SOURCE TESTING STUDY

at an

IRON ORE BENEFICIATION FACILITY

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Prepared for the

U.S. Environmental Protection Agency

by

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Task 20

Contract No. 68-02-1408

Report No. 76 IOB-2

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I. INTRODUCTION

The U.S. Environmental Protection Agency retained Clayton Environmental Consultants, Inc. to conduct a source testing study of various emission sources at the pelletizing operations of Empire Mining Company near Palmer, Michigan. The primary purpose of this study was to provide data for the establishment of emission standards for iron ore beneficiation facilities.

The test program included measurement of particulate and asbestos emissions from four sampling locations of the pelletizing operation (Figure 1). Particulate samples were collected simultaneously in triplicate from the duct exhausting the drying section of the pelletizing operation, both before and after the electrostatic precipitator which controls this exhaust point. Triplicate particulate tests with an in-stack filter were also obtained at the precipitator outlet. Particle sizing samples were collected at precipitator inlet and outlet sampling locations. Triplicate measurements were taken simultaneously at the inlet and outlet locations of a Rotoclone controlling emissions from the pellet discharge end of the pelletizing operations.

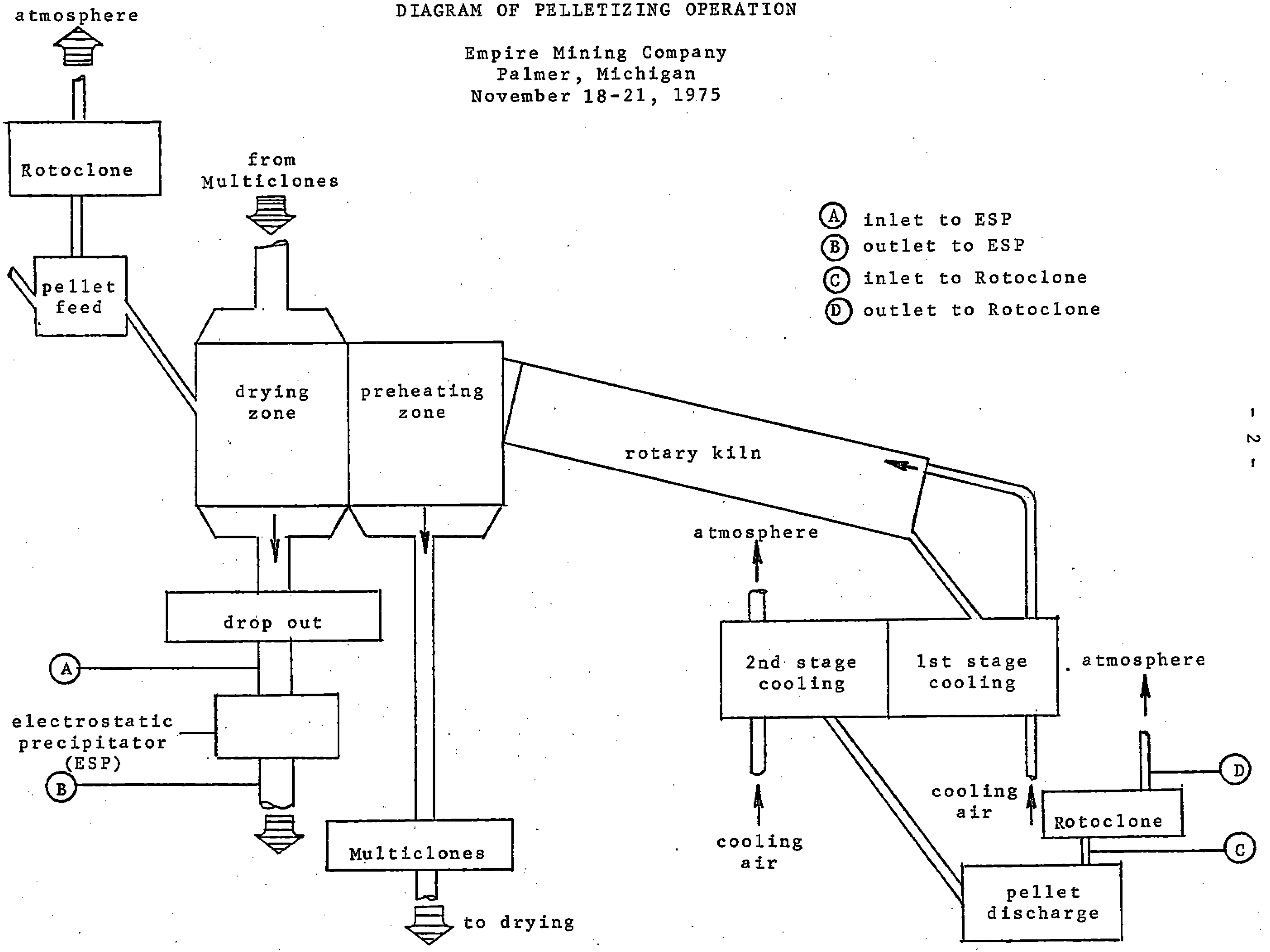
Associated data, including exhaust gas composition and moisture content, gas temperatures, and flowrates were also collected.

This study was conducted during the week of November 16, 1975. A list of project participants is included in Appendix A.

FIGURE 1

DIAGRAM OF PELLETIZING OPERATION

Empire Mining Company
Palmer, Michigan
November 18-21, 1975



II. SUMMARY AND DISCUSSION OF RESULTS

Table I summarizes results of the inlet and outlet particulate sampling at the No. 3 Kiln Electrostatic Precipitator which controls emissions from the drying zone of the pelletizing operation. Table II presents these same data in metric units. The uncontrolled total particulate emission rate from this source averaged 480 pounds per hour (218 kg/hr), while the outlet of the precipitator was found to have a total particulate emission rate of 13.3 pounds per hour (6.0 kg/hr). Emission rates decreased continually during the sampling at these two locations.

Tables III and IV present the results of the special (in-stack filter) tests conducted on the electrostatic precipitator outlet in English and metric units, respectively. The average total particulate emission rate was 21.4 pounds per hour (9.7 kg/hr).

Emissions measured by the in-stack filter and reference method tests are comparable only for the two tests which were collected simultaneously, tests 1 and 2. Impinger catch emission rates measured by the reference method, 14.3 and 9.2 pounds per hour (6.5 and 4.2 kg/hr), were similar to those measured by the special sampling train, 14.2 and 6.5 pounds per hour (6.4 and 2.9 kg/hr), differing by 0.7 and 34 percent, respectively. Filterable particulate emissions measured by the reference method were expected to be similar to those measured by the front filter, probe wash, and second filter of the special sampling train with a relatively small amount of particulate expected in the latter two fractions. During both tests, however, front filterable particulate of the special train was less than that measured by the reference method, and a relatively large portion of the particulate was captured in the probe wash and second filter. Special test 3

TABLE I

SUMMARY OF PARTICULATE EMISSIONS (ENGLISH UNITS)
NO. 3 KILN ELECTROSTATIC PRECIPITATOR

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Source	Test No.	Stack Gas Conditions			Concentration (gr/DSCF)			Emission Rate (lbs/hr)		
		Temp (°F)	Flowrate		Filterable Particulate	Impinger Catch	Total Particulate	Filterable Particulate	Impinger Catch	Total Particulate
			DSCFM	ACFM						
Inlet	1	214	168,000	272,000	0.476	0.006	0.482	686	8.1	694
	2	210	168,000	276,000	0.360	0.005	0.366	519	7.8	527
	3	217	171,000	282,000	0.289	0.006	0.295	424	8.8	433
	4	209	174,000	282,000	0.174	0.004	0.178	259	6.1	265
	Avg.	212	170,000	278,000	0.325	0.005	0.330	472	7.7	480
Outlet	1	230	201,000	322,000	0.002	0.008	0.010	3.5	14.3	17.8
	2	220	201,000	322,000	0.003	0.005	0.008	5.0	9.2	14.2
	4	225	205,000	332,000	0.001	0.003	0.004	2.3	5.5	7.8
	Avg.	225	202,000	325,000	0.002	0.005	0.007	3.6	9.7	13.3

TABLE II

SUMMARY OF PARTICULATE EMISSIONS (METRIC UNITS)
NO. 3 KILN ELECTROSTATIC PRECIPITATOR

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Source	Test No.	Stack Gas Conditions			Concentration (mg/DNm^3)			Emission Rate (kg/hr)		
		Temp (°C)	Flowrate DNm^3/min	Flowrate Am^3/min	Filterable Particulate	Impinger Catch	Total Particulate	Filterable Particulate	Impinger Catch	Total Particulate
Inlet	1	101	4760	7700	1090	12.8	1100	311	3.7	315
	2	99	4760	7820	825	12.4	837	236	3.5	239
	3	103	4840	7990	662	13.7	676	192	4.0	196
	4	98	4930	7990	398	9.4	407	118	2.8	120
	Avg.	100	4820	7880	744	11.8	755	214	3.4	218
Outlet	1	110	5690	9120	4.7	18.9	23.6	1.6	6.5	8.1
	2	104	5690	9120	6.7	12.3	18.9	2.3	4.2	6.5
	4	107	5810	9400	3.0	7.1	10.1	1.0	2.5	3.5
	Avg.	107	5730	9210	4.8	12.8	17.5	1.6	4.4	6.0

TABLE III

SUMMARY OF PARTICULATE EMISSIONS (ENGLISH UNITS)
SPECIAL TESTS ON NO. 3 KILN ELECTROSTATIC PRECIPITATOR OUTLET

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Test No.	Stack Gas Conditions			Concentration (gr/DSCF)				Emission Rate (lbs/hr)			
	Temp (°F)	Flowrate DSCFM	Flowrate ACFM	Filterable Particulate	Probe & Second Filter	Impinger Catch	Total Particulate	Filterable Particulate	Probe & Second Filter	Impinger Catch	Total Particulate
1	230	203,000	316,000	0.002	0.010	0.008	0.019	2.8	16.6	14.2	33.6
2	215	204,000	328,000	0.001	0.004	0.004	0.009	2.5	6.8	6.5	15.8
3	226	203,000	331,000	0.0006	0.004	0.004	0.009	1.0	7.6	6.2	14.8
Avg.	224	203,000	325,000	0.001	0.006	0.005	0.012	2.1	10.3	9.0	21.4

TABLE IV

SUMMARY OF PARTICULATE EMISSIONS (METRIC UNITS)
SPECIAL TESTS ON NO. 3 KILN ELECTROSTATIC PRECIPITATOR OUTLET

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Test No.	Stack Gas Conditions			Concentration (mg/DNm^3)				Emission Rate (kg/hr)			
	Temp (°C)	Flowrate		Filterable Particulate	Probe & Second Filter	Impinger Catch	Total Particulate	Filterable Particulate	Probe & Second Filter	Impinger Catch	Total Particulate
		DNm^3/min	Am^3/min								
1	110	5750	8950	3.7	21.8	18.7	44.2	1.3	7.5	6.4	15.3
2	102	5780	9290	3.3	8.9	8.5	20.7	1.2	3.1	2.9	7.2
3	108	5750	9370	1.3	10.0	8.2	19.5	0.46	3.5	2.8	6.7
Avg	107	5760	9200	2.8	13.6	11.8	28.1	0.99	4.7	4.0	9.7

and reference test 4, although not collected simultaneously, confirm this observation. A statistical comparison of the simultaneous test results cannot be made due to an insufficient number of samples.

Table V summarizes the efficiencies measured during the simultaneous inlet and outlet testing conducted on the electrostatic precipitator. The average control efficiency for filterable particulate was 99.2 percent by weight; the average efficiency for total particulate was somewhat lower, 97.3 percent.

Tables VI and VII display the results of the simultaneous particulate testing conducted on the Rotoclone inlet and outlet in English and metric units, respectively. Analysis of these data shows a likely malfunction in this piece of control equipment. The volumetric flowrates at the inlet and outlet were measured to be 9,900 and 19,500 dry standard cubic feet per minute (280 and 551 DNm^3/min), respectively. The total particulate emission rates were found to be very similar; the average inlet rate of 57.7 pounds per hour (26.2 kg/hr) approximately equals the outlet rate of 54.7 pounds per hour (24.9 kg/hr). The first test shows a slightly higher outlet than inlet emission rate. Mr. Paul Rosten indicated that the staff of the Cleveland-Cliffs Iron Company Research Lab measured a similar difference in flowrates both before and after the EPA testing. Mr. Martin Jones of the CCIC Research Lab staff remeasured the flowrates at this juncture at a later date and found them to be more nearly equal (inlet - 12,000 SCFM; outlet - 14,000 SCFM), although the temperatures were significantly higher. Mr. Jones also examined the maintenance on the control system during

TABLE V

EFFICIENCY OF NO. 3 KILN ELECTROSTATIC PRECIPITATOR

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Test Number	Efficiency, Percent	
	Filterable Particulate	Total Particulate
1	99.5	97.4
2	99.0	97.3
3	--	--
4	99.1	97.1
Average	99.2	97.3

TABLE VI

SUMMARY OF PARTICULATE EMISSIONS (ENGLISH UNITS)
NO. 3 KILN ROTOCLONE

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Source	Test No.	Stack Gas Conditions			Concentration (gr/DSCF)			Mass Emission Rate (lbs/hr)		
		Temp (°F)	Flowrate		Filterable Particulate	Impinger Catch	Total Particulate	Filterable Particulate	Impinger Catch	Total Particulate
			DSCFM	ACFM						
Inlet	1	270	9,880	14,800	0.668	0.0005	0.668	56.6	0.04	56.6
	2	270	9,930	14,800	0.703	0.001	0.704	59.9	0.08	59.9
	3	270	9,880	14,700	0.667	0.002	0.669	56.5	0.13	56.6
	Avg.	270	9,900	14,800	0.679	0.001	0.680	57.7	0.08	57.7
Outlet	1	158	19,300	24,500	0.353	0.0003	0.353	58.4	0.05	58.4
	2	157	19,600	24,400	0.316	0.0006	0.317	53.1	0.11	53.2
	3	155	19,500	24,400	0.314	0.0002	0.314	52.5	0.04	52.5
	Avg.	157	19,500	24,400	0.328	0.0004	0.328	54.7	0.07	54.7

TABLE VII

SUMMARY OF PARTICULATE EMISSIONS (METRIC UNITS)
NO. 3 KILN ROTOCLONE

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Source	Test No.	Stack Gas Conditions			Concentration (mg/DNm^3)			Mass Emission Rate (kg/hr)		
		Temp (°C)	Flowrate		Filterable Particulate	Impinger Catch	Total Particulate	Filterable Particulate	Impinger Catch	Total Particulate
			DNm^3/min	Am^3/min						
Inlet	1	132	280	419	1530	1.1	1530	25.7	0.02	25.7
	2	132	281	419	1610	2.3	1610	27.1	0.04	27.2
	3	132	280	416	1530	3.5	1530	25.7	0.06	25.7
	Avg.	132	280	418	1560	2.3	1560	26.2	0.04	26.2
Outlet	1	70	546	694	808	0.6	808	26.5	0.02	26.5
	2	69	555	691	724	1.5	725	24.1	0.05	24.2
	3	68	553	691	719	0.5	719	23.8	0.02	23.9
	Avg.	69	551	692	750	0.9	751	24.8	0.03	24.9

the testing period. We must conclude that the exit flowrate includes significant in-leakage presumably from leakage through the dust removal system of the device.

Table VIII shows the exhaust gas compositions found during each test at each sampling location on the No. 3 kiln pelletizing operations.

Tables IX to XV display the results of the simultaneous particle sizing tests conducted on the electrostatic precipitator inlet and outlet.

The high particulate concentration at the inlet location relative to the outlet location created a difficult sampling situation. Because of its inherently lower sampling rate (less than 0.15 CFM) a modified Brink cascade impactor was used at the inlet location, and sampling time was adjusted to provide optimum loading in the impactor. At the outlet location, an Andersen Stack Sampler was used to obtain ahhigher sample volume. Due to the time required to obtain optimum loading at the outlet location, several inlet tests were conducted during a single test at the outlet. Accordingly, inlet tests 1-A and 1-B are simultaneous with outlet test 1, and inlet tests 2-A, 2-B, and 2-C are simultaneous with outlet test 2. During outlet test 2 the electrostatic precipitator malfunctioned and went into manual control. It was restored to full operation approximately 45 minutes later.

The particle size data for the electrostatic precipitator inlet and outlet have been plotted on log-probability paper as illustrated in Figures 2 and 3, respectively. A comparison of

TABLE VIII

SUMMARY OF EXHAUST GAS COMPOSITION

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Source	Particulate Test No.	1975 Date	Sampling Period Start	Sampling Period Stop	Composition, Percent CO_2 (dry basis)	O_2 (dry basis)	CO (dry basis)	N_2 (dry basis)	H_2O (wet basis)
No. 3 Kiln Electrostatic Precipitator Inlet	1	11-18	15:23	17:39	2.1	15.9	<0.1	82.0	15.3
	2	11-19	10:41	12:46	2.0	16.0	<0.1	82.0	16.0
	3	11-19	16:04	18:00	1.9	16.2	<0.1	81.9	11.5
	4	11-20	08:38	10:26	(2.0)	(16.0)	(<0.1)	(82.0)	11.5
	Average				2.0	16.0	<0.1	82.0	13.6
No. 3 Kiln Electrostatic Precipitator Outlet	Special - 1	11-18	15:19	17:40	1.7	15.7	<0.1	82.6	15.0
	Special - 2	11-19	10:39	12:45	1.8	16.2	<0.1	82.0	16.2
	Special - 3	11-19	16:03	17:59	1.8	16.2	<0.1	82.0	15.8
	Average				1.8	16.0	<0.1	82.2	15.7
	1	11-18	15:19	17:40	1.7	15.7	<0.1	82.6	15.3
	2	11-19	10:41	12:46	1.8	16.2	<0.1	82.0	15.1
	4	11-20	08:38	10:33	(1.8)	(16.0)	(<0.1)	(82.2)	14.8
	Average				1.8	16.0	<0.1	82.2	15.1
No. 3 Kiln Rotoclone Inlet	1	11-20	17:43	18:43	---	----	----	----	2.0
	2	11-21	09:54	10:54	---	----	----	----	1.2
	3	11-21	12:53	13:53	---	----	----	----	1.0
	Average				---	----	----	----	1.4
No. 3 Kiln Rotoclone Outlet	1	11-20	17:40	18:47	---	----	----	----	2.2
	2	11-21	09:50	11:08	---	----	----	----	0.5
	3	11-21	12:48	13:51	---	----	----	----	1.1
	Average				---	----	----	----	1.3

TABLE IX

PARTICLE SIZE DISTRIBUTION
ELECTROSTATIC PRECIPITATOR INLET

Test 1-A

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Fraction	Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
			Percent	Cumulative Percent
Cyclone	>5.1	43.4	80.2	100.0
Stage 1	5.1 -1.7	4.4	8.1	19.8
Stage 2	1.7 -0.98	1.7	3.1	11.7
Stage 3	0.98-0.66	1.6	3.0	8.6
Stage 4	0.66-0.32	1.0	1.9	5.6
Stage 5	0.32-0.19	0.6	1.1	3.7
Back-up Filter	<0.19	1.4	2.6	2.6
Total	--	54.1	100.0	100.0

TABLE X

PARTICLE SIZE DISTRIBUTION
ELECTROSTATIC PRECIPITATOR INLET

Test 1-B

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Fraction	Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
			Percent	Cumulative Percent
Cyclone	>5.4	41.1	71.3	100.0
Stage 1	5.4 -1.8	10.0	17.4	28.7
Stage 2	1.8 -1.1	1.9	3.3	11.3
Stage 3	1.1 -0.71	0.8	1.4	8.0
Stage 4	0.71-0.35	0.7	1.2	6.6
Stage 5	0.35-0.21	1.7	3.0	5.4
Back-up Filter	<0.21	1.4	2.4	2.4
Total	--	57.6	100.0	100.0

