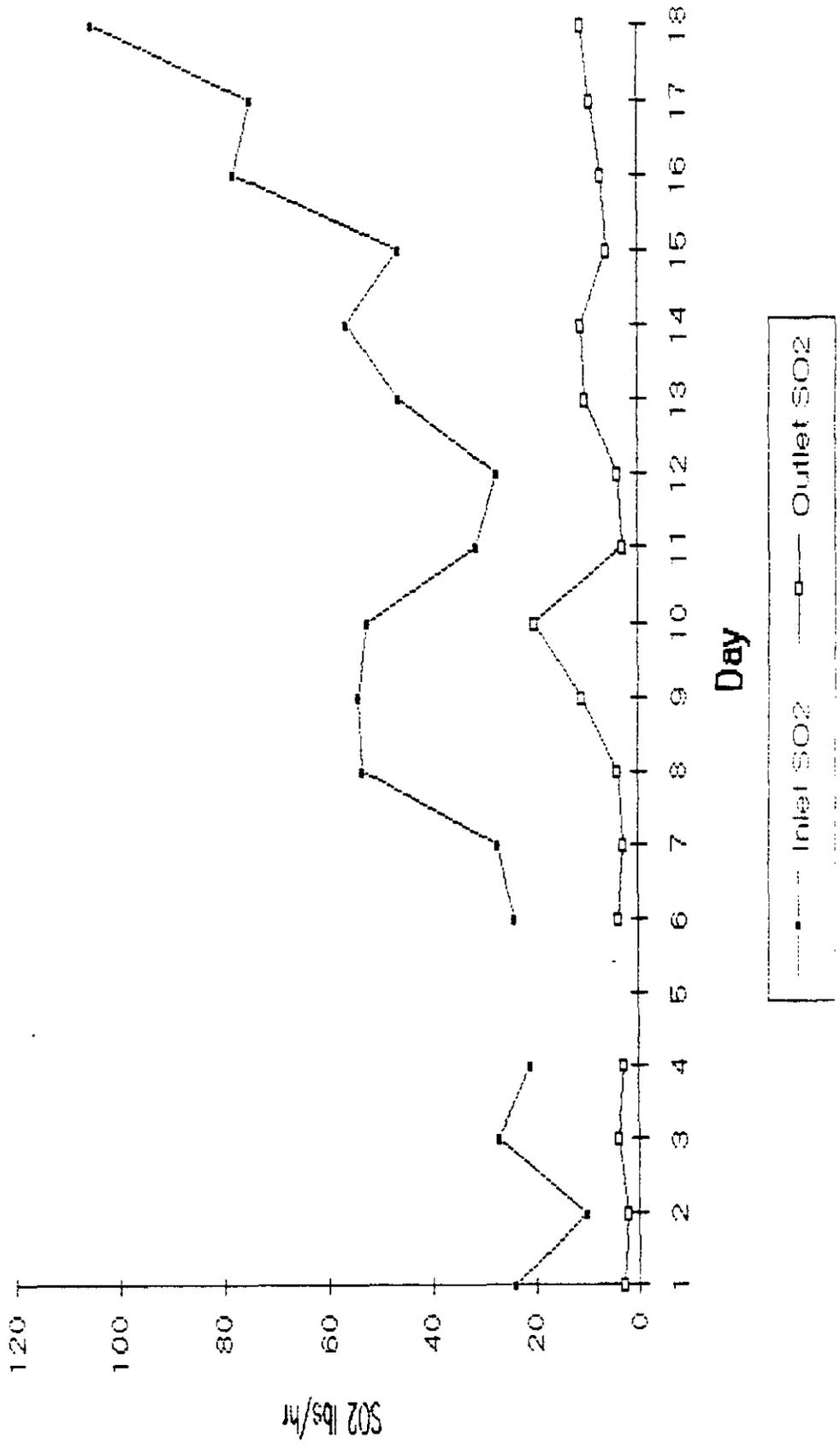


Time Period # 8 - Inlet and Outlet SO2 vs Day

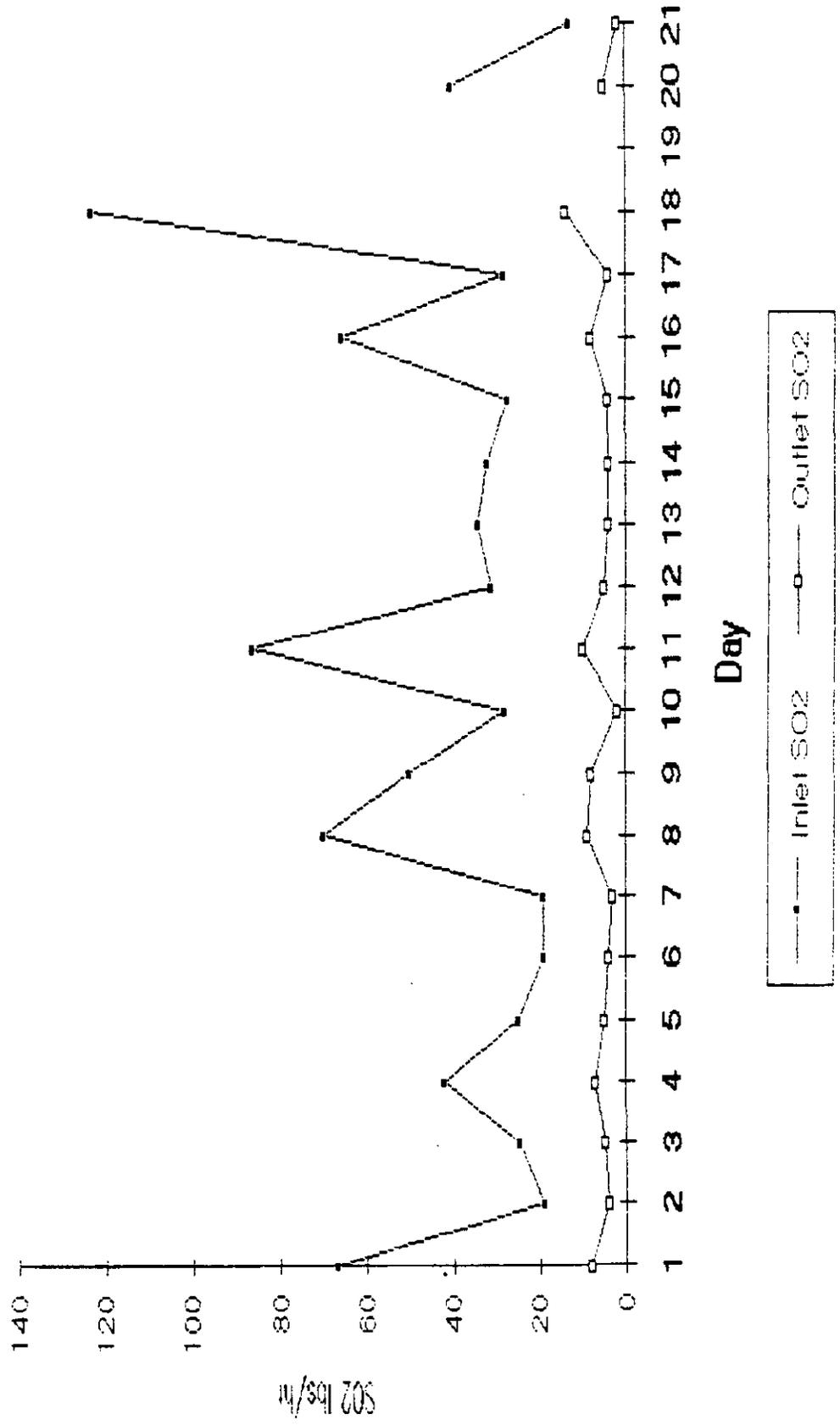


Legend:
—■— Inlet SO2
- - - □ - - - Outlet SO2

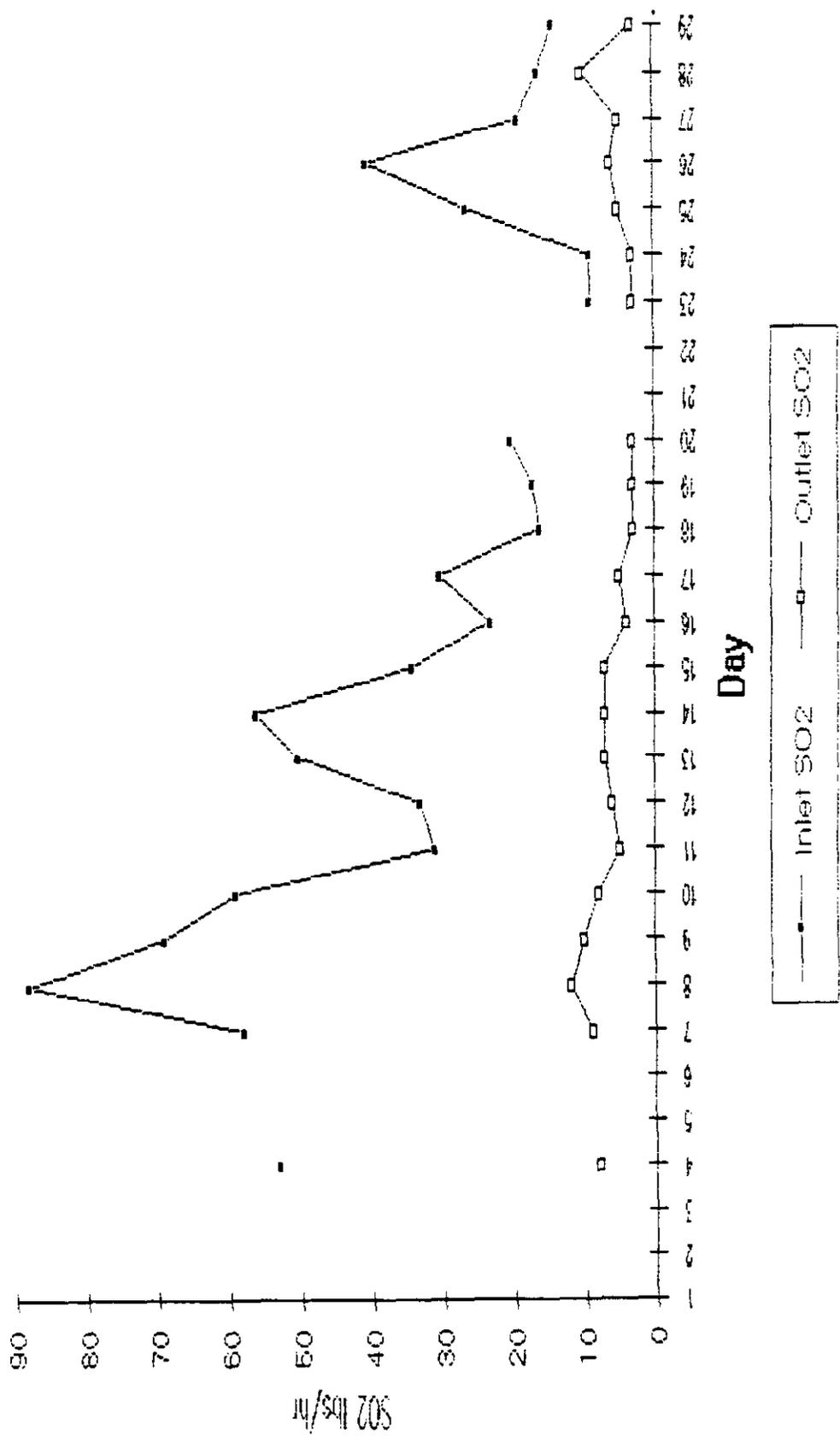
Time Period # 9 - Inlet and Outlet SO2 vs Day



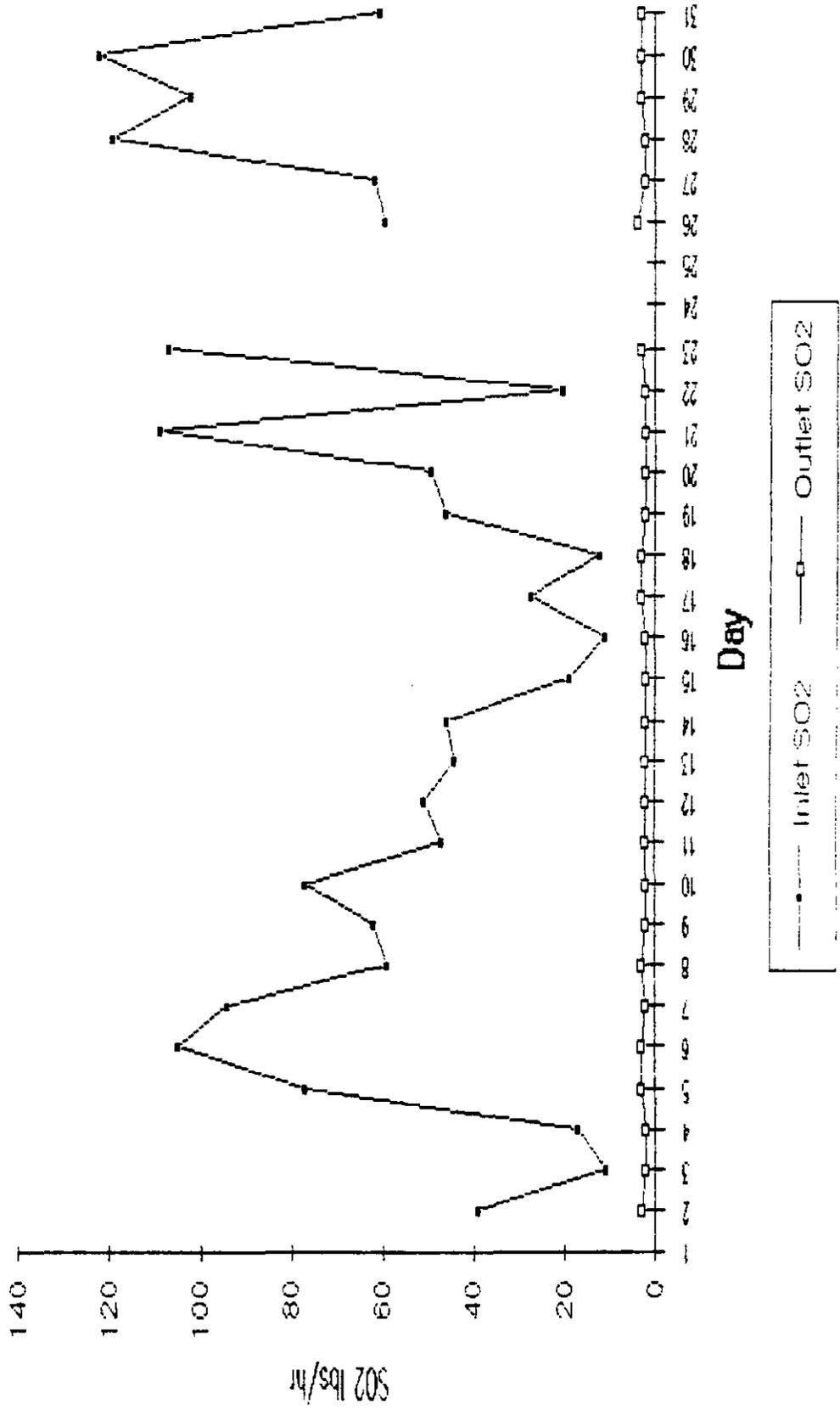
Time Period # 10 - Inlet and Outlet SO2 vs Day



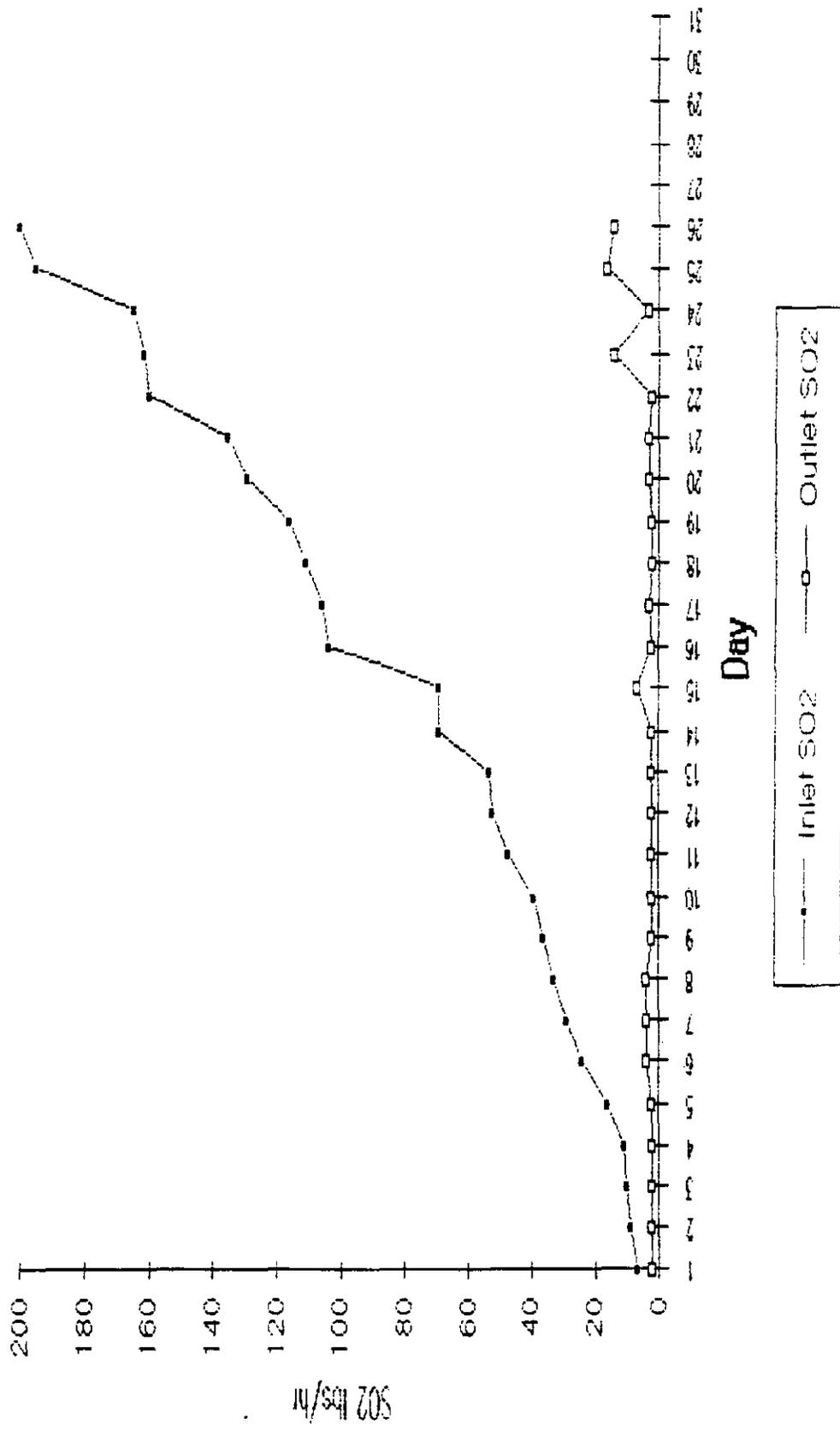
Time Period # 11 - Inlet and Outlet SO2 vs Day



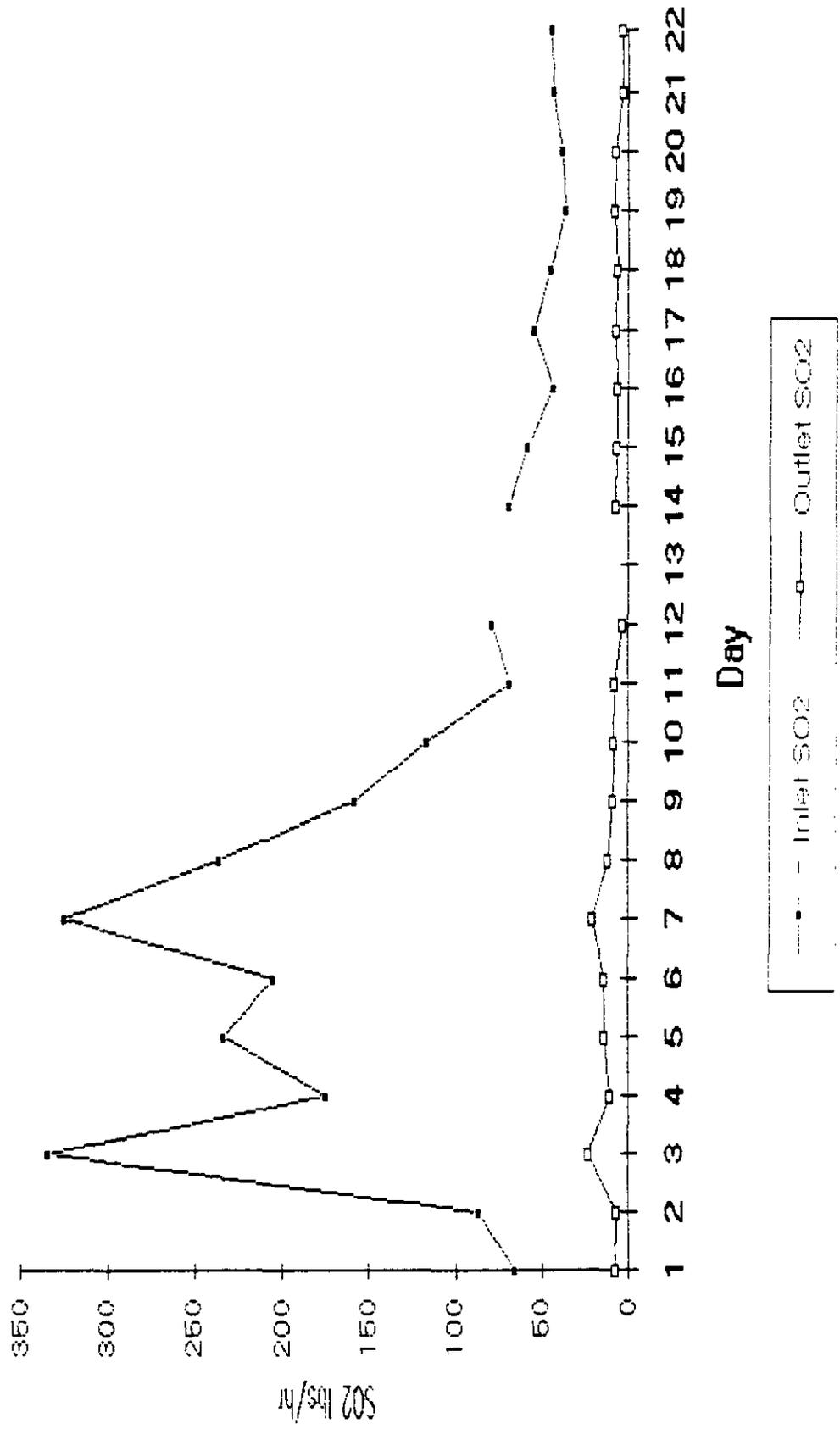
Time Period # 12 - Inlet and Outlet SO2 vs Day



Time Period # 13 - Inlet and Outlet SO2 vs Day

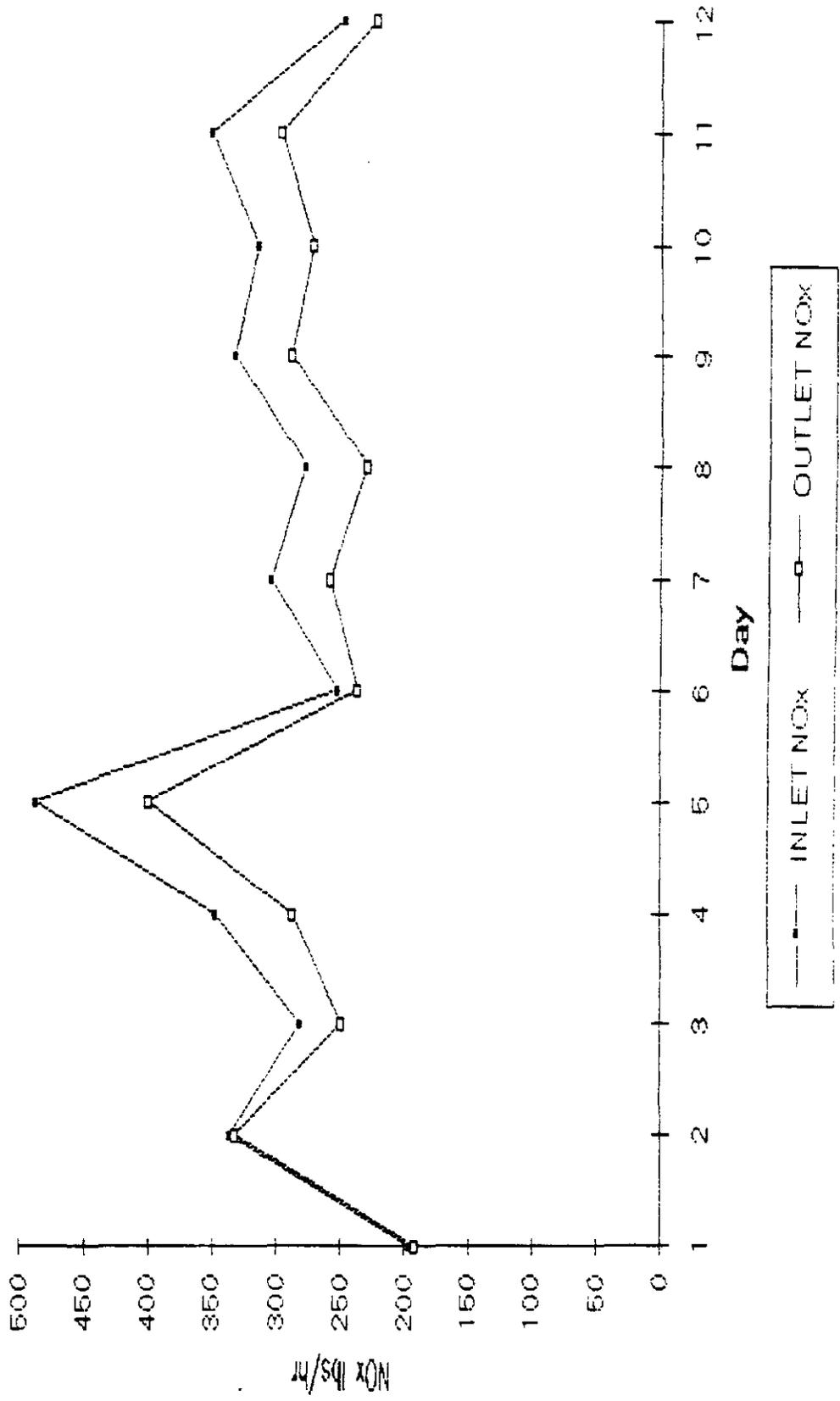


Time Period # 14 - Inlet and Outlet SO2 vs Day

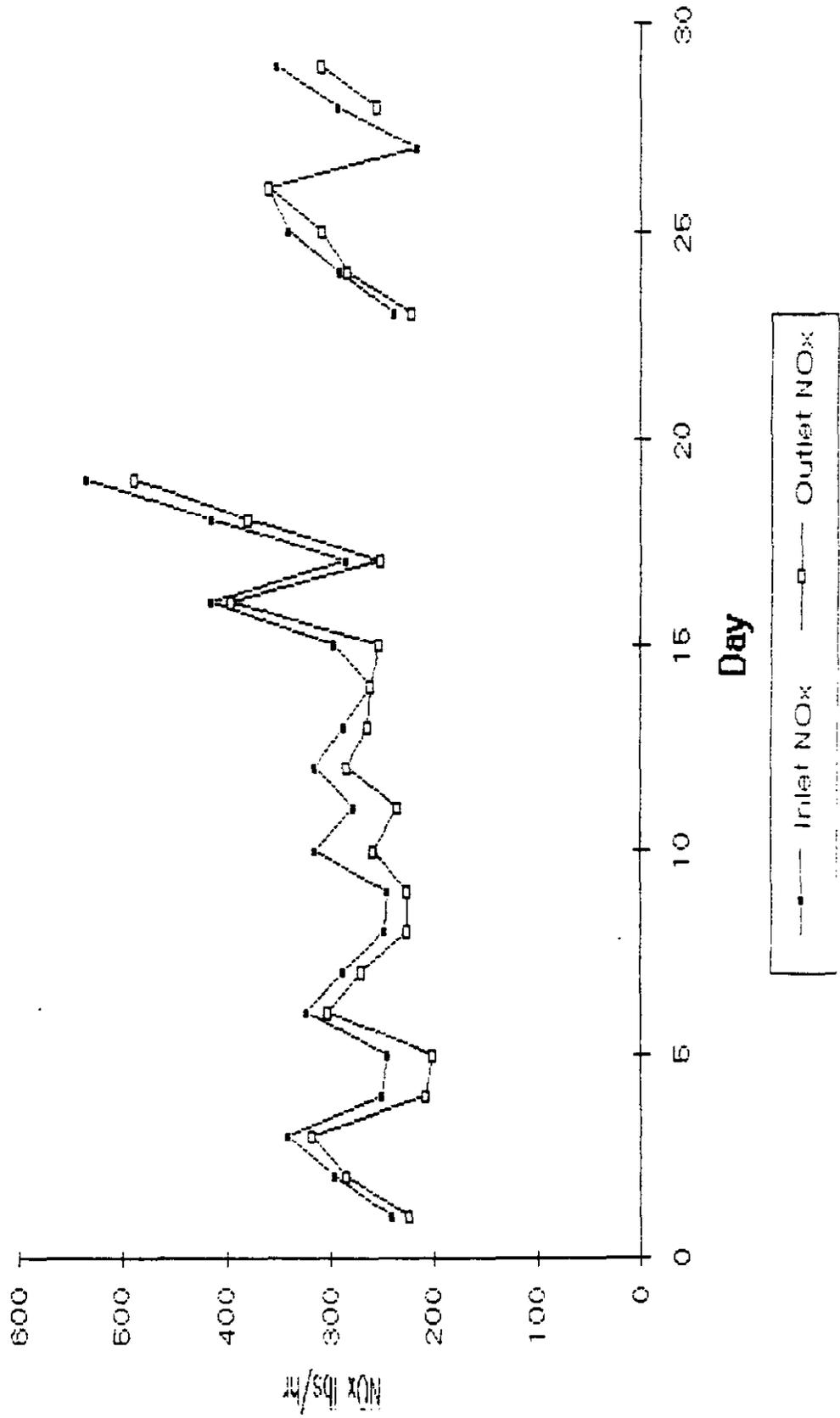


Appendix J
Graphs of Daily Inlet and Outlet NO_x Emissions
Versus
Time
For 14 Operational Time Periods

