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PARTICULATE EMISSIONS TESTING

ERC REPORT No. 4-7683

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Submitted to:

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1.0 INTRODUCTION

During November 12-14, three (3) cyclones at the Egeland Elevator Company, Egeland, N.D. were tested to determine cyclone efficiency and compliance with North Dakota particulate emission standards. The tests were performed using standard EPA procedures.

A summary of the data and resulting calculation is presented in tabular form in Section 2.

2.0 SUMMARY OF DATA AND CALCULATIONS

TABLE 1

RESULTS OF TESTING ON CYCLONE NUMBER 1

PARAMETERS	Test Run #1		Test Run #2		Test Run #3	
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Barometric Pressure inches of Mercury	29.48	29.48	29.28	29.28	29.18	29.18
Static Pressure inches of water	0.5	1.5	0.45	1.5	0.5	1.6
Gas Temperature °F	38	36	34	30	37	36
Gas Velocity ft./sec.	-	-	31.4	15.3	33.1	22.5
Gas Moisture Content, %	-	-	0.4	0.5	0.5	0.4
Gas Volumetric Flow Rate, SCFM, dry	-	-	2761	4455	2882	6459
Particulate Grain Loading Grains/SCF, dry	0.541	0.053	0.341	0.056	0.107	0.027
Isokinetic Variation, %	-	-	109.4	108.5	106.8	105.0
Process Weight Rate, lb./hr.	54630	54630	57600	57600	43200	43200
Maximum Allowable Emission Rate, lbs./hr.	37.6	37.6	39.0	39.0	32.1	32.1
Actual Emission Rate, lbs./hr.	11.0	4.6	8.1	2.1	2.6	1.5
Average Opacity, %		<5	-	<5	-	<5
Efficiency, %	90		84		75	

Cyclone No 1 + No 3 serve the Superior Cleaner

avg Inlet = 7.23 lb/hr

avg Proc Rate = 51,810 lb/hr = 25.9 Ton/hr

avg E F for Superior Cleaner = $\frac{\frac{\text{Cy No 1}}{7.23} + \frac{\text{Cy No 3}}{3.85}}{3} \Big/ 27.35\ \text{T/hr} = 0.40\ \text{lb/Ton}$

TABLE 2

RESULTS OF TESTING ON CYCLONE NUMBER 2

PARAMETERS	Test Run #1		Test Run #2		Test Run #3	
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Barometric Pressure inches of mercury	29.14	29.14	28.94	28.94		
Static Pressure inches of water	-3.9	-0.3	-5.6	-0.5		
Gas Temperature °F	35	43	44	52		
Gas Velocity ft./sec.	76.1	73.1	74.7	74.2		
Gas Moisture Content, %	0.5	0.4	0.3	0.4		
Gas Volumetric Flow Rate, SCFM, dry	11306	12949	10800	12815		
Particulate Grain Loading grains/SCF, dry	0.091	0.052	0.096	0.057		
Isokinetic Variation, %	107.2	109.4	103.4	106.2		
Process Weight Rate, lb./hr.	168370	168370	190290	190290	←	NOTE
Maximum Allowable Emission Rate, lbs./hr.	49.6	49.6	50.8	50.8		
Actual Emission Rate, lbs./hr.	8.8	5.8	8.9	6.3	←	NOTE
Average Opacity, %	-	night	-	<5		
Efficiency, %	43		41			