TABLE XI

PARTICLE SIZE DISTRIBUTION
ELECTROSTATIC PRECIPITATOR INLET

Test 2-A

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Fraction	Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
			Percent	Cumulative Percent
Cyclone	>5.1	7.9	54.9	100.0
Stage 1	5.1 -1.7	1.9	13.2	45.1
Stage 2	1.7 -0.98	0.8	5.6	31.9
Stage 3	0.98-0.66	1.5	10.4	26.3
Stage 4	0.66-0.32	1.1	7.6	15.9
Stage 5	0.32-0.19	0.4	2.8	8.3
Back-up Filter	<0.19	0.8	5.5	5.5
Total	--	14.4	100.0	100.0

TABLE XII

PARTICLE SIZE DISTRIBUTION
ELECTROSTATIC PRECIPITATOR INLET

Test 2-B

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Fraction	Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
			Percent	Cumulative Percent
Cyclone	>5.4	91.3	84.2	100.0
Stage 1	5.4 -1.8	11.0	10.2	15.8
Stage 2	1.8 -1.1	2.6	2.4	5.6
Stage 3	1.1 -0.71	1.1	1.0	3.2
Stage 4	0.71-0.35	1.1	1.0	2.2
Stage 5	0.35-0.21	0.2	0.2	1.2
Back-up Filter	<0.21	1.1	1.0	1.0
Total	--	108.4	100.0	100.0

TABLE XIII

PARTICLE SIZE DISTRIBUTION
ELECTROSTATIC PRECIPITATOR INLET

Test 2-C

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Fraction	Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
			Percent	Cumulative Percent
Cyclone	>5.3	54.7	77.1	100.0
Stage 1	5.3 -1.8	10.6	15.0	22.9
Stage 2	1.8 -1.0	1.9	2.7	7.9
Stage 3	1.0 -0.69	0.9	1.3	5.2
Stage 4	0.69-0.34	0.6	0.8	3.9
Stage 5	0.34-0.20	0.3	0.4	3.1
Back-up Filter	<0.20	1.9	2.7	2.7
Total	--	70.9	100.0	100.0

TABLE XIV

PARTICLE SIZE DISTRIBUTION
ELECTROSTATIC PRECIPITATOR OUTLET

Test 1

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Fraction	Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
			Percent	Cumulative Percent
Stage 0	>5.5	4.2	17.0	100.0
Stage 1	5.5 -3.5	5.8	23.4	83.0
Stage 2	3.5 -2.3	1.8	7.3	59.6
Stage 3	2.3 -1.6	1.1	4.4	52.3
Stage 4	1.6 -0.99	7.2	29.0	47.9
Stage 5	0.99-0.52	1.0	4.0	18.9
Stage 6	0.52-0.31	1.0	4.0	14.9
Stage 7	0.31-0.21	1.1	4.4	10.9
Back-up Filter	<0.21	1.6	6.5	6.5
Total	--	24.8	100.0	100.0

TABLE XV

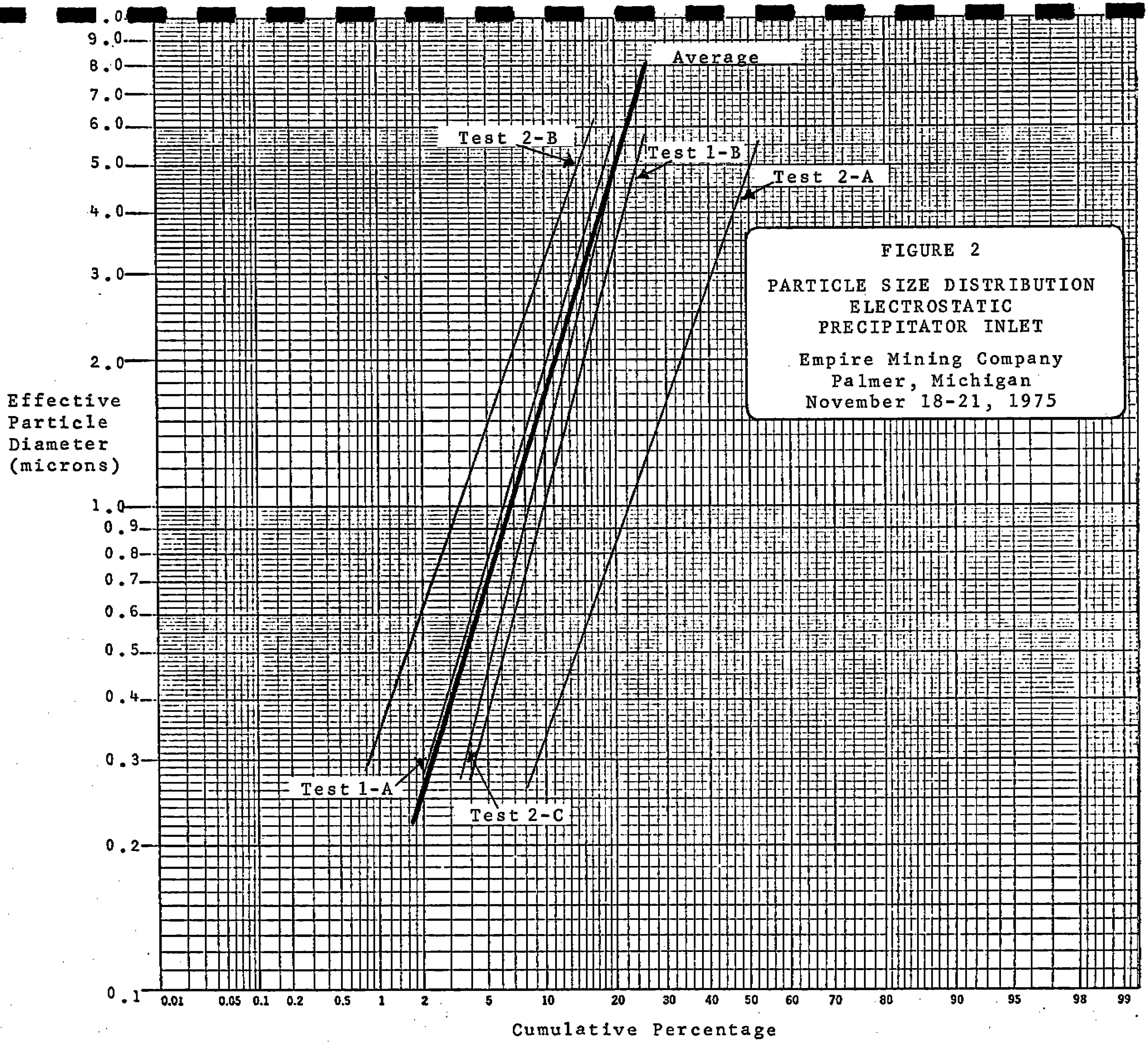
PARTICLE SIZE DISTRIBUTION
ELECTROSTATIC PRECIPITATOR OUTLET

Test 2*

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Fraction	Characteristic Diameter of Particles (μ)	Weight (mg)	Size Distribution by Weight	
			Percent	Cumulative Percent
Stage 0	>4.3	17.9	40.5	100.0
Stage 1	4.3 -2.8	6.3	14.3	59.5
Stage 2	2.8 -1.8	6.2	14.0	45.2
Stage 3	1.8 -1.3	4.6	10.4	31.2
Stage 4	1.3 -0.80	3.0	6.8	20.8
Stage 5	0.80-0.40	2.0	4.5	14.0
Stage 6	0.40-0.24	0.9	2.0	9.5
Stage 7	0.24-0.16	1.1	2.5	7.5
Back-up Filter	<0.16	2.2	5.0	5.0
Total	--	44.2	100.0	100.0

* The electrostatic precipitator malfunctioned for approximately 45 minutes during this test. This may have exaggerated the percentage of larger particles in the sampler.



Average
Test 2-B
Test 1-B
Test 2-A
Test 1-A
Test 2-C
FIGURE 2
PARTICLE SIZE DISTRIBUTION
ELECTROSTATIC
PRECIPITATOR INLET
Empire Mining Company
Palmer, Michigan
November 18-21, 1975
Effective Particle Diameter (microns)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.01
0.05
0.1
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
Cumulative Percentage

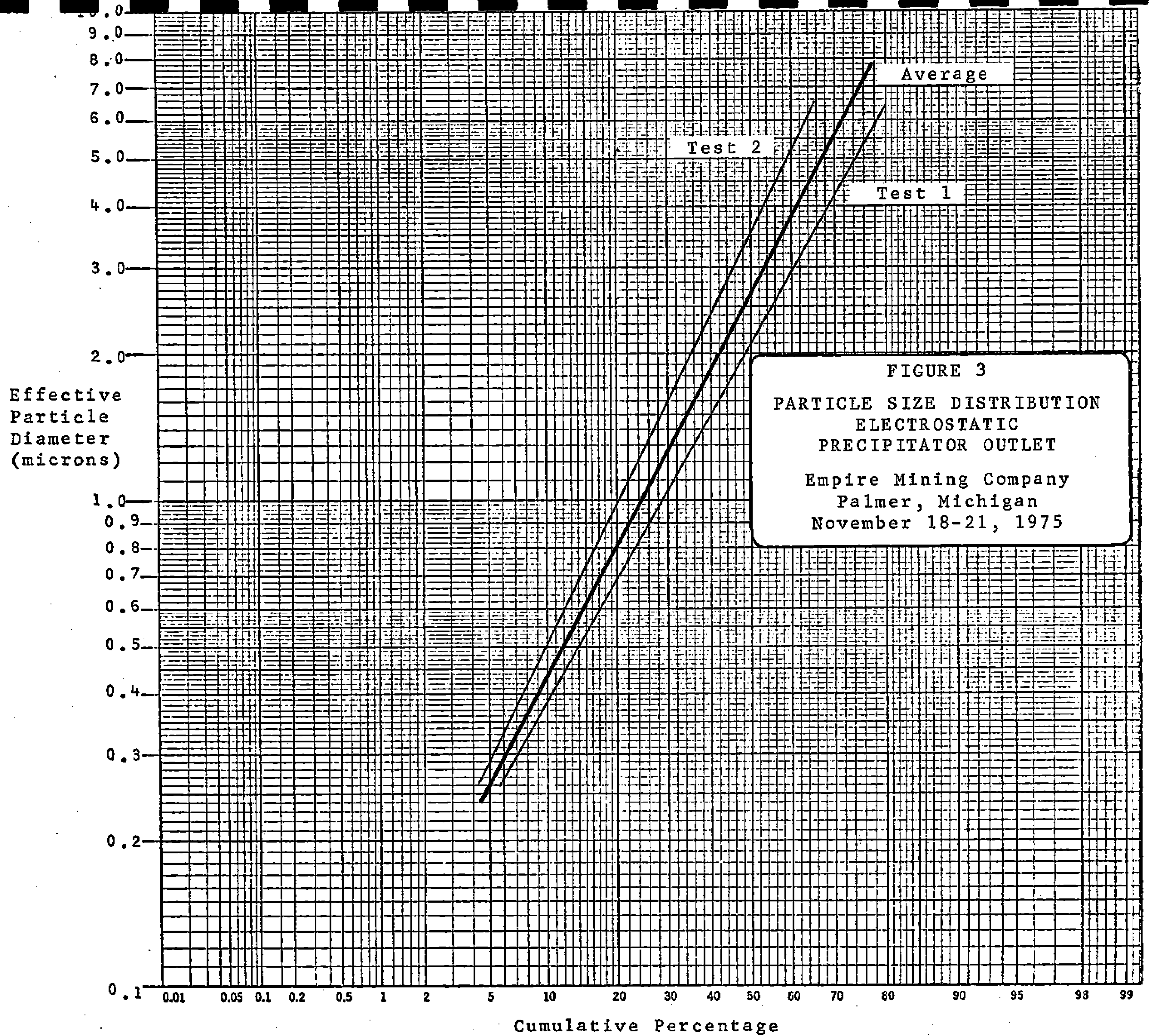


FIGURE 3

PARTICLE SIZE DISTRIBUTION
ELECTROSTATIC
PRECIPITATOR OUTLET

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

these figures shows that the median diameter of the particles sampled at the inlet exceeds 10 microns while 50 percent of the particles at the outlet were found to be below 2.7 microns. The 50-percentile diameter from outlet test 2 (3.5 microns) was somewhat higher than that from test 1 (2.1 microns). This difference may have been caused by the malfunction of the precipitator during test 2.

III. PROCESS DESCRIPTION AND OPERATION

A. Process Description

Empire Mining Company is an iron ore beneficiation operation owned by Inland Steel Company (40 percent), McLouth Steel Corporation (25 percent), The Cleveland-Cliffs Iron Company (20 percent), and International Harvester Company (15 percent). Cleveland-Cliffs is the manager. The Empire mine and plant are located in Richmond and Tilden Townships in Marquette County, Michigan, a few miles south of Ishpeming and Negaunee, at Palmer. The old Empire mine of 1907 to 1928 shipped a total of 768,000 tons of hard, red siliceous hematite ore of less than 40-percent iron. The new mine and pellet plant started production in late 1963 with a rated capacity of 1.2 million long tons of 64.5-percent iron (6.6-percent SiO_2, 0.5- to 1.0-percent H_2O) pellets per year. The operation was expanded to a rated capacity of 3.4 million long tons per year in 1967 and to 5.3 million long tons per year in 1974.

Empire uses conventional open-pit mining techniques (rotary drills, 6- to 11-cubic yard electric shovels, ANFO or slurry blasting, 85- to 100-ton haulage trucks) to mine a magnetite ore body which dips approximately 38 to 40 degrees to the northwest. The ore is blended on the basis of diamond drill cores to yield a crude ore grade of 32- to 34-percent total iron (22- to 24-percent magnetic iron). Weight recovery at the concentrator is about 36 to 38 percent (33 to 34 percent on a dry basis).

The ore is hauled by truck to the primary crusher which is a 60-inch gyratory with a closed side setting of eight inches. The gyratory crusher utilizes Rotoclones for dust collectors. Water sprays are used to control fugitive dust emissions at the dump pocket and transfer points.

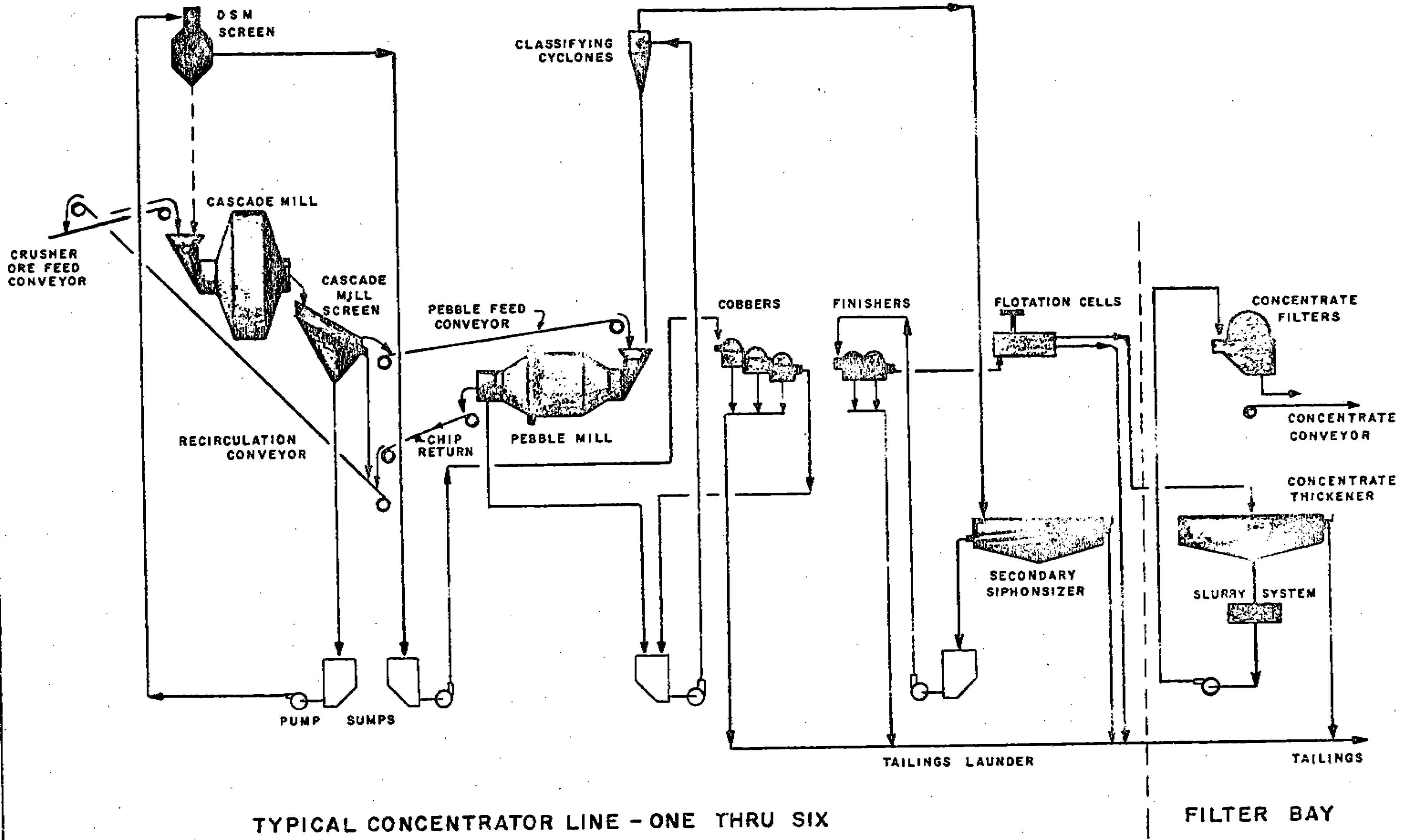
The primary crusher discharges into the primary grinding circuit which consists of 21 lines of double-deck screens and autogeneous mills. Figure 4 is a flow diagram of a typical circuit. The mills are operated as truly autogeneous mills. The five newest lines incorporate 25-foot-diameter by 12-foot Allis-Chalmers Rockcyl primary mills and 15.5-foot-diameter by 24-foot Allis-Chalmers pebble mills. The other lines have 24-foot-diameter by 8-foot primary mills and 12.5-foot-diameter by 24-foot pebble mills. The double-deck screens separate the 1- to 2.5-inch material which is used for the grinding media in the pebble mills (the secondary grinding circuit). The discharge from the primary mill is screened on a double-deck 20-mesh DSM screen with the fraction less than 20 mesh going to the magnetic cobbers. The oversize from the DSM screens is returned to the primary mill. The magnetic cobbers produce a concentrate containing about 50-percent iron. The reject (tailings) from the cobbers is sent to a tailings thickener; the concentrate from the cobbers is sent to a sump which discharges to a cyclone in closed circuit with the pebble mill.

The pebble mill discharge is reclassified and ground again. The cyclone overflow is sent to a siphonsizer. The underflow from the siphonsizer is sent to the tailings thickener. The magnetic

FIGURE 4

SIMPLIFIED FLOW DIAGRAM
CONCENTRATOR AND FILTER BAY

Empire Mining Company
Palmer, Michigan
November 18-21, 1975



finishers concentrate is then sent to flotation cells with the tailings from the finishers reporting to the tailings thickener. The concentrate from the magnetic finishers reports to the flotation circuit. Approximately 90 to 92 percent of the concentrate is less than 500 mesh. This is very fine grind.