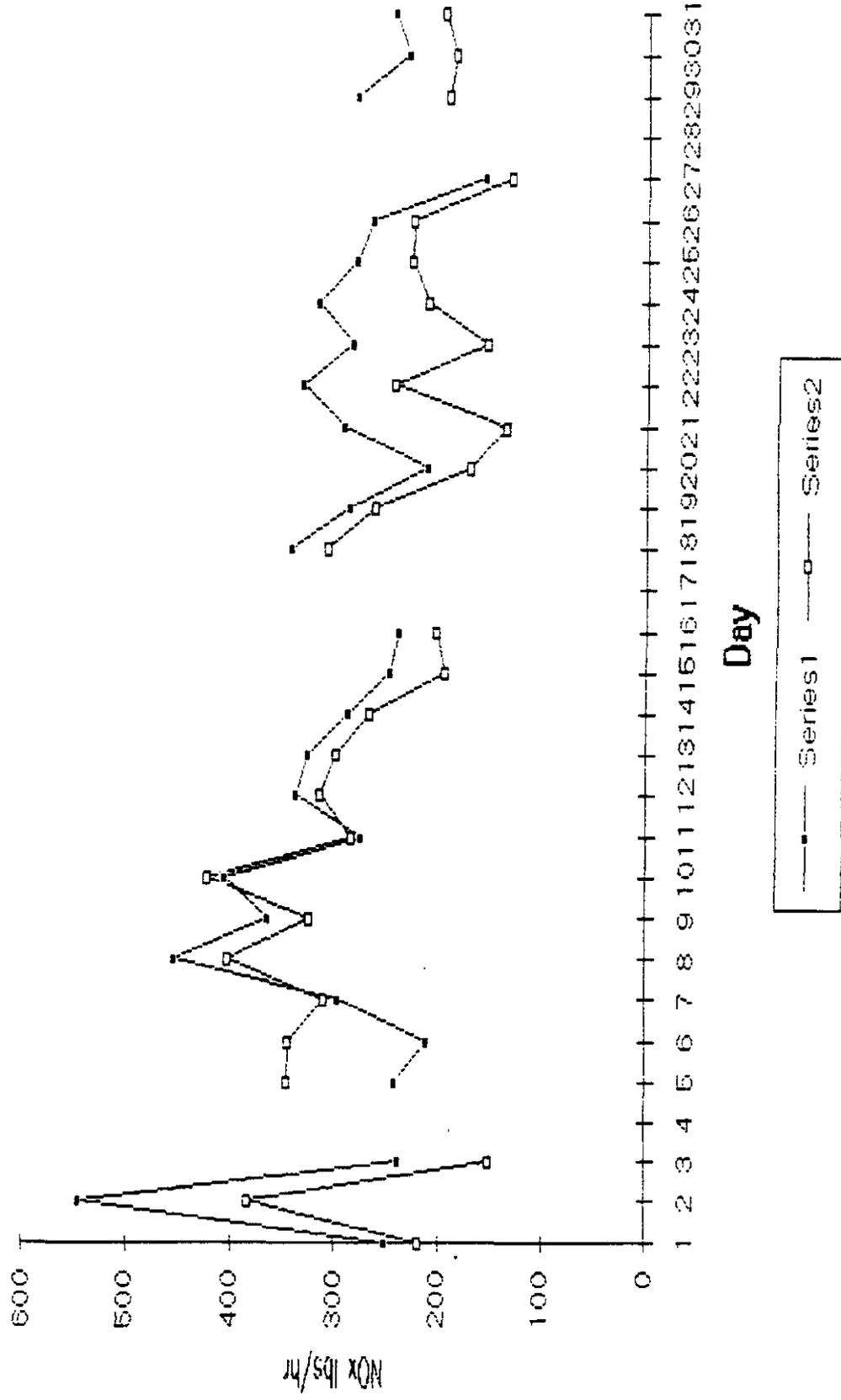
Time Period # 1 - Inlet and Outlet NOx vs Day



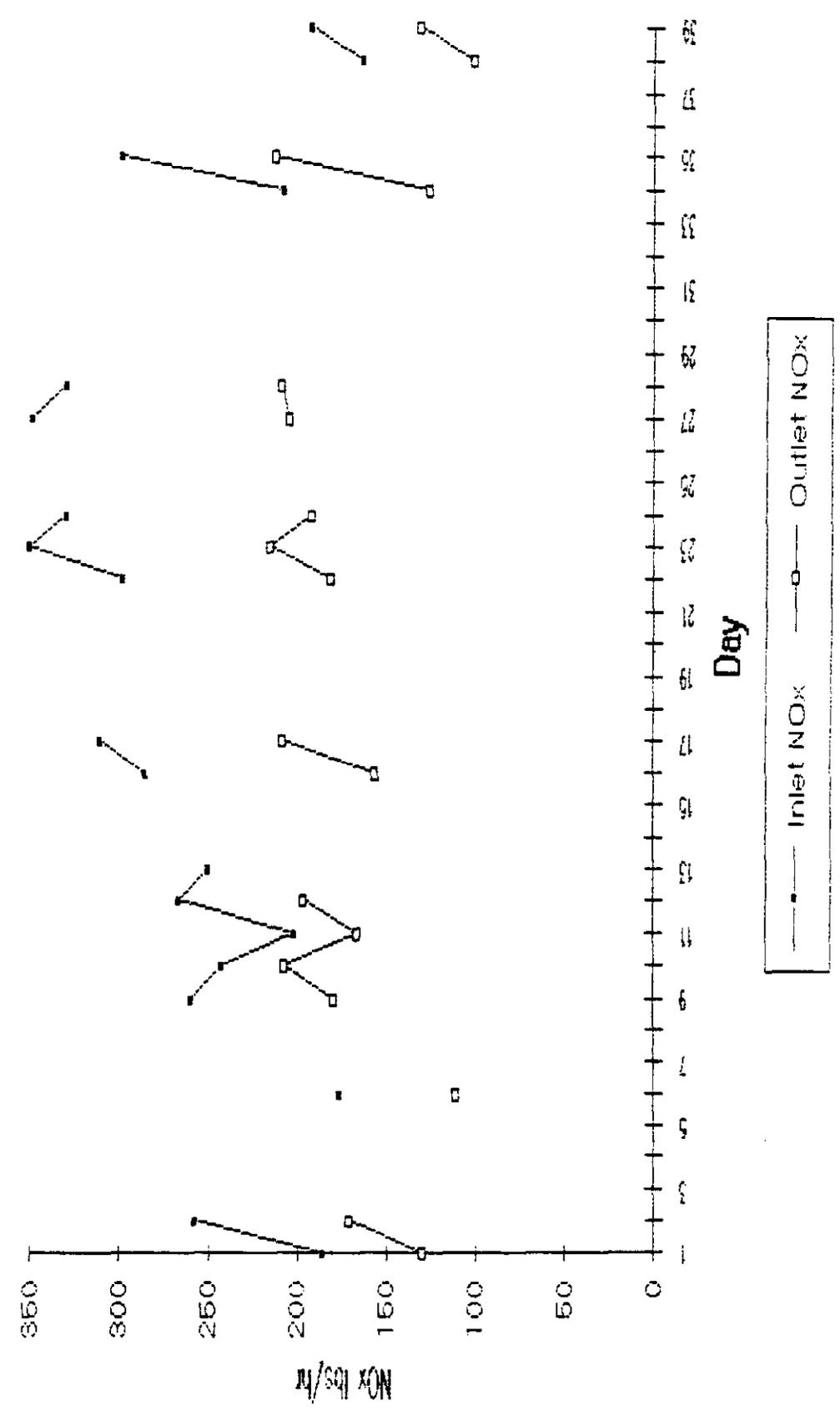
Time Period # 2 - Inlet and Outlet NOx vs Day



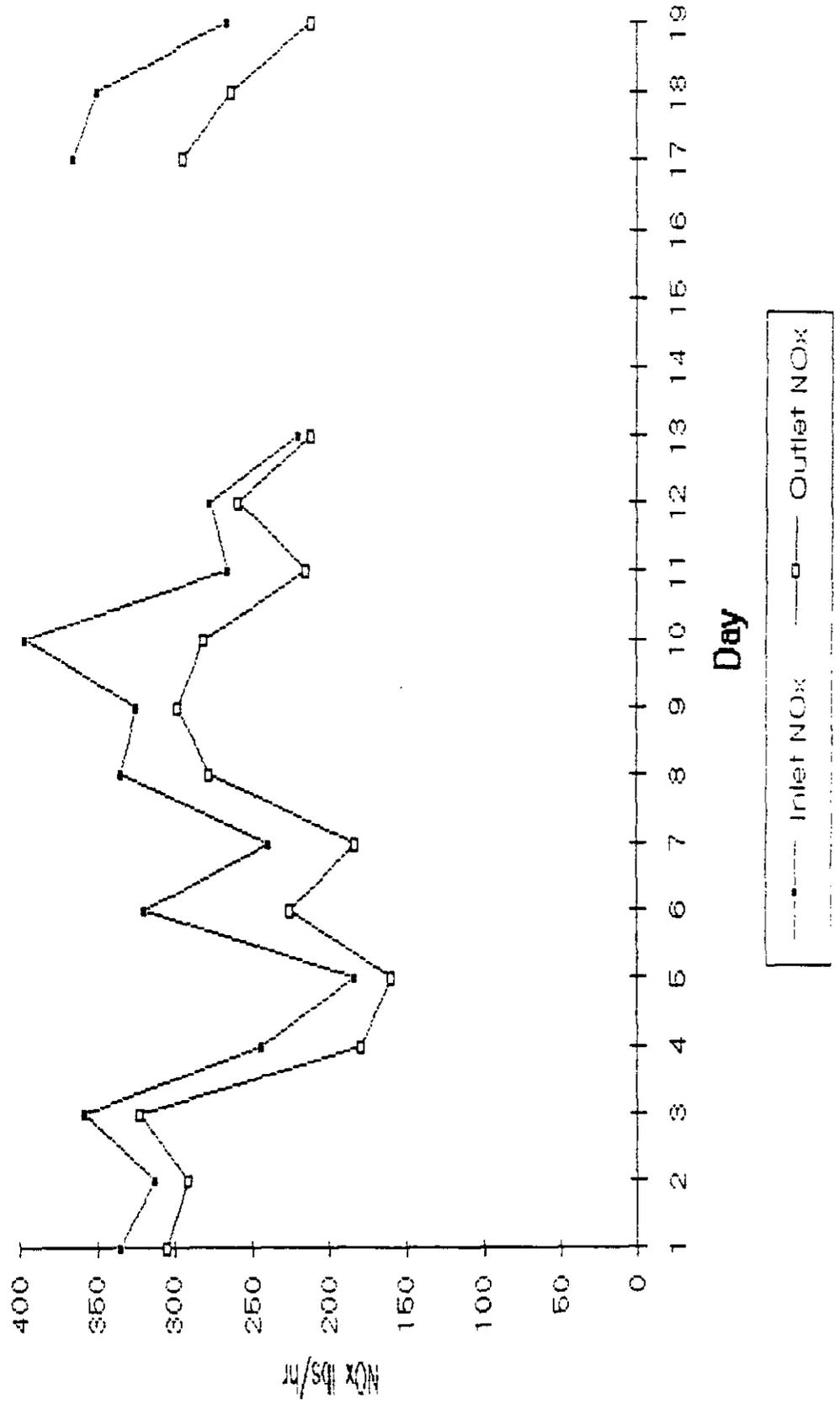
Time Period # 3 - Inlet and Outlet NOx vs Day



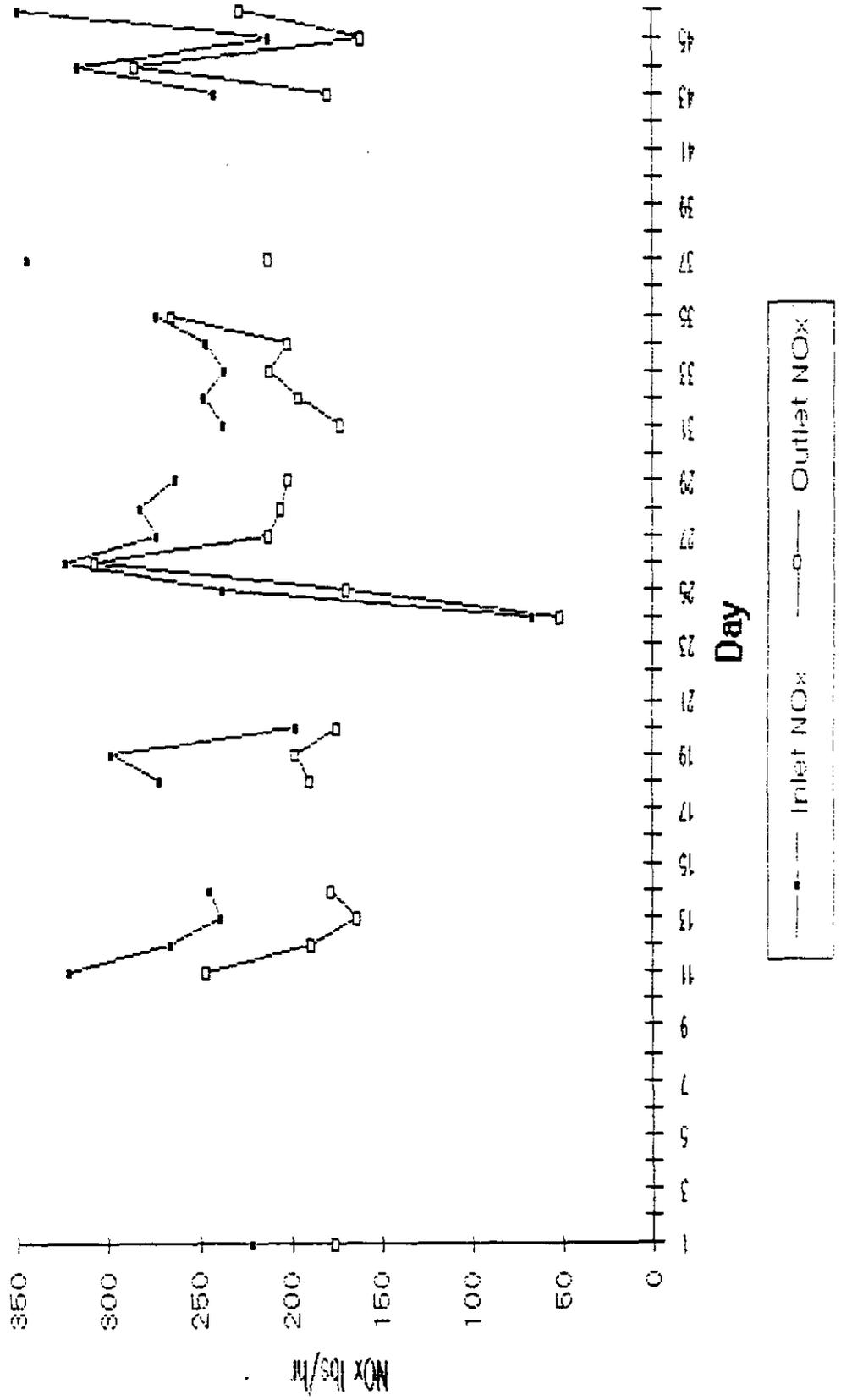
Time Period # 4 - Inlet and Outlet NOx vs Day



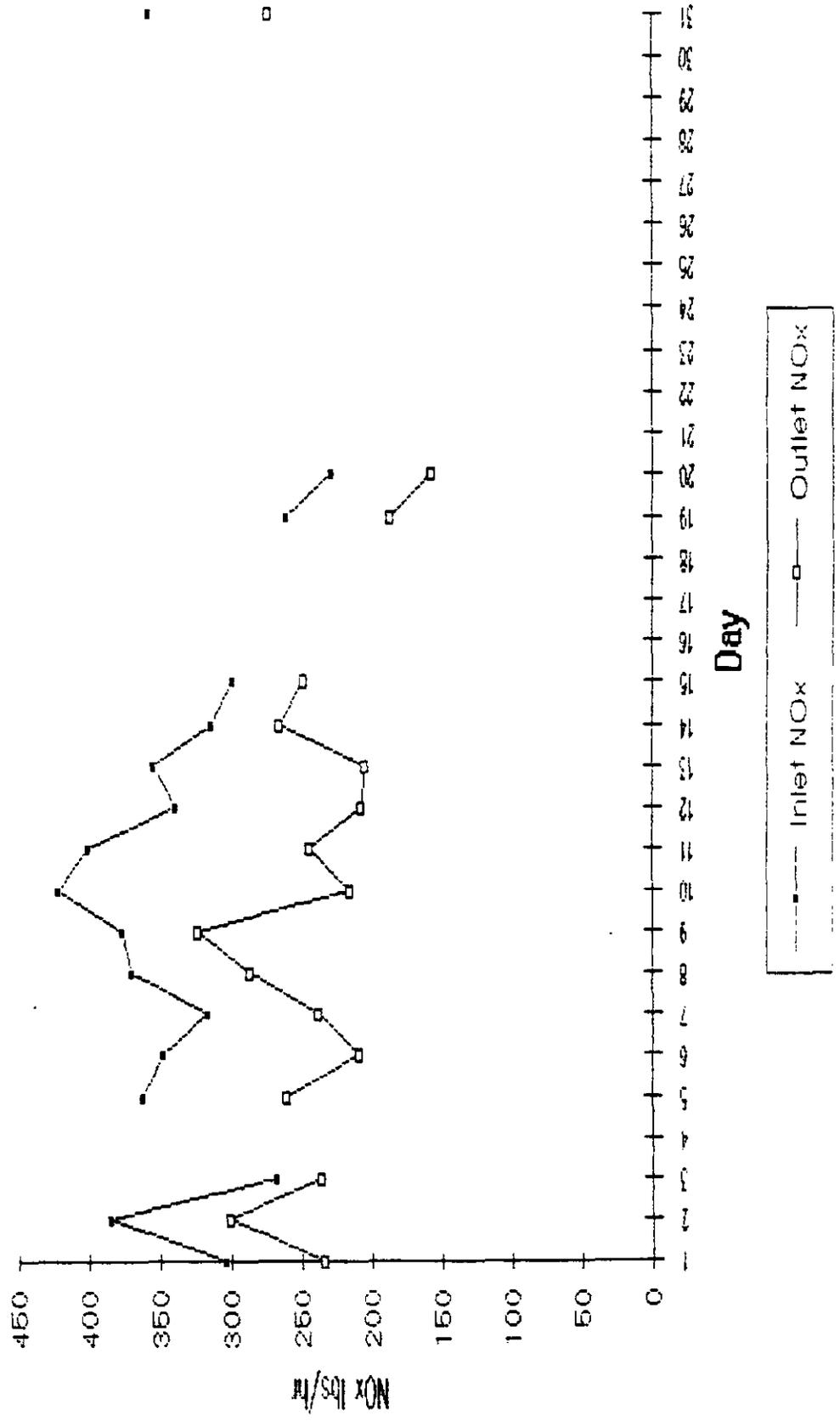
Time Period # 5 - Inlet and Outlet NOx vs Day



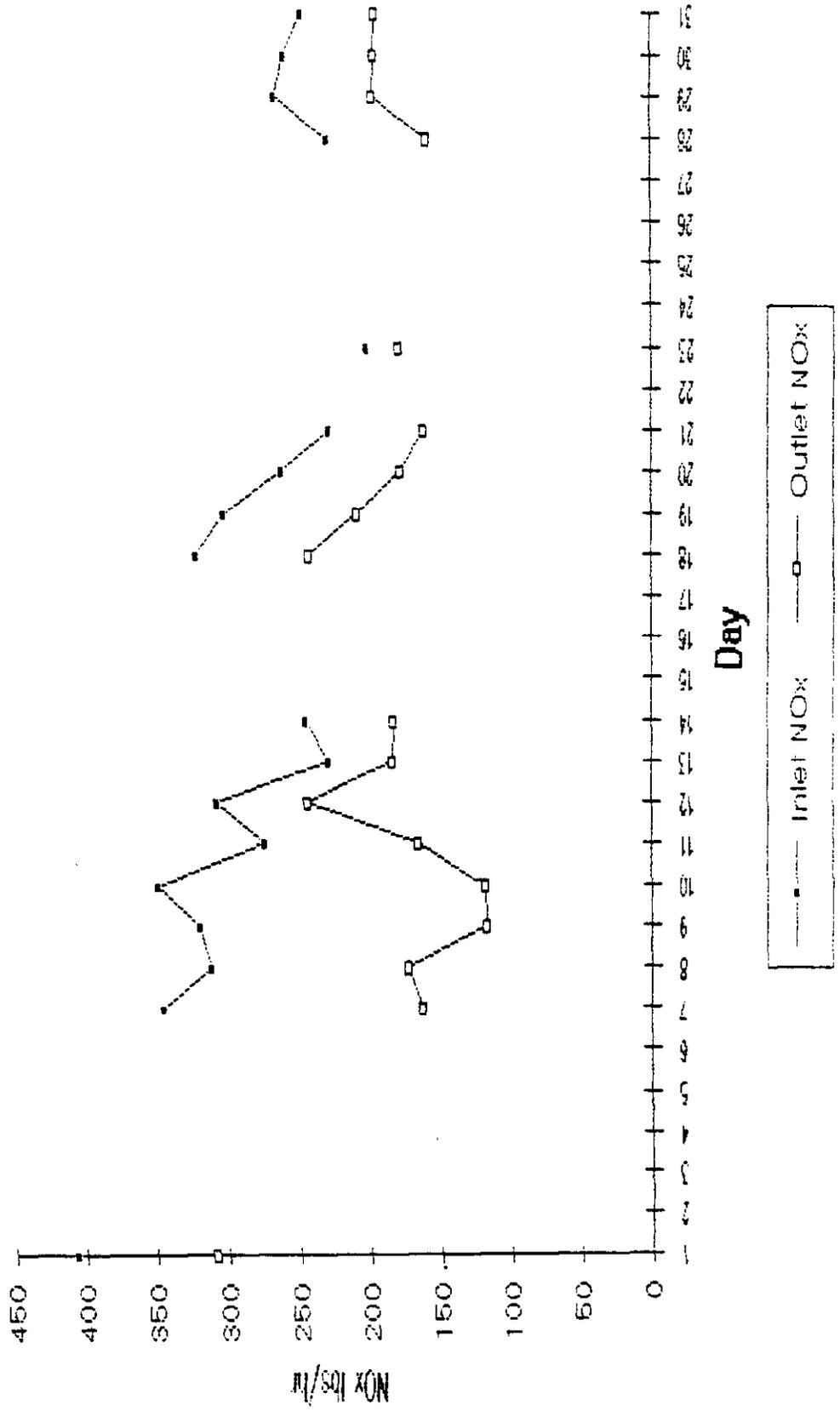
Time Period # 6 - Inlet and Outlet NOx vs Day



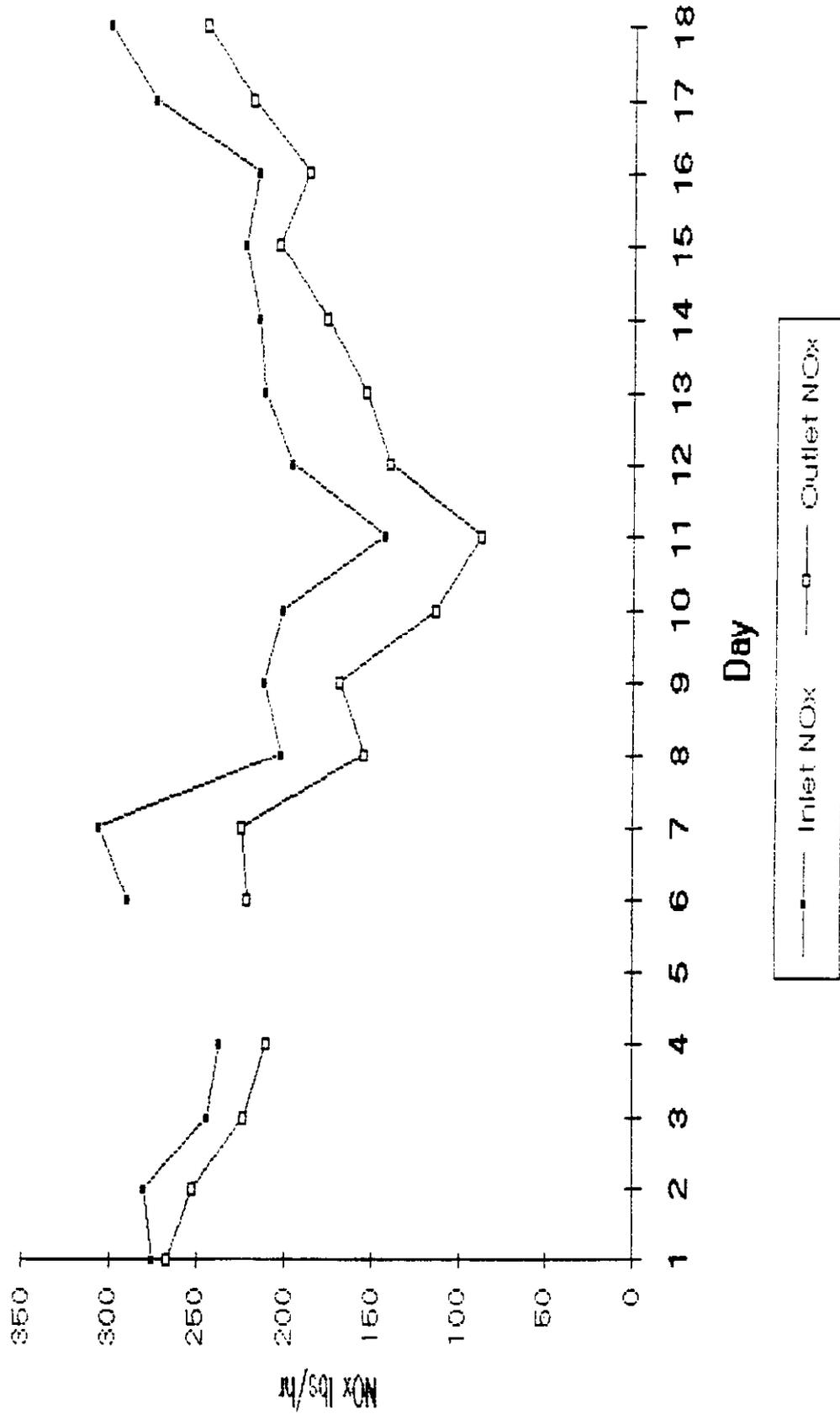
Time Period # 7 - Inlet and Outlet NOx vs Day