[illegible] head, front & back side scale, 2 legs

$$EF = \frac{8.85\ lb/hr}{89.5\ Ton/hr} = 0.10\ lb/Ton$$

RESULTS OF TESTING ON CYCLONE NUMBER 3

PARAMETERS	Test Run #1		Test Run #2		Test Run #3	
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Barometric Pressure inches of Mercury	28.96	28.96	28.94	28.94	28.94	28.94
Static Pressure inches of water	-8.3	-0.2	-8.3	-0.3	-8.3	-0.2
Gas Temperature °F	36	42	42	49	43	52
Gas Velocity ft./sec.	34.3	48.0	38.1	48.5	37.4	47.7
Gas Moisture Content, %	0.6	0.3	0.4	0.4	0.4	0.3
Gas Volumetric Flow Rate, SCFM, dry	1367	2318	1502	2305	1472	2257
Particulate Grain Loading grains/SCF, dry	0.248	0.107	0.387	0.084	0.217	0.081
Isokinetic Variation, %	151.0	119.8	106.2	101.0	106.4	103.4
Process Weight Rate, lb./hr.	56300	56300	54600	54600	60500	60500
Maximum Allowable Emission Rate, lbs./hr.	38.4	38.4	37.6	37.6	40.0	40.0
Actual Emission Rate, lbs./hr.	2.9	2.1	5.0	1.7	2.7	1.6
Average Opacity, %	-	<5	-	<5	-	
Efficiency, %	57		78		63	

→ avg Inlet = 3.85 lb/hr
avg Process Rate = 57,550 lb/hr = 28.78 T/hr

TABLE 4

VELOCITY CHECK IN FLOOR SWEEP DUCTS

	Ground Floor Duct	Third Floor Duct	Fourth Floor Duct
Duct Diameter, in.	16	16	12
Gas Temperature, ^{o}F	44	44	44
Assumed Moisture Content, %	0.4	0.4	0.4
Barometric Pressure, in Hg	28.94	28.94	28.94
Static Pressure, in Hg	-3.8	-4.6	-4.6
Average Velocity, Ft./sec.	79.5	80.8	79.6
Flow Rate, SCFM, dry	6686	6774	3757

3.0 CYCLONE LOCATION AND INLET AIR SOURCES

A. Cyclone #1

(a) Location: ground floor, outside

(b) Inlet air source: Superior Cleaner

B. Cyclone #2

(a) Location: head house

(b) Inlet air sources:

(1) Distributor
(2) Auto scale
(3) Front pit
(4) Back pit
(5) Leg head (2)
(6) Leg boot (2)
(7) Floor sweeps (on each floor)

C. Cyclone #3

(a) Location: head house

(b) Inlet air source: Superior Cleaner

4.0 GRAIN ELEVATOR OPERATION

(a) In order to test cyclones #1 and #3, which have the Superior Cleaner as their inlet air source, the grain elevator was operated as follows. Prior to each test run, one bin was filled with grain. The grain was then gravity fed to the Superior Cleaner, from where the cleaned grain was gravity fed to the back pit. From the pit, the grain was elevated up an elevator leg and then gravity fed through the distributor and auto-scale to a second bin. The total amount of grain run through the system during the test run was recorded.

(b) For purposes of testing cyclone #2, grain was gravity fed, from a previously filled bin, into the back pit. The grain was then elevated up both legs and then gravity fed to the distributor. Half of the grain then went directly to a storage bin. The remaining half was gravity fed to the auto-scale and then to a storage bin. Since only one-half of the grain went through the auto-scale, this amount was double in order to obtain the process weight rate.

5.0 PROCEDURES

The sampling was performed using two standard EPA sampling trains purchased from Lear Siegler. Due to location of the sampling ports, it was not possible to use the standard glass-lined probe, hot box, cold box assembly. The probes and S-type pitot tubes which were used were stainless steel. The standard hot box was replaced with a heated in-line filter holder. Reeve Angel 9.0 cm 900 AF glass fiber filters were used. The cold box and condensing impingers were replaced with a single desicant (silica gel) column. This assembly was then attached to the Lear Siegler control unit using the Lear Siegler umbilical cord.

Using the above described sampling train, sampling was performed according to the procedures described in EPA Methods 1, 2, 3, & 5.

6.0 DATA SHEETS

NOZZLE DIAMETER AS DETERMINED WITH A VERNIER CALIPER 11/7/75

Nozzle Number	Nominal Diameter (inch)	Actual Diameter (inch)	Actual Area ($ft.^2$)
1	0.125	0.132	0.000095
2	0.125	0.138	0.000104
3	0.125	0.134	0.000098
4	0.250	0.270	0.000398
5	0.250	0.255	0.000355
6	0.250	0.258	0.000363
7	0.250	0.252	0.000346
8	0.375	0.383	0.000800
9	0.375	0.385	0.000808