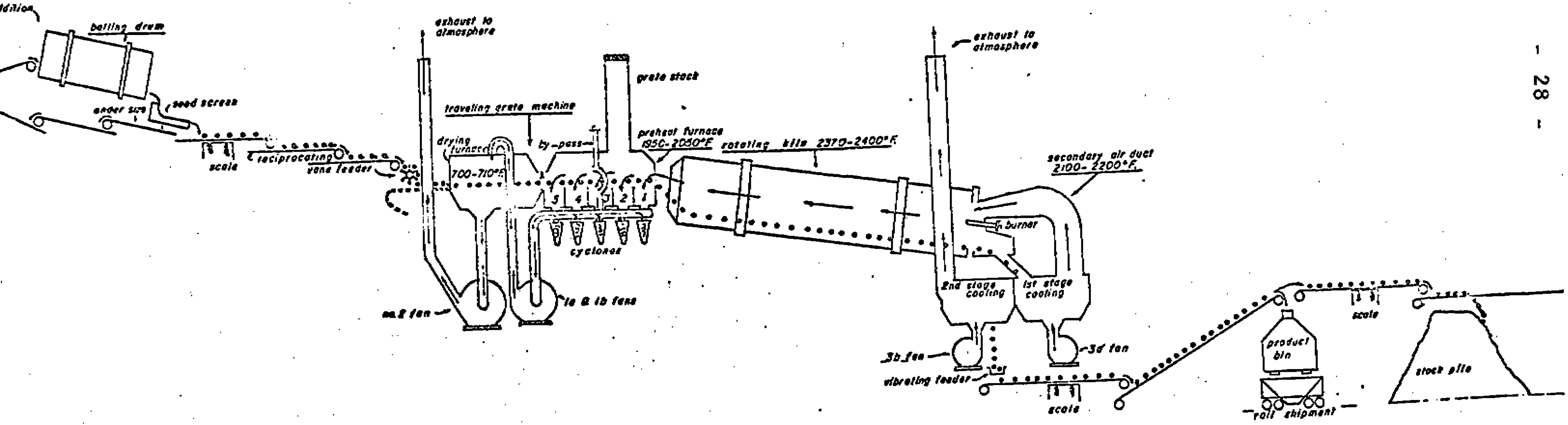
In the flotation circuit, Empire utilizes 60-cubic-foot cells in the older circuits and 500-cubic-foot cells in the newer circuits to produce a 66-1/2-percent iron concentrate. The flotation reagents used are MIBC Amine M9883 and an alcoholic frother. The concentrate from the flotation circuit is put into a concentrate thickener and the underflow is pumped to the disc filters. The disc filters reduce the moisture content to approximately 10.5 percent.

Figure 5 is a flow diagram of the pellet plant. The filtered concentrate is transferred into holding bins and discharged by table feeders onto a conveyor belt where bentonite is added. Empire uses approximately 27 pounds of bentonite per ton of ore. The mixed concentrate and bentonite is then added to the balling drums. There are 12 balling drums, each 12 feet in diameter and 33 feet long. The balling drums discharge onto screens and the oversize from the screens is then returned to the filtered concentrate bins; the undersize is then passed onto reciprocating conveyors which feed the three indurating lines. For each line, the induration of the pellets is accomplished by a traveling grate drying machine and an Allis-Chalmers rotary kiln. The traveling grate for line 1 is about 97 feet long. For lines 2 and 3, the grate is 104 feet and 8 inches long. Each rotary

FIGURE 5

PELLET PLANT FLOW SHEET

Empire Mining Company
Palmer, Michigan
November 18-21, 1975



kiln is 17 feet in diameter by 115 feet long. The pellets travel through the grate machine, rotary kiln, and granular cooler. The kiln is fired by natural gas and No. 2 fuel oil. The pellets are discharged from the cooler onto the vibrating grizzly feeder which then feeds conveyor belts for loading directly into cars for shipment or onto an outside stockpile for storage.

As shown in Figure 5, the pellets are first dried at about 700 - 710°F, preheated to 1950 - 2080°F, indurated at 2370 - 2400°F, and then cooled to near ambient temperatures. The main waste gases make several passes through the pellets. The first stage cooling air (updraft) is used as the secondary air in the kiln. (The second stage cooling gases are emitted directly to the atmosphere.) The kiln gases flow countercurrent to the pellet flow in the kiln and go down through the pellet bed in the preheat section. The preheat gases are cleaned by cyclones and then are used for down-draft drying. The downdraft drying gases pass through a dropout box and an electrostatic precipitator before being emitted to the atmosphere.

The electrostatic precipitators on the three lines are manufactured by Buell. They were installed as a result of pilot-plant testing of several types of control devices. Empire personnel have estimated that the collection efficiency is about 97 to 98 percent. None of the United States iron ore beneficiation plants other than Empire, Tilden, and Republic currently utilize electrostatic precipitators. (All three of these plants are managed by the Cleveland-Cliffs Iron Company.) The electrostatic precipitator on line 3 was installed as an integral part of the line; those on the two older lines were added after start-up. The three Empire electrostatic precipitators have 42, 44, and 48 plates, respectively, on a 9-inch spacing. They are rated at about 70 kva with an area of about 41,581 square feet for the smallest unit which is rated to handle about 400,000 acfm at a temperature of 220°F. Empire had some trouble with buildup in the downcomers which caused bridging over the insulators and has wrapped these to prevent the bridging. According to Empire personnel, normal maintenance needs are nominal and do not require any excessive downtime or maintenance costs. However, the electrostatic precipitator on line 2 was experiencing problems during the sampling on line 3.

On the feed end of the traveling grate machines, American Air Filter Type N Rotoclones are utilized. The grate return area dust is ducted to a Ducon wet scrubber. The cooler discharge point (discharge to grizzly feeders) and the cooler area (grizzly feeder and transfer points) utilize separate American Air Filter Type R Rotoclones. The pellet loading facility utilizes a Ducon wet scrubber.

B. <u>Process Operation During Sampling</u>

1. <u>Sites A and B - Main Waste Gas Stack Electrostatic Precipitator</u>

The first emission source tested at Empire was the grate-kiln system main waste gas effluent which was operating with a dropout box and a Buell electrostatic precipitator.

Sites A and B were the inlet and outlet streams for the electrostatic precipitator, respectively. Four particulate tests were taken at the inlet and three at the outlet. In addition, five particle sizing tests were conducted at the inlet and two at the outlet.

The first stack samples at Sites A and B were taken from 15:19 to 17:40 on November 18, 1975. The plant was operating with balling drums 10, 11, and 12 running at a rate of about 280 long tons of green balls per hour. The pertinent operating data during this period are shown in Table XVI. The electrostatic precipitator was functioning normally. The grate-kiln was operating within normal variations. About 24 minutes before testing began a balling drum was shut down in order for an Allis-Chalmers representative to check the screens. This caused a momentary change in the feed which resulted in a peak in the cooler waste gas temperature between 15:10 and 15:55. However, the effect on the emissions should be minimal.

The second samples taken at Sites A and B were obtained from 10:39 to 12:46 on November 19. Again, the plant was operating at a rate of about 280 long tons of green balls (240 long tons of pellets) per hour. Other pertinent operating data are shown in Table XVI. The electrostatic precipitator was functioning normally and the grate-kiln was operating within normal variations.

TABLE XVI

PLANT OPERATING DATA DURING PARTICULATE TESTS

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

long ton

Parameter	Sampling Site						
	Sites A and B (Electrostatic Precipitator)				Sites C and D (Rotoclone)		
Particulate Test No.	1	2	3	4	1	2	3
Date (1975)	11-18	11-19	11-19	11-20	11-20	11-21	11-21
Green Ball Feed, lt/hr	276	281	280	282	279	281	277
Grate Bed Depth, in	5-6	5-6	5-6	5-6	5-6	5-6	5-6
Grate Speed, in/min	165	165	162	162	158	157	161
Kiln Speed, rph	90	90	90	90	90	90	90
Cooler Speed, in/min	50	50	50	50	50	49	50
Gas Consumption, cf/hr	1808	1541	1607	1673	1649	1553	1552
Production Rate, lt/hr	233	242	242	242	241	242	238
Bentonite, lb/lt	27.4	28.6	28.3	27.8	26.7	28.4	28.8
Temperatures, °F							
Drying Furnace	570-670	600-640	640-660	650-670	640-650	650-660*	660
Preheat Windbox	-	830-900	880-980	870-940	860-880	870-900*	890-900
Preheat Furnace	1880-1900	1880	1850-1880	1880	1880-1900	1880-1920*	1880-1900
Kiln Exit Gas	1920-1930	1920-1925	1920-1925	1920-1925	1920-1930	1925-2100*	2050-2070
Kiln Burning Zone	2340-2360	2350-2360	2360-2370	2360-2370	2350-2360	2330-2390*	2370-2390
Secondary Air	2250-2300	2300	2300	2300	2300	2250-2290*	2280-2300
Cooler Waste Gas	550-1050	760-900	760-820	760-860	820-860	660-920*	760-830
Damper Positions, % Open							
Bypass Damper (South)	40-60	54	54-66	59-60	59	59	59
Bypass Damper (North)	60-80	60	60-72	72	72	72	72
Tempering Air (South)	0	0	0	0	0	0	0
Tempering Air (North)	0	0	0	0	0	0	0
Bleed-In Air (South)	0	0	0	0	0	0	0
Bleed-In Air (North)	0	0	0	0	0	0	0
Grate Stack Cap	0	0	0	0	0	0	0

* Temperature gauges adjusted during test.

The third sample at Site A was obtained from 16:04 to 18:00 on November 19. Again the plant was operating at a rate of about 280 long tons of green balls per hour. Other pertinent data are included in Table XVI. The electrostatic precipitator was functioning normally. The grate-kiln was operating within normal variations. At 16:13 the high grate bed warning signal was set off by the cleaning of the vane feeder, i.e., the accumulated pellets that had adhered to the vanes were knocked off the vanes and onto the bed. The preheat windbox temperature increased and the bypass dampers were opened further. As the temperatures decreased, the dampers were closed slightly. The effect on the emissions should be minimal.

The fourth samples taken at Sites A and B were obtained from 08:38 to 10:33 on November 20. Again, the plant was operating at a rate of about 280 long tons of green balls per hour. Other operating data are included in Table XVI. The electrostatic precipitator was functioning normally. The grate-kiln was operating within normal variations.

During each of the stack sampling tests, two or three grab samples of green balls were obtained at the grate feed and composited to form one sample per test. The samples will be stored at Battelle-Columbus Laboratories to be used for later analysis if deemed necessary.

Simultaneous particle sizing tests were conducted on the electrostatic precipitator inlet and outlet. The first set of tests was conducted from 12:00 to 19:00 on November 20. The plant was operating at about 280 long tons of green balls per hour. The grate-kiln and the electrostatic precipitator were operating normally. The second set of tests was conducted from 10:25 to 17:15 on November 21. The plant was again operating at 280 long tons of green balls per hour. The grate-kiln was operating within normal variations. However, the electrostatic precipitator malfunctioned at 13:30. Its low power fault signal was set off and the precipitator was switched to manual control. Normal power was restored and the electrostatic precipitator was switched back on between 13:49 and 14:14. The record of the electrostatic precipitator operating data is shown in Table XVII. Thus, the second outlet particle sizing test must be considered to be an indication of a higher-than-normal outlet emission size.

The detailed plant operating field data log is presented in Appendix B.

2. <u>Sites C and D - Cooler Pellet Discharge Point Rotoclone</u>

The second set of sampling locations was the cooler pellet discharge point which was operating with an American Air Filter Type R Rotoclone. Sites C and D were the inlet and outlet for the Rotoclone, respectively. Three samples

TABLE XVII

ELECTROSTATIC PRECIPITATOR OPERATING DATA

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

	Operating Time	Primary Current (AC) amps	Primary Voltage (AC) volts	Secondary Current (DC) amps
Module A	Normal	173	362	1.32
	11/21 13:30	Fault Signal for Electrostatic Precipitator		
	13:49	172	365	1.32
	14:14	172	365	1.33
	15:06	172	367	1.33
	16:04	174	368	1.33
	16:44	174	365	1.32
Module B	Normal	200	270	1.34
	11/21 13:30	Fault Signal for Electrostatic Precipitator		
	13:49	200	270	1.37
	14:14	198	270	1.37
	15:06	198	270	1.37
	16:04	197	270	1.37
	16:44	200	270	1.36
Module C	Normal	150	322	1.47
	11/21 13:30	Fault Signal for Electrostatic Precipitator		
	13:49	150	325	1.47
	14:14	150	325	1.48
	15:06	150	325	1.48
	16:04	151	328	1.48
	16:44	151	326	1.48
Module D	Normal	162	306	0.78
	11/21 13:30	Fault Signal for Electrostatic Precipitator		
	13:49	75	210	0.72
	14:14	140	309	0.75
	15:06	152	305	0.74
	16:04	152	308	0.75
	16:44	152	308	0.75

were obtained at each site. At Empire the cooler pellet discharge collector draws the dust from the dumping of the pellets from the cooler to grizzly feeders. A separate collector (coöler area collector) draws the dust from the grizzly feeder which transfers the pellets to either a belt conveyor or a pan conveyor.

The three Rotoclone samples were taken from 17:40 to 18:47 on November 20, 09:50 to 11:08 on November 21, and 12:48 to 13:53 on November 21, respectively. For all three tests the plant was operating at a rate of about 280 long tons of green balls per hour. The grate-kiln was operating within normal variations. The second test was delayed until the grate-kiln could stabilize after a balling drum had shut down. An increase in the cooler waste gas temperature was exhibited, but the effect on emissions should have been minimal.

The Rotoclone on the cooler discharge apparently was not operating properly. The water feed pipe was leaking and little water was being used. In addition, a large volume of non-process air was leaking into the system. Thus, neither the inlet nor outlet samples are valid. Tests by Empire personnel before and after the EPA particulate sampling suggest that essentially no water was being added to the stream and dilution air approximately equal in volume to the process air was apparently leaking into the system.

The EPA process engineer's inspection of the Rotoclone at the time of the sampling was superficial and did not indicate that the Rotoclone was malfunctioning. The process engineer and Empire personnel discussed the potential of increasing the dust collector draft or placing a baffle between the pellet discharge collector drawpoint and the second stage cooling stack in new plants. However, the amount of dust from the cooler discharge point which was being emitted from the secondary cooling stack was not noted as being atypical for existing plants. Empire personnel had checked the collector not long before the sampling and no problems were noted. At the time of the sampling there was no steam plume from the stack. A wet collector should have had a steam plume in the cold weather.

Empire personnel have stated that the collector is operating properly now. The leaking water pipe has been repaired. No reason was found for the dilution air, but the flowrates are now correct. Empire has offered to test the Rotoclone if EPA personnel will observe the test. Empire personnel believe that a properly operating Rotoclone will adequately capture the particulate for the cooler discharge point. The EPA may take advantage of the offer in the near future.

IV. LOCATION OF SAMPLING PORTS

A. Pelletizing Drying Zone Exhaust - Electrostatic Precipitator Inlet - No. 3 Kiln

Exhaust gas measurements were conducted through each of the four ports located in a rectangular duct upstream of the electrostatic precipitator and downstream of the pelletizer drying zone. Exhaust gases passed the sampling location horizontally as shown in Figure 6. Sampling point locations are shown in Figure 7.

B. Pelletizing Drying Zone Exhaust - Electrostatic Precipitator Outlet - No. 3 Kiln

Samples were drawn through each of four sampling ports, 90 degrees apart, located in a circular duct section downstream of the electrostatic precipitator (Figure 8). The 48 sampling points are indicated in Figure 9.

C. Pellet Discharge - Rotoclone Inlet - No. 3 Kiln

Sampling was conducted through three sampling ports located in a square duct before the exhaust gases were drawn through a Rotoclone by an induced draft fan as shown in Figure 10. Figure 11 illustrates the locations of the 12 sampling points on the duct cross section.

D. Pellet Discharge - Rotoclone Outlet - No. 3 Kiln

Sampling was conducted through two sampling ports 90 degrees apart located in a circular duct as shown in Figure 12. Figure 13 shows the locations of the 12 points sampled.

Table XVIII summarizes the sampling site dimensions and characteristics. Sampling site locations and the chosen number of sampling points follow the procedure outlined in EPA Method 1 (40 CFR 60) as far as practicable.

