Background Report Reference

AP-42 Section Number: 11.6

Background Chapter: 4

Reference Number: 71

Title: Field Data Source Test of Lone Star Industries at Davenport, CA

Chemecology Corp

Chemecology Corp

August 1983

CHE
690-B Garcia Avenue, Pittsburg, CA 94

AP-42 Section 11.6
Reference NOT USED
Report Sect. 4
Reference 71

FIELD DATA SOURCE TEST

PREPARED FOR Lonestar Industries
Highway 1
Davenport, California 95017

ATTENTION Duc Vu

REGARDING Particulate, NOx & SO_2 Emissions Testing

REGULATORY AGENCY MBUAPCD & EPA

PURPOSE Compliance

TEST DATE August 22 and 23, 1983

UNIT TESTED Main Stack

ASSOCIATED REPORT NUMBERS

REPORT NUMBER 1716

PREPARED BY Larry Borrelli

REVIEWED BY

Reference 49:

(1) Unspecified kiln w/ unspecified control

(1) Unspecified cooler w/ unspecified control

(1) "Coal" stack

Delete!

Delete for above reasons

SUMMARY

PLANT: LONE STAR - SANTA CRUZ

LOCATION: DAVENPORT CALIFORNIA

TEST/IDENTIFICATION 1698 #1716 DATE: AUGUST 1983

TESTING BY: CHEMECOLOGY CORP.

KILN/COOLER NO. 1

			PERFORMANCE		ALLOWABLE
Kiln Production	Ton/Hr.	.....	107.9	@ [illegible] K.F. Factor	
Kiln Feed Rate	Ton/Hr.	.....	170		
Fuel Rate (Coal)	Ton/Hr.	.....	11.2	@ 11810 BTU/lb.	
" " (Oil)	Gal/Hr.	.....			
Fuel Ash	%	.....	13.4		
Fuel Sulphur	%	.....	0.5%	3.1 Kiln Feed S.	
KILN (Stack)					
Exhaust Gas Flow	DSCFM	.....	143,700		
Part. Concen.	lb/SCF	.....	0.000003		
Emission Rate	lb/Ton	.....	0.15 / 25.5 #/Hr		0.3 / 51.0 #/Hr
SOX (Kiln) (Concentration)	PPM	.....	110		
Emission Rate	lb/Ton	.....	0.93 / 159 #/Hr		
Emission Rate	lb/MMBTU	.....			
NOX (Kiln) (Concentration)	PPM	.....	202		
Emission Rate	lb/Ton	.....	1.22/208 #/Hr		
COOLER (Stack)					
Exhaust Gas Flow	DSCFM	.....	95,700		
Part. Concen.	lb/SCF	.....	0.000002		
Emission Rate	lb/Ton	.....	0.07/11.5 #/Hr		0.1 / 17.0 #/Hr

REMARKS:

CHEMECOLOGY CORPORATION
690-B Garcia Avenue, Pittsburg, CA 94565 / (415) 439-5766

FIELD DATA SOURCE TEST

PREPARED FOR: Lonestar Industries
Highway 1
Davenport, California 95017

ATTENTION: Duc Vu

REGARDING: Particulate, NOx & SO2 Emissions Testing

REGULATORY AGENCY: MBUAPCD & EPA

PURPOSE: Compliance

TEST DATE: August 22 and 23, 1983

UNIT TESTED: Main Stack

ASSOCIATED REPORT NUMBERS

REPORT NUMBER: 1716

PREPARED BY: Larry Borrelli

REVIEWED BY:

ABSTRACT

On August 22 and 23, 1983, Chemecology personnel performed source emissions testing for Lonestar Industries in Davenport, California. The testing team consisted of four persons; Larry Borrelli, project supervisor, Kevin Crosby, continuous analyzer operator, and Dave Ray, sampling technician. The unit tested was the main stack. The components sampled for were; particulates, NOx and SO_2. Triplicate tests for each component were performed. On the first day the Kiln and Roller Mill were both operating at full capacity. On the second day the Kiln was operating at full capacity and the Roller Mill was not operating. The purpose of the testing was to demonstrate compliance with Monterey Bay Unified APCD and Environmental Protection Agency Regulations.

TABLE OF CONTENTS

SELECTED RESULTS

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SELECTED RESULTS

Client: Lonestar
Unit: Main Stack
Date: 8/22/83

Time:	1043-1232	1310-1433	1514-1635	
Process Conditions:				
ACFM:	225612	203645	207449	
SDCFM:	146830	135406	140577	
Kiln feed (TPH):	170	170	170	
Roller Mill (TPH):	200	200	200	
% H_2O:	14.8	13.7	13.0	
Particulate Emissions:				
gr/SDCF (total):	0.0089	0.0065	0.0068	
gr/SDCF (front half):	0.0060	0.0035	0.0050	
lbs/hr (total):	11.21	7.55	8.20	
lbs/ton of feed (front half):	0.044	0.024	0.035	

Gaseous Emissions:

Time:	1131-1203	1333-1414	1550-1637	
O_2:				
% vol dry:	10.5	10.3	10.4	
NOx:				
ppm vol dry:	204	265	182	
ppm @ 10% O_2:	214	273	189	
lbs/hr:	218	261	186	
SO_2:				
ppm vol dry:	28	42	51	
ppm @ 10% O_2:	29	43	53	
lbs/hr:	41.6	57.5	72.5	

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SELECTED RESULTS

Client: Lonestar
Unit: Main Stack
Date: 8/23/83

Time:	0826-0955	1030-1153	1305-1430
Process Conditions:			
ACFM:	249973	250205	202296
SDCFM:	155939	155971	121452
Kiln feed (TPH):	170	170	170
Roller Mill (TPH):	0	0	0
% H_2O:	10.7	11.6	13.7
Particulate Emissions:			
gr/SDCF (total):	0.0348	0.0243	0.0456
gr/SDCF (front half):	0.0030	0.0012	0.0031
lbs/hr (total):	46.56	32.52	47.52
lbs/ton of feed (front half):	0.024	0.009	0.019
Gaseous Emissions:			
Time:	0833-0937	1047-1159	1300-1400
O_2:			
% vol dry:	12.0	11.1	8.9
NOx:			
ppm vol dry:	138	205	218
ppm @ 10% O_2:	169	228	198
lbs/hr:	157	233	193
SO_2:			
ppm vol dry:	165	170	204
ppm @ 10% O_2:	202	189	185
lbs/hr:	260	268	251

VELOCITY PROFILE & VOLUME FLOW RATE

CHEMECOLOGY CORPORATION

VELOCITY TRAVERSE AND VOLUME FLOW RATE

REF: Environmental Protection Agency, Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 1 and 2, 1981
: Bay Area AQMD, Manual of Procedures, San Francisco, CA, Method St-17 January, 1982
: ASME Performance Test Code #27, New York, NY, 1957
: ASTM D-2928-71
: Western Precipitation Division of Joy Manufacturing, WP-50, 1968

PROCEDURE:

Duct temperature and velocity were read at each of several traverse points within the duct. The number and location of traverse points was chosen to aid in the extraction of a representative sample (i.e. by EPA Method 1). Velocity head was determined using a calibrated type "S" pitot tube and Magnehelic differential pressure gauge. Duct temperature was measured by means of a thermocouple attached to the pitot tube. Static pressure was measured with the Magnehelic and one leg of the pitot tube. Using the molecular weight and traverse data, velocity was calculated at each traverse point. From the average velocity, duct area, temperature, pressure and composition, actual and standard gas volume flow rate were calculated for the duct.

CALCULATIONS:

Performed by computer based on the following equations:

Symbol Identification:

A_d = duct area, square feet
C_p = pitot tube correction factor, unitless
D = duct diameter (circular ducts), inches
k = number of traverse points on D or W
L = duct dimension having ports (rectangular), inches
MW = molecular weight (wet)
n = traverse point number on a diameter
Δp = velocity head, "H_2O
P_L = number of ports on dimension L
P_d & P_{std} = duct (barometric + static) and standard pressure, "Hg
Q_d = volume flow rate, actual CFM
Q_{std} = volume flow rate, standard condition (wet or dry), SCFM
T_d & T_{std} = duct and standard temperature, °R
t.p. = traverse point (distance from sample port wall), inches
v_d = velocity at duct conditions, fps
W = second duct dimension (rectangular), inches

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VELOCITY TRAVERSE AND VOLUME FLOW RATE (cont)

Equations:

Location of Traverse Points:

Circular Duct:

$$\text{t.p. (1st half)} = D/2 - (D/2k) * \sqrt{k(k+1-2n)}$$

$$\text{t.p. (2nd half)} = D/2 + (D/2k) * \sqrt{k(2n-1)}$$

Where n = 1 to k/2

Rectangular Duct:

$$\text{t.p.} = W/2k + (n-1) * W/k$$

Where $k = (W/L) * (P_L)$

n = 1 to k

Velocity & Volume Flow Rate:

$$vd = 85.49 * Cp * \sqrt{\frac{Td * \Delta p}{Pd * MW}}$$

$$Qd = 60 * vd\ (avg) * Ad = \text{ACFM}$$

$$Qstd(wet) = Qd * \frac{Tstd}{Td(avg)} * \frac{Pd}{Pstd} = \text{SCFM}$$

$$Qstd(dry) = Qstd(wet) * (1 - \%H2O/100) = \text{SDCFM}$$

CHEMECOLOGY CORPORATION

VELOCITY TRAVERSE & VOLUME FLOW RATE (cont')

DATA:

CLIENT: Lonestar UNIT: Main Stack

DATE: 8/22/83 TIME: 1043 - 1232 RUN #: 1

Description: Four: 4-inch female ports, properly spaced approximately 8 diameters after and 2 diameters before disturbances in flow.

Duct Diameter 120 inches Area 78.54 ft^2

Rectangular duct _____ X _____

% H_2O 14.8 MW 29.43 Mag. Box # 375

Duct Static Pressure -0.52 inches H_2O Temp. Unit # 5562

Standard Conditions 60 °F & 29.92 "Hg Pitot Tube # 5293

Pitot Tube Coefficient 0.80

Trav. Pt.	Ins. From Edge	Southeast Temp °F	Southeast ΔP In.	Southeast V_d ft/sec	Southwest Temp °F	Southwest ΔP In.	Southwest V_d ft/sec	Northwest Temp °F	Northwest ΔP In.	Northwest V_d ft/sec	Northeast Temp °F	Northeast ΔP In.	Northeast V_d ft/sec
1	5.2	220	0.46	40.8	220	0.46	40.8	225	0.76	52.6	215	0.62	47.1
2	17.6	220	0.52	43.3	220	0.56	45.0	225	0.84	55.3	220	0.84	55.1
3	35.5	220	0.56	45.0	220	0.54	44.2	220	0.80	53.8	220	0.74	51.7
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RESULTS:

Average Velocity (V_d) 47.9 FPS Average duct temp. 270 °F, press. 29.91 "Hg

Volume Flow Rate at 220 °F & 29.91 "Hg (Q_d) 225612 ACFM

Volume Flow Rate at standard conditions ($Q_{std(wet)}$) 172378 SCFM

Volume Flow Rate at standard conditions ($Q_{std(dry)}$) 146830 SDCFM

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VELOCITY TRAVERSE & VOLUME FLOW RATE (cont')

DATA:

CLIENT: Lonestar UNIT: Main Stack

DATE: 8/22/83 TIME: 1310 - 1433 RUN #: 2

Description: Four 4-inch ports properly located approximately 8 diameters after and 2 diameters before disturbances in flow.

Duct Diameter 120 inches Area 78.54 ft^2

Rectangular duct _____ X _____

% H_2O 13.7 MW 29.54 Mag. Box # 375

Duct Static Pressure -0.52 inches H_2O Temp. Unit # 5562

Standard Conditions 60 °F & 29.92 "Hg Pitot Tube # 5294

Pitot Tube Coefficient 0.78

Trav. Pt.	Ins. From Edge	Northeast Temp °F	Northeast ΔP In.	Northeast V_d ft/sec	Northwest Temp °F	Northwest ΔP In.	Northwest V_d ft/sec	Southwest Temp °F	Southwest ΔP In.	Southwest V_d ft/sec	Southeast Temp °F	Southeast ΔP In.	Southeast V_d ft/sec
1	5.2	215	0.60	45.1	220	0.60	45.3	210	0.36	34.8	210	0.50	41.1
2	17.6	215	0.68	48.1	215	0.70	48.8	215	0.48	40.4	210	0.50	41.1
3	35.5	215	0.66	47.3	215	0.64	46.6	215	0.46	39.5	220	0.48	40.5
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RESULTS:

Average Velocity (V_d) 43.2 FPS Average duct temp. 215 °F, press. 29.91 "Hg

Volume Flow Rate at 215 °F & 29.91 "Hg (Q_d) 203645 ACFM

Volume Flow Rate at standard conditions ($Q_{std(wet)}$) 156940 SCFM

Volume Flow Rate at standard conditions ($Q_{std(dry)}$) 135406 SDCFM

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VELOCITY TRAVERSE & VOLUME FLOW RATE (cont')

DATA:

CLIENT: Lonestar UNIT: Main Stack

DATE: 8/22/83 TIME: 1514 - 1635 RUN #: 3

Description: Ports: two 3-inch female ports, properly located, approximately 8 diameters after and 2 diameters before disturbances in flow.

Duct Diameter 120 inches Area 78.54 ft^2

Rectangular duct _____ X _____

% H_2O 13.0 MW 29.64 Mag. Box # 375

Duct Static Pressure -0.52 inches H_2O Temp. Unit # 5562

Standard Conditions 60 °F & 29.92 "Hg Pitot Tube # 5293

Pitot Tube Coefficient 0.80

Trav. Pt.	Ins. From Edge	Southeast Temp °F	Southeast ΔP In.	Southeast V_d ft/sec	Southwest Temp °F	Southwest ΔP In.	Southwest V_d ft/sec	Northwest Temp °F	Northwest ΔP In.	Northwest V_d ft/sec	Northeast Temp °F	Northeast ΔP In.	Northeast V_d ft/sec
1	5.2	200	0.42	38.2	205	0.40	37.5	210	0.66	48.3	210	0.62	46.8
2	17.6	205	0.48	41.0	205	0.48	41.0	210	0.76	51.8	210	0.70	49.7
3	35.3	205	0.46	40.2	205	0.44	39.3	210	0.64	47.6	210	0.62	46.8
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RESULTS:

Average Velocity (V_d) 44.0 FPS Average duct temp. 207 °F, press. 29.91 "Hg

Volume Flow Rate at 207 °F & 29.91 "Hg (Q_d) 207449 ACFM

Volume Flow Rate at standard conditions ($Q_{std(wet)}$) 161669 SCFM

Volume Flow Rate at standard conditions ($Q_{std(dry)}$) 140577 SDCFM

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VELOCITY TRAVERSE & VOLUME FLOW RATE (cont')

DATA:

CLIENT: Lonestar UNIT: Main Stack

DATE: 8/23/83 TIME: 0826 - 0955 RUN #: 1

Description: Ports: two 3-inch female ports, properly located, approximately 8 diameters after and 2 diameters before disturbances in flow.

Duct Diameter 120 inches Area 78.54 ft^2

Rectangular duct _____ X _____

% H_2O 10.7 MW 29.50 Mag. Box # 375

Duct Static Pressure -0.52 inches H_2O Temp. Unit # 5562

Standard Conditions 60 °F & 29.92 "Hg Pitot Tube # 5294

Pitot Tube Coefficient 0.78

Trav. Pt.	Ins. From Edge	Northeast Temp °F	Northeast ΔP In.	Northeast V_d ft/sec	Northwest Temp °F	Northwest ΔP In.	Northwest V_d ft/sec	Southwest Temp °F	Southwest ΔP In.	Southwest V_d ft/sec	Southeast Temp °F	Southeast ΔP In.	Southeast V_d ft/sec
1	5.2	290	0.66	50.0	285	0.84	56.2	275	0.56	45.6	270	0.58	46.2
2	17.6	290	0.84	56.4	285	0.96	60.1	280	0.70	51.1	280	0.76	53.3
3	35.5	295	0.80	55.2	285	0.92	58.8	285	0.72	52.0	275	0.72	51.7
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RESULTS:

Average Velocity (V_d) 53.0 FPS Average duct temp. 283 °F, press. 29.86 "Hg

Volume Flow Rate at 283 °F & 29.86 "Hg (Q_d) 249973 ACFM

Volume Flow Rate at standard conditions ($Q_{std(wet)}$) 174631 SCFM

Volume Flow Rate at standard conditions ($Q_{std(dry)}$) 155939 SDCFM

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VELOCITY TRAVERSE & VOLUME FLOW RATE (cont')

DATA:

CLIENT: Lonestar UNIT: Main Stack

DATE: 8/23/83 TIME: 1030 - 1153 RUN #: 2

Description: Ports: two 3-inch female ports, properly located, approximately 8 diameters after and 2 diameters before disturbances in flow.

Duct Diameter 120 inches Area 78.54 ft^2

Rectangular duct _____ X _____

% H_2O 11.6 MW 29.69 Mag. Box # 375

Duct Static Pressure -0.52 inches H_2O Temp. Unit # 5562

Standard Conditions 60 °F & 29.92 "Hg Pitot Tube # 5293

Pitot Tube Coefficient 0.80

Trav. Pt.	Ins. From Edge	Southeast Temp °F	Southeast ΔP In.	Southeast V_d ft/sec	Southwest Temp °F	Southwest ΔP In.	Southwest V_d ft/sec	Northwest Temp °F	Northwest ΔP In.	Northwest V_d ft/sec	Northeast Temp °F	Northeast ΔP In.	Northeast V_d ft/sec
1	5.2	275	0.62	49.0	275	0.58	47.4	275	0.80	55.7	280	0.48	43.3
2	17.6	280	0.76	54.5	275	0.76	54.3	280	0.94	60.6	275	0.54	45.8
3	35.5	275	0.76	54.3	275	0.76	54.3	275	0.90	59.1	275	0.90	59.1
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RESULTS:

Average Velocity (V_d) 53.1 FPS Average duct temp. 276 °F, press. 29.86 "Hg

Volume Flow Rate at 276 °F & 29.86 "Hg (Q_d) 250205 ACFM

Volume Flow Rate at standard conditions ($Q_{std(wet)}$) 176376 SCFM

Volume Flow Rate at standard conditions ($Q_{std(dry)}$) 155971 SDCFM

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VELOCITY TRAVERSE & VOLUME FLOW RATE (cont')

DATA:

CLIENT: Lonestar UNIT: Main Stack

DATE: 8/23/83 TIME: 1305 - 1430 RUN #: 3

Description: Ports: two 3-inch female ports, properly located, approximately 8 diameters after and 2 diameters before disturbances in flow.

Duct Diameter 120 inches Area 78.58 ft^2

Rectangular duct _____ X _____

% H_2O 13.7 MW 29.71 Mag. Box # 375

Duct Static Pressure -0.52 inches H_2O Temp. Unit # 5562

Standard Conditions 60 °F & 29.92 "Hg Pitot Tube # 5294

Pitot Tube Coefficient 0.78

Trav. Pt.	Ins. From Edge	Northeast Temp °F	Northeast ΔP In.	Northeast Vd ft/sec	Northwest Temp °F	Northwest ΔP In.	Northwest Vd ft/sec	Southwest Temp °F	Southwest ΔP In.	Southwest V_d ft/sec	Southeast Temp °F	Southeast ΔP In.	Southeast V_d ft/sec
1	5.2	275	0.46	41.2	285	0.50	43.2	290	0.36	36.8	300	0.40	39.0
2	17.6	280	0.58	46.4	280	0.64	48.7	290	0.44	40.7	300	0.46	41.9
3	35.5	275	0.60	47.0	280	0.60	47.2	290	0.46	41.6	290	0.46	41.6
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RESULTS:

Average Velocity (V_d) 42.9FPS Average duct temp. 286 °F, press. 29.86"Hg

Volume Flow Rate at 286 °F & 29.86 "Hg (Q_d) 202296 ACFM

Volume Flow Rate at standard conditions ($Q_{std(wet)}$) 140693 SCFM

Volume Flow Rate at standard conditions ($Q_{std(dry)}$) 121452 SDCFM

PARTICULATE EMISSIONS

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS

REF: EPA, Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 5, 1981
: South Coast AQMD, Source Testing Manual, Los Angeles, CA, April, 1981
: State of California, Air Resources Board, Draft Stationary Source Test Methods, Method 1-5, June, 1979

SAMPLING PROCEDURE:

The apparatus consisted of a nozzle, heater wrapped probe and heated filter holder (see data sheets for type of nozzle, probe and filter holder). A series of impinger-absorbers (see data sheet for type and contents) were connected in tandem and immersed in an ice bath. The absorption train was followed by a gas drying tube containing indicating silica gel, a diaphragm pump, dry test meter and a calibrated restriction orifice fitted with a magnehelic differential pressure gauge.

