AP-42 Section Number: 9.9.1

Reference Number: 20

Title: Dust Control Systems Performance Test

Pollution Curbs, Inc.

July 1976

AP-42 Section Reference 9.9.1
Report Sect. Reference 20

Equipment Division

PCI Contract No. 508357

July 15, 1976

DUST CONTROL

SYSTEMS

PERFORMANCE TEST

Prepared For:

FARMERS UNION ELEVATOR ASSOCIATION
SARLES, NORTH DAKOTA

Prepared By:

POLLUTION CURBS, INC.
502 NORTH PRIOR AVENUE
ST. PAUL, MINNESOTA 55104

Frank J. Belgea
Vice President of Operations

PCI Contract No. 508357

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1. SUMMARY

The average dust emission rate from each of the three dust control systems was as follows:

House System	-	0.71 lb/hr
Crippen System	-	0.37 lb/hr
Ideal System	-	0.25 lb/hr

The emissions from all three stacks were found to comply with the Air Pollution Control Regulations of the State of North Dakota.

2. INTRODUCTION

Jacobson and Sons Construction Company (Jacobson) had purchased from the Equipment Division of Pollution Curbs, Inc. (PCI) eight dust control systems to be installed in three grain elevators under construction at Niobe, Sarles, and Kramer, North Dakota. Plans and specifications for the eight dust control systems were submitted to the North Dakota State Health Department for review and approval. Construction permits for the three projects were subsequently issued.

By letter from Mr. Willis Van Heuvelen, dated February 5, 1976, PCI was apprised of North Dakota State Health Department policy requiring all suppliers of dust control equipment to the North Dakota market to provide performance test data on the supplier's initial installation. Because construction at the Sarles site was completed before Niobe or Kramer, and because the ductwork configuration at Sarles presented an opportunity to collect more representative data than did either Niobe or Kramer, Sarles was selected by PCI as the most appropriate installation at which to conduct the required performance tests.

On July 8 and 9, 1976 a field test crew representing PCI's Consulting Division occupied the Sarles site to collect samples and other pertinent data relative to evaluating the performance of the three dust control systems known as the House System, the Crippen System, and the Ideal System.

The following persons participated in the test:

Name	Affiliation
Howard Thompson	Farmers Union Elevator Association
Bud Hinkle	Jacobson & Sons Construction Company
Gerry Wentz	Jacobson & Sons Construction Company

Name	Affiliation
Frank Belgea	Pollution Curbs, Inc.
Mark Oemichen	PCI - Field Services Section
Dean Franke	PCI - Air Engineering Section
Robert King	North Dakota State Health Department
Kevin Kiemele	North Dakota State Health Department

3. PROCEDURES

3.1 Emissions Measurements

The quantity of particulate matter passing each of the cyclone dust collectors was determined by sampling the respective exhaust stacks and extrapolating the data. Three representative isokinetic samples were obtained from the vertical ductwork serving as the clean air exhaust for the House Dust Control System and three such samples were obtained from a similar location in the Crippen Cleaner Dust Control System. Two samples were obtained from the Ideal Cleaner cyclone exhaust. A planned third sample run on the Ideal System was aborted due to a malfunction in the sampling equipment.

All of the above samples were collected by extracting exhaust gas from preselected points located on horizontal planes in the exhaust stacks. The dust was captured on tared fiberglass filters and the sample gas volume was metered. The velocity of exhaust gas was measured simultaneously with the sample extraction to ensure isokinetic conditions and to provide flow rates for subsequent extrapolation of the sampling data. For all sample runs, the sample site selections and traverse techniques, the gas velocity and volumetric flow rates, and the sample collection and recovery procedures all followed EPA Reference Methods 1, 2 and 5 and North Dakota Performance Test Guidelines. The equipment employed in sampling and data gathering met or exceeded EPA specifications. Copies of all field data sheets and all calculations were reproduced for inclusion in the Appendix of this report.

The opacity of the exhaust stream from each stack was determined employing the procedures in EPA Reference Method 9. Readings were made by Mr. Frank Belgea,

a certified smoke reader. A copy of Mr. Belgea's certification was reproduced for inclusion in the Appendix.

3.2 Process Weight Rate

During the sampling periods for each dust control system, the pertinent elevator grain handling equipment or cleaners were operated at or near their maximum capacity.

Grain was either dumped by truck or continuously spouted into the front pit throughout testing of the house system. The process weight rate for the house system was calculated from the rated leg capacity, 5000 bushels per hour, which was operated at its maximum speed. Huge clouds of dust were observed in the pits, however, none excaped through the grate or hatches but was instead captured by the dust control system. Some dust was noticed puffing out between the floor and the scale deck. However, this occurred because the stripping to cover the opening had not yet been installed pending calibration of the scale by State inspectors.

The process weight rate for each of the cleaners was determined by timing the throughput of a measured volume of grain with the cleaner operating at maximum conditions.

The cleaner fan dampers were appropriately set by Mr. Howard Thompson for the grain to be handled during testing. No dust could be found escaping the cleaners or the bell hood bleed-ins although billows of dust in the back pits showed the grain to be dirty.

As the elevator was new and not yet operating normally, a limited amount of

grain was available for test purposes. Therefore, it was necessary to transfer grain from place to place within the facility to provide a constant flow at maximum operating conditions during testing of each dust control system. This was accomplished without interruption.

4. RESULTS

4.1 House Dust Control System

Item	Run #1	Run #2	Run #3	Averace
Volumetric Flow Rate (sdcfm)	7440	7620	7480	7510
Temperature (°F)	85	85	85	85
Moisture Content (vol. %)	1.8	1.8	1.7	1.8
Dust Concentration (gr/sdcf)	0.015	0.012	0.007	0.011
Process Weight Rate (bu/hr)	5000	5000	5000	5000
Process Weight Rate (ton/hr)[1]	150	150	150	150
Dust Emission Rate (lb/hr)	0.96	0.78	0.45	0.71
Allowable Emission Rate (lb/hr)[2]	55	55	55	55
Stack Opacity (%)	<5	<5	<5	<5

4.2 Crippen Cleaner Dust Control System

Volumetric Flow Rate (sdcfm)	4350	4360	4270	4330
Temperature (°F)	80	80	80	80
Moisture Content (vol. %)	1.5	1.7	1.8	1.7
Dust Concentration (gr/sdcf)	0.012	0.008	0.010	0.010
Process Weight Rate (bu/hr)	430	430	430	430
Process Weight Rate (ton/hr)[1]	13	13	13	13
Dust Emission Rate (lb/hr)	0.45	0.30	0.37	0.37
Allowable Emission Rate (lb/hr)[2]	23	23	23	23
Stack Opacity (%)	<5	<5	<5	<5

4.3 Ideal Cleaner Dust Control System

Item	Run #1	Run #2	Average
Volumetric Flow Rate (sdcfm)	2440	2400	2420
Temperature (°F)	80	80	80
Moisture Content (vol. %)	1.6	1.7	1.6
Dust Concentration (gr/sdcf)	0.012	0.012	0.012
Process Weight Rate (bu/hour)	900	900	900
Process Weight Rate (ton/hr)[1]	27	27	27
Dust Emission Rate (lb/hr)	0.25	0.25	0.25
Allowable Emission Rate (lb/hr)[2]	37	37	37
Stack Opacity (%)	<5	<5	<5

4.4 Discussion

The reliability of the above tabulated results is evidenced by the close agreement among successive flow rate measurements for the respective systems, by the compatibility between low dust concentrations and respective low stack opacities, and by the degree of isokinesis achieved for each sample run. The progressive lessening of dust concentrations over successive runs for the House System is probably due to the test grain becoming cleaner as sampling proceeded.

Notes: 1. Calculated @ 60 lb/bu

2. From Table 3, Regulation 23-25-05

5. CONCLUSIONS

The results tabulated in Sections 4.1, 4.2, and 4.3 indicate that all three dust control systems perform up to the specifications of the North Dakota State Health Department as presented in Regulation 23-25. Particulate emissions were well below the maximum allowed by Table 3, Rule 23-25-05 and visible emisisons were less than the 20% opacity limitation of Rule 23-25-03 for new sources.

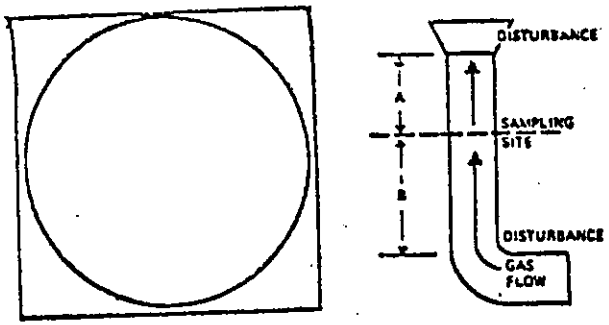
Based on the excellent performance of the three dust control systems tested, as observed by previously named State officials and as reported herein, it is the Consulting Division's opinion that final approval and operating permits be granted to the Farmers Union Elevator Association of Sarles, North Dakota and to other in the state having similar design and operating characteristics.

A P P E N D I X

1. acfm = Actual cubic feet per minute
2. BOD =
3. COD = Chemical oxygen demand
4. Btu = British thermal units
5. cfm = Cubic feet per minute
6. cps = Cycles per second
7. Δ = Delta, signifies a change
8. dB = Decibel
9. dBA = Decibel as measured on the A scale of a sound level meter
10. DO = Dissolved oxygen
11. E = Symbol for sum of
12. gpd = Gallons per day
13. gpm = Gallons per minute
14. g = Grams
15. gpcd = Gallons per capita day
16. $<$ = Less than
17. $>$ = Greater than
18. hp = Horsepower
19. Hz = Hertz
20. KHz = Kilo Hertz
21. l = Liter
22. lb = Pound
23. lpm = Liters per minute
24. mg = Milligram
25. mg/l = Milligrams per liter
26. mg/m^3 = Milligrams per cubic meter
27. ml = Milliliter
28. M^2 = Square meter
29. M^3 = Cubic meter
30. μ = Micron
31. μm = Micrometer
32. μg = Microgram
33. MPN = Most probable number
34. mgd = Million gallons per day
35. ou = Odor unit
36. ou/min = Odor unit per minute
37. ppm = Parts per million
38. SDI = Sludge density index
39. SS = Suspended solids
40. scf = Standard cubic feet
41. scfh = Standard cubic feet per hour
42. scfm = Standard cubic feet per minute
43. sdcfm = Standard dry cubic feet per minute
44. TWA = Time weighted average
45. rpm = Revolutions per minute
46. TOC = Total organic carbon
47. Vol % = Volume percent
48. Wt % = Weight percent
49. TS = Total solids
50. VS = Volatile solids

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

N. POINT

PLANT Sarles, N. D. | AMBIENT TEMPERATURE 80°F | METER ΔH@ _____

DATE 8 July 1976 | BAROMETRIC PRESSURE 28.96 | C FACTOR 0.84

LOCATION Elev. Henhouse | ASSUMED MOISTURE, % 20.2 | PROCESS WEIGHT RATE _____

OPERATOR E.J.B., D.F.E., M.W.O. | PROBE LENGTH, in. 36

STACK NO. House System | NOZZLE DIAMETER, in. 0.25

RUN NO. One (1) | STACK DIAMETER, in. 13 1/4"

SAMPLE BOX NO. 2343-3 | PROBE HEATER SETTING None

METER BOX NO. 2343-3 | HEATER BOX SETTING None

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.7178	63.6385
TARE WEIGHT	0.6870	63.5977
WEIGHT GAIN	0.0308	0.0408
TOTAL		0.0716

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
	1450							332.772						
1		+0.6	85	1.1	1.049	5.0	5.0	339	81	79	85	85	1 to 2	
2	1453			1.1	"	5.0	5.0	336	83	80				
3				1.1	"	5.0	5.0	337	85	80				
4	1456			1.1	"	5.0	5.0	338	88	80				
5				1.2	1.096	5.5	5.5	340	91	80				
6	1459			1.2	"	5.5	5.5	342	93	80				
7				1.2	"	5.5	5.5	344	94	80				
8	1502			1.2	"	5.5	5.5	346	97	81				
9				1.2	"	5.5	5.5	348	99	82				
10	1505			1.2	"	5.5	5.5	350	101	82				
11				1.5	1.225	6.6	6.6	351	105	83				
12	1508			1.5	"	6.6	6.6	353	106	83				
13				1.5	"	6.6	6.6	355	107	84				
14	1511			1.5	"	6.6	6.6	357	108	85				
15		V	V	1.5	"	6.6	6.6	359	110	86	V	V	V	
TOTAL														
AVERAGE														

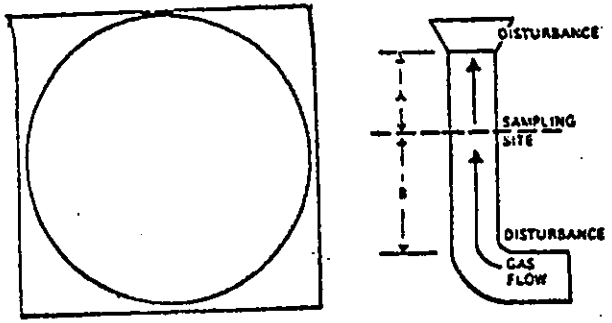
VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					28.5

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION N. PORT

PLANT Sorles, N. C.
DATE 8 July 1976
LOCATION Elev. Henhouse
OPERATOR E.J.B, D.F.K, M.W.O.
STACK NO. House System
RUN NO. One (1)
SAMPLE BOX NO. 2343-3
METER BOX NO. 2343-3

AMBIENT TEMPERATURE 80 F
BAROMETRIC PRESSURE 28.46
ASSUMED MOISTURE, % 2.0
PROBE LENGTH, in. 36
NOZZLE DIAMETER, in. 0.495
STACK DIAMETER, in. 19"
PROBE HEATER SETTING None
HEATER BOX SETTING None

METER $\Delta H_@$ _____ _____
C FACTOR 0.84
PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.7178	63.6385
TARE WEIGHT	0.6870	63.5977
WEIGHT GAIN	0.0308	0.0408
TOTAL		0.0716

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in., H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm_{IN}), °F	OUTLET (Tm_{OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
16	1514	+0.6	85	1.5	1.225	6.6	6.6	360	111	87	85	85	1 to 2	
17				1.5	"	6.6	6.6	362	113	88				
18	1517			1.5	"	6.6	6.6	364	114	88				
19				1.5	"	6.6	6.6	366	115	88				
20	1520	↓	↓	1.5	"	6.6	6.6	368	116	88	↓	↓	↓	
TOTAL	30													
AVERAGE			85											

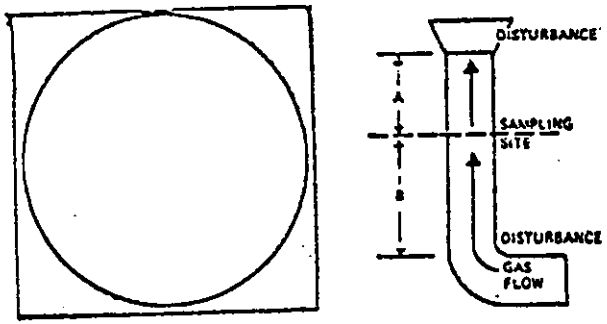
VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

E. PORT

PLANT Sorles, N. D. AMBIENT TEMPERATURE 80°F

DATE 8 July 1976 BAROMETRIC PRESSURE 28.76

LOCATION Elev. Henhouse ASSUMED MOISTURE, % 2.03

OPERATOR E.J.B., D.F.K., M.W.O. PROBE LENGTH, in. 36

STACK NO. House System NOZZLE DIAMETER, in. 0.25

RUN NO. One (1) STACK DIAMETER, in. 19"

SAMPLE BOX NO. 2343-3 PROBE HEATER SETTING None

METER BOX NO. 2343-3 HEATER BOX SETTING None

METER ΔH@ _____

C FACTOR 0.84

PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WAS
FINAL WEIGHT	0.7178	63.638
TARE WEIGHT	0.6870	63.597
WEIGHT GAIN	0.0308	0.0408

TOTAL 0.0716

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft^3	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm_{IN}), °F	OUTLET (Tm_{OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
	1525													
1		+0.6	85	1.5	1.225	6.6		370	110	90	85	85	1 to 2	
2	1528			1.5	"	6.6		372	111	90				
3				1.5	"	6.6		374	112	91				
4	1531			1.5	"	6.6		377	113	91				
5				1.5	"	6.6		379	113	92				
6	1534			1.5	"	6.6		381	114	92				
7				1.5	"	6.6		383	115	93				
8	1537			1.6	1.265	7.1		385	117	94				
9				1.6	"	7.1		387	118	94				
10	1540			1.6	"	7.1		389	118	94				
11				1.6	"	7.1		391	119	94				
12	1543			1.6	"	7.1		393	120	95				
13				1.6	"	7.1		395	121	96				
14	1546			1.6	"	7.1		397	121	98				
15		V	V	1.6	"	7.1		399	122	98	= V	V	V	
TOTAL														
AVERAGE														

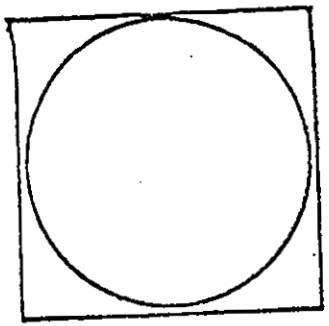
VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					

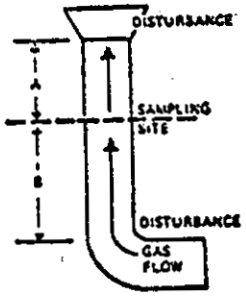
COMMENTS:

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION



E. PORT

PLANT Sarles, N. U.
DATE 8 July 1976
LOCATION Elec. Henhouse
OPERATOR E.T.B., D.F.K., M.D.O.
STACK NO. House System
RUN NO. One (1)
SAMPLE BOX NO. 2343-3
METER BOX NO. 2343-3

AMBIENT TEMPERATURE 80 F
BAROMETRIC PRESSURE 28.96
ASSUMED MOISTURE, % 2 to 3
PROBE LENGTH, in. 36
NOZZLE DIAMETER, in. 0.25
STACK DIAMETER, in. 19"
PROBE HEATER SETTING None
HEATER BOX SETTING None

METER ΔH@ _____
C FACTOR 0.84
PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.7178	23.6385
TARE WEIGHT	0.6870	23.5977
WEIGHT GAIN	0.0308	0.0408

TOTAL 0.0716

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in., H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm_{IN}), °F	OUTLET (Tm_{OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
16	1549	+0.6	85	1.6	1.265	7.1		402	122	98	85	85	1 to 2	
17				1.6	"	7.1		409	123	99				
18	1552			1.5	1.225	6.6		406	124	99				
19				1.5	"	6.6		408	125	99				
20	1555 =	↓	↓	1.5	"	6.6		411.200	125	99	↓	↓	↓	
	END							END =						
								411.200						
TOTAL	60				17.962				4381	3562				
AVERAGE	1.5	+0.6	85		1.198				109.53	89.05	85	85	1.5	

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					75.2

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

HS-1

PARTICULATE EMISSION CALCULATION

Plant: SARLES, NORTH. DAKOTA

Location: ELEVATOR HEADHOUSE

Stack or Source: HOUSE SYSTEM

Date: 8 JULY 1976

Run No.: ONE (1)

Operator: F.J.B., O.F.F., M.W.O.