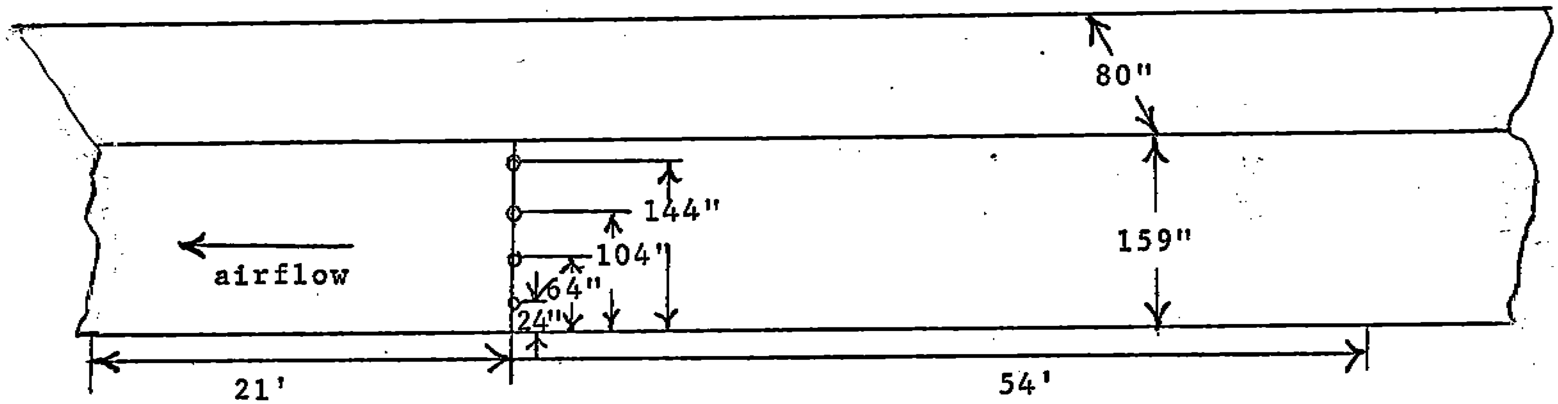


FIGURE 6

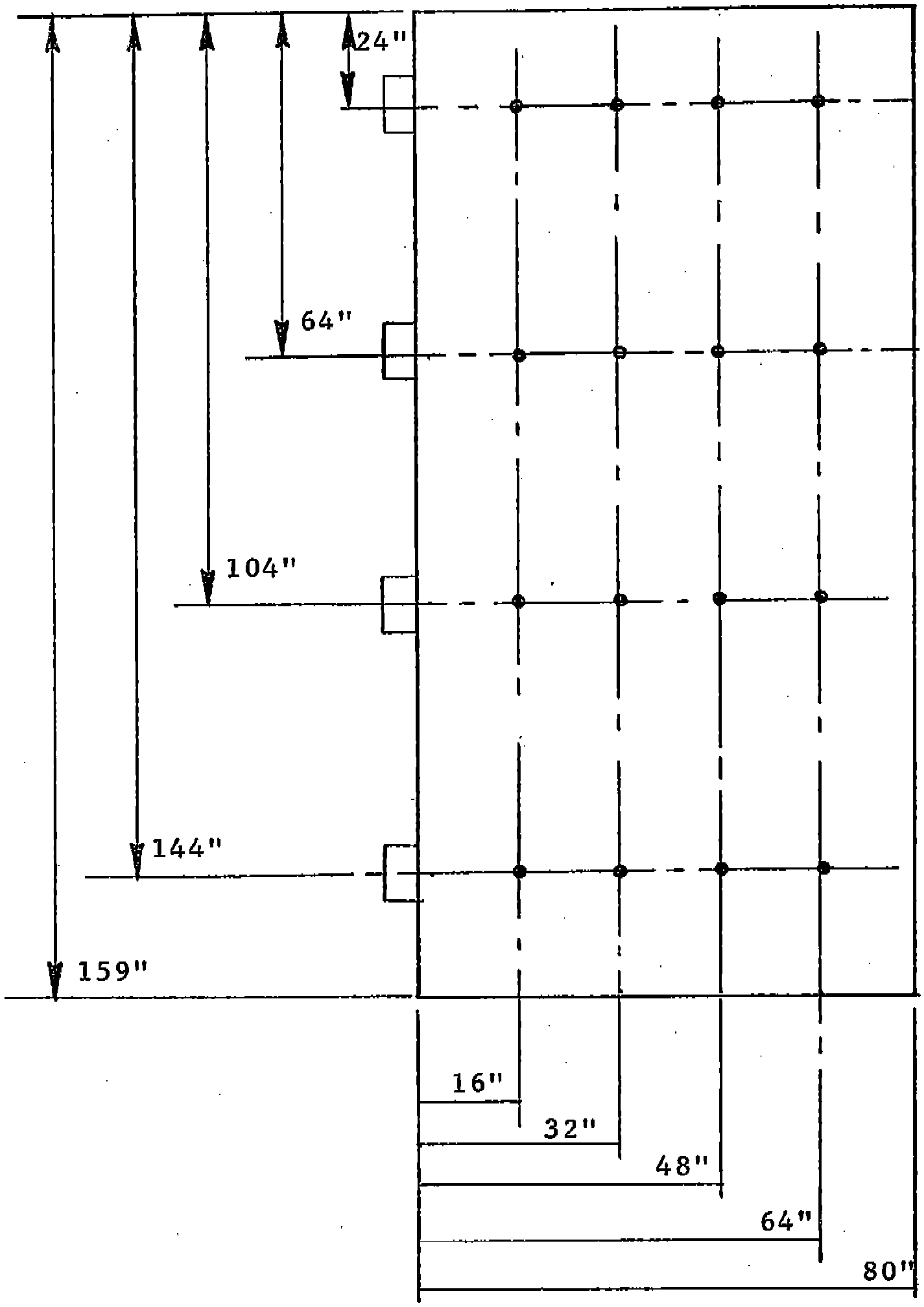
LOCATION OF SAMPLING PORTS
ELECTROSTATIC PRECIPITATOR INLET - NO. 3 KILN

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

FIGURE 7

LOCATION OF SAMPLING POINTS
ELECTROSTATIC PRECIPITATOR INLET - NO. 3 KILN

Empire Mining Company
Palmer, Michigan
November 17-21, 1975



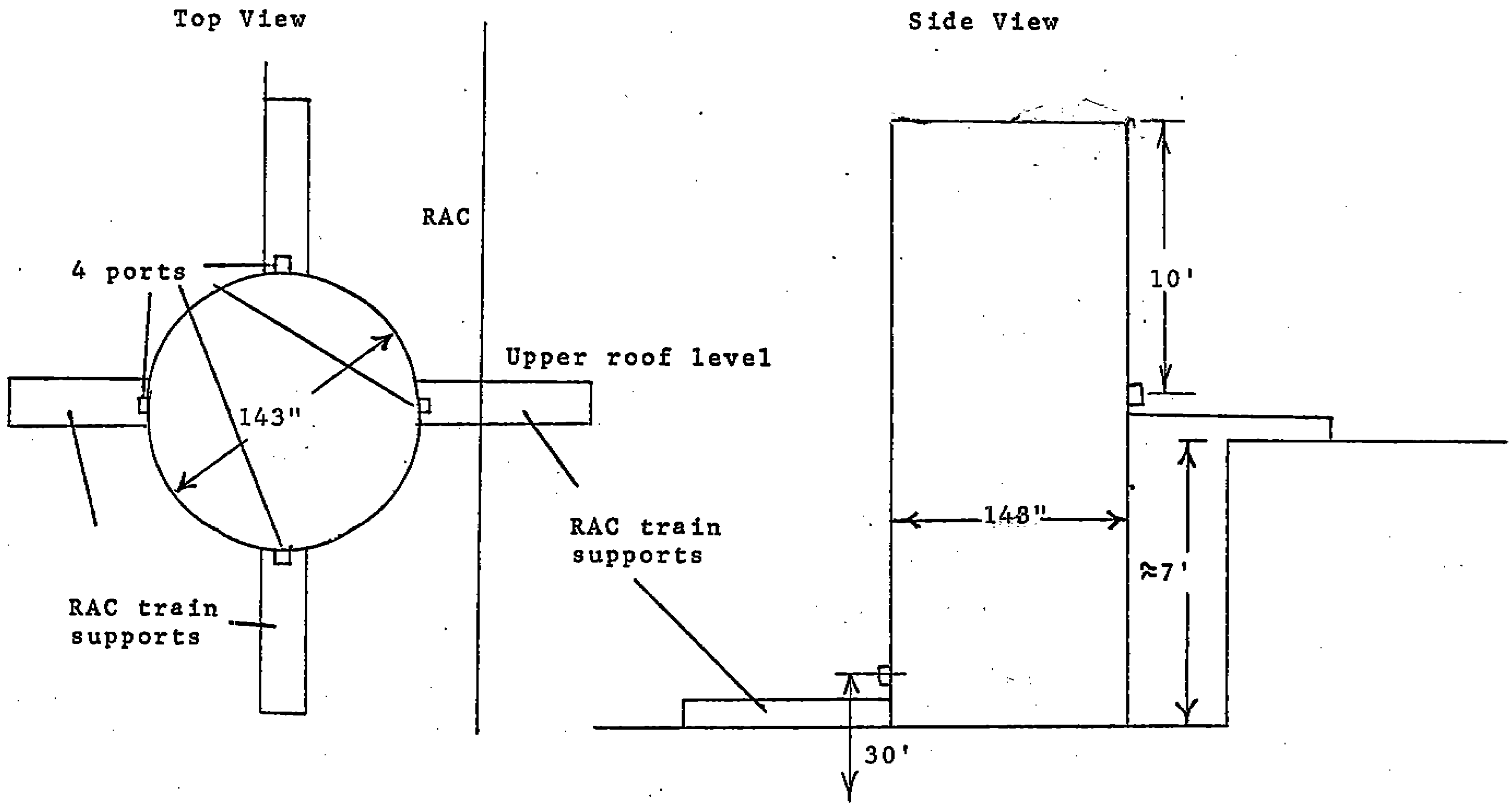


FIGURE 8

LOCATION OF SAMPLING PORTS
ELECTROSTATIC PRECIPITATOR OUTLET NO. 3 KILN

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

FIGURE 9

LOCATION OF SAMPLING POINTS - ELECTROSTATIC PRECIPITATOR OUTLET NO. 3 KILN

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

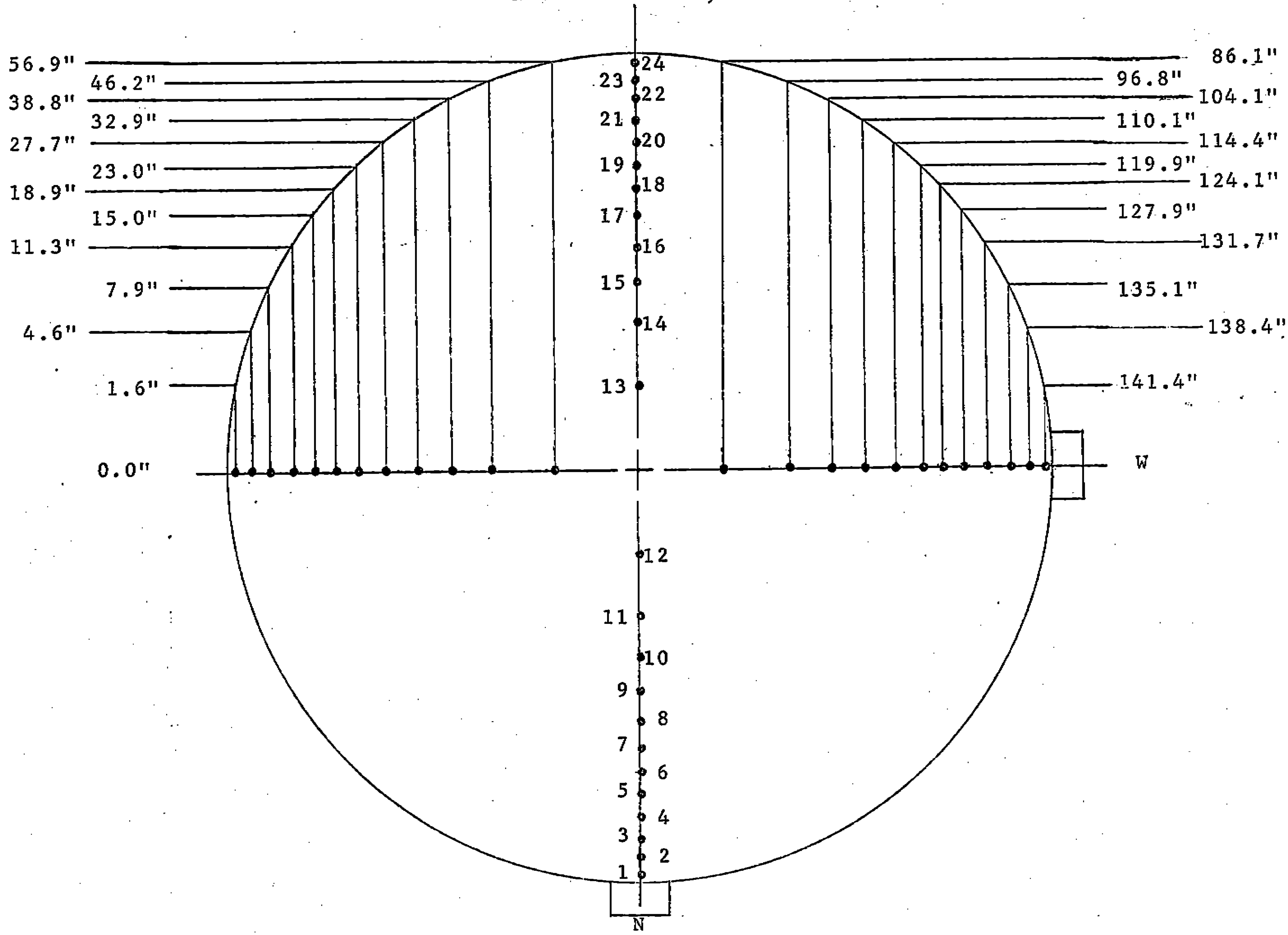


FIGURE 10

LOCATION OF SAMPLING PORTS
ROTOCLONE INLET PELLET DISCHARGE AREA NO. 3 KILN

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

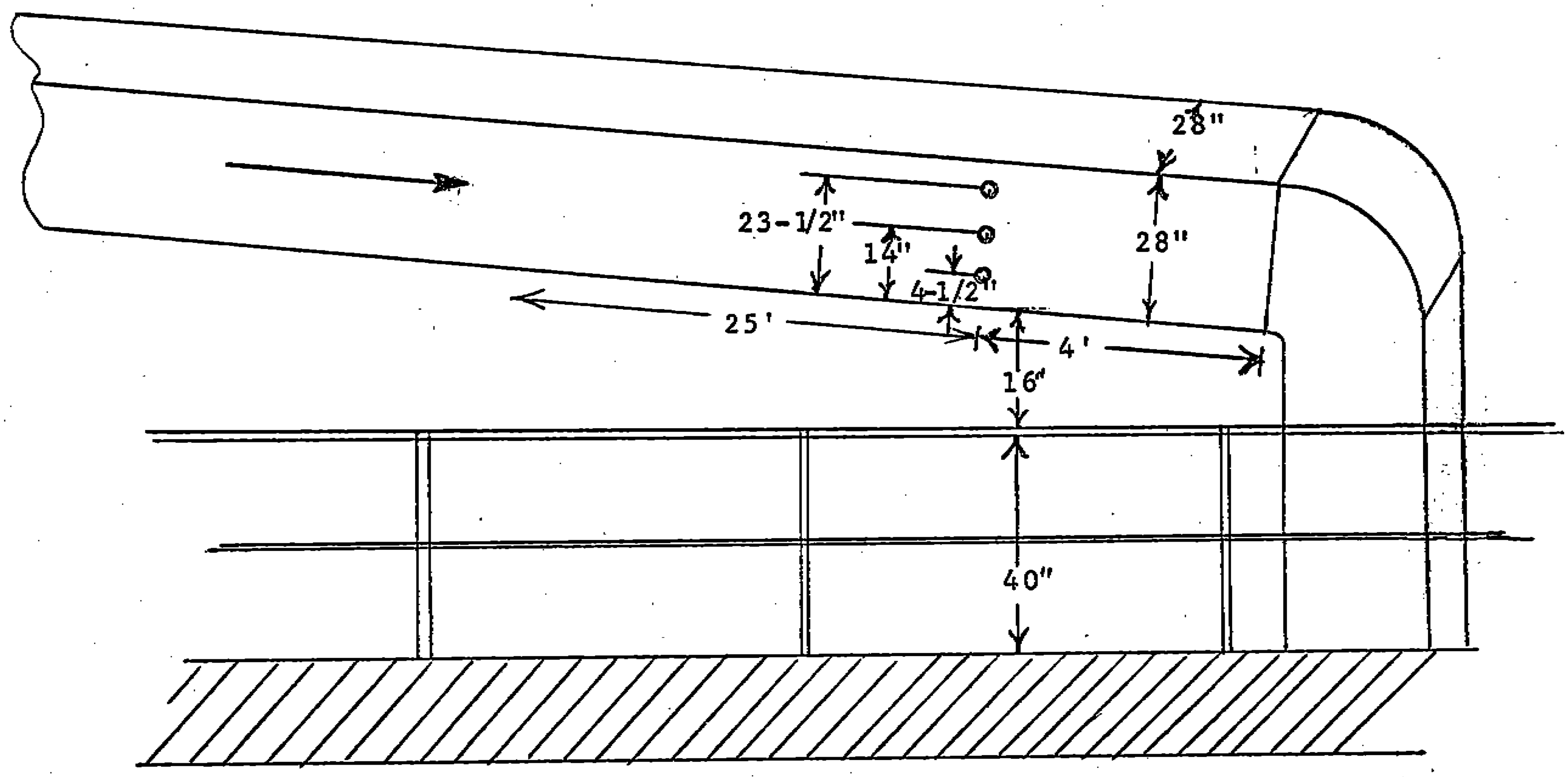
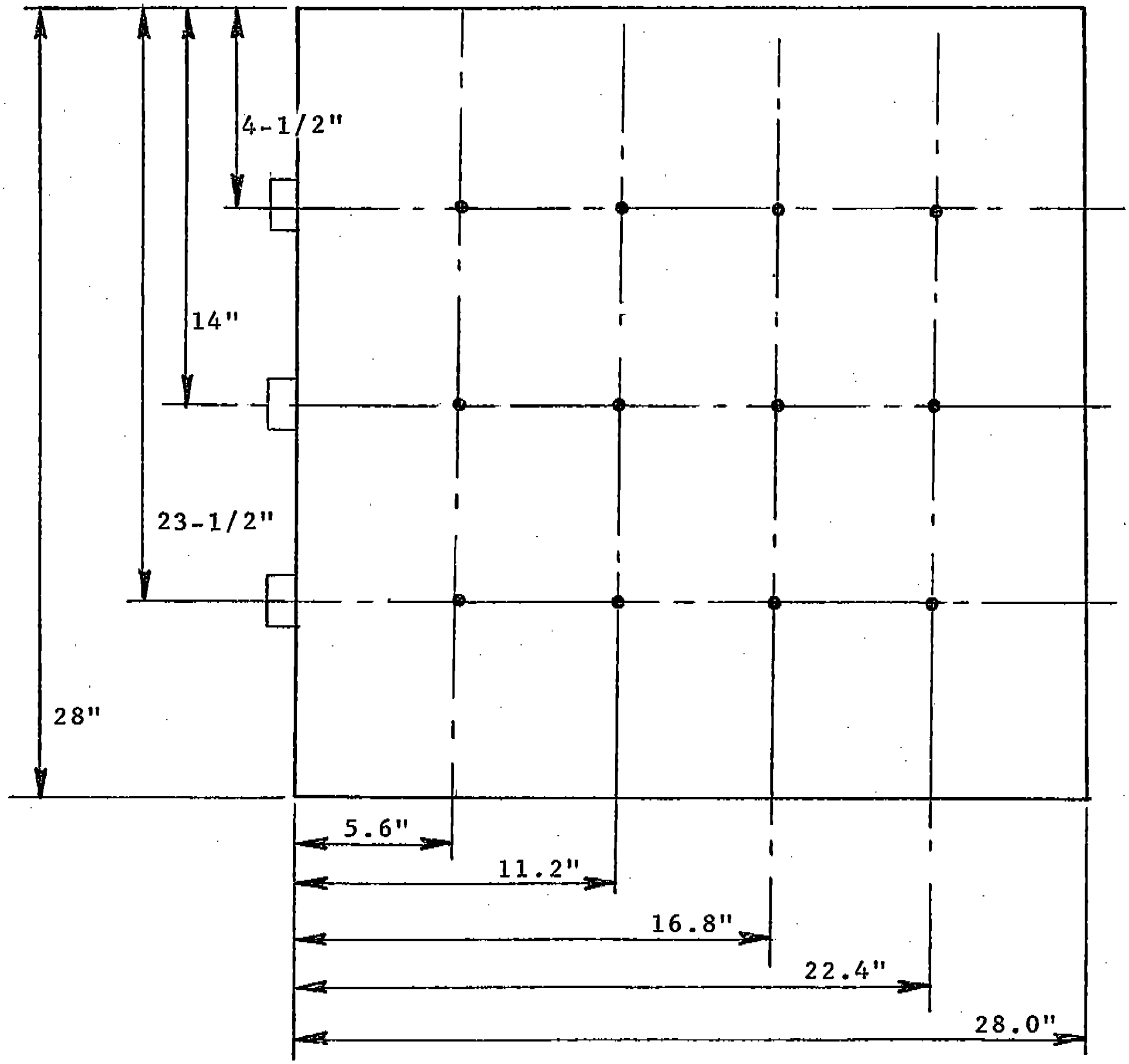