The computer was used in selection of suitable sampling points, nozzle size, and orifice constant. The apparatus was leak tested, the probe heaters were brought to temperature and the nozzle was positioned at the first sampling point. The pump was immediatley started and adjusted to obtain the isokinetic sampling rate.

Duct conditions were monitored throughout the sampling period with a type "S" pitot tube and a thermocouple simultaneously positioned at the traverse point. Conditions at the sampling apparatus and metering device were constantly monitored and regularly recorded on the data sheet. Isokinetic sampling rate in terms of orifice differential pressure was calculated by computer for each set of duct and sampling apparatus conditions. Data was relayed between the computer and site by radio.

On completion of sampling from all usable traverse points, the apparatus was removed, leak-checked, sealed from possible contamination and transported to the laboratory. Replicate samples were taken as indicated by the data sheets.

Concurrent with each particulate sampling, an integrated gas sample was withdrawn from the summation of the traverse points through the train and collected at the outlet of the meter into a sample bag.

ANALYTICAL PROCEDURE:

The weight or volume increase of the impingers was measured and recorded for calculation of percent water.

The contents of the sample bladder were analyzed by Orsat for fixed gas and molecular weight determination.

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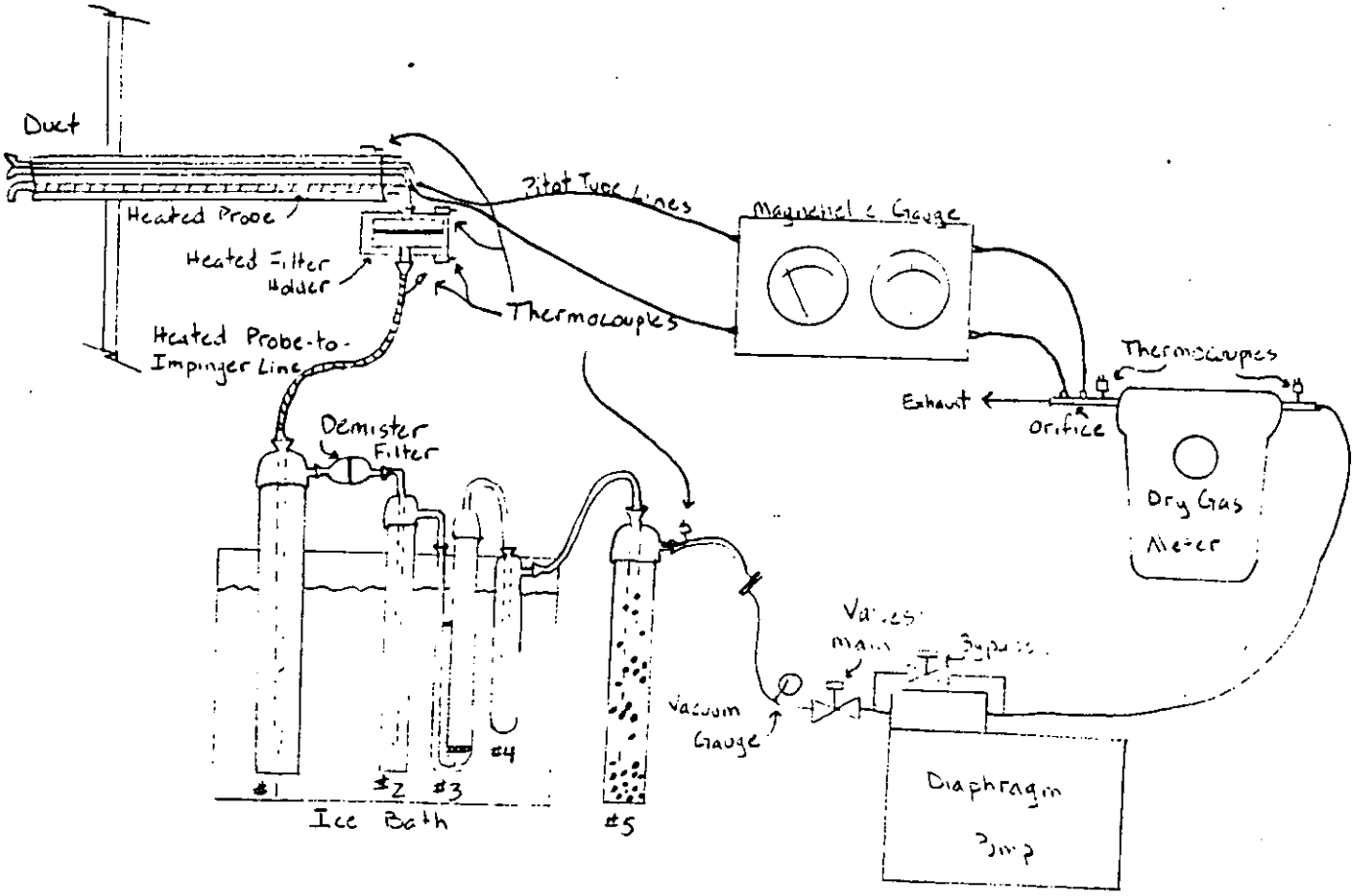
METHOD 5/8 SAMPLING TRAIN



Impinger #	Contents
#1	100 mls 80 percent IPA
#2	100 mls 6% H_2O_2
#3	100 mls 6% H_2O_2
#4	Empty
#5	250 grms Silica Gel (8 mesh)

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PARTICULATE EMISSIONS

Calculations (cont)

Equations:

Duct gas velocity at any traverse point (see Velocity & Volume Flow Rate):

$$v_d = 85.49 * C_p * \sqrt{\frac{T_d * \Delta P}{P_d * MW}}$$

Isokinetic sampling rate at any traverse point:

$$Q_m = Q_n * \frac{P_d * T_m}{P_m * T_d} * (1 - \% H_2O/100)$$

where $Q_n = 60 * v_n * A_n$ and for isokinetic sampling, $v_n = v_d$

$$\Delta H = Q_o^2 * \frac{P_b}{k_m^2 * T_m} * \frac{[MW - (0.18 * \% H_2O)]}{(1 - \% H_2O/100)}$$

where $Q_o = 1.23 * Q_m - 0.23 * Q_m^{(2 - Q_m)}$ (for non-linear orifice)

Percent of isokinetic sampling:

$$I = T_d * \frac{[0.00267 * W + V_m/T_m(avg) * (P_{bar} + \Delta H(avg)/13.6)]}{t * v_d(avg) * P_d * A_n * 60} * 100$$

Sampled Volume:

$$V_m(std) = V_m * \frac{T_{std}}{T_m(avg)} * \frac{(P_{bar} + \Delta H(avg)/13.6)}{P_{std}}$$

Particulate Concentration:

$$C_o = \frac{0.0154 * M}{V_m(std)}$$

Emission Rate:

$$E.R. = 8.58 * 10^{-3} * Q_{std}(dry) * C_o$$

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PARTICULATE EMISSIONS

Analytical Procedure (cont)

The filter section was recovered, placed in a 105°C drying oven and desiccated to constant weight. The weight increase was determined from the tare weight and recorded on the individual data sheet.

Sample was recovered from the nozzle and probe sections with distilled water and/or acetone and a rubber policeman or nylon bristle brush. A tared dish was used for subsequent evaporation, desiccation and weight determination.

If analysis of the condensable fraction of the particulate ("impinger catch" or "back half") was required, an aliquot of the impinger liquid was poured into a tared dish. The liquid was evaporated to dryness and the residue was desiccated to a constant weight.

Aliquots of blank impinger and/or probe wash reagents were evaporated to dryness in tared dishes. The residue was desiccated and weighed for subtraction of the blank residue from the total probe wash or condensables residue.

An estimate of sampling accuracy was performed by calculation of percent isokinetic rate over the entire sampling period.

CALCULATIONS:

Performed by computer based on the following equations:

Symbol Identification:

Subscripts d, m and n denote duct, dry gas meter and nozzle respectively
Subscripts std, bar and avg denote standard, barometric and average

A = area, square feet
C_o = particulate concentration, grains/SDCF
C_p = pitot tube correction, unitless
E.R. = emission rate of particulate, lb/hr
ΔH = orifice differential pressure, inches H_2O
I = percent of isokinetic sampling
k_m = orifice constant, unitless
M = mass of particulate collected, milligrams
MW = wet molecular weight of duct gas, g/mole
P = absolute pressure, inches Hg
Δp = velocity pressure head, inches H_2O
Q = volume flow rate, CFM
Q_o = parameter of volume flow rate through the orifice
T = absolute temperature, °R
t = time of sampling period, minutes
V = gas volume, CF
v = velocity, feet/second
W = water collected, grams
% H_2O = duct gas water content, percent volume

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS
TEST MONITOR DATA

Date 8/22/83 Run 1
Client Lonestar
Unit Main Stack
Ambient Temp. ____ °F
Press.bar 29.95 in. Hg
Press.static -0.52 in. H_2O
Press.duct 29.91 in. Hg
Assumed MW 27.70 %H_2O 10.5

Sample Train Temp.:
Probe 250,250,260 °F
Filter 260,250,235 °F
Sample Line 245, °F 240 235
Post-Test Leak Check:
Leak Rate 0.010 CFM
@ 5 in. Hg Vac.

Nozzle & Probe Mat. SS
Filter Holder Mat. SS
Filter # 31
Nozzle # 6G i.d. 6.0 mm
Pitot # 5293 Cp 0.80
Temp. Unit # 5562
Mag. # 375 Meter # 631 @ 1.016
Orifice km 0.5

		Duct Data			Meter Data			
Trav. Point	Time	Temp. °F	Head Δp	Velocity ft/sec	Vacuum "Hg	Temp. °F	Orifice ΔH, "H_2O	Volume CF
Southeast Port								
3	1043	220	0.56	45.0		95	2.56	227.90
2	1048	220	0.52	43.3	1	95	2.40	
1	1053	220	0.46	40.8		95	2.16	
	1058	Stop to change ports						236.10
Southwest Port								
3	1109	220	0.54	44.2		90	2.46	
2	1114	220	0.56	45.0	2	90	2.54	
1	1119	220	0.46	40.8		95	2.16	
	1124	Stop to change ports, disconnect and leak check						244.65
Northwest Port								
3	1139	220	0.80	53.8		85	3.46	244.80
2	1144	225	0.84	55.3	2	85	3.59	
1	1149	225	0.76	52.6		85	3.29	
	1154	Stop to change ports						255.80
Northeast Port								
3	1200	220	0.74	51.7		70	3.16	
2	1205	220	0.84	55.1		85	3.62	
	1210	Power failure, test stopped						262.35
1	1227	215	0.64	47.1		65	2.70	
	1232	End of test						266.70
Total	60 Minutes				Max. 2		TOTAL	38.65
Average		220		47.9	Average	86	2.84	39.27

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS

DATA & RESULTS:

Site: Lonestar Main Stack Run: 1

Date: 8/22/83 Time: 1043 - 1232

Absorber Type	Contents	Final	Tare	Net gms H2O
Lg. Greenburg	80% IPA	604.4	547.1	57.3
Sm. Greenburg	6% Peroxide	432.8	429.0	3.8
Gas Absorber	6% Peroxide	261.1	264.5	- 3.4
liquid trap	empty	148.3	99.6	48.7
	silica gel	734.8	699.4	35.4
			TOTAL	141.8

Filter Sample: Type EPA Flat Filter

Sample Fraction	Final Wt.	Tare Wt.	Net mgram	Co,grains/SDCF
Probe & Nozzle Wash	66.7617	66.7677	6.0	0.0025
Condensables 200/200	84.6801	84.6729	7.2	0.0029
Filter #31	0.4358	0.4172	8.6	0.0035
Acetone blank 55mls			<0.1	<0.0001
		TOTAL	21.8	0.0089

Gas Composition:

CO2 18.8 % volume (dry)
O2 10.4 % volume (dry)
CO - % volume (dry)
N2 70.8 % volume (dry)
H2O 14.8 % volume

MW (wet) 29.43
Excess Air %
Sampled Volume 37.68 SDCF
Isokinetic Rate 110 %

Particulate Concentration:

Co 0.0089 grains/SDCF @ 60 °F and 29.92 "Hg
C grains/SDCF @

Emission Rate:

E.R. 11.21 lbs/hr @ Qstd(dry) 146830 SDCFM

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS
TEST MONITOR DATA

Date 8/22/83 Run 2
Client Lonestar
Unit Main Stack
Ambient Temp. ____ °F
Press.bar 29.95 in. Hg
Press.static -0.52 in. H2O
Press.duct 29.91 in. Hg
Assumed MW 27.70 %H2O 10.5

Sample Train Temp.:
Probe 270,265,250 °F
Filter 235,240,239 °F 240
Sample Line 235, °F 235
Post-Test Leak Check:
Leak Rate 0.014 CFM
@ 6 in. Hg Vac.

Nozzle & Probe Mat. SS
Filter Holder Mat. SS
Filter # 32
Nozzle # 6A i.d. 6.0 mm
Pitot # 5294 Cp 0.78
Temp. Unit # 5562
Mag. # 375 Meter # 631 @ 1.016
Orifice km 0.5

		Duct Data			Meter Data			
Trav. Point	Time	Temp. °F	Head Δp	Velocity ft/sec	Vacuum "Hg	Temp. °F	Orifice ΔH, "H2O	Volume CF
Northeast Port								267.80
3	1310	215	0.66	47.3		65	2.73	
2	1315	215	0.68	48.1		75	2.84	
1	1320	215	0.60	45.1	2	75	2.55	
	1325	Stop to	change	ports				277.10
Northwest Port								
3	1330	215	0.64	46.6		70	2.68	
2	1335	215	0.70	48.8		75	2.92	
1	1340	220	0.60	45.3	2	80	2.55	
	1345	Stop to	change	ports, disconnect				286.65
				Leak check 0.002 @ 5in vac				
Southwest Port								268.80
3	1329	215	0.46	39.5		75	2.02	
2	1404	215	0.48	40.4		80	2.11	
1	1409	210	0.36	34.8	2	80	1.66	
	1414	Stop to	change	ports				295.00
Southeast Port								
3	1418	220	0.48	40.5		75	2.09	
2	1423	210	0.50	41.1		80	2.20	
1	1428	210	0.50	41.1	2	80	2.20	
	1433	End of test						302.95
Total	60 Minutes				Max 2		TOTAL	35.00
Average		215		43.2	Average	76	2.38	35.56 = corr

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS

DATA & RESULTS:

Site: Main Stack Run: 2

Date: 8/22/83 Time: 1310 - 1433

Absorber Type	Contents	Final	Tare	Net gms H2O
Lg. Greenburg	80% IPA	565.90	526.6	39.3
Sm. Greenburg	6% Peroxide	467.4	432.3	35.1
Gas Absorber	6% Peroxide	307.8	279.6	28.2
liquid trap	empty	100.0	98.7	1.3
	silica gel	718.6	703.0	15.6
			TOTAL	119.5

Filter Sample: Type EPA Flat Filter

Sample Fraction	Final Wt.	Tare Wt.	Net mgram	Co,grains/SDCF
Probe & Nozzle Wash	53.3066	53.3032	3.4	0.0015
Condensables 200/200	64.9487	64.9420	6.7	0.0030
Filter #32	0.4237	0.4191	4.6	0.0020
Acetone blank 67mls			<0.1	<0.0001
		TOTAL	14.7	0.0065

Gas Composition:

CO2 18.5 % volume (dry)
O2 10.4 % volume (dry)
CO - % volume (dry)
N2 71.1 % volume (dry)
H2O 13.7 % volume

MW (wet) 29.54
Excess Air %
Sampled Volume 34.75 SDCF
Isokinetic Rate 110 %

Particulate Concentration:

Co 0.0065 grains/SDCF @ 60 °F and 29.92 "Hg
C grains/SDCF @

Emission Rate:

E.R. 7.55 lbs/hr @ Qstd(dry) 135406 SDCFM

4.07

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS
TEST MONITOR DATA

Date 8/22/83 Run 3
Client Lonestar
Unit MainStack
Ambient Temp. °F
Press.bar 29.95 in. Hg
Press.static -0.52 in. H2O
Press.duct 29.91 in. Hg
Assumed MW 29.43 %H2O 14.8

Sample Train Temp.:
Probe 265,250,260 °F
Filter 265,265,260 °F
Sample Line 235, °F 235 240
Post-Test Leak Check:
Leak Rate 0.008 CFM
@ 5 in. Hg Vac.

Nozzle & Probe Mat. SS
Filter Holder Mat. SS
Filter # 33
Nozzle # 6G i.d. 6.0 mm
Pitot # 5293 Cp 0.80
Temp. Unit # 5562
Mag. # 375 Meter # 631 @ 1.016
Orifice km 0.5

		Duct Data			Meter Data			
Trav. Point	Time	Temp. °F	Head Δp	Velocity ft/sec	Vacuum "Hg	Temp. °F	Orifice ΔH, "H2O	Volume CF
Southeast Port								
3	1514	205	0.46	40.2		70	2.02	305.30
2	1519	205	0.48	41.0	2	75	2.11	
1	1524	200	0.42	38.2		80	1.90	
	1529	Stop to	change	ports				313.58
Southwest Port								
3	1534	205	0.44	39.3	2	75	1.95	
2	1539	205	0.48	41.0		80	2.12	
1	1544	205	0.40	37.5		80	1.81	
	1549	Change ports						321.32
Northwest Port								321.40
3	1600	210	0.64	47.6		75	2.69	
2	1605	210	0.76	51.8	2	80	3.15	
1	1610	210	0.66	48.3		80	2.78	
	1615	Change Ports						331.03
Northeast Port								
3	1620	210	0.62	46.8		75	2.62	
2	1625	210	0.70	49.7		80	2.93	
1	1630	210	0.62	46.8		80	2.63	
	1635	End of Test						340.30
Total	60 Minutes				Max. 2		TOTAL	35.00
Average		207		44.0	Average	78	2.39	35.56 = corr

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS

DATA & RESULTS:

Site: Main Stack
Date: 8/22/83

Run: 3
Time: 1514 - 1635

Absorber Type	Contents	Final	Tare	Net gms H2O
Lg. Greenburg	80% IPA	589.1	547.5	41.6
Sm. Greenburg	6% Peroxide	445.6	426.2	19.4
Gas Absorber	6% Peroxide	263.2	243.6	19.6
liquid trap	empty	118.5	100.0	18.5
	silica gel	731.9	718.6	13.3
			TOTAL	112.4

Filter Sample: Type EPA Flat Filter

Sample Fraction	Final Wt.	Tare Wt.	Net mgram	Co, grains/SDCF
Probe & Nozzle Wash	62.5547	62.5466	8.1	0.0036
Condensables 200/200	68.5172	68.5131	4.1	0.0018
Filter #33	0.4218	0.4187	3.1	0.0014
Acetone Blank 48mls			<0.1	<0.0001
		TOTAL	15.3	0.0068

Gas Composition:
- CO_2 18.5 % volume (dry)
- O_2 10.6 % volume (dry)
- CO - % volume (dry)
- N_2 70.9 % volume (dry)
- H_2O 13.0 % volume

MW (wet) 29.64
Excess Air %
Sampled Volume 34.64 SDCF
Isokinetic Rate 106 %

Particulate Concentration:
Co 0.0068 grains/SDCF @ 60 °F and 29.92 "Hg
C grains/SDCF @

Emission Rate:
E.R. 8.20 lbs/hr @ Qstd(dry) 140577 SDCFM

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS
TEST MONITOR DATA

Date 8/23/83 Run 1
Client Lonestar
Unit Main Stack
Ambient Temp. ____ °F
Press.bar 29.90 in. Hg
Press.static -0.52 in. H_2O
Press.duct 29.86 in. Hg
Assumed MW 29.43 %H_2O 14.8

Sample Train Temp.:
Probe 250,270,250 °F
Filter 260,250,260 °F
Sample Line 240, °F 230 260
Post-Test Leak Check:
Leak Rate 0.012 CFM
@ 6 in. Hg Vac.