Bar. Pr., In. Hg: 28.76 ABSOLUTE

Nozzle Dia, In.: 0.25 (1/4)"

Stack Dia., In.: 19" ϕ

Cp: 0.82

Total Time, Min.: 60 (1 HOUR)

Orsat Analysis: (Dry Basis, % by Vol.), Average

CO_2	ZERO
O_2	20.9
CO	ZERO
N_2	79.1

Water Collected, GMS.: 28.5

Filter No.: A

Particulate Collected, GMS.:

Filter 0.0308

Probe Wash 0.0408

Vol. Through Gas Meter, Cu. Ft.: FRONT END TOTAL 0.0716

Impinger Catch

FRONT PLUS BACK END CATCH TOTAL

Standard Conditions: Dry Gas at 15.6°C and 29.92 in. Hg.

C - 1 Calculate Average Meter Temperature

T_m = The average of both inlet and outlet temperatures obtained during sampling, 559.3 °R.

C - 2 Calculate Sample Volume at Standard Conditions

V_{mstd} = SCF (Dry) Through meter

$$= 17.32 \frac{V_m \times P_m}{T_m}$$

$$= 17.32 \frac{93.29 \times 28.96}{559.3}$$

$$= 73.71 \text{ SCF (Dry)}$$

Where: V_m = Dry gas measured by meter, cu.ft.

P_m = Abs. Pr. at meter (use barometric pressure, uncorrected for altitude), In. H_g

C - 3 Calculate Volume Fraction Water in Flue Gas

V_{wstd} = Water vapor in SCF

$= 0.0465 V_{lc}$

$= 0.0465 \cdot 28.5$

$= 1.33$ SCF

B_{wo} = Water $\frac{V}{V}$

$$= \frac{V_{wstd}}{(V_{wstd} + V_{mstd})}$$

$$= \frac{1.33}{1.33 + 73.71} = \frac{1.33}{(75.04)} = 0.0178$$

Where V_{lc} = Weight of water collected in impingers plus that gained by drierite, GMS

HS-1

C - 4 Calculate Dry and Wet Molecular Weight of Stack Gas

M_d = Dry Mol. Wt.

= 0.44 (% CO_2) + 0.32 (% O_2)

+0.28 (% N_2 + CO)

= 0.44 x ZERO + 0.32 x 20.9 = 6.69 + 0.28 x 79.1 = 22.15

= 28.84

M_s = Wet Mol. Wt.

= M_d (1- B_{wo}) + 18 B_{wo}

= 28.84 x 0.9822 + 18 x 0.0178

= 28.65 0.320

C - 5 Calculate The Average $\sqrt{\Delta P}$, $(\sqrt{\Delta P})$ Avg., Obtained during gas sample acquisition

$(\sqrt{\Delta P})$ Avg. = 1.198

C - 6 Calculate The Average Stack Gas Temperature, T_s, at time of Gas Sample Acquisition

T_s = 545 °R

C - 7 Calculate The Average Stack Gas Velocity

(V_s)Avg. = 85.48 x C_p x $(\sqrt{\Delta P})$ Avg. $\sqrt{\frac{T_s}{P_s \times M_s}}$

= 85.48 x 0.84 x 1.198 $\sqrt{\frac{545}{28.50 \times 28.65}} = 0.82$

= 70.54 ft./sec

Where:

C_p = Pitot Tube Coefficient

P_s = Absolute Stack Gas Press., In. Hg.

17
HS-1

C - 8 Calculate Stack Cross Sectional Area at Sampling Site

A_s = 1.97 Sq. Ft.

C - 9 Calculate Stack Gas Average Volumetric Flow Rate

Q_s = Stack Gas Flow Rate, SCFM (Dry)

$$= 1043 \times (1-B_{wo}) \, (V_s)\text{Avg.} \times A_s \times \frac{P_s}{T_s}$$

$$= \frac{1043 \times 0.9822 \times 70.54 \times 1.97 \times 28.50}{545}$$

= 7,770 SCFM (Dry)

C - 10 Calculate Isokinetic Sampling Efficiency

$$I = \frac{0.00321 \, (V_{wstd} + V_{mstd}) \times T_s \times P_m}{\theta \times A_n \times (V_s)\text{Avg.} \times P_s}$$

$$= 0.00321 \times \frac{74.74 \times 545 \times 28.46}{60 \times 0.00034 \times 70.54 \times 28.50}$$

= 90.5 %

θ = Total Sampling Time, Min.

A_n = Nozzle Opening, Sq. Ft.

C - 11 Calculate Heat Input during testing period

Z = Total Heat Input Rate to Boiler, MEGA BTU/hr.

= $W_1 \times H_1$ =

+ $W_2 \times H_2$

+ $W_3 \times H_3$

= TOTAL

= _____ x _____

_____ x _____

_____ x _____

TOTAL _____ MEGA BTU/hr.

Where W_1, W_2, & W_3 = hourly fuel input of respective fuels and H_1, H_2, & H_3 = gross (as received) heating value of respective fuels in mega BTU per input unit (consistent with fuel input unit).

C - 12 Calculate Front End Particulate Grain Loading (with Front Half Washings Only)

C_s' = Part. Grain Loading, gr/SCF (Dry)

$$= 15.42 \times \frac{M_n}{V_{mstd}}$$

$$= 15.42 \times \frac{0.0716}{23.41}$$

= 0.015 gr/SCF (Dry)

Where

M_n = Total Particulate Collected (Filter Plus Front Half Washings Only), GMS

C - 13 Calculate Front End Emission Factor

E_t = Hourly Mass Rate, lbs/hr.

$= 0.00857 \times C_s' \, Q_s$

$= 0.00857 \times 0.015 \times 7,440$

= 0.96 lbs/hr.

E_h = Front End Emission Factor, lbs/MEGA BTU

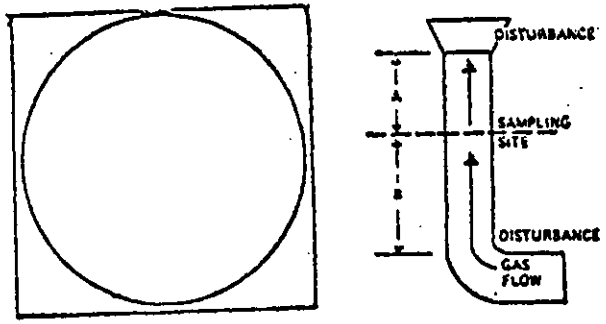
$$= \frac{E_t}{Z}$$

$$= \frac{\qquad}{\qquad}$$

= _____ lbs/MEGA BTU

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Sarles, W. Va. AMBIENT TEMPERATURE 80 F METER ΔH@ _____

DATE 8 July 1976 BAROMETRIC PRESSURE 28.46 C FACTOR 0.84

LOCATION Elec. Henhouse ASSUMED MOISTURE, % 2 to 3 PROCESS WEIGHT RATE _____

OPERATOR E.J.B., D.F.K., M.A.O. PROBE LENGTH, in. 36

STACK NO. House System NOZZLE DIAMETER, in. 0.425

RUN NO. Two (2) STACK DIAMETER, in. 19"

SAMPLE BOX NO. 2343-3 PROBE HEATER SETTING None

METER BOX NO. 2343-3 HEATER BOX SETTING None

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6799	42.2075
TARE WEIGHT	0.6538	41.1753
WEIGHT GAIN	0.0261	0.0322
TOTAL		0.0583

N. PORT

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min. (1613)	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³ (411.700)	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm_{IN}), °F	OUTLET (Tm_{OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
1	1616	+0.6	85	1.5	1.225	6.6	6.6	414	106	97	85	85	10 2	
2	1619			1.5	"	6.6	6.6	417	108	98				
3	1622			1.5	"	6.6	6.6	420	111	98				
4	1625			1.5	"	6.6	6.6	424	114	99				
5	1628			1.5	"	6.6	6.6	428	118	100				
6	1631			1.6	1.265	7.1	7.1	432	119	100				
7	1634			1.6	"	7.1	7.1	437	120	99				
8	1637			1.6	"	7.1	7.1	441	123	100				
9	1640			1.6	"	7.1	7.1	450	123	100				
10	1643			1.6	"	7.1	7.1	453	124	100				
11														
12		During this run, 2a static points were sampled instead of 4o,												
13		enabling the use of 3 min./pt. sampling periods												
14														
15		V	V								V	V	V	
TOTAL														
AVERAGE														

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					30

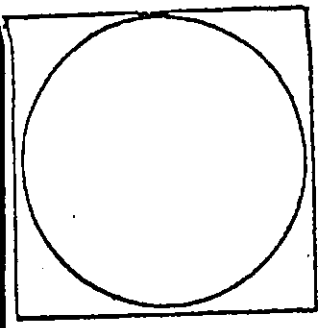
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

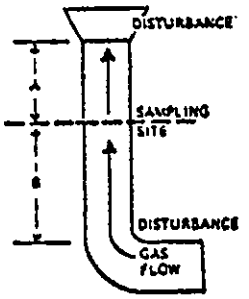
COMMENTS:

2/

PARTICULATE FIELD DATA

SCHEMATIC OF STACK





CROSS SECTION

PLANT Sorrels, N. C. | AMBIENT TEMPERATURE 80.°F | METER ΔH@ _____ _____

DATE 8 July 1976 | BAROMETRIC PRESSURE 28.96 | C FACTOR 0.84

LOCATION Elec. Henhouse | ASSUMED MOISTURE, % 2 to 3 | PROCESS WEIGHT RATE _____

OPERATOR E.J.B., D.F.F., M.W.O. | PROBE LENGTH, in. 36

STACK NO. House System | NOZZLE DIAMETER, in. 0.25

RUN NO. Two (2) | STACK DIAMETER, in. 19.11

SAMPLE BOX NO. 2343-3 | PROBE HEATER SETTING None

METER BOX NO. 2343-3 | HEATER BOX SETTING None

N. POINT

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
16		+0.6	85							85	85	1 to 2	
17													
18		During this run, 20 total points were sampled instead of 40,											
19		owing the use of 3 min./pt. sampling periods.											
20													
TOTAL													
AVERAGE													

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					

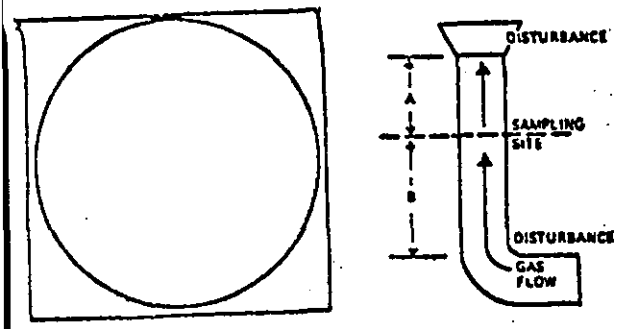
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

22

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION E. PORT

PLANT Sarles, N. U. | AMBIENT TEMPERATURE 80~ | METER $\Delta H_@$ ____

DATE 8 July 1976 | BAROMETRIC PRESSURE 28.46 | C FACTOR 0.84

LOCATION Elev. Henhouse | ASSUMED MOISTURE, % 2.03 | PROCESS WEIGHT RATE ____

OPERATOR E.J.B., D.F.F., M.W.O. | PROBE LENGTH, in. 36

STACK NO. House System | NOZZLE DIAMETER, in. 0.25

RUN NO. Two (2) | STACK DIAMETER, in. ~19"

SAMPLE BOX NO. 2343-3 | PROBE HEATER SETTING None

METER BOX NO. 2343-3 | HEATER BOX SETTING None

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6799	62.2078
TARE WEIGHT	0.6532	61.1753
WEIGHT GAIN	0.0267	0.0322

TOTAL 0.0583

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	VELOCITY HEAD ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O DESIRED	GAS SAMPLE VOLUME (V_m), ft^3	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm_{IN}), °F	GAS SAMPLE TEMPERATURE AT DRY GAS METER OUTLET (Tm_{OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
	1648													
1	1651	+0.6	85	1.5	1.225	6.6	6.6	457	117	101	85	85	10 2	
2	1654			1.5	"	6.6	6.6	461	118	102				
3	1657			1.4	1.183	6.2	6.2	465	120	102				
4	1700			1.4	"	6.2	6.2	469	120	101				
5	1703			1.4	"	6.2	6.2	473	120	102				
6	1706			1.4	"	6.2	6.2	477	120	102				
7	1709			1.4	"	6.2	6.2	481	120	100				
8	1712			1.6	1.265	7.1	7.1	485	120	100				
9	1715			1.6	"	7.1	7.1	489	120	100				
10	1718 =			1.6	"	7.1	7.1	494.210	120	100				
11	End													
12		During this run, 2a Total points were sampled instead of 4a,												
13		enabling the use of 3 min. per sampling periods.												
14								End =						
15		V	V					494.210			= V	V	V	
TOTAL	60				22.660				2361	2000				
AVERAGE	3	+0.6	85		1.231				118.05	100	85	85	1.5	

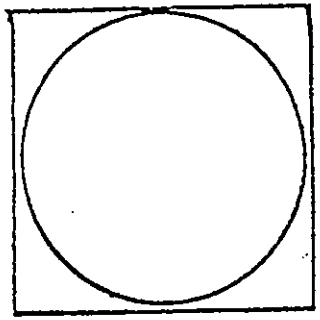
VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					30

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

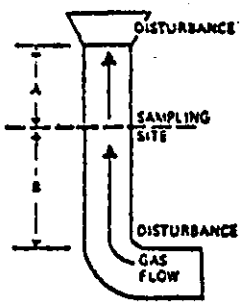
COMMENTS:

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION



E. PORT

PLANT Sarles, N. D. AMBIENT TEMPERATURE 80°F METER ΔH@ _____

DATE 8 July 1976 BAROMETRIC PRESSURE 28.76 C FACTOR 0.84

LOCATION Elec. Henhouse ASSUMED MOISTURE, % 2703 PROCESS WEIGHT RATE _____

OPERATOR E.J.B., D.F.E., M.W.O. PROBE LENGTH, in. 36

STACK NO. House System NOZZLE DIAMETER, in. 0.25

RUN NO. Two (2) STACK DIAMETER, in. 19-11

SAMPLE BOX NO. 2343-3 PROBE HEATER SETTING None

METER BOX NO. 2343-3 HEATER BOX SETTING None

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT		
TARE WEIGHT		
WEIGHT GAIN		
TOTAL		

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in., H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm_{IN}), °F	OUTLET (Tm_{OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
16		+0.6	85								85	85	1 to 2	
17														
18		During this run, 20 total points were sampled instead of 40,												
19														
20														
TOTAL											=			
AVERAGE				☒										

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					

COMMENTS:

24

HS-2

PARTICULATE EMISSION CALCULATION

Plant: Sarles, Nth. Dakota
Location: Elevator Headhouse
Stack or Source: House System
Date: 8 July 1976
Run No.: Two (2)
Operator: E.J.B., O.F.F., M.W.O.
Bar. Pr., In. Hg: 28.96 Absolute
Nozzle Dia, In.: 0.25 (1/4)"
Stack Dia., In.: 19" ϕ
Cp: 0.84
Total Time, Min.: 60 (1 hour)

Orsat Analysis: (Dry Basis, % by Vol.), Average

CO_2	Zero
O_2	20.9
CO	Zero
N_2	79.1

Water Collected, GMS.: 30
Filter No.: B
Particulate Collected, GMS.:
Filter 0.0261
Probe Wash 0.0322

Vol. Through Gas Meter, Cu. Ft.: FRONT END TOTAL 0.0583

Impinger Catch

FRONT PLUS BACK END CATCH TOTAL

Standard Conditions: Dry Gas at 15.6°C and 29.92 in. Hg.

C - 1 Calculate Average Meter Temperature

T_m = The average of both inlet and outlet temperatures obtained during sampling, 569 °R.

C - 2 Calculate Sample Volume at Standard Conditions

V_{mstd} = SCF (Dry) Through meter

$$= 17.32 \frac{V_m \times P_m}{T_m}$$

$$= 17.32 \frac{87.63 \times 28.76}{569}$$

$$= 75.91 \text{ SCF (Dry)}$$

Where: V_m = Dry gas measured by meter, cu.ft.

P_m = Abs. Pr. at meter (use barometric pressure, uncorrected for altitude), In. Hg

C - 3 Calculate Volume Fraction Water in Flue Gas

V_{wstd} = Water vapor in SCF

$= 0.0465 V_{lc}$

$= 0.0465 \cdot 30$

$= 1.40$ SCF

B_{wo} = Water $\frac{V}{V}$

$$= \frac{V_{wstd}}{(V_{wstd} + V_{mstd})}$$

$$= \frac{1.40}{1.40 + 75.91} = \frac{1.40}{(77.31)} = 0.0181$$

Where V_{lc} = Weight of water collected in impingers plus that gained by drierite, GMS

C - 4 Calculate Dry and Wet Molecular Weight of Stack Gas

M_d = Dry Mol. Wt.

= 0.44 (% CO_2) + 0.32 (% O_2)

+0.28 (% N_2 + CO)

= 0.44 x ZERO + 0.32 x 20.9 = 6.69 + 0.28 x 79.1 = 22.15

= 28.84

M_S = Wet Mol. Wt.

= M_d (1- B_{wo}) + 18 B_{wo}

= 28.84 x 0.9819 + 18 x 0.0181

= 28.64 0.326

C - 5 Calculate The Average $\sqrt{\Delta P}$, ($\sqrt{\Delta P}$) Avg., Obtained during gas sample acquisition

($\sqrt{\Delta P}$) Avg. = 1.231

C - 6 Calculate The Average Stack Gas Temperature, T_S, at time of Gas Sample Acquisition

T_S = 545 °R

C - 7 Calculate The Average Stack Gas Velocity

(V_S)Avg. = 85.48 x C_p x ($\sqrt{\Delta P}$) Avg. $\sqrt{\frac{T_S}{P_S \times M_S}}$

= 85.48 x 0.84 x 1.231 $\sqrt{\frac{545}{28.50 \times 28.64}}$ = 0.817

= 72.21 ft./sec

Where:

C_p = Pitot Tube Coefficient

P_S = Absolute Stack Gas Press., In. Hg.

C - 8 Calculate Stack Cross Sectional Area at Sampling Site

A_s = 1.97 Sq. Ft.

C - 9 Calculate Stack Gas Average Volumetric Flow Rate

Q_s = Stack Gas Flow Rate, SCFM (Dry)

$$= 1043 \times (1-B_{wo}) \; (V_s)\text{Avg.} \times A_s \times \frac{P_s}{T_s}$$

$$= \frac{1043 \times 0.9819 \times 72.21 \times 1.97 \times 28.50}{545}$$

= 7,620 SCFM (Dry)

C - 10 Calculate Isokinetic Sampling Efficiency

$$I = \frac{0.003241 \; (V_{wstd} + V_{mstd}) \times T_s \times P_m}{\theta \times A_n \times (V_s)\text{Avg.} \times P_s}$$

$$= \frac{0.003241 \times 77.31 \times 545 \times 28.46}{60 \times 0.000341 \times 72.21 \times 28.50}$$

= 91.4 %

θ = Total Sampling Time, Min.