FIGURE 11

LOCATION OF SAMPLING POINTS
ROTOCLONE INLET PELLET DISCHARGE AREA NO. 3 KILN

Empire Mining Company
Palmer, Michigan
November 18-21, 1975



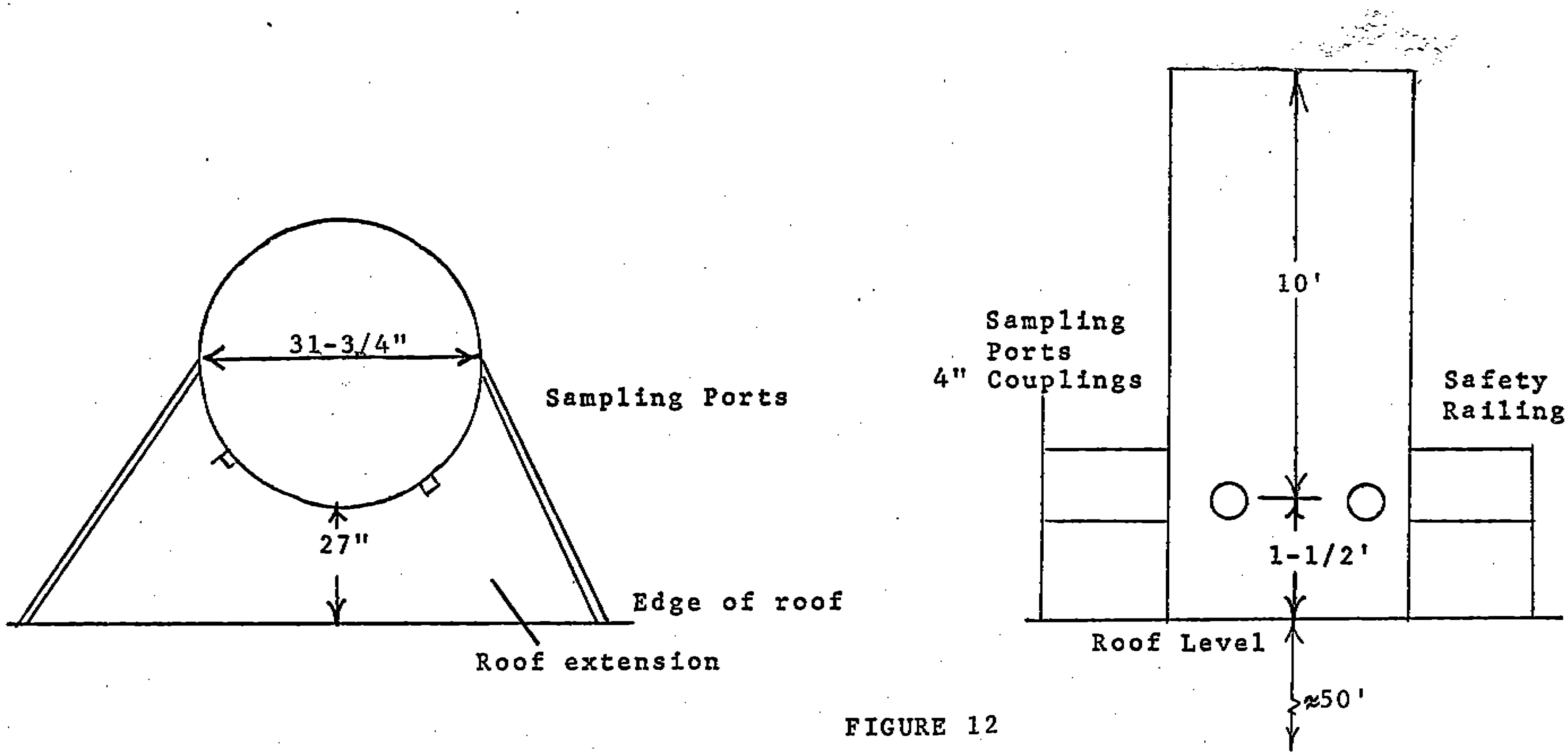


FIGURE 12

LOCATION OF SAFETY RAILING, ROOF EXTENSION, & SAMPLING PORTS
ROTOCLONE OUTLET PELLET DISCHARGE AREA NO. 3 KILN

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

FIGURE 13

LOCATION OF SAMPLING POINTS
ROTOCLONE OUTLET PELLET DISCHARGE AREA NO. 3 KILN

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

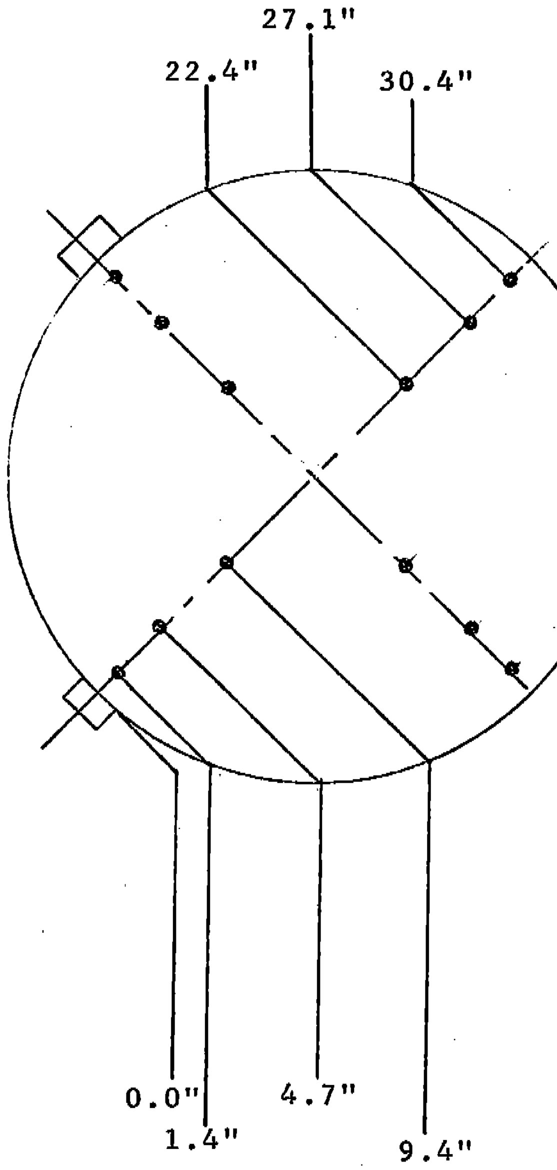


TABLE XVIII

SUMMARY OF SAMPLING POINT LOCATIONS

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Source	Dimensions	Effective Diameter (feet)	Distance to Upstream Disturbance (feet)	Distance to Downstream Disturbance (feet)	Number of Sampling Ports	Number of Sampling Points	Sampling Time (Minutes per Point)
Pelletizing Drying Zone Exhaust - No. 3 Kiln Electrostatic Precipitator Inlet	159" x 80"	10.6	54	21	4	16	6
Pelletizing Drying Zone Exhaust - No. 3 Kiln Electrostatic Precipitator Outlet	147" I.D.	12.2	30	10	4	48	2
Pellet Discharge - No. 3 Kiln Rotoclone Inlet	28" x 28"	2.6	25	4	3	12	5
Pellet Discharge - No. 3 Kiln Rotoclone Outlet	31-3/4" I.D.	2.6	50	10	2	12	5

V. SAMPLING AND ANALYTICAL PROCEDURES

Sampling procedures at the four locations follow those outlined in Methods 1 through 5 (40 CFR 60, Standards of Performance for New Stationary Sources, December 23, 1971). Alterations in the particulate sampling and analytical procedure were employed in order to measure asbestos emissions in the particulate samples. Deviations from Methods 1 to 5 include:

1) A 115-mm diameter cellulose acetate filter replaced the glass fiber filter in the sampling train in order that fibrous asbestos particles could be identified on this filter material.
2) The temperature of the sampling probe and heated filter were maintained at approximately 180°F (less than the 250°F suggested by Method 5). Deterioration of the cellulose acetate material at 200°F dictated this alteration.
3) A glass cyclone was placed in the heated filter box area to remove some particulate materials prior to their filtration.
4) The sampling probes and cyclone separator were rinsed with distilled water rather than acetone after the collection of each sample. Acetone rinsing was conducted only after these components were thoroughly rinsed with water. Acetone rinsing was necessary to remove the final residue on the glass as repeated washing and brushing would not remove this residue. The acetone wash was

stored separately. The distilled water wash was employed in order that the sample collection procedure be amenable with deviations in the sample analysis.

5) In the laboratory, aqueous probe wash fractions were combined with the residue remaining after evaporation of corresponding acetone probe wash fractions. This suspension was then drawn through a tared cellulose acetate filter. The filter was subsequently desiccated to a constant weight and the weight of suspended solids was determined on an analytical balance. The filtrate passing through the filter was evaporated to dryness and the residue weight was added to the weight increase on the filter to determine the total weight of probe wash materials.

6) The impinger catch was extracted with chloroform-ether and the organic phase was evaporated to a constant weight. This residue weight was added to the aqueous portion to calculate the back-half emission.

7) After determining the weight of particulate emissions in the front half of the Method 5 sampling train, the cellulose acetate filters were subsequently transferred to another contractor to perform the asbestos analysis under a separate contract.

Special particulate tests were performed at the outlet of the No. 3 Kiln Electrostatic Precipitator. Alteration of the normal Method 5 procedure was limited to the addition of an in-stack type A filter between the nozzle and the sampling probe. (The sampling train included the normal 110-mm type A heated filter as well.)

Particle size tests at the electrostatic precipitator inlet were collected with the Brink impactor which included the use of five separation stages plus a cyclone pre-separator and a 47-mm type A backup filter. The entire unit was placed in the stack and samples were drawn isokinetically through an appropriately-sized nozzle preceding the cyclone. After a sufficient exhaust gas volume was sampled to collect a weighable portion of material on each stage, the collection plates and cyclone collector were rinsed with acetone and the sample transferred to glass sample containers. In the laboratory, the acetone from the samples was evaporated and the samples were weighed on a laboratory balance capable of resolving 0.1 milligram.

Particle size sampling at the electrostatic precipitator outlet employed the Andersen Stack Sampler in a similar fashion. Filter paper was used in the collection plates and the cyclone pre-separator was also used during this evaluation. Multiple samples were collected at the inlet for each sample obtained at the outlet due to the differences in exhaust gas dust loadings.

The procedures for sampling with the Brink sampler follow the principles outlined in BMS-11 Sampler - Sampling Instructions (Monsanto Enviro-Chem Systems, Inc.). The sampling procedure for the Andersen sampler follows that presented in the operating instruction manual for the Andersen sampler (Operating Instructions for Andersen Stack Sampling Equipment, Andersen 2000, Inc.).

The particulate/asbestos field sampling data sheets are presented in Appendix C. The particle sizing field data sheets are presented in Appendix D. A sample log is shown in Appendix E.

Appendix F contains a summary of sampling data. Appendices G and H show the particulate weight data and the calibration data, respectively. Appendix I presents the example calculations.

APPENDIX A

PROJECT PARTICIPANTS

<u>Clayton Environmental Consultants, Inc.</u>

Victor W. Hanson	Project Leader
Jonathan B. Schoch	Assistant Project Leader Field Team Sampler
Kent D. Shoemaker	Laboratory Coordinator Field Team Sampler
George M. Santorilla	Field Team Sampler
Harold P. Flood	Field Team Sampler
Richard G. Keller	Field Team Sampler
Richard J. Griffin	Visible Emissions Observer
Janet L. Vecchio	Data Processing
Janice M. Alore	Data Processing
Aileen G. Hayes	Assistant Laboratory Director
Sally A. Akehurst	Laboratory Technician
Justine H. Schroeder	Laboratory Technician
Mary L. Fegan	Laboratory Technician
John E. Mutchler, P.E.	Contract Manager

<u>U.S. Environmental Protection Agency</u>

Lance Granger	Project Officer
Gilbert H. Wood	Process Engineer

<u>The Cleveland-Cliffs Iron Company</u>

Paul Rosten	Project Coordinator

<u>Empire Mining Company</u>

Lawrence Carr	Plant Operations Coordinator

APPENDIX B

PROCESS FIELD DATA

FIELD OPERATING DATA

EMPIRE GRATE-KILN LINE 3

(p. 1 of 10)

DATE	11/18/75	11/18/75	11/18	11/18	11/18	11/18	11/18
TIME	10:35	11:18	11:30	12:02	13:01	13:15 Grate bed OK.	14:40
Product Totalizer, lt	98975 (10:48)	99117 (11:24)		99277 (12:05)	99513 (13:03)	Balling drums okay.	
Natural Gas Totalizer, cf Valve, %	73	78		78	70		
Balling Drum #10			Balling drums look good. Negligible amount of oversize is conveyed back to concentrate surge bin			14 RPM	
Green Ball Totalizer, lt						35 SPM (Cutter bar)	
Rate lt/hr	105	105		105	105		105
Bentonite lb/lt	28.3	27.5		27.5	27.5	60 LTPH Recycle	28.3
Balling Drum #11						14 RPM	
Green Ball Totalizer, lt						33 SPM	
Rate lt/hr	90	90		90	90	90 LTPH (Re)	90
Bentonite lb/lt	31.7	31.7		31.7	30		28.3
Balling Drum #12						14 RPM	
Green Ball Totalizer, lt						34 SPM	
Rate lt/hr	85	85		86	85	65 LTPH (Re)	90
Bentonite lb/lt	32	35.9		32.5	31.7		28.3
Grate Bed Depth, in	5.5	5.6		5.5	5.5		5.5
Grate Speed, in/min	170	170		175	170		170
Kiln Speed, rph							
Cooler Speed, in/min				50	50		
Temperatures, °F							
Drying Furnace	690	690		680	680		
Preheat Windbox	910	910					
Preheat Furnace	1900	1900		1900	1900		
Kiln Exit Gas	1900	1925		1920	1940		
Kiln Burning Zone	2350	2350		2345	2350		
Secondary Air							
Cooler Waste Gas	860	840		820	810		
Damper Positions, % Open							
Bypass Damper S	60	60			60		
Bypass Damper N	80	80			80		
Tempering Air S	0	0			0		
Tempering Air N	4	4			4		
Bleed-In Air S	0	0			0		
Bleed-In Air N	0	0			0		
Grate Stack Cap	0	0			0		

FIELD OPERATING DATA (CONT.)

EMPIRE G-K LINE 3

(p. 2 of 10)

	11/18 14:55	11/18 15:10	11/18 15:55	11/18 16:20	11/18 16:40	11/18 16:50	11/18 17:01	11/18 17:03	11/18 17:10	11/18 17:14
Product	Balling drum went down for few minutes. Minor impact on G-K. Probably see higher cooler temperature than lower.	0087 (15:16)	00188 (16:00)	00273 (16:21)	00355 (16:42)		00436 (16:03)			
Gas		444602	446024 (1557)	446646	447314		447966			
#10		1001 106 28.3	1797 107 28.3	2179 106 28.3	2521 106 28.3	Spraying H_2O change to 26.7	2933 106 26.7	Change to 25.0		
#11		625 90 28.3	1302 90 28.3	1648 90 28.4	1956 90 28.3	change to 26.7	2257 90 26.7			
#12		804 90 28.3	1460 85 28.3	1782 85 28.3	2061 84 28.3		2352 82 28.3			
Grate		5.5 180	5.5 175	5.5 170	5.5 170		5.5 175			
Kiln		90	90	90 50	90 50		90			
Cooler		48	50				50			
Temps: Drying		660	670	660	650		640			650 → 600
PHT WB									Dropped from 840 to 760	
PHT		1880	1900	1900	1900		1900		Did not change	
Exit		1920	1920	1925	1930		1920			
Burning		2350	2350	2350	2350		2340		Dropped to 2320 then up to 2350	
Secondary		2250		2300	2300		2300			
Cooler		760 (1050) ^ peak	940	900	840		850			
Bypass S		60	60	60	52		52		Change to 46	40
Bypass N		80	80	80	80		80		60	60
Temp S		0	0	0	0		0			
Temp N		5	5	5	4		4			
Bleed S		0	0	0	0		0			
Bleed N		0	0	0	0		0			
Stack		0	0	0	0		0			

ESP Test 1: Green ball samples at 15:30, 16:15, 16:55

(Test 1: 15:19 – 17:40) 11/18

No visible emissions at grate feed.

FIELD OPERATING DATA (CONT.)

EMPIRE G-K LINE 3

DATE	11/18	11/18	11/18		11/19	11/19	11/19	11/19	11/19
Time	17:25	17:40	17:47	Balling Drum #11 went down on midnight shift greater than 3 hrs (before 6:00) ago. Everything smooth since before 9:00.		9:00	9:20	9:58	10:08
Product	00534 (17:26)		00616			04099 (9:01)	04174	04324	04363
Nat Gas	448651		449333			47362 (?) (9:03)	473767	474762	475210
Drum 10									
	3368		3721			2747	3092	3756	3929
	107		100			106	105	106	106
	25.		25			28.3	28.3	28.3	28.3
Drum #11									
	2624		2932			2376	2664	3226	3373
	90		26.7			90	90	96	89
	26.7		100			28.3	28.3	28.3	28.3
Drum 12									
	2696		2986			2231	2496	3026	3165
	84		82			86	86	86	85
	28.3		28.3			28.3	28.3	change 29.2	29.2
Grate	5.5		5.5			5.5	5.5	5.5	5.5
	170		170			170	175	177	170
Kiln	90		90			90	90		90
Cooler	50	changed to 47	47			50	50		50
Temp									
Drying	600		570			610	605	600	600
PHT WB						820	820	920 830	810
PHT	1900		1900			1870	1875	max 1880	1880
Ext	1925		1900			1925	1925	1925	1925
Burning	2340		2360			2360	2360	2380 2350	2360
Secondary	2300		2300			2300	2300	2300	2300
Cooler	550	540	880			800	830	900 840	840
Dampers									
Bypass S	40		40			54	54	54	54
N	60		60			60	60	60	60
Temper S	0		0			0	0	0	0
N	0		0			0	0	0	0
Bleed-in S	0		0			0	0	0	0
N	0		0			0	0	0	0
Cap	0		0			0	0	0	0

FIELD OPERATING DATA (CONT.)

EMPIRE G-K LINE 3

DATE	11/19	11/19	11/19	11/19	11/19	11/19		11/19
Time	10:42	11:15	11:31	12:06	12:21	12:41		12:46
Product	04498	04628	04698	04815	04898	04978		
Nat Gas	476076	476883	477328	478061	478583	479133		
Drum 10	4530 106 28.3	5107 107 28.3	5415 106 28.3	5919 106 28.3	6236 106 28.3	6638 105 28.3		
Drum 11	3883 90 28.3	4393 90 28.3	4633 90 28.3	5060 90 28.3	5393 90 28.3	5691 89 28.3		
Drum 12	3646 86 29.2	4105 86 29.2	4353 85 29.2	4956 85 29.2	5050 86 29.2	5332 86 29.2		
Grate	5.5 170	5.5 175	5.5 170	5.5 170	5.5 175	5.5 175		
Kiln	90	90	90	90	90	90		
Cooler	50	50	50	50	50	50		
Temp								
Drying	600	610	620	640	640	640		
Pht WB	830	830	830	900	880	830		
Pht	1880	1880	1880	1880	1880	1880		
Ext	1925	1920	1925	1925	1925	1920		
Burning	2350	2360	2350	2360	2360	2360		
Secondary	2300	2300	2300	2300	2300	2300		
Cooler	800 (960-900)	830	800	770	800	780		
Dampers								
Bypass S	54	54	54	54	54	54		
Bypass N	60	60	60	60	60	60		
Temper S	0	0	0	0	0	0		
Temper N	0	0	0	0	0	0		
Bleed S	0	0	0	0	0	0		
Bleed N	0	0	0	0	0	0		
Cap	0	0	0	0	0	0		

Dry Furn Press −.9 " H_2O
Dry WB Press 120"
Pht Furn Press −.4
Pht WB Press −14.0
Feed End Draft −.7
Hood Draft −.1
Prim Air Diff +20.
1st Stage Cool Over Bed 0
WB #1 +6
#2 +13
1st St. Cool Under Bed +13
2nd Cool Over +.2
Under +12.5

ESP Test #2 – Greenballs @ 10:57, 11:40

(Test #2 – 10:39 – 12:46) 11/19

No visible emissions at grate feed

Field Operating Data (Cont.)

Empire G-K Line 3

(p. 5 of 10)

Date	11/19	11/19	11/19	11/19	11/19	11/19	11/19	11/19	11/19
Time	14:44	15:16	15:44	16:00	16:15	16:20	16:24	16:25	16:27
Product	5473	5601	5714	5779	5845				
Nat Gas	482475	483383	484132	484552	484,985				
Drum 10	495	1068	1560	1846	2134				
	106	106	105	105	106				
	28.3	28.3	28.3	28.3	28.3				
Drum 11	415	900	1317	1559	1803				
	91	91	90	90	90				
	28.3	28.3	28.3	28.3	28.3				
Drum 12	383	840	1234	1464	1692				
	85	85	85	85	85				
	28.3	28.3	28.3	28.3	28.3				
Grate	5.5	5.5	5.5	5.5	5.5				
	180	175	175	175	170				
Kiln	90	90	90	90	90				
Cooler	50	50	50	50	50				
Temp Drying	620	630	640	640	640	High WB			
Pht WB	820	860	890	900	900	980			880
Pht	1880	1880	1880	1880	1880	So adjust			
Exit	1930	1910	1920	1920	1925	bypass			
Burning	2360	2360	2370	2360	2370	dampers			
Secondary	2300	2300	2300	2300	2300	↓			
Cooler	750	780	840	820	790				
Dampers Bypass S	54	54	54	54	54	64	66	64	62
N	60	60	60	60	60	68	72	72	72
Temper S	0	0	0	0	0				
N	0	0	0	0	0				
Bleed S	0	0	0	0	0				
N	0	0	0	0	0				
Cap	0	0	0	0	0				

Note: At 16:13 high grate bed warning signal set off by cleaning paddle wheel feed to grate.

Field Operating Data (Cont.)

Empire G-K Line 3

(p. 6 of 10)

Date	11/19	11/19	11/19	11/19	11/19	11/20	11/20	11/20	11/20
Time	16:33	17:07	17:27	17:54	18:14	8:22	8:51	9:00	9:16
Product	5914	6048	6126	6240	6317	9697	9813	9850	9918
Nat Gas	485452	486363	486846	487620	488140	510514	511325	511594	512039
Drum 10	2432	3022	3367	3863	4209	2246	2751	2914	3212
	106	106	106	106	105	105	106	106	106
	28.3	28.3	28.3	28.3	28.3	28.3	26.7	26.7	26.7
Drum 11	2056	2556	2850	3269	3562	1894	2324	2463	2717
	90	91	90	90	90	90	91	91	91
	28.3	28.3	28.3	28.3	28.3	28.3	28.3	28.3	28.3
Drum 12	1931	2402	2679	3077	3351	1584	1987	2117	2355
	85	85	83	84	84	85	86	84	84
	28.3	28.3	28.3	28.3	28.3	30	30.	30.	28.3
Grate	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
	168	170	170	170	170	170	170	170	168 (156)
Kiln	90	90	90	90		90		90	90
Cooler	50	50	50	50		50		50	50
Temp									
Drying	660	660	660	650	640	670	670	670	660
PH WB	890	890	890	880	890	940	940	900	880
PH	1880	1880	1880	1880	1850	1880	1880	1880	1880
Exit	1920	1920	1920	1925	1920	1920	1925	1925	1925
Burning	2360	2360	2360	2360	2360	2360	2360	2360	2370
Secondary	2300	2300	2300	2300	2300				
Cooler	810	760	800	760	760	800	790	790	820
Dampers									
Bypass S	62	62	62	60	60	60	59	59	59
N	72	72	72	70	70	72	72	72	72
Temper S	0	0	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0	0	0
Bleed S	0	0	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0	0	0
Cap	0	0	0	0	0	0	0	0	0

ESP Test #3 16:04 – 18:00 (11/19)
Green balls @ 16:45, 17:40

No visible emissions at grate feed

ESP Test #4: 8:38 – 10:33 (11/20)

Green balls @ 9:07, 9:57

No visible emissions at grate feed

FIELD OPERATING DATA (CONT.)