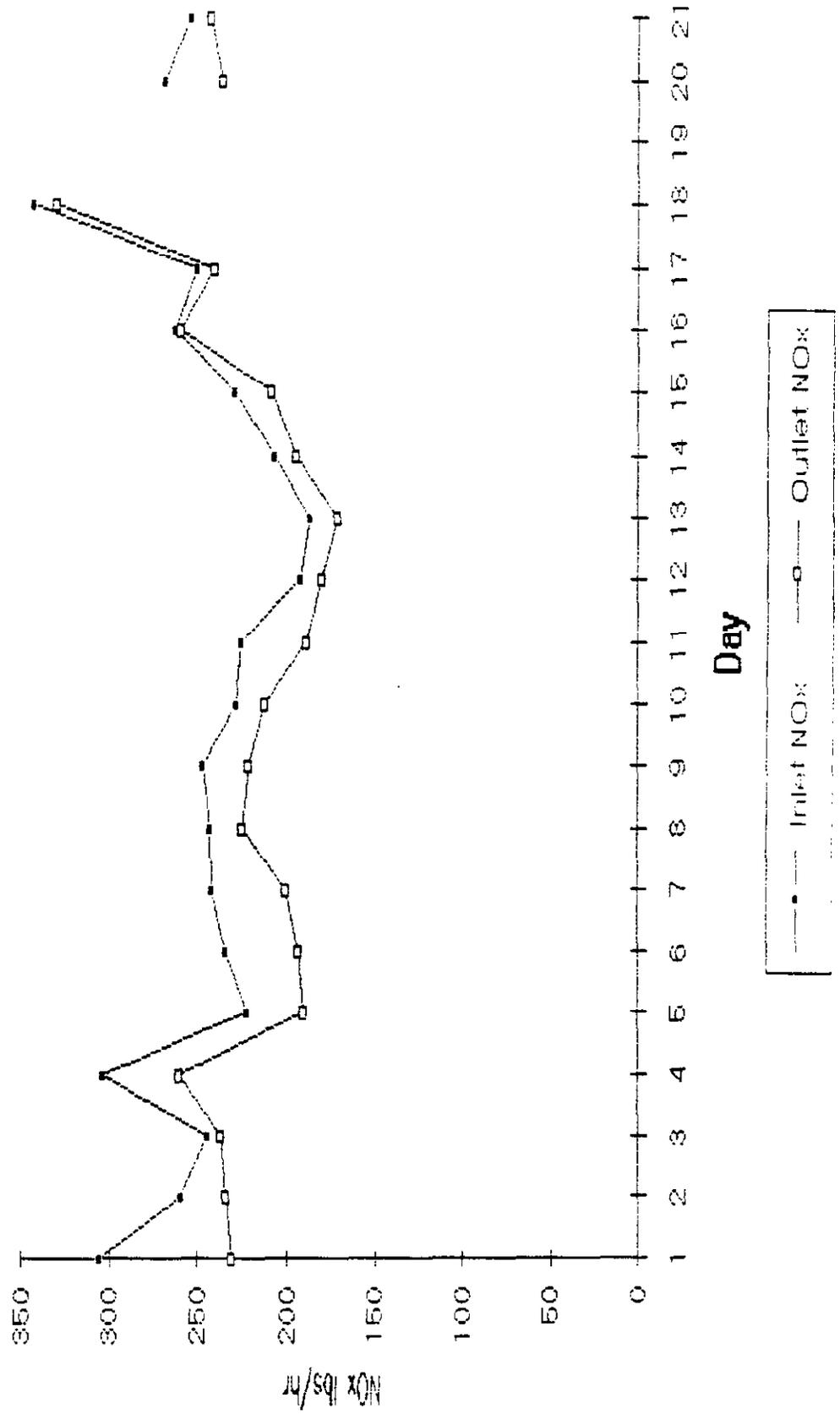
Time Period # 8 - Inlet and Outlet NOx vs Day



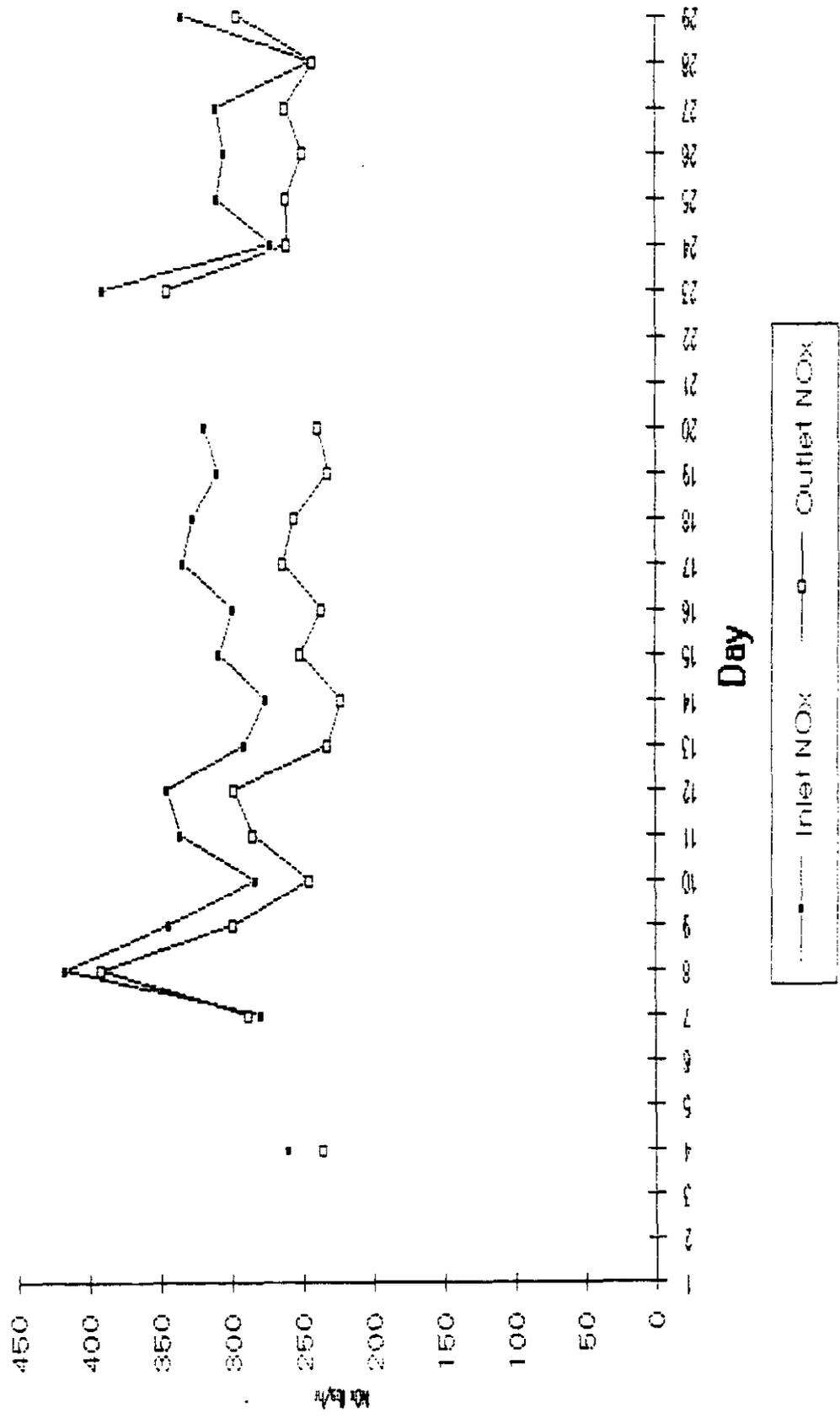
Time Period # 9 - Inlet and Outlet NOx vs Day



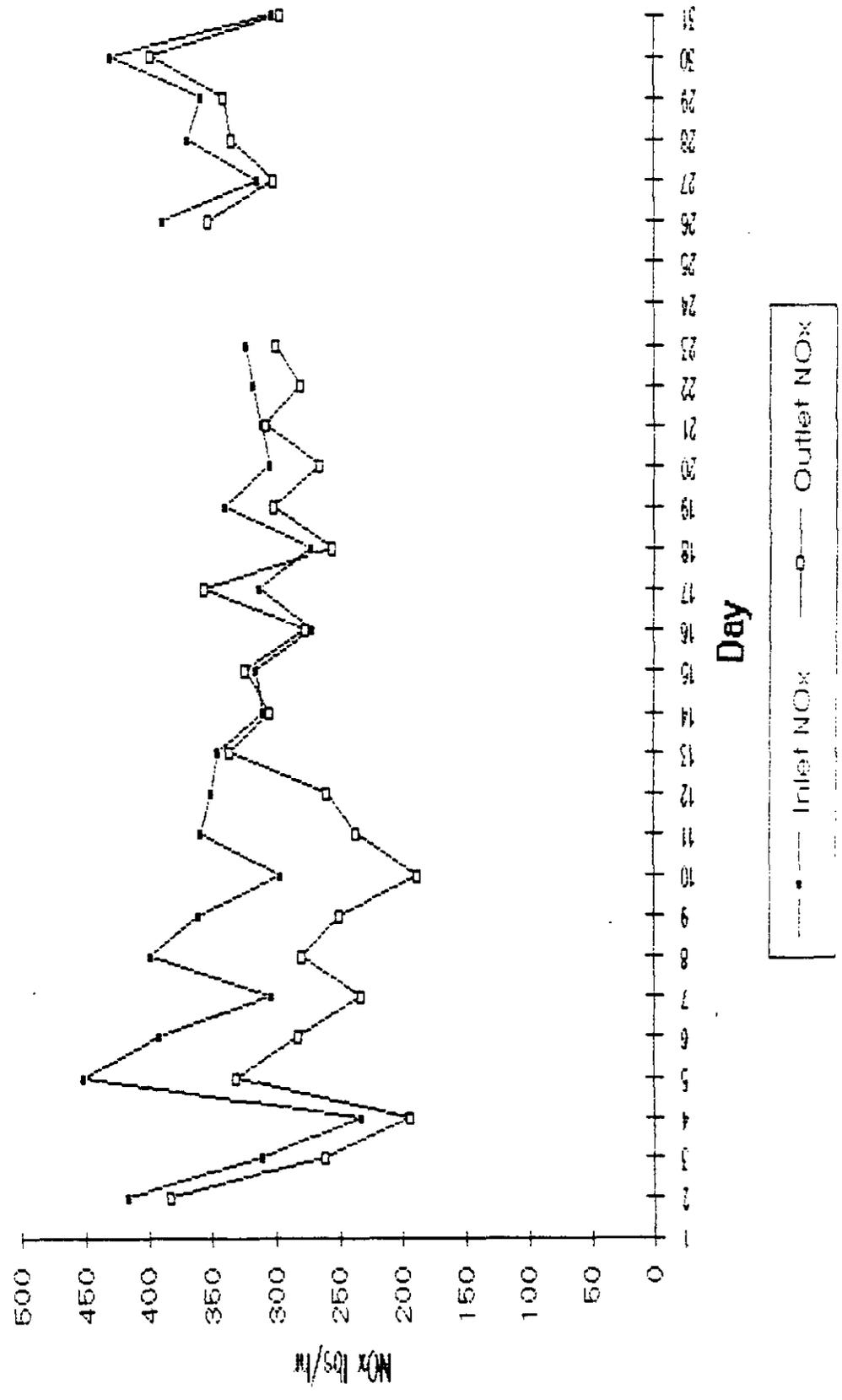
Time Period # 10 - Inlet and Outlet NOx vs Day



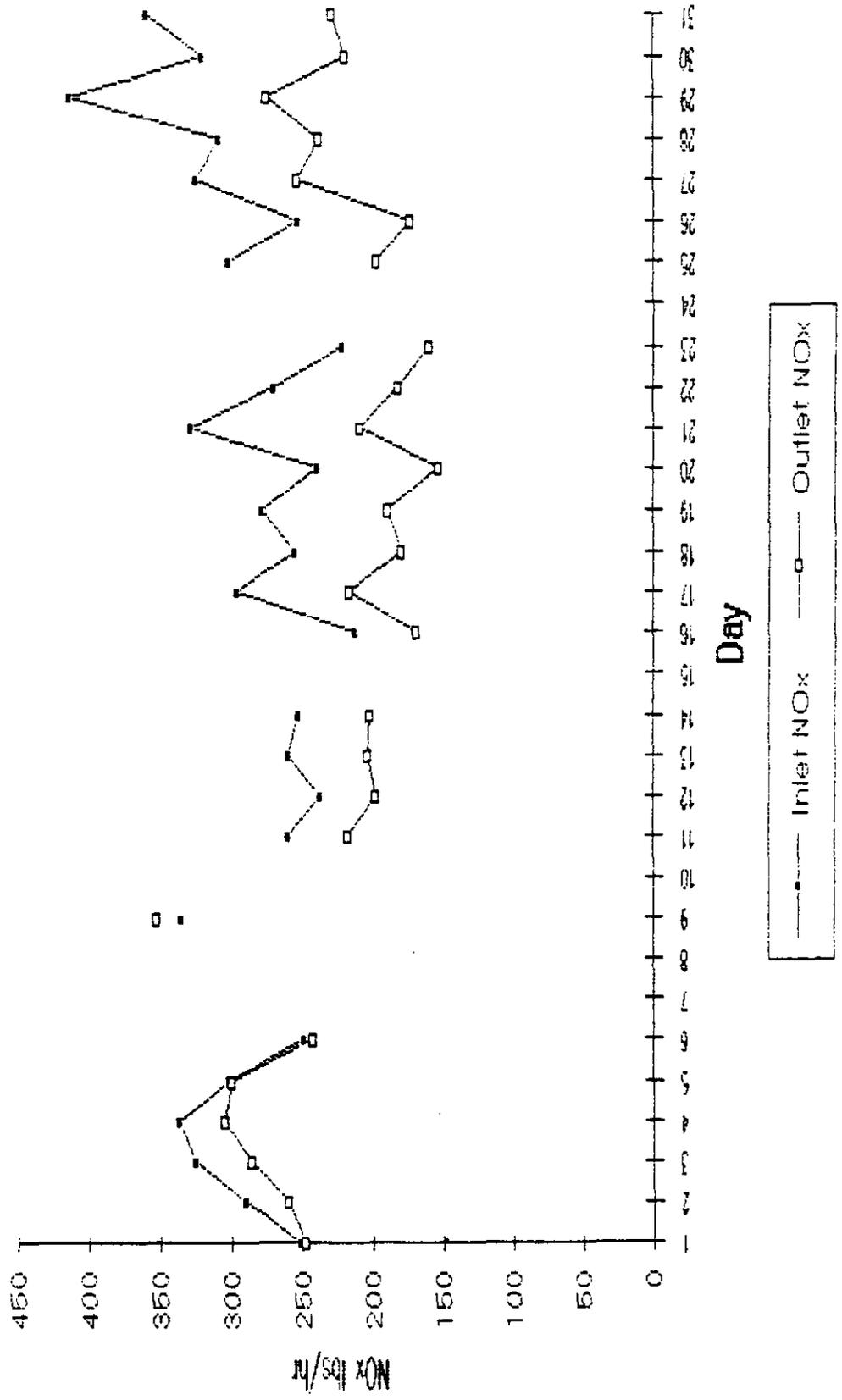
Time Period # 11 - Inlet and Outlet NOx vs Day



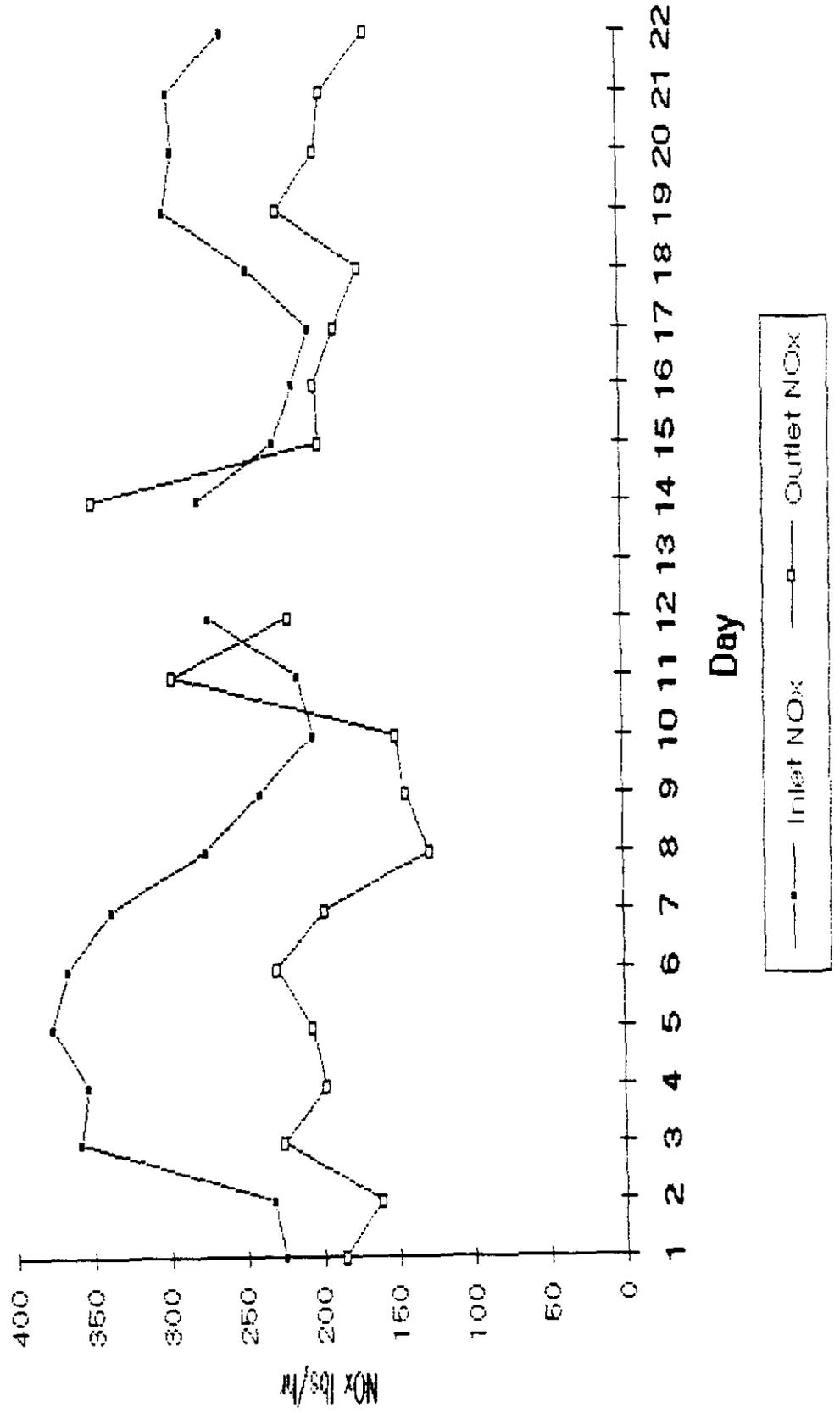
Time Period # 12 - Inlet and Outlet NOx vs Day



Time Period # 13 - Inlet and Outlet NOx vs Day



Time Period # 14 - Inlet and Outlet NOx vs Day



APPENDIX K

Report for Research Triangle Institute

HCl MACT STANDARDS DEVELOPMENT PROJECT
APPLICATION OF A
PASSAMAQUODDY TECHNOLOGY RECOVERY SCRUBBER™
TO THREE CEMENT PLANT MODELS
WITH 5 PPM, 12 PPM, AND 100 PPM HCl IN EXHAUST GASES

Prepared For

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EXECUTIVE SUMMARY

In response to a letter dated July 26, 1993, requesting information about the Passamaquoddy Technology Recovery Scrubber™ (the Recovery Scrubber) with respect to Research Triangle Institute's (RTI) contract with the US EPA to provide technical support for development of "MACT" standards for the 189 hazardous air pollutants (HAPs) as called for in the Clean Air Act Amendments of 1990, and more specifically, control of HCl emissions from portland cement kilns, we are forwarding the following information.

The Recovery Scrubber, was originally developed by Dr. Garrett L. Morrison to address two environmental problems facing the Dragon Products Company, Inc. cement plant (Dragon) in Thomaston, Maine. The first was a solid waste disposal problem, cement kiln dust (CKD), and the second was emissions of SO₂ in flue gases from their wet process portland cement kiln. The Recovery Scrubber was selected in Round II of the U. S. Department of Energy's (DOE) Innovative Clean Coal Technology (CCT) program for partial funding. The DOE has been very supportive of this project.

The Recovery Scrubber removes more than 98% of the HCl in exhaust gases, as demonstrated in pilot scale testing by Acurex Corp. at EPA's laboratory in Research Triangle Park, NC. This technology also removes SO₂ at greater than 92% removal efficiency as consistently demonstrated at the full scale prototype at Dragon and, in the process, renovates cement kiln dust (CKD) so that it may be recycled by a cement plant rather than landfilled as in the past. In addition, particulate emissions testing on the full scale prototype has demonstrated a particulate emission rate from the Recovery Scrubber of about 0.006 grains per SCF (15 mg/NM³).

BACKGROUND

Calcium, silica, iron, and alumina are some of the necessary elements and compounds required to produce portland cement. Also, several trace elements that are not required are present. Potassium is one of these elements that is present and is not only not required but is deleterious to the long term durability of cement products. Potassium has a relatively low boiling point; and, at the temperatures achieved in a cement kiln, several potassium compounds boil or vaporize. As gases travel to cooler parts of the kiln, potassium compounds condense onto fine dust particles in the exhaust gas stream. Consequently, CKD captured in the dust collector at the rear of a portland cement kiln contains elevated levels of potassium. Since potassium is not good for cement, CKD is landfilled at many cement plants.

The Passamaquoddy Technology Recovery Scrubber™ uses CKD as the reactant for exhaust gas scrubbing. Potassium in the CKD reacts with and removes acid gases (SO₂, HCl, etc.) from exhaust gases with the resultant production of potassium sulfate or potassium chloride, both valuable commercial fertilizers. Exhaust gases are cleaned of acid rain producing compounds; potassium is removed from CKD and it can therefore be recycled; and valuable products are produced from waste materials.

The Recovery Scrubber, in many preliminary feasibility studies conducted for numerous cement companies, generally operates at a net annual profit. That is, the value of the products produced or expenses that may be avoided when using the Recovery Scrubber exceeds the costs of maintenance and operation of the Recovery Scrubber.

COST/BENEFIT ESTIMATES FOR THE MODEL KILNS

In all 9 cases examined, application of the Recovery Scrubber resulted in net income to the model plant under study. As can be seen in the Financial Summary below, the calculated capital cost ranged from a high of nearly \$19 million to a low of less than \$6 million. The estimated net benefits ranged from a low of over \$700,000 per year to nearly \$3.1 million per year. A simple pay back period was also calculated by dividing the capital cost by the annual net income to get a payback period for the Recovery Scrubber installations. The payback periods ranged from 5 years to 8.4 years. While investment in the models with shorter payback periods may be justifiable on a purely financial basis, it must also be emphasized that even in the least beneficial case studied, in less than 8.5 years, the Recovery Scrubber generated sufficient income to pay for its initial installation.

Financial Summary

	<u>Estimated Capital Costs</u>	<u>Estimated Annual Net Benefits</u>	<u>Number of Years to Pay Back Investment</u>
Model Kiln A			
5 ppm HCl	12,067,804	2,118,648	5.7
12 ppm HCl	13,747,448	2,096,628	6.6
100 ppm HCl	17,556,569	3,057,912	5.7
Model Kiln B			
5 ppm HCl	10,967,819	2,214,956	5.0
12 ppm HCl	12,671,503	2,035,172	6.2
100 ppm HCl	14,709,738	1,955,910	7.5
Model Kiln C			
5 ppm HCl	5,956,540	708,006	8.4
12 ppm HCl	7,893,347	1,038,919	7.6
100 ppm HCl	18,986,664	3,011,356	6.3

1.0 INTRODUCTION

In the letter to Dr. Garrett L. Morrison from Mr. Jeffrey W. Portzer, dated July 26, 1993, a numbered list of questions was presented on page 2. To respond as completely as possible Passamaquoddy Technology will attempt to address each question in order.

2.0 QUESTION 1: DESCRIPTION OF THE PROCESS AT DRAGON PRODUCTS

In the Recovery Scrubber, dry CKD is mixed with water to form a dilute slurry. Exhaust gas, generally 200°F or warmer is passed through a heat exchanger where it is cooled. The CKD-water slurry and cooled flue gas are then brought into contact with each other, and allowed to react to perform both CKD renovation and flue gas scrubbing.

Reacted CKD undergoes significant chemical change during the process (see Table 1). It is freed of soluble alkali (Na and K) and significantly reduced in calcium sulfate content. Calcium, from dissolved gypsum (CaSO_4) and calcined limestone (CaO), is precipitated as calcium carbonate (CaCO_3). Reacted CKD at this point in the process has essentially the same composition as kiln feed.

Reacted slurry is separated into a liquid and a solid fraction (thickened slurry). The liquid fraction containing dissolved material is pumped to an evaporator where water is removed from the potassium salt solution leaving solid crystalline potassium sulfate. The processed CKD solids, as a concentrated slurry, are washed with distilled water (derived from the evaporation process) and returned to the cement plant raw material preparation system.

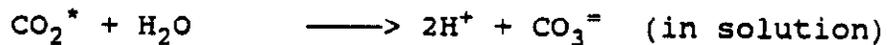
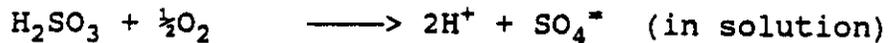
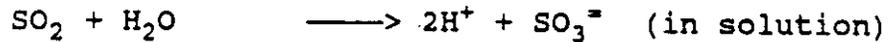
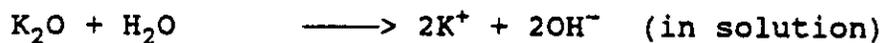
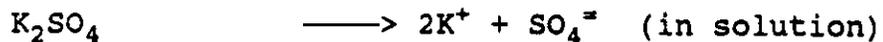
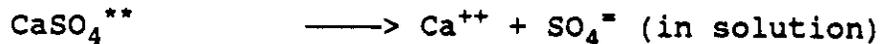
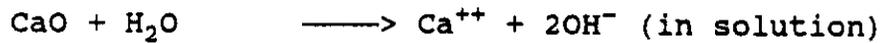
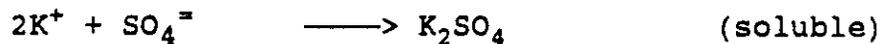
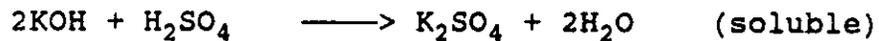
Waste CKD, exhaust gases, and wastewater are inputs to the process. Renovated CKD, potassium-based fertilizer (either KCl or K_2SO_4), scrubbed exhaust gas, and distilled water are process outputs. No waste is generated.