Nozzle & Probe Mat. SS
Filter Holder Mat. SS
Filter # 45
Nozzle # 6A i.d. 6.0 mm
Pitot # 5294 Cp 0.78
Temp. Unit # 5562
Mag. #375 Meter # 631 @ 1.016
Orifice km 0.5

		Duct Data			Meter Data			
Trav. Point	Time	Temp. °F	Head Δp	Velocity ft/sec	Vacuum "Hg	Temp. °F	Orifice ΔH, "H2O	Volume CF
Northeast Port								353.70
3	0826	295	0.80	55.2		65	2.78	
2	0831	290	0.84	56.4		65	2.91	
1	0836	290	0.66	50.0	2	70	2.38	
	0841	Stop to change ports						362.40
Northeast Port								
3	0848	285	0.92	58.8	2	70	3.20	
2	0853	285	0.96	60.1		75	3.34	
1	0858	285	0.84	56.2		75	2.97	
	0903	Stop to change ports, disconnect & leak check						371.60
Southwest Port								371.70
3	0917	285	0.72	52.0	2	80	2.62	
2	0922	280	0.70	51.1		90	2.60	
1	0927	275	0.56	45.6		100	2.19	
	0932	Stop to change ports						379.70
Southeast Port								
3	0940	275	0.72	51.7		95	2.70	
2	0945	280	0.76	53.3	2	90	2.80	
1	0950	270	0.58	46.2		100	2.27	
	0955	End of Test						387.90
Total	60 Minutes				Max. 2		TOTAL	34.10
Average		283		530	Average	81	2.73	34.64 = corr

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS

DATA & RESULTS:

Site: Main Stack Run: 1

Date: 8/23/83 Time: 0826 - 0955

Absorber Type	Contents	Final	Tare	Net H2O
Lg. Greenburg	80% IPA	539.3	531.8	7.5
Sm. Greenburg	6% Peroxide	454.9	431.8	23.1
Gas Absorber	6% Peroxide	251.4	254.9	- 3.5
liquid trap	empty	135.8	99.2	36.6
	silica gel	717.1	694.0	23.1
			TOTAL	86.8

Filter Sample: Type EPA Flat Filter

Sample Fraction	Final Wt.	Tare Wt.	Net mgram	Co,grains/SDCF
Probe & Nozzle Wash	66.4158	66.4108	5.0	0.0023
Condensables 200/200	81.9232	81.8541	69.1	0.0318
Filter #45	0.4218	0.4203	1.5	0.0007
Acetone blank 54mls			<0.1	<0.0001
		TOTAL	75.6	0.0348

Gas Composition:

CO2 15.0 % volume (dry)
O2 12.0 % volume (dry)
CO - % volume (dry)
N2 73.0 % volume (dry)
H2O 10.7 % volume

MW (wet) 29.50
Excess Air %
Sampled Volume 33.48 SDCF
Isokinetic Rate 92.4 %

Particulate Concentration:

Co 0.0348 grains/SDCF @ 60 °F and 29.92 "Hg
C grains/SDCF @

Emission Rate:

E.R. 46.56 lbs/hr @ Qstd(dry) 155940 SDCFM

4.01

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS
TEST MONITOR DATA

Date 8/23/83 Run 2
Client Lonestar
Unit Main Stack
Ambient Temp. °F
Press.bar 29.90 in. Hg
Press.static -0.52 in. H2O
Press.duct 29.86 in. Hg
Assumed MW 29.43 %H2O 14.8

Sample Train Temp.:
Probe 270,260,240 °F
Filter 250,250,260 °F
Sample Line 240 °F
Post-Test Leak Check:
Leak Rate 0.007 CFM
@ 5 in. Hg Vac.

Nozzle & Probe Mat. SS
Filter Holder Mat. SS
Filter # 47
Nozzle # 6G i.d. 6.0 mm
Pitot # 5293 Cp 0.80
Temp. Unit # 5562
Mag. # 375 Meter # 631 @ 1.016
Orifice km 0.5

		Duct Data			Meter Data			
Trav. Point	Time	Temp. °F	Head Δp	Velocity ft/sec	Vacuum "Hg	Temp. °F	Orifice ΔH, "H2O	Volume CF
Southeast Port								
3	1030	275	0.76	54.3		90	2.94	388.50
2	1035	280	0.76	54.5	2	95	2.95	
1	1040	275	0.62	49.0		95	2.48	
	1045	Stop to change ports, disconnect & leak check						397.20
Southwest Port								
3	1050	275	0.76	54.3		90	2.94	397.30
2	1055	275	0.76	54.3	2	95	2.96	
1	1100	275	0.58	47.4		95	2.34	
	1105	Stop to change ports, disconnect & leak check						405.90
Northwest Port								
3	1120	275	0.90	59.1		70	3.32	
2	1125	280	0.94	60.6	2	75	3.45	406.0
1	1130	275	0.80	55.7		75	3.01	
	1135	Stop to change ports						415.75
Northeast Port								
3	1138	275	0.90	59.1		65	3.30	
2	1143	275	0.54	45.8		75	2.14	
1	1148	280	0.48	43.3	2	75	1.92	
	1153	End of Test						424.25
Total	60 Minutes				Max 2		TOTAL	35.55
Average		276		53.1	Average	83	2.81	36.12 = corr

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS

DATA & RESULTS:

Site: Main Stack Run: 2

Date: 8/23/83 Time: 1030 - 1153

Absorber Type	Contents	Final	Tare	Net H2O
Lg. Greenburg	80% IPA	574.2	551.2	23.0
Sm Greenburg	6% Peroxide	450.8	426.5	24.3
Gas Absorber	6% Peroxide	251.9	241.8	10.1
liquid trap	empty	118.9	100.2	18.7
	silica gel	738.5	716.1	22.4
			TOTAL	98.5

Filter Sample: Type EPA Flat Filter

Sample Fraction	Final Wt.	Tare Wt.	Net mgram	Co,grains/SDCF
Probe & Nozzle Wash	65.0469	65.0445	2.4	0.0011
200/ Condensables 200	68.8862	68.8337	52.5	0.0232
Filter #47	0.4133	0.4132	0.1	0.0001
49.2 mls Acetone blank			<0.1	<0.0001
		TOTAL	55	0.0243

Gas Composition:

CO2 17.5 % volume (dry)

O2 10.6 % volume (dry)

CO - % volume (dry)

N2 - % volume (dry)

H2O 11.6 % volume

MW (wet) 29.69

Excess Air %

Sampled Volume 34.81 SDCF

Isokinetic Rate 96.0 %

Particulate Concentration:

Co 0.0243 grains/SDCF @ 60 °F and 29.92 "Hg

C grains/SDCF @

Emission Rate:

E.R. 32.52 lbs/hr @ Qstd(dry) 155971 SDCFM

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS
TEST MONITOR DATA

Date 8/23/83 Run 3
Client Lonestar
Unit Main Stack
Ambient Temp. °F
Press.bar 29.90 in. Hg
Press.static -0.52 in. H_2O
Press.duct 29.86 in. Hg
Assumed MW 29.50 %H_2O 10.7

Sample Train Temp.:
Probe 250,240,250 °F
Filter 245,260,269 °F 230, 240
Sample Line 240, °F
Post-Test Leak Check:
Leak Rate 0.005 CFM
@ 8 in. Hg Vac.

Nozzle & Probe Mat. SS
Filter Holder Mat. SS
Filter # 44
Nozzle # 6A i.d. 6.0 mm
Pitot # 5294 Cp 0.78
Temp. Unit # 5562
Mag. # 375 Meter # 631 @ 1.016
Orifice km 0.5

		Duct Data			Meter Data			
Trav. Point	Time	Temp. °F	Head Δp	Velocity ft/sec	Vacuum "Hg	Temp. °F	Orifice ΔH, "H_2O	Volume CF
Northeast Port								
3	1305	275	0.60	47.0		70	2.37	427.20
2	1310	280	0.58	46.4	2	75	2.31	
1	1315	275	0.46	41.2		75	1.90	
	1320	Stop to change ports						434.90
Northwest Port								
3	1325	280	0.60	47.2		70	2.36	
2	1330	280	0.64	48.7	2	75	2.51	
1	1335	285	0.50	43.2		75	2.01	
	1340	Stop to change ports, disconnect & leak check						442.90
Southwest Port								443.00
3	1350	290	0.46	41.6		75	1.86	
2	1355	290	0.44	40.7	2	85	1.82	
1	1400	290	0.36	36.8		85	1.52	
	1405	Stop to change ports						449.85
Southeast Port								
3	1415	290	0.46	41.6		75	1.86	
2	1420	300	0.46	41.6		85	1.87	
1	1425	300	0.40	39.0	2	85	1.65	
	1430	End of Test						456.60
Total	60 Minutes				Max. 2		TOTAL	29.30
Average		286		42.9	Average	78	2.00	29.77 = corr

PARTICULATE EMISSIONS

DATA & RESULTS:

Site: Main Stack Run: 3

Date: 8/23/83 Time: 1305 - 1430

Absorber Type	Contents	Final	Tare	Net gms. H_2O
Lg. Greenburg	80% IPA	566.7	529.8	36.9
Sm. Greenburg	6 % Peroxide	470.0	430.4	39.6
Gas Absorber	6 % Peroxide	264.8	255.0	9.8
liquid trap	empty	101.8	99.1	2.7
	silica gel	705.4	695.3	10.1
			TOTAL	99.1

Filter Sample: Type EPA Flat Filter

Sample Fraction	Final Wt.	Tare Wt.	Net mgram	Co, grains/SDCF
Probe & Nozzle Wash	63.7717	63.7702	1.5	0.0008
Condensables 200/200	68.6964	68.6166	79.8	0.0425
Filter #44	0.4225	0.4182	4.3	0.0023
Acetone blank 63mls			<0.1	<0.0001
		TOTAL	85.6	0.0456

Gas Composition:

CO_2 20.0 % volume (dry)

O_2 9.0 % volume (dry)

CO - % volume (dry)

N_2 69.5 % volume (dry)

H_2O 13.7 % volume

MW (wet) 29.71

Excess Air %

Sampled Volume 28.92 SDCF

Isokinetic Rate 102.5 %

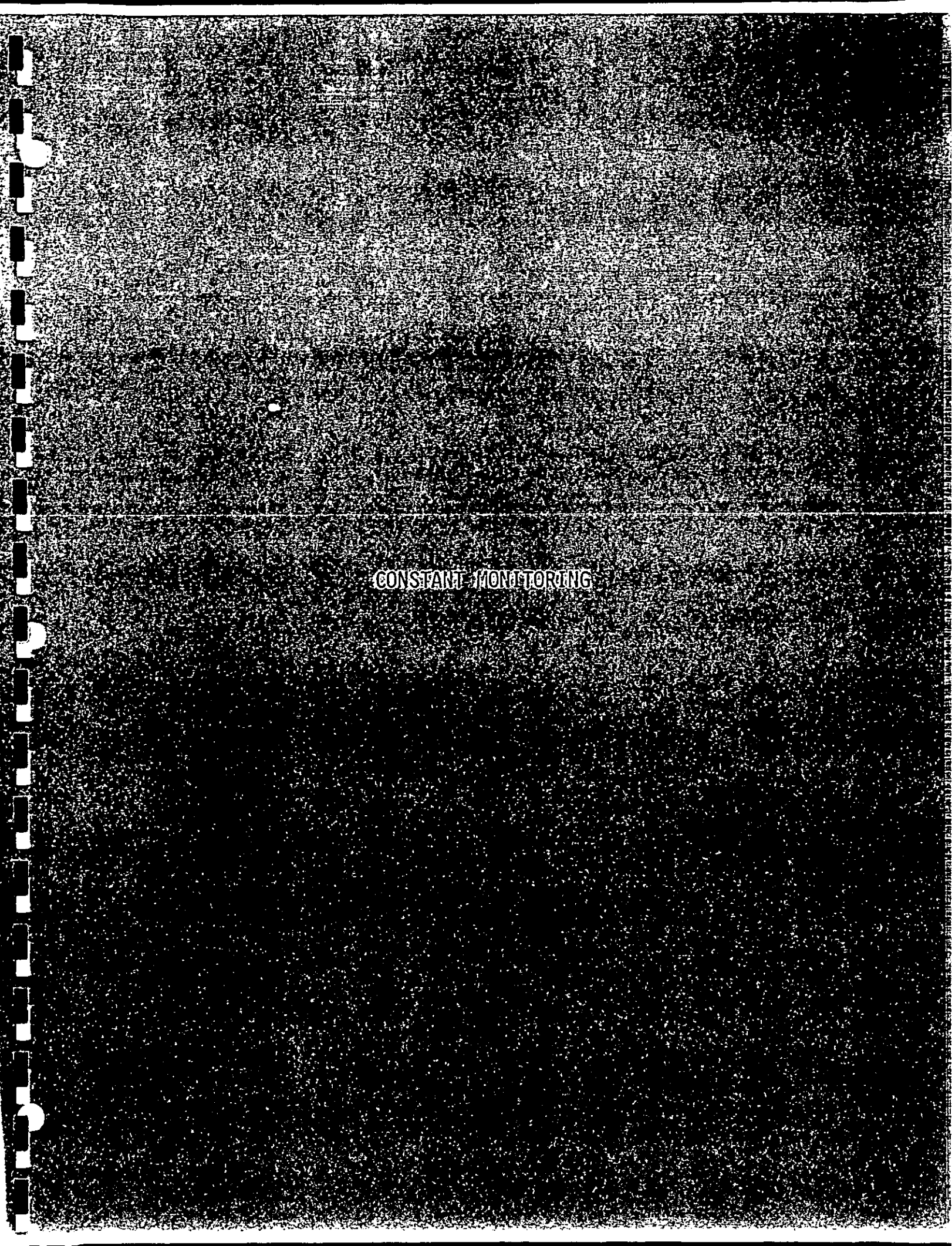
Particulate Concentration:

Co 0.0456 grains/SDCF @ 60 °F and 29.92 "Hg

C grains/SDCF @

Emission Rate:

E.R. 47.52 lbs/hr @ Qstd(dry) 121452 SDCFM


CONSTANT MONITORING

CHEMECOLOGY CORPORATION

CONSTANT MONITORING

REF: Bay Area AQMD, Manual of Procedures, San Francisco, CA, Methods ST-5, ST-6, ST-13A, ST-14, ST-19A, January, 1982
: State of California, Air Resources Board, Draft Stationary Source Test Methods, Method 1-100, June, 1979

METHOD SUMMARY:

A representative sample of duct gas was extacted through a probe, filter, condenser and sample line by a pump. The sample was then pumped into a sampling manifold for distribution to one or more sample analyzers. The analyzers output a continuous analog recording of the concentrations of the analyzed gases in the sample. All analyzers were calibrated with EPA Protocol gases (traceable to National Bureau of Standards SRMs) or with recently analyzed gases (analysis by EPA Reference Methods).

SAMPLING SYSTEM:

A Pyrex glass or stainless steel probe with a Pyrex wool or glass fibre mat filter was positioned in the duct. The end of the probe was located at a point of average duct flow and average pollutant concentrations. The probe was connected with a short (about 2 feet) Teflon line to a sample conditioning train. The conditioning train included three glass knockout traps connected in series with Teflon lines and immersed in an ice bath. The train was connected with a Teflon line (¼ inch o.d.) to the pneumatic delivery system which was housed in the monitoring van.

PNEUMATIC DELIVERY SYSTEM:

The Teflon sample line delivered sample gas into a small glass knockout trap, then through an in-line Balston filter and a Hoke four-way selector valve to the Teflon-lined diaphragm sample pump (see accompanying diagram). The flow rate of the sample gas was regulated with main and bypass-flow needle valves and was read on the main flow meter (typical setting 10 SCFH). A 10 PSI pressure-relief valve kept the entire system pressure at a safe level. The manifold pressure was regulated with an exhaust needle valve and was read on the pressure gauge (typical setting 1 PSI). The sample in the manifold was delivered through needle valves and flow meters to the various analyzers.

LEAK CHECK PROCEDURE:

The sampling system was checked for leaks by plugging the end of the probe. The exhaust needle valve was closed and the entire sample flow was directed through one analyzer flow meter (range 0-1.0 SCFH). The bypass valve was closed until the vacuum gauge showed at least 15 inches Hg vacuum. The leak rate was observed at the analyzer flow meter (maximum allowable 2% of total sample flow). The system was checked for leaks before and after sampling.

CHEMECOLOGY CORPORATION

CONSTANT MONITORING

CALIBRATION PROCEDURE:

Each analyzer was calibrated before and after each sample run. The Hoke four-way selector valve was used to direct the flow of the various calibration gases into the sample manifold. Each analyzer was calibrated with a zero gas (typically, ambient air or zero grade Nitrogen) and with a span gas (typical span gas concentration 60 to 90 percent of analyzer full scale and/or similar to expected sample concentration). All zero and span checks were recorded and noted on the recorder strip charts.

STRIP CHART DATA REDUCTION:

The analog recordings were averaged over time periods as shown on the data pages (typically 5 minutes, 15 minutes or 30 minutes). The data for each averaging period was digitized and recorded as average percent of full scale. These sample readings were then compared with the zero and span gas readings for calculation of the average concentration for each averaging period.

Any drift[1/] of the zero and span readings from the beginning to the end of a sampling period was corrected by calculating apparent zero and span readings for the midpoint of each averaging period. The sample average concentrations were then calculated from the sample readings and the apparent zero and span readings.

1/ Drift is defined as any change in zero or span readings of more than one percent full scale from the beginning to the end of a sampling period.