EMPIRE G-K LINE 3

(p.7 of 10)

DATE	11/20	11/20	11/20	11/20	11/20	11/20		11/20	11/20
Time	9:24	9:30	9:46	9:50	10:15	10:31		10:19	10:53
Product		9980 (9:32)	10037		10152	10218	Drying Furn Press -.9" H_2O " WB -12.		10306
Nat Gas		512483	512901	(10:00 Oversize Minimal)	513679	514111	Pht Furn Press -.4 Pht WB Press -13. Feed End Draft -1.0		514687
Drum 10	Change to case #11	3467	3763		4987	4588	Hood Draft -.2		499.0
	110	110	110		110	110	Prim Air Diff +20.0		109
		26.7	26.7		26.7	26.7	1st Cool Over Bed +.01 WB #1 +6. #2 +13.		26.7
Drum 11		2908	3121		3501	3720	1st St Cool Under +13.		4012
	80	81	81		82	80	2nd Cool Over +0.3		80
		28.3	28.3	26.7	26.7	26.7	2nd Cool Underbed +13.		26.7
Drum 12		2564	2802		3227	3472			3797
	90	89	90		88	88			88
	(Total remains the same)	28.3	28.3		28.3	28.3			28.3
Grate		5.5 168 (165)	5.5 170 (162)		5.5 170 (162)	5.5 169 (159)			5.5 170 (162)
Kiln		90	90		90	90			90
Cooler		50	50		50	50			50
Temp Drying		650	660		650	650			650
Pht WB		870	890		870	880			870
Pht		1880	1880		1880	1880			1880
Exit		1925	1925		1925	1925			1928
Burning		2360	2370		2370	2370			2360
Secondary Cooler		860	860		760	770			770
Dampers Bypass S		59	59		59	59			59
N		72	72		72	72			72
Temp S		0	0		0	0			0
N		0	0		0	0			0
Bleed S		0	0		0	0			0
N		0	0		0	0			0
Cap		0	0		0	0			0

Field Operating Data (Cont)

Empire G-K Line 3

Date	11/20	11/20	11/20	11/20	11/20	11/20	11/20	11/20	11/20
Time	10:53-13:00	14:02	14:14	14:30	15:11	15:30	16:00	16:45	17:30
Product	"No Problems"	11072		11185	11347	11428	11548	11729	11915
Nat Gas		520042		520762	521795	522291	523098	524401	525581
Drum 10		848.4		21.1	94.8	131.3	185.8	269.1	352.6
		110		110	110	110	110	110	110
		26.7		26.7	26.7	26.7	26.7	26.7	26.7
Drum 11		654.6		14.7	68.0	94.5	134.0	194.5	255.0
		80		80	79	80	80	80	80
		25.		25.	25	25.	26.7	26.7	26.7
Drum 12		663.0		14.9	74.7	104.2	148.4	215.9	283.6
		90		90	90	90	89	90	90
		28.3	changed to 26.7	26.7	26.7	26.7	26.7	26.7	26.7
Grate		5.5		5.5	5.5	5.5	5.5	5.5	5.5
		170(162)		170(162)	165(156)	166(162)	166(162)	168(156)	170(162)
Kiln		90		90	90	90	90	90	90
Cooler		50		50	50	50	50	50	50
Temp Drying		650		650	650	650	650	660	650
Pht WB		860		870	870	870	870	890	880
Pht		1880		1880	1880	1880	1880	1880	1880
Exit		1925		1925	1925	1925	1925	1925	1925
Burning		2360		2370	2360	2370	2370	2360	2350
Secondary Cooler		770		760	790	740	820	790	820
Dampers Bypass S		59		59	59	59	59	59	59
N		72		72	72	72	72	72	72
Temp S		0		0	0	0	0	0	0
N		0		0	0	0	0	0	0
Bleed S		0		0	0	0	0	0	0
N		0		0	0	0	0	0	0
Cap		0		0	0	0	0	0	0

ESP Particle Sizing Tests 1A, 1B, and J were conducted between 1200 and 1900 on 11/20.

Field Operating Data (Cont.)

Empire G-K Line 3

(p.9 of 10)

Date	11/20	11/20	11/20	11/21	11/21	11/21
Time	17:57	18:21	18:47	9:49	10:21	10:30
Product	12024	12122	12224	[On bypass so must use 85% of concentrate]		
Nat Gas	526351	527040	527697	552206	553031	553303
Drum 10						
	4023	4472	4940	3440	4024	4222
	110	110	110	110	110	110
	26.7	26.7	26.7	31.7	31.7	31.7
Drum 11						
	2911	3237	3576	2778	3199	3340
	81	80	80	80	79	80
	26.7	26.7	26.7	30.	30.	28.3
Drum 12						
	3238	3605	3981	3192	3671	3832
	90	90	90	90	90	90
	26.7	26.7	26.7	19.2	26.7	29.5
Grate	5.5	5.5	5.5	5.5	5.5	5.5
	170(156)	168 (156)	170(162)	165(156)	168 (156)	168(158)
Kiln	90	90	90	90	90	90
Cooler	50	50	50	48	48	50
Temp						
Drying	650	650	640	650	650	650
Pht WB	860	860	860	870	880	900
Pht	1890	1900	1900	1880	1920	1920
Exit	1920	1925	1930	1925	1925	1925
Burning	2360	2360	2360	2330 (gauge 2350)	2340	2335
Secondary				2270 (low)	2270	2270
Cooler	840	820	860	660	810	840
Dampers						
Bypass S	59	59	59	59	59	59
N	72	72	72	72	72	72
Temp S	0	0	0	0	0	0
N	0	0	0	0	0	0
Bleed S	0	0	0	0	0	0
N	0	0	0	0	0	0
Cap	0	0	0	0	0	0

11/20 — 18:29

Drying Furn Press -.7" H_2O
" WB Press -13.
Preht WB Press -13.
Preht Furn Press -.4
Feed End Draft -.9
Hood Draft -.01
Prim Air Diff +20
1st St. Cool Over Bed +.1
WB #1 +6.
#2 +13.
1st St. Cool Under +13.
2nd Cool Over +.3
Under +13.
Grate 360v (DC)
20 Amps (@66) (max)
Fan 2 Damper 77% open
2 220 amps (280)
1A (S) 100% 220 amps (220)
1B (N) 100% 220 (220)
Kiln 230 amps (660)
Kiln motor (S) 255
(N) 255
Prim Air Fan 105 amps (115)
" Standby 0 amps (115)
Burn Gas Valve 40% open
Cooler 320 volts
Motor (S) 3.5 amps (12)
(N) 3.5 (12)
Fan 3A Damper 50% open
70 amps (115)
Fan 3B 60%
90 amps (135)
Preht WB (N) 860°F
Bypass (N) 1360°F
Fan 1B Outlet 650°F
Cooler Screenwall 200°

11/21 — 8:58

Balling Drum 10 just back on line. Need to wait for temperatures to stabilize.

Rotoclone Test #1 17:40-18:47 (11/20)

Green balls @ 17:40, 18:10

No visible emissions at grate feed

Rotoclone Test #2 9:50 - 11:08 (11/21)

Green balls @ 10:10, 10:39

No visible emissions at grate feed

FIELD OPERATING DATA (CONT)

EMPIRE G-K LINE 3

DATE	11/21	11/21	11/21	11/21	11/21	11/21	11/21	11/21
Time	10:30-10:50	10:51	11:02	12:48	12:50	13:26	13:30	13:54
Product	TEMPERATURE	On bypass; have to estimate as 85% of concentrate.						
Net Gas	GAUGES ADJUSTED	553794	554096	556888	Momentarily Lost Power On Control Panel	557884	ESP FAULT	558595
Drum 10							Switched to manual control	
		4565	4787	6738		7440		7736
		110	110	110		110		110
		31.7	31.7	31.7		31.7		31.7
Drum 11								
		3591	3747	5153		5658		6016
		80	80	80		80		80
		28.3	28.3	28.3		28.3		28.3
Drum 12								
		4117	4294	5894		6468		6875
		90	90	90		90		92
		25.8	25.8	25.8		25.8		25.8
Grate		5.5	5.5	5.5		5.5		5.5
		172(162)	175(165)	170(160)		175 (162)		170 (160)
Kiln		90	90	90		90		90
Cooler		50	50	50		50		48
Temp.								
Drying		650	650	660		660		660
PHt WB		890	890	900		890		900
PHt		Adjusting	1900	1900		1900		1880
Exit		2100	2050	2070		2070		2050
Burning		2390	2370	2370		2380		2390
Secondary Cooler		2290	2250	2300		2300		2280
		920 (?)	790	790		830		760
Dampers								
Bypass S		59	59	59		59		59
N		72	72	72		72		72
Temp. S		0	0	0		0		0
N		0	0	0		0		0
Bleed S		0	0	0		0		0
N		0	0	0		0		0
Cap		0	0	0		0		0

Rotoclone Test #3 12:48-13:53 (11/21)

Green balls @ 13:12, 13:45

No visible emissions at grate feed

ESP Operating Data
Empire G-K Line 3
Downdraft Drying

Time	Module A			Module B			Module C			Module D		
	Primary Current	Primary Voltage	Secondary Current	PC	PV	SC	PC	PV	SC	PC	PV	SC
	(AC) amps	(AC) volts	(DC) amps									
"Normal" As stated on panel	—	—	1.0	—	—	1.0	—	—	1.0	—	—	1.0
11/17 Day	175	380	1.3	180	280	1.2	150	330	1.5	160	310	.75
Afternoon	175	380	1.3	190	270	1.2	160	340	1.4	165	315	.74
11/18 Night	175	390	1.3	190	270	1.3	150	325	1.45	155	315	.74
Day	175	380	1.4	180	280	1.0	150	325	1.5	160	310	.8
Aft	170	360	1.3	195	270	1.45	150	310	1.45	155	310	.65
11/19 Night	170	360	1.3	195	270	1.32	150	310	1.45	155	305	.75
Day	170	370	1.3	200	280	1.35	150	310	1.45	160	300	.8
Aft	175	370	1.3	195	270	1.34	150	325	1.45	160	300	.8
15:30	175	375	1.34	195	270	1.35	150	325	1.47	160	300	.77
16:48	175	375	1.34	192	270	1.36	150	325	1.47	160	300	.77
17:00	175	372	1.35	193	270	1.36	151	322	1.47	161	300	.77
17:46	175	372	1.35	193	270	1.36	151	325	1.48	161	300	.77
11/20 8:45	175	370	1.33	200	270	1.37	150	322	1.47	162	303	.78
10:04	173	365	1.32	200	270	1.37	151	322	1.47	162	303	.78
Day	170	370	1.3	200	280	1.34	150	310	1.45	160	300	.8
14:44	173	365	1.32	200	270	1.37	151	322	1.47	162	303	.78
16:34	172	359	1.3	198	270	1.38	151	320	1.46	162	302	.78
17:45	172	359	1.3	198	270	1.38	151	320	1.46	162	302	.78
18:15	172	360	1.3	198	270	1.38	151	320	1.46	162	303	.78
11/21 10:06	173	365	1.32	200	270	1.37	150	322	1.47	162	303	.78
10:42	173	362	1.32	200	270	1.37	156	322	1.47	162	303	.78
13:16	173	362	1.32	200	270	1.34	150	322	1.47	162	306	.78
13:30	ESP Fault Flashed at Control Room; switched to manual control											
13:47	172	365	1.32	200	270	1.37	150	325	1.47	75	210	.72
	Switched back to auto between 13:47 and 14:14									Apparent short in D		
14:14	172	365	1.33	198	270	1.37	150	325	1.48	140	309	.75
15:06	172	367	1.33	198	270	1.37	150	325	1.48	152	305	.74
16:04	174	368	1.33	197	270	1.37	151	328	1.48	152	308	.75
16:44	174	365	1.32	200	270	1.36	151	326	1.48	152	308	.75

Note: Maintenance logs from 11/6 to 11/21 – "All OK"

EPA Test # Empire – 1 11-18-75

Day 1:30 Aft 3:30 Aft 5:30

Balling Drum Output T/Hr
Grate Bed Depth or Set Point
Grate Speed IPm
Drying Furnace Temp
Preheat Furnace Press
Drying Furnace Press
Preheat Furnace Temp
Preheat Windbox Press
Drying Windbox Press
Kiln Speed
Burning Zone Radiamatic
Burning Zone optical
Primary Air
Gas Meter Reading
Cooler Speed In/min
Cooler Waste Gas temp
Product Scale

Data not Available. Logs incomplete due to #2 unit being down.

Time	1:30	2:30	3:30	4:30	5:30
Product Scale	243 LT	222	240	240	225

Green Balls

Drums	10	11	12
+3/4"	0.31	—	0.51
3/4 + 5/8"	0.63	0.66	1.54
5/8 + 1/2"	10.47	18.81	12.22
1/2 + 3/8"	84.75	77.89	82.47
3/8 + 1/4"	2.75	2.18	2.91
-1/4"	1.09	0.46	0.35
Wet Crush (lbs)	3.15	3.30	3.16
Wet Knock (12")	22.0	23.0	24.4
Dry Crush (lbs)	23.35	23.95	21.50
% H_2O	10.83	10.66	10.69
Bentonite lbs/LT	23.99	27.02	31.20

Product

+1 1/2	
-1 1/2 +1"	
-1 + 3/4"	0.17
-3/4" + 5/8"	0.48
-5/8 + 1/2"	11.64
-1/2" + 3/8"	77.87
-3/8 + 1/4"	8.71
-1/4" + 30m	1.04
-30m	0.09
+1/4" After tumble	97.28
+30m After Tumble	98.20
Tumble Index	1.80
Q index	96.18
Average Crush 1/2	680 lbs
Average Crush 3/8	637 lbs
Bulk density	127 lbs/ft^3

Daily Iron 64.50

Daily Silica 6.66

EPA Test # Empire 2 11-19-75

	0930 Day	1130 Day	130 day
Balling Drum Output T/Hr	280	280	280
Grate Bed Depth or Set Point	5.4	5.4	5.4
Grate Speed IPm	165	165	165
Drying Furnace Temp	620	620	620
Preheat Furnace Press	-.6	-.6	-.6
Drying Furnace Press	-.65	-.65	-.6
Preheat Furnace Temp	1875	1875	1850
Preheat Windbox Press	16	15	15
Drying Windbox Press	14	12.5	12
Kiln Speed	89	89	89
Burning Zone Radiamatic	2350	2350	2350
Burning Zone optical	2410	2400	2390
Primary Air Differential	20	20	20
Gas Meter Reading	474145	477216	480460
Cooler Speed In/min	59	50	50
Cooler Waste Gas temp	810	790	760

Product Scale 0930 - 241 10:30 240 11:30 239 12:30 246 1:30 238

Green Balls Drums	10	11	12
+3/4"	1.13	0.84	1.50
-3/4 +5/8"	2.46	0.70	1.09
-5/8 + 1/2"	18.10	14.59	17.46
-1/2 + 3/8"	75.92	80.86	77.29
-3/8 + 1/4"	1.48	2.38	2.11
-1/4"	0.91	0.63	0.55
Wet Crush (lbs)	3.02	3.03	3.16
Wet Knock (12")	20.90	23.0	18.6
Dry Crush (lbs)	20.65	23.45	22.95
% H_2O	10.95	10.85	10.58
Bentonite	24.99	23.65	28.41

Daily Iron 64.60

Daily Silica 6.62

Product	
+1 1/2	
-1 1/2 +1"	
-1 +3/4"	0.14
-3/4" + 5/8"	0.96
-5/8 + 1/2"	27.25
-1/2" + 3/8"	64.30
-3/8 + 1/4"	6.61
-1/4" + 30m.	0.40
-30m	0.34
+1/4" After tumble	96.28
+30m After Tumble	97.68
Tumble Index	2.32
Q index	95.57
Average Crush 1/2	680
Average Crush 3/8	514
Bulk density	128

EPA Test # Empire 3 and 4 11/20/75

	730	930	11:30	1:30	3:30	5:30	7:30
Balling Drum Output T/Hr	280	280	—	280	280	280	280
Grate Bed Depth or Set Point	5.4	5.4	—	5.4	5.4	5.4	5.4
Grate Speed IPm	167	166	—	165	165	165	165
Drying Furnace Temp	660	650	—	640	650	650	640
Preheat Furnace Press	-.9	-.87	—	-.87	-.75	-.75	-.7
Drying Furnace Press	-.9	-.85	—	-.86	-.7	-.7	-.7
Preheat Furnace Temp	1890	1900	—	1900	1875	1890	1910
Preheat Windbox ~~Press~~	13	14	—	14.6	14	14	14
Drying Windbox Press	10.5	12	—	12.3	12	12	12
Kiln Speed	89	89	—	89	89	89	89
Burning Zone Radiamatic	2360	2370	—	2370	2370	2360	2360
Burning Zone optical	2400	2400	—	2400	2410	2410	2410
Primary Air differential	20.5	20	—	20	20	20	20
Gas Meter Reading	509350	—	—	—	522209	525756	528736
Cooler Speed In/min	51	50	—	50	50	50	50
Cooler Waste Gas temp	800	800	—	900	820	780	830
Product Scale							

Green Balls

Drums	10	11	12
+3/4"	2.85	.18	1.02
-3/4 +5/8"	1.32	.52	.78
-5/8 + 1/2"	19.88	23.10	28.74
-1/2 + 3/8"	70.04	72.26	67.27
-3/8 + 1/4"	4.64	2.95	1.80
-1/4"	1.27	.99	.39
Wet Crush (lbs)	2.45	2.43	2.54
Wet Knock (12")	22.50	23.40	25.00
Dry Crush (lbs)	24.15	21.35	21.50
% H_2O	10.67	10.61	10.96
Bentonite	27.40	27.95	31.72

Daily Iron 64.70

Daily Silica 6.52

Product

+1 1/2	
-1 1/2 +1"	
-1 +3/4"	
-3/4" + 5/8"	
-5/8 + 1/2"	0.90
- 1/2" + 3/8"	15.66
-3/8 + 1/4"	78.14
-1/4" +30m	4.76
-30m	0.43
	0.11
+1/4" After tumble	97.36
+30m After Tumble	98.16
Tumble Index	1.84
Q index	96.83
Average Crush 1/2	619
Average Crush 3/8	565
Bulk density	128

EPA Test # Empire 5 and 6 11/21/75

	0730	0930	1130	130	330
Balling Drum Output T/HR	280	—	280	—	280
Grate Bed Depth or Set Point	5.4	—	5.4	—	5.4
Grate Speed IPm	170	—	170	—	165
Drying Furnace Temp	610	—	620	—	680
Preheat Furnace Press	-.65	—	.82	—	.8
Drying Furnace Press	-.8	—	.7	—	.7
Preheat Furnace Temp	1950	—	1900	—	1870
Preheat Windbox Press	15	—	13.8	—	13
Drying Windbox Press	13.5	—	11	—	10.5
Kiln Speed	.89	—	89	—	89
Burning Zone Radiamatic	2340	—	2380	—	2380
Burning Zone optical	2400	—	2400	—	2420
Primary Air Differential	21	—	20	—	20
Gas Meter Reading	549151		554900	~~[illegible]~~	561274
Cooler Speed In/min	50	—	50	—	50
Cooler Waste Gas temp	780	—	790	—	800
Product Scale		10:30	204		244

Green Balls

Drums	10	11	12
+3/4"	.27	—	.155
-3/4 +5/8"	.73	.09	.36
-5/8 + 1/2"	16.71	23.20	28.39
-1/2 + 3/8"	78.57	74.46	67.42
-3/8 + 1/4"	2.82	1.82	2.64
-1/4"	.90	.43	.64
Wet Crush (lbs)	2.12	2.39	2.26
Wet Knock (12")	11.50	16.60	13.70
Dry Crush (lbs)	17.53	18.85	17.70
% H_2O	10.29	10.30	10.42
Bentonite	25.62	23.38	24.92

Daily Iron

Daily Silica

Product

+1 1/2

-1 1/2 +1"

-1 + 3/4"

-3/4" + 5/8"

-5/8 + 1/2"

- 1/2" + 3/8"

-3/8 + 1/4"

-1/4" +30m

-30m

+1/4" After tumble

+30m After Tumble

Tumble Index

Q index

Average Crush 1/2

Average Crush 3/8

Bulk density

APPENDIX C

PARTICULATE/ASBESTOS FIELD DATA SHEETS

$\Delta H = 4.1136 \frac{T_m}{T_s} H$

SAMPLING TRAIN DATA

$\Delta H = .006 T_m H$

Company: EPA TASK 20 EMPIRE MINING

Source Designation: PRECIPITATOR INLET NO. 3 KILN

Date: 11-18-75

Test Number: P-1

Field Person: H.P.F. G.M.S.