A_n = Nozzle Opening, Sq. Ft.

C - 11 Calculate Heat Input during testing period

Z = Total Heat Input Rate to Boiler, MEGA BTU/hr.

= $W_1 \times H_1$ =

+ $W_2 \times H_2$

+ $W_3 \times H_3$

= TOTAL

= _____ x _____

_____ x _____

_____ x _____

TOTAL _____ MEGA BTU/hr.

Where W_1, W_2, & W_3 = hourly fuel input of respective fuels and H_1, H_2, & H_3 = gross (as received) heating value of respective fuels in mega BTU per input unit (consistent with fuel input unit).

C - 12 Calculate Front End Particulate Grain Loading (with Front Half Washings Only)

C_s' = Part. Grain Loading, gr/SCF (Dry)

$$= 15.42 \times \frac{M_n}{V_{mstd}}$$

$$= 15.42 \frac{\times\ 0.0583}{75.91}$$

$$= \underline{\quad 0.012 \quad} \text{ gr/SCF (Dry)}$$

Where

M_n = Total Particulate Collected (Filter Plus Front Half Washings Only), GMS

C - 13 Calculate Front End Emission Factor

E_t = Hourly Mass Rate, lbs/hr.

$= 0.00857 \times C_s' \, Q_s$

$= 0.00857 \times \underline{\quad 0.012 \quad} \times \underline{\quad 7,620 \quad}$

$= \underline{\quad 0.78 \quad}$ lbs/hr.

E_h = Front End Emission Factor, lbs/MEGA BTU

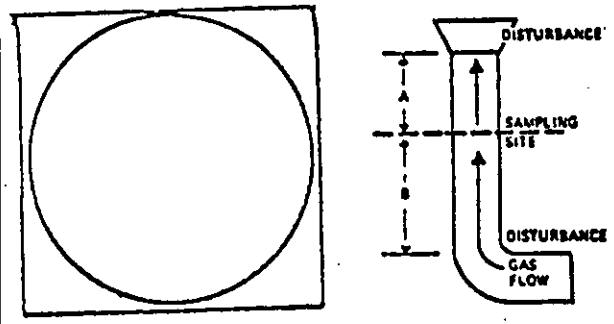
$$= \frac{E_t}{Z}$$

$$= \frac{\qquad}{\qquad}$$

$= \underline{\qquad\qquad}$ lbs/MEGA BTU

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Sarles, W. Va. AMBIENT TEMPERATURE 80°

DATE 8 July 1976 BAROMETRIC PRESSURE 28.96

LOCATION Elev. Henhouse ASSUMED MOISTURE, % 2.03

OPERATOR E.T.B., D.F.E., M.W.O. PROBE LENGTH, in. 36

STACK NO. House System NOZZLE DIAMETER, in. 0.25

RUN NO. Three (3) STACK DIAMETER, in. 19"

SAMPLE BOX NO. 2383-3 PROBE HEATER SETTING None

METER BOX NO. 2383-3 HEATER BOX SETTING None

METER ΔH@ _____

C FACTOR 0.84

PROCESS WEIGHT RATE _____

E. PORT

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6921	62.3019
TARE WEIGHT	0.6723	62.2816
WEIGHT GAIN	0.0198	0.0203
TOTAL		0.0331

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft^3	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
	1723.5													
1	1745	+0.6	85	1.6	1.265	7.1	7.1	495.305	95	95	85	85	10 2	
2				1.6	"	7.1	7.1	497	97	97				
3	1748			1.6	"	7.1	7.1	499	97	97				
4				1.6	"	7.1	7.1	501	97	97				
5	1751			1.6	"	7.1	7.1	503	164	97				
6				1.6	"	7.1	7.1	506	164	97				
7	1754			1.6	"	7.1	7.1	509	164	97				
8				1.7	1.304	7.7	7.7	511	164	97				
9	1757			1.7	"	7.7	7.7	514	164	97				
10				1.7	"	7.7	7.7	516	164	97				
11	1800			1.7	"	7.7	7.7	518	164	97				
12				1.7	"	7.7	7.7	520	164	97				
13	1803			1.7	"	7.7	7.7	521	164	97				
14				1.7	"	7.7	7.7	524	164	97				
15	1806	V	V	1.7	"	7.7	7.1	526	164	97	= V	V	V	
TOTAL														
AVERAGE														

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					28

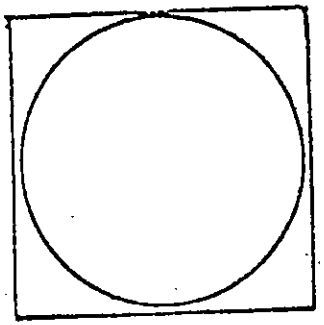
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

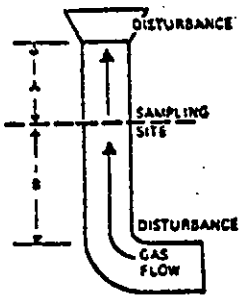
50

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION



PLANT Sarles, N. W. | AMBIENT TEMPERATURE 80.= | METER ΔH@ _____

DATE 8 July 1976 | BAROMETRIC PRESSURE 28.46 | C FACTOR 0.84

LOCATION Elev. Henhouse | ASSUMED MOISTURE, % 2.03 | PROCESS WEIGHT RATE _____

OPERATOR E.J.B., D.F.K., M.W.O. | PROBE LENGTH, in. 36

STACK NO. House System | NOZZLE DIAMETER, in. 0.425

RUN NO. Three (3) | STACK DIAMETER, in. 19"

SAMPLE BOX NO. 2343-3 | PROBE HEATER SETTING None

METER BOX NO. 2343-3 | HEATER BOX SETTING None

E. Port

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6921	60.9019
TARE WEIGHT	0.6793	60.8816
WEIGHT GAIN	0.0128	0.0203

TOTAL 0.0331

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in., H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm_{IN}), °F	OUTLET (Tm_{OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
16		+0.6	85	1.7	1.304	1.7	1.7	5.28	104	97	85	85	1 to 2	
17	1809			1.7	"	1.7	1.7	5.31	109	98				
18				1.7	"	1.7	1.7	5.34	109	98				
19	1812			1.7	"	1.7	1.7	5.36	109	98				
20	1813.5	↓	↓	1.7	"	1.7	1.7	5.37	109	98	↓	↓	↓	
TOTAL														
AVERAGE														

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					28

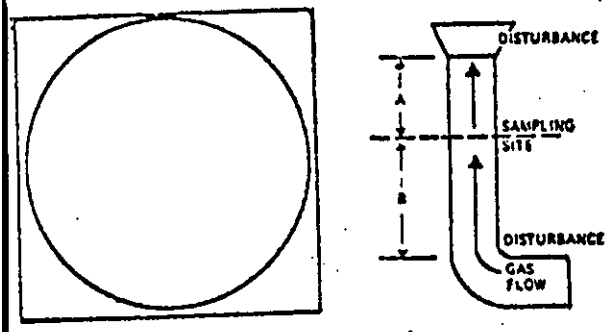
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

3/

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION N. POINT

PLANT Sarles, W. Va.
DATE 8 July 1976
LOCATION Elec. Henhouse
OPERATOR E.T.B., D.F.K., M.W.O.
STACK NO. House System
RUN NO. Three (3)
SAMPLE BOX NO. 2343-3
METER BOX NO. 2343-3

AMBIENT TEMPERATURE 80
BAROMETRIC PRESSURE 28.96
ASSUMED MOISTURE, % 2?
PROBE LENGTH, in. 36
NOZZLE DIAMETER, in. 0.25
STACK DIAMETER, in. ~19"
PROBE HEATER SETTING None
HEATER BOX SETTING None

METER ΔH@ _____
C FACTOR 0.84
PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6921	22.9019
TARE WEIGHT	0.6793	22.8816
WEIGHT GAIN	0.0128	0.0203
TOTAL		0.0331

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in., H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
1	1818	+0.6	85	1.15	1.072	5.2	5.2	538	109	98	85	85	17	02	
2				1.15	"	5.2	5.2	541	109	98					
3	1821			1.15	"	5.2	5.2	542	109	98					
4				1.15	"	5.2	5.2	544	109	98					
5	1824			1.15	"	5.2	5.2	545	109	98					
6				1.15	"	5.2	5.2	548	109	98					
7	1827			1.15	"	5.2	5.2	550	109	98					
8				1.15	"	5.2	5.2	552	109	98					
9	1830			1.15	"	5.2	5.2	554	109	98					
10				1.15	"	5.2	5.2	556	109	98					
11	1833			1.15	"	5.2	5.2	558	109	98					
12				1.15	"	5.2	5.2	561	109	98					
13	1836			1.15	"	5.2	5.2	562	109	98					
14				1.15	"	5.2	5.2	564	109	98					
15	1839	V	V	1.15	"	5.2	5.2	565	109	98	= V	V	V		
TOTAL														
AVERAGE														

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					28

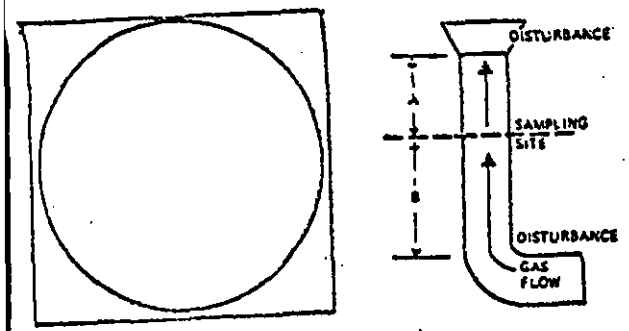
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

G2

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION N. PORT

PLANT Sarles, N. W. Va.
DATE 8 July 1976
LOCATION Elec. Henhouse
OPERATOR E.T.B., D.A.K., M.W.O.
STACK NO. House System
RUN NO. Three (3)
SAMPLE BOX NO. 2343-3
METER BOX NO. 2343-3

AMBIENT TEMPERATURE 80's
BAROMETRIC PRESSURE 28.46
ASSUMED MOISTURE, % 2.0
PROBE LENGTH, in. 36
NOZZLE DIAMETER, in. 0.425
STACK DIAMETER, in. 19.11
PROBE HEATER SETTING None
HEATER BOX SETTING None

METER $\Delta H_@$ ____
C FACTOR 0.84
PROCESS WEIGHT RATE ____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6921	60.3019
TARE WEIGHT	0.6793	60.8816
WEIGHT GAIN	0.0128	0.0203
TOTAL	0.0331	

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
16		+0.6	85	1.25	1.118	5.8	5.8	568	109	98	85	85	1 to 2	
17	1842			1.8	1.342	8.0	8.0	569	109	98				
18				1.7	1.304	7.7	7.7	572	110	99				
19	1845			1.7	1.304	7.7	7.7	574	110	99				
20	18:46.5 =			1.7	1.304	7.7	7.7	578.100 =	110	99				
	END							END						
TOTAL	60				48.062				4253	3905				
AVERAGE	1.5	+0.6	85		1.207				106.33	97.63	85	85	1.5	

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					28

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

HS-3

PARTICULATE EMISSION CALCULATION

Plant: Sarles, North. Dakota

Location: Elevator Headhouse

Stack or Source: House System

Date: 8 July 1976

Run No.: Three (3)

Operator: F.J.B., O.F.F., M.W.O.

Bar. Pr., In. Hg: 28.46 Absolute

Nozzle Dia, In.: 0.25 (1/4)"

Stack Dia., In.: 19" ϕ

Cp: 0.82

Total Time, Min.: 60

Orsat Analysis: (Dry Basis, % by Vol.), Average

CO_2	Zero
O_2	20.9
CO	Zero
N_2	79.1

Water Collected, GMS.: 28.

Filter No.: C

Particulate Collected, GMS.:

Filter 0.0128

Probe Wash 0.0203

Vol. Through Gas Meter, Cu. Ft.: FRONT END TOTAL 0.0331

Impinger Catch ~~~

FRONT PLUS BACK END CATCH TOTAL ~~~

Standard Conditions: Dry Gas at 15.6°C and 29.92 in. Hg.

C - 1 Calculate Average Meter Temperature

T_m = The average of both inlet and outlet temperatures obtained during sampling, 562 °R.

C - 2 Calculate Sample Volume at Standard Conditions

V_{mstd} = SCF (Dry) Through meter

$$= 17.32 \frac{V_m \times P_m}{T_m}$$

$$= 17.32 \frac{87.93 \times 28.76}{562}$$

$$= 77.12 \text{ SCF (Dry)}$$

Where: V_m = Dry gas measured by meter, cu.ft.

P_m = Abs. Pr. at meter (use barometric pressure, uncorrected for altitude), In. Hg

C - 3 Calculate Volume Fraction Water in Flue Gas

V_{wstd} = Water vapor in SCF

$$= 0.0465 V_{lc}$$

$$= 0.0465 \cdot 28$$

$$= 1.30 \text{ SCF}$$

B_{wo} = Water $\frac{V}{V}$

$$= \frac{V_{wstd}}{(V_{wstd} + V_{mstd})}$$

$$= \frac{1.30}{1.30 + 77.12} = \frac{1.30}{(78.42)} = 0.0166$$

Where V_{lc} = Weight of water collected in impingers plus that gained by drierite, GMS

H5-3

C - 4 Calculate Dry and Wet Molecular Weight of Stack Gas

M_d = Dry Mol. Wt.

= 0.44 (% CO_2) + 0.32 (% O_2)

+0.28 (% N_2 + CO)

= 0.44 x ZERO + 0.32 x 20.9 = 6.69 + 0.28 x 79.1 = 22.15

= 28.84

M_s = Wet Mol. Wt.

= M_d (1- B_{wo}) + 18 B_{wo}

= 28.84 x 0.9834 + 18 x 0.0166

= 28.66 0.30

C - 5 Calculate The Average $\sqrt{\Delta P}$, ($\sqrt{\Delta P}$) Avg., Obtained during gas sample acquisition

($\sqrt{\Delta P}$) Avg. = 1.207

C - 6 Calculate The Average Stack Gas Temperature, T_s, at time of Gas Sample Acquisition

T_s = 545 °R

C - 7 Calculate The Average Stack Gas Velocity

(V_s)Avg. = 85.48 x C_p x ($\sqrt{\Delta P}$) Avg. $\sqrt{\frac{T_s}{P_s \times M_s}}$

= 85.48 x 0.84 x 1.207 $\sqrt{\frac{545}{28.50 \times 28.66}} = 0.817$

= 70.81 ft./sec

Where:

C_p = Pitot Tube Coefficient

P_s = Absolute Stack Gas Press., In. Hg.

HS-3
37

C - 8 Calculate Stack Cross Sectional Area at Sampling Site

A_s = 1.97 Sq. Ft.

C - 9 Calculate Stack Gas Average Volumetric Flow Rate

Q_s = Stack Gas Flow Rate, SCFM (Dry)

$$= 1043 \times (1-B_{wo}) \; (V_s)\text{Avg.} \times A_s \times \frac{P_s}{T_s}$$

$$= \frac{1043 \times 0.9832 \times 70.81 \times 1.97 \times 28.50}{545}$$

= 7,480 SCFM (Dry)

C - 10 Calculate Isokinetic Sampling Efficiency

$$I = \frac{0.00321 \; (V_{wstd} + V_{mstd}) \times T_s \times P_m}{\theta \times A_n \times (V_s)\text{Avg.} \times P_s}$$

$$= 0.00321 \times \frac{78.92 \times 545 \times 28.46}{60 \times 0.000341 \times 70.81 \times 28.50}$$

= 97.6 %

θ = Total Sampling Time, Min.

A_n = Nozzle Opening, Sq. Ft.

C - 11 Calculate Heat Input during testing period

Z = Total Heat Input Rate to Boiler, MEGA BTU/hr.

= $W_1 \times H_1$ =

+ $W_2 \times H_2$

+ $W_3 \times H_3$

= TOTAL

= _____ x _____

_____ x _____

_____ x _____

TOTAL _____ MEGA BTU/hr.

Where W_1, W_2, & W_3 = hourly fuel input of respective fuels and H_1, H_2, & H_3 = gross (as received) heating value of respective fuels in mega BTU per input unit (consistent with fuel input unit).

C - 12 Calculate Front End Particulate Grain Loading (with Front Half Washings Only)

C_s' = Part. Grain Loading, gr/SCF (Dry)

$$= 15.42 \times \frac{M_n}{V_{mstd}}$$

$$= 15.42 \times \frac{0.0331}{27.12}$$

$$= 0.007 \text{ gr/SCF (Dry)}$$

Where

M_n = Total Particulate Collected (Filter Plus Front Half Washings Only), GMS

C - 13 Calculate Front End Emission Factor

E_t = Hourly Mass Rate, lbs/hr.

$= 0.00857 \times C_s' \, Q_s$

$= 0.00857 \times 0.007 \times 7,480$

$= 0.45$ lbs/hr.