CONSTANT MONITORING (cont)

CALCULATIONS (Strip Chart Analysis):

Calculations were performed based on the following equations:

Symbol Identification

Subscripts i and f indicate initial and final respectively (beginning and end of sampling period)

z = zero reading, % full scale
s = span reading, % full scale
t = averaging time period numbered 1 to n
n = number of t's in the sampling period
Δz = rate of change of zero reading, % full scale/time interval
Δs = rate of change of span reading, % full scale/time interval
R_t = average sample reading over time t, % full scale
z_t = corrected (apparent) zero reading for midpoint of t, % full scale
s_t = corrected (apparent) span reading for midpoint of t, % full scale
C_s = span gas concentration, ppm or % vol. (as shown on data sheet)
C_t = average sample concentration for time t, ppm or % vol. (as indicated)

Equations:

Apparent Zero:

$$\Delta z = (z_f - z_i)/n$$

For each t from 1 to n,

$$z_t = \Delta z/2 + \Delta z * (t - 1) + z_i$$

Apparent Span:

$$\Delta s = (s_f - s_i)/n$$

For each t from 1 to n,

$$s_t = \Delta s/2 + \Delta s * (t - 1) + s_i$$

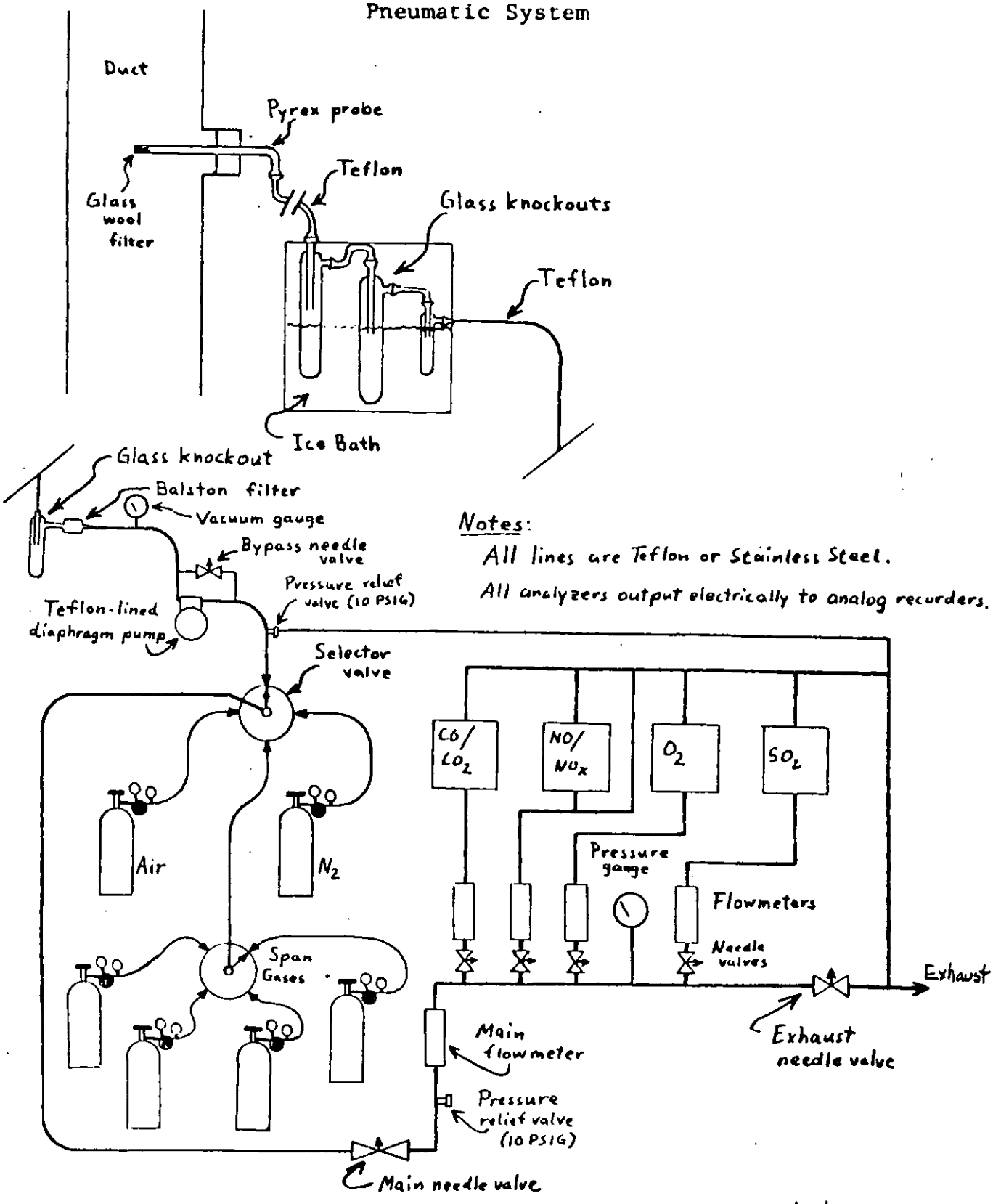
Average Sample Concentration

$$C_t = \frac{R_t - z_t}{s_t - z_t} * C_s$$

CHEMECOLOGY CORPORATION

CONSTANT MONITOR

Pneumatic System



Notes:

All lines are Teflon or Stainless Steel.

All analyzers output electrically to analog recorders.

5/11/82 KJC

CHEMECOLOGY CORPORATION

CONSTANT MONITORING

ANALYZERS:

Taylor Servomex OA250 or OA580 Oxygen Analyzer

The Taylor paramagnetic analyzer is used to measure the percent dry volume of oxygen in the sample gas. This analyzer contains a quartz-glass "dumb-bell" that is filled with nitrogen and suspended in a non-uniform magnetic field. The spheres at the ends of the dumb-bell are repelled from the strongest part of the field by their diamagnetic property. The dumb-bell therefore rotates to a position where the repellent force and the torque-resistance of the suspension are in equilibrium.

The sample gas flows into a sample cell which encases the dumb-bell. The paramagnetism of any oxygen in the sample gas reduces the intensity of the field and therefore alters the position of the dumb-bell. A small mirror at the center of the dumb-bell reflects a beam of light onto twin photocells (see schematic diagram). The output of the photocells is amplified and fed back to a coil around the dumb-bell. The current required to keep the dumb-bell at the zero position is a direct measure of the magnetic force and is therefore a measure of the oxygen content of the sample gas.

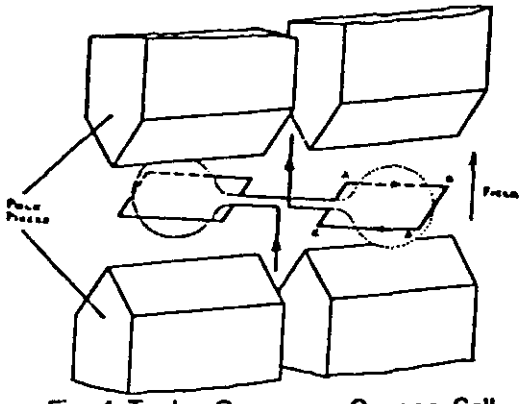


Fig. 1. Taylor Servomex Oxygen Cell — Schematic using Munday's principles

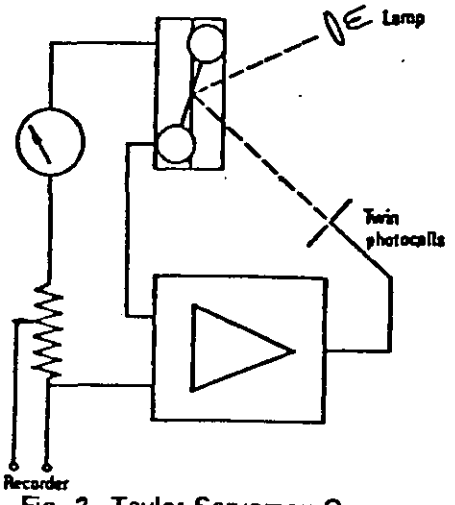


Fig. 2. Taylor Servomex Oxygen Analyser — Schematic

CHEMECOLOGY CORPORATION

CONSTANT MONITORING

ANALYZERS:

Monitor Labs 8430 Nitrogen Oxides Analyzer

The Monitor Labs chemiluminescent analyzer is used to measure parts per million dry volume of Nitrogen Oxides in the sample gas. The analyzer measures the concentration of NO_x by converting NO_x to NO and then measuring the light emitted by the reaction of NO with ozone.

The sample gas is drawn into the analyzer by a vacuum pump which partially evacuates the reaction chamber. The sample flows through a NO2-to-NO converter1/ for NOx analysis or may bypass the converter for NO analysis. The sample then flows through a temperature controlled critical orifice into the partially evacuated reaction chamber.

Ambient air is also drawn into the analyzer as an ozone carrier. The air flows through a desiccant cartridge for drying, then through an ozone generator which converts some of the oxygen in the air to ozone. The ozonated air then flows through a temperature-controlled critical orifice into the reaction chamber.

The sample gas and the ozonated air are mixed in the reaction chamber, where the following reaction takes place:

$$NO + O3 \longrightarrow NO2 + O2 + h\nu$$

The intensity of the chemiluminescence is proportional to the concentration of NO in the reaction chamber. The light emitted by this chemiluminescent reaction shines through a window in the chamber onto a photomultiplier tube (PMT). A spinning light chopper wheel between the reaction chamber and the PMT allows the PMT output with no light to be compared electronically with the PMT output with light. The signal is processed electronically and output for recording of the concentration of NO (or NO_x if the converter is used).

1/ Either of two types of converter may be used-a 300°C Molybdenum-catalyst converter or a 900°C stainless steel converter.

CONSTANT MONITORING

ANALYZERS:

DuPont Series 400 Sulfur Dioxide Analyzer

The DuPont 400 analyzer is used to measure parts per million dry volume of Sulfur Dioxide in the sample gas. The analyzer measures the concentration of SO_2 by measuring its absorption of ultraviolet light.

The sample gas flows through a tubular cell 50.8 cm long. An ultraviolet lamp shines a light beam through the sample cell to a beam splitter at the other end. The split beam shines through optical filters onto phototubes which measure the beam intensity at the filtered wavelengths (see diagram). The reference phototube measures at a wavelength (578 nm) that is not absorbed by SO_2. The measuring phototube measures at a wavelength (280 nm) that is strongly absorbed by an SO_2 in the sample. Each phototube conducts a current to the logarithmic amplifier that is proportional to the light intensity striking the phototube. The signals are linearized and compared electronically to determine the absorption of 280 nm wavelength light and therefore to determine the concentration of SO_2 in the sample gas.

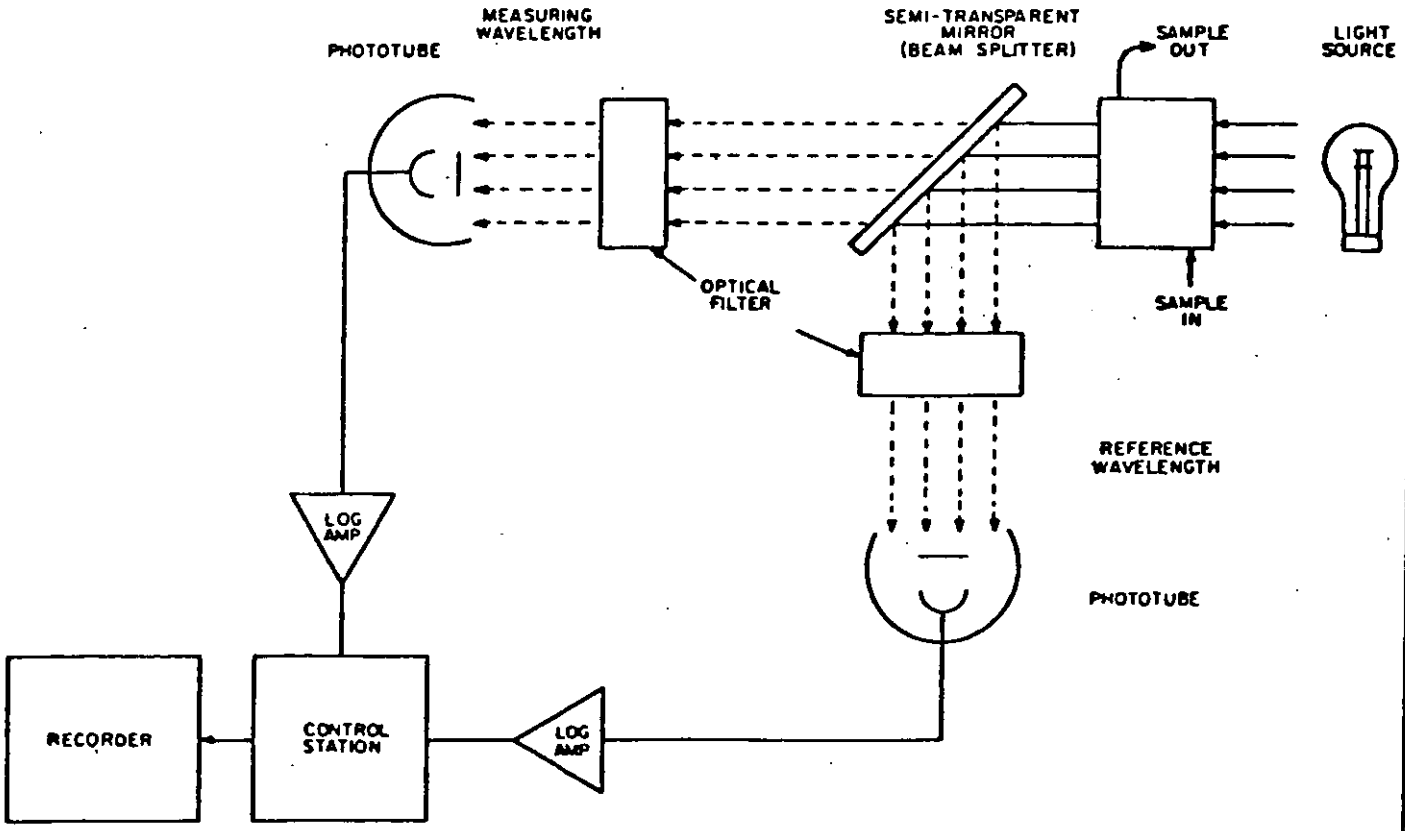


Figure 1. Analyzer Block Diagram

CHEMECOLOGY CORPORATION

CONSTANT MONITORING

DATA & RESULTS

Client: Lonestar, Davenport, CA
Unit: Main Stack
Date: 8/22/83

Analyzed Gas	O_2
Analyzer Range	0 to 25%
Recorder Range	0 to 25%

Zero Gas : Scott #CAL 4516 (span gas for NOx and SO_2)
Span Gas: 21% O_2- Ambient Air

Time	% FULL SCALE						Average Concentration % O_2
	Initial		Final		Apparent		Sample Reading	
	Zero	Span	Zero	Span	Zero	Span		
1125	0.0	84.0						
1131 to 1203					0.0	84.0	42.1	10.5
1210			0.0	84.0				
1325	0.0	84.0						
1333 to 1414					0.0	84.1	41.3	10.3
1420			0.0	84.2				
1545	0.0	84.0						
1550 to 1637					0.2	84.1	41.8	10.4
1640			0.4	84.2				

CONSTANT MONITORING

DATA & RESULTS

Client: Lonestar, Davenport, CA
Unit: Main Stack
Date: 8/22/83

Analyzed Gas NOx
Analyzer Range 0 to 500 ppm
Recorder Range 0 to 500 ppm

Zero Gas : Ambient Air
Span Gas: 309.9 ppm NOx with SO_2 in N_2 - Scott #CAL 4516

Time	% FULL SCALE						Sample Reading	Average Concentration ppm NOx
	Initial		Final		Apparent			
	Zero	Span	Zero	Span	Zero	Span		
1125	0.0	62.0						
1131 to 1203					0.0	62.4	41.0	204
1210			0.0	62.8				
1325	0.0	62.0						
1333 to 1414					0.0	62.5	53.5	265
1420			0.0	63.0				
1545	0.1	61.9						
1550 to 1637					0.1	60.6	35.5	182
1640			0.1	59.3				

CHEMECOLOGY CORPORATION

CONSTANT MONITORING

DATA & RESULTS

Client: Lonestar, Davenport, CA
Unit: Main Stack
Date: 8/22/83

Analyzed Gas SO_2
Analyzer Range 0 to 1000 ppm
Recorder Range 0 to 1000 ppm
(-50 to 950 ppm)

Zero Gas : Ambient Air
Span Gas: 522.4 ppm SO_2, with NOx in N_2 - Scott #CAL 4516

Time	% FULL SCALE						Sample Reading	Average Concentration ppm SO_2
	Initial		Final		Apparent			
	Zero	Span	Zero	Span	Zero	Span		
1125	0.0	52.1						
1131 to 1203					- 1.0	52.8	1.9	28
1210			2.1	53.5				
1325	5.2	57.2						
1333 to 1414					5.2	57.1	9.4	42
1420			5.3	57.0				
1545	5.0	57.2						
1550 to 1637					5.0	57.2	10.1	51
1640			5.0	57.2				

CHEMECOLOGY CORPORATION

CONSTANT MONITORING

DATA & RESULTS

Client: Lonestar, Davenport, CA
Unit: Main Stack
Date: 8/23/83

Analyzed Gas O_2
Analyzer Range 0 to 25%
Recorder Range 0 to 25%

Zero Gas : Scott #CAL 4516 (span gas for NOx and SO_2)
Span Gas: 21% O_2 - Ambient Air

Time	% FULL SCALE						Sample Reading	Average Concentration % O_2
	Initial		Final		Apparent			
	Zero	Span	Zero	Span	Zero	Span		
825	0.0	84.0						
833 to 937					0.0	84.0	48.0	12.0
945			0.0	84.0				
1040	0.0	83.8						
1047 to 1159					0.0	83.8	44.3	11.1
1210			0.0	83.8				
1255	0.0	83.8						
1300 to 1400					0.0	83.7	35.6	8.9
1410			0.0	83.7				

CHEMECOLOGY CORPORATION

CONSTANT MONITORING

DATA & RESULTS

Client: Lonestar, Davenport, CA
Unit: Main Stack
Date: 8/23/83

Analyzed Gas: NOx
Analyzer Range: 0 to 500 ppm
Recorder Range: 0 to 500 ppm

Zero Gas : Ambient Air
Span Gas: 309.9 ppm NOx with SO_2 in N_2 - Scott #CAL 4516

Time	% FULL SCALE						Sample Reading	Average Concentration ppm NOx
	Initial		Final		Apparent			
	Zero	Span	Zero	Span	Zero	Span		
825	0.0	61.8						
833 to 937					0.0	61.6	27.5	138
945			0.0	61.4				
1040	0.0	62.0						
1047 to 1159					0.0	58.2	38.5	205
1240			0.0	54.5				
1255	0.0	62.0						
1300 to 1400					0.0	61.5	43.2	218
1410			0.0	61.0				

CHEMECOLOGY CORPORATION

CONSTANT MONITORING

DATA & RESULTS

Client: Lonestar, Davenport, CA
Unit: Main Stack
Date: 8/23/83

Analyzed Gas SO_2
Analyzer Range 0 to 1000 ppm
Recorder Range -50 to 950 ppm

Zero Gas : Ambient Air

Span Gas: 522.4 ppm SO_2 with NOx in N_2 - Scott #CAL 4516

Time	% FULL SCALE						Sample Reading	Average Concentration ppm SO_2
	Initial		Final		Apparent			
	Zero	Span	Zero	Span	Zero	Span		
825	5.1	57.1						
833 to 937					5.4	57.4	21.8	165
945			5.7	57.6				
1040	5.0	57.1						
1047 to 1159					4.6	57.0	21.7	170
1210			4.2	56.9				
1255	5.0	57.2						
1300 to 1400					5.2	57.2	25.5	204
1410			5.3	57.2				

CALIBRATION DATA

CHEMECOLOGY CORPORATION

PITOT TUBE CAL SUMMARY

Calibrated by DER

Pitot Tube Number	Description	Cp_A	Cp_B	$\overline{Cp}$
5192	3' In	.783	.779	.781
5210	3' SS	.796	.799	.797
5211	3' SS	.799	.801	.800
5212	3' SS	.798	.795	.796
5270	6' In	.768	.771	.769
5272	6' In	.780	.778	.779
5273	6' In	.777	.777	.777
5293	6' SS	.805	.803	.804
5294	6' SS	.778	.783	.780
5295	6' SS	.780	.782	.781
5330	9' In	.771	.770	.770
5332	9' In	.782	.781	.781
5350	9' SS	.776	.778	.777
5352	9' SS	.778	.781	.779

INV. NO.

POTENTIOMETER MAINTENENCE TEST RESULTS

OLD NO.