Filter Number: Ga 4-281-20

Barometric Pressure ("Hg): 28.84

Stack Static Pressure ("H_2O): -13.3

Stack Dimensions: 80" X 159"

Plume Appearance:

Ambient Temperature (°F): 60°

Record all Data Every 6 Minutes

Filter Heater Setting: 90%

Probe Heater Setting: 95%

Nozzle Number: ____, Dia. (in.): .251

Pitot Tube No. 19, Corr. Factor: 0.818

Meter Box No. RAC-1, Corr. Factor: 0.998

Meter Isokinetic Factor: ~~1730~~ 1753

Assumed Moisture (%): 12%

Condensate Volume (ml): 250

Silica Gel Weight Gain (g): 10.7

Leak Rate .009 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
A-4	0	15:23	.63	219	498.425	86	85	2.1	160	60	2.5
A-3	6	15:29	.67	221	502.85	94	87	2.2	160	60	2.5
A-2	12	15:35	.63	220	507.64	98	89	2.1	160	60	2.5
A-1	18	15:41	.57	220	512.39	100	90	1.9	160	60	2.5
* B-4	24	15:47 15:58	.65	220	516.935	96	92	2.2	160	60	2.5
B-3	30	16:04	.68	220	521.73	98	92	2.3	160	60	2.9
B-2	36	16:10	.64	220	526.68	100	92	2.1	160	60	2.9
B-1	42	16:16	.50	220	531.44	102	92	1.8	160	64	2.7
* C-4	48	16:22 16:30	.75	220	535.762	96	92	2.5	160	64	3.0
C-3	54	16:36	.71	218	540.88	98	92	2.4	160	66	3.0
C-2	60	16:42	.63	215	545.97	102	92	2.1	160	70	2.7
C-1	66	16:48	.55	210	550.74	102	92	1.9	160	76	2.7
* D-4	72	16:54 17:15	.54	205	555.288	92	90	1.9	165	54	2.7
D-3	78	17:21	.62	200	559.73	92	90	2.1	165	60	2.8
D-2	84	17:27	.55	200	563.66	96	92	2.0	165	58	3.0
D-1	90	17:33	.45	200	568.23	98	90	1.6	165	56	3.0
	96	17:39			572.360						
AVERAGE (TOTAL)				214	(73.787)	97	90	2.1	160	62	2.7

* PORT CHANGE TIME

LEAK RATE - 0

Clayton Environmental Consultants, Inc.

DRY MOLECULAR WEIGHT DETERMINATION (M_d)

Plant: Empire Mine
Date: 11/6/75
Sampling Time (24-hour Clock): 1512?-16-26
Sampling Location:: Inlet precipitator
Comments: Part 1

Sample Type (bag, integrated, continuous)
Analytical Method: orsat
Ambient Temperature: 45
Operator: [illegible]

Gas \ Run	1 Actual Reading	1 Net	2 Actual Reading	2 Net	3 Actual Reading	3 Net	Average Net Volume	Multiplier	Molecular Weight Of Stack Gas (dry basis) M_d, lb/lb-mole
CO_2	2.0	2.0	2.2	2.2	2.0	2.0	2.1	44/100	0.924
O_2 (Net is actual O_2 reading minus actual CO_2 reading)	17.8	15.8	18.0	15.8	18.0	16.0	15.9	32/100	5.088
CO (net is actual CO reading minus actual O_2 reading)	—							28/100	
N_2 (Net is 100 minus actual CO reading)		82.2		82.0		82.0	82.0	28/100	22.960
								Total	28.972 = M_d

WET MOLECULAR WEIGHT DETERMINATION (M_s)

B_{wo} = Proportion by volume of water vapor in the gas stream

M_s = Molecular weight of stack gas (wet basis), lb/lb-mole = $M_d(1-B_{wo}) + 18(B_{wo})$

M_s = ( )(1-) + 18( ) =

$G_m = \frac{M_d}{28.96} = \frac{\quad}{28.96} =$, $G_s = \frac{M_s}{28.96} = \frac{\quad}{28.96} =$, $\frac{G_m}{G_s} = \frac{\quad}{\quad} =$

Clayton Environmental Consultants, Inc.

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SAMPLING TRAIN DATA

$\Delta H = 3.3 \frac{T_m}{T_s} H$

Company: EPA TASK 20 EMPIRE MINING

Source Designation: PRECIPITATOR INLET NO.3 KILN

Date: 11-19-75

Test Number: P-2 PAGE 1

Field Person: HPF, GMS

Filter Number: Ga 4-281-17

Barometric Pressure ("Hg): 28.41

Stack Static Pressure ("H_2O): -13.3

Stack Dimensions: 80" X 159"

Plume Appearance:

Ambient Temperature (°F): 53°

Record all Data Every 6 Minutes

Filter Heater Setting: 100%

Probe Heater Setting: 80%

Nozzle Number: ____, Dia. (in.): .251

Pitot Tube No. 19, Corr. Factor: 0.818

Meter Box No. RAC-1, Corr. Factor: 0.998

Meter Isokinetic Factor: ~~1730~~ 1753

Assumed Moisture (%): 15%

Condensate Volume (ml): 229

Silica Gel Weight Gain (g): 23.7

Leak Rate 0.000 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
A-4	0	10:41	.66	210	572.880	80	80	1.80	160	88	2.0
A-3	6	10:47	.67	210	576.69	90	86	1.9	160	80	2.0
A-2	12	10:53	.67	205	581.15	94	88	1.9	165	68	2.0
A-1	18	10:59	.55	210	585.63	100	90	1.5	165	68	2.0
	24	11:05			589.786						
B-4	24	11:16	.63	210	589.786	96	92	1.8	165	74	2.0
B-3	30	11:22	.69	210	594.08	100	94	1.9	165	72	2.0
B-2	36	11:28	.67	210	598.66	104	94	1.9	165	70	2.0
B-1	42	11:34	.53	210	603.18	106	96	1.5	165	70	2.0
	48	11:40	[redacted]	[redacted]	607.366						
C-4	48	11:50	.75	210	607.366	100	96	2.1	165	75	2.1
C-3	54	11:56	.67	210	612.06	104	98	1.9	165	75	2.1
C-2	60	12:02	.62	215	616.64	106	98	1.7	160	73	2.0
C-1	66	12:08	.50	215	620.99	108	100	1.4	165	76	2.0
	72	12:14			624.948						
AVERAGE (TOTAL)					( )						

2 of 2

SAMPLING TRAIN DATA

$\Delta H = 3.39 \frac{T_m}{T_s} H$

Company: EPA TASK 20 EMPIRE MINING

Source Designation: PRECIPITATOR INLET NO. 3 KILN

Date: 11-19-75

Test Number: P-2 PAGE 2

Field Person: ______

Filter Number: ______

Barometric Pressure ("Hg): ______

Stack Static Pressure ("H_2O): ______

Stack Dimensions: ______

Plume Appearance: ______

Ambient Temperature (°F): ______

Record all Data Every ______ Minutes

Filter Heater Setting: ______

Probe Heater Setting: ______

Nozzle Number: ______, Dia. (in.): ______

Pitot Tube No. ______, Corr. Factor: ______

Meter Box No. ______, Corr. Factor: ______

Meter Isokinetic Factor: ______

Assumed Moisture (%): ______

Condensate Volume (ml): ______

Silica Gel Weight Gain (g): ______

Leak Rate ______ CFM at ______ "Hg

Traverse Point No.	Time		Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter			Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
	Sampling (min)	Clock			Volume (ft^3)	Temp (°F) Inlet	Temp (°F) Outlet				
D-4	72	12:16	.68	215	624.948	104	100	1.9	165	82	2.2
D-3	78	12:22	.63	215	629.53	106	100	1.8	170	76	2.3
D-2	84	12:34	.59	215	633.98	110	100	1.7	170	76	2.3
D-1	90	12:40	.46	215	638.35	110	102	1.3	160	76	2.1
	96	12:46			642,214						
AVERAGE (TOTAL)				210	(69.195)	101	95	1.8	165	75	2.1

FINAL LEAK 0.000 AT 15" Hg

Clayton Environmental Consultants, Inc.

DRY MOLECULAR WEIGHT DETERMINATION (M_d)

Plant: Empire Mining
Date: 11/19/75
Sampling Time (24-hour Clock): 10:45 - 11:45
Sampling Location:: Inlet Rpt
Comments: P #2 Precipitator Inlet

Sample Type (bag, integrated, continuous) ______
Analytical Method: Orsat
Ambient Temperature: ______
Operator: [illegible]

Gas \ Run	1 Actual Reading	1 Net	2 Actual Reading	2 Net	3 Actual Reading	3 Net	Average Net Volume	Multiplier	Molecular Weight Of Stack Gas (dry basis) M_d, lb/lb-mole
CO_2	2.0	2.0	1.9	1.9			2.0	44/100	0.880
O_2 (Net is actual O_2 reading minus actual CO_2 reading)	18.0	16.0	17.9	16.0			16.0	32/100	5.120
CO (net is actual CO reading minus actual O_2 reading)								28/100	
N2 (Net is 100 minus actual CO reading)		82.0		82.1			82.0	28/100	22.960
								Total	28.960 = M_d

WET MOLECULAR WEIGHT DETERMINATION (M_s)

B_{wo} = Proportion by volume of water vapor in the gas stream

M_s = Molecular weight of stack gas (wet basis), lb/lb-mole = $M_d(1-B_{wo}) + 18(B_{wo})$

$M_s = (\quad)(1- \quad) + 18(\quad) =$

$G_m = \frac{M_d}{28.96} = \frac{\quad}{28.96} = \quad$, $G_s = \frac{M_s}{28.96} = \frac{\quad}{28.96} = \quad$, $\frac{G_m}{G_s} = \frac{\quad}{\quad} =$

1/2

SAMPLING TRAIN DATA

$\Delta A = 3.39 \frac{Tm}{Ts} H$

Company: EPA TASK 20 EMPIRE MINING CO.

Source Designation: E. PRECIPITATOR INLET KILN NO. 3

Date: 11/19/75

Test Number: P-3 PAGE 1

Field Person: HPF GMS

Filter Number: Ga 4-281-16

Barometric Pressure ("Hg): 28.41

Stack Static Pressure ("H_2O): -13.3

Stack Dimensions: 80"X159"

Plume Appearance:

Ambient Temperature(°F):

Record all Data Every 6 Minutes

Filter Heater Setting: 100%

Probe Heater Setting: 80%

Nozzle Number: , Dia. (in.): .251

Pitot Tube No. 19, Corr. Factor: 0.818

Meter Box No. RAC 1, Corr. Factor: 0.998

Meter Isokinetic Factor: ~~1730~~ 1753

Assumed Moisture(%): 15%

Condensate Volume(ml): 244

Silica Gel Weight Gain(g):

Leak Rate 0.000 CFM at 15 "Hg

Traverse Point No.	Time		Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter			Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
	Sampling (min)	Clock			Volume (ft^3)	Temp (°F) Inlet	Temp (°F) Outlet				
A-4	0	16:04	.66	220	642.502	86	86	1.8	160	64	2.0
A-3	6	16:10	.68	220	646.78	90	86	1.85	160	60	2.0
A-2	12	16:16	.65	225	650.52	94	86	1.8	160	60	2.0
A-1	18	16:22	.56	220	655.67	100	90	1.5	160	64	2.0
	24	16:28			659.743						
B-4	24	16:35	.69	220	659.743	96	92	1.9	160	66	2.0
B-3	30	16:41	.73	220	664.18	100	93	2.0	160	60	2.0
B-2	36	16:47	.69	215	668.89	104	94	1.9	160	60	2.0
B-1	42	16:53	.57	215	673.46	106	96	1.6	160	64	2.0
	48	16:59	[illegible]	[illegible]	677.677	[illegible]	[illegible]	[illegible]			
C-4	48	17:03	.76	214	677.677	102	96	2.1	165	66	2.5
C-3	54	17:09	.70	215	682.37	105	97	2.0	165	64	2.5
C-2	60	17:15	.64	210	687.07	108	98	1.8	165	70	2.5
C-1	66	17:21	.47	215	691.58	110	100	1.3	170	66	
	72	17:27			695.440						
AVERAGE (TOTAL)					( )						

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SAMPLING TRAIN DATA

Company: EPA TASK 20 EMPIRE MINING CO.

Source Designation: E. PRECIPITATOR INLET KILN NO 3

Date: 11/19/75

Test Number: P-3 PAGE 2

Field Person:

Filter Number: 6a 4-281-16

Barometric Pressure ("Hg):

Stack Static Pressure ("H_2O):

Stack Dimensions:

Plume Appearance:

Ambient Temperature (°F):

Record all Data Every ______ Minutes

Filter Heater Setting:

Probe Heater Setting:

Nozzle Number: ____, Dia. (in.):

Pitot Tube No. ____, Corr. Factor:

Meter Box No. ____, Corr. Factor:

Meter Isokinetic Factor:

Assumed Moisture (%):

Condensate Volume (ml):

Silica Gel Weight Gain (g):

FINAL Leak Rate 0.000 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
D-4	72	17:36	.73	215	695.440	104	100	2.1	170	68	2.2
D-3	78	17:42	.65	215	700.20	108	100	1.8	170	68	2.6
D-2	84	17:48	.62	215	704.78	110	102	1.8	170	68	2.6
D-1	90	17:54	.50	215	709.32	112	102	1.4	170	66	2.5
	96	18:00			713.404						
AVERAGE (TOTAL)				217	(70.760)	102	95	1.8	165	65	2.2

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[redacted] 16:08
Out 16:05

DRY MOLECULAR WEIGHT DETERMINATION (M_d)

Plant: Empire Mining
Date: 11/19/75
Sampling Time (24-hour Clock): 16:08
Sampling Location:: Inlet port
Comments: Precipitator Inlet

Sample Type (bag, integrated, continuous) ______
Analytical Method: ______
Ambient Temperature: ______
Operator: ______

Gas \ Run	1		2		3		Average Net Volume	Multiplier	Molecular Weight Of Stack Gas (dry basis) M_d, lb/lb-mole
	Actual Reading	Net	Actual Reading	Net	Actual Reading	Net			
CO_2	1.8	1.8	2.0	2.0	1.9	1.9	1.9	44/100	0.836
O_2 (Net is actual O_2 reading minus actual CO_2 reading)	18.1	16.3	18.0	16.0	18.1	16.2	16.2	32/100	5.184
CO (net is actual CO reading minus actual O_2 reading)								28/100	
N_2 (Net is 100 minus actual CO reading)		81.9		82.0		81.9	81.9	28/100	22.932
								Total	28.952 = M_d

WET MOLECULAR WEIGHT DETERMINATION (M_s)

B_{wo} = Proportion by volume of water vapor in the gas stream

M_s = Molecular weight of stack gas (wet basis), lb/lb-mole = $M_d(1-B_{wo}) + 18(B_{wo})$

$M_s = (\quad)(1- \quad) + 18(\quad) =$

$G_m = \frac{M_d}{28.96} = \frac{\quad}{28.96} = \quad$, $G_s = \frac{M_s}{28.96} = \frac{\quad}{28.96} = \quad$, $\frac{G_m}{G_s} = \frac{\quad}{\quad} =$

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PAGE 1 of 2

SAMPLING TRAIN DATA

ΔM: 3.84 $\frac{Tm}{Ts}$ H

Company: EPA TASK 20 EMPIRE MINING
Source Designation: E.S.P. INLET
Date: 11/20/75
Test Number: P-4 PAGE 1
Field Person: HPF GMS
Filter Number: Ga 4 - 281 -15
Barometric Pressure ("Hg): 28.35
Stack Static Pressure ("H_2O): -13.3
Stack Dimensions: 80X159"
Plume Appearance:
Ambient Temperature(°F): 40°
Record all Data Every 6 Minutes

Filter Heater Setting: 100
Probe Heater Setting: 180
Nozzle Number: ____, Dia.(in.): .251
Pitot Tube No. 19, Corr.Factor: 0.818
Meter Box No. 2ACI, Corr.Factor: 0.998
Meter Isokinetic Factor: ~~1730~~ 1753
Assumed Moisture(%): 15%
Condensate Volume(ml): 215
Silica Gel Weight Gain(g): 30
Leak Rate 0.005 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
A4	0	8:38	.70	210	713.668	44	42	2.0	150	40	1.8
A-3	6	8:44	.71	210	717.77	48	42	2.0	150	40	1.7
A-2	12	8:50	.69	215	721.75	54	44	2.0	150	40	1.7
A-1	18	8:56	.62	215	724.98	60	46	1.8	100	40	1.7
	24	9:02			729.872				150	40	
B-4	24	9:08	.71	215	729872	56	50	2.1	150	40	9.0
B-3	30	9:14	.73	210	734.00	62	56	2.2	150	46	8.0 2.0
B-2	36	9:20	.69	210	739.99	68	62	2.1	150	52	2.0
B-1	42	9:26	.60	210	743.69	70	56	1.8	150	54	2.0
	48	9:32			748.025						
C-4	48	9:38	.74	205	748.025	66	58	2.2	150	60	2.2
C-3	54	9:44	.74	210	752.85	70	60	2.2	140	58	2.2
C-2	60	9:50	.64	205	757.63	72	60	1.9	145	58	2.2
C-1	66	9:56	.49	210	762.08	72	62	1.6	150	58	2.0
	72	1002			766.290						
AVERAGE (TOTAL)					( )						

PAGE 2 of 2

SAMPLING TRAIN DATA

ΔM= 3.84 Tm/TS H

Company: EPA TASK 20 EMPIRE MINING

Source Designation: E.SP. INLET NO. 3 KILN

Date: 11/20/75

Test Number: D-4 PAGE 2

Field Person: HPF GMS

Filter Number:

Barometric Pressure ("Hg):

Stack Static Pressure ("H_2O):

Stack Dimensions:

Plume Appearance:

Ambient Temperature(°F):

Record all Data Every 6 Minutes

Filter Heater Setting:

Probe Heater Setting:

Nozzle Number: , Dia.(in.):

Pitot Tube No. , Corr.Factor:

Meter Box No. , Corr.Factor:

Meter Isokinetic Factor:

Assumed Moisture(%):

Condensate Volume(ml):

Silica Gel Weight Gain(g):

Leak Rate 0.000 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
D-4	72	10:08	.64	206	766.290	68	62	1.9	145	50	2.0
D-3	78	10:14	.63	205	770.63	70	62	1.9	145	60	2.0
D-2	84	10:20	.60	206	775.05	72	64	1.8	150	68	2.0
D-1	90	10:26	.53	206	779.38	74	64	1.6	150	72	2.0
	96				783.444						
AVERAGE (TOTAL)				209	(69.636)	64	55	1.9	145	52	2.8