Process Details (see Figure 1 - Process Flowsheet)

A vortex type slurry mixer is located on top of the reaction storage tank. CKD is conveyed to the vortex mixer by a screw conveyor/elevator combination. Reacted slurry from the reaction storage tank is pumped to the vortex mixer at 300 - 500 GPM and injected tangentially at four points around the

TABLE 1

Chemical reactions in the Recovery Scrubber.

Exhaust Gas ReactionsCKD ReactionsReactions Between Products of Exhaust Gas and CKD Reactions

* Slurry in reaction tank is saturated with CO_2 .

**Greater than 100 times more soluble than CaCO_3 at Recovery Scrubber reaction conditions (in water, 140°F)

periphery of the vortex. CKD is dropped into the center of the vortex, mixed with reacted slurry and immediately discharged into the reaction storage tank. Process make-up water is added to the reaction storage tank to maintain the desired slurry moisture content.

After CKD is mixed to form a slurry it is used in the reaction tank. The reaction tank is a dual purpose subsystem where the CKD slurry is used as the scrubbing reagent for the flue gas, and where flue gas, dissolved in water, simultaneously renovates CKD. Exhaust gas bubbles through a depth of slurry rather than having the slurry sprayed into

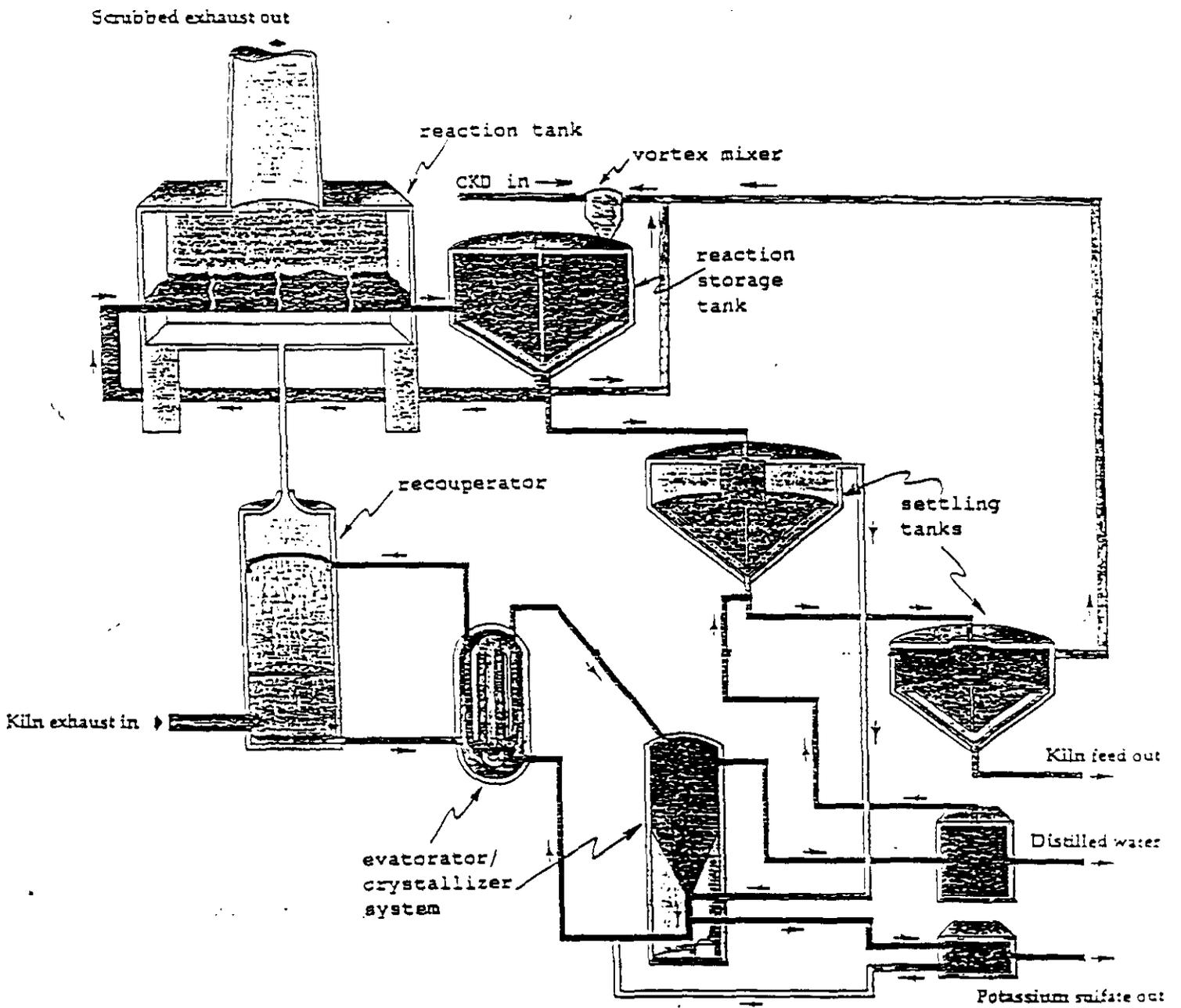


Figure 1. Recovery Scrubber - Process Flow

the gas stream. This method of gas-liquid contact provides for very efficient scrubbing of the gas while maintaining a chemical solution capable of dissolving calcium sulfate and precipitating calcium carbonate. This result is the direct opposite of limestone-based scrubber systems where calcium carbonate is reacted to form a calcium sulfate waste sludge.

The reaction storage tank affords a long residence time for CKD slurry to be in contact with water and flue gas. A long residence time is necessary to dissolve and react minerals of low solubility. Reacted CKD slurry from the reaction tank is pumped to the settling tanks.

There are two settling tanks. The first recovers the most concentrated alkali sulfate solution which is evaporated to crystallize potassium sulfate. Settled CKD from the first tank is rinsed with distilled water and conveyed to the second settling tank. Settled solids from the second tank are conveyed to the cement plant raw material preparation system for use as a raw material component. Water from the second settling tank is recycled to the reaction storage tank to provide process make-up water.

CKD which has been through the process exits the second settling tank as a slurry of about 50 percent solids. At Dragon, where the cement kiln is a wet process kiln, a slurry is useful as direct feed to the raw mill. The slurry moisture content is not a problem, simply a replacement for raw mill make-up water.

For application to a dry process plant the slurry should be substantially dewatered before reentering the raw material stream. Water may be removed in cyclones, filters, settling tanks, or thermal drying. The drying method to be applied to a specific plant should be selected after detailed evaluation of that plant. Careful study of a specific plant will determine heat availability and best auxiliary method for water reduction.

The potassium oxide content of reacted CKD is reduced to the level of normal kiln feed or below so that return of the CKD will not add alkali to the total raw material mix. The sulfate content of reacted CKD is also significantly reduced. Trace metals, particularly those that could render potassium salts unsuitable for fertilizer use, and those that could become progressively concentrated by reuse of CKD, must also be considered. Heavy metals, not already present as insoluble oxides, generally precipitate as the insoluble oxide, sulfate or carbonate in the Recovery Scrubber process. The heavy metals are then separated from the liquid fraction which feeds the crystallizer. They are returned with the reacted CKD to the cement plant as raw material. Therefore, the crystallized solid potassium sulfate salt has

nondetectable to very low levels of heavy metals. Heavy metals may be reduced to whatever level is desired by appropriate, selective precipitation.

The recuperator-crystallizer or evaporator is a multiple function sub-system. It is the beginning of the process for input of gaseous material and is also the source for much of the water, and the major portion of the heat, used by the process. The recuperator first cools the hot flue gas prior to it being used for CKD renovation. Cooling is necessary to prevent excessive evaporative loss of water from the CKD-water slurry during reaction. Cooling also condenses exhaust gas moisture for recovery and use in the system and permits use of fiberglass as an economical construction material.

The recuperator also captures energy for evaporating water from the potassium sulfate solution obtained by CKD renovation. The recuperator is a direct contact heat exchanger. Water is sprayed countercurrent to the exhaust gas flow thus cooling the gas and heating the water. The heated water is circulated to a flash tank operating under vacuum where the water flashes to low temperature steam. This steam is circulated through a shell and tube heat exchanger which transfers the thermal energy to the crystallizer circuit.

Water vapor from the crystallizer is condensed for reuse. Because it is good quality distilled water it could be made available for plant use or, with some additional treatment, for boiler make-up water.

Potassium sulfate crystals produced in the crystallizer pass through a centrifuge and to a pelletizer to form a granular product suitable for fertilizer use. The pellets are then dried and conveyed to storage for shipment.

3.0 QUESTION 2, 3, AND 4: PURCHASED EQUIPMENT COST, FREIGHT, AND ESTIMATE OF INSTALLATION AND ERECTION COST

Appendix A and Appendix B provide some of the assumptions and process calculations used for estimating the capital cost of a Passamaquoddy Technology Recovery Scrubber™ for each of the nine cases described in the U.S. EPA HCl MACT Standards Development Project. These costs include freight to Thomaston, Maine. Item 4 in each of the following tables provides an estimate of the installation and erection costs.

The following assumptions, scaling equation and exponents have been applied to the full size installation at Dragon to estimate the capital cost to purchase and install a Recovery Scrubber:

$$\frac{\text{Cost 2}}{\text{Cost 1}} = \left[\frac{\text{Size 2}}{\text{Size 1}} \right]^r$$

EXPONENTS (r=):

Gas dependent	0.6
Dust dependent	0.6
Product dependent	0.7
Gas, dust, and product dependent	0.9

Also:

Assume cost of a second crystallizer is 50% of the first.

Assume maximum cost of single crystallizer is twice the base case cost.

3.1 COST ESTIMATES - MODEL KILN A

TABLE 2

Model Kiln A Cost Estimate Worksheet
(in US dollars, unless otherwise noted)

	<u>Base Case</u>	<u>5 ppm HCl</u>	<u>12 ppm HCl</u>	<u>100 ppm HCl</u>
DATA:				
Gas volume, acfm	225,000	273,000	273,000	273,000
Dust, TPH	10.5	7.5	8.0	10.0
Salt product, TPH	0.4	0.7	0.6	1.1
Chlorine, TPD		0	0	10.5
1. GAS DEPENDENT				
Recouperator	450,000	505,360	505,360	505,360
Reaction tank	607,000	681,674	681,674	681,674
Fan	119,000	133,640	133,640	133,640
Stack, ducting, etc	316,000	354,875	354,875	354,875
Sub-Total	1,492,000	1,675,549	1,675,549	1,675,549
2. DUST DEPENDENT				
Storage, tanks, etc	552,000	451,089	468,899	536,075
3. PRODUCT DEPENDENT				
Crystallizer	2,000,000	2,971,116	2,656,402	3,687,875
Pelletizer, storage	225,000	334,250	298,845	414,886
Second Crystallizer		0	1,328,201	0
Sub-Total	2,225,000	3,305,366	4,283,448	4,102,761
4. GAS, DUST, AND PRODUCT DEPENDENT				
Field erection	2,500,000	3,105,349	3,613,337	3,555,857
Other	865,000	1,074,451	1,250,215	1,230,327
Sub-Total	3,365,000	4,179,800	4,863,552	4,786,184
5. FIXED COSTS				
Controls	188,000	188,000	188,000	188,000
Emission monitoring	109,000	109,000	109,000	109,000
Process design	1,162,000	1,162,000	1,162,000	1,162,000
Engineering design	997,000	997,000	997,000	997,000
Sub-Total	2,456,000	2,456,000	2,456,000	2,456,000
6. ELECTROLYSIS (Cl removal)				
		0	0	4,000,000
7. GRAND TOTAL				
	<u>10,090,000</u>	<u>12,067,804</u>	<u>13,747,448</u>	<u>17,556,569</u>

3.2 COST ESTIMATES - MODEL KILN B

TABLE 3

Model Kiln B Cost Estimate Worksheet
(in US dollars, unless otherwise noted)

	<u>Base Case</u>	<u>5 ppm HCl</u>	<u>12 ppm HCl</u>	<u>100 ppm HCl</u>
DATA:				
Gas volume, acfm	225,000	65,000	65,000	65,000
Dust, TPH	10.5	4.0	4.0	4.0
Salt product, TPH	0.4	0.8	0.7	0.8
Chlorine, TPD		0	0	11.0
1. GAS DEPENDENT				
Recouperator	450,000	213,624	213,624	213,624
Reaction tank	607,000	288,156	288,156	288,156
Fan	119,000	56,492	56,492	56,492
Stack, ducting, etc	316,000	150,012	150,012	150,012
Sub-Total	1,492,000	708,284	708,284	708,284
2. DUST DEPENDENT				
Storage, tanks, etc	552,000	309,358	309,358	309,358
3. PRODUCT DEPENDENT				
Crystallizer	2,000,000	3,385,269	2,959,079	3,249,010
Pelletizer, storage	225,000	380,843	332,896	365,514
Second Crystallizer		0	1,479,540	0
Sub-Total	2,225,000	3,766,112	4,771,515	3,614,524
4. GAS, DUST, AND PRODUCT DEPENDENT				
Field erection	2,500,000	2,769,736	3,288,519	2,690,618
Other	865,000	958,329	1,137,827	930,954
Sub-Total	3,365,000	3,728,065	4,426,346	3,621,572
5. FIXED COSTS				
Controls	188,000	188,000	188,000	188,000
Emission monitoring	109,000	109,000	109,000	109,000
Process design	1,162,000	1,162,000	1,162,000	1,162,000
Engineering design	997,000	997,000	997,000	997,000
Sub-Total	2,456,000	2,456,000	2,456,000	2,456,000
6. ELECTROLYSIS (Cl removal)		0	0	4,000,000
7. GRAND TOTAL	10,090,000	10,967,819	12,671,503	14,709,738

3.3 COST ESTIMATES - MODEL KILN C

TABLE 4

Model Kiln C Cost Estimate Worksheet
(in US dollars, unless otherwise noted)

	<u>Base Case</u>	<u>5 ppm HCl</u>	<u>12 ppm HCl</u>	<u>100 ppm HCl</u>
DATA:				
Gas volume, acfm	225,000	5,182	12,954	129,541
Dust, TPH	10.5	0.3	0.8	7.6
Salt product, TPH	0.4	0.1	0.2	1.1
Chlorine, TPD		1.1	2.7	22.1
1. GAS DEPENDENT				
Recouperator	450,000	46,836	81,161	323,108
Reaction tank	607,000	63,177	109,477	435,837
Fan	119,000	12,386	21,463	85,444
Stack, ducting, etc	316,000	32,890	56,993	226,894
Sub-Total	1,492,000	155,289	269,094	1,071,283
2. DUST DEPENDENT				
Storage, tanks, etc	552,000	65,910	114,213	454,688
3. PRODUCT DEPENDENT				
Crystallizer	2,000,000	694,702	1,319,351	4,000,000
Pelletizer, storage	225,000	78,154	148,427	450,000
Sub-Total	2,225,000	772,856	1,467,778	4,450,000
4. GAS, DUST, AND PRODUCT DEPENDENT				
Field erection	2,500,000	673,466	1,178,501	3,383,873
Other	865,000	233,019	407,761	1,170,820
Sub-Total	3,365,000	906,485	1,586,262	4,554,693
5. FIXED COSTS				
Controls	188,000	188,000	188,000	188,000
Emission monitoring	109,000	109,000	109,000	109,000
Process design	1,162,000	1,162,000	1,162,000	1,162,000
Engineering design	997,000	997,000	997,000	997,000
Sub-Total	2,456,000	2,456,000	2,456,000	2,456,000
6. ELECTROLYSIS (Cl removal)		1,600,000	2,000,000	6,000,000
7. GRAND TOTAL	<u>10,090,000</u>	<u>5,956,540</u>	<u>7,893,347</u>	<u>18,986,664</u>

4.0 QUESTION 5: ESTIMATE OF PRESSURE DROP FROM INLET FLANGE TO STACK OUTLET

The pressure drop from the inlet flange to the stack outlet at the Dragon installation ranges between 5 - 8 inches WC. This would be typical for other installations.

5.0 QUESTION 6: OUTLET GAS CONDITIONS

The outlet gas would be approximately 140°F. The SO₂ would be reduced by 92%, the HCl would be reduced by 98%, and the particulate grain loading would be a maximum of 0.006 grains per SCF. In each case the moisture content of the exhaust gas would be at the saturation point.

6.0 QUESTION 7: OPERATING UTILITY REQUIREMENTS

The Dragon prototype has approximately 800 kW of connected electrical equipment. An estimate of the electrical requirements is provided in Table 5.

TABLE 5

Estimated Electrical Requirements
(all values are kW)

	<u>Model Kiln A</u>	<u>Model Kiln B</u>	<u>Model Kiln C</u>
5 ppm HCl	950	250	200
12 ppm HCl	950	250	500
100 ppm HCl	2,500	1,900	3,800

All values for Model Kiln C and all values for 100 ppm HCl include substantial power requirements for electrolysis for the production for recovery and sale of chlorine gas.

7.0 QUESTION 8: LIQUID FLOWS

7.1 Scrubber fluid circulation rate.

Liquid circulation rates are very site and process specific. No estimate can be provided at this time, however, the indicated power requirements in Table 5 above does include an estimate of the power required for pumping fluids.

7.2 Process water makeup flow rates

The prototype at Dragon requires approximately 20 GPM of make up water. Water balance and makeup water requirements are site specific and more detailed information would be required to determine water requirements.

7.3 Blowdown flow rate

There is no blowdown when using the Recovery Scrubber.

7.4 Wastewater flow rate and characteristics

The Recovery Scrubber does not produce wastewater or any other waste streams. It recycles wastewater and other waste streams and produces valuable by-products (potassium-based fertilizer, cement plant kiln feed, etc) with global markets.

8.0 QUESTION 9: REAGENT CONSUMPTION RATE

The Recovery Scrubber uses cement kiln dust (CKD) as the reagent to scrub exhaust gases from a cement kiln. No additional reagent is required. However, if it is economically advantageous, a cement plant may also use other caustic waste from other industries (e.g., biomass ash from the wood products industries) as a scrubbing reagent in the Recovery Scrubber and recycle them into valuable by-products and cement plant kiln feed.

If heavy metals are to be recovered from CKD, reagents may be required to precipitate heavy metal compounds. Reagent use will depend on heavy metal concentration in CKD.

9.0 QUESTION 10: OPERATING LABOR REQUIREMENTS

The Recovery Scrubber prototype at the Dragon cement plant has a net operating labor requirement of a negative two (2) people. Prior to installation of the Recovery Scrubber, Dragon landfilled an average of 250 tons of CKD per day. This represented about 10% of their raw material requirement, which, in turn, represented 10% of their mining labor requirements. In addition, personnel were required to haul CKD to the landfill and to maintain the landfill. Additional personnel were required to test and treat collected leachate from the CKD landfill. It is estimated that the net reduction in labor represents, at a minimum, two (2) full time employees.

10.0 QUESTION 11: ANNUAL MAINTENANCE REQUIREMENTS

The estimated annual maintenance costs, for labor, parts and materials at the Dragon plant is \$100,000. In Table 6 - Annual Maintenance Expenses, estimates for each of the model plants have been made.

TABLE 6

Annual Maintenance Expenses

	<u>Model Kiln A</u>	<u>Model Kiln B</u>	<u>Model Kiln C</u>
5 ppm HCl	\$150,000	\$150,000	\$150,000
12 ppm HCl	\$100,000	\$110,000	\$110,000
100 ppm HCl	\$50,000	\$100,000	\$100,000

11.0 ANNUAL NET SAVINGS FROM RECOVERY SCRUBBER OPERATION

In addition to the eleven questions above, Passamaquoddy Technology was asked to define "typical" CKD compositions and rates for the model plants, and to use those values for the budgetary estimates. Appendix A provides the assumptions used in determining the calculated annual net savings (including annual operating costs) and the process reactions when using a Passamaquoddy Technology Recovery Scrubber™ at the three model cement plants emitting the specified levels of HCl. Appendix B provides the process calculations used in determining the calculated annual net savings.

11.1 MODEL KILN A

11.1.1 ANNUAL QUANTITIES - MODEL KILN A

TABLE 7

Model Kiln A
Annual Tonnages When Renovating CKD, and
Scrubbing HCl and SO₂ Emissions with a Recovery Scrubber
(all figures are tons per year)

	<u>5 PPM HCl</u>	<u>12 PPM HCl</u>	<u>100 PPM HCl</u>
CKD to RS	59,400	63,360	79,200
CKD from RS	61,618	65,498	81,972
K ₂ SO ₄	5,621	5,067	8,842
KCl	0	441	0
SO ₂ Allowances	1,146	1,146	1,146
Chlorine gas	0	0	3,474

**11.1.2 ANNUAL SAVINGS AND AVOIDED COSTS -
MODEL KILN A**

TABLE 8

Estimate of Annual Economic Benefits for Model Kiln A
(in dollars, on an annual basis)

	<u>5 PPM HCl</u>	<u>12 PPM HCl</u>	<u>100 PPM HCl</u>
Value of K ₂ SO ₄ ¹			
(5,621 T) (\$240/T)	1,349,040 ²		
(5,067 T) (\$240/T)		1,216,080	
(8,842 T) (\$240/T)			2,122,080 ²
Value of KCl ¹			
(441 T) (\$100/T)	0	44,100	0
Value of CKD as KF			
(61,618 T) (\$6/T)	369,708		
(65,498 T) (\$6/T)		392,988	
(81,972 T) (\$6/T)			491,832
Value of Chlorine gas			
(3,474 T) (\$150/T)	0	0	521,100
Avoided CKD landfill			
(59,400 T) (\$11/T)	653,400		
(63,360 T) (\$11/T)		696,960	
(79,200 T) (\$11/T)			871,200
SO ₂ Allowances			
(1,146 T) (\$250/T)	<u>286,500</u>	<u>286,500</u>	<u>286,500</u>
Sub-Total	2,658,648	2,636,628	4,292,712
Elect for Cl ₂ prod			
(3,474 T) (\$200/T)	0	0	- 694,800
Annual Maint. Costs	- 150,000	- 150,000	- 150,000
Annual Operation Costs	<u>- 390,000</u>	<u>- 390,000</u>	<u>- 390,000</u>
ANNUAL NET BENEFIT	<u>2,118,648</u>	<u>2,096,628</u>	<u>3,057,912</u>

Notes:

¹A mixed salt product may be separated by selective crystallization.

²Na is less than 3% of the combined salt product and will not, therefore, detract from the value of the K₂SO₄ and consequently, will not be removed separately.

11.2 MODEL KILN B

11.2.1 ANNUAL QUANTITIES - MODEL KILN B

TABLE 9

Model Kiln B
Annual Tonnages When Renovating CKD, and
Scrubbing HCl and SO₂ Emissions with a Recovery Scrubber
(all figures are tons per year)

	<u>5 PPM HCl</u>	<u>12 PPM HCl</u>	<u>100 PPM HCl</u>
CKD to RS	31,680	31,680	31,680
CKD from RS	34,056	33,502	32,155
K ₂ SO ₄	6,686	5,797	6,450
KCl	0	469	0
SO ₂ Allowances	1,130	1,130	1,130
Chlorine gas	0	0	3,620

**11.2.2 ANNUAL SAVINGS AND AVOIDED COSTS -
MODEL KILN B**

TABLE 10

Estimate of Annual Economic Benefits for Model Kiln B
(in dollars, on an annual basis)

	<u>5 PPM HCl</u>	<u>12 PPM HCl</u>	<u>100 PPM HCl</u>
Value of K ₂ SO ₄			
(6,686 T) (\$240/T)	1,604,640 ¹		
(5,797 T) (\$240/T)		1,391,280 ²	
(6,450 T) (\$240/T)			1,548,000 ¹
Value of KCl			
(469 T) (\$100/T)	0	46,900 ²	0
Value of CKD as KF			
(34,056 T) (\$6/T)	204,336		
(33,502 T) (\$6/T)		201,012	
(32,155 T) (\$6/T)			192,930
Value of Chlorine gas			
(3,620 T) (\$150/T)	0	0	543,000
Avoided CKD landfill			
(31,680 T) (\$11/T)	348,480	348,480	348,480
SO ₂ Allowances			
(1,130 T) (\$250/T)	<u>282,500</u>	<u>282,500</u>	<u>282,500</u>
Sub-Total	2,439,956	2,270,172	2,914,910
Elect for Cl ₂ prod			
(3,620 T) (\$200/T)	0	0	- 724,000
Annual Maint. Costs	- 100,000	- 110,000	- 110,000
Annual Operation Costs	<u>- 125,000</u>	<u>- 125,000</u>	<u>- 125,000</u>
ANNUAL NET BENEFIT	<u>2,214,956</u>	<u>2,035,172</u>	<u>1,955,910</u>

Notes:

¹Na is less than 3% of the combined salt product and will not, therefore, detract from the value of the K₂SO₄ and consequently, will not be removed separately.

²A mixed salt product may be separated by selective crystallization.

11.3 MODEL KILN C

11.3.1 ANNUAL QUANTITIES - MODEL KILN C

TABLE 11

Model Kiln C
Annual Tonnages When Renovating CKD, and
Scrubbing HCl and SO₂ Emissions with a Recovery Scrubber
(all figures are tons per year)

	<u>5 PPM HCl</u>	<u>12 PPM HCl</u>	<u>100 PPM HCl</u>
CKD to RS	2,376	6,019	60,192
CKD from RS	1,980	4,990	66,449
K ₂ SO ₄	811	2,058	8,735
KCl	0	0	0
SO ₂ Allowances	2,276	2,276	2,276
Chlorine gas	373	903	7,297

**11.3.2 ANNUAL SAVINGS AND AVOIDED COSTS -
MODEL KILN C**

TABLE 12

Estimate of Annual Economic Benefits for Model Kiln C
(in dollars, on an annual basis)

	<u>5 PPM HCl</u>	<u>12 PPM HCl</u>	<u>100 PPM HCl</u>
Value of K ₂ SO ₄ (811 T) (\$240/T)	194,640 ¹		
(2,058 T) (\$240/T)		493,920	
(8,735 T) (\$240/T)			2,096,400 ¹
Value of CKD as KF (1,980 T) (\$6/T)	11,880		
(4,990 T) (\$6/T)		29,940	
(66,449 T) (\$6/T)			398,694
Value of Chlorine gas (373 T) (\$150/T)	55,950		
(903 T) (\$150/T)		135,450	
(7,297 T) (\$150/T)			1,094,550
Avoided CKD landfill (2,376 T) (\$11/T)	26,136		
(6,019 T) (\$11/T)		66,209	
(60,192 T) (\$11/T)			662,112
SO ₂ Allowances (2,276 T) (\$250/T)	<u>569,000</u>	<u>569,000</u>	<u>569,000</u>
Sub-Total	857,606	1,294,519	4,820,756
Elect for Cl ₂ prod (373 T) (\$200/T)	- 74,600		
(903 T) (\$200/T)		- 180,600	
(7,297 T) (\$200/T)			-1,459,400
Annual Maint. Costs	- 50,000	- 50,000	- 100,000
Annual Operation Costs	- <u>25,000</u>	- <u>25,000</u>	- <u>250,000</u>
ANNUAL NET BENEFIT	<u>708,006</u>	<u>1,038,919</u>	<u>3,011,356</u>

Notes:

¹Na is less than 3% of the combined salt product and will not, therefore, detract from the value of the K₂SO₄ and consequently, will not be removed separately.

APPENDIX A
ASSUMPTIONS

1.0 Recovery Scrubber Acid Gas Removal Efficiency

HCl removal efficiency of greater than 98% will be achieved in all cases and an SO₂ removal efficiency of 92% has been consistently demonstrated as a long term average at the full scale prototype operating at the Dragon Products Company, Inc. cement plant in Thomaston, Maine.