SIMULATOR* TEMPERATURES

Rl

VH 10-Ly Model 20

DATE	32	50	75	110	212	300	375	450	600	875	1000	1200	1500	1800
3 548														
28-83														
3-549	34	53	78	111	216	303	376	453	578	849	-	-	-	-
3-550														
15-83														
3-551	32	42	67	99	199	285	361	438	589	867	-	-	-	-
13-83														
3-552	31	48	71	106	208	291	369	443	595	893	999	1198	1476	1802
28-83														
3-554	42	61	84	119	219	305	379	455	610	886	1008	1210	1506	1807
3-555														
15-83														
3-556	39	57	81	115	213	299	373	449	600	876	-	-	-	-
8-83														
3-5561	32	53	77	112	213	300	374	448	599	876	992	1191	1492	1787
983														
3-5562	39	58	82	116	215	301	377	451	604	876	995	1195	1492	1793
5-83														
-5563	33	51	76	111	212	299	373	448	600	875	993	1190	1490	1783

AVG CORR

MAGNEHELIC GAUGE BOXES

INCLINOMETER RATE	# 3-374 1-28-83	CORREC. FACTOR	# 3-371	CORREC. FACTOR	# 3-373	CORREC FACTOR	# 375	CORREC FACTOR	# 376	CORREC FACT
					0-5					
5.00	488	103	487	103	491	101	478	105	489	102
4.50	440	102	440	102	448	100	437	103	443	101
4.00	384	103	390	103	402	100	392	102	397	101
3.50	337	104	344	102	359	97	349	101	345	100
3.00	294	104	291	102	310	97	298	101	300	100
2.50	247	103	248	101	260	96	249	100	250	100
2.00	195	103	196	101	207	97	200	100	201	100
1.74	172	101	174	100	181	96	174	100	176	99
1.48	148	100	148	100	157	95	149	99	151	98
1.24	124	100	125	99	133	95	125	99	126	98
1.08	108	100	109	99	114	95	110	98	110	98
1.00	101	99	100	100	105	96	102	98	102	98
ε		1.22		1.11		1.06		1.06		1.06
x̄		102		101		97		101		100
√x		101		100		98		100		100
					0—1					
1.00	101	99	100	100	96	104	94	100	95	105
.88	88	100	88	100	85	104	83	104	83	106
.65	65	100	64	102	64	102	62	105	61	107
.52	52	100	52	100	50	104	50	104	49	106
.30	30	101	30	100	30	100	30	100	29	103
.22	21	104	21	105	22	100	22	100	21	105
.12	11	109	11	109	12	100	12	100	12	100
ε		1.11		1.10		1.04		1.03		1.03
x̄		102		102		101		101		101
√x		101		101		101		101		101

MAGNEHELIC GAUGE READINGS WERE COMPARED TO READINGS ON WALL MOUNTE
WYER INCLINE MANOMETER AS A STANDARD & CALCULATED A CORRECTION

Scott Specialty Gases
Scott Environmental Technology, Inc.
PLUMSTEADVILLE, PA. 18949 PHONE: 215-766-8861 TWX: 510-665-9344

Date Shipped 7/18/83
Our Project No: 320989
Your P.O. No: 610
Page 1 of 1

CHEMECOLOGY
ATTN: RIP HUNTER
690 GARCIA AVENUE
PITTSBURGH, CA 94565

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES*

(Concentrations are in mole % or ppm)

Cylinder Number CAL-4516 Certified Accuracy 1 % NBS Traceable Analysis Dates: First 4/28/83 Last 7/15/83 7/12/83

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
NITRIC OXIDE	309.6 ppm	1/12/84	CHEMILUMINESCENCE	1686, 1687	309.4ppm	309.8 ppm
NOx	309.9 ppm					
SULFUR DIOXIDE	522.4 ppm	1/15/84	ELECTRO-CHEMICAL	1663, 1661	520.7 ppm	524.1 ppm

Cylinder Number _____ Certified Accuracy _____ % NBS Traceable Analysis Dates: First _____ Last _____

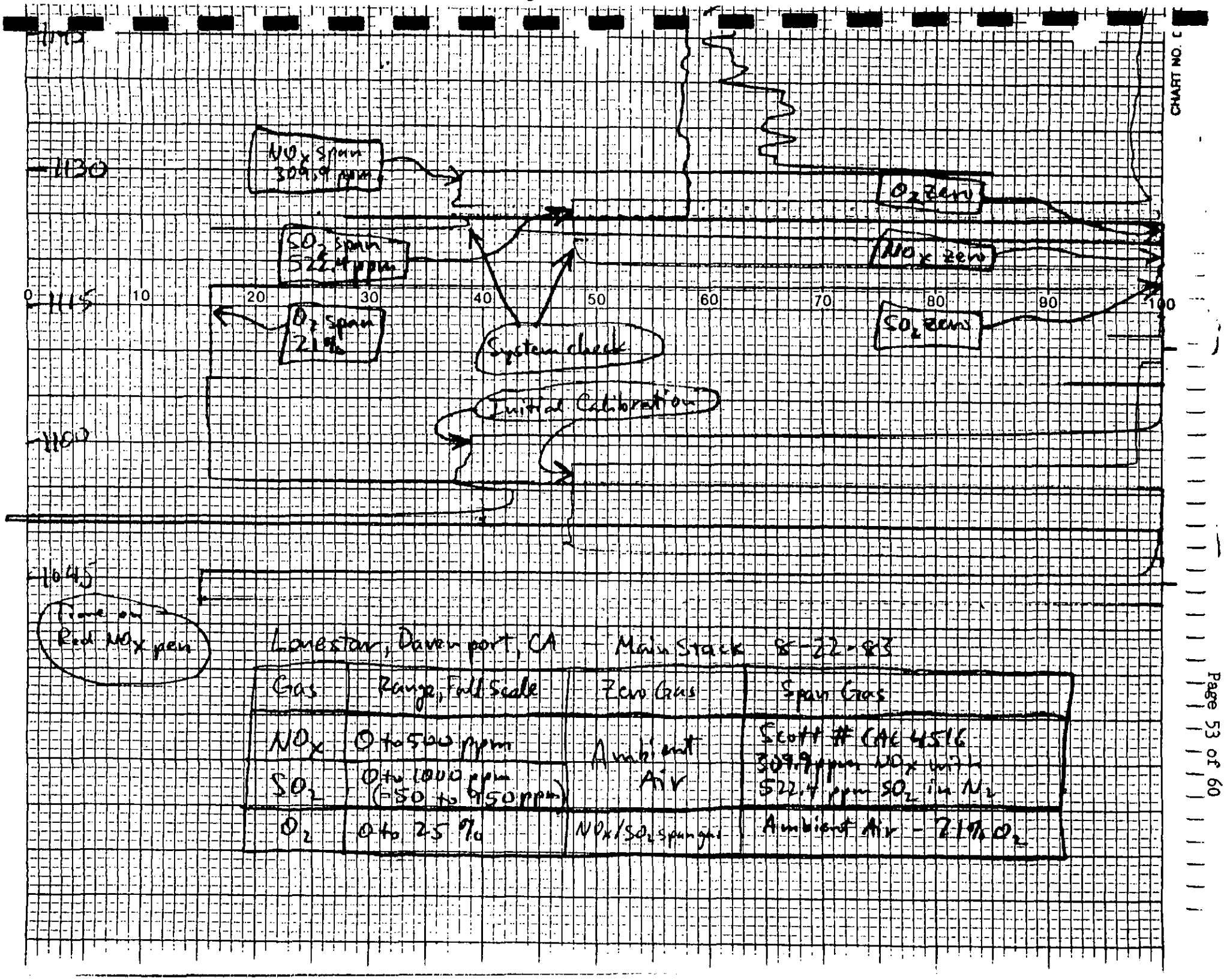
COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND

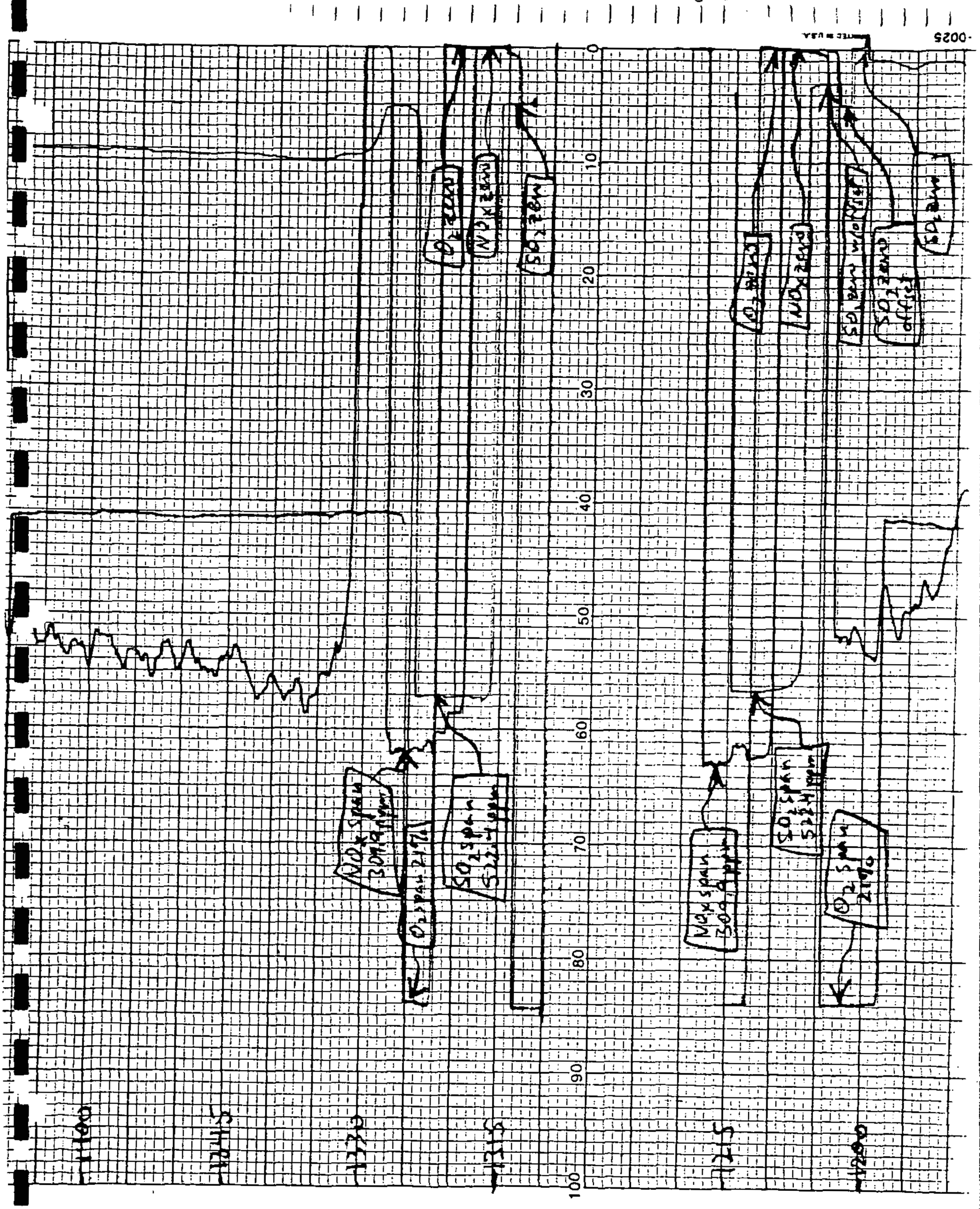
*We hereby certify the cylinder gas has been analyzed according to EPA Protocol No:

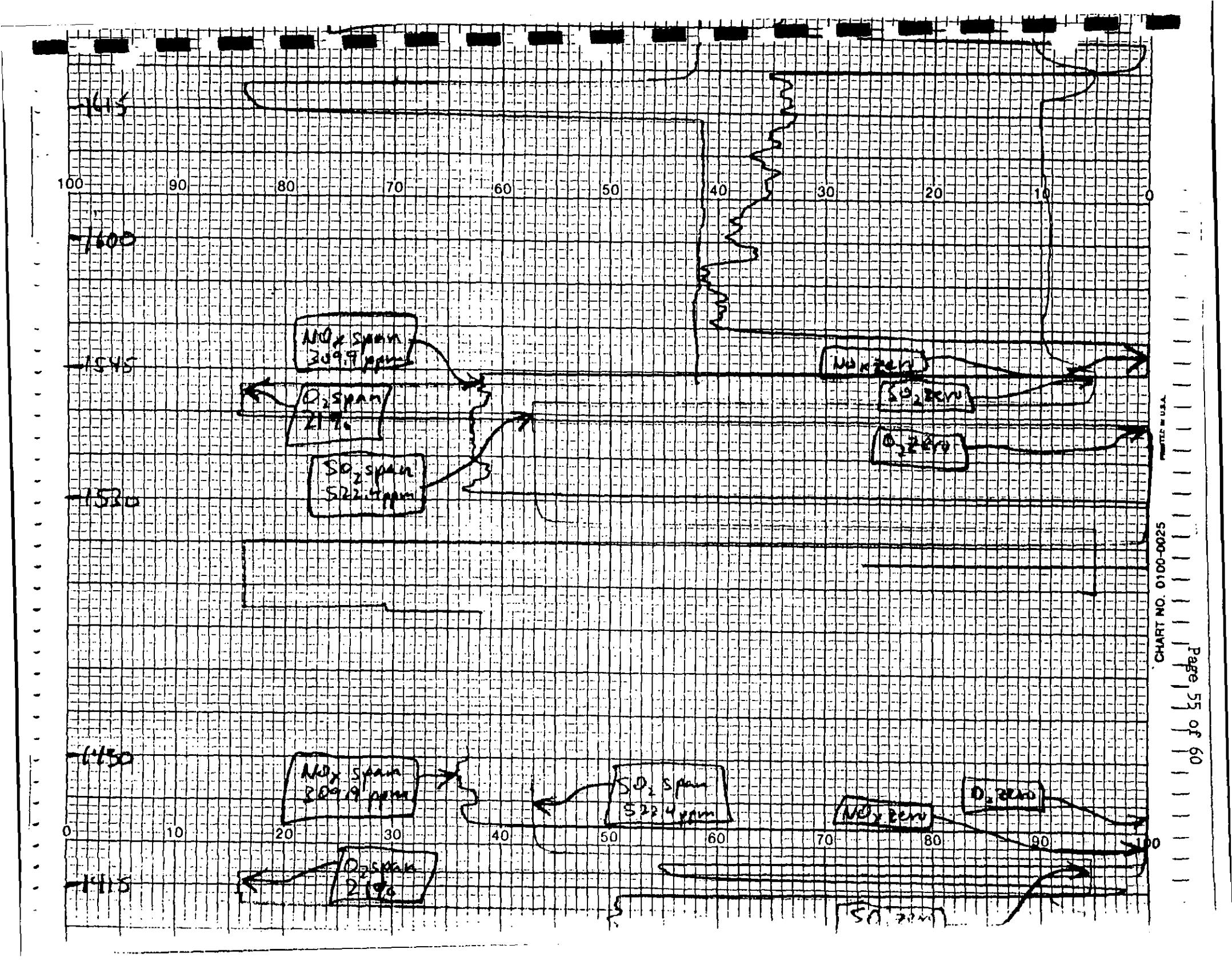
Analyst Penrose Hallowell Jr. PENROSE HALLOWELL, JR. Approved By FRANCIS E. NEVILL

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the Company without extra cost.

CHART RECORDINGS


1105
1130
1115
1100
1045
10
20
30
40
50
60
70
80
90
100
NO_x span 309.9 ppm
SO_2 span 522.4 ppm
O_2 span 21%
O_2 zero
NO_x zero
SO_2 zero
System check
Initial Calibration
Red NO_x pen
Lonestar, Davenport, CA — Main Stack 8-22-83
Gas | Range, Full Scale | Zero Gas | Span Gas
NO_x | 0 to 500 ppm | Ambient Air | Scott # CAL 4516 309.9 ppm NO_x in N_2
SO_2 | 0 to 1000 ppm (+50 to 950 ppm) | | 522.4 ppm SO_2 in N_2
O_2 | 0 to 25 % | NO_x/SO_2 sponge | Ambient Air - 21% O_2
CHART NO.




1445
1600
1545
1530
1430
1415
100
90
80
70
60
50
40
30
20
10
0
NOx span 309.9 ppm
O2 span 21%
SO2 span 522.4 ppm
NOx zero
SO2 zero
O2 zero
NOx span 209.9 ppm
SO2 span 522.4 ppm
O2 span 21%
NOx zero
O2 zero
50 ppm
CHART NO. 0100-0025
Page 55 of 60

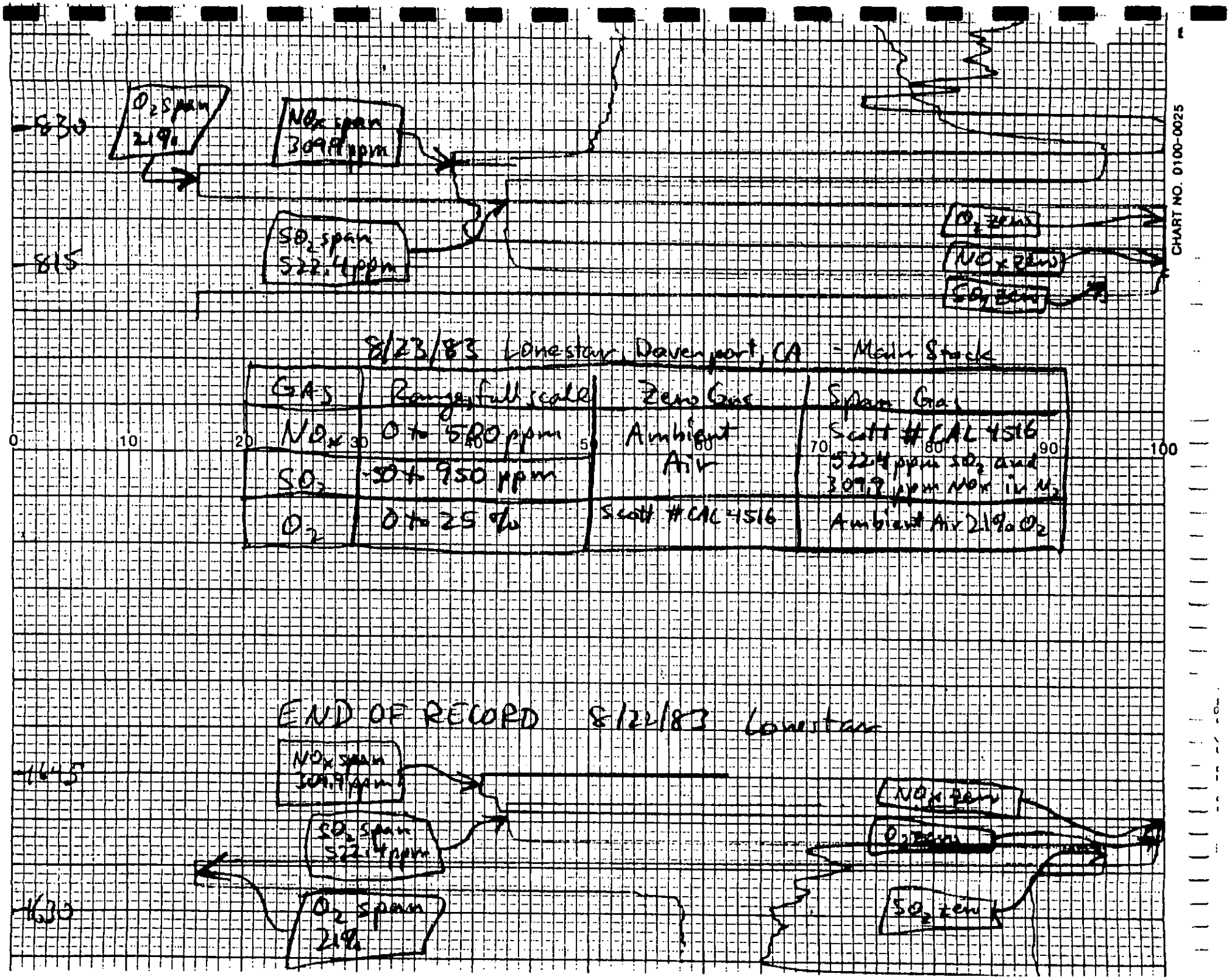


CHART NO. 0100-0025
0
10
20
30
40
50
60
70
80
90
100
8/23/83 Lonestar Davenport CA = Main Stack
GAS
Range, full scale
Zero Gas
Span Gas
NOx
0 to 500 ppm
Ambient Air
Scott #CAL 4516
522.4 ppm SO2 and 309.9 ppm NOx in N2
SO2
0 to 950 ppm
O2
0 to 25 %
Scott #CAL 4516
Ambient Air 21% O2
END OF RECORD 8/22/83 Lonestar