E_h = Front End Emission Factor, lbs/MEGA BTU

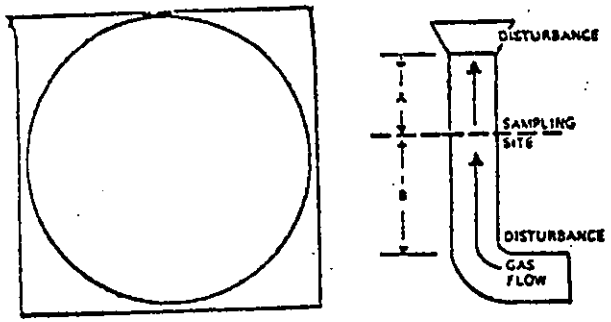
$$= \frac{E_t}{Z}$$

$$= \frac{\quad}{\quad}$$

$$= \quad \text{lbs/MEGA BTU}$$

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

PLANT Sarles, N. U. AMBIENT TEMPERATURE 80 ± METER ΔH@ _____

DATE 9 July 1976 BAROMETRIC PRESSURE 28.69 C FACTOR 0.82

LOCATION Elec. Henhouse ASSUMED MOISTURE, % 2703 PROCESS WEIGHT RATE _____

OPERATOR E.J.B., D.F.G., N.N.O. PROBE LENGTH, in. 36

STACK NO. Crippen Cleaner NOZZLE DIAMETER, in. 0.25

RUN NO. One (1) STACK DIAMETER, in. 17"

SAMPLE BOX NO. 2343-3 PROBE HEATER SETTING None

METER BOX NO. 2343-3 HEATER BOX SETTING None

N. Port

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.7091	61.9069
TARE WEIGHT	0.6785	61.8838
WEIGHT GAIN	0.0306	0.0231
TOTAL		0.0537

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min. (1038)	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm_{IN}), °F	OUTLET (Tm_{OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
1	1040	+0.2	80	.62	.787	2.8	2.8	578.600	75	75	80	80	10 2	
2	1042			.62	"	2.8	2.8	580	82	76				
3	1044			.72	.849	3.2	3.2	582	88	78				
4	1046			.72	"	3.2	3.2	585	88	78				
5	1048			.72	"	3.2	3.2	586	88	78				
6	1050			.72	"	3.2	3.2	588	88	78				
7	1052			.72	"	3.2	3.2	590	90	80				
8	1054			.73	.854	3.3	3.3	591	90	80				
9	1056			.73	"	3.3	3.3	594	92	82				
10	1058			.73	"	3.3	3.3	596	92	82				
11	1100			.73	"	3.3	3.3	598	92	82				
12	1102			.73	"	3.3	3.3	599	92	82				
13	1104			.73	"	3.3	3.3	602	92	82				
14	1106			.73	"	3.3	3.3	604	92	82				
15	1108	↓	↓	.73	"	3.3	3.3	606	92	82	↓	↓	↓	
TOTAL														
AVERAGE														

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					23.5

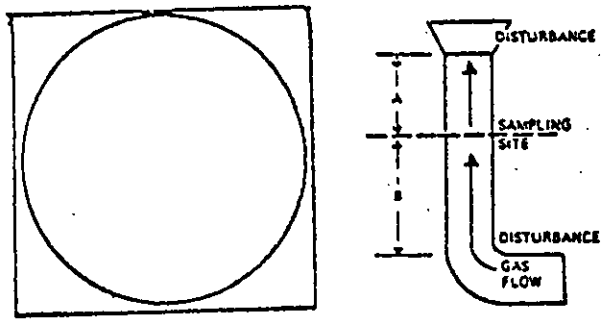
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

CB 9

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

N. PORT

PLANT Sarles, N. D. AMBIENT TEMPERATURE 60 °F METER ΔH@ _____

DATE 9 July 1976 BAROMETRIC PRESSURE 28.69 C FACTOR 0.84

LOCATION Elec. Henhouse ASSUMED MOISTURE, % 20.3 PROCESS WEIGHT RATE _____

OPERATOR E.T.B., D.F.R., M.A.O. PROBE LENGTH, in. 36

STACK NO. Cripple Cleaner NOZZLE DIAMETER, in. 0.95

RUN NO. One (1) STACK DIAMETER, in. 17"

SAMPLE BOX NO. 2343-3 PROBE HEATER SETTING None

METER BOX NO. 2343-3 HEATER BOX SETTING None

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.7491	61.4069
TARE WEIGHT	0.6785	61.3838
WEIGHT GAIN	0.0706	0.0231
TOTAL		0.0537

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in., H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm_{IN}), °F	OUTLET (Tm_{OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
16	1110	+0.2	80	.73	.854	3.3	3.3	609	92	82	80	80	10 2	
17	1112	↓	↓	.73	.854	3.3	3.3	610	92	82	↓	↓	↓	
18	1114	↓	↓	.73	.854	3.3	3.3	612	92	82	↓	↓	↓	
TOTAL														
AVERAGE				X										

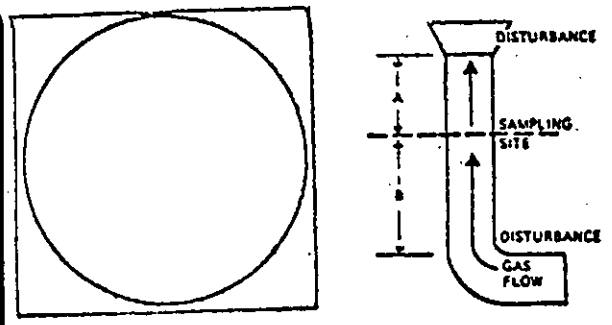
VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					23.5

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

E. PORT

PLANT Sarles, W. Va. AMBIENT TEMPERATURE 80 ± F

DATE 9 July 1976 BAROMETRIC PRESSURE 28.69

LOCATION Elec. Henhouse ASSUMED MOISTURE, % 2 to 3

OPERATOR E.J.B., D.F.K., M.D.O. PROBE LENGTH, in. 36

STACK NO. Crippen Cleaner NOZZLE DIAMETER, in. 0.25

RUN NO. One (1) STACK DIAMETER, in. 17"

SAMPLE BOX NO. 2343-3 PROBE HEATER SETTING None

METER BOX NO. 2343-3 HEATER BOX SETTING None

METER ΔH@ _____

C FACTOR 0.82

PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.7091	61.4069
TARE WEIGHT	0.6785	61.3838
WEIGHT GAIN	0.0306	0.0231
TOTAL		0.0537

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min. (11:22)	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
1	1124	+0.2	80	.73	.854	3.3	3.3	614	92	82	80	80	1 to 2	
2	1126			.73	"	3.3	3.3	616	92	82				
3	1128			.73	"	3.3	3.3	618	92	82				
4	1130			.73	"	3.3	3.3	621	92	82				
5	1132			.78	.883	3.5	3.5	623	92	82				
6	1134			.78	"	3.5	3.5	626	92	82				
7	1136			.78	"	3.5	3.5	628	92	82				
8	1138			.78	"	3.5	3.5	630	92	82				
9	1140			.78	"	3.5	3.5	632	92	82				
10	1142			.88	.938	4.0	4.0	634	92	82				
11	1144			.88	"	4.0	4.0	636	92	82				
12	1146			.88	"	4.0	4.0	638	92	82				
13	1148			.80	.894	3.6	3.6	640	92	82				
14	1150			.80	"	3.6	3.6	643	92	82				
15	1152	↓	↓	.80	"	3.6	3.6	645	92	82	↓	↓	↓	
TOTAL														
AVERAGE														

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					23.5

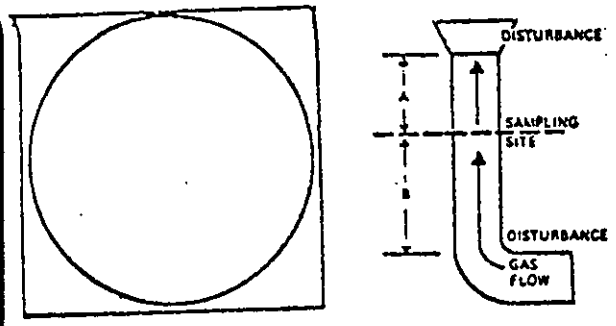
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

17

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

E. PORT

PLANT Sarles, N. D.
DATE 9 July 1976
LOCATION Elev. Henhouse
OPERATOR E.J.B., O.F.F., M.D.O.
STACK NO. Gripper Cleaner
RUN NO. One (1)
SAMPLE BOX NO. 2343-3
METER BOX NO. 2343-3

AMBIENT TEMPERATURE 80 ≈
BAROMETRIC PRESSURE 28.69
ASSUMED MOISTURE, % 20?
PROBE LENGTH, in. 36
NOZZLE DIAMETER, in. 0.95
STACK DIAMETER, in. 17"
PROBE HEATER SETTING None
HEATER BOX SETTING None

METER ΔH@ ____
C FACTOR 0.84
PROCESS WEIGHT RATE ____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.7091	[illegible]
TARE WEIGHT	0.6785	[illegible]
WEIGHT GAIN	0.0306	0.0231

TOTAL 0.0537

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY fps
16	1154	+0.2	80	.80	.894	3.6	3.6	647	92	82	80	80	1 to 2	
17	1156	↓	↓	.78	.883	3.5	3.5	648	92	82	↓	↓	↓	
18	1158 =	↓	↓	.78	"	3.5	3.5	650	92	82	↓	↓	↓	
	END							652.900 =						
								END						
TOTAL	72				31.220				3265	2919				
AVERAGE	2	+0.2	80		0.867				90.69	81.08	80	80	1.5	

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					23.5

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

42

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CR-1

PARTICULATE EMISSION CALCULATION

Plant: Sarles, North Dakota

Location: Elevator Headhouse

Stack or Source: Cripple Cleaner

Date: 9 July 1976

Run No.: One (1)

Operator: F.J.B., O.F.F., M.W.O.

Bar. Pr., In. Hg: 28.69 Absolute

Nozzle Dia, In.: 0.25 (1/4)"

Stack Dia., In.: 17" ∅

Cp: 0.84

Total Time, Min.: 72

Orsat Analysis: (Dry Basis, % by Vol.), Average

CO_2	Zero
O_2	20.9
CO	Zero
N_2	79.1

Water Collected, GMS.: 23.5

Filter No.: 0

Particulate Collected, GMS.:

Filter 0.0306

Probe Wash 0.0231

Vol. Through Gas Meter, Cu. Ft.: FRONT END TOTAL 0.0537

Impinger Catch ~~~~

FRONT PLUS BACK END CATCH TOTAL ~~~~

Standard Conditions: Dry Gas at 15.6°C and 29.92 in. Hg.

C - 1 Calculate Average Meter Temperature

T_m = The average of both inlet and outlet temperatures obtained during sampling, 545.9 °R.

C - 2 Calculate Sample Volume at Standard Conditions

V_{mstd} = SCF (Dry) Through meter

$$= 17.32 \frac{V_m \times P_m}{T_m}$$

$$= 17.32 \frac{78.91 \times 28.69}{585.9}$$

$$= 71.83 \text{ SCF (Dry)}$$

Where: V_m = Dry gas measured by meter, cu.ft.

P_m = Abs. Pr. at meter (use barometric pressure, uncorrected for altitude), In. Hg

C - 3 Calculate Volume Fraction Water in Flue Gas

V_{wstd} = Water vapor in SCF

$$= 0.0465 V_{lc}$$

$$= 0.0465 \cdot 23.5$$

$$= 1.09 \text{ SCF}$$

B_{wo} = Water $\frac{V}{V}$

$$= \frac{V_{wstd}}{(V_{wstd} + V_{mstd})}$$

$$= \frac{1.09}{1.09 + 71.83} = \frac{1.09}{(72.92)} = 0.0149$$

Where V_{lc} = Weight of water collected in impingers plus that gained by drierite, GMS

45
CR-1

C - 4 Calculate Dry and Wet Molecular Weight of Stack Gas

M_d = Dry Mol. Wt.

= 0.44 (% CO_2) + 0.32 (% O_2)

+0.28 (% N_2 + CO)

= 0.44 x Zero + 0.32 x 20.9 = 6.69 + 0.28 x 79.1 = 22.15

= 28.84

M_S = Wet Mol. Wt.

= M_d (1- B_{WO}) + 18 B_{WO}

= 28.84 x 0.9851 + 18 x 0.0149

= 28.68 0.268

C - 5 Calculate The Average $\sqrt{\Delta P}$, ($\sqrt{\Delta P}$) Avg., Obtained during gas sample acquisition

($\sqrt{\Delta P}$) Avg. = 0.867

C - 6 Calculate The Average Stack Gas Temperature, T_S, at time of Gas Sample Acquisition

T_S = 540 °R

C - 7 Calculate The Average Stack Gas Velocity

(V_S)Avg. = 85.48 x C_p x ($\sqrt{\Delta P}$) Avg. $\sqrt{\frac{T_S}{P_S \times M_S}}$

= 85.48 x 0.84 x 0.867 $\sqrt{\frac{540}{28.70 \times 28.68}}$ = 0.81

= 50.73 ft./sec

Where:

C_p = Pitot Tube Coefficient

P_S = Absolute Stack Gas Press., In. Hg.

C - 8 Calculate Stack Cross Sectional Area at Sampling Site

A_s = 1.58 Sq. Ft.

C - 9 Calculate Stack Gas Average Volumetric Flow Rate

Q_s = Stack Gas Flow Rate, SCFM (Dry)

$$= 1043 \times (1-B_{wo}) \; (V_s)\text{Avg.} \times A_s \; \frac{P_s}{T_s}$$

$$= \frac{1043 \times 0.9851 \times 50.43 \times 1.58 \times 28.70}{540}$$

= 4,350 SCFM (Dry)

C - 10 Calculate Isokinetic Sampling Efficiency

$$I = \frac{0.003241 \; (V_{wstd} + V_{mstd}) \times T_s \times P_m}{\theta \times A_n \times (V_s)\text{Avg.} \times P_s}$$

$$= 0.003241 \times \frac{72.92 \times 540 \times 28.69}{72 \times 0.000341 \times 50.43 \times 28.70}$$

= 102.1 %

θ = Total Sampling Time, Min.

A_n = Nozzle Opening, Sq. Ft.

C - 11 Calculate Heat Input during testing period

Z = Total Heat Input Rate to Boiler, MEGA BTU/hr.

= $W_1 \times H_1$ =

+ $W_2 \times H_2$

+ $W_3 \times H_3$

= TOTAL

= _____ x _____

_____ x _____

_____ x _____

TOTAL _____ MEGA BTU/hr.

Where W_1, W_2, & W_3 = hourly fuel input of respective fuels and H_1, H_2, & H_3 = gross (as received) heating value of respective fuels in mega BTU per input unit (consistent with fuel input unit).

C - 12 Calculate Front End Particulate Grain Loading (with Front Half Washings Only)

C_s' = Part. Grain Loading, gr/SCF (Dry)

$$= 15.42 \times \frac{M_n}{V_{mstd}}$$

$$= 15.42 \frac{\times 0.0537}{71.83}$$

= 0.012 gr/SCF (Dry)

Where

M_n = Total Particulate Collected (Filter Plus Front Half Washings Only), GMS

C - 13 Calculate Front End Emission Factor

E_t = Hourly Mass Rate, lbs/hr.

= 0.00857 x C_s' Q_s

= 0.00857 x 0.012 x 8,350

= 0.85 lbs/hr.

E_h = Front End Emission Factor, lbs/MEGA BTU

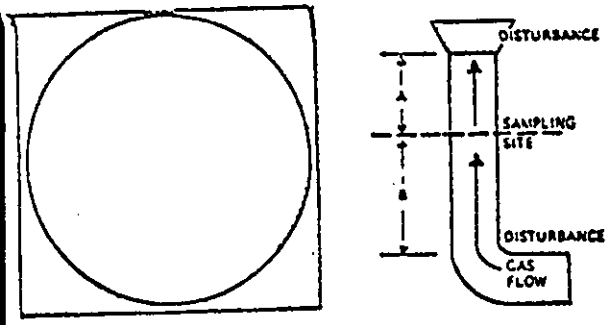
$$= \frac{E_t}{Z}$$

$$= \frac{\qquad}{\qquad}$$

= _____ lbs/MEGA BTU

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

N. PORT

PLANT Sinclair, N.C. AMBIENT TEMPERATURE 80.°F

DATE 9 July 1976 BAROMETRIC PRESSURE 28.69

LOCATION Elec. Hendhouse ASSUMED MOISTURE, % 2.03

OPERATOR E.T.B., D.F.K., M.A.O. PROBE LENGTH, in. 36

STACK NO. Cripple Cleaner NOZZLE DIAMETER, in. 0.25

RUN NO. Two (2) STACK DIAMETER, In. 17"

SAMPLE BOX NO. 2383-3 PROBE HEATER SETTING None

METER BOX NO. 2383-3 HEATER BOX SETTING None

METER Adj. _____

C FACTOR 0.84

PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6211	60.5331
TARE WEIGHT	0.6013	60.5165
WEIGHT GAIN	0.0198	0.0166
TOTAL		0.0354

1212

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft^3	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm_{IN}), °F	OUTLET (Tm_{OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
1	1214	+0.2	80	.62	.787	2.8	2.8	654.200	98	92	80	80	1 to 2	
2	1216			.62	"	2.8	2.8	657	98	92				
3	1218			.62	"	2.8	2.8	659	98	92				
4	1220			.62	"	2.8	2.8	661	98	92				
5	1222			.62	"	2.8	2.8	662	98	92				
6	1224			.25	.866	3.3	3.3	664	98	92				
7	1226			.25	"	3.3	3.3	666	98	92				
8	1228			.79	.889	3.5	3.5	669	98	92				
9	1230			.79	"	3.5	3.5	670	98	92				
10	1232			.79	"	3.5	3.5	672	98	92				
11	1234			.79	"	3.5	3.5	674	98	92				
12	1236			.71	"	3.5	3.5	677	98	92				
13	1238			.79	"	3.5	3.5	680	98	92				
14	1240			.79	"	3.5	3.5	681	98	92				
15	1242	↓	↓	.79	"	3.5	3.5	683	98	92	↓	↓	↓	
TOTAL														
AVERAGE														

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					96

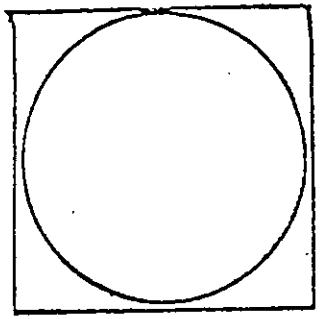
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

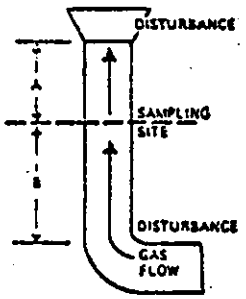
COMMENTS:

87

PARTICULATE FIELD DATA

SCHEMATIC OF STACK





CROSS SECTION

N. PORT

PLANT Sarles, N. D. AMBIENT TEMPERATURE 80 °F

DATE 9 July 1976 BAROMETRIC PRESSURE 28.69

LOCATION Elev. Penthouse ASSUMED MOISTURE, % 2.03

OPERATOR E.J.B., D.A.K., M.W.O. PROBE LENGTH, in. 36

STACK NO. Gripper Cleaner NOZZLE DIAMETER, in. 0.25

RUN NO. Two (2) STACK DIAMETER, in. 17.11

SAMPLE BOX NO. 2343-3 PROBE HEATER SETTING None

METER BOX NO. 2343-3 HEATER BOX SETTING None

METER ΔH@ _____ _____

C FACTOR 0.84

PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6701	62.5331
TARE WEIGHT	0.6513	62.5165
WEIGHT GAIN	0.0188	0.0166
	TOTAL	0.0354

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft^3	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm_{IN}), °F	OUTLET (Tm_{OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
16	1299	+0.2	80	.79	.889	3.5	3.5	685	100	93	80	80	10.2	
17	1246	↓	↓	.79	"	3.5	3.5	687	100	93	↓	↓	↓	
18	1298	↓	↓	.79	"	3.5	3.5	689	100	93	↓	↓	↓	
TOTAL														
AVERAGE														

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					

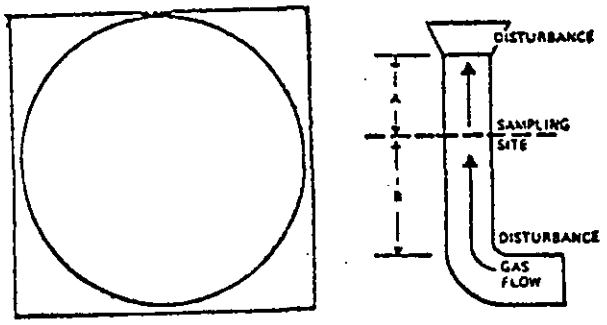
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					

COMMENTS:

64

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

E. PORT

PLANT Sarles, N. D.
DATE 9 July 1976
LOCATION Elev. Penthouse
OPERATOR E.J.B., D.F.K., N.N.O.
STACK NO. Cripple Cleaner
RUN NO. Two (2)
SAMPLE BOX NO. 2343-3
METER BOX NO. 2343-3

AMBIENT TEMPERATURE 80 F
BAROMETRIC PRESSURE 28.68
ASSUMED MOISTURE, % 2.03
PROBE LENGTH, in. 36
NOZZLE DIAMETER, in. 0.495
STACK DIAMETER, in. 17"
PROBE HEATER SETTING None
HEATER BOX SETTING None

METER ΔH@ _____
C FACTOR 0.82
PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6701	2.5331
TARE WEIGHT	0.5513	2.5165
WEIGHT GAIN	0.0188	0.0166
TOTAL	0.0354	

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min. (1252)	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in., H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg. gauge	VELOCITY fps
1	1254	+0.2	80	.73	.854	3.3	3.3	691	100	93	80	80	10.2	
2	1256			.73	"	3.3	3.3	694	100	93				
3	1258			.73	"	3.3	3.3	695	100	93				
4	1300			.78	.883	3.5	3.5	698	100	93				
5	1302			.78	.883	3.5	3.5	700	100	93				
6	1304			.84	.917	3.8	3.8	702	100	93				
7	1306			.84	.917	3.8	3.8	704	100	93				
8	1308			.84	.917	3.8	3.8	705	100	93				
9	1310			.84	.917	3.8	3.8	708	100	93				
10	1312			.81	.900	3.6	3.6	710	105	95				
11	1314			.81	.900	3.6	3.6	712	105	95				
12	1316			.81	.900	3.6	3.6	714	105	95				
13	1318			.82	.906	3.6	3.6	717	108	97				
14	1320			.78	.883	3.5	3.5	719	108	97				
15	1322	↓	↓	.72	.854	3.3	3.3	721	111	98	↓	↓	↓	
TOTAL														
AVERAGE														

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					26

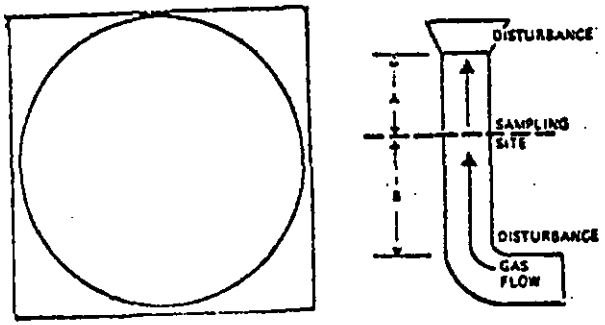
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

90

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



PLANT Sarles, N. D.
DATE 9 July 1976
LOCATION Elev. Henhouse
OPERATOR E.J.B., O.E.E., M.W.O.
STACK NO. Cripper Cleaner
RUN NO. Two (2)
SAMPLE BOX NO. 2343-3
METER BOX NO. 2343-3

AMBIENT TEMPERATURE 80 °F
BAROMETRIC PRESSURE 28.69
ASSUMED MOISTURE, % 2.03
PROBE LENGTH, in. 36
NOZZLE DIAMETER, in. 0.25
STACK DIAMETER, in. 17.11
PROBE HEATER SETTING None
HEATER BOX SETTING None

METER ΔH@ _____
C FACTOR 0.82
PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6721	0.5331
TARE WEIGHT	0.6543	0.5165
WEIGHT GAIN	0.0188	0.0166

TOTAL 0.0354

E. PORT

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in., H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm_{IN}), °F	OUTLET (Tm_{OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
16	1328	+0.2	80	.71	.843	3.2	3.2	723	111	98	80	80	1 to 2	
17	1326	↓	↓	.69	.831	3.1	3.1	725	111	98	↓	↓	↓	
18	1328	↓	↓	.71	.843	3.2	3.2	727	111	98	↓	↓	↓	
								END = 729.6						
TOTAL	72				2.532				3645	3367				
AVERAGE	2	+0.2	80	X	0.870				101.25	93.53	80	80	1.5	

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					

COMMENTS:

51

4/1/76 52

CR-2

PARTICULATE EMISSION CALCULATION

Plant: SARLES, NORTH. DAKOTA

Location: ELEVATOR HEADHOUSE

Stack or Source: CRIPPEN CLEANER

Date: 9 JULY 1976

Run No.: TWO (2)

Operator: A.J.B., O.F.F., M.W.O.

Bar. Pr., In. Hg: 28.69 ABSOLUTE

Nozzle Dia, In.: 0.25 (1/4)"

Stack Dia., In.: 17" ϕ

Cp: 0.84

Total Time, Min.: 72

Orsat Analysis: (Dry Basis, % by Vol.), Average

CO_2	ZERO
O_2	20.9
CO	ZERO
N_2	79.1

Water Collected, GMS.: 26

Filter No.: E

Particulate Collected, GMS.:

Filter 0.0188

Probe Wash 0.0166

Vol. Through Gas Meter, Cu. Ft.: FRONT END TOTAL 0.0354

Impinger Catch

FRONT PLUS BACK END CATCH TOTAL ~

Standard Conditions: Dry Gas at 15.6°C and 29.92 in. Hg.

C - 1 Calculate Average Meter Temperature

T_m = The average of both inlet and outlet temperatures obtained during sampling, 557.4 °R.

53
CR-2

C - 2 Calculate Sample Volume at Standard Conditions

V_{mstd} = SCF (Dry) Through meter

$$= 17.32 \frac{V_m \times P_m}{T_m}$$

$$= 17.32 \frac{80.08 \times 28.69}{557.2}$$

$$= 71.39 \text{ SCF (Dry)}$$

Where: V_m = Dry gas measured by meter, cu.ft.

P_m = Abs. Pr. at meter (use barometric pressure, uncorrected for altitude), In. Hg

C - 3 Calculate Volume Fraction Water in Flue Gas

V_{wstd} = Water vapor in SCF

$= 0.0465 V_{lc}$

$= 0.0465 \cdot 26$

$= 1.21$ SCF

B_{wo} = Water $\frac{V}{V}$

$$= \frac{V_{wstd}}{(V_{wstd} + V_{mstd})}$$

$$= \frac{1.21}{1.21 + (71.39)} = \frac{1.21}{72.60} = 0.0167$$

Where V_{lc} = Weight of water collected in impingers plus that gained by drierite, GMS

54
Cr-2

C - 4 Calculate Dry and Wet Molecular Weight of Stack Gas

M_d = Dry Mol. Wt.

= 0.44 (% CO_2) + 0.32 (% O_2)

+0.28 (% N_2 + CO)

= 0.44 x ZERO + 0.32 x 20.9 = 6.69 + 0.28 x 78.1 = 22.15

= 28.84

M_s = Wet Mol. Wt.

= M_d (1- B_{wo}) + 18 B_{wo}

= 28.84 x 0.9833 + 18 x 0.0167

= 28.66 0.301

C - 5 Calculate The Average $\sqrt{\Delta P}$, $(\sqrt{\Delta P})$ Avg., Obtained during gas sample acquisition

$(\sqrt{\Delta P})$ Avg. = 0.870

C - 6 Calculate The Average Stack Gas Temperature, T_s, at time of Gas Sample Acquisition

T_s = 540 °R

C - 7 Calculate The Average Stack Gas Velocity

(V_s)Avg. = 85.48 x C_p x $(\sqrt{\Delta P})$ Avg. $\sqrt{\frac{T_s}{P_s \times M_s}}$

= 85.48 x 0.84 x 0.870 $\sqrt{\frac{540}{28.70 \times 28.66}}$ = 0.810

= 50.6 ft./sec

Where:

C_p = Pitot Tube Coefficient

P_s = Absolute Stack Gas Press., In. Hg.

Cr-2
55

C - 8 Calculate Stack Cross Sectional Area at Sampling Site

A_s = 1.58 Sq. Ft.

C - 9 Calculate Stack Gas Average Volumetric Flow Rate

Q_s = Stack Gas Flow Rate, SCFM (Dry)

$$= 1043 \times (1-B_{WO}) \; (V_s)\text{Avg.} \times A_s \times \frac{P_s}{T_s}$$

$$= \frac{1043}{} \times \frac{0.9833}{} \times \frac{50.6}{} \times \frac{1.58}{} \times \frac{28.70}{540}$$

= 1,360 SCFM (Dry)

C - 10 Calculate Isokinetic Sampling Efficiency

$$I = \frac{0.00321 \; (V_{wstd} + V_{mstd}) \times T_s \times P_m}{\theta \times A_n \times (V_s)\text{Avg.} \times P_s}$$

$$= 0.00321 \times \frac{72.60 \times 540 \times 28.69}{72 \times 0.000371 \times 50.6 \times 28.70}$$

= 101.3 %

θ = Total Sampling Time, Min.

A_n = Nozzle Opening, Sq. Ft.

C - 11 Calculate Heat Input during testing period

Z = Total Heat Input Rate to Boiler, MEGA BTU/hr.

= $W_1 \times H_1$ =

+ $W_2 \times H_2$

+ $W_3 \times H_3$

= TOTAL

= _____ x _____

_____ x _____

_____ x _____

TOTAL _____ MEGA BTU/hr.

Where W_1, W_2, & W_3 = hourly fuel input of respective fuels and H_1, H_2, & H_3 = gross (as received) heating value of respective fuels in mega BTU per input unit (consistent with fuel input unit).

C - 12 Calculate Front End Particulate Grain Loading (with Front Half Washings Only)

C_s' = Part. Grain Loading, gr/SCF (Dry)

$$= 15.42 \times \frac{M_n}{V_{mstd}}$$

$$= 15.42 \times \frac{0.0358}{71.39}$$

= 0.008 gr/SCF (Dry)

Where

M_n = Total Particulate Collected (Filter Plus Front Half Washings Only), GMS

C - 13 Calculate Front End Emission Factor

E_t = Hourly Mass Rate, lbs/hr.

$= 0.00857 \times C_s' \, Q_s$

$= 0.00857 \times 0.008 \times 7,360$

= 0.30 lbs/hr.

E_h = Front End Emission Factor, lbs/MEGA BTU

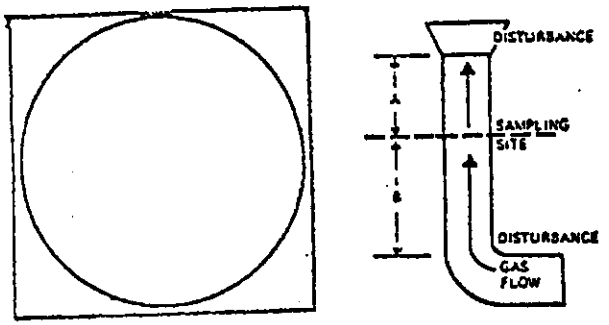
$$= \frac{E_t}{Z}$$

$$= \frac{\quad}{\quad}$$

= _____ lbs/MEGA BTU

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

N. PORT

PLANT Sinclair, N.J.
DATE 9 July 1976
LOCATION Elec. Henhouse
OPERATOR E.J.B., D.F.K., M.D.O.
STACK NO. Cripped Cleaner
RUN NO. Three (3)
SAMPLE BOX NO. 2343-3
METER BOX NO. 2343-3

AMBIENT TEMPERATURE 80 F
BAROMETRIC PRESSURE 28.69
ASSUMED MOISTURE, % 2703
PROBE LENGTH, in. 36
NOZZLE DIAMETER, in. 0.25
STACK DIAMETER, in. 17"
PROBE HEATER SETTING None
HEATER BOX SETTING None

METER box
C FACTOR 0.84
PROCESS WEIGHT RATE

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6785	61.9754
TARE WEIGHT	0.6453	61.9636
WEIGHT GAIN	0.0332	0.0118
TOTAL	0.0450	

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min. (1400)	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in., H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³ (730.100)	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm_{IN}), °F	OUTLET (Tm_{OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
1	1402	+0.2	80	.55	.742	2.5	2.5	731	100	95	80	80	10 2	
2	1404			.56	.748	2.5	2.5	732	101	96				
3	1406			.55	.742	2.5	2.5	733	103	96				
4	1408			.62	.787	2.8	2.8	735	104	96				
5	1410			.62	"	2.8	2.8	736	105	97				
6	1412			.62	"	2.8	2.8	737	105	96				
7	1414			.67	.819	3.0	3.0	739	106	98				
8	1416			.66	.812	3.0	3.0	741	106	98				
9	1418			.79	.889	3.5	3.5	743	106	96				
10	1420			.80	.894	3.5	3.5	745	107	96				
11	1422			.79	.889	3.5	3.5	747	108	97				
12	1424			.79	.889	3.5	3.5	749	108	95				
13	1426			.76	.872	3.4	3.4	751	109	96				
14	1428			.75	.866	3.4	3.4	753	108	96				
15	1430	↓	↓	.76	.872	3.4	3.4	755	108	96	↓	↓	↓	
TOTAL														
AVERAGE				☒										

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					35.5

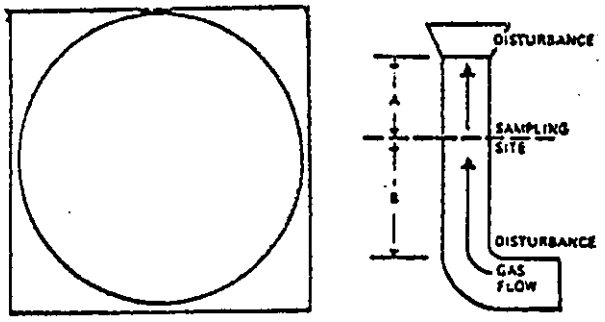
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

57

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

N. POINT

PLANT Sarles, N. D. AMBIENT TEMPERATURE 80 °F METER ΔH, _____

DATE 9 July 1976 BAROMETRIC PRESSURE 28.69 C FACTOR 0.84

LOCATION Elec. Henhouse ASSUMED MOISTURE, % 20.3 PROCESS WEIGHT RATE _____

OPERATOR E.J.B., D.F.K., M.N.O. PROBE LENGTH, in. 36

STACK NO. Cripple Cleaner NOZZLE DIAMETER, in. 0.25

RUN NO. Three (3) STACK DIAMETER, in. 17"

SAMPLE BOX NO. 2343-3 PROBE HEATER SETTING None

METER BOX NO. 2343-3 HEATER BOX SETTING None

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WAS
FINAL WEIGHT	0.6775	61.9754
TARE WEIGHT	0.6483	61.9626
WEIGHT GAIN	0.0292	0.0128
	TOTAL	0.0420

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft^3	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tm_{IN}), °F	OUTLET (Tm_{OUT}), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
16	1432	+0.2	80	.76	.872	3.4	3.4	757	108	96	80	80	10 2	
17	1437	↓	↓	.73	.859	3.3	3.3	759	109	98	↓	↓	↓	
18	1436	↓	↓	.73	.854	3.3	3.3	761	111	99	↓	↓	↓	
TOTAL														
AVERAGE				⊠										

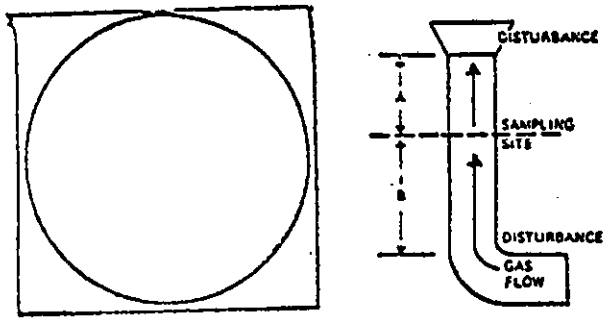
VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					

COMMENTS:

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

E. PORT

PLANT Sparrows, N. J. | AMBIENT TEMPERATURE 80 F | METER ΔH@ _____

DATE 9 July 1976 | BAROMETRIC PRESSURE 28.69 | C FACTOR 0.82

LOCATION Elec. Henhouse | ASSUMED MOISTURE, % 2.03 | PROCESS WEIGHT RATE _____

OPERATOR E.J.B., O.F.K., M.W.O. | PROBE LENGTH, in. 36

STACK NO. Griffen Cleaner | NOZZLE DIAMETER, in. 0.495

RUN NO. Three (3) | STACK DIAMETER, in. 17"

SAMPLE BOX NO. 2343-3 | PROBE HEATER SETTING None

METER BOX NO. 2343-3 | HEATER BOX SETTING None

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6745	21.9752
TARE WEIGHT	21.6553	21.9624
WEIGHT GAIN	0.0192	0.0128
TOTAL	0.0320	

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min. (1440)	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
1	1442	+0.2	80	.71	.843	3.1	3.1	763	106	96	80	80	1 to 2	
2	1444			.71	"	3.1	3.1	769	107	97				
3	1446			.66	.812	3.0	3.0	766	108	97				
4	1448			.71	.843	3.1	3.1	768	108	95				
5	1450			.71	"	3.1	3.1	770	108	96				
6	1452			.72	.849	3.1	3.1	772	108	97				
7	1454			.70	.837	3.1	3.1	774	108	98				
8	1456			.75	.866	3.3	3.3	776	108	96				
9	1458			.75	.866	3.3	3.3	778	108	96				
10	1500			.75	.866	3.3	3.3	780	108	96				
11	1502			.79	.889	3.4	3.4	782	108	98				
12	1504			.85	.922	3.8	3.8	784	107	96				
13	1506			.84	.917	3.8	3.8	786	104	96				
14	1508			.85	.922	3.8	3.8	788	109	96				
15	1510	↓	↓	.82	.906	3.6	3.6	790	110	98	↓	↓	↓	
TOTAL														
AVERAGE														

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					25.5

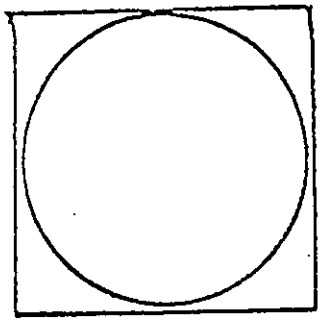
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

9

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



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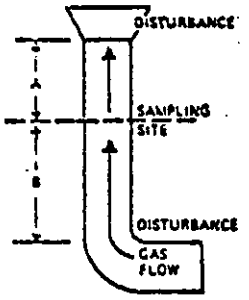

E. PORT

PLANT Sarles, N. D. AMBIENT TEMPERATURE 80 °F METER ΔH@ _____

DATE 9 July 1976 BAROMETRIC PRESSURE 28.69 C FACTOR 0.84

LOCATION Elec. Generator ASSUMED MOISTURE, % 27.3 PROCESS WEIGHT RATE _____

OPERATOR A.J.B., D.F.E., M.N.O. PROBE LENGTH, in. 36

STACK NO. Gripper Cleaner NOZZLE DIAMETER, in. 0.25

RUN NO. Three (3) STACK DIAMETER, in. 17.11

SAMPLE BOX NO. 2343-3 PROBE HEATER SETTING None

METER BOX NO. 2343-3 HEATER BOX SETTING None

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6725	61.9757
TARE WEIGHT	0.6933	61.9636
WEIGHT GAIN	0.0092	0.0128
TOTAL		0.0420

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in., H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
16	15:12	+0.2	80	.82	.906	3.6	3.6	791	111	96	80	80	10 2	
17	15:14	↓	↓	.78	.883	3.5	3.5	793	111	97	↓	↓	↓	
18	15:16	↓	↓	.78	.883	3.5	3.5	798.000 =	110	99	↓	↓	↓	
								END						
TOTAL	72				30.171				386	397				
AVERAGE	2	+0.2	80		0.852				107.39	102.02	80	80	10 2	

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					25.2

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

09

LR-3

PARTICULATE EMISSION CALCULATION

Plant: SARLES, NORTH DAKOTA

Location: ELEVATOR HEADHOUSE

Stack or Source: CRIPPEN CLEANER

Date: 9 JULY 1976

Run No.: THREE (3)

Operator: F.J.B., O.F.F., M.W.O.