2.0 Value of By-Products and Avoided Costs

Value of K ₂ SO ₄	\$240.00/T
Value of KCl	\$100.00/T
Value of returned CKD as feed	\$ 6.00/T
Value of SO ₂ emissions credits	\$250.00/T
Value of Cl ₂ gas	\$150.00/T
Cost to produce Cl ₂ gas	\$200.00/T
Avoided CKD landfill costs	\$ 11.00/T

3.0 Model Kiln A

3.1 Chloride Distribution In Model Kiln A

Chloride introduced into a kiln system has been assumed to partition as follows (actual distribution should be confirmed for each application):

- 1% to clinker product
- 9% to stack gas (includes residual particulates)
- 90% to cement kiln dust

Therefore:

At 5 ppm HCl in exhaust gas,

$$\begin{aligned} \text{HCl emitted} &= 147,000 \text{ dscfm} \times 5 \text{ ppm} = 0.735 \text{ dscfm} \\ &= 4.48 \text{ Lb/Hr HCl} \end{aligned}$$

$$\begin{aligned} \text{Then Cl input is} &= [(4.48 \text{ Lb/Hr}) / 0.09] \times (35.45 / 36.45) \\ &= 48.4 \text{ Lb/Hr input} \\ &= 0.019\% \text{ of KF} \end{aligned}$$

This level of Cl in KF should not be a problem in a long kiln so that no CKD needs to be wasted for chloride purging. It is, however, assumed that 7.5 TPH of CKD is wasted for alkali control.

The Cl distribution for Model Kiln A at 5 ppm HCl emissions in the stack gases before installation of a Recovery Scrubber is:

Cl in with KF	= 48.4 Lb/Hr	= 0.019%
Cl out with CKD	= 43.5 Lb/Hr	= 0.29 %
Cl out with Clinker	= 0.48 Lb/Hr	= 0.0003%
HCl out with flue gas	= 4.48 Lb/Hr	= 5 ppm

At 12 ppm HCl in exhaust gas,

HCl emitted = 147,000 dscfm X 12 ppm = 1.76 dscfm
= 10.75 Lb/Hr

Then Cl input is = [(10.75 Lb/Hr)/0.09]x(35.45/36.45)
= 116.1 Lb/Hr input
= 0.046% of KF

This level of Cl in KF is marginal for kiln build-ups and electrostatic precipitator (ESP) operating problems. However, it is assumed that 8.0 TPH of CKD is wasted for both chloride and alkali control.

The Cl distribution for Model Kiln A at 12 ppm HCl emissions in the stack gases before installation of a Recovery Scrubber is:

Cl in with KF	= 116.1 Lb/Hr	= 0.046%
Cl out with CKD	= 104.5 Lb/Hr	= 0.65 %
Cl out with Clinker	= 1.16 Lb/Hr	= 0.0008%
HCl out with flue gas	= 10.75 Lb/Hr	= 12 ppm

At 100 ppm HCl in exhaust gas,

HCl emitted = 147,000 dscfm X 100 ppm = 14.7 dscfm
= 89.6 Lb/Hr

Then Cl input is = [(89.6 Lb/Hr)/0.09]x(35.45/36.45)
= 967.7 Lb/Hr input
= 0.387% of KF

This is considered an excessive level of chloride input and it is assumed that 10 TPH of CKD must be wasted for chloride control to avoid kiln build-ups and ESP operating problems.

The Cl distribution for Model Kiln A at 100 ppm HCl emissions in the stack gases before installation of a Recovery Scrubber is:

Cl in with KF	= 967.7	Lb/Hr =	0.387%
Cl out with CKD	= 870.9	Lb/Hr =	4.35 %
Cl out with Clinker	= 9.68	Lb/Hr =	0.006%
HCl out with flue gas	= 89.6	Lb/Hr =	100 ppm

3.2 Typical CKD for Model Kiln A

Typical CKD compositions and rates for each of the model plants have been estimated by Passamaquoddy Technology, L.P. Below are the estimated CKD analyses and rates for Model Kiln A.

TABLE 1

Model Kiln A - Typical CKD Chemistry
(in percent)

	<u>5ppm HCl</u>	<u>12ppm HCl</u>	<u>100ppm HCl</u>
SiO ₂	13.4	13.4	13.4
Al ₂ O ₃	3.9	3.9	3.9
Fe ₂ O ₃	1.8	1.8	1.8
CaO	44.0	44.0	44.0
MgO	1.7	1.7	1.7
SO ₃	5.4	5.4	5.4
K ₂ O	5.45	5.45	6.45
Na ₂ O	0.45	0.45	0.45
Cl	0.29	0.65	4.35
LOI	22.9	22.9	18.5
TPH	7.5	8.0	10.0

4.0 Model Kiln B

4.1 Chloride Distribution in Model Kiln B

Chloride introduced into the kiln system is assumed to partition as described for Model Kiln A in Section 3.1.

The given HCl values for exhaust gas concentrations are assumed to be for the total exhaust gas volume. It is assumed, however, that effectively all the SO₂ and HCl actually originate from the gas bypass and that only the bypass gas and CKD need to be treated.

The bypass is assumed to be operated at 50% (relative to kiln exhaust gas) for all three levels of HCl and the bypass dust catch is 4 TPH.

Therefore:

At 5 ppm HCl in exhaust gas,

$$\begin{aligned} \text{HCl emitted} &= 145,000 \text{ dscfm} \times 5 \text{ ppm} = 0.725 \text{ dscfm} \\ &= 4.42 \text{ Lb/Hr HCl} \end{aligned}$$

$$\begin{aligned} \text{Then Cl input is} &= [(4.42 \text{ Lb/Hr})/0.09] \times (35.45/36.45) \\ &= 47.7 \text{ Lb/Hr input} \\ &= 0.019\% \text{ of KF} \end{aligned}$$

The Cl distribution, for Model Kiln B at 5 ppm HCl emissions in the stack gases before installation of a Recovery Scrubber, is:

Cl in with KF	= 47.7 Lb/Hr = 0.019%
Cl out with CKD	= 43.0 Lb/Hr = 0.54 %
Cl out with Clinker	= 0.48 Lb/Hr = 0.0008%
HCl out with flue gas	= 4.42 Lb/Hr = 5 ppm

At 12 ppm HCl in exhaust gas,

$$\begin{aligned} \text{HCl emitted} &= 145,000 \text{ dscfm} \times 12 \text{ ppm} = 1.74 \text{ dscfm} \\ &= 10.61 \text{ Lb/Hr} \end{aligned}$$

$$\begin{aligned} \text{Then Cl input is} &= [(10.61 \text{ Lb/Hr})/0.09] \times (35.45/36.45) \\ &= 114.5 \text{ Lb/Hr input} \\ &= 0.046\% \text{ of KF} \end{aligned}$$

The Cl distribution, for Model Kiln B at 12 ppm HCl emissions in the stack gases before installation of a Recovery Scrubber, is:

Cl in with KF	= 114.5 Lb/Hr = 0.046%
Cl out with CKD	= 103.1 Lb/Hr = 0.65 %
Cl out with Clinker	= 1.14 Lb/Hr = 0.0008%
HCl out with flue gas	= 10.61 Lb/Hr = 12 ppm

At 100 ppm HCl in exhaust gas,

HCl emitted = 145,000 dscfm X 100 ppm = 14.5 dscfm
 = 88.3 Lb/Hr

Then Cl input is = [(88.3 Lb/Hr)/0.09]x(35.45/36.45)
 = 954.6 Lb/Hr input
 = 0.382% of KF

The Cl distribution, for Model Kiln B at 100 ppm HCl emissions in the stack gases before installation of a Recovery Scrubber, is:

Cl in with KF	= 954.6 Lb/Hr = 0.382%
Cl out with CKD	= 859.1 Lb/Hr = 10.74 %
Cl out with Clinker	= 9.55 Lb/Hr = 0.006%
HCl out with flue gas	= 88.3 Lb/Hr = 100 ppm

4.2 Typical CKD for Model Kiln B

Typical CKD compositions and rates for each of the model plants have been estimated by Passamaquoddy Technology, L.P. Below are the estimated CKD analyses and rates for Model Kiln B.

TABLE 2

Model Kiln B - Typical CKD Chemistry
 (in percent)

	<u>5ppm HCl</u>	<u>12ppm HCl</u>	<u>100ppm HCl</u>
SiO ₂	13.8	13.9	13.7
Al ₂ O ₃	3.6	3.5	3.2
Fe ₂ O ₃	1.7	1.9	1.9
CaO	45.5	45.0	43.0
MgO	2.8	2.2	2.2
SO ₃	10.5	10.5	10.0
K ₂ O	11.5	11.5	11.0
Na ₂ O	0.75	0.75	0.75
Cl	0.54	1.29	10.74
LOI	9.0	9.0	4.0
TPH	4.0	4.0	4.0

5.0 Model Kiln C

5.1 Chloride Distribution in Model Kiln C

Chloride introduced into the kiln system is assumed to partition as described for Model Kiln A in Section 3.1.

Our calculations indicate calculated equivalent chloride levels in kiln feed at all HCl emission levels would exceed the 0.015% limit beyond which air-suspension preheater and precalciner kilns typically experience severe build-up and cyclone plugging. Therefore, Model Kiln C must operate a bypass to avoid severe plugging problems. However, we have made our process calculations assuming minimum bypass operation consistent with good operating practice for these kiln types (actual bypass requirements would need to be confirmed for each application).

The HCl values that have been provided for exhaust gas concentrations are assumed to be for the total exhaust gas volume. It is assumed, however, that effectively all the SO₂ and HCl actually originate from the gas bypass and that only the bypass gas and CKD need to be treated.

Depending upon the calculated kiln feed chloride concentration, the necessary gas bypass has been estimated for each level of HCl emission. The kiln exhaust gas quantity has been calculated by scaling from the data provided for Model Kiln B.

Therefore:

At 5 ppm HCl in exhaust gas,

$$\begin{aligned} \text{HCl emitted} &= 292,000 \text{ dscfm} \times 5 \text{ ppm} = 1.46 \text{ dscfm} \\ &= 8.9 \text{ Lb/Hr HCl} \end{aligned}$$

$$\begin{aligned} \text{Then Cl input is} &= [(8.9 \text{ Lb/Hr})/0.09] \times (35.45/36.45) \\ &= 96.11 \text{ Lb/Hr input} \\ &= 0.019\% \text{ of KF} \end{aligned}$$

The Cl distribution, for Model Kiln C at 5 ppm HCl emissions in the stack gases before installation of a Recovery Scrubber, is:

Cl in with KF	= 96.1	Lb/Hr	= 0.019%
Cl out with CKD	= 86.6	Lb/Hr	= 14.23 %
Cl out with Clinker	= 0.96	Lb/Hr	= 0.0003%
HCl out with flue gas	= 8.9	Lb/Hr	= 5 ppm

A 2% gas bypass is estimated to yield: 2,640 dscfm, and
0.304 TPH CKD

At 12 ppm HCl in exhaust gas,

$$\begin{aligned} \text{HCl emitted} &= 292,000 \text{ dscfm} \times 12 \text{ ppm} = 3,504 \text{ dscfm} \\ &= 21.3 \text{ Lb/Hr} \end{aligned}$$

$$\begin{aligned} \text{Then Cl input is} &= [(21.3 \text{ Lb/Hr})/0.09] \times (35.45/36.45) \\ &= 230.7 \text{ Lb/Hr input} \\ &= 0.046\% \text{ of KF} \end{aligned}$$

The Cl distribution, for Model Kiln C at 12 ppm HCl emissions in the stack gases before installation of a Recovery Scrubber, is:

Cl in with KF	= 230.7	Lb/Hr =	0.046%
Cl out with CKD	= 207.6	Lb/Hr =	13.66 %
Cl out with Clinker	= 2.31	Lb/Hr =	0.0008%
HCl out with flue gas	= 21.3	Lb/Hr =	12 ppm

A 5% gas bypass is estimated to yield: 6,600 dscfm, and
0.76 TPH CKD

At 100 ppm HCl in exhaust gas,

$$\begin{aligned} \text{HCl emitted} &= 292,000 \text{ dscfm} \times 100 \text{ ppm} = 29.2 \text{ dscfm} \\ &= 177.9 \text{ Lb/Hr} \end{aligned}$$

$$\begin{aligned} \text{Then Cl input is} &= [(177.9 \text{ Lb/Hr})/0.09] \times (35.45/36.45) \\ &= 1,922.3 \text{ Lb/Hr input} \\ &= 0.384\% \text{ of KF} \end{aligned}$$

The Cl distribution, for Model Kiln C at 100 ppm HCl emissions in the stack gases before installation of a Recovery Scrubber, is:

Cl in with KF	= 1,922.3	Lb/Hr =	0.387%
Cl out with CKD	= 1,730.0	Lb/Hr =	11.38 %
Cl out with Clinker	= 19.22	Lb/Hr =	0.006%
HCl out with flue gas	= 177.9	Lb/Hr =	100 ppm

A 50% gas bypass is estimated to yield: 66,000 dscfm, and
7.6 TPH CKD

5.2 Typical CKD for Model Kiln C

Typical CKD compositions and rates for each of the model plants have been estimated by Passamaquoddy Technology, L.P. Below are the estimated CKD analyses and rates for Model Kiln C.

TABLE 3

Model Kiln C - Typical CKD Chemistry
(in percent)

	<u>5ppm HCl</u>	<u>12ppm HCl</u>	<u>100ppm HCl</u>
SiO ₂	11.1	11.3	15.0
Al ₂ O ₃	2.6	2.6	3.5
Fe ₂ O ₃	1.6	1.6	2.1
CaO	34.3	34.7	46.6
MgO	1.8	1.8	2.4
SO ₃	11.0	11.0	6.0
K ₂ O	18.0	18.0	7.9
Na ₂ O	0.90	0.90	0.60
Cl	14.23	13.66	11.38
LOI	4.5	4.5	4.5
TPH	0.3	0.8	7.6

APPENDIX B
PROCESS CALCULATIONS

1.0 INTRODUCTION

It is given that each kiln operates 24 hours/day and 330 days/year. Using the estimated kiln feed (KF), cement kiln dust (CKD), clinker analyses and the given exhaust gas analyses, the anions and cations available for reaction may be calculated. The by-products produced by the Recovery Scrubber may then be calculated.

2.0 MODEL KILN A

2.1 MODEL KILN A AT 5 PPM HCl EMISSION LEVEL

2.1.1 KF, CKD, CLINKER, AND EXHAUST GAS ANALYSES

Model Kiln A at 5 PPM HCl¹ (in percent)

	<u>Typical Kiln Feed</u>	<u>Typical Kiln Dust</u>	<u>Typical Clinker</u>
SiO ₂	13.6	13.4	22.0
Al ₂ O ₃	3.3	3.9	5.2
Fe ₂ O ₃	1.9	1.8	3.0
CaO	42.8	44.0	65.2
MgO	1.8	1.7	2.9
SO ₃	0.6	5.4	0.5
K ₂ O	0.66	5.45	0.58
Na ₂ O	0.15	0.45	0.22
Cl	0.019	0.29	0.000
LOI	35.5	22.9	0.1
TPH	125.1	7.5	75

Exhaust Gas Analysis¹

Temp (°F)	350
ACFM	273,000
DSCFM	147,000
H ₂ O %	18
CO ₂ %	15
O ₂ %	12
CO (ppm)	800
NOx (ppm)	400
SO ₂ (ppm)	200
Particulate (gr/dscf)	0.03
HCl (ppm)	5

¹Three kilns combined

2.1.2 ANIONS AND CATIONS AVAILABLE

K₂O from CKD

$$[(7.5 \text{ tph} * 0.0545) - (7.8 \text{ tph} * 0.0066)] * (2000 \text{ lb/T}) = 714.5 \text{ pounds}$$
$$714.1 \text{ lb} / (94.2 \text{ lb/pound mole}) = 7.59 \text{ pound moles}$$

Na₂O from CKD

$$[(7.5 \text{ tph} * 0.0045) - (7.8 \text{ tph} * 0.0015)] * (2000 \text{ lb/T}) = 44.1 \text{ pounds}$$
$$44.1 \text{ lb} / (61.98 \text{ lb/pound mole}) = 0.712 \text{ pound moles}$$

Sulfur from CKD

$$[(7.5 \text{ tph} * 0.0540) - (7.8 \text{ tph} * 0.0060)] * (2000 \text{ lb/T}) = 716.4 \text{ pounds}$$
$$716.4 \text{ lb SO}_3 / (80 \text{ lb SO}_3 / \text{pound mole}) = 8.96 \text{ pound moles}$$

Chlorine from CKD

$$[(7.5 \text{ tph} * 0.0029) - (7.8 \text{ tph} * 0.00019)] * (2000 \text{ lb/T}) = 40.54 \text{ pounds}$$
$$40.54 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 1.14 \text{ pound moles}$$

Sulfur from Stack Scrubbing

$$(314.5 \text{ lb/hr}) * (0.92 \text{ eff.}) = 289.34 \text{ pounds SO}_2$$
$$289.34 \text{ lb SO}_2 / (64 \text{ lb SO}_2 / \text{pound mole}) = 4.52 \text{ pound moles}$$

Chlorine from Stack Scrubbing

$$(4.5 \text{ lb/hr}) * (0.98 \text{ eff.}) = 4.41 \text{ pounds Cl}$$
$$4.41 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 0.124 \text{ pound moles}$$

It then follows that, anions and cations available for use in the Recovery Scrubber (in pound moles per hour) would be:

	Sulfur	Chlorine	K ₂ O	Na ₂ O
From CKD	8.96	1.14	7.59	0.712
From Exhaust	<u>4.52</u>	<u>0.124</u>	<u>--</u>	<u>--</u>
Totals	13.48	1.264	7.59	0.712

Therefore, Recovery Scrubber reaction products would include:

	NaCl	Na ₂ SO ₄	K ₂ SO ₄
Pound Moles per hour	1.264	0.16	7.59
Pounds per hour	74	23	1,323
Tons per year	293	90	5,238

As these calculations indicate, if all of the CKD produced were recycled after being treated in a Recovery Scrubber, there would be 5.7 pound moles of sulfur remaining which would be returned to the kiln and incorporated into the clinker product which would result in an acceptable increase in the clinker SO₃ content of about 0.3%.

The 5,621 tons of combined salt product would have the following analysis as a fertilizer:

SO ₄	52%
Cl	3%
K	42%
Na	3%

This product would be acceptable for sale as potassium sulfate fertilizer.

2.2 MODEL KILN A AT 12 PPM HCl EMISSION LEVEL

2.2.1 KF, CKD, CLINKER, AND EXHAUST GAS ANALYSES

Model Kiln A at 12 PPM HCl¹ (in percent)

	<u>Typical Kiln Feed</u>	<u>Typical Kiln Dust</u>	<u>Typical Clinker</u>
SiO ₂	13.6	13.4	22.0
Al ₂ O ₃	3.3	3.9	5.2
Fe ₂ O ₃	1.9	1.8	3.0
CaO	42.8	44.0	65.2
MgO	1.8	1.7	2.9
SO ₃	0.6	5.4	0.5
K ₂ O	0.66	5.45	0.58
Na ₂ O	0.15	0.45	0.22
Cl	0.046	0.653	0.001
LOI	35.5	22.9	0.1
TPH	125.1	8.0	75

Exhaust Gas Analysis¹

Temp (°F)	350
ACFM	273,000
DSCFM	147,000
H ₂ O %	18
CO ₂ %	15
O ₂ %	12
CO (ppm)	800
NOx (ppm)	400
SO ₂ (ppm)	200
Particulate (gr/dscf)	0.03
HCl (ppm)	12

¹Three kilns combined

2.2.2 ANIONS AND CATIONS AVAILABLE

K₂O from CKD

$$[(8.0 \text{ tph} * 0.0545) - (8.3 \text{ tph} * 0.0066)] * (2000 \text{ lb/T}) = 762.44 \text{ pounds}$$
$$762.4 \text{ lb} / (94.2 \text{ lb/pound mole}) = 8.09 \text{ pound moles}$$

Na₂O from CKD

$$[(8.0 \text{ tph} * 0.0045) - (8.3 \text{ tph} * 0.0015)] * (2000 \text{ lb/T}) = 47.1 \text{ pounds}$$
$$47.1 \text{ lb} / (61.98 \text{ lb/pound mole}) = 0.760 \text{ pound moles}$$

Sulfur from CKD

$$[(8.0 \text{ tph} * 0.0540) - (8.3 \text{ tph} * 0.006)] * (2000 \text{ lb/T}) = 764.4 \text{ pounds}$$
$$764.4 \text{ lb SO}_3 / (80 \text{ lb SO}_3 / \text{pound mole}) = 9.56 \text{ pound moles}$$

Chlorine from CKD

$$[(8.0 \text{ tph} * 0.0065) - (8.3 \text{ tph} * 0.00046)] * (2000 \text{ lb/T}) = 96.36 \text{ pounds}$$
$$96.36 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 2.718 \text{ pound moles}$$

Sulfur from Stack Scrubbing

$$(314.5 \text{ lb/hr}) * (0.92 \text{ eff.}) = 289.34 \text{ pounds SO}_2$$
$$289.34 \text{ lb SO}_2 / (64 \text{ lb SO}_2 / \text{pound mole}) = 4.52 \text{ pound moles}$$

Chlorine from Stack Scrubbing

$$(10.7 \text{ lb/hr}) * (0.98 \text{ eff.}) = 10.49 \text{ pounds Cl}$$
$$10.49 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 0.296 \text{ pound moles}$$

It then follows that, anions and cations available for use in the Recovery Scrubber (in pound moles per hour) would be:

	Sulfur	Chlorine	K ₂ O	Na ₂ O
From CKD	9.56	2.718	8.09	0.76
From Exhaust	<u>4.52</u>	<u>0.296</u>	<u>--</u>	<u>--</u>
Totals	14.08	3.014	8.09	0.76

Therefore, Recovery Scrubber reaction products would include:

	NaCl	KCl	K ₂ SO ₄
Pound Moles per hour	1.52	1.49	7.34
Pounds per hour	89	111	1,280
Tons per year	352	441	5,067

As these calculations indicate, if all of the CKD produced were recycled after being treated in a Recovery Scrubber, there would be 6.7 pound moles of sulfur remaining which would be returned to the kiln and incorporated into the clinker product which would result in an acceptable increase in the clinker SO₃ content of about 0.4%.

The 5,860 tons of combined salt product would have the following analysis as a fertilizer:

SO ₄	48%
Cl	7%
K	43%
Na	2%

The chloride content of the combined salt product is sufficiently high that potassium sulfate and potassium chloride should be crystallized separately to enhance the value of the by-products and improve the economics of the system.

2.3 MODEL KILN A AT 100 PPM HCl EMISSION LEVEL

2.3.1 KF, CKD, CLINKER, AND EXHAUST GAS ANALYSES

Model Kiln A at 100 PPM HCl¹ (in percent)

	<u>Typical Kiln Feed</u>	<u>Typical Kiln Dust</u>	<u>Typical Clinker</u>
SiO ₂	13.6	13.4	22.0
Al ₂ O ₃	3.2	3.9	5.2
Fe ₂ O ₃	1.8	1.8	3.0
CaO	42.6	44.0	65.2
MgO	1.7	1.7	2.9
SO ₃	0.6	5.4	0.5
K ₂ O	0.75	6.45	0.50
Na ₂ O	0.15	0.45	0.22
Cl	0.387	4.35	0.006
LOI	35.3	18.5	0.1
TPH	125.1	10.0	75

Exhaust Gas Analysis¹

Temp (°F)	350
ACFM	273,000
DSCFM	147,000
H ₂ O %	18
CO ₂ %	15
O ₂ %	12
CO (ppm)	800
NOx (ppm)	400
SO ₂ (ppm)	200
Particulate (gr/dscf)	0.03
HCl (ppm)	100

¹Three kilns combined

2.3.2 ANIONS AND CATIONS AVAILABLE

K₂O from CKD

$$[(10 \text{ tph} * 0.0645) - (10.4 \text{ tph} * 0.0075)] * (2000 \text{ lb/T}) = 1,134 \text{ pounds}$$
$$1,134 \text{ lb} / (94.2 \text{ lb/pound mole}) = 12.04 \text{ pound moles}$$

Na₂O from CKD

$$[(10 \text{ tph} * 0.0045) - (10.4 \text{ tph} * 0.0015)] * (2000 \text{ lb/T}) = 58.8 \text{ pounds}$$
$$58.8 \text{ lb} / (61.98 \text{ lb/pound mole}) = 0.949 \text{ pound moles}$$

Sulfur from CKD

$$[(10 \text{ tph} * 0.0540) - (10.4 \text{ tph} * 0.006)] * (2000 \text{ lb/T}) = 955.2 \text{ pounds}$$
$$955.2 \text{ lb SO}_3 / (80 \text{ lb SO}_3 / \text{pound mole}) = 11.94 \text{ pound moles}$$

Chlorine from CKD

$$[(10 \text{ tph} * 0.0435) - (10.4 \text{ tph} * 0.00387)] * (2000 \text{ lb/T}) = 789.5 \text{ pounds}$$
$$798.5 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 22.27 \text{ pound moles}$$

Sulfur from Stack Scrubbing

$$(314.5 \text{ lb/hr}) * (0.92 \text{ eff.}) = 289.34 \text{ pounds SO}_2$$
$$289.34 \text{ lb SO}_2 / (64 \text{ lb SO}_2 / \text{pound mole}) = 4.52 \text{ pound moles}$$

Chlorine from Stack Scrubbing

$$(89.6 \text{ lb/hr}) * (0.98 \text{ eff.}) = 87.81 \text{ pounds Cl}$$
$$87.81 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 2.48 \text{ pound moles}$$

It then follows that, anions and cations available for use in the Recovery Scrubber (in pound moles per hour) would be:

	Sulfur	Chlorine	K ₂ O	Na ₂ O
From CKD	11.94	22.27	12.04	0.95
From Exhaust	<u>4.52</u>	<u>2.48</u>	<u>--</u>	<u>--</u>
Totals	16.46	24.75	12.04	0.95

Therefore, Recovery Scrubber reaction products would include, when removing chlorine by electrolysis:

	K ₂ SO ₄	Na ₂ SO ₄	Cl ₂
Pound Moles per hour	12.04	0.95	24.75
Pounds per hour	2,098	135	877
Tons per year	8,308	534	3,474

As these calculations indicate, if all of the CKD produced were recycled after being treated in a Recovery Scrubber, and chlorine were removed and recovered as gaseous chlorine, there would be 3.5 pound moles of sulfur remaining which would be returned to the kiln and incorporated into the clinker product. This would result in an acceptable increase in the clinker SO₃ content of less than 0.2%.

After chlorine removal, the 8,842 tons of combined salt product would have the following analysis as a fertilizer:

SO ₄	56%
Cl	Trace
K	42%
Na	2%

This product would be acceptable for sale as potassium sulfate fertilizer.