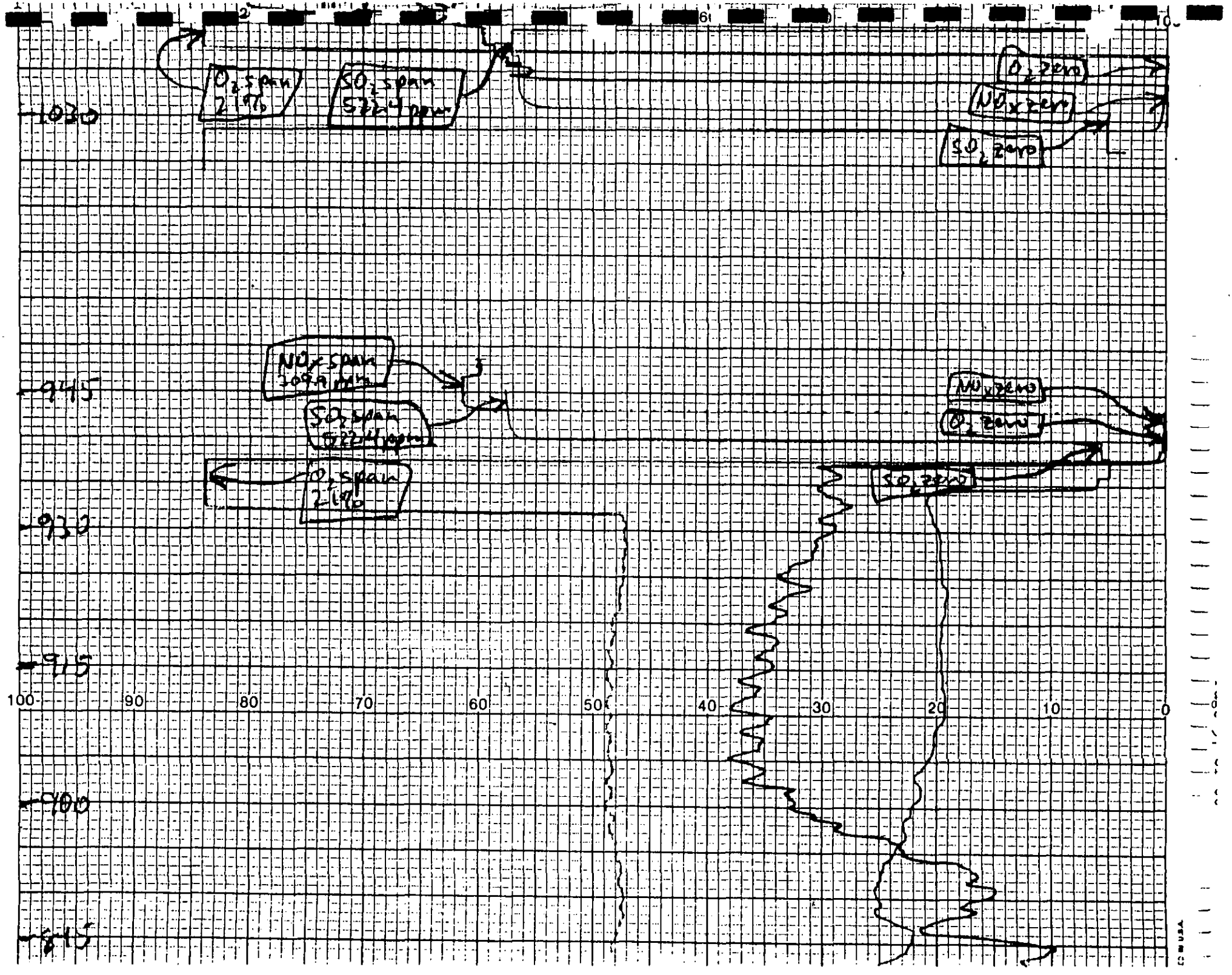
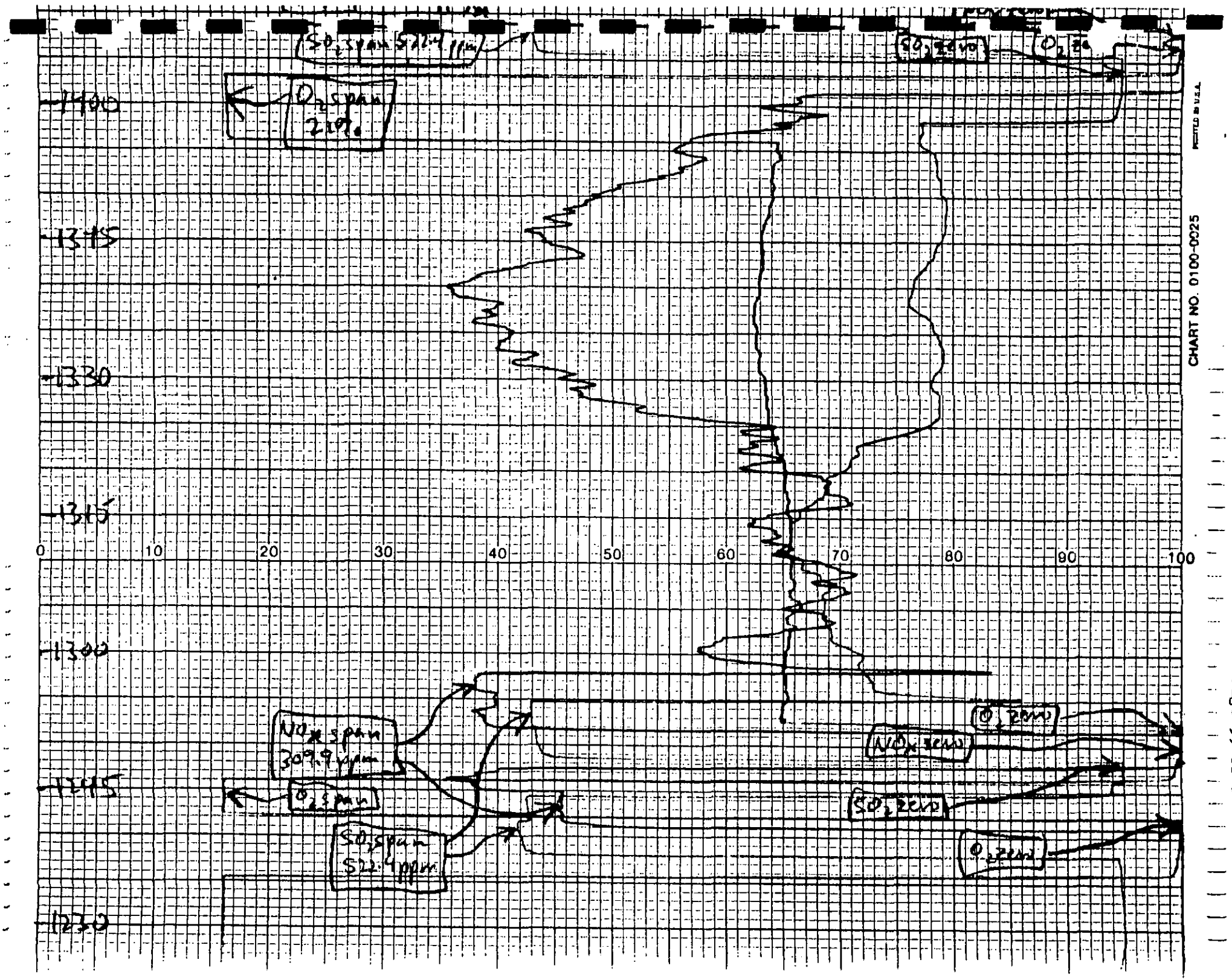

1030
945
930
915
900
845
100
90
80
70
60
50
40
30
20
10
0
O2 span 21%
SO2 span 522.4 ppm
O2 zero
NOx zero
SO2 zero
NOx span 109.8 ppm
SO2 span 522.4 ppm
O2 span 21%
NOx zero
O2 zero
SO2 zero

CHART NO. 0100-0025
PRINTED IN U.S.A.
0
10
20
30
40
50
60
70
80
90
100
1100
1115
1130
1145
1200
1215


1400
1345
1330
1315
1300
1245
1230
0
10
20
30
40
50
60
70
80
90
100
O_2 span 21%
SO_2 span 22.4 ppm
SO_2 zero
O_2 zero
NO_x span 309.9 ppm
O_2 span
SO_2 span 22.4 ppm
O_2 zero
NO_x zero
SO_2 zero
O_2 zero
CHART NO. 0100-0025
Page 59 of 60

0
10
20
30
40
50
60
70
80
90
100
END OF RECORD 8/23/67

CHEMECOLOGY CORPORATION
690-B Garcia Avenue, Pittsburg, CA 94565 / 415-439-5766

F I E L D D A T A S O U R C E T E S T

PREPARED FOR: LONESTAR INDUSTRIES
Highway 1
Davenport, California 95017

ATTENTION: Doc Vu

REGARDING: Particulate Emissions Testing

REGULATORY AGENCY: Monterey Bay Unified APCD

PURPOSE: Compliance

TEST DATE: August 4, 1983

UNIT TESTED: Clinker Cooler and Coal Stack

ASSOCIATED REPORT NUMBERS

REPORT NUMBER: 1698

PREPARED BY: Larry Borrelli

REVIEWED BY:

Introduction

On August 4, 1983, Chemecology personnel; Larry Borrelli, Dave Ray and Kevin Crosby, performed particulate emissions testing at two sites simultaneously. The two sites were the Clinker Cooler and Coal Stack.

The purpose of testing was to determine compliance with Monterey Bay Unified APCD regulations.

The testing was coordinated as follows; Dave Ray conducted sampling at the Clinker Cooler Stack, Kevin Crosby sampled at the Coal Stack, and Larry Borrelli operated the computer and supervised the testing team. All samples were transported to the Pittsburg Laboratory and analyzed the following day by Cherry Padilla, Chemecology's Lab technician.

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SELECTED RESULTS

SELECTED RESULTS

Client: Lonestar

Unit: Clinker Cooler

Date: August 4, 1983

Time:		1105-1214 Run #1	1403-1520 Run #2	1648-1800 Run #3
Process Conditions:				
ACFM:		163400	151600	149000
SDCFM:	95700	99540	95430	92130
TPH (kiln feed):	170	170	170	170
TPH (Clinker Production):	94	94	94	94
CO_2 (% vol dry):		0	0	0
O_2 (% vol dry):		21.0	21.0	21.0
H_2O (% vol)		1.4	1.3	1.6
Particulate Emissions:				
gr/SDCF:		0.0130	0.0127	0.0166
gr:SDCF (less condensables):		0.0120	0.0082	0.0149
lbs/hr (total):	11.5	11.10	10.40	13.12
lbs. part/Ton Feed (less condensables)		0.060	0.041	0.069
Test Conditions:				
Duration (min):		60	60	60
Sample vol. (SDCF):		43.58	41.27	39.97
% isokinetic:		100.0	98.7	99.1

SELECTED RESULTS

Client: Lonestar

Unit: Coal Stack

Date: August 4, 1983

Time:	1107-1220 Run #1	1410-1519 Run #2	1654-1805 Run #3
Process Conditions:			
ACFM:	26590	26840	27060
SDCFM:	20970	21290	21400
TPH (kiln feed):	170	170	170
TPH (Coal Mill):	15.5	15.5	15.5
CO_2 (% vol dry):	0.5	0.5	0.4
O_2 (% vol dry):	20.5	20.5	20.6
H_2O (% vol):	4.1	3.8	4.1
Particulate Emissions:			
gr/SDCF:	0.0053	0.0032	0.0008
gr/SDCF (less condensables):	0.0033	0.0019	0.0005
lb/hr. (total):	0.95	0.58	0.15
Test Conditions:			
Duration (min):	60	60	60
Sample vol. (SDCF):	34.26	36.57	39.38
% isokinetic:	91.5	95.8	102.6

VELOCITY PROFILE & VOLUME FLOW RATE

CHEMECOLOGY CORPORATION

VELOCITY TRAVERSE AND VOLUME FLOW RATE

REF: Environmental Protection Agency, Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 1 and 2, 1981
: Bay Area AQMD, Manual of Procedures, San Francisco, CA, Method St-17 January, 1982
: ASME Performance Test Code #27, New York, NY, 1957
: ASTM D-2928-71
: Western Precipitation Division of Joy Manufacturing, WP-50, 1968

PROCEDURE:

Duct temperature and velocity were read at each of several traverse points within the duct. The number and location of traverse points was chosen to aid in the extraction of a representative sample (i.e. by EPA Method 1). Velocity head was determined using a calibrated type "S" pitot tube and Magnehelic differential pressure gauge. Duct temperature was measured by means of a thermocouple attached to the pitot tube. Static pressure was measured with the Magnehelic and one leg of the pitot tube. Using the molecular weight and traverse data, velocity was calculated at each traverse point. From the average velocity, duct area, temperature, pressure and composition, actual and standard gas volume flow rate were calculated for the duct.

CALCULATIONS:

Performed by computer based on the following equations:

Symbol Identification:

A_d = duct area, square feet
C_p = pitot tube correction factor, unitless
D = duct diameter (circular ducts), inches
k = number of traverse points on D or W
L = duct dimension having ports (rectangular), inches
MW = molecular weight (wet)
n = traverse point number on a diameter
Δp = velocity head, $"H_2O$
P_L = number of ports on dimension L
P_d & P_{std} = duct (barometric + static) and standard pressure, "Hg
Q_d = volume flow rate, actual CFM
Q_{std} = volume flow rate, standard condition (wet or dry), SCFM
T_d & T_{std} = duct and standard temperature, °R
t.p. = traverse point (distance from sample port wall), inches
v_d = velocity at duct conditions, fps
W = second duct dimension (rectangular), inches

VELOCITY TRAVERSE AND VOLUME FLOW RATE (cont)

Equations:

Location of Traverse Points:

Circular Duct:

$$\text{t.p. (1st half)} = D/2 - (D/2k) * \sqrt{k(k+1-2n)}$$

$$\text{t.p. (2nd half)} = D/2 + (D/2k) * \sqrt{k(2n-1)}$$

Where $n = 1$ to $k/2$

Rectangular Duct:

$$\text{t.p.} = W/2k + (n-1) * W/k$$

Where $k = (W/L) * (P_L)$

$n = 1$ to k

Velocity & Volume Flow Rate:

$$vd = 85.49 * Cp * \sqrt{\frac{Td * \Delta p}{Pd * MW}}$$

$$Qd = 60 * vd\ (avg) * Ad = \text{ACFM}$$

$$Qstd(wet) = Qd * \frac{Tstd}{Td(avg)} * \frac{Pd}{Pstd} = \text{SCFM}$$

$$Qstd(dry) = Qstd(wet) * (1 - \%H2O/100) = \text{SDCFM}$$

VELOCITY TRAVERSE & VOLUME FLOW RATE (cont')

DATA:

CLIENT: Lonestar UNIT: Clinker Cooler

DATE: 8/4/83 TIME: 1105 - 1214 RUN #: 1

Description: Ports: two 3-inch female ports, properly located, approximately 6 diameters after and 2 diameters before disturbances in flow.

Duct Diameter 102 inches Area 56.75 ft^2

Rectangular duct _____ X _____

% H_2O 1.4 MW 28.69 Mag. Box # 371

Duct Static Pressure 1.10 inches H_2O Temp. Unit # 5562

Standard Conditions 60 °F & 29.92 "Hg Pitot Tube # 5352

Pitot Tube Coefficient 0.78

Trav. Pt.	Ins. From Edge	Northwest Port Temp °F	ΔP In.	V_d ft/sec	Southwest Port Temp °F	ΔP In.	V_d ft/sec	Temp °F	ΔP In.	V_d ft/sec	Temp °F	ΔP In.	V_d ft/sec
1	2.2	380	0.44	43.8	380	0.46	44.8						
2	6.8	390	0.53	48.3	385	0.50	46.8						
3	12.0	390	0.60	51.4	390	0.54	48.8						
4	18.1	395	0.58	50.7	390	0.54	48.8						
5	25.5	395	0.58	50.7	390	0.52	47.9						
6	36.3	395	0.57	50.3	390	0.52	47.9						
7	65.7	395	0.52	48.0	390	0.50	46.9						
8	76.5	395	0.52	48.0	390	0.56	49.7						
9	83.9	385	0.55	49.1	290	0.50	44.1						
10	90.0	385	0.55	49.1	290	0.50	44.1						
11	95.2	390	0.54	48.8	390	0.56	49.7						
12	99.8	390	0.54	48.8	385	0.48	45.8						
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RESULTS:

Average Velocity (V_d) 48.0 FPS Average duct temp. 381 °F, press. 29.90 "Hg

Volume Flow Rate at 381 °F & 29.90 "Hg (Q_d) 163421 ACFM

Volume Flow Rate at standard conditions ($Q_{std(wet)}$) 100978 SCFM

Volume Flow Rate at standard conditions ($Q_{std(dry)}$) 99542 SDCFM

VELOCITY TRAVERSE & VOLUME FLOW RATE (cont')

DATA:

CLIENT: Lonestar UNIT: Clinker Cooler

DATE: 8/4/83 TIME: 1403 - 1520 RUN #: 2

Description: Ports: two 3-inch female ports, properly located, approximately 6 diameters after and 2 diameters before disturbances in flow.

Duct Diameter 102 inches Area 56.75 ft^2

Rectangular duct _____ X _____

% H_2O 1.3 MW 28.70

Duct Static Pressure 1.10 inches H_2O

Standard Conditions 60 °F & 29.92 "Hg

Pitot Tube Coefficient 0.78

Mag. Box # 371

Temp. Unit # 5562

Pitot Tube # 5352

Trav. Pt.	Ins. From Edge	Southwest Port Temp °F	Southwest Port ΔP In.	Southwest Port V_d ft/sec	Northwest Port Temp °F	Northwest Port ΔP In.	Northwest Port V_d ft/sec	Temp °F	ΔP In.	V_d ft/sec	Temp °F	ΔP In.	V_d ft/sec
1	2.2	360	0.40	41.2	365	0.50	46.2						
2	6.8	360	0.42	42.2	365	0.50	46.2						
3	12.0	360	0.46	44.2	365	0.54	48.0						
4	18.1	360	0.46	44.2	365	0.54	48.0						
5	25.5	360	0.50	46.1	365	0.53	47.6						
6	36.3	360	0.46	44.2	365	0.53	47.6						
7	56.7	370	0.40	41.5	360	0.50	46.1						
8	76.5	270	0.42	39.9	350	0.50	45.8						
9	83.9	270	0.42	39.9	350	0.50	45.8						
10	90.0	375	0.46	44.6	355	0.48	45.0						
11	95.2	375	0.45	44.1	355	0.46	44.1						
12	99.8	375	0.44	43.6	355	0.42	42.1						
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RESULTS:

Average Velocity (V_d) 44.5 FPS Average duct temp. 355 °F, press. 29.90 "Hg

Volume Flow Rate at 355 °F & 29.90 "Hg (Q_d) 151550 ACFM

Volume Flow Rate at standard conditions (Qstd(wet)) 96685 SCFM

Volume Flow Rate at standard conditions (Qstd(dry)) 95434 SDCFM

VELOCITY TRAVERSE & VOLUME FLOW RATE (cont')

DATA:

CLIENT: Lonestar UNIT: Clinker Cooler

DATE: 8/4/83 TIME: 1648-1800 RUN #: 3

Description: Ports: two 3-inch female ports, properly located, approximately 2 diameters after and 6 diameters before disturbances in flow.