Bar. Pr., In. Hg: 28.69 ABSOLUTE

Nozzle Dia, In.: 0.25 (1/4)"

Stack Dia., In.: 17" ϕ

Cp: 0.84

Total Time, Min.: 72

Orsat Analysis: (Dry Basis, % by Vol.), Average

CO_2	ZERO
O_2	20.9
CO	ZERO
N_2	79.1

Water Collected, GMS.: 25.5

Filter No.: L

Particulate Collected, GMS.:

Filter 0.0292

Probe Wash 0.0128

Vol. Through Gas Meter, Cu. Ft.: FRONT END TOTAL 0.0420

Impinger Catch ~~~

FRONT PLUS BACK END CATCH TOTAL ~~~

Standard Conditions: Dry Gas at 15.6°C and 29.92 in. Hg.

C - 1 Calculate Average Meter Temperature

T_m = The average of both inlet and outlet temperatures obtained during sampling, 102.0 °R.

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CR-3

C - 2 Calculate Sample Volume at Standard Conditions

V_{mstd} = SCF (Dry) Through meter

$$= 17.32 \frac{V_m \times P_m}{T_m}$$

$$= 17.32 \frac{72.11 \times 28.69}{562}$$

$$= \underline{63.76} \text{ SCF (Dry)}$$

Where: V_m = Dry gas measured by meter, cu.ft.

P_m = Abs. Pr. at meter (use barometric pressure, uncorrected for altitude), In. H_g

C - 3 Calculate Volume Fraction Water in Flue Gas

V_{wstd} = Water vapor in SCF

$= 0.0465 V_{lc}$

$= 0.0465 \cdot 25.5$

$= \underline{1.19}$ SCF

B_{wo} = Water $\frac{V}{V}$

$$= \frac{V_{wstd}}{(V_{wstd} + V_{mstd})}$$

$$= \frac{1.19}{1.19 + 63.76} = \frac{1.19}{(64.95)} = 0.0183$$

Where V_{lc} = Weight of water collected in impingers plus that gained by drierite, GMS

C - 4 Calculate Dry and Wet Molecular Weight of Stack Gas

M_d = Dry Mol. Wt.

= 0.44 (% CO_2) + 0.32 (% O_2)

+0.28 (% N_2 + CO)

= 0.44 x ZERO + 0.32 x 20.9 = 6.69 + 0.28 x 79.1 = 22.15

= 28.84

M_s = Wet Mol. Wt.

= M_d (1- B_{wo}) + 18 B_{wo}

= 28.84 x 0.9817 + 18 x 0.0183

= 28.64 0.329

C - 5 Calculate The Average $\sqrt{\Delta P}$, ($\sqrt{\Delta P}$) Avg., Obtained during gas sample acquisition

($\sqrt{\Delta P}$) Avg. = 0.852

C - 6 Calculate The Average Stack Gas Temperature, T_s, at time of Gas Sample Acquisition

T_s = 540 °R

C - 7 Calculate The Average Stack Gas Velocity

(V_s)Avg. = 85.48 x C_p x ($\sqrt{\Delta P}$) Avg. $\sqrt{\frac{T_s}{P_s \times M_s}}$

= 85.48 x 0.84 x 0.852 $\sqrt{\frac{540}{28.70 \times 28.64}} = 0.811$

= 49.61 ft./sec

Where:

C_p = Pitot Tube Coefficient

P_s = Absolute Stack Gas Press., In. Hg.

CR-3
64

C - 8 Calculate Stack Cross Sectional Area at Sampling Site

A_s = 1.58 Sq. Ft.

C - 9 Calculate Stack Gas Average Volumetric Flow Rate

Q_s = Stack Gas Flow Rate, SCFM (Dry)

$$= 1043 \times (1-B_{wo}) \; (V_s)\text{Avg.} \times A_s \; \frac{P_s}{T_s}$$

$$= \frac{1043 \times 0.9817 \times 29.61 \times 1.58 \times 28.70}{540}$$

= 4,270 SCFM (Dry)

C - 10 Calculate Isokinetic Sampling Efficiency

$$I = \frac{0.00321 \; (V_{wstd} + V_{mstd}) \times T_s \times P_m}{\theta \times A_n \times (V_s)\text{Avg.} \times P_s}$$

$$= 0.00321 \times \frac{64.95 \times 540 \times 28.69}{72 \times 0.000371 \times 29.61 \times 28.70}$$

= 92.7 %

θ = Total Sampling Time, Min.

A_n = Nozzle Opening, Sq. Ft.

C - 11 Calculate Heat Input during testing period

Z = Total Heat Input Rate to Boiler, MEGA BTU/hr.

= $W_1 \times H_1$ =

+ $W_2 \times H_2$

+ $W_3 \times H_3$

= TOTAL

= _____ x _____

_____ x _____

_____ x _____

TOTAL _____ MEGA BTU/hr.

Where W_1, W_2, & W_3 = hourly fuel input of respective fuels and H_1, H_2, & H_3 = gross (as received) heating value of respective fuels in mega BTU per input unit (consistent with fuel input unit).

C - 12 Calculate Front End Particulate Grain Loading (with Front Half Washings Only)

C_s' = Part. Grain Loading, gr/SCF (Dry)

$$= 15.42 \times \frac{M_n}{V_{mstd}}$$

$$= 15.42 \times \frac{0.042}{63.76}$$

= 0.01 gr/SCF (Dry)

Where

M_n = Total Particulate Collected (Filter Plus Front Half Washings Only), GMS

C - 13 Calculate Front End Emission Factor

E_t = Hourly Mass Rate, lbs/hr.

$= 0.00857 \times C_s' \, Q_s$

$= 0.00857 \times$ 0.01 $\times$ 1,270

= 0.37 lbs/hr.

E_h = Front End Emission Factor, lbs/MEGA BTU

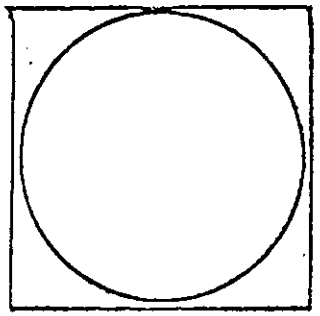
$$= \frac{E_t}{Z}$$

$$= \frac{\quad}{\quad}$$

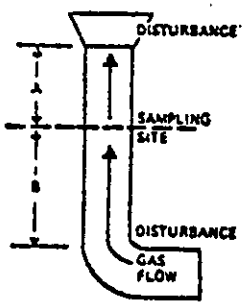
= _____ lbs/MEGA BTU

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION



E. PORT

PLANT Sarles, N. D.
DATE 9 July 1976
LOCATION Elev. Henhouse
OPERATOR E.J.B., D.F.K., M.W.O.
STACK NO. Idem Cleaner
RUN NO. One (1)
SAMPLE BOX NO. 2343-3
METER BOX NO. 2343-3

AMBIENT TEMPERATURE 80°
BAROMETRIC PRESSURE 28.69
ASSUMED MOISTURE, % 2.03
PROBE LENGTH, in. 36
NOZZLE DIAMETER, in. 0.25
STACK DIAMETER, in. 13.11
PROBE HEATER SETTING None
HEATER BOX SETTING None

METER ΔH@ _____
C FACTOR 0.82
PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	2.6690	63.2507
TARE WEIGHT	2.4351	63.2300
WEIGHT GAIN	0.2339	0.0207

TOTAL 0.0748

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min. (1607)	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
1	1610	+0.3	80	.52	.721	2.3	2.3	798.810	92	92	80	70	2	
2	1613			.52	"	2.3	2.3	800	92	93				
3	1616			.60	.775	2.6	2.6	802	98	95				
4	1619			.60	"	2.6	2.6	805	100	96				
5	1622			.66	.812	3.1	3.1	807	100	96				
6	1625			.82	.906	4.0	4.0	810	100	96				
7	1628			.82	"	4.0	4.0	815	100	96				
8	1631			.88	.938	4.3	4.3	818	100	96				
9	1634			.88	"	4.3	4.3	822	106	98				
10	1637	↓	↓	.82	.906	4.0	4.0	825	106	98	↓	↓	↓	
TOTAL											=			
AVERAGE				X										

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					

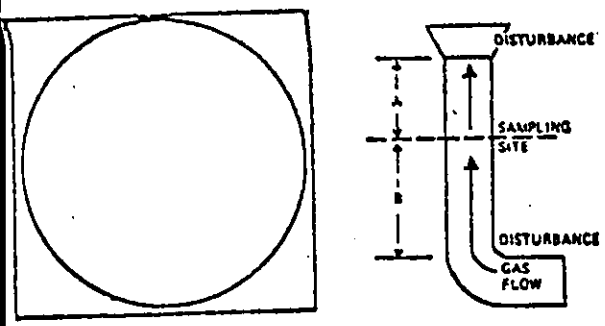
ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					

COMMENTS:

99

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

5 POINT

PLANT Sparks, N. C.
DATE 9 July 1976
LOCATION Elev. Henhouse
OPERATOR E.T.B., D.E.G., M.D.O.
STACK NO. Long Cleaner
RUN NO. One (1)
SAMPLE BOX NO. 2343-3
METER BOX NO. 2343-3

AMBIENT TEMPERATURE 80
BAROMETRIC PRESSURE 28.69
ASSUMED MOISTURE, % 2.03
PROBE LENGTH, in. 36
NOZZLE DIAMETER, in. 0.25
STACK DIAMETER, in. 13"
PROBE HEATER SETTING None
HEATER BOX SETTING None

METER $\Delta H_@$ _____
C FACTOR 0.84
PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6690	63.2569
TARE WEIGHT	0.6451	63.2300
WEIGHT GAIN	0.0239	0.0269
TOTAL		0.0508

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min. (1641)	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY fps
1	1644	+0.3	80	.70	.837	3.4	3.4	828	106	98	80	80	1 to 2	
2	1647			.70	.837	3.4	3.4	832	106	98				
3	1650			.68	.825	3.2	3.2	835	110	98				
4	1653			.70	.837	3.4	3.4	838	110	98				
5	1656			.70	.837	3.4	3.4	841	110	98				
6	1659			.70	.837	3.4	3.4	844	110	98				
7	1702			.70	.837	3.4	3.4	848	110	98				
8	1705			.70	.837	3.4	3.4	851	110	98				
9	1708			.65	.806	3.1	3.1	854	110	98				
10	1711	↓	↓	.65	.806	3.1	3.1	857	110	98	↓	↓	↓	
								860.300 =						
								END						
TOTAL	60				16.694				2086	1935				
AVERAGE	3	+0.3	80	☒	0.835				104.30	100.50	80	80	1.5	

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					20.5

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

ID-1

PARTICULATE EMISSION CALCULATION

Plant: SARLES, NORTH. DAKOTA
Location: ELEVATOR HEADHOUSE
Stack or Source: IDEAL CLEANER
Date: 9 JULY 1976
Run No.: ONE (1)
Operator: F.J.B., O.F.F., M.W.O.
Bar. Pr., In. Hg: 28.69 ABSOLUTE
Nozzle Dia, In.: 0.25 (1/4)"
Stack Dia., In.: 13"Ø
Cp: 0.84
Total Time, Min.: 60

Orsat Analysis: (Dry Basis, % by Vol.), Average

CO_2	ZERO
O_2	20.9
CO	ZERO
N_2	79.1

Water Collected, GMS.: 20.5
Filter No.: 6
Particulate Collected, GMS.:
Filter 0.0239
Probe Wash 0.0209

Vol. Through Gas Meter, Cu. Ft.: FRONT END TOTAL 0.0448

Impinger Catch

FRONT PLUS BACK END CATCH TOTAL ~~~~

Standard Conditions: Dry Gas at 15.6°C and 29.92 in. Hg.

C - 1 Calculate Average Meter Temperature

T_m = The average of both inlet and outlet temperatures obtained during sampling, 560.5 °R.

C - 2 Calculate Sample Volume at Standard Conditions

V_{mstd} = SCF (Dry) Through meter

$$= 17.32 \frac{V_m \times P_m}{T_m}$$

$$= 17.32 \frac{65.31 \times 28.69}{560.5}$$

$$= 57.9 \text{ SCF (Dry)}$$

Where: V_m = Dry gas measured by meter, cu.ft.

P_m = Abs. Pr. at meter (use barometric pressure, uncorrected for altitude), In. H_g

C - 3 Calculate Volume Fraction Water in Flue Gas

V_{wstd} = Water vapor in SCF

$= 0.0465 V_{lc}$

$= 0.0465 \cdot 20.5$

$= 0.95$ SCF

B_{wo} = Water $\frac{V}{V}$

$$= \frac{V_{wstd}}{(V_{wstd} + V_{mstd})}$$

$$= \frac{0.95}{0.95 + 57.9} = \frac{0.95}{(58.85)} = 0.0161$$

Where V_{lc} = Weight of water collected in impingers plus that gained by drierite, GMS

C - 4 Calculate Dry and Wet Molecular Weight of Stack Gas

M_d = Dry Mol. Wt.

= 0.44 (% CO_2) + 0.32 (% O_2)

+0.28 (% N_2 + CO)

= 0.44 x Zero + 0.32 x 3.9 - 6.69 + 0.28 x 79.1 - 82.15

= 28.84

M_s = Wet Mol. Wt.

= M_d (1- B_{wo}) + 18 B_{wo}

= 28.84 x 0.9839 + 18 x 0.0161

= 28.67 0.290

C - 5 Calculate The Average $\sqrt{\Delta P}$, ($\sqrt{\Delta P}$) Avg., Obtained during gas sample acquisition

($\sqrt{\Delta P}$) Avg. = 0.835

C - 6 Calculate The Average Stack Gas Temperature, T_s, at time of Gas Sample Acquisition

T_s = 540 °R

C - 7 Calculate The Average Stack Gas Velocity

(V_s)Avg. = 85.48 x C_p x ($\sqrt{\Delta P}$) Avg. $\sqrt{\frac{T_s}{P_s \times M_s}}$

= 85.48 x 0.84 x 0.835 $\sqrt{\frac{540}{28.71 \times 28.67}}$ = 0.810

= 28.56 ft./sec

Where:

C_p = Pitot Tube Coefficient

P_s = Absolute Stack Gas Press., In. Hg.

Io-1
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C - 8 Calculate Stack Cross Sectional Area at Sampling Site

A_s = 0.92 Sq. Ft.

C - 9 Calculate Stack Gas Average Volumetric Flow Rate

Q_s = Stack Gas Flow Rate, SCFM (Dry)

$$= 1043 \times (1-B_{wo}) \; (V_s)\text{Avg.} \times A_s \; \frac{P_s}{T_s}$$

$$= \frac{1043}{} \times \frac{0.9839}{} \times \frac{78.56}{} \times \frac{0.92}{} \times \frac{28.69}{540}$$

= 2,440 SCFM (Dry)

C - 10 Calculate Isokinetic Sampling Efficiency

$$I = \frac{0.00321 \; (V_{wstd} + V_{mstd}) \times T_s \times P_m}{\theta \times A_n \times (V_s)\text{Avg.} \times P_s}$$

$$= 0.00321 \times \frac{58.85 \times 540 \times 28.69}{60 \times 0.000371 \times 78.56 \times 28.71}$$

= 102.6 %

θ = Total Sampling Time, Min.

A_n = Nozzle Opening, Sq. Ft.

C - 11 Calculate Heat Input during testing period

Z = Total Heat Input Rate to Boiler, MEGA BTU/hr.

= $W_1 \times H_1$ =

+ $W_2 \times H_2$

+ $W_3 \times H_3$

= TOTAL

= _____ x _____

_____ x _____

_____ x _____

TOTAL _____ MEGA BTU/hr.

Where W_1, W_2, & W_3 = hourly fuel input of respective fuels and H_1, H_2, & H_3 = gross (as received) heating value of respective fuels in mega BTU per input unit (consistent with fuel input unit).

C - 12 Calculate Front End Particulate Grain Loading (with Front Half Washings Only)

C_s' = Part. Grain Loading, gr/SCF (Dry)

$$= 15.42 \times \frac{M_n}{V_{mstd}}$$

$$= 15.42 \times \frac{0.0198}{57.9}$$

$$= \underline{0.012} \text{ gr/SCF (Dry)}$$

Where

M_n = Total Particulate Collected (Filter Plus Front Half Washings Only), GMS

C - 13 Calculate Front End Emission Factor

E_t = Hourly Mass Rate, lbs/hr.

$= 0.00857 \times C_s' \, Q_s$

$= 0.00857 \times \underline{0.012} \times \underline{2,770}$

$= \underline{0.25}$ lbs/hr.