3.0 MODEL KILN B

3.1 MODEL KILN B AT 5 PPM HCl EMISSION LEVEL

3.1.1 KF, CKD, CLINKER, AND EXHAUST GAS ANALYSES

Model Kiln B at 5 PPM HCl
(in percent)

	<u>Typical Kiln Feed</u>	<u>Typical Kiln Dust</u>	<u>Typical Clinker</u>
SiO ₂	13.7	13.8	22.0
Al ₂ O ₃	3.2	3.6	5.0
Fe ₂ O ₃	1.9	1.7	2.9
CaO	42.2	45.5	64.6
MgO	2.2	2.8	3.6
SO ₃	0.3	10.5	0.3
K ₂ O	0.65	11.5	0.55
Na ₂ O	0.16	0.75	0.22
Cl	0.019	0.54	0.000
LOI	35.6	9.0	0.2
TPH	125.0	4.0	76

Exhaust Gas Analysis

	<u>Kiln Stack</u>	<u>Bypass Stack</u>
Temp (°F)	300	450
ACFM	196,000	65,000
DSCFM	112,000	33,000
H ₂ O %	18	10
CO ₂ %	15	15
O ₂ %	12	12
CO (ppm)	800	800
SO ₂ (ppm)	200	200
NOx (ppm)	400	400
Particulate (gr/dscf)	0.03	0.03
HCl (ppm)	5	5

3.1.2 ANIONS AND CATIONS AVAILABLE

K₂O from CKD

$$[(4.0 \text{ tph} * 0.1150) - (4.3 \text{ tph} * 0.0065)] * (2000 \text{ lb/T}) = 864.1 \text{ pounds}$$
$$864.1 \text{ lb} / (94.2 \text{ lb/pound mole}) = 9.173 \text{ pound moles}$$

Na₂O from CKD

$$[(4.0 \text{ tph} * 0.0075) - (4.3 \text{ tph} * 0.0016)] * (2000 \text{ lb/T}) = 46.24 \text{ pounds}$$
$$46.24 \text{ lb} / (61.98 \text{ lb/pound mole}) = 0.746 \text{ pound moles}$$

Sulfur from CKD

$$[(4.0 \text{ tph} * 0.1050) - (4.3 \text{ tph} * 0.0030)] * (2000 \text{ lb/T}) = 814.2 \text{ pounds}$$
$$814.2 \text{ lb SO}_3 / (80 \text{ lb SO}_3 / \text{pound mole}) = 10.178 \text{ pound moles}$$

Chlorine from CKD

$$[(4.0 \text{ tph} * 0.0054) - (4.3 \text{ tph} * 0.00019)] * (2000 \text{ lb/T}) = 41.57 \text{ pounds}$$
$$41.57 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 1.173 \text{ pound moles}$$

Sulfur from Stack Scrubbing

$$(310.2 \text{ lb/hr}) * (0.92 \text{ eff.}) = 285.38 \text{ pounds SO}_2$$
$$285.38 \text{ lb SO}_2 / (64 \text{ lb SO}_2 / \text{pound mole}) = 4.46 \text{ pound moles}$$

Chlorine from Stack Scrubbing

$$(4.4 \text{ lb/hr}) * (0.98 \text{ eff.}) = 4.31 \text{ pounds Cl}$$
$$4.31 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 0.122 \text{ pound moles}$$

It then follows that, anions and cations available for use in the Recovery Scrubber (in pound moles per hour) would be:

	Sulfur	Chlorine	K ₂ O	Na ₂ O
From CKD	10.18	1.17	9.17	0.75
From Exhaust	<u>4.46</u>	<u>0.12</u>	<u>--</u>	<u>--</u>
Totals	14.64	1.29	9.17	0.75

Therefore, Recovery Scrubber reaction products would include:

	NaCl	Na ₂ SO ₄	K ₂ SO ₄
Pound Moles per hour	1.29	0.11	9.17
Pounds per hour	75	15	1,598
Tons per year	299	59	6,328

As these calculations indicate, if all of the CKD produced were recycled after being treated in a Recovery Scrubber, there would be 5.4 pound moles of sulfur remaining which would be returned to the kiln and incorporated into the clinker product which would result in an acceptable increase in the clinker SO₃ content of about 0.3%.

The 6,686 tons of combined salt product would have the following analysis as a fertilizer:

SO ₄	53%
Cl	3%
K	43%
Na	2%

This product would be acceptable for sale as potassium sulfate fertilizer.

3.2 MODEL KILN B AT 12 PPM HCl EMISSION LEVEL

3.2.1 KF, CKD, CLINKER, AND EXHAUST GAS ANALYSES

Model Kiln B at 12 PPM HCl (in percent)

	<u>Typical Kiln Feed</u>	<u>Typical Kiln Dust</u>	<u>Typical Clinker</u>
SiO ₂	13.7	13.9	22.0
Al ₂ O ₃	3.2	3.5	5.0
Fe ₂ O ₃	1.9	1.9	2.9
CaO	42.2	45.0	64.6
MgO	2.2	2.2	3.6
SO ₃	0.3	10.5	0.3
K ₂ O	0.65	11.5	0.55
Na ₂ O	0.16	0.75	0.22
Cl	0.046	1.29	0.001
LOI	35.6	9.0	0.2
TPH	125.0	4.0	76

Exhaust Gas Analysis

	<u>Kiln Stack</u>	<u>Bypass Stack</u>
Temp (°F)	300	450
ACFM	196,000	65,000
DSCFM	112,000	33,000
H ₂ O %	18	10
CO ₂ %	15	15
O ₂ %	12	12
CO (ppm)	800	800
SO ₂ (ppm)	200	200
NOx (ppm)	400	400
Particulate (gr/dscf)	0.03	0.03
HCl (ppm)	12	12

3.2.2 ANIONS AND CATIONS AVAILABLE

K₂O from CKD

$$[(4.0 \text{ tph} * 0.1150) - (4.2 \text{ tph} * 0.0065)] * (2000 \text{ lb/T}) = 865.4 \text{ pounds}$$
$$865.4 \text{ lb} / (94.2 \text{ lb/pound mole}) = 9.19 \text{ pound moles}$$

Na₂O from CKD

$$[(4.0 \text{ tph} * 0.0075) - (4.2 \text{ tph} * 0.0016)] * (2000 \text{ lb/T}) = 46.56 \text{ pounds}$$
$$46.56 \text{ lb} / (61.98 \text{ lb/pound mole}) = 0.751 \text{ pound moles}$$

Sulfur from CKD

$$[(4.0 \text{ tph} * 0.1050) - (4.2 \text{ tph} * 0.003)] * (2000 \text{ lb/T}) = 814.8 \text{ pounds}$$
$$814.8 \text{ lb SO}_3 / (80 \text{ lb SO}_3 / \text{pound mole}) = 10.18 \text{ pound moles}$$

Chlorine from CKD

$$[(4.0 \text{ tph} * 0.0129) - (4.2 \text{ tph} * 0.00046)] * (2000 \text{ lb/T}) = 99.34 \text{ pounds}$$
$$99.34 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 2.80 \text{ pound moles}$$

Sulfur from Stack Scrubbing

$$(310.2 \text{ lb/hr}) * (0.92 \text{ eff.}) = 285.38 \text{ pounds SO}_2$$
$$285.38 \text{ lb SO}_2 / (64 \text{ lb SO}_2 / \text{pound mole}) = 4.46 \text{ pound moles}$$

Chlorine from Stack Scrubbing

$$(10.6 \text{ lb/hr}) * (0.98 \text{ eff.}) = 10.39 \text{ pounds Cl}$$
$$10.39 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 0.293 \text{ pound moles}$$

It then follows that, anions and cations available for use in the Recovery Scrubber (in pound moles per hour) would be:

	Sulfur	Chlorine	K ₂ O	Na ₂ O
From CKD	10.18	2.80	9.19	0.75
From Exhaust	<u>4.46</u>	<u>0.29</u>	<u>--</u>	<u>--</u>
Totals	14.64	3.09	9.19	0.75

Therefore, Recovery Scrubber reaction products would include:

	NaCl	KCl	K ₂ SO ₄
Pound Moles per hour	1.50	1.59	8.40
Pounds per hour	88	119	1,464
Tons per year	347	469	5,797

As these calculations indicate, if all of the CKD produced were recycled after being treated in a Recovery Scrubber, there would be 6.2 pound moles of sulfur remaining which would be returned to the kiln and incorporated into the clinker product which would result in an acceptable increase in the clinker SO₃ content of about 0.3%.

The 6,613 tons of combined salt product would have the following simple analysis:

SO ₄	48%
Cl	7%
K	43%
Na	2%

The chloride content of the combined salt product is sufficiently high that potassium sulfate and potassium chloride should be crystallized separately to enhance the value of the by-products and improve the economics of the system.

3.3 MODEL KILN B AT 100 PPM HCl EMISSION LEVEL

3.3.1 KF, CKD, CLINKER, AND EXHAUST GAS ANALYSES

Model Kiln B at 100 PPM HCl (in percent)

	<u>Typical Kiln Feed</u>	<u>Typical Kiln Dust</u>	<u>Typical Clinker</u>
SiO ₂	13.5	13.7	22.0
Al ₂ O ₃	3.1	3.2	5.0
Fe ₂ O ₃	1.8	1.9	2.9
CaO	42.0	43.0	64.6
MgO	2.2	2.2	3.6
SO ₃	0.5	10.0	0.3
K ₂ O	0.72	11.0	0.60
Na ₂ O	0.15	0.75	0.22
Cl	0.382	10.74	0.006
LOI	35.4	4.0	0.2
TPH	125.0	4.0	76

Exhaust Gas Analysis

	<u>Kiln Stack</u>	<u>Bypass Stack</u>
Temp (°F)	300	450
ACFM	196,000	65,000
DSCFM	112,000	33,000
H ₂ O %	18	10
CO ₂ %	15	15
O ₂ %	12	12
CO (ppm)	800	800
SO ₂ (ppm)	200	200
NOx (ppm)	400	400
Particulate (gr/dscf)	0.03	0.03
HCl (ppm)	100	100

3.3.2 ANIONS AND CATIONS AVAILABLE

K₂O from CKD

$$[(4.0 \text{ tph} * 0.1100) - (4.1 \text{ tph} * 0.0072)] * (2000 \text{ lb/T}) = 821.0 \text{ pounds}$$

$$821.0 \text{ lb} / (94.2 \text{ lb/pound mole}) = 8.72 \text{ pound moles}$$

Na₂O from CKD

$$[(4.0 \text{ tph} * 0.0075) - (4.1 \text{ tph} * 0.0015)] * (2000 \text{ lb/T}) = 47.7 \text{ pounds}$$

$$47.7 \text{ lb} / (61.98 \text{ lb/pound mole}) = 0.770 \text{ pound moles}$$

Sulfur from CKD

$$[(4.0 \text{ tph} * 0.1000) - (4.1 \text{ tph} * 0.005)] * (2000 \text{ lb/T}) = 759.0 \text{ pounds}$$

$$759.0 \text{ lb SO}_3 / (80 \text{ lb SO}_3 / \text{pound mole}) = 9.49 \text{ pound moles}$$

Chlorine from CKD

$$[(4.0 \text{ tph} * 0.1074) - (4.1 \text{ tph} * 0.00382)] * (2000 \text{ lb/T}) = 827.9 \text{ pounds}$$

$$827.9 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 23.35 \text{ pound moles}$$

Sulfur from Stack Scrubbing

$$(310.2 \text{ lb/hr}) * (0.92 \text{ eff.}) = 285.38 \text{ pounds SO}_2$$

$$285.38 \text{ lb SO}_2 / (64 \text{ lb SO}_2 / \text{pound mole}) = 4.46 \text{ pound moles}$$

Chlorine from Stack Scrubbing

$$(88.3 \text{ lb/hr}) * (0.98 \text{ eff.}) = 86.53 \text{ pounds Cl}$$

$$86.53 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 2.44 \text{ pound moles}$$

It then follows that, anions and cations available for use in the Recovery Scrubber (in pound moles per hour) would be:

	Sulfur	Chlorine	K ₂ O	Na ₂ O
From CKD	9.49	23.35	8.72	0.77
From Exhaust	<u>4.46</u>	<u>2.44</u>	<u>--</u>	<u>--</u>
Totals	13.95	25.79	8.72	0.77

Therefore, Recovery Scrubber reaction products would include, when removing chlorine by electrolysis:

	K ₂ SO ₄	Na ₂ SO ₄	Cl ₂
Pound Moles per hour	8.72	0.77	25.79
Pounds per hour	1,520	109	914
Tons per year	6,017	433	3,620

As these calculations indicate, if all of the CKD produced were recycled after being treated in a Recovery Scrubber, there would be 4.5 pound moles of sulfur remaining which would be returned to the kiln and incorporated into the clinker product which would result in an acceptable increase in the clinker SO₃ content of about 0.23%.

After chlorine removal, the 6,450 tons of combined salt product would have the following analysis as a fertilizer:

SO ₄	56%
Cl	Trace
K	42%
Na	2%

This product would be acceptable for sale as potassium sulfate fertilizer.

4.0 MODEL KILN C

4.1 MODEL KILN C AT 5 PPM HCl EMISSION LEVEL

4.1.1 KF, CKD, CLINKER, AND EXHAUST GAS ANALYSES

Model Kiln C at 5 PPM HCl (in percent)

	<u>Typical Kiln Feed</u>	<u>Typical Kiln Dust</u>	<u>Typical Clinker</u>
SiO ₂	13.7	11.1	22.0
Al ₂ O ₃	3.2	2.6	5.0
Fe ₂ O ₃	1.9	1.6	2.9
CaO	42.2	34.3	64.6
MgO	2.2	1.8	3.4
SO ₃	0.4	11.0	0.9
K ₂ O	0.60	18.0	0.95
Na ₂ O	0.10	0.90	0.16
Cl	0.019	14.23	0.000
LOI	35.6	4.5	0.2
TPH	250	0.3	152

Exhaust Gas Analysis

	<u>Kiln Stack</u>	<u>Bypass Stack</u>
Temp (°F)	300	450
ACFM	509,000	5,200
DSCFM	289,360	2,640
H ₂ O %	18	10
CO ₂ %	15	15
O ₂ %	12	12
CO (ppm)	800	800
SO ₂ (ppm)	200	200
NOx (ppm)	400	400
Particulate (gr/dscf)	0.03	0.03
HCl (ppm)	5	5

4.1.2 ANIONS AND CATIONS AVAILABLE

K₂O from CKD

$$[(0.3 \text{ tph} * 0.180) - (0.25 \text{ tph} * 0.006)] * (2000 \text{ lb/T}) = 105.0 \text{ pounds}$$
$$105.0 \text{ lb} / (94.2 \text{ lb/pound mole}) = 1.11 \text{ pound moles}$$

Na₂O from CKD

$$[(0.3 \text{ tph} * 0.009) - (0.25 \text{ tph} * 0.001)] * (2000 \text{ lb/T}) = 4.90 \text{ pounds}$$
$$4.90 \text{ lb} / (61.98 \text{ lb/pound mole}) = 0.079 \text{ pound moles}$$

Sulfur from CKD

$$[(0.3 \text{ tph} * 0.110) - (0.25 \text{ tph} * 0.004)] * (2000 \text{ lb/T}) = 64.00 \text{ pounds}$$
$$64.0 \text{ lb SO}_3 / (80 \text{ lb SO}_3 / \text{pound mole}) = 0.800 \text{ pound moles}$$

Chlorine from CKD

$$[(0.3 \text{ tph} * 0.1423) - (0.25 \text{ tph} * 0.00019)] * (2000 \text{ lb/T}) = 85.28 \text{ pounds}$$
$$85.28 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 2.41 \text{ pound moles}$$

Sulfur from Stack Scrubbing

$$(624.7 \text{ lb/hr}) * (0.92 \text{ eff.}) = 574.72 \text{ pounds SO}_2$$
$$574.72 \text{ lb SO}_2 / (64 \text{ lb SO}_2 / \text{pound mole}) = 8.98 \text{ pound moles}$$

Chlorine from Stack Scrubbing

$$(8.9 \text{ lb/hr}) * (0.98 \text{ eff.}) = 8.72 \text{ pounds Cl}$$
$$8.72 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 0.25 \text{ pound moles}$$

It then follows that, anions and cations available for use in the Recovery Scrubber (in pound moles per hour) would be:

	Sulfur	Chlorine	K ₂ O	Na ₂ O
From CKD	0.80	2.41	1.11	0.08
From Exhaust	<u>8.98</u>	<u>0.25</u>	<u>--</u>	<u>--</u>
Totals	9.78	2.66	1.11	0.08

Therefore, Recovery Scrubber reaction products would include, when removing chlorine by electrolysis:

	K ₂ SO ₄	Na ₂ SO ₄	Cl ₂
Pound Moles per hour	1.11	0.08	2.66
Pounds per hour	193	11	94
Tons per year	766	45	373

As these calculations indicate, if all of the CKD produced were recycled after being treated in a Recovery Scrubber, there would be 8.6 pound moles of sulfur remaining which would be returned to the kiln and incorporated into the clinker product which would result in an acceptable increase in the clinker SO₃ content of about 0.23%.

After chlorine removal, the 811 tons of combined salt product would have the following analysis as a fertilizer:

SO ₄	56%
Cl	Trace
K	42%
Na	2%

This product would be acceptable for sale as potassium sulfate fertilizer.

4.2 MODEL KILN C AT 12 PPM HCl EMISSION LEVEL

4.2.1 KF, CKD, CLINKER, AND EXHAUST GAS ANALYSES

Model Kiln C at 12 PPM HCl (in percent)

	<u>Typical Kiln Feed</u>	<u>Typical Kiln Dust</u>	<u>Typical Clinker</u>
SiO ₂	13.7	11.3	22.0
Al ₂ O ₃	3.2	2.6	5.0
Fe ₂ O ₃	1.9	1.6	2.9
CaO	42.2	34.7	64.6
MgO	2.2	1.8	3.6
SO ₃	0.4	11.0	0.9
K ₂ O	0.60	18.0	0.90
Na ₂ O	0.10	0.90	0.16
Cl	0.046	13.66	0.001
LOI	35.6	4.5	0.2
TPH	250	0.76	152

Exhaust Gas Analysis

	<u>Kiln Stack</u>	<u>Bypass Stack</u>
Temp (°F)	300	450
ACFM	509,000	13,000
DSCFM	285,400	6,600
H ₂ O %	18	10
CO ₂ %	15	15
O ₂ %	12	12
CO (ppm)	800	800
SO ₂ (ppm)	200	200
NOx (ppm)	400	400
Particulate (gr/dscf)	0.03	0.03
HCl (ppm)	12	12

4.2.2 ANIONS AND CATIONS AVAILABLE

K₂O from CKD

$$[(0.76\text{tph} \cdot 0.180) - (0.63\text{tph} \cdot 0.006)] \cdot (2000 \text{ lb/T}) = 266.04 \text{ pounds}$$
$$266.04 \text{ lb} / (94.2 \text{ lb/pound mole}) = 2.82 \text{ pound moles}$$

Na₂O from CKD

$$[(0.76\text{tph} \cdot 0.009) - (0.63\text{tph} \cdot 0.001)] \cdot (2000 \text{ lb/T}) = 12.42 \text{ pounds}$$
$$12.42 \text{ lb} / (61.98 \text{ lb/pound mole}) = 0.20 \text{ pound moles}$$

Sulfur from CKD

$$[(0.76 \text{ tph} \cdot 0.110) - (0.63\text{tph} \cdot 0.004)] \cdot (2000 \text{ lb/T}) = 162.2 \text{ pounds}$$
$$162.2 \text{ lb SO}_3 / (80 \text{ lb SO}_3/\text{pound mole}) = 2.03 \text{ pound moles}$$

Chlorine from CKD

$$[(0.76\text{tph} \cdot 0.1366) - (0.63\text{tph} \cdot 0.00046)] \cdot (2000 \text{ lb/T}) = 207.1 \text{ pound}$$
$$207.1 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 5.84 \text{ pound moles}$$

Sulfur from Stack Scrubbing

$$(624.7 \text{ lb/hr}) \cdot (0.92 \text{ eff.}) = 574.72 \text{ pounds SO}_2$$
$$574.72 \text{ lb SO}_2 / (64 \text{ lb SO}_2/\text{pound mole}) = 8.98 \text{ pound moles}$$

Chlorine from Stack Scrubbing

$$(21.3 \text{ lb/hr}) \cdot (0.98 \text{ eff.}) = 20.87 \text{ pounds Cl}$$
$$20.87 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 0.59 \text{ pound moles}$$

It then follows that, anions and cations available for use in the Recovery Scrubber (in pound moles per hour) would be:

	Sulfur	Chlorine	K ₂ O	Na ₂ O
From CKD	2.03	5.84	2.82	0.20
From Exhaust	<u>8.98</u>	<u>0.59</u>	<u>--</u>	<u>--</u>
Totals	11.01	6.43	2.82	0.20

Therefore, Recovery Scrubber reaction products would include, when removing chlorine by electrolysis:

	K ₂ SO ₄	Na ₂ SO ₄	Cl ₂
Pound Moles per hour	2.82	0.20	6.43
Pounds per hour	491	28	228
Tons per year	1,946	112	903

As these calculations indicate, if all of the CKD produced were recycled after being treated in a Recovery Scrubber, there would be 8 pound moles of sulfur remaining which would be returned to the kiln and incorporated into the clinker product which would result in an acceptable increase in the clinker SO₃ content of about 0.21%.

After chlorine removal, the 2,058 tons of combined salt product would have the following analysis as a fertilizer:

SO ₄	56%
Cl	Trace
K	42%
Na	2%

This product would be acceptable for sale as potassium sulfate fertilizer.

4.3 MODEL KILN C AT 100 PPM HCl EMISSION LEVEL

4.3.1 KF, CKD, CLINKER, AND EXHAUST GAS ANALYSES

Model Kiln C at 100 PPM HCl (in percent)

	<u>Typical Kiln Feed</u>	<u>Typical Kiln Dust</u>	<u>Typical Clinker</u>
SiO ₂	13.6	15.0	22.0
Al ₂ O ₃	3.2	3.5	5.0
Fe ₂ O ₃	1.9	2.1	2.9
CaO	42.0	46.6	64.6
MgO	2.2	2.4	3.6
SO ₃	0.5	6.0	0.7
K ₂ O	0.60	7.9	0.62
Na ₂ O	0.10	0.60	0.14
Cl	0.384	11.38	0.006
LOI	35.6	4.5	0.2
TPH	250	7.6	152

Exhaust Gas Analysis

	<u>Kiln Stack</u>	<u>Bypass Stack</u>
Temp (°F)	300	450
ACFM	509,000	129,500
DSCFM	226,000	66,000
H ₂ O %	18	10
CO ₂ %	15	15
O ₂ %	12	12
CO (ppm)	800	800
SO ₂ (ppm)	200	200
NOx (ppm)	400	400
Particulate (gr/dscf)	0.03	0.03
HCl (ppm)	100	100

4.3.2 ANIONS AND CATIONS AVAILABLE

K₂O from CKD

$$[(7.6 \text{ tph} * 0.079) - (8.4 \text{ tph} * 0.006)] * (2000 \text{ lb/T}) = 1,100.0 \text{ pounds}$$
$$1,100.0 \text{ lb} / (94.2 \text{ lb/pound mole}) = 11.68 \text{ pound moles}$$

Na₂O from CKD

$$[(7.6 \text{ tph} * 0.006) - (8.4 \text{ tph} * 0.001)] * (2000 \text{ lb/T}) = 74.40 \text{ pounds}$$
$$74.4 \text{ lb} / (61.98 \text{ lb/pound mole}) = 1.20 \text{ pound moles}$$

Sulfur from CKD

$$[(7.6 \text{ tph} * 0.060) - (8.4 \text{ tph} * 0.005)] * (2000 \text{ lb/T}) = 828.0 \text{ pounds}$$
$$828.0 \text{ lb SO}_3 / (80 \text{ lb SO}_3 / \text{pound mole}) = 10.35 \text{ pound moles}$$

Chlorine from CKD

$$[(7.6 \text{ tph} * 0.1138) - (8.4 \text{ tph} * 0.00384)] * (2000 \text{ lb/T}) = 1,665.2 \text{ pounds}$$
$$1,665.2 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 46.97 \text{ pound moles}$$

Sulfur from Stack Scrubbing

$$(624.7 \text{ lb/hr}) * (0.92 \text{ eff.}) = 574.72 \text{ pounds SO}_2$$
$$574.72 \text{ lb SO}_2 / (64 \text{ lb SO}_2 / \text{pound mole}) = 8.98 \text{ pound moles}$$

Chlorine from Stack Scrubbing

$$(177.9 \text{ lb/hr}) * (0.98 \text{ eff.}) = 174.34 \text{ pounds Cl}$$
$$174.34 \text{ lb Cl} / (35.45 \text{ lb Cl/pound mole}) = 4.92 \text{ pound moles}$$

It then follows that, anions and cations available for use in the Recovery Scrubber (in pound moles per hour) would be:

	Sulfur	Chlorine	K ₂ O	Na ₂ O
From CKD	10.35	46.97	11.68	1.20
From Exhaust	<u>8.98</u>	<u>4.92</u>	<u>--</u>	<u>--</u>
Totals	19.33	51.89	11.68	1.20

Therefore, Recovery Scrubber reaction products would include, when removing chlorine by electrolysis:

	K ₂ SO ₄	Na ₂ SO ₄	Cl ₂
Pound Moles per hour	11.68	1.20	51.98
Pounds per hour	2,035	170	1,843
Tons per year	8,060	675	7,297

As these calculations indicate, if all of the CKD produced were recycled after being treated in a Recovery Scrubber, there would be 6.45 pound moles of sulfur remaining which would be returned to the kiln and incorporated into the clinker product which would result in an acceptable increase in the clinker SO₃ content of about 0.17%.

After chlorine removal, the 8,735 tons of combined salt product would have the following analysis as a fertilizer:

SO ₄	56%
Cl	Trace
K	41%
Na	2%

This product would be acceptable for sale as potassium sulfate fertilizer.

APPENDIX L

Environmental Science Services report for MEC on
"Reactor Removal of Alpha-Pinene Efficiency"



In Response To The Future

**REACTOR REMOVAL OF
ALPHA-PINENE EFFICIENCY
REPORT**

Prepared for:

MEC Company
P.O. Box 330
Neodesha, KS

Prepared by:

Environmental Science Services
532 Atwells Avenue
Providence, RI 02909

September, 1993



In Response To The Future

TABLE OF CONTENTS

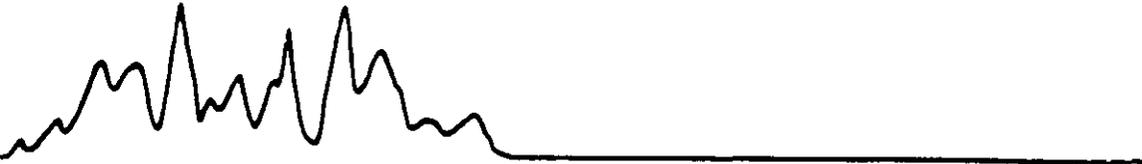
<u>Section</u>		<u>Page</u>
1.0	Introduction	1
2.0	Results	2
2.1	Alpha-Pinene	2
2.2	Ammonia	5
3.0	Methods	6

Tables

Table 2.1 - Passamaquoddy Technology Reactor Removal	4
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Appendices

- Appendix A - Data Calculations
- Appendix B - Field Data Sheets
- Appendix C - Certificates of Analysis



1.0 INTRODUCTION

Environmental Science Services was contracted by MEC Company (Neodesha, KS) and Passamaquoddy Technology (Thomaston, ME) to evaluate the removal efficiency of α -pinene using a pollution control reactor system located at the Dragon Products Company facility in Thomaston, ME. The α -pinene was injected downstream of the particulate control device (bag house) but before the equipment used for sulfur dioxide and carbon dioxide emission control. The concentration of α -pinene was then quantified in the stack which is located downstream of the reactor vessel.

Testing was conducted on September 1 and 2, 1993, by David Adelman, Kenneth Otis and Charles Farrell of ESS. Observers on-site for MEC were Mike Hudson and Kevin Kaff. Assistance during the test was provided by Dr. Garrett Morrison and Roger Turcotte of Passamaquoddy Technology.



2.0 RESULTS

Testing of removal efficiency for α -pinene was conducted on September 1, 1993 by injecting a metered quantity of α -pinene and measuring the concentration in the stack after the control device. Because of the possible importance of ammonia in the removal process, testing for the presence of ammonia was conducted on September 2.

2.1 Alpha-Pinene

Three 1-hour tests were conducted to determine reactor efficiency in the removal of α -pinene. One test was conducted while the system was operated under normal conditions. Fifteen pounds of a surfactant (Pluronic L-101, BASF Corp.) was then added to the reactor liquid circulation system. After one hour, to allow for mixing of the surfactant into the system, the reactor was tested two more times.

The amount of α -pinene added to the system was quantified by gauging the liquid level in the 55-gallon drum being used as a reservoir. The material (92% pure) was injected into the reactor inlet ducting as a spray using an airless sprayer.

The concentration of α -pinene exiting the reactor was quantified by collecting composite samples in Tedlar bags over the course of the hour tests. The sample point was located on the stack downstream of the reactor. Concentrations were measured using a flame ionization detector calibrated using propane. A relative response factor for α -pinene vs. propane was measured to be 3.5:1.