Duct Diameter 102 inches Area 56.75 ft^2

Rectangular duct _____ X _____

% H_2O 1.6 MW 28.67

Mag. Box # 371

Duct Static Pressure 1.10 inches H_2O

Temp. Unit # 5562

Standard Conditions 60 °F & 29.92 "Hg

Pitot Tube # 5352

Pitot Tube Coefficient 0.78

Trav. Pt.	Ins. From Edge	Northwest Port Temp °F	Northwest Port ΔP In.	Northwest Port V_d ft/sec	Southwest Port Temp °F	Southwest Port ΔP In.	Southwest Port V_d ft/sec	Temp °F	ΔP In.	V_d ft/sec	Temp °F	ΔP In.	V_d ft/sec
1	2.2	370	0.42	42.5	370	0.43	43.0						
2	6.8	370	0.53	47.8	370	0.43	43.0						
3	12.0	370	0.53	47.8	370	0.40	41.5						
4	18.1	360	0.56	48.8	370	0.40	41.5						
5	25.5	370	0.54	48.2	375	0.40	41.6						
6	36.3	360	0.46	44.2	375	0.40	41.6						
7	65.7	360	0.46	44.2	380	0.37	40.1						
8	76.5	360	0.50	46.1	380	0.42	42.8						
9	83.9	360	0.50	46.1	380	0.42	42.8						
10	90.0	360	0.46	44.2	380	0.40	41.7						
11	95.2	345	0.46	43.8	365	0.42	42.4						
12	99.8	340	0.42	41.7	365	0.42	42.4						
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RESULTS:

Average Velocity (V_d) 43.8 FPS Average duct temp. 367 °F, press. 29.90 "Hg

Volume Flow Rate at 367 °F & 29.90 "Hg (Q_d) 148961 ACFM

Volume Flow Rate at standard conditions ($Q_{std(wet)}$) 93620 SCFM

Volume Flow Rate at standard conditions ($Q_{std(dry)}$) 92128 SDCFM

VELOCITY TRAVERSE & VOLUME FLOW RATE (cont')

DATA:

CLIENT: Lonestar UNIT: Coal Stack

DATE: 8/4/83 TIME: 1107 - 1220 RUN #: 1

Description: Ports: two 3-inch female ports, properly located, approximately 8 diameters after and 8 diameters before disturbances in flow.

Duct Diameter 36.0 inches Area 7.07 ft^2

Rectangular duct _____ X _____

% H_2O 4.1 MW 28.45 Mag. Box # 375

Duct Static Pressure -27.0 inches H_2O Temp. Unit # 549

Standard Conditions 60 °F & 29.92 "Hg Pitot Tube # 5294

Pitot Tube Coefficient 0.78

Trav. Pt.	Ins. From Edge	South Port Temp °F	South Port ΔP In.	South Port V_d ft/sec	West Port Temp °F	West Port ΔP In.	West Port V_d ft/sec								
								Temp °F	ΔP In.	V_d ft/sec	Temp °F	ΔP In.	V_d ft/sec		
1	1.6	120	0.86	52.9	140	0.60	45.0								
2	5.3	128	1.20	65.5	128	1.15	61.6								
3	10.7	128	1.20	65.5	128	1.40	68.0								
4	25.3	128	1.20	65.5	128	1.50	70.4								
5	30.7	128	1.20	65.5	128	1.40	68.0								
6	34.4	128	1.15	61.6	128	1.20	62.9								
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RESULTS:

Average Velocity (V_d) 62.7 FPS Average duct temp. 128 °F, press. 27.84 "Hg

Volume Flow Rate at 128 °F & 27.84 "Hg (Q_d) 26589 ACFM

Volume Flow Rate at standard conditions ($Q_{std(wet)}$) 21864 SCFM

Volume Flow Rate at standard conditions ($Q_{std(dry)}$) 20969 SDCFM

VELOCITY TRAVERSE & VOLUME FLOW RATE (cont')

DATA:

CLIENT: Lonestar UNIT: Coal Stack

DATE: 8/4/83 TIME: 1410 - 1519 RUN #: 2

Description: Ports: two 3-inch female ports, properly located, approximately 8 diameters after and 8 diameters before disturbances in flow.

Duct Diameter 36.0 inches Area 7.07 ft^2

Rectangular duct _____ X _____

% H_2O 3.8 MW 28.49 Mag. Box # 375

Duct Static Pressure -27.0 inches H_2O Temp. Unit # 549

Standard Conditions 60 °F & 29.92 "Hg Pitot Tube # 5294

Pitot Tube Coefficient 0.78

Trav. Pt.	Ins. From Edge	West Port Temp °F	West Port ΔP In.	West Port V_d ft/sec	South Port Temp °F	South Port ΔP In.	South Port V_d ft/sec	Temp °F	ΔP In.	V_d ft/sec	Temp °F	ΔP In.	V_d ft/sec
1	1.6	120	0.56	42.7	120	0.60	44.2						
2	5.3	128	1.20	62.9	128	1.25	64.2						
3	10.7	128	1.40	67.9	128	1.50	70.3						
4	25.3	128	1.50	70.3	128	1.50	70.3						
5	30.7	128	1.50	70.3	128	1.45	69.1						
6	34.4	128	1.25	64.2	128	1.20	62.9						
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RESULTS:

Average Velocity (V_d) 633 FPS Average duct temp. 127 °F, press. 27.84 "Hg

Volume Flow Rate at 127 °F & 27.84 "Hg (Q_d) 26839 ACFM

Volume Flow Rate at standard conditions ($Q_{std(wet)}$) 22132 SCFM

Volume Flow Rate at standard conditions ($Q_{std(dry)}$) 21289 SDCFM

VELOCITY TRAVERSE & VOLUME FLOW RATE (cont')

DATA:

CLIENT: Lonestar UNIT: Coal Stack

DATE: 8/4/83 TIME: 1654 - 1805 RUN #: 3

Description:

Duct Diameter 3.0 inches Area 7.07 ft^2

Rectangular duct _____ X _____

% H_2O 4.1 MW 28.44

Duct Static Pressure -27.0 inches H_2O

Standard Conditions 60 °F & 29.92 "Hg

Pitot Tube Coefficient 0.78

Mag. Box # 375

Temp. Unit # 549

Pitot Tube # 5294

Trav. Pt.	Ins. From Edge	South Port Temp °F	South Port ΔP In.	South Port V_d ft/sec	West Port Temp °F	West Port ΔP In.	West Port V_d ft/sec	Temp °F	ΔP In.	V_d ft/sec	Temp °F	ΔP In.	V_d ft/sec
1	1.6	120	0.40	36.1	125	0.85	52.8						
2	5.3	128	1.30	65.5	128	1.25	64.2						
3	10.7	128	1.45	69.2	128	1.45	69.2						
4	25.3	128	1.45	69.2	128	1.55	71.5						
5	30.7	128	1.40	68.0	128	1.50	70.4						
6	34.4	125	1.30	65.3	128	1.25	64.2						
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RESULTS:

Average Velocity (V_d) 63.8 FPS Average duct temp. 127 °F, press. 27.84 "Hg

Volume Flow Rate at 127 °F & 27.84 "Hg (Q_d) 27064 ACFM

Volume Flow Rate at standard conditions ($Q_{std(wet)}$) 22311 SCFM

Volume Flow Rate at standard conditions ($Q_{std(dry)}$) 21399 SDCFM

PARTICULATE EMISSIONS

PARTICULATE EMISSIONS

REF: EPA, Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 5, 1981
: South Coast AQMD, Source Testing Manual, Los Angeles, CA, April, 1981
: State of California, Air Resources Board, Draft Stationary Source Test Methods, Method 1-5, June, 1979

SAMPLING PROCEDURE:

The apparatus consisted of a nozzle, heater wrapped probe and heated filter holder (see data sheets for type of nozzle, probe and filter holder). A series of impinger-absorbers (see data sheet for type and contents) were connected in tandem and immersed in an ice bath. The absorption train was followed by a gas drying tube containing indicating silica gel, a diaphragm pump, dry test meter and a calibrated restriction orifice fitted with a magnehelic differential pressure gauge.

The computer was used in selection of suitable sampling points, nozzle size, and orifice constant. The apparatus was leak tested, the probe heaters were brought to temperature and the nozzle was positioned at the first sampling point. The pump was immediatley started and adjusted to obtain the isokinetic sampling rate.

Duct conditions were monitored throughout the sampling period with a type "S" pitot tube and a thermocouple simultaneously positioned at the traverse point. Conditions at the sampling apparatus and metering device were constantly monitored and regularly recorded on the data sheet. Isokinetic sampling rate in terms of orifice differential pressure was calculated by computer for each set of duct and sampling apparatus conditions. Data was relayed between the computer and site by radio.

On completion of sampling from all usable traverse points, the apparatus was removed, leak-checked, sealed from possible contamination and transported to the laboratory. Replicate samples were taken as indicated by the data sheets.

Concurrent with each particulate sampling, an integrated gas sample was withdrawn from the summation of the traverse points through the train and collected at the outlet of the meter into a sample bag.

ANALYTICAL PROCEDURE:

The weight or volume increase of the impingers was measured and recorded for calculation of percent water.

The contents of the sample bladder were analyzed by Orsat for fixed gas and molecular weight determination.

PARTICULATE EMISSIONS

Analytical Procedure (cont)

The filter section was recovered, placed in a 105°C drying oven and desiccated to constant weight. The weight increase was determined from the tare weight and recorded on the individual data sheet.

Sample was recovered from the nozzle and probe sections with distilled water and/or acetone and a rubber policeman or nylon bristle brush. A tared dish was used for subsequent evaporation, desiccation and weight determination.

If analysis of the condensable fraction of the particulate ("impinger catch" or "back half") was required, an aliquot of the impinger liquid was poured into a tared dish. The liquid was evaporated to dryness and the residue was desiccated to a constant weight.

Aliquots of blank impinger and/or probe wash reagents were evaporated to dryness in tared dishes. The residue was desiccated and weighed for subtraction of the blank residue from the total probe wash or condensables residue.

An estimate of sampling accuracy was performed by calculation of percent isokinetic rate over the entire sampling period.

CALCULATIONS:

Performed by computer based on the following equations:

Symbol Identification:

Subscripts d, m and n denote duct, dry gas meter and nozzle respectively
Subscripts std, bar and avg denote standard, barometric and average

A = area, square feet
C_o = particulate concentration, grains/SDCF
C_p = pitot tube correction, unitless
E.R. = emission rate of particulate, lb/hr
ΔH = orifice differential pressure, inches H_2O
I = percent of isokinetic sampling
k_m = orifice constant, unitless
M = mass of particulate collected, milligrams
MW = wet molecular weight of duct gas, g/mole
P = absolute pressure, inches Hg
Δp = velocity pressure head, inches H_2O
Q = volume flow rate, CFM
Q_o = parameter of volume flow rate through the orifice
T = absolute temperature, °R
t = time of sampling period, minutes
V = gas volume, CF
v = velocity, feet/second
W = water collected, grams
% H_2O = duct gas water content, percent volume

PARTICULATE EMISSIONS

Calculations (cont)

Equations:

Duct gas velocity at any traverse point (see Velocity & Volume Flow Rate):

$$v_d = 85.49 * C_p * \sqrt{\frac{T_d * \Delta P}{P_d * MW}}$$

Isokinetic sampling rate at any traverse point:

$$Q_m = Q_n * \frac{P_d * T_m}{P_m * T_d} * (1 - \% H_2O/100)$$

where $Q_n = 60 * v_n * A_n$ and for isokinetic sampling, $v_n = v_d$

$$\Delta H = Q_o^2 * \frac{P_b}{k_m^2 * T_m} * \frac{[MW - (0.18 * \% H_2O)]}{(1 - \% H_2O/100)}$$

where $Q_o = 1.23 * Q_m - 0.23 * Q_m^{(2 - Q_m)}$ (for non-linear orifice)

Percent of isokinetic sampling:

$$I = T_d * \frac{[0.00267 * W + V_m/T_m(avg) * (P_{bar} + \Delta H(avg)/13.6)]}{t * v_d(avg) * P_d * A_n * 60} * 100$$

Sampled Volume:

$$V_m(std) = V_m * \frac{T_{std}}{T_m(avg)} * \frac{(P_{bar} + \Delta H(avg)/13.6)}{P_{std}}$$

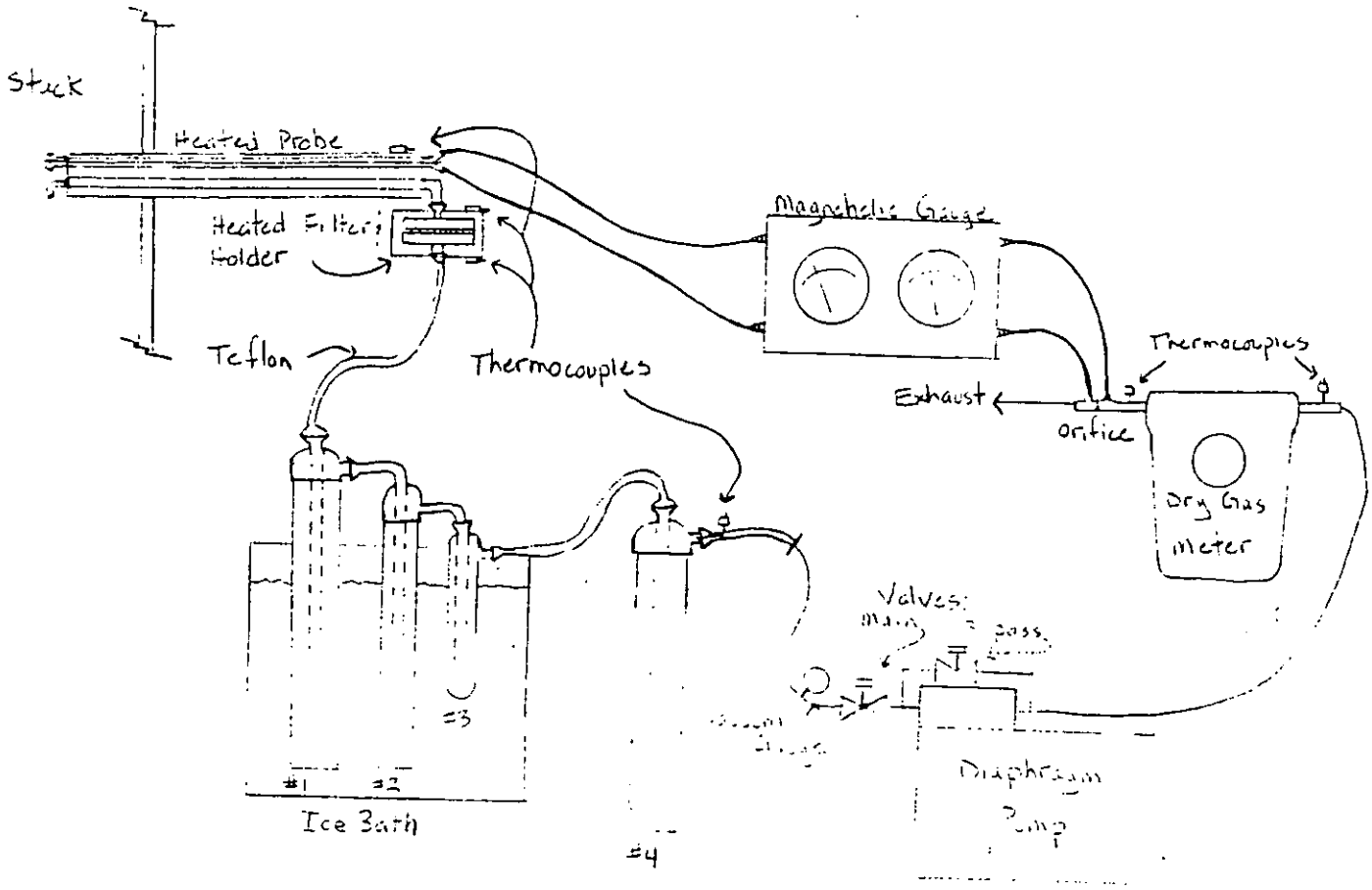
Particulate Concentration:

$$C_o = \frac{0.0154 * M}{V_m(std)}$$

Emission Rate:

$$E.R. = 8.58 * 10^{-3} * Q_{std}(dry) * C_o$$

Method 5 Particulate Sampling Train



Impinger #	Contents
#1	100 mls Distilled Water
#2	100 mls Distilled Water
#3	Empty
#4	250 grms Silica Gel (8 mesh)

PARTICULATE EMISSIONS
TEST MONITOR DATA

Date 8/4/83 Run 1
Client Lonestar
Unit Clinker Cooler
Ambient Temp. 75 °F
Press.bar 29.82 in. Hg
Press.static 1.10 in. H_2O
Press.duct 29.90 in. Hg
Assumed MW 28.80 %H_2O 1.0

Sample Train Temp.:
Probe 400,420,400 °F 400
Filter 275,280,225 °F 230
Sample Line ____ °F
Post-Test Leak Check:
Leak Rate 0.005 CFM
@ 5 in. Hg Vac.

Nozzle & Probe Mat. SS
Filter Holder Mat. SS
Filter # 5
Nozzle # 7G i.d. 7.0 mm
Pitot # 5352 Cp 0.78
Temp. Unit # 5562
Mag. # 371 Meter # 632
Orifice k_m 0.4

		Duct Data			Meter Data			
Trav. Point	Time	Temp. °F	Head Δp	Velocity ft/sec	Vacuum "Hg	Temp. °F	Orifice ΔH, "H_2O	Volume CF
Northwest Port								
12	1105	390	0.54	48.8		80	3.82	754.10
11	1107.5	390	0.54	48.8		80	3.82	
10	1110	385	0.55	49.1		70	3.85	
9	1112.5	385	0.55	49.1		70	3.85	
8	1115	395	0.52	48.0	0	75	3.65	
7	1117.5	395	0.52	48.0		75	3.65	
6	1120	395	0.57	50.3		75	3.97	
5	1122.5	395	0.58	50.7		75	4.03	
4	1125	395	0.58	50.7	0	75	4.03	
3	1127.5	390	0.60	51.4		75	4.18	
2	1130	390	0.53	48.3		75	3.73	
1	1132.5	380	0.44	43.8		75	3.19	
	1135	Stop to change ports						776.26
Southwest Port								
12	1154	385	0.48	45.8		75	3.43	
11	1156.5	390	0.56	49.7		75	3.92	
10	1159	290	0.50	44.1		75	3.97	
9	1201.5	290	0.50	44.1	0	75	3.97	
8	1204	390	0.56	49.7		80	3.95	
7	1206.5	390	0.50	46.9		85	3.59	
6	1209	390	0.52	47.9	2	85	3.72	
5	1211.5	390	0.52	47.9		85	3.72	
4	1204	390	0.54	48.8		85	3.85	
3	1206.5	390	0.54	48.8		85	3.85	
2	1209	385	0.50	46.8		80	3.59	
1	1211.5	380	0.46	44.8		80	3.35	
	1214	End of test						798.90
Total 60 Minutes					Max. 2		TOTAL	44.80
Average		381		48.0	Average	78	3.78	

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS

DATA & RESULTS:

Site: Clinker Cooler Run: 1

Date: 8/4/83 Time: 1105 - 1214

Absorber Type	Contents	Final	Tare	Net H20
Lg. Grunbrg	Distilled H_2O	523.1	517.8	5.3
Sm. Grunbrg	Distilled H_2O	353.1	352.8	0.3
liquid trap	empty	98.0	97.5	0.5
	silica gel	601.8	594.3	7.5
			TOTAL	13.6

Filter Sample: Type EPA Flat Filter

Sample Fraction	Final Wt.	Tare Wt.	Net mgram	Co,grains/SDCF
Probe & Nozzle Wash	65.9606	65.9570	3.6	0.0013
Condensables 350 mls	83.1926	83.1898	2.8	0.0010
Filter #5	4509	4205	30.4	0.0107
H_2O (8.7 mls)	blank @	8.7 mls =		<0.0001
Acetone (54.1 mls)	blank @	54.1 mls =		<0.0001
		TOTAL	36.8	0.0130

Gas Composition:

CO2 0 % volume (dry)
O2 21 % volume (dry)
CO ____ % volume (dry)
N2 79 % volume (dry)
H2O 1.4 % volume

MW (wet) 28.69
Excess Air ____ %
Sampled Volume 43.58 SDCF
Isokinetic Rate 100.0 %

Particulate Concentration:

Co 0.0130 grains/SDCF @ 60 °F and 29.92 "Hg
C ____ grains/SDCF @ ____

Emission Rate:

E.R. 11.16 lbs/hr @ Qstd(dry) 99500 SDCFM

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS
TEST MONITOR DATA

Date 8/4/83 Run 2
Client Lonestar
Unit Clinker Cooler
Ambient Temp. 75 °F
Press.bar 29.82 in. Hg
Press.static 1.10 in. H_2O
Press.duct 29.90 in. Hg
Assumed MW 28.69 %H_2O 1.4

Sample Train Temp.:
Probe 410, 420, 420, °F 410
Filter 275, 260, 260, °F 265
Sample Line ____ °F
Post-Test Leak Check:
Leak Rate 0.004 CFM
@ 6 in. Hg Vac.