E_h = Front End Emission Factor, lbs/MEGA BTU

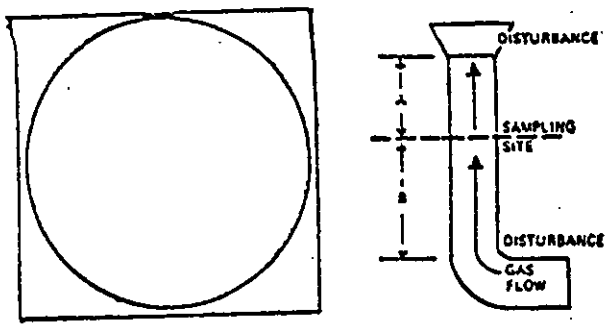
$$= \frac{E_t}{Z}$$

$$= \frac{\quad}{\quad}$$

$= \underline{\quad}$ lbs/MEGA BTU

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

E. PORT

PLANT Sparrows, N. J.
DATE 9 July 1976
LOCATION Elev. Henrylose
OPERATOR E.T.B., O.F.K., N.J.O.
STACK NO. Ideng Cleaner
RUN NO. Two (2)
SAMPLE BOX NO. 2343-3
METER BOX NO. 2343-3

AMBIENT TEMPERATURE 60°
BAROMETRIC PRESSURE 28.69
ASSUMED MOISTURE, % 2.03
PROBE LENGTH, in. 36
NOZZLE DIAMETER, in. 0.25
STACK DIAMETER, in. 13.11
PROBE HEATER SETTING None
HEATER BOX SETTING None

METER ΔH@ _____
C FACTOR 0.84
PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg

SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	0.6782	2.1889
TARE WEIGHT	0.6512	2.1658
WEIGHT GAIN	0.0270	0.0231

TOTAL 0.0427

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
	1725						860.700							
1	1728	+0.3	80	.55	.742	2.5	2.5	863	100	96	80	50	10	
2	1731			.55	"	2.5	2.5	866	101	97				
3	1734			.70	.837	3.9	3.9	869	102	96				
4	1737			.69	.831	3.3	3.3	872	104	96				
5	1740			.71	.843	3.4	3.4	875	103	96				
6	1743			.68	.825	3.2	3.2	878	105	97				
7	1746			.68	"	3.2	3.2	881	106	98				
8	1749			.70	.837	3.4	3.4	884	106	97				
9	1752			.72	.849	3.4	3.4	887	107	98				
10	1755	↓	↓	.72	.849	3.4	3.4	890	108	98	↓	↓	↓	
TOTAL														
AVERAGE				☒										

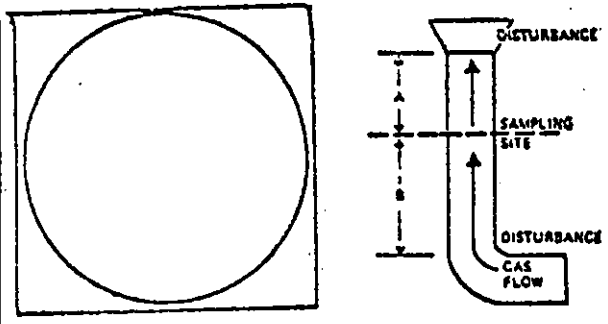
VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					21

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

PARTICULATE FIELD DATA

SCHEMATIC OF STACK



CROSS SECTION

5. Point

PLANT Sparrows N. U. AMBIENT TEMPERATURE 80

DATE 9 July 1976 BAROMETRIC PRESSURE 28.69

LOCATION Elev. Henhouse ASSUMED MOISTURE, % 2 to 3

OPERATOR F.J.B, D.F.K, M.W.O. PROBE LENGTH, in. 36

STACK NO. Joe's Cleaner NOZZLE DIAMETER, in. 0.425

RUN NO. Two (2) STACK DIAMETER, in. 13"

SAMPLE BOX NO. 2343-3 PROBE HEATER SETTING None

METER BOX NO. 2343-3 HEATER BOX SETTING None

METER $\Delta H_@$ _____ _____

C FACTOR 0.84

PROCESS WEIGHT RATE _____

WEIGHT OF PARTICULATE COLLECTED, mg		
SAMPLE	FILTER	PROBE WASH
FINAL WEIGHT	2.6288	6.2.1889
TARE WEIGHT	2.6542	6.2.1658
WEIGHT GAIN	0.0196	0.0231
TOTAL	0.0427	

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min. (1258)	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
1	1801	+0.3	80	.52	.721	2.3	2.3	893	109	98	80	80	1 to 2	
2	1809			.52	"	2.3	2.3	896	109	98				
3	1807			.55	.742	2.5	2.5	899	108	98				
4	1810			.55	"	2.5	2.5	902	109	98				
5	1813			.66	.812	3.0	3.0	905	109	98				
6	1816			.66	.812	3.0	3.0	908	111	98				
7	1819			.81	.900	3.9	3.9	911	110	99				
8	1822			.88	.938	4.3	4.3	914	110	98				
9	1825			.88	.938	4.3	4.3	917	110	98				
10	1828	↓	↓	.88	.938	4.3	4.3	921.998 = End	110	98	↓	↓	↓	
TOTAL	60				16.444				2137	1950	=			
AVERAGE	3	+0.3	80	☒	0.822				106.85	97.50	80	80	1.5	

VOLUME OF LIQUID WATER COLLECTED	IMPINGER VOLUME ml 1	2	3	4	SILICA GEL WEIGHT, g
FINAL					
INITIAL					
LIQUID COLLECTED					
TOTAL VOLUME COLLECTED					21

ORSAT MEASUREMENT	TIME	CO_2	O_2	CO	N_2
1					
2					
3					
4					

COMMENTS:

74

4/1/76 75

ID-2

PARTICULATE EMISSION CALCULATION

Plant: SARLES, NORTH DAKOTA

Location: ELEVATOR HEADHOUSE

Stack or Source: IDEAL CLEANER

Date: 9 JULY 1976

Run No.: TWO (2)

Operator: E.J.B., O.F.A., M.W.O.

Bar. Pr., In. Hg: 28.69 ABSOLUTE

Nozzle Dia, In.: 0.25 (1/4)"

Stack Dia., In.: 13"ϕ

Cp: 0.84

Total Time, Min.: 60

Orsat Analysis: (Dry Basis, % by Vol.), Average

CO_2	ZERO
O_2	20.9
CO	ZERO
N_2	79.1

Water Collected, GMS.: 21

Filter No.: H

Particulate Collected, GMS.:

Filter 0.0196

Probe Wash 0.0231

Vol. Through Gas Meter, Cu. Ft.: FRONT END TOTAL 0.0427

Impinger Catch ~

FRONT PLUS BACK END CATCH TOTAL _____

Standard Conditions: Dry Gas at 15.6°C and 29.92 in. Hg.

C - 1 Calculate Average Meter Temperature

T_m = The average of both inlet and outlet temperatures obtained during sampling, 569.2 °R.

C - 2 Calculate Sample Volume at Standard Conditions

V_{mstd} = SCF (Dry) Through meter

$$= 17.32 \frac{V_m \times P_m}{T_m}$$

$$= 17.32 \frac{14.52 \times 28.69}{562.2}$$

$$= 57.03 \text{ SCF (Dry)}$$

Where: V_m = Dry gas measured by meter, cu.ft.

P_m = Abs. Pr. at meter (use barometric pressure, uncorrected for altitude), In. Hg

C - 3 Calculate Volume Fraction Water in Flue Gas

V_{wstd} = Water vapor in SCF

$= 0.0465 V_{lc}$

$= 0.0465 \cdot 21$

$= 0.98$ SCF

B_{wo} = Water $\frac{V}{V}$

$$= \frac{V_{wstd}}{(V_{wstd} + V_{mstd})}$$

$$= \frac{0.98}{0.98 + 57.03} = \frac{0.98}{(58.01)} = 0.0169$$

Where V_{lc} = Weight of water collected in impingers plus that gained by drierite, GMS

C - 4 Calculate Dry and Wet Molecular Weight of Stack Gas

M_d = Dry Mol. Wt.

= 0.44 (% CO_2) + 0.32 (% O_2)

+0.28 (% N_2 + CO)

= 0.44 x ZERO + 0.32 x 20.9 = 6.69 + 0.28 x 79.1 = 22.1

= 28.84

M_s = Wet Mol. Wt.

= M_d (1- B_{wo}) + 18 B_{wo}

= 28.84 x 0.9831 + 18 x 0.0169

= 28.66 0.304

C - 5 Calculate The Average $\sqrt{\Delta P}$, ($\sqrt{\Delta P}$) Avg., Obtained during gas sample acquisition

($\sqrt{\Delta P}$) Avg. = 0.822

C - 6 Calculate The Average Stack Gas Temperature, T_s, at time of Gas Sample Acquisition

T_s = 540 °R

C - 7 Calculate The Average Stack Gas Velocity

(V_s)Avg. = 85.48 x C_p x ($\sqrt{\Delta P}$) Avg. $\sqrt{\frac{T_s}{P_s \times M_s}}$

= 85.48 x 0.84 x 0.822 $\sqrt{\frac{540}{28.71 \times 28.66}}$ = 0.810

= 77.81 ft./sec

Where:

C_p = Pitot Tube Coefficient

P_s = Absolute Stack Gas Press., In. Hg.

C - 8 Calculate Stack Cross Sectional Area at Sampling Site

A_s = 0.92 Sq. Ft.

C - 9 Calculate Stack Gas Average Volumetric Flow Rate

Q_s = Stack Gas Flow Rate, SCFM (Dry)

$$= 1043 \times (1-B_{wo}) \; (V_s)\text{Avg.} \times A_s \; \frac{P_s}{T_s}$$

$$= \frac{1043 \times 0.9831 \times 47.81 \times 0.92 \times 28.71}{540}$$

= 2,700 SCFM (Dry)

C - 10 Calculate Isokinetic Sampling Efficiency

$$I = \frac{0.00321 \; (V_{wstd} + V_{mstd}) \times T_s \times P_m}{\theta \times A_n \times (V_s)\text{Avg.} \times P_s}$$

$$= 0.00321 \times \frac{58.01 \times 540 \times 28.69}{60 \times 0.00037 \times 47.81 \times 28.71}$$

= 102.7 %

θ = Total Sampling Time, Min.

A_n = Nozzle Opening, Sq. Ft.

C - 11 Calculate Heat Input during testing period

Z = Total Heat Input Rate to Boiler, MEGA BTU/hr.

$= W_1 \times H_1 =$

$+ W_2 \times H_2$

$+ W_3 \times H_3$

= TOTAL

= _____ x _____

_____ x _____

_____ x _____

TOTAL _____ MEGA BTU/hr.

Where W_1, W_2, & W_3 = hourly fuel input of respective fuels and H_1, H_2, & H_3 = gross (as received) heating value of respective fuels in mega BTU per input unit (consistent with fuel input unit).

C - 12 Calculate Front End Particulate Grain Loading (with Front Half Washings Only)

C_s' = Part. Grain Loading, gr/SCF (Dry)

$$= 15.42 \times \frac{M_n}{V_{mstd}}$$

$$= 15.42 \times \frac{0.0727}{57.03}$$

$$= 0.012 \text{ gr/SCF (Dry)}$$

Where

M_n = Total Particulate Collected (Filter Plus Front Half Washings Only), GMS

C - 13 Calculate Front End Emission Factor

E_t = Hourly Mass Rate, lbs/hr.

$= 0.00857 \times C_s' \, Q_s$

$= 0.00857 \times 0.012 \times 2,700$

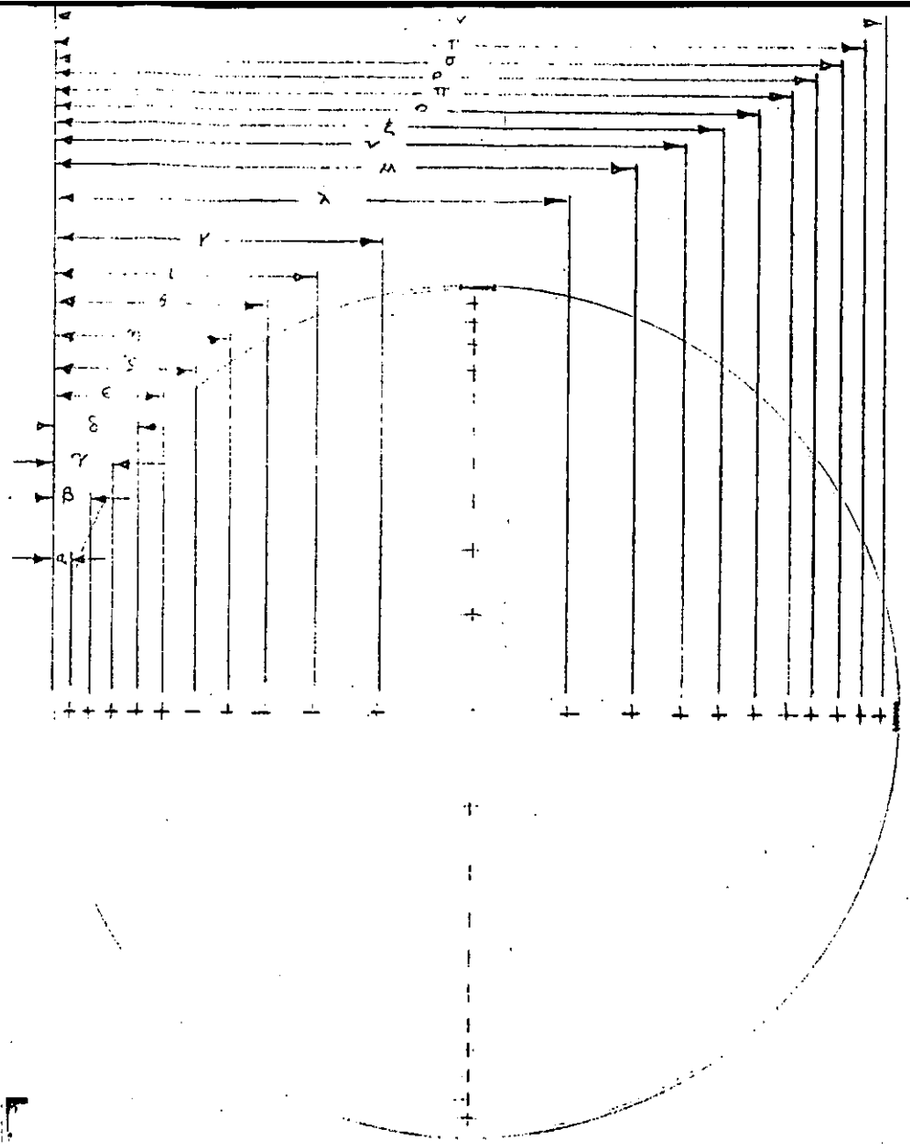
$= 0.025$ lbs/hr.

E_h = Front End Emission Factor, lbs/MEGA BTU

$$= \frac{E_t}{Z}$$

$$= \frac{\quad}{\quad}$$

$$= \quad \text{lbs/MEGA BTU}$$



SECTION A-A

19" DIA. DUCT

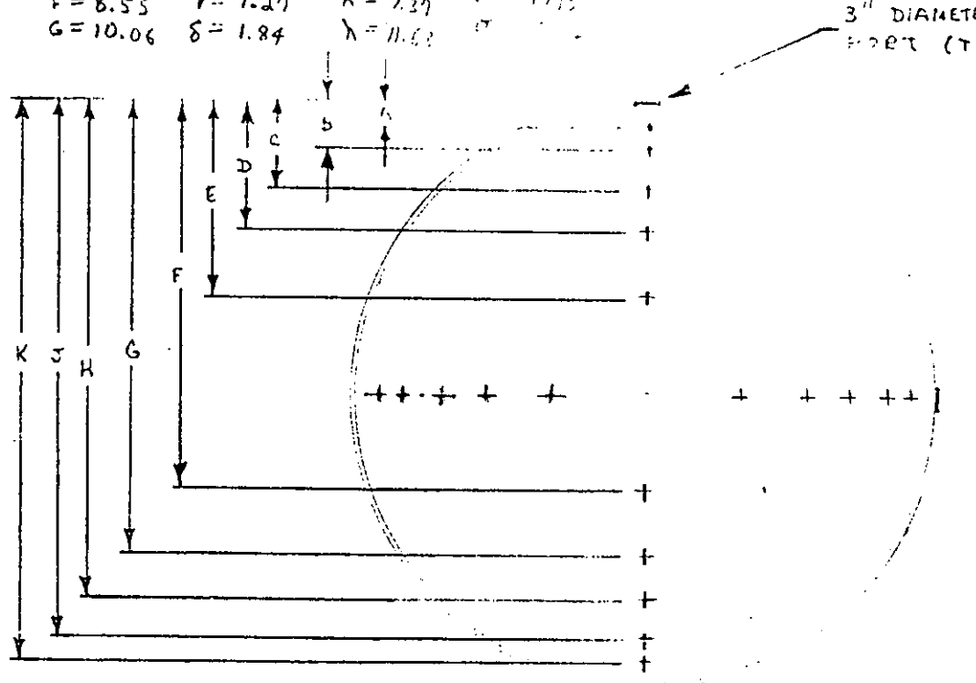
SCALE: 1"=1'

NOTES:

1. + INDICATES TRAVERSE POINTS AT WHICH AIR FLOW RATES AND SAMPLES WERE TAKEN.

2. DISTANCE FROM DUCT WALL TO TRAVERSE POINTS ARE AS LISTED BELOW

A= .33	H= 11.10	ε = 2.45	μ = 13.18
B= 1.07	J= 11.93	ς = 3.13	ν = 14.25
C= 1.90	K= 12.68	η = 3.87	ξ = 15.12
D= 2.94	α= .25	θ = 4.95	ο = 15.86
E= 4.45	β= .74	ι = 5.81	π = 16.55
F= 8.55	γ= 1.27	κ = 7.39	ρ = 17.15
G= 10.06	δ= 1.84	λ = 11.62	

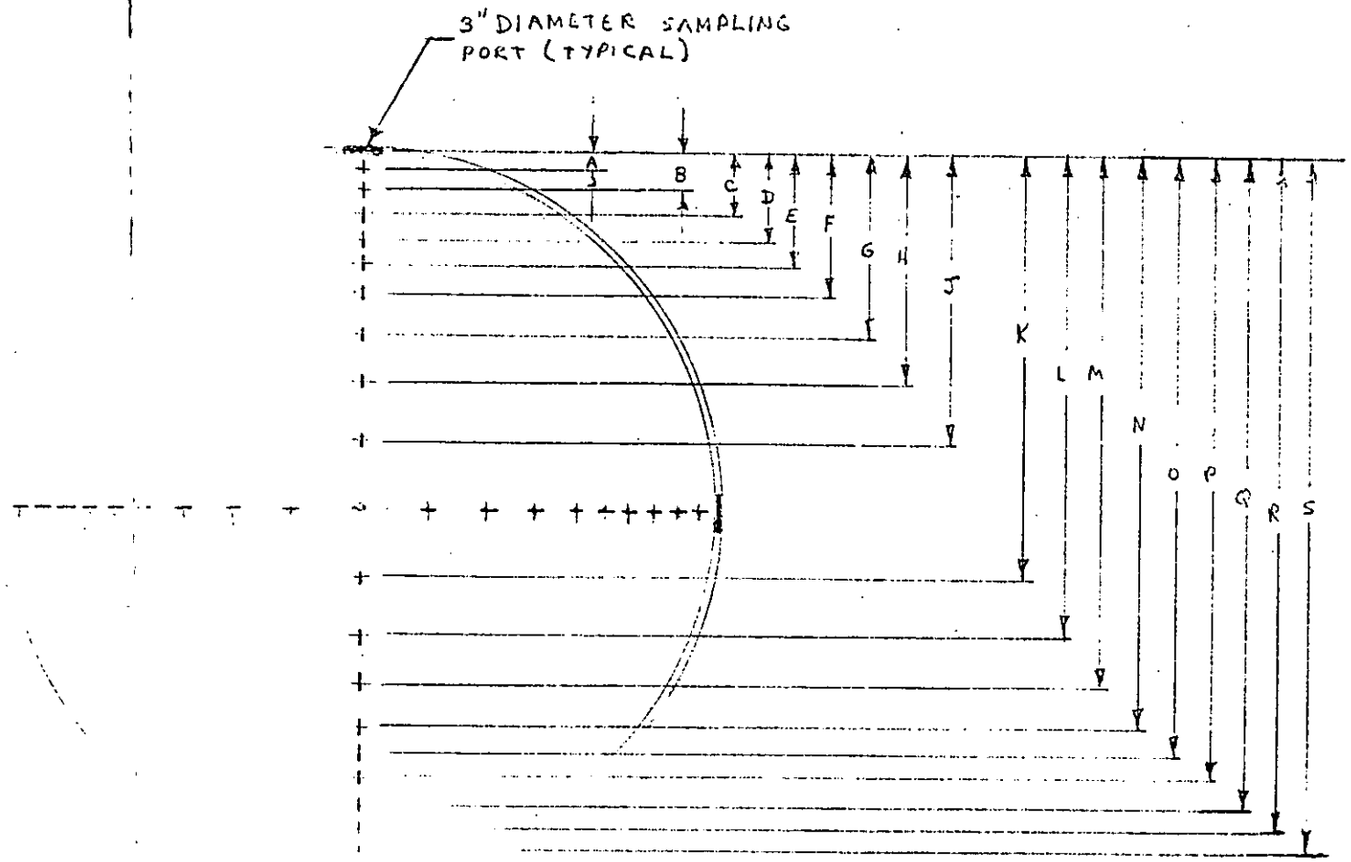


SECTION C-C

13" DIA. DUCT

SCALE: 3"=1'

POLLUTION CURBS INC.