The flow rate of the exiting gas stream was quantified by measuring stack flow at 20 points located on two traverses during each test. These flow rates, in combination with α -pinene injection rates, were used to quantify reactor inlet concentrations.



In Response To The Future

Comparison of inlet and outlet concentrations presented in Table 2.1 indicate that the reactor efficiency was 72% without using surfactant and increase to 75 to 83% while using surfactant. Calculation of these values can be found in Appendix A, Table 4.

In addition to monitoring stack concentrations, liquid samples were collected from the recuperator and the reactor storage tank. They were analyzed for α -pinene and volatile organic compounds, so that degradation products of α -pinene would be found if chemical reactions were involved in its removal. Although no α -pinene was found in any sample (method detection limit of 5 $\mu\text{g/l}$) acetone was found in all samples while methyl ethyl ketone was found in the recuperator sample and methylene chloride and toluene were found in one of the reactor storage tank samples. These results are attached in Appendix C.



In Response To The Future

Table 2.1. Passamaquoddy Technology Reactor Removal
Efficiency for α -pinene as determined on 1 Sept. 1993.

Run No.	Concentration ppm		Efficiency %
	Inlet	Outlet	
3	4.22	1.17	72.3
4	14.68	2.49	83.1
5	13.13	3.34	74.5

Run Nos. 1 & 2 were conducted for stack flow rate determination only.



2.2 Ammonia

The concentration of ammonia at the reactor inlet and outlet was monitored on 2 September. Three 1-hour runs were conducted with sampling occurring simultaneously at the inlet and outlet. A US EPA draft method was employed which consists of bubbling a sample of gas at a rate of 1 liter per minute through three midget impingers containing 15 ml each of 1N H₂SO₄.

Ammonia was found in the inlet at concentrations ranging from 0.095 to 0.148 mg/dscf. Outlet concentrations were found to range from 0.22 to 0.37 mg/dscf. Calculation of concentrations can be found in Appendix A, Tables 2A and 3A.



3.0 METHODS

Alpha-pinene was spray injected into the gas stream in a duct up-stream of the induced draft fan leading to the recuperator. The injection rate of α -pinene varied from 100 to 300 ml/min but was constant during each test and quantities were measured according to the liquid level in the drum. Gas flow coming from the cement kiln varied during the tests from 167,000 to 192,000 ACFM as measured in the stack. The calculated concentration of α -pinene, therefore, varied from 4.22 to 14.68 ppmv during these tests as shown on Table 2.1.

A reactor inlet monitoring point was located up stream of a second draft blower. It was intended that the concentration measured at this location would be used for determination of α -pinene loading to the reactor. The concentration found at this location was far below expected values and was unstable. The reason for the discrepancy was not determined. It was, therefore, necessary to use changes in liquid level in the drum holding the α -pinene to determine inlet concentrations.

The outlet monitoring point was located on the stack. Samples were collected in Tedlar bags as composites over the course of each hour of testing. Samples were then analyzed using a Thermo Environmental Instruments, Inc., Model 51 Total Hydrocarbon Analyzer. The instrument was calibrated using an EPA Protocol One propane in air standard at a concentration of 29.8 ppm. The instrument was zeroed using zero grade air. Instrument response was checked at the end of each 1-hour run. The response factor of the instrument to α -pinene relative to propane was determined in the laboratory by preparing a 10 ppm concentration in a Tedlar bag and measuring instrument response after calibrating with propane. The response factor was found to be 3.5 to 1.

In order to determine if the reactor system had any major leaks which could bias results, a sample of gas was collected at the inlet and outlet locations simultaneously. The samples were



analyzed for oxygen and carbon dioxide by Orsat analysis. It was found that oxygen increased from a concentration of 11.0% to 11.3% across the unit. A slight infusion of air into the system was indicated. Carbon dioxide concentration across the reactor was found to decrease from 15.8% to 14.5%, which was in line with the expected decrease due to chemical reactions taking place in the reactor being tested.

Ammonia was quantified at the inlet and outlet of the reactor simultaneously. In addition to being used for ammonia analysis, these samples were used for measurement of moisture content of the two gas streams for calculation of dry standard flow conditions. The inlet concentration was found to average 24% while the outlet concentration averaged 27% moisture.



In Response To The Future

APPENDIX A
Data Calculations

Table No. 1A. PTech, Thomaston, ME. A-pinene sampling, 1 Sept. 1993.

Parameter	Units	Results				
RUN DATA						
Location		Stack	Stack	Stack	Stack	Stack
Run No.		1	2	3	4	5
Date		8/31/93	9/1/93	9/1/93	9/1/93	9/1/93
Start Time		4:45	9:00	2:45	4:45	5:45
End Time		5:15	9:20	3:10	5:45	6:45
STACK DATA						
Diameter	Ft.	12.00	12.00	12.00	12.00	12.00
Temp.	F	148	148	148	149	150
Press.	In WC	0.03	0.04	0.04	0.01	0.01
Bar. Press.	In Hg	29.92	29.92	29.92	29.92	29.92
Delta P.	Sqrt	0.39	0.46	0.41	0.40	0.41
TRAIN DATA						
Nozzle ID	In.					
Meter Y	Frac.					
Pitot Cp	Frac.	0.84	0.84	0.84	0.84	0.84
SAMPLE DATA						
Smple Time	Min.					
Volume	Cu. Ft.					
Meter Temp	F					
Delta H	In WC					
CATCH DATA						
Carb. Diox.	%	14.5	14.5	14.5	14.5	14.5
Oxygen	%	11.3	11.3	11.3	11.3	11.3
Water	ml					
a-pinene	ppm					
COMPOSITION						
Water	SCF					
Sample	SCF					
Moisture	Frac.	0.273	0.273	0.273	0.273	0.273
Gas	Frac.	0.727	0.727	0.727	0.727	0.727
MW Dry	g/g-mole	30.772	30.772	30.772	30.772	30.772
MW Stack	g/g-mole	27.285	27.285	27.285	27.285	27.285
FLOW						
Velocity	FPS	24.2	28.5	25.4	24.8	25.5
Volumetric	ACFM	163,921	193,340	172,325	168,266	172,614
Volumetric	DSCFM	103,498	122,076	108,807	106,062	108,624

Table No. 2A. PTech, Thomaston, ME. Ammonia sampling, 2 Sept. 1993.

Parameter	Units	Results		
RUN DATA				
Location		Stack	Stack	Stack
Run No.		1	2	3
Date		9/2/93	9/2/93	9/2/93
Start Time		7:50	9:20	10:45
End Time		8:50	10:20	11:45
STACK DATA				
Diameter	Ft.	12.00	12.00	12.00
Temp.	F	148	149	150
Press.	In WC	0.03	0.03	0.03
Bar. Press.	In Hg	29.92	29.92	29.92
Delta P.	Sqrt			
TRAIN DATA				
Nozzle ID	In.	0.13	0.13	0.13
Meter Y	Frac.	1.00	1.00	1.00
Pitot Cp	Frac.	0.84	0.84	0.84
SAMPLE DATA				
Smple Time	Min.	60	60	60
Volume	Cu. Ft.	2.375	2.375	2.375
Meter Temp	F	75	75	75
Delta H	In WC			
CATCH DATA				
Carb. Diox.	%	14.5	14.5	14.5
Oxygen	%	11.3	11.3	11.3
Water	ml	17.8	18.9	19.5
Ammonia	mg	0.74	0.87	0.52
COMPOSITION				
Water	SCF	0.838	0.890	0.918
Sample	SCF	2.343	2.343	2.343
Moisture	Frac.	0.263	0.275	0.282
Gas	Frac.	0.737	0.725	0.718
MW Dry	g/g--mole	30.772	30.772	30.772
MW Stack	g/g--mole	27.408	27.257	27.177
Ammonia	mg/dscf	0.312	0.368	0.220

Table No. 3A. PTech, Thomaston, ME. Ammonia sampling, 2 Sept. 1993.

Parameter	Units	Results		
RUN DATA				
Location		Inlet	Inlet	Inlet
Run No.		1	2	3
Date		9/2/93	9/2/93	9/2/93
Start Time		7:50	9:20	10:45
End Time		8:50	10:20	11:45
STACK DATA				
Diameter	Ft.	12.00	12.00	12.00
Temp.	F	260	259	264
Press.	In WC	0.05	0.05	0.05
Bar. Press.	In Hg	29.92	29.92	29.92
Delta P.	Sqrt			
TRAIN DATA				
Nozzle ID	In.	0.13	0.13	0.13
Meter Y	Frac.	1.00	1.00	1.00
Pitot Cp	Frac.	0.84	0.84	0.84
SAMPLE DATA				
Smple Time	Min.	60	60	60
Volume	Cu. Ft.	2.290	2.290	2.290
Meter Temp	F	75	75	75
Delta H	In WC			
CATCH DATA				
Carb. Diox.	%	15.8	15.8	15.8
Oxygen	%	11.0	11.0	11.0
Water	mi	13.4	15.2	16.1
Ammonia	mg	0.34	0.27	0.22
COMPOSITION				
Water	SCF	0.631	0.715	0.758
Sample	SCF	2.259	2.259	2.259
Moisture	Frac.	0.218	0.241	0.251
Gas	Frac.	0.782	0.759	0.749
MW Dry	g/g-mole	30.968	30.968	30.968
MW Stack	g/g-mole	28.138	27.849	27.711
Ammonia	mg/dscf	0.148	0.117	0.095

Table 4A. PTech, Thomaston, ME. A-Pinene injection. 1 Sept. 1993.

Run No.		3	4	5
Parameter	Units			
Liquid Drop	cm	2.06	7.62	6.98
Volume	ml	5,053	18,692	17,122
Time	min	55	60	60
Liquid Injection	ml/min	91.88	311.53	285.36
Vapor Injection	DSCFM	0.459	1.557	1.427
Stack Flow	DSCFM	108,807	106,062	108,624
Inlet Conc.	ppm	4.22	14.68	13.13
Outlet Response	ppm	4.10	8.70	11.70
Outlet Conc.	ppm	1.17	2.49	3.34
Efficiency	%	72.3	83.1	74.5

Run Nos. 1 and 2 were conducted for flow data only.



In Response To The Future

APPENDIX B
Field Data Sheets



COMPANY

Neodesha, Kansas U.S.A.

By JKK

Date 9/1/93

Customer PTI/MEC

Job No. _____ Location THOMASTON, MO

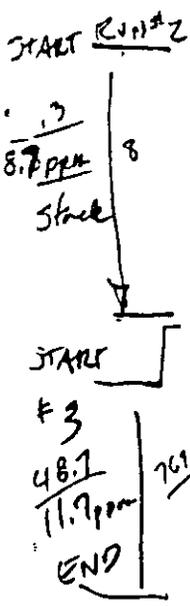
Sht. No. 1 of _____

	TIME	LEVEL	KILN EXH. FAN	TEMP	STACK	ACFM / SCFM	TEMP
	2:00P	7.0"	150,000	268°		119/103K	149°
	2:30P						
240P	2:35P	7.75"	150,000	265°		118/103K	149°
	2:50P						
<i>circ. no. stamp / PUN #1</i>	3:05P	8.06"	147,000			117/102K	149°
	3:15P	8.12"	149,000	268°		118/103K	149°
3:40	3:30P	8.56"					
	3:37P	8.75"	147,000	271°		124/107K	150
	3:45P	9.0"	148,000	271°		123/106K	150
	4:00P	9.38"	146,000	271		125/108K	150
	4:15P	10.75	149,000	271		129/106K	150°
	4:30P	10.95	147,000	271		119/102K	150°
	4:45P	11.25					
	5:00P	12.12	147,000	271		120/104K	150°
	5:15P	12.75	149,000	271°		125/109K	150
	5:30P	13.50	149,000	271		124 127/110K	150°
	5:45P	14.25	148,000	271		125/109K	150
	6:00P	14.75	148,000			125/107K	150
	6:15P	15.5"	147,000	271		118/102K	150
	6:30P	16.38"	148,000	271		118/103K	150
	6:45P	16.94"	148,000	271		115/100K	150
	7:00P	17.63"	149,000	271		113/98K	150

circ. no. stamp / PUN #1

→ Adjusted PUMP FLOW

200 SURFACTANT



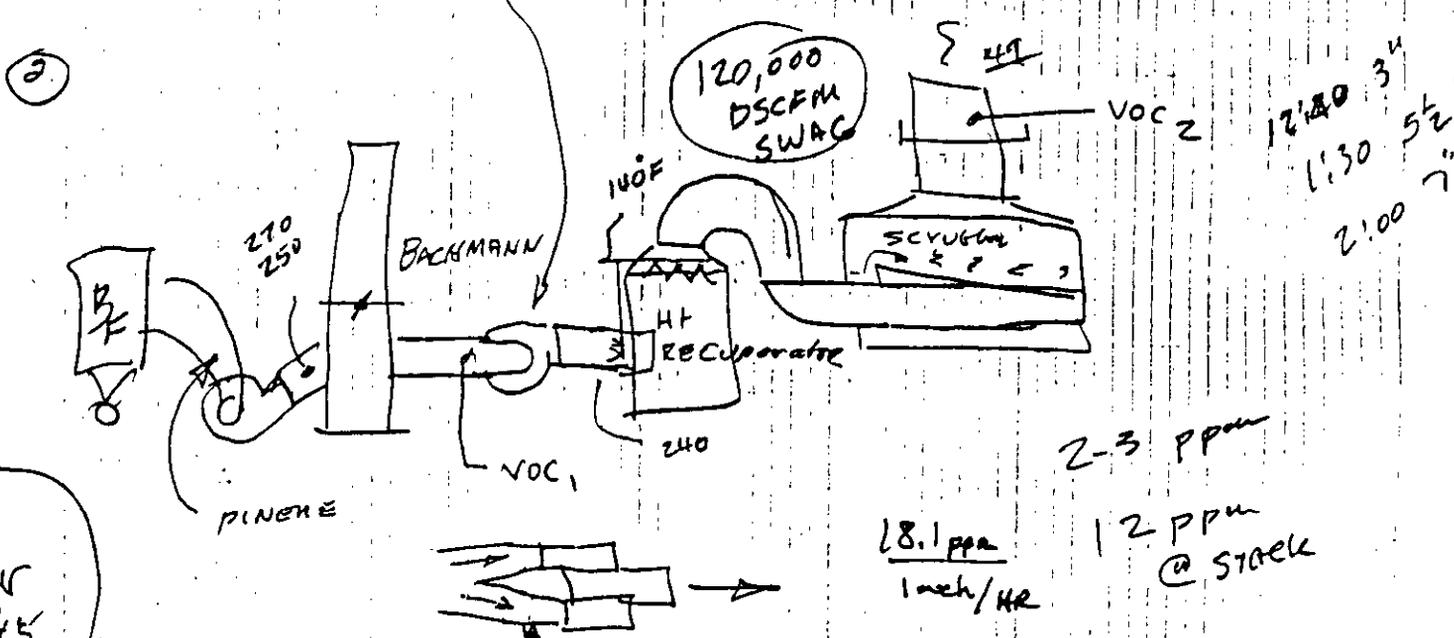


Neodesha, Kansas

Job No. _____ Locatic

MEC
Neodesha, Kansas
1968

① 700 HP 1187 RPM
 ROBINSON Eng 92 TYPE UB SIN 759-P
 73% IN = 14.66 ppm (RUN #1)
 OUT = 4.00 ppm



unc
 1 gal
 = 8.5
 LB
 gal
 3

2 1/2" x 22.5" φ

Vol = 5752 ft³

× 7.47

4.297 gal/hr

30.46 LB/hr

$$PPM = \frac{30.46 \times 120,000 / 60}{MW / 3.853 \times 10^{-8}} = 45,3 \text{ ppm}$$

1.72 gal
 inch

7.47

22.5" φ x 34" H

Vol = 7.823 ft³
 = 58.44 gal

C₃ ≈ (2 × 3 = 3C)

④ 2:00 — 1 1/2" — 20 min = 4.5" / hr
 = 7.7 gal/hr = 54.8 #/hr = 81.5 ppm

Plant Dragon Products
 Date 2/8/93 Location Stack
 Vent Dia. 12' Run No. 1 4:45 - 5:15
 Vent Area Pitot Coeff. 0.84
 Bar. Pres. Vent Pres. 0.03" WC
 Operators Chris/Farrall



Schematic of Vent

Travers Pt. No.	Velocity Head inches H2O	Vent Temperature		SRT(Del P)
		Deg. F	Deg. R	
1	0.16	147		
2	0.16	148		
3	0.16	147		
4	0.14	144		
5	0.15	143		
6	0.16	151		
7	0.15	152		
8	0.15	152		
9	0.14	151		
10	0.14	148		
Average				

NW

SW

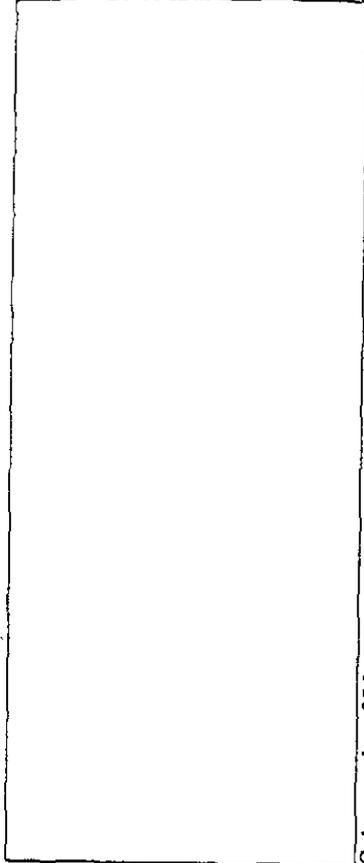
Travers Pt. No.	Velocity Head inches H2O	Vent Temperature		SRT(Del P)
		Deg. F	Deg. R	
1	0.15	147		
2	0.14	146		
3	0.14	145		
4	0.13	145		
5	0.13	144		
6	0.16	152		
7	0.17	152		
8	0.16	153		
9	0.16	153		
10	0.14	151		
Average				148 0.39

NE

SE

Control Room = 104,000 ACFM

Plant Deegan Ponds
 Date 1 Sept 73 Location Stack
 Vent Dia. 12 Run No. 3 (2:45-3:10)
 Vent Area _____ Pitot Coeff. 0.84
 Bar. Pres. _____ Vent Pres. 0.04
 Operators CRS/FAST



Schematic of Vent

Travers Pt. No.	Velocity Head inches H2O	Vent Temperature		SRT(Del P)
		Deg. F	Deg. R	
1	0.16	148		
2	0.16	148		
3	0.15	148		
4	0.15	147		
5	0.14	147		
6	0.16	149		
7	0.15	149		
8	0.14	148		
9	0.14	148		
10	0.12	147		
Average				

Travers Pt. No.	Velocity Head inches H2O	Vent Temperature		SRT(Del P)
		Deg. F	Deg. R	
1	0.19	151		
2	0.19	151		
3	0.19	150		
4	0.18	150		
5	0.17	150		
6	0.22	151		
7	0.21	150		
8	0.21	150		
9	0.21	149		
10	0.20	148		
Average				0.41

Impinger Catch Data

Date: 9/2/93

Plant: Dragon Products

Test No.: 3 Inlet

Impinger #	Content	Final Wt.	Initial Wt.	Difference
------------	---------	-----------	-------------	------------

1	15 ml 1.0N H ₂ SO ₄	106.3	91.2	
2	"	93.0	92.4	
3	"	91.8	91.8	
4	S. Gal	92.2	91.8	

~~5~~

383.3 - 367.2 = 16.1

Totals

8170353A

Impinger Catch Data

Date: 9/2/93

Plant: Dragon Products

Test No.: 3 Stack

Impinger #	Content	Final Wt.	Initial Wt.	Difference
------------	---------	-----------	-------------	------------

1	15ml IN H ₂ SO ₄	107.3	98.5	
2	"	90.3	90.2	
3	"	89.0	89.0	
4	S. Gel	91.1	90.5	

~~5~~

Totals		377.7	-	368.2	:	9.5
--------	--	-------	---	-------	---	-----

Impinger Catch Data

Date: 9/2/93

Plant: Dragon Products

Test No.: 2 - Inlet

Impinger #	Content	Final Wt.	Initial Wt.	Difference
1	15 ml 1N H ₂ SO ₄	104.5	90.9	
2	"	92.1	92.0	
3	"	92.0	91.5	
4	S. Gel	91.7	90.7	
5				

Totals

$$390.3 - 365.1 = 15.2$$

Impinger Catch Data

Date: 2 Sept 93

Plant: Dragon Products

Test No.: 2-Stack

Impinger #	Content	Final Wt.	Initial Wt.	Difference
------------	---------	-----------	-------------	------------

1	15 ml 1N H ₂ SO ₄	103.9	89.5	
2	"	94.3	90.0	
3	"	85.5	85.5	
4	S. Gel	90.4	90.2	

~~5~~

374.1 - 355.2 = 18.9

Totals

Impinger Catch Data

Date: 1-2 Sept 93

Plant: Dragon Products

Test No.: 1- Inlet

Impinger #	Content	Final Wt.	Initial Wt.	Difference
------------	---------	-----------	-------------	------------

1	15ml 1N H ₂ SO ₄	102.0	90.0	
---	--	-------	------	--

2	"	92.2	91.8	
---	---	------	------	--

3	"	88.4	87.7	
---	---	------	------	--

4	S, Gel	92.7	92.4	
---	--------	------	------	--

~~5~~

375.3 - 361.9 = 13.4

Totals

Impinger Catch Data

Date: 1-2 Sept 93

Plant: Dragon Products

Test No.: 1 - Stack

Impinger #	Content	Final Wt.	Initial Wt.	Difference
------------	---------	-----------	-------------	------------

1	15 ml 1N H ₂ SO ₄	107.6	90.6	
2	"	91.7	91.4	
3	"	88.8	87.8	
4	S ₂ Gel	87.5	88.0	

5

Totals		375.6	- 357.8	= 17.8
--------	--	-------	---------	--------

ENVIRONMENTAL SCIENCE SERVICES

532 Atwells Avenue
PROVIDENCE, RHODE ISLAND 02909
(401) 421-0398

JOB Dragon Products

SHEET NO. _____ OF _____

CALCULATED BY Adelman DATE _____

CHECKED BY _____ DATE _____

SCALE _____

Pump No	Flow l/min		Avg	
	Initial	Final		
244	1.05			
215	1.08	1.08	1.08	Inlet
246	1.10			
243	1.17	1.10	1.14	stack

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JOB Dragon Products

SHEET NO _____ OF _____

CALCULATED BY Adelman DATE 1 Sept 93

CHECKED BY _____ DATE _____

SCALE _____

Orsat
Run 2 (1st w/ surfactant)

	<u>Outlet</u>	<u>Inlet</u>
Total	25.8	26.8
CO ₂ %	14.5	15.8
O ₂ %	11.3	11.0



In Response To The Future

APPENDIX C
Certificates of Analysis



In Response To The Future

CERTIFICATE OF ANALYSIS

Client: Environmental Science Services

Client Project ID: P Tech Test

ESS Project ID: 932716

Client Sample ID: Recuperator-1

ESS Sample ID: 932716-09

Date Sample Received: 9/3/93

Date Reported: 9/24/93

Parameter	Results	Units	MRL	Method
Pinene	ND	ug/L	5	GC/MS
Volatile Organics				
Acetone	610	ug/L	Attached	8260
Methyl Ethyl Ketone	130	ug/L	Attached	8260

ND = Not Detected above Method Reporting Limit (MRL)

Approved by:

Date: 24 Sept 93

Environmental Science Services

532 Atwells Avenue, Providence, Rhode Island 02909 (401) 421-0398 Fax. (401) 421-5731





In Response To The Future

CERTIFICATE OF ANALYSIS

VOLATILE ORGANICS Method 8260

Client: Environmental Science Services

Client Project ID: P Tech Test

Client Sample ID: Recouperator-1

Date Sampled: NA

Date Analyzed: 9/17/93

ESS Project ID: 932716

ESS Sample ID: 932716-09

Dilution Factor: 1x

Units: ug/L

Parameter	Result	MRL
Chloromethane	ND	10
Vinyl Chloride	ND	10
Bromomethane	ND	10
Chloroethane	ND	10
Trichlorofluoromethane	ND	5
1,1-Dichloroethene	ND	5
Acetone	610	50
Carbon Disulfide	ND	5
Methylene Chloride	ND	5
Methyl tert-Butyl Ether	ND	10
Cis-1,2-Dichloroethene	ND	5
Trans-1,2-Dichloroethene	ND	5
1,1-Dichloroethane	ND	5
Methyl Ethyl Ketone	130	50
Chloroform	ND	5
1,1,1-Trichloroethane	ND	5
Carbon Tetrachloride	ND	5
Benzene	ND	5
1,2-Dichloroethane	ND	5
Trichloroethene	ND	5
1,2-Dichloropropane	ND	5
Bromodichloromethane	ND	5
Cis-1,3-Dichloropropene	ND	5
Methyl Isobutyl Ketone	ND	50
Toluene	ND	5
Trans-1,3-Dichloropropene	ND	5
1,1,2-Trichloroethane	ND	5
Tetrachloroethene	ND	5
2-Hexanone	ND	50
Dibromochloromethane	ND	5
Chlorobenzene	ND	5
Ethylbenzene	ND	5
Xylenes (Total)	ND	5
Styrene	ND	10
Bromoform	ND	5
1,1,2,2-Tetrachloroethane	ND	5
Dichlorobenzene (Total)	ND	10

NA = Not Available

ND = Not Detected above Method Reporting Limit (MRL)

Approved by:

Date: 24/9/93

Environmental Science Services



In Response To The Future

CERTIFICATE OF ANALYSIS

Client: Environmental Science Services

Client Project ID: P Tech Test

ESS Project ID: 932716

Client Sample ID: Rector Strg-1

ESS Sample ID: 932716-10

Date Sample Received: 9/3/93

Date Reported: 9/24/93

Parameter	Results	Units	MRL	Method
Pinene	ND	ug/L	5	GC/MS
Volatile Organics				
Acetone	70	ug/L	Attached	8260

ND = Not Detected above Method Reporting Limit (MRL)

Approved by: 

Date: 24/9/93

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In Response To The Future

CERTIFICATE OF ANALYSIS

VOLATILE ORGANICS
Method 8260

Client: Environmental Science Services

Client Project ID: P Tech Test

ESS Project ID: 932716

Client Sample ID: Reactor Strg-1

ESS Sample ID: 932716-10

Date Sampled: NA

Dilution Factor: 1x

Date Analyzed: 9/17/93

Units: ug/L

Parameter	Result	MRL
Chloromethane	ND	10
Vinyl Chloride	ND	10
Bromomethane	ND	10
Chloroethane	ND	10
Trichlorofluoromethane	ND	5
1,1-Dichloroethene	ND	5
Acetone	70	50
Carbon Disulfide	ND	5
Methylene Chloride	ND	5
Methyl tert-Butyl Ether	ND	10
Cis-1,2-Dichloroethene	ND	5
Trans-1,2-Dichloroethene	ND	5
1,1-Dichloroethane	ND	5
Methyl Ethyl Ketone	ND	50
Chloroform	ND	5
1,1,1-Trichloroethane	ND	5
Carbon Tetrachloride	ND	5
Benzene	ND	5
1,2-Dichloroethane	ND	5
Trichloroethene	ND	5
1,2-Dichloropropane	ND	5
Bromodichloromethane	ND	5
Cis-1,3-Dichloropropene	ND	5
Methyl Isobutyl Ketone	ND	50
Toluene	ND	5
Trans-1,3-Dichloropropene	ND	5
1,1,2-Trichloroethane	ND	5
Tetrachloroethene	ND	5
2-Hexanone	ND	50
Dibromochloromethane	ND	5
Chlorobenzene	ND	5
Ethylbenzene	ND	5
Xylenes (Total)	ND	5
Styrene	ND	10
Bromoform	ND	5
1,1,2,2-Tetrachloroethane	ND	5
Dichlorobenzene (Total)	ND	10

NA = Not Available

ND = Not Detected above Method Reporting Limit (MRL)

Approved by:

Date: 24 Sep 93



In Response To The Future

CERTIFICATE OF ANALYSIS

Client: Environmental Science Services

Client Project ID: P Tech Test

ESS Project ID: 932716

Client Sample ID: Rector Strg-2

ESS Sample ID: 932716-11

Date Sample Received: 9/3/93

Date Reported: 9/24/93

Parameter	Results	Units	MRL	Method
Pinene	ND	ug/L	5	GC/MS
Volatile Organics				
Acetone	75	ug/L	Attached	8260
Methylene Chloride	5	ug/L	Attached	8260
Toluene	9	ug/L	Attached	8260

ND = Not Detected above Method Reporting Limit (MRL)

Approved by: 

Date: 24 Sept 93

Environmental Science Services

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10



In Response To The Future

CERTIFICATE OF ANALYSIS

VOLATILE ORGANICS Method 8260

Client: Environmental Science Services

Client Project ID: P Tech Test

Client Sample ID: Reactor Strg-2

Date Sampled: NA

Date Analyzed: 9/17/93

ESS Project ID: 932716

ESS Sample ID: 932716-11

Dilution Factor: 1x

Units: ug/L

Parameter	Result	MRL
Chloromethane	ND	10
Vinyl Chloride	ND	10
Bromomethane	ND	10
Chloroethane	ND	10
Trichlorofluoromethane	ND	5
1,1-Dichloroethene	ND	5
Acetone	75	50
Carbon Disulfide	ND	5
Methylene Chloride	5	5
Methyl tert-Butyl Ether	ND	10
Cis-1,2-Dichloroethene	ND	5
Trans-1,2-Dichloroethene	ND	5
1,1-Dichloroethane	ND	5
Methyl Ethyl Ketone	ND	50
Chloroform	ND	5
1,1,1-Trichloroethane	ND	5
Carbon Tetrachloride	ND	5
Benzene	ND	5
1,2-Dichloroethane	ND	5
Trichloroethene	ND	5
1,2-Dichloropropane	ND	5
Bromodichloromethane	ND	5
Cis-1,3-Dichloropropene	ND	5
Methyl Isobutyl Ketone	ND	50
Toluene	9	5
Trans-1,3-Dichloropropene	ND	5
1,1,2-Trichloroethane	ND	5
Tetrachloroethene	ND	5
2-Hexanone	ND	50
Dibromochloromethane	ND	5
Chlorobenzene	ND	5
Ethylbenzene	ND	5
Xylenes (Total)	ND	5
Styrene	ND	10
Bromoform	ND	5
1,1,2,2-Tetrachloroethane	ND	5
Dichlorobenzene (Total)	ND	10

NA = Not Available

ND = Not Detected above Method Reporting Limit (MRL)

Approved by:

Date: 24 Sept 93

Environmental Science Services

110



In Response To The Future

CERTIFICATE OF ANALYSIS

VOA AQUEOUS SURROGATE RECOVERY

Client: Environmental Science Services Client
 Project ID: P Tech Test

Date Sample Analyzed: 9/17/93 ESS
 Project ID: 932716

SAMPLE ID	1,2 DICHLOROETHANE-D4 (76-114%)*	TOLUENE-D8 (86-110%)*	BFB (86-115%)*
V0917B1	108%	100%	105%
932716-09	104	103	103
932716-10	94	107	107
932716-11	101	110	115

* Acceptance criteria

Approved by: *[Signature]*

Date: 24/9/93

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In Response To The Future

CERTIFICATE OF ANALYSIS

VOLATILE ORGANICS Method 8260

Client: Environmental Science Services

Client Project ID: P Tech Test

Client Sample ID: Method Blank

Date Sampled: N/A

Date Analyzed: 9/17/93

ESS Project ID: 932716

ESS Sample ID: V0917B1

Dilution Factor: 1x

Units: ug/L

Parameter	Result	MRL
Chloromethane	ND	10
Vinyl Chloride	ND	10
Bromomethane	ND	10
Chloroethane	ND	10
Trichlorofluoromethane	ND	5
1,1-Dichloroethene	ND	5
Acetone	ND	50
Carbon Disulfide	ND	5
Methylene Chloride	ND	5
Methyl tert-Butyl Ether	ND	10
Cis-1,2-Dichloroethene	ND	5
Trans-1,2-Dichloroethene	ND	5
1,1-Dichloroethane	ND	5
Methyl Ethyl Ketone	ND	50
Chloroform	ND	5
1,1,1-Trichloroethane	ND	5
Carbon Tetrachloride	ND	5
Benzene	ND	5
1,2-Dichloroethane	ND	5
Trichloroethene	ND	5
1,2-Dichloropropane	ND	5
Bromodichloromethane	ND	5
Cis-1,3-Dichloropropene	ND	5
Methyl Isobutyl Ketone	ND	50
Toluene	ND	5
Trans-1,3-Dichloropropene	ND	5
1,1,2-Trichloroethane	ND	5
Tetrachloroethene	ND	5
2-Hexanone	ND	50
Dibromochloromethane	ND	5
Chlorobenzene	ND	5
Ethylbenzene	ND	5
Xylenes (Total)	ND	5
Styrene	ND	10
Bromoform	ND	5
1,1,2,2-Tetrachloroethane	ND	5
Dichlorobenzene (Total)	ND	10

N/A = Not Applicable

ND = Not Detected above Method Reporting Limit (MRL)

Approved by: 
Environmental Science Services

Date: 24 Sep 1993



In Response To The Future

CERTIFICATE OF ANALYSIS

AMMONIA-N
Method 350.3

Client: Environmental Science Services

Client Project ID: P TECH Test

ESS Project ID: 932716

Date Samples Received: 9/3/93

Date Reported: 9/24/93

Client ID	Lab ID	Result (mg)	Sample Volume (mls)	MRL
Inlet-1	932716-01	0.28	82.5	0.01
Stack-1	932716-02	0.61	73.6	0.01
Inlet-2	932716-03	0.22	81.3	0.01
Stack-2	932716-04	0.72	72.2	0.01
Inlet-3	932716-05	0.18	82.3	0.01
Stack-3	932716-06	0.43	68.9	0.01
Blank 1	932716-07	ND	160	0.02
Blank DI	932716-08	ND		0.02

ND = Not Detected above Method Reporting Limit (MRL)

Approved by:

Date: 24 Sep 93

Environmental Science Services

532 Atwells Avenue, Providence, Rhode Island 02909 (401) 421-0398 Fax. (401) 421-5731

13816

CHAIN OF CUSTODY

Company Name ESS		Project No. M031		Project Name P-Tech Test		Turn Around Time Requested Two Weeks		Due Date 17 Sept 93	
Contact Person Addman		Address		Telephone		Analysis Required			
City		State		Zip		Type of Container			
Laboratory Sample No.	Date	Collection Time	Q	GR	MATRIX	FR	No. of Containers	Type of Container	
01									
02									
03									
04									
05									
06									
07									
08									
09									
10									
11									

Type: P-Poly G-Glass V-VOS Matrix: DW-Drinking Water S-Soil SL-Sludge WW-Wastewater

Sampler Type: Addman Special Conditions:

Special Remarks/Requests: **NH3 in 1N H2SO4. Report total quantity**

Note: Pres. - Preservative

Relinquished by: (Signature) D Addman	Date/Time 3 Sept 93 9:00	Received by: (Signature) Manuel Ferrera	Date/Time 9/13/93	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)

APPENDIX M

EPA's "Draft Strategy for Combustion of Hazardous Waste in
Incinerators, Boilers and Furnaces"

DRAFT STRATEGY FOR COMBUSTION OF HAZARDOUS WASTE IN INCINERATORS AND BOILERS AND FURNACES

I. INTRODUCTION

During the last decade, a dramatic transition in hazardous waste management has occurred. Untreated hazardous waste ceased to be placed on the land, and widespread use of waste treatment technologies, including combustion, ensued. We also began to understand that even vigorously regulated and enforced hazardous waste management requirements cannot totally solve our long-term waste problems. Rather, our long-term national waste management strategy must have reduction of waste as its first and primary goal.

EPA, the States, industry, and the public have learned much about the concept of waste reduction over the last decade. Our challenge for the next decade is to take these lessons and develop a strategy to accomplish our goal of source reduction.

Source reduction is and will continue to be at the top of our waste management hierarchy and must be more aggressively pursued to reduce the long-term demand for waste management facilities. EPA intends to take a fresh look at hazardous waste management issues as part of moving towards the premise of pollution prevention and source reduction. Specifically, in this effort, EPA's goal is to develop an integrated and balanced program for source reduction and waste management. EPA will examine the appropriate roles of source reduction and waste treatment in the nation's hazardous waste management system. EPA also intends to reexamine its existing regulations and policies on waste combustion.

This evaluation will be led by a committee of EPA and State officials. This EPA-State Committee will first be asked to address the relationship between hazardous waste combustion facilities and source reduction of hazardous waste, and to make recommendations on additional source reduction opportunities that should be pursued. The Committee's second charge will be to address how EPA could improve its technical and permitting rules for hazardous waste combustion facilities to ensure that such facilities reflect the state-of-the-art as well as continued technological innovation. The Committee will also be asked to explore the development of alternative waste treatment technologies, as well as the need for better science in evaluating combustion technologies and monitoring emissions from combustion facilities.

As a starting point for this effort, EPA is issuing this draft Combustion Strategy. This document will serve as a

catalyst for discussion with and input from all interested parties on how best to integrate source reduction and waste combustion and on ways by which we can better assure the public of safe operation of hazardous waste combustion facilities.

This draft combustion strategy consists of a discussion of the goals and objectives for this project and a series of short and longer-term actions that can be taken to achieve our goals. These actions are intended as the starting point for discussions with the public and industry. The list of actions in this document are presented for debate and additional ideas. However, while that discussion is taking place, EPA intends to aggressively pursue several of the interim activities.

II. EPA'S STRATEGIC GOALS

A. Background for the Goals

Combustion is currently a large component of hazardous waste management in the United States. It has become a large component as the nation moved away from land disposal in the 1980's and into treatment to reduce the volume and toxicity of hazardous waste. As this shift occurred in the 1980's, citizens in areas where incinerators or boilers and industrial furnaces (BIFs) are located have increasingly challenged the need for these hazardous waste combustion facilities. Citizens evidence concern that waste combustion is too frequently used where source reduction may be the preferred alternative. Citizens also raise concerns regarding facility siting and potential health risks posed by waste management facilities.

Hazardous wastes being burned today are generated by major segments of American industry, and represent a spectrum of commonly-encountered wastes, including spent solvents, sludges and distillation bottoms, and off-spec organic chemicals and products. About 5 million tons of these highly organic wastes are being combusted each year -- some 40% in incinerators and 60% in BIFs. Based on our most recent data, it appears that substantial excess capacity exists for combustion of hazardous waste, particularly liquid wastes. It should also be recognized that although some additional wastes are untreated today, these wastes will soon be subject to treatment requirements mandated under the Hazardous and Solid Waste Amendments of 1984 (HSWA). These treatment requirements could use up much of today's surplus capacity over the next several years.

Incinerators and BIFs burning hazardous waste are regulated by EPA and authorized states under the Resource Conservation and Recovery Act (RCRA). EPA's incinerator permit regulations, first promulgated in 1981, control emissions of principal organic hazardous constituents (POHCs), hydrochloric acid (HCl), and

particulate matter at incinerators. For interim status incinerators, only general facility regulations are in place. In 1988, the Office of Solid Waste (OSW) issued guidance to the EPA Regional Offices directing that, on a case-by-case basis under the omnibus provision in RCRA section 3005(c), incinerator permits should be issued with major substantive improvements including controls on metals and products of incomplete combustion (PICs) and improved controls on HCl and acid gases.

SIF facilities burning hazardous waste are all currently in interim status. These facilities -- such as cement and lightweight aggregate kilns -- are subject to EPA regulations adopted in 1991. These regulations, among other things, impose emission controls for metals, PICs, and HCl and acid gases that remain in effect until final permits are issued for these facilities. Currently, there are about 160 interim status SIFs, which are pending final determinations on their permits.

Waste combustion has been viewed as a means to detoxify many hazardous wastes, particularly those containing high levels of organics. EPA's position has been that, if conducted in compliance with regulatory standards and guidance, combustion can be a safe and effective means of disposing of hazardous waste. As new information has come to light, improvements to the regulations governing SIFs and incinerators have been and will continue to be pursued.

EPA believes that our task now is to better integrate source reduction with the regulatory approach to combustion of hazardous waste, and further ensure that national rules reflect the best combustion controls possible. For example, we should broaden our approach to include consideration of how an aggressive source reduction program should factor into national policy on the permitting of hazardous waste combustion facilities. Of course, remediation wastes present a different circumstance than newly-generated wastes and, given the finite set of options for dealing with historic cleanup sites, combustion may be the most appropriate remedy. In addition, waste minimization opportunities at cleanup sites are usually severely limited. The EPA-State Committee will focus on these and other similar issues as part of the national dialogue on integration of source reduction and waste management.

B. EPA's Goals

The foundation of this draft strategy are the following five goals:

- o To establish a strong preference for source reduction over waste management, and thereby reduce the long-term

demand for combustion and other waste management facilities.

- o To better address public participation in setting a national source reduction agenda, in evaluating technical combustion issues, and in reaching site-specific decisions during the waste combustion permitting process.
- o To develop and impose implementable and rigorous state-of-the-art safety controls on hazardous waste combustion facilities by using the best available technologies and the best current science.
- o To ensure that combustion facilities do not pose an unacceptable risk, and use the full extent of legal authorities in permitting and enforcement.
- o To continue to advance scientific understanding with regard to waste combustion issues.

These goals address the major issues surrounding hazardous waste combustion today and provide an appropriate framework for a broad assessment of how source reduction and combustion of hazardous waste can be integrated into a national waste management program. This assessment will be comprised of many different activities, many of which will be led by the EPA-State Committee. The Committee and other interested parties are encouraged to examine these goals critically and to consider whether and how they can be improved.

III. THE PROCESS FOR PURSUING A NATIONAL STRATEGY

Under RCRA, EPA and the States are partners and co-regulators of the generation, transportation, treatment, storage, and disposal of hazardous waste. EPA therefore is firmly committed to the view that any evaluation of the role of hazardous waste combustion in our hazardous waste management strategy must be undertaken as a joint federal and state effort. To that end, an EPA-State Committee will be formed under the aegis of the EPA-State Operations Committee. As mentioned earlier, the initial charge to this Committee includes components dealing with aggressive source reduction, improvements to technical and permitting standards, alternative treatment technologies, and a better scientific foundation for decision making.

In each of these areas, this draft strategy lays out a series of short and longer-term actions for public discussion. EPA intends to involve all stakeholders in this dialogue. EPA is providing these ideas as a starting point for discussion on

needed source reduction actions and regulatory changes that must be pursued, and encourages all interested parties to comment upon and contribute additional ideas. In addition, however, EPA believes that we must immediately pursue a number of actions to ensure that existing combustion facilities are operated safely and without unacceptable risks to human health and the environment. Accordingly, while we implement the elements of this strategy, EPA is directing its Regions to immediately take actions to pursue aggressive source reduction programs at hazardous waste facilities, and to ensure that waste combustion is closely controlled through permitting and aggressive enforcement.

Both EPA and the EPA-State Committee will seek to engage the widest range of interested parties in our evaluation of source reduction and waste combustion. This will include federal, state, and local officials, waste generators and treaters, the waste combustion industry, environmental and citizen groups, and members of the public at large. Meaningful participation by, and communication among, all affected parties is a cornerstone of EPA's federal hazardous waste program. We intend to take all steps necessary to foster this participation and communication.

EPA is also keenly aware that, ultimately, we serve the public. Our mission under RCRA, and that of the authorized states, is explicit -- we must ensure adequate protection of human health and the environment. EPA fulfills this responsibility in the light of full public scrutiny. We will continue to do so during this reevaluation of the role of combustion in our national waste management strategy.

IV. ACTIONS TO IMPLEMENT STRATEGIC GOALS

All waste management technologies must assure full protection of human health and the environment. EPA will not tolerate operation of waste management facilities that present unacceptable risks to human health and the environment. Accordingly, EPA will engage in a series of short and longer-term actions designed to pursue aggressive source reduction, to enhance controls on existing combustion facilities, and to promote public participation in permitting and source reduction efforts.

The short term actions include:

- o An aggressive source reduction program that integrates waste combustion with waste management decision making
- o Direction to EPA Regions and states to:

- Perform site-specific risk assessments, including indirect exposure, at incinerator and BIF facilities in the permitting process
- Use omnibus permit authority in new permits at incinerator and BIF facilities as necessary to protect human health to impose upgraded particulate matter standards and if necessary additional metal emission controls, and to impose limits on dioxin/furan emissions
- Establish a priority for reaching final permit decisions for incinerators and BIF facilities
- Enhance public participation in permitting of incinerators and BIFs
- Enhance inspection and enforcement for incinerators and BIFs.

The longer-term actions include:

- o Continued efforts to build an aggressive source reduction program, including exploration of the usefulness and feasibility of setting a national capacity reduction goal for generation of combustible waste
- o Investigation of feasibility and risks associated with alternative waste treatment technologies
- o Upgrades to EPA's rules on emission controls at combustion facilities and on continuous emission monitoring techniques
- o Upgrades to EPA's rules on the permitting and public involvement process for combustion facilities

A. Short Term Actions

1. Integration of Aggressive Source Reduction and Waste Combustion
 - o Use of permit priorities to stimulate source reduction

Over the next 18 months, as the national dialogue on source reduction is held, EPA will give low priority to permit-related requests for additional combustion capacity except where that capacity offsets the retirement of existing combustion capacity.

The Agency will consider such requests for additional combustion capacity only if the new capacity would provide a substantial reduction in emissions. These administrative measures will allow the Agency to focus as a priority matter on assuring the safety of currently operating facilities. Furthermore, to the extent any new capacity is considered, it will be state-of-the-art combustion units designed to achieve more efficient combustion and lower emissions. These measures will extend to new permit applications, modifications to existing permits to expand combustion capacity, and expansion of interim status combustion operations.

- o Publication of final "Waste Minimization Program in Place" guidelines.

These guidelines identify the elements of a waste minimization program for generators and facilities to make a proper certification to EPA that they have a waste minimization program in place, as required by the RCRA statute. EPA will also pursue compliance with the enhanced certification requirements to the maximum extent permitted under RCRA authority. EPA is also considering publication of lists of non-compliers to alert the public and the waste treatment industry. Where legally appropriate, EPA may also use enforcement orders and permits to incorporate the elements of a good waste minimization program into the set of requirements that a facility must meet.

- o Work with the waste treatment industry as a means to get more aggressive action on source reduction from the generators of combustible waste.

EPA will ask treatment companies to consider accepting wastes only from customers that have conducted source reduction audits and have an enhanced waste minimization program in place (per EPA's "Program in Place" notice). In doing so, we hope that a working partnership can be established among the regulatory agencies, the treaters, and the generators such that we can achieve, as a national priority, the maximum amount of source reduction possible. All interested parties must pursue an aggressive source reduction program. EPA will work closely with the treatment industry to identify additional opportunities for source reduction.

- o Target generating industries that produce combustible wastes both for source reduction inspections and for requiring generators to conduct waste minimization audits.

EPA will give top priority to ensuring compliance with waste minimization requirements/guidance at those facilities that are driving the demand for waste combustion. In addition, at the same facilities, EPA will to the maximum extent possible include audit requirements in enforcement settlement agreements, permits, and as part of corrective action orders. The audits will allow these companies to investigate the maximum possible use of source reduction to the extent that they are not already doing so in partnership with EPA and the states.

- o Maximum public involvement and information regarding source reduction and its integration with waste combustion

EPA will also establish a program to more effectively provide information to the public on the types of wastes going to combustion units and the sources of those wastes. First, EPA will compile information from the Biennial Report and will collect information from commercial combustion facilities. This information -- such as the specific types and volumes of wastes being sent for combustion as well as the generators of these wastes -- will be compiled in a report and be provided to the public. This information will apprise citizens of those industries that rely on combustion of their wastes and will allow the public to better focus their attention on the appropriate generating facilities.

2. Immediate Actions in Combustion Facility Permitting

The Agency's goal is to continuously improve the regulation of hazardous waste combustion to reflect advances in scientific understanding so that adequate protection of human health and the environment is assured. During the time it takes to propose and finalize updates to national regulations, EPA will use its omnibus authority on a case-by-case basis as necessary to protect human health and the environment to include the appropriate conditions in permits being issued.

At this time, EPA believes that regions and states should use the RCRA omnibus provision and RCRA permit modification regulations to add permit conditions as necessary to protect human health and the environment whenever a combustion facility owner/operator is seeking issuance of a new permit or reissuance of an expiring permit, or, in appropriate circumstances, when

existing permits are reopened for modification. The following will be addressed during the permitting process.

o Risk Assessments

EPA is directing that site-specific risk assessments be conducted at incinerators and BIFs during the permitting process. These should be done in accordance with EPA's draft indirect risk assessment guidance. EPA is currently developing updated, final guidance on conducting risk assessments at combustion facilities, including consideration of the risks from indirect exposures. Until this national risk assessment guidance is completed, all risk assessments at combustion facilities will be done on a site-by-site basis. EPA and State technical experts will be available to serve on risk assessment teams to assist regions and states in conducting these risk assessments (particularly with regard to indirect risks).

o Upgraded Particulate Matter Standard and Supplemental Controls on Metal Emissions

Hazardous waste combustion units should be required, through appropriate use of the omnibus permit authority, to meet the more stringent particulate matter standard that is now applicable to municipal waste combustors -- 0.015 mg/dscm. This technology-based standard operates to provide a major control on metals emissions from combustion unit. In addition, each combustion facility should be required to consider, as part of its facility-specific risk assessment, whether the upgraded PM standard affords adequate protection against the risks posed by metals. If additional metal controls are found to be necessary, the regions and states should impose these controls through use of the omnibus permit authority.

The upgraded PM standard will be used for BIFs unless another protective standard is applicable under state or federal law. These upgraded PM standards will continue to be used until an alternative PM standard has been promulgated for incinerators and BIFs. It may be that the upgraded PM standard is sufficient for many combustion facilities. However, some combustion units may be emitting metals above de minimis quantities, in which case additional controls may be warranted.

o Dioxins and Furans

Site specific risk assessments at hazardous waste combustion facilities may reveal the need for additional controls on dioxin and furan emissions. Through appropriate use of the omnibus permit authority, the regions and states should impose as an

Interim measure emission limits of 30 ng/dscm (based on the sum of all tetra through octa dioxin and furan congeners). This standard is the same as the New Source Performance Standard for new municipal waste combustors. Regions and states should supplement this with more stringent emission limits if the site-specific risk assessment warrants.

o Permit Controls on Incinerators and BIFs

EPA regions and states should bring incinerators and BIFs under permit controls as soon as possible. This will be implemented through establishment of a schedule for calling in all BIF permits for final determinations. Each region will develop a plan that provides for commercial BIF permits to be called in within the next 12 months and for all other BIF permits to be called in within the succeeding 24 months. Permits represent one of the most effective means by which EPA and the authorized states can develop and enforce conditions on the operation of incinerators and BIFs. At this point, no BIFs have had final permit decisions. Thus, permit determinations should be made as expeditiously as feasible to effectively control those operations that can be operated safely as well as deny permits at those facilities that can not be operated safely.

o Enhanced Public Participation

Public participation is one of the major cornerstones of EPA's environmental programs. EPA is committed to meaningful public involvement in its permitting programs. Local citizens must be given the opportunity to assure themselves that facilities in their neighborhoods will be operated safely.

EPA will immediately provide for greater public participation in the permitting of BIFs and incinerators, and will initiate amendments to its rules to reflect new avenues for public participation. Prior to these amendments being finally adopted, EPA will direct all regions and states to provide immediately for additional public participation opportunities during permitting of combustion units - particularly at earlier stages than now provided for under EPA's current permitting regulations. These should include, but are not limited to, public comment on the trial burn plan. EPA will also direct that local citizens be given the opportunity to participate during the risk assessment process at combustion facilities.

o Enhanced Inspection and Enforcement

EPA will continue and enhance its current enforcement efforts regarding combustion units through aggressive inspection

and enforcement at both BIFs and incinerators and through use of specialized combustion inspectors. Based on our experience and the level of public concern about the compliance record of commercial combustion units, the use of aggressive enforcement and special inspectors will ensure the maximum timeliness and extent of compliance. In particular, if an event occurs that results in non-compliance, EPA or the state will be in a position to take the appropriate enforcement or permitting action, including abatement of the problem or, if necessary, shutdown of combustion operations. Whenever appropriate, Regions and States are encouraged to use permanent on-site inspectors at commercial incinerators and BIFs.

B. Longer Term Actions

EPA will also immediately pursue a number of longer term actions to continue the progress towards our goals of source reduction, balancing the amount of combustion capacity with the actual needs, ensuring combustion safety, and providing for greater public participation.

- o Continue to build an aggressive source reduction program

EPA will conduct a national round table on source reduction opportunities for hazardous wastes. The national round table on source reduction will seek to highlight avenues for reducing the amount of waste being combusted, and will explore the appropriate balance between source reduction and use of combustion as a waste management tool. The round table will explore both regulatory and non-regulatory options to encourage and/or require source reduction. Generating and treatment industries will be asked to participate actively in this effort. Results will also be used by the EPA-State Committee to establish a national dialogue among the interested parties on the proper integration of source reduction and waste combustion.

- o Establishment of a Percent/Target Year Program for reduction of combustible hazardous wastes

EPA will work with the states towards establishing a program in which industry is challenged to reduce by a selected percentage and by a target year the amount of process wastes going to combustion units. EPA will discuss with all interested parties the appropriate percentage reduction to be used as a goal and the appropriate time frame for this reduction.

o Upgrade EPA's Rules to reflect state-of-the-art advancements

EPA will initiate a rulemaking to upgrade our combustion rules. In doing so, EPA will explore the feasibility of a technology-based approach, particularly with respect to setting emission controls on metals, dioxins and furans, acid gases, particulate matter, and products of incomplete combustion. In addition, EPA will continue to refine its risk assessment guidelines to ensure that all risks are effectively addressed by national regulations or site-specific permit conditions.

o Upgrade EPA's rules on permit process for combustion units

While EPA is directing regions and states to immediately afford greater public participation on a permit-by-permit basis, we will seek to modify our rules to reflect expanded public participation. EPA will initiate a rulemaking to codify our goal of increased public participation at earlier stages in the permitting process for incinerators and BIFs. In particular, EPA will address the trial burn process and the public's role in that process.

EPA also believes there is a need to explore a rulemaking to reform the permit appeal process for combustion units whose permit applications have been denied by the Regional Administrator or State Director. In particular, where the unit has been burning waste under interim status, EPA will seek to establish rules that prevent the continued burning of waste during administrative appeals of a permit denial decision. EPA will also explore additional guidance or a rulemaking to clarify the number of permissible trial burns allowed before permit denial.

o Use and Feasibility of a Long-Term National Capacity Reduction Goal

EPA will explore the usefulness of developing a long-term reduction goal (e.g., a 25% reduction in combustion capacity over the next 10 years) to reduce combustion capacity beyond that which can be achieved through source reduction efforts. The purpose of such a goal would be to give more concrete national guidance on how best to match combustion demand with capacity.

- o Conduct research on continuous monitoring for organics, including dioxins and metals.

EPA will use its research resources to continue and enhance scientific inquiry on ways to better determine what constituents are in emissions from combustion units and to develop the technology needed to monitor these emissions on a continuous basis. EPA will work cooperatively with the waste combustion industry to address these research areas.

- o Investigate innovative waste treatment technologies that provide protection to human health and the environment.

EPA will continue and enhance its efforts to foster the development of innovative technologies for the safe and effective treatment of hazardous waste. Such actions are essential to our national waste management system and to our global competitiveness.

V. CONCLUSION

EPA is committed to evaluating the role that source reduction and combustion of hazardous waste should play in our national waste management program. EPA will work in full partnership with the States in this effort. EPA and the States will embark upon a full and open discussion with all stakeholders, including affected citizens and industries, on the issues and actions detailed in this Draft Combustion Strategy.