Nozzle & Probe Mat. SS
Filter Holder Mat. SS
Filter # 11
Nozzle # 7G 1.d. 7.0 mm
Pitot # 5352 Cp 0.78
Temp. Unit # 5562
Mag. # 371 Meter # 632
Orifice km 0.5

		Duct Data			Meter Data			
Trav. Point	Time	Temp. °F	Head Δp	Velocity ft/sec	Vacuum "Hg	Temp. °F	Orifice ΔH, "H_2O	Volume CF
Southwest Port								
12	1403	375	0.44	43.6		75	3.19	779.20
11	1405.5	375	0.45	44.1	0	75	3.25	
10	1408	375	0.46	44.6		80	3.34	
9	1410.5	270	0.42	39.9		80	3.48	
8	1403	270	0.42	39.9		80	3.48	
7	1415.5	370	0.40	41.5		80	2.97	
6	1418	360	0.46	44.2	0	80	3.40	
5	1420.5	360	0.50	46.1		85	3.69	
4	1423	360	0.46	44.2		85	3.40	
3	1425.5	360	0.46	44.2		85	3.42	
2	1428	360	0.42	42.2		85	3.16	
1	1430.5	360	0.40	41.2		85	3.02	
	1433	Stop to change ports						820.10
Northwest Port								820.30
12	1450	355	0.42	42.1		75	3.13	
11	1452.5	355	0.46	44.1	0	75	3.39	
10	1455	355	0.48	45.0		75	3.52	
9	1457.5	350	0.50	45.8		75	3.67	
8	1500	350	0.50	45.8		75	3.67	
7	1502.5	360	0.50	46.1		80	3.66	
6	1505	365	0.53	47.6	0	80	3.84	
5	1507.5	365	0.53	47.6		80	3.84	
4	1510	365	0.54	48.0		80	3.90	
3	1512.5	365	0.54	48.0		80	3.90	
2	1515	365	0.50	46.2		80	3.64	
1	1517.5	365	0.50	46.2		80	3.64	
	1520	End of test						842.00
Total 60 Minutes					Max. 0		TOTAL	42.60
Average 355				44.5	Average	80	3.48	

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS

DATA & RESULTS:

Site: Clinker Cooler Run: 2

Date: 8/4/83 Time: 1403 - 1520

Absorber Type	Contents	Final	Tare	Net H2O
Lg. Grnbrg	Distilled H O	555.2	549.7	5.5
Sm. Grnbrg	Distilled H O	387.6	387.0	0.6
liquid trap	empty	100.2	99.9	0.3
	silica gel	590.8	584.7	5.3
			TOTAL	11.7

Filter Sample: Type EPA Flat Filter

Sample Fraction	Final Wt.	Tare Wt.	Net mgram	Co,grains/SDCF
Probe & Nozzle wash	67.3439	67.3425	1.4	0.0001
Condensables 300 mls	84.5057	84.4946	11.1	0.0041
Filter #11	0.5368	0.5152	21.6	0.0081
H O (145 mls)	blank	@ 14.5 mls	=	0.0001
Acetone (43.7 mls)	bland	@ 43.7 mls	=	<0.0001
		TOTAL	34.1	<0.0127

Gas Composition:

CO2 0 % volume (dry)
O2 21 % volume (dry)
CO _____ % volume (dry)
N2 79 % volume (dry)
H2O 1.3 % volume

MW (wet) 28.70
Excess Air _____ %
Sampled Volume 41.27 SDCF
Isokinetic Rate 98.7 %

Particulate Concentration:

Co 0.0127 grains/SDCF @ 60 °F and 29.92 "Hg
C _____ grains/SDCF @ _____

Emission Rate:

E.R. 10.40 lbs/hr @ Qstd(dry) 95400 SDCFM

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS
TEST MONITOR DATA

Date 8/4/83 Run 3
Client Lonestar
Unit Clinker Cooler
Ambient Temp. °F
Press.bar 29.82 in. Hg
Press.static 1.10 in. H2O
Press.duct 29.90 in. Hg
Assumed MW 28.70 %H2O 1.3

Sample Train Temp.:
Probe 250,260,260,°F250
Filter260,270,260,°F50
Sample Line °F
Post-Test Leak Check:
Leak Rate 0.000 CFM
@ 7 in. Hg Vac.

Nozzle & Probe Mat. SS
Filter Holder Mat. SS
Filter # 7
Nozzle # 7G i.d. 7.0 mm
Pitot # 5352 Cp 0.78
Temp. Unit # 5562
Mag. # 371 Meter # 632
Orifice km 0.5

		Duct Data			Meter Data			
Trav. Point	Time	Temp. °F	Head Δp	Velocity ft/sec	Vacuum "Hg	Temp. °F	Orifice ΔH, "H2O	Volume CF
Northwest Port								842.30
12	1648	340	0.42	41.7		70	3.16	
11	1650.5	345	0.46	43.8		70	3.41	
10	1653	360	0.46	44.2		75	3.38	
9	1655.5	360	0.50	46.1	0	75	3.64	
8	1658	360	0.50	46.1		75	3.64	
7	1700.5	360	0.46	44.2		75	3.38	
6	1703	360	0.46	44.2		75	3.38	
5	1705.5	370	0.54	48.2		75	3.86	
4	1708	360	0.56	48.8		75	4.03	
3	1710.5	370	0.53	47.8	0	75	3.80	
2	1713	370	0.53	47.8		75	3.80	
1	1715.5	370	0.42	42.5		75	3.08	
	1718	Stop to change ports						863.80
Southwest Port								
12	1730	365	0.42	42.4		75	3.10	864.10
11	1732.5	365	0.42	42.4		75	3.10	
10	1735	380	0.40	41.7		75	2.92	
9	1737.5	380	0.42	42.8	0	75	3.05	
8	1740	380	0.42	42.8		75	3.05	
7	1742,5	380	0.37	40.1		75	2.73	
6	1745	375	0.40	41.6		75	2.94	
5	1747.5	375	0.40	41.6		75	2.94	
4	1750	370	0.40	41.5		75	2.95	
3	1752.5	370	0.40	41.5	1	75	2.95	
2	1755	370	0.43	43.0		75	3.15	
1	1757.5	370	0.43	43.0		75	3.15	
	1800	End of test						883.90
Total 60 Minutes					Max.1		TOTAL	40.9
Average		367		43.8	Average	75	3.28	

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS

DATA & RESULTS:

Site: Clinker Cooler Run: 3

Date: 8/4/83 Time: 1648 - 1800

Absorber Type	Contents	Final	Tare	Net H2O
Lg. Grnbrg	Distilled H_2O	527.2	522.2	5.0
Sm. Ginbrg	Distilled H_2O	395.5	396.2	0.7
liquid trap	empty	102.1	99.7	2.4
	silica gel	655.9	648.6	7.3
			TOTAL	14.0

Filter Sample: Type EPA Flat Filter

Sample Fraction	Final Wt.	Tare Wt.	Net mgram	Co,grains/SDCF
Probe & Nozzle wash	68.6317	68.6249	6.8	0.0026
Condensables (325 mls)	84.6739	84.6696	4.3	0.0017
Filter #7	0.4505	0.4186	31.9	0.0123
Acetone (102.7 mls)	blank	@ 102.7 mls =		<0.0001
H_2O (65.3 mls)	blank	@ 65.3 mls =		<0.0001
		TOTAL	43.0	0.0166

Gas Composition:

CO2 0 % volume (dry)
O2 21.0 % volume (dry)
CO % volume (dry)
N2 79 % volume (dry)
H2O 1.6 % volume

MW (wet) 28.67
Excess Air %
Sampled Volume 39.97 SDCF
Isokinetic Rate 99.1 %

Particulate Concentration:

Co 0.0166 grains/SDCF @ 60 °F and 29.92 "Hg

C grains/SDCF @

Emission Rate:

E.R. 13.12 lbs/hr @ Qstd(dry) 92100 SDCFM

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS

DATA & RESULTS:

Site: Clinker Cooler Run: 3

Date: 8/4/83 Time: 1648 - 1800

Absorber Type	Contents	Final	Tare	Net H2O
Lg. Grnbrg	Distilled H_2O	527.2	522.2	5.0
Sm. Ginbrg	Distilled H_2O	395.5	396.2	0.7
liquid trap	empty	102.1	99.7	2.4
	silica gel	655.9	648.6	7.3
			TOTAL	14.0

Filter Sample: Type EPA Flat Filter

Sample Fraction	Final Wt.	Tare Wt.	Net mgram	Co,grains/SDCF
Probe & Nozzle wash	68.6317	68.6249	6.8	0.0026
Condensables (325 mls)	84.6739	84.6696	4.3	0.0017
Filter #7	0.4505	0.4186	31.9	0.0123
Acetone (102.7 mls)	blank @ 102.7 mls	=		<0.0001
H_2O (65.3 mls)	blank @ 65.3 mls	=		<0.0001
		TOTAL	43.0	0.0166

Gas Composition:

CO2 0 % volume (dry)
O2 21.0 % volume (dry)
CO % volume (dry)
N2 79 % volume (dry)
H2O 1.6 % volume

MW (wet) 28.67
Excess Air %
Sampled Volume 39.97 SDCF
Isokinetic Rate 99.1 %

Particulate Concentration:

Co 0.0166 grains/SDCF @ 60 °F and 29.92 "Hg
C grains/SDCF @

Emission Rate:

E.R. 13.12 lbs/hr @ Qstd(dry) 92100 SDCFM

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS
TEST MONITOR DATA

Date 8/4/83 Run 1
Client Lonestar
Unit Coal Stack
Ambient Temp. 75 °F
Press.bar 29.82 in. Hg
Press.static -27.0 in. H2O
Press.duct 27.84 in. Hg
Assumed MW 29.62 %H2O 10.0

Sample Train Temp.:
Probe 235,235,275 °F 250
Filter 250,250,260 °F 255
Sample Line °F
Post-Test Leak Check:
Leak Rate 0.00 CFM
@ 6 in. Hg Vac.

Nozzle & Probe Mat. SS
Filter Holder Mat. SS
Filter # 6
Nozzle # 5G 1.d. 5.0 mm
Pitot # 5294 Cp .78
Temp. Unit # 549
Mag. # 375 Meter # 631
Orifice km 0.4

		Duct Data			Meter Data			
Trav. Point	Time	Temp. °F	Head Δp	Velocity ft/sec	Vacuum "Hg	Temp. °F	Orifice ΔH, "H2O	Volume CF
South	Port							
6	1107	128	1.15	61.6		65	3.98	703.20
5	1112	128	1.30	65.5	2	70	4.46	
4	1117	128	1.30	65.5		75	4.49	
3	1122	128	1.30	65.5		80	4.52	
2	1127	128	1.30	65.5	2	80	4.52	
1	1132	120	0.86	52.9		80	3.19	
		Stop to change ports						720.95
West	Port							
6	1150	128	1.20	62.9	2	80	4.22	
5	1155	128	1.40	68.0		80	4.83	
4	1200	128	1.50	70.4		80	5.13	
3	1205	128	1.40	68.0	2	85	4.86	
2	1210	128	1.15	61.6		85	4.09	
1	1215	140	0.60	45.0		90	2.29	
	1220	End of test						738.97
Total	60 Minutes				Max.		TOTAL	35.27
Average		128		62.7	Average	79	4.21	

PARTICULATE EMISSIONS

DATA & RESULTS:

Site: Coal Stack

Date: 8/4/83

Run: 1

Time: 1107 - 1220

Absorber Type	Contents	Final	Tare	Net H2O
Lg. Ginbrg	Distilled H_2O	611.4	549.3	62.1
Sm. Ginbrg	Distilled H_2O	364.8	402.1	-37.3
liquid trap	empty	99.8	99.3	0.5
	silica gel	666.6	660.3	6.3
			TOTAL	31.6

Filter Sample: Type EPA Flat Filter

Sample Fraction	Final Wt.	Tare Wt.	Net mgram	Co,grains/SDCF
Probe & Nozzle wash	68.3080	68.3009	7.1	0.0032
Condensables 400 mls	68.5165	68.5120	4.5	0.0020
Filter #6	0.4182	0.4180	0.2	0.0001
H_2O (12.1 mls)	blank @ 12.1 mls =			<0.0001
Acetone (55.3 mls)	blank @ 55.3 mls -			<0.0001
		TOTAL		

Gas Composition:

CO2 0.5 % volume (dry)

O2 20.5 % volume (dry)

CO ____ % volume (dry)

N2 79.0 % volume (dry)

H2O 4.1 % volume

MW (wet) 28.74

Excess Air ____ %

Sampled Volume 34.26 SDCF

Isokinetic Rate 91.5 %

Particulate Concentration:

Co ____ grains/SDCF @ 60 °F and 29.92 "Hg

C ____ grains/SDCF @ ____

Emission Rate:

E.R. 0.95 lbs/hr @ Qstd(dry) 21000 SDCFM

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS
TEST MONITOR DATA

Date 8/4/83 Run 2
Client Lonestar
Unit Coal Stack
Ambient Temp. 75 °F
Press.bar 29.82 in. Hg
Press.static -27.0 in. H2O
Press.duct 27.84 in. Hg
Assumed MW 28.45 %H2O 4.1

Sample Train Temp.:
Probe 245, 245, 250 °F
Filter 240, 245, 255 °F
Sample Line ___ °F
Post-Test Leak Check:
Leak Rate 0.008 CFM
@ 7 in. Hg Vac.

		Duct Data			Meter	
Trav. Point	Time	Temp. °F	Head Δp	Velocity ft/sec	Vacuum "Hg	Temp. °F
West Port						
6	1410	128	1.25	64.2		70
5	1415	128	1.50	70.3	6	75
4	1420	128	1.50	70.3		80
3	1425	128	1.40	67.9		85
2	1430	128	1.20	62.9	5	85
1	1435	120	0.56	42.7		90
	1440					
South Port						
6	1449	128	1.20	62.9	4	75
5	1454	128	1.45	69.1		85
4	1459	128	1.50	70.3		90
3	1504	128	1.50	70.3	6	90
2	1509	128	1.25	64.2		90
1	1514	120	0.60	44.2		90
	1519	End of test				
Total	60 Minutes				Max. 6	
Average	127		63.3		Average	84

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS

DATA & RESULTS:

Site: Coal Stack Run: 2

Date: 8/4/83 Time: 1410 - 1519

Absorber Type	Contents	Final	Tare	Net H2O
Lg. Genbrg	Distilled H_2O	679.3	578.6	100.7
Sm. Genbrg	Distilled H_2O	296.9	375.0	- 78.1
liquid trap	empty	100.5	98.6	1.9
	silica gel	654.8	648.0	6.8
			TOTAL	31.3

Filter Sample: Type EPA Flat Filter

Sample Fraction	Final Wt.	Tare Wt.	Net mgram	Co,grains/SDCF
Probe & Nozzle wash	63.5920	63.5880	4.0	0.0017
Condensables 350 mls	90.1761	90.1731	3.0	0.0013
Filter #10	0.4212	0.4207	0.5	0.0002
H_2O (11.6 mls)	blank @	11.6 mls	=	<0.0001
Acetone (52.5 mls)	blank @	52.5 mls	=	<0.0001
		TOTAL	7.5	0.0032

Gas Composition:

CO2 0.5 % volume (dry)
O2 20.5 % volume (dry)
CO % volume (dry)
N2 79.0 % volume (dry)
H2O 3.8 % volume

MW (wet) 28.49
Excess Air %
Sampled Volume 36.57 SDCF
Isokinetic Rate 95.8 %

Particulate Concentration:

Co 0.0032 grains/SDCF @ 60 °F and 29.92 "Hg
C grains/SDCF @

Emission Rate:

E.R. 0.58 lbs/hr @ Qstd(dry) 21300 SDCFM

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS
TEST MONITOR DATA

Date 8/4/83 Run 3
Client Lonestar
Unit Coal Stack
Ambient Temp. °F
Press.bar 29.82 in. Hg
Press.static -27.0 in. H2O
Press.duct 27.84 in. Hg
Assumed MW 28.49 %H2O 3.8

Sample Train Temp.:
Probe 260,260,270 °F 260
Filter 235,245,260 °F 260
Sample Line °F
Post-Test Leak Check:
Leak Rate 0.008 CFM
@ 4 in. Hg Vac.

Nozzle & Probe Mat. SS
Filter Holder Mat. SS
Filter # 9
Nozzle # 5G i.d. 5.0 mm
Pitot # 5294 Cp 0.78
Temp. Unit # 549
Mag. # 375 Meter # 631
Orifice km 0.5

		Duct Data			Meter Data			
Trav. Point	Time	Temp. °F	Head Δp	Velocity ft/sec	Vacuum "Hg	Temp. °F	Orifice ΔH, "H2O	Volume CF
South	Port							
6	1654	125	1.30	65.3		70	3.12	779.06
5	1659	128	1.40	68.0	3	75	3.34	
4	1704	128	1.45	69.2		75	3.44	
3	1709	128	1.45	69.2	4	80	3.47	
2	1714	128	1.30	65.5		85	3.17	
1	1719	120	0.40	36.1		90	1.15	
	1724	Stop to change ports						798.90
West	Port							
6	1735	128	1.25	64.2	4	80	3.04	
5	1740	128	1.50	70.4		85	3.60	
4	1745	128	1.55	71.5		90	3.74	
3	1750	128	1.45	69.2		90	3.52	
2	1755	128	1.25	64.2	4	95	3.11	
1	1800	125	0.85	52.8		95	2.22	
	1805	End of test						820.10
Total	60 Minutes				Max. 4		TOTAL	41.04
Average	127			63.8	Average	84	3.08	

CHEMECOLOGY CORPORATION

PARTICULATE EMISSIONS

DATA & RESULTS:

Site: Coal Stack Run: 3

Date: 8/4/83 Time: 1654 - 1805

Absorber Type	Contents	Final	Tare	Net H2O
Lg. Grnbrg	Distilled H_2O	573.0	549.4	23.6
Sm. Ginbrg	Distilled H_2O	425.8	422.2	3.6
liquid trap	empty	100.0	99.8	0.2
	silica gel	695.2	686.3	8.9
			TOTAL	36.3

Filter Sample: Type EPA Flat Filter

Sample Fraction	Final Wt.	Tare Wt.	Net mgram	Co,grains/SDCF
Probe & Nozzle wash	83.5999	83.5994	0.5	0.0002
Condensables 325 mls	86.8324	68.8316	0.8	0.0003
Filter #9	0.4220	0.4213	0.7	0.0003
H_2O (19.3 mls)	blank	@ 19.3 mls	=	<0.0001
Acetone (54.5 mls)	blank	@ 54.5 mls	=	<0.0001
		TOTAL	2.0	0.0008

Gas Composition:

CO2 0.4 % volume (dry)
O2 20.6 % volume (dry)
CO ____ % volume (dry)
N2 79 % volume (dry)
H2O 4.1 % volume

MW (wet) 28.44
Excess Air ____ %
Sampled Volume 39.38 SDCF
Isokinetic Rate 102.6 %

Particulate Concentration:

Co 0.0008 grains/SDCF @ 60 °F and 29.92 "Hg
C ____ grains/SDCF @ ____

Emission Rate:

E.R. 0.15 lbs/hr @ Qstd(dry) 21400 SDCFM