NOTES:

1. + INDICATES TRAVERSE PTS. AT WHICH AIR FLOW RATES AND SAMPLES WERE TAKEN.

2. DISTANCE FROM DUCT WALL TO TRAVERSE POINTS ARE AS LISTED BELOW.

A = .24	K = 10.51
B = .75	L = 11.97
C = 1.29	M = 12.96
D = 1.85	N = 13.80
E = 2.48	O = 14.56
F = 3.19	P = 15.15
G = 4.01	Q = 15.72
H = 5.03	R = 16.25
J = 6.49	S = 16.76

SECTION B-B

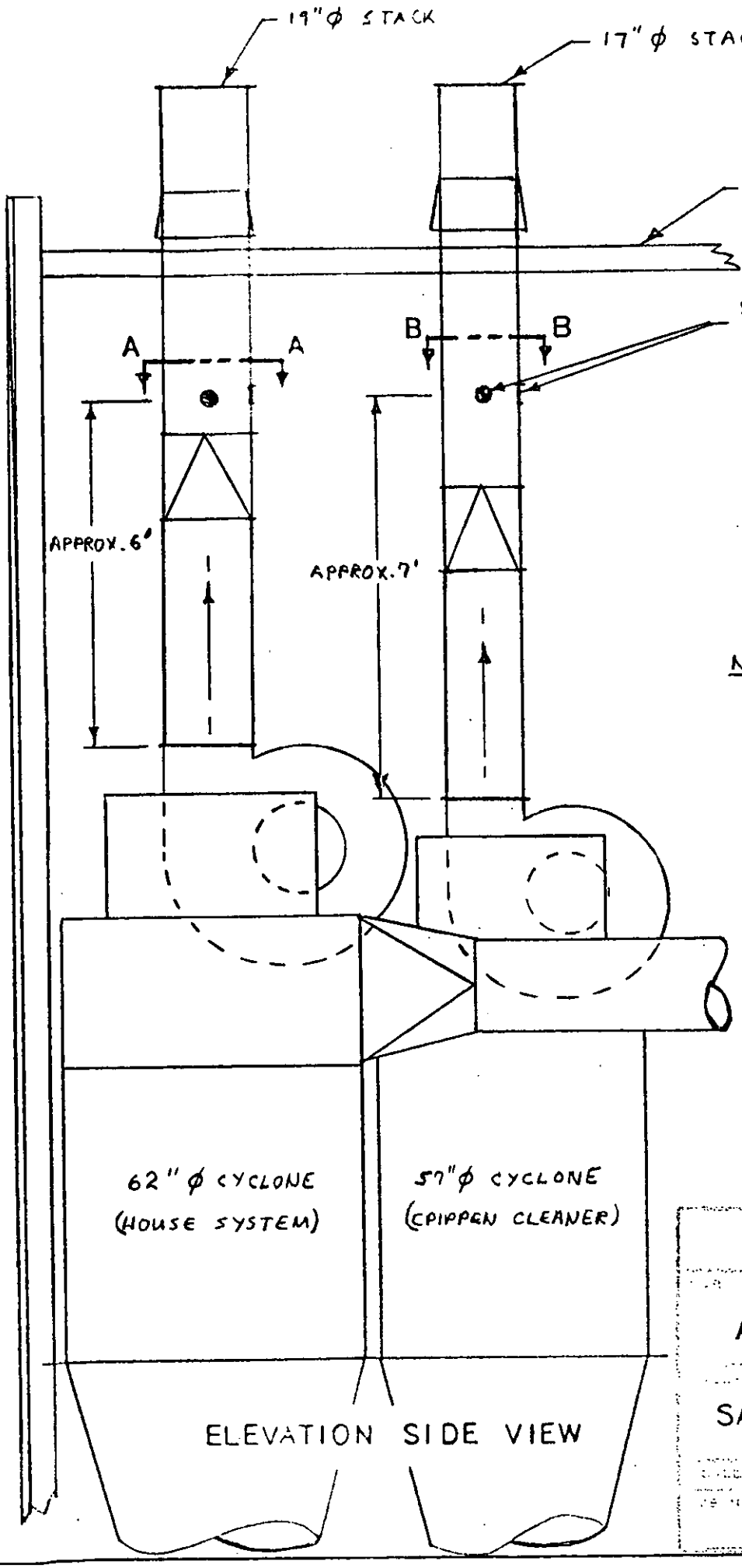
17" DIA. DUCT

SCALE: 3" = 1'

[illegible]

BY: DEAN FRANKE JULY 15, [illegible]

18 69



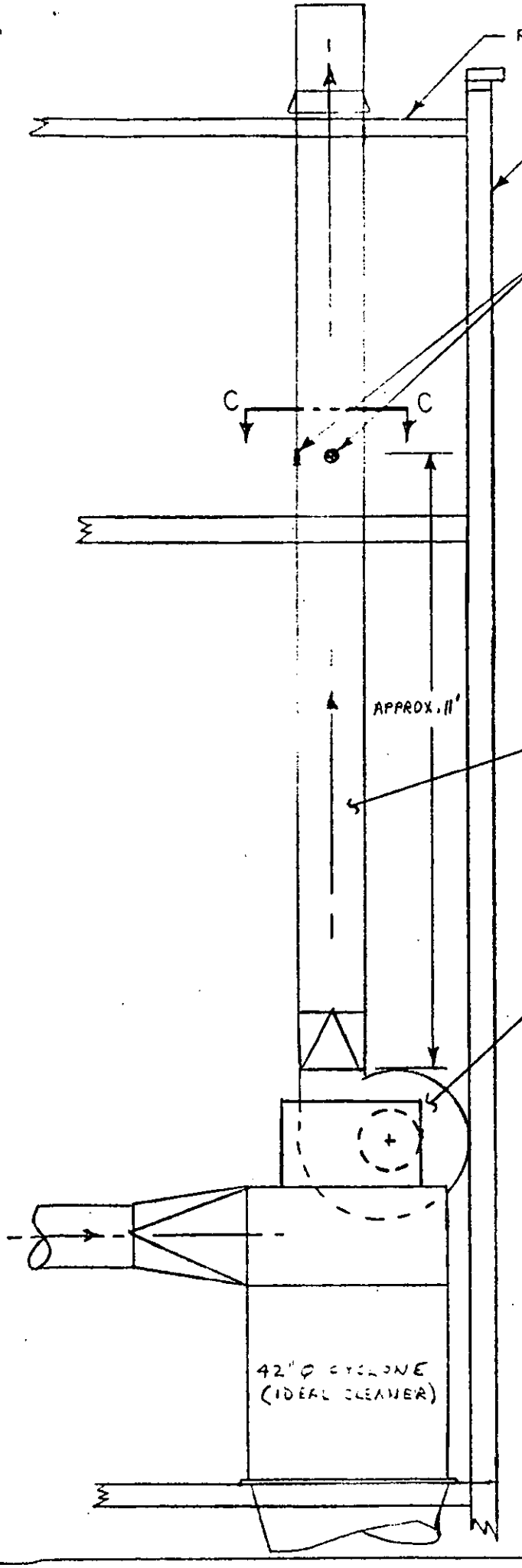
NOTE : FOR DETAILED VIEWS OF SECTIONS A-A & B-B SEE PCI SKETCHS SK-210 AND SK-211

POLLUTION CURBS INC.
ST. PAUL, MINNESOTA

FARMERS UNION ELEV. ASSOCIATION SARLES, N.D.

SAMPLING SITE SKETCH

SCALE 3/8"=1'	D. FRANKE	DATE 7-15-76
JOB NO. 508357	DWG. NO. SK-212	



NOTE: FOR DETAILED VIEW OF SECTION C-C SEE PCI SKETCH SK-210

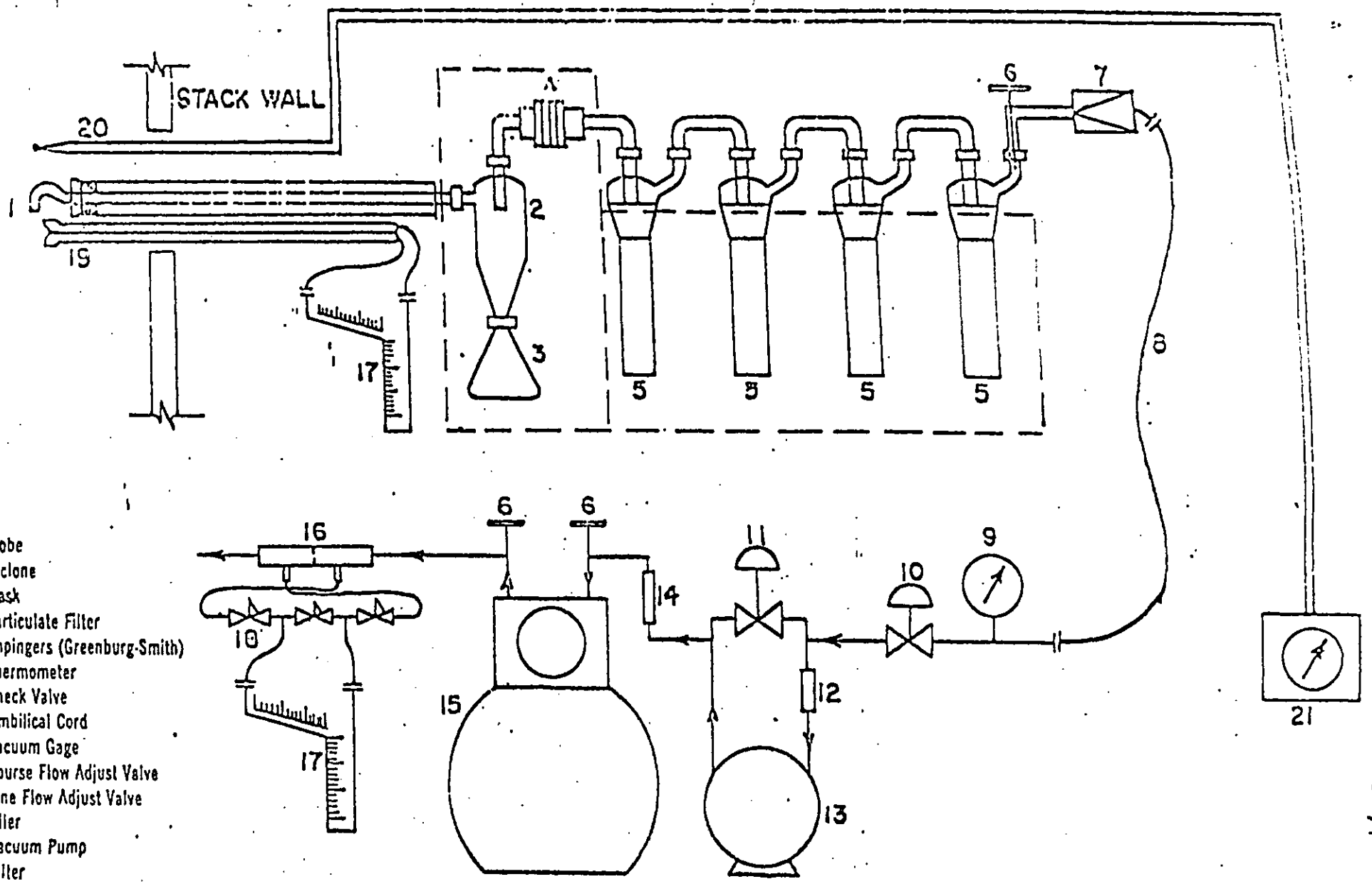
POLLUTION CURBS INC.
ST. PAUL, MINNESOTA

FARMERS UNION ELEV. ASSOCIATION SARLES, N.D.

SAMPLING SITE SKETCH

3/8"=1' D. FRANKE 7-15-76

508357 SK-213



1) Probe
2) Cyclone
3) Flask
4) Particulate Filter
5) Impingers (Greenburg-Smith)
6) Thermometer
7) Check Valve
8) Umbilical Cord
9) Vacuum Gage
10) Course Flow Adjust Valve
11) Fine Flow Adjust Valve
12) Oiler
13) Vacuum Pump
14) Filter
15) Dry Gas Meter
16) Orifice Tube
17) Incline Manometer
18) Solenoid Valves
19) Pilot
20) Thermocouple
21) Pyrometer

FIGURE 10

PROPERTY OF
RESEARCH APPLIANCE Co. GIBSONIA, PA.

TOLERANCES DEC. ± FRACT. ±	TITLE: STACK SAMPLE FLOW SYSTEM		
	DWG. NO. 1748	MATL	SCALE
NO. REQ'D	DRAWN BY R.C.	APPR.	DATE 6-23-6
FINISH		JIG NO.	PART NO.

65 A

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MINNESOTA POLLUTION CONTROL AGENCY

1935 W. County Road B2, / Roseville, Minnesota 55113

612-296-7373

This is to certify that,

FRANK BELGEA

attended and fulfilled the requirements of the

VISIBLE EMISSION EVALUATION RE-CERTIFICATION COURSE

offered by

THE MINNESOTA POLLUTION CONTROL AGENCY

on

APRIL 1, 1976

During the course of the test an average deviation of less than 7.5% for a set of 25 white smoke and a set of 25 black smoke was maintained and none of the readings deviated by 20% or more.

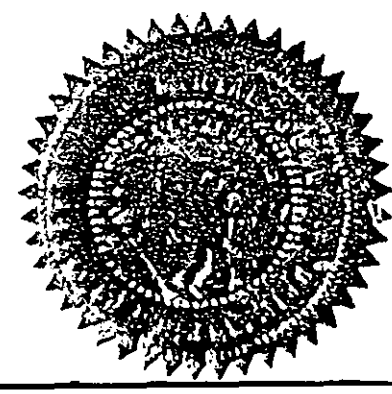
By achieving the above accuracy, certification as a "Smoke Reader" is granted for a period of six months from the date of the test.

James L. Kolar

JAMES L. KOLAR
Instructor
Pollution Control Specialist
MPCA, DAQ

Richard J. Sandberg

RICHARD J. SANDBERG
Instructor
Pollution Control Specialist
MPCA, DAQ



Environmental Health
and
Engineering Services

Division of
Environmental Engineering
GENE A. CHRISTIANSON, P.E.
DIRECTOR
(701) 224-2374

North Dakota State

W. VAN HEUVELEN, C-[illegible]

Department of Health

State Capitol
Bismarck, North Dakota 58505

February 5, 1976

Mr. Frank J. Belgea
Vice President of Operations
Pollution Curbs, Incorporated
502 North Prior Avenue
St. Paul, Minnesota 55104

Re: Niobe Farmers Co-op Elevator Company
PCI Project No. 508357

Dear Mr. Belgea:

In response to your letter of January 22, 1976, regarding the above referenced facility, we have received a copy of revisions to the dust control system design from Jacobson & Sons Construction Company. These revisions have been reviewed and are satisfactory to the Department.

Performance testing is required for your company's collection equipment as this is the Department's policy regarding initial installation of a line of collection equipment for which no performance tests, efficiency curves, etc. are available. Once performance tests of the control equipment have been submitted and are satisfactory to us, we will give approval for the use of your equipment throughout the State without further tests. However, if the design of your equipment should be modified, additional tests may be required.

Our records indicate that your firm will also be installing dust control systems for the Farmers Union Elevator Association at Sarles, North Dakota and the Kramer Equity Elevator Company at Kramer, North Dakota. As mentioned earlier, performance testing of your collection equipment would be required at only one of these locations (Niobe, Sarles, or Kramer). If the tests are satisfactory to us, we would approve the use of your equipment throughout the State without further testing. We request that the testing be conducted as soon as possible on the first of these three facilities to begin operation.

Please inform us of your decision as to which dust control system will be tested. Enclosed is a copy of the guidelines to be used in conducting performance testing in North Dakota.

If you have any questions, please feel free to contact us.

Yours truly,

W. Van Heuvelen, Chief
Environmental Control

CDR:lrr
Encl:
cc: Wesley Hennix - Niobe Farmers Elevator
Howard Thompson - Farmers Union Elev. Assoc., Sarles
Myron Brandt - Kramer Equity Elevator

DRY TEST METER CALIBRATION

Date: June 1, 1976 Meter No. RAC 2343-3

Standard: "Precision" Wet Test Meter - Precision Scientific Co

DATA:

	Standard	Test Meter
Flow Rate	1.0 CFM	1.0 CFM
Test Volume	65.40 CU. FT.	61.35
Test Time	65.4 MINS.	65.4 MINS.
Gas Temperature	77°F (25°C)	77°F (25°C)
Gas Pressure	760 mm Hg.	760 mm Hg.
Correction Factor	ZERO	0.938

Date: _____ Meter No. _____

Standard: _____

DATA:

	Standard	Test Meter
Flow Rate		
Test Volume		
Test Time		
Gas Temperature		
Gas Pressure		
Correction Factor		

PCI Contract No. 508357

PITOT TUBE CALIBRATION - STAUSCHEIBE TYPE

Date: June 1, 1976

Pitot Tube: 3 foot RAC Stainless Steel Pitobe with 0.25" nozzle attached.

Standard: 12" Standard type pitot tube (Dwyer Instruments, Inc.) - Used for calibration purposes only.

Data:

Indicated Velocity Pressure (inches of water) A. Standard	B. Stauscheibe	Calibration Factor	Coefficient
1. 0.02	0.03	0.667	0.817
2. 0.05	0.07	0.714	0.845
3. 0.10	0.14	0.714	0.845
4. 0.18	0.24	0.750	0.866
5. 0.32	0.45	0.711	0.843
6. 0.49	0.68	0.721	0.849
7. 0.65	0.95	0.684	0.827
8. 0.90	1.28	0.708	0.839
9. 0.22	0.30	0.733	0.856
10. 0.07	0.10	0.700	0.837
Average pitot tube coefficient:			0.842

Client: Farmers Union Elevator Association, Sarles, North Dakota

Specifications of Calibration System:

6" inside diameter PVC pipe - Calibration orifice or access port is 18 duct diameters downstream and 11 diameters upstream from any outlet, bend, or obstruction - 1 hp Dayton Electric Motor (3450 rpm) - Dayton Blower with 10-5/8"Ø wheel - Bell housing inlet to calibration system.