19.5 apart

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SAMPLING TRAIN DATA

Company: EMPIRE MINING CO. EPA TASK #20
Source Designation: NO. 3 KILN PRECIPITATOR OUTLET
Date: 11/18/75
Test Number: P-1 ✓
Field Person: JBS, GJS
Filter Number: GA4-281-39
Barometric Pressure ("Hg): 28.84
Stack Static Pressure ("H_2O): -0.43
Stack Dimensions: 147"φ
Plume Appearance: <10%
Ambient Temperature (°F): 40°F.
Record all Data Every 2 Minutes

Filter Heater Setting: 185 °F
Probe Heater Setting: 185 °F
Nozzle Number: ___, Dia. (in.): 0.249
Pitot Tube No. 12, Corr. Factor: 0.824
Meter Box No. MAC-5, Corr. Factor: 1.011
Meter Isokinetic Factor: 1730
Assumed Moisture (%): 14.0%
Condensate Volume (ml): 202.0
Silica Gel Weight Gain (g): 20.0
Leak Rate 0.006 CFM at 16.0 "Hg

ΔM = 3.7 Tm/Ts H

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
N-12	0	15:19	0.25	225	929.848	65	64	0.72	145	50	0.1
11	2	15:21	0.26	230	930.7	65	65	0.75	136	50	0.1
10	4	15:23	0.28	230	931.7	65	65	0.80	141	49	0.1
9	6	15:25	0.33	230	932.6	65	65	0.94	170	49	0.1
8	8	15:27	0.34	230	933.6	65	64	0.97	175	48	0.1
7	10	15:29	0.32	230	934.6	65	64	0.92	150	49	0.1
6	12	15:31	0.33	230	935.6	65	64	0.94	145	50	0.1
5	14	15:33	0.36	230	936.7	65	64	1.0	134	49	0.1
4	16	15:35	0.36	230	937.7	65	64	1.0	150	50	0.1
3	18	15:37	0.33	230	938.8	65	64	0.94	164	50	0.1
2	20	15:39	0.19	230	940.0	65	64	0.55	170	52	0.1
1	22	15:41	0.10	230	940.7	65	64	0.29	168	53	0.1
	24	15:43			941.386						
					0.012	at		16	in Hg		
AVERAGE (TOTAL)					( )						

SAMPLING TRAIN DATA

Company: EMPIRE MINING CO — EPA TASK #20
Source Designation: NO. 3 KILN PRECIPITATOR OUTLET
Date: 11/18/75 | Filter Heater Setting: 185 °F
Test Number: P-1 | Probe Heater Setting: 185°F
Field Person: JBS & JS | Nozzle Number: ____, Dia. (in.): 0.249
Filter Number: GAA-281-39 | Pitot Tube No. 12, Corr. Factor: 0.824
Barometric Pressure ("Hg): 28.84 | Meter Box No. MAC-5, Corr. Factor: 1.011
Stack Static Pressure ("H_2O): -0.43 | Meter Isokinetic Factor: 1.730
Stack Dimensions: 14'6" | Assumed Moisture (%): 14%
Potentiometer No. SN-51751-24 | Condensate Volume (ml): ____
Ambient Temperature (°F): 40 | Silica Gel Weight Gain (g): ____
Record all Data Every 2 Minutes | Leak Rate 0.018 CFM at 18 "Hg

ΔH = Tm/Ts H -0.448

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
S-12	24	16:01	0.30	230	941.834	65	64	0.85	155	51	0.1
11	26	16:03	0.28	230	942.8	65	64	0.80	140	49	0.1
10	28	16:05	0.28	230	943.7	65	64	0.80	140	48	0.1
9	30	16:07	0.27	230	944.7	65	64	0.77	160	48	0.1
8	32	16:09	0.34	230	945.6	65	64	0.97	175	47	0.1
7	34	16:11	0.47	230	946.7	65	64	1.3	168	47	0.1
6	36	16:13	0.57	230	947.7	65	64	1.6	156	47	1.0
5	38	16:15	0.61	230	949.0	65	64	1.7	145	47	1.0
4	40	16:17	0.67	230	950.4	65	64	1.9	134	47	1.0
3	42	16:19	0.70	230	951.8	65	64	1.95	150	47	1.0
2	44	16:21	0.62	230	953.2	65	64	1.7	168	47	1.0
1	46	16:23	0.32	230	954.6	65	64	0.90	162	48	0.1
	48	16:25	~~[illegible]~~								
					955.657						
					0.019			at 20.5 in Hg			
AVERAGE (TOTAL)					( )						

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: EMPIRE MINING CO - EPA TASK # 20
Source Designation: NO. 3 KILN PRECIPITATOR OUTLET
Date: 11/18/75
Test Number: P-1
Field Person: JBS - GJS
Filter Number: GA4-281-39
Barometric Pressure ("Hg): 28.84
Stack Static Pressure ("H_2O): -0.43
Stack Dimensions: 147" ø
Potentiometer No. SN 51751-214
Ambient Temperature(°F): 40
Record all Data Every 2 Minutes

Filter Heater Setting: 185 °F
Probe Heater Setting: 185 °F
Nozzle Number: ___, Dia.(in.): 0.249
Pitot Tube No. 12, Corr. Factor: 0.824
Meter Box No. MAE5, Corr. Factor: 1.0116
Meter Isokinetic Factor: 1.730
Assumed Moisture(%): 14%
Condensate Volume(ml):
Silica Gel Weight Gain(g):
Leak Rate 0.018 CFM at 15 "Hg

-0.280

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
E-12	48	16:31	0.33	230	955.937	65	64	0.94	160	47	0.1
11	50	16:33	0.48	230	956.9	65	64	1.35	166	46	1.0
10	52	16:35	0.62	230	958.1	65	64	1.75	156	46	1.0
9	54	16:37	0.82	230	959.5	65	64	2.3	158	46	1.0
8	56	16:39	0.88	230	961.0	65	64	2.5	190	46	1.0
7	58	16:41	0.93	230	962.6	65	64	2.6	155	46	1.0
6	60	16:43	0.90	230	964.3	65	64	2.5	175	48	1.0
5	62	16:45	0.85	230	966.1	65	64	2.4	178	49	1.0
4	64	16:47	0.85	230	967.8	65	64	2.4	151	50	1.0
3	66	16:49	0.81	230	969.3	65	64	2.3	152	50	1.0
2	68	16:51	0.64	230	970.9	65	64	1.7	145	50	0.0
1	70	16:53	0.20	230	972.3	65	64	0.56	167	50	0.0
	72	16:55			973.140						
						0.012 at 17.5 in Hg					
AVERAGE (TOTAL)					( )						

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: EMPIRE MINING CO. - EPA TASK #20
Source Designation: NO. 3 KILN PRECIPITATOR OUTLET
Date: 11/18/75
Test Number: P-1
Field Person: JBS, GJS
Filter Number: GA4 - 281-39
Barometric Pressure ("Hg): 28.84
Stack Static Pressure ("H_2O): -0.43
Stack Dimensions: 147"Ø
Potentiometer No. SN-51751-214
Ambient Temperature (°F): 40
Record all Data Every 2 Minutes

Filter Heater Setting: 185°F
Probe Heater Setting: 185°F
Nozzle Number: ____, Dia. (in.): 0.249
Pitot Tube No. 12, Corr. Factor: 0.824
Meter Box No. MAE-5, Corr. Factor: 1.011
Meter Isokinetic Factor: 1730
Assumed Moisture (%): 14%
Condensate Volume (ml):
Silica Gel Weight Gain (g):
Leak Rate 0.012 CFM at 16 "Hg

0.448

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
N-12	72	17:16	0.32	230	~~[illegible]~~	63	62	0.92	145	50	0.1
11	74	17:18	0.41	230	973.588 974.6	63	62	1.15	135	42	0.1
10	76	17:20	0.47	230	975.7	63	62	1.3	136	42	0.1
9	78	17:22	0.56	230	976.9	63	62	1.6	153	42	0.1
8	80	17:24	0.69	230	978.2	63	62	1.95	176	42	1.0
7	82	17:26	0.76	225	979.7	63	62	2.15	185	44	1.0
6	84	17:28	0.80	225	981.2	63	62	2.2	172	45	1.0
5	86	17:30	0.86	220	982.8	63	62	2.35	170	46	1.0
4	88	17:32	0.81	220	984.3	64	62	2.3	148	47	1.0
3	90	17:34	0.67	220	986.0	64	62	1.9	140	48	1.0
2	92	17:36	0.62	220	987.4	64	62	1.75	150	48	1.0
1	94	17:38	0.14	220	988.8	64	62	0.40	170	48	0.1
	96	17:40	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~		
					989.647						
						0.018		at	21.5	in	Hg
AVERAGE (TOTAL)				230	(59.268)	64	63	1.4	156	48	0.5

Clayton Environmental Consultants, Inc.

DRY MOLECULAR WEIGHT DETERMINATION (M_d)

Plant: EMPIRE MINE
Date: 11/18/75
Sampling Time (24-hour Clock): 15:24–16:24.
Sampling Location:: outlet – Precipitator

Comments:
P-1

Sample Type (bag, integrated, continuous) ______
Analytical Method: ______
Ambient Temperature: ______
Operator: ______

Gas \ Run	1 Actual Reading	1 Net	2 Actual Reading	2 Net	3 Actual Reading	3 Net	Average Net Volume	Multiplier	Molecular Weight Of Stack Gas (dry basis) M_d, lb/lb-mole
CO_2	1.8	1.8	1.6	1.6	1.8	1.8	1.7	44/100	0.748
O_2 (Net is actual O_2 reading minus actual CO_2 reading)	17.6	15.8	17.6	16.0	17.0	15.2	15.7	32/100	5.024
CO (net is actual CO reading minus actual O_2 reading)	—						—	28/100	
N_2 (Net is 100 minus actual CO reading)		82.4		82.4		83.0	82.6	28/100	23.128
								Total	28.900 = M_d

WET MOLECULAR WEIGHT DETERMINATION (M_s)

B_{wo} = Proportion by volume of water vapor in the gas stream

M_s = Molecular weight of stack gas (wet basis), lb/lb-mole = $M_d(1-B_{wo}) + 18(B_{wo})$

M_s = ( )(1-) + 18( ) =

$G_m = \frac{M_d}{28.96} = \frac{\quad}{28.96} =$, $G_s = \frac{M_s}{28.96} = \frac{\quad}{28.96} =$, $\frac{G_m}{G_s} = \_\_\_\_ =$

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: EMPIRE MINING CO. EPA TASK 20

Source Designation: NO. 3 KILN PRECIP OUTLET

Date: 11/19/75

Test Number: P-2

Field Person: JBS, GJS

Filter Number: GA4-281-79

Barometric Pressure ("Hg): 28.43

Stack Static Pressure ("H_2O): −0.43

Stack Dimensions: 147" ϕ

Plume Appearance: <10%

Ambient Temperature (°F): 50

Record all Data Every 2 Minutes

Filter Heater Setting: 185°F

Probe Heater Setting: 185°F

Nozzle Number: ____, Dia. (in.): .249

Pitot Tube No. 12, Corr. Factor: 0.824

Meter Box No. MAC-5, Corr. Factor: 1.011

Meter Isokinetic Factor: 1.730

Assumed Moisture (%): 15.5

Condensate Volume (ml): 193

Silica Gel Weight Gain (g): 19

Leak Rate 0.015 CFM at 16 "Hg

$\Delta m = 3.58 \left(T_m / T_s\right) H$

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
N-12	0	10:41	0.30	215	991.826	60	60	0.82	154	56	0.1
11	2	10:43	0.34	220	992.7	60	60	0.92	150	52	0.1
10	4	10:45	0.42	215	993.7	60	60	1.15	180	51	0.5
9	6	10:47	0.57	215	994.8	60	60	1.5	185	50	0.5
8	8	10:49	0.70	220	996.1	62	60	1.9	175	49	1.0
7	10	10:51	0.75	220	997.5	62	60	2.0	158	49	1.0
6	12	10:53	0.83	220	999.0	64	60	2.25	145	50	1.5
5	14	10:55	0.92	220	0.7	64	61	2.5	151	51	1.5
4	16	10:57	0.84	220	2.3	65	61	2.3	170	52	1.5
3	18	10:59	0.67	215	3.8	65	61	1.8	166	52	1.0
2	20	11:01	0.20	215	5.3	66	61	0.54	150	56	0.1
1	22	11:03	0.18	155	6.2	65	61	0.55	142	56	0.1
	24	11:05			6.962						
						0.012		at	17.0	in	Hg
AVERAGE (TOTAL)					( )						

SAMPLING TRAIN DATA

Company: EMPIRE MINING CO. EPA TASK 20
Source Designation: NO. 3 KILN PRECIP OUTLET
Date: 11/19/75
Test Number: P-2
Field Person: JBS, GJS
Filter Number: GA4-281-79
Barometric Pressure ("Hg): 28.43
Stack Static Pressure ("H_2O): -0.43
Stack Dimensions: 147"⌀
Plume Appearance: <10%
Ambient Temperature(°F): 50
Record all Data Every 2 Minutes

Filter Heater Setting: 185°F
Probe Heater Setting: 185°F
Nozzle Number: ____, Dia.(in.): 0.249
Pitot Tube No. 12, Corr. Factor: 0.824
Meter Box No. MAGS, Corr. Factor: 1.011
Meter Isokinetic Factor: 1730
Assumed Moisture(%): 15.5%
Condensate Volume(ml):
Silica Gel Weight Gain(g):
Leak Rate 0.010 CFM at 16 "Hg

-0.300

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
E-12	24	11:16	0.32	220	7.262	64	62	0.87	145	45	0.1
11	26	11:18	0.43	220	8.1	64	62	1.2	135	51	0.5
10	28	11:20	0.63	220	9.3	64	62	1.7	130	50	0.5
9	30	11:22	0.79	220	10.7	64	62	2.15	135	50	1.0
8	32	11:24	0.85	220	12.2	65	62	2.3	157	50	1.0
7	34	11:26	0.93	220	13.6	65	62	2.5	166	52	1.5
6	36	11:28	0.93	220	15.4	66	62	2.5	165	52	1.5
5	38	11:30	0.94	220	17.0	66	62	2.5	150	53	1.5
4	40	11:32	0.87	220	18.7	68	63	2.3	140	54	1.0
3	42	11:34	0.84	220	20.4	68	63	2.3	155	54	1.0
2	44	11:36	0.72	220	22.0	68	63	1.95	166	54	1.0
1	46	11:38	0.27	220	23.4	68	63	0.74	160	54	0.0
	48	11:40			24.496						
						0.10		at 16.0" Hg			
AVERAGE (TOTAL)					( )						

SAMPLING TRAIN DATA

Company: EMPIRE MINING CO   EPA TASK 20

Source Designation: NO. 3 KILN PRECIP OUTLET

Date: 11/19/75   Filter Heater Setting: 185°F

Test Number: P-2   Probe Heater Setting: 185°F

Field Person: JBS, GJS   Nozzle Number: ____, Dia. (in.): .249

Filter Number: GA4-281-79   Pitot Tube No. 12, Corr. Factor: 0.824

Barometric Pressure ("Hg): 28.43   Meter Box No. MAC5, Corr. Factor: 1.011

Stack Static Pressure ("H_2O): -0.43   Meter Isokinetic Factor: 1.730

Stack Dimensions: 147"ϕ   Assumed Moisture (%): 15.5%

Plume Appearance: <10%   Condensate Volume (ml):

Ambient Temperature (°F): 50   Silica Gel Weight Gain (g):

Record all Data Every 2 Minutes   Leak Rate 0.01 CFM at 26 "Hg

-0.120

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
S-12	48	11:50	0.29	220	24.616	66	64	0.79	152	56	0.5
11	50	11:52	0.29	220	25.6	67	64	0.79	156	52	0.5
10	52	11:54	0.27	220	26.6	67	64	0.73	160	52	0.5
9	54	11:56	0.32	220	27.5	67	64	0.87	172	52	0.5
8	56	11:58	0.40	220	28.5	67	64	1.1	160	52	0.5
7	58	12:00	0.43	220	29.6	67	64	1.2	150	52	0.5
6	60	12:02	0.52	220	30.7	67	64	1.4	150	52	0.5
5	62	12:04	0.58	220	32.0	67	65	1.6	172	54	1.0
4	64	12:06	0.69	220	33.3	68	65	1.9	172	54	1.5
3	66	12:08	0.72	220	34.7	68	65	2.0	160	55	1.5
2	68	12:10	0.68	220	36.2	69	65	1.9	148	56	1.5
1	70	12:12	0.35	220	37.7	69	65	0.95	160	57	1.0
	72	12:14			38.766						
						0.005		at		" Hg	
AVERAGE (TOTAL)					( )						

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: EMPIRE MINING CO EPA TASK 20
Source Designation: NO. 3 KILN PRECIP OUTLET
Date: 11/19/75
Test Number: P-2
Field Person: JBS, GJS
Filter Number: GA4-281-79
Barometric Pressure ("Hg): 28.43
Stack Static Pressure ("H_2O): -0.43
Stack Dimensions: 147" ⌀
Plume Appearance: <10%
Ambient Temperature(°F): 50
Record all Data Every 2 Minutes

Filter Heater Setting: 185°F
Probe Heater Setting: 185°F
Nozzle Number: ____, Dia.(in.): .249
Pitot Tube No. 12, Corr. Factor: 0.824
Meter Box No. MAC 5, Corr. Factor: 1.011
Meter Isokinetic Factor: 1730 ?
Assumed Moisture(%): 15.5
Condensate Volume(ml):
Silica Gel Weight Gain(g):
Leak Rate 0.007 CFM at 15.5 "Hg

-0.219

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
W-12	72	12:22	0.25	220	[illegible]	68	66	0.68	152	57	0.1
11	74	12:24	0.24	220	38.985 39.9	68	66	0.65	166	56	0.1
10	76	12:26	0.28	220	40.7	68	66	0.77	160	54	0.5
9	78	12:28	0.28	225	41.6	68	66	0.77	150	54	0.5
8	80	12:30	0.32	225	42.6	68	66	0.86	150	56	1.0
7	82	12:32	0.33	225	43.5	68	66	0.90	163	54	1.0
6	84	12:34	0.36	225	44.6	68	66	0.98	171	55	1.5
5	86	12:36	0.33	225	45.6	68	66	0.90	164	55	1.5
4	88	12:38	0.36	225	46.6	68	66	0.98	150	56	1.5
3	90	12:40	0.32	225	47.7	68	66	0.86	155	56	1.0
2	92	12:42	0.29	225	48.7	68	66	0.79	166	56	1.0
1	94	12:44	0.16	210	49.5	68	66	0.44	172	56	1.0
	96	12:46			50.345						
							0.010 at	15" Hg			
AVERAGE (TOTAL)				220	(58.517)	66	63	1.4	157	53	0.8

Clayton Environmental Consultants, Inc.

DRY MOLECULAR WEIGHT DETERMINATION (M_d)

Plant: Empire Mining
Date: 11/19/74
Sampling Time (24-hour Clock): 10:43
Sampling Location:: Ppt Outlet
Comments: Precipitator Outlet P-2

Sample Type (bag, integrated, continuous) ________
Analytical Method: Orsat
Ambient Temperature: ________
Operator: Hanson

Gas \ Run	1 Actual Reading	1 Net	2 Actual Reading	2 Net	3 Actual Reading	3 Net	Average Net Volume	Multiplier	Molecular Weight Of Stack Gas (dry basis) M_d, lb/lb-mole
CO_2	1.8	1.8	1.9	1.9			1.8	44/100	0.792
O_2 (Net is actual O_2 reading minus actual CO_2 reading)	18.0	16.2	18.2	16.3			16.2	32/100	5.184
CO (net is actual CO reading minus actual O_2 reading)								28/100	—
N_2 (Net is 100 minus actual CO reading)		82.0		81.8			82.0	28/100	22.960
								Total	28.936 = M_d

WET MOLECULAR WEIGHT DETERMINATION (M_s)

B_{wo} = Proportion by volume of water vapor in the gas stream

M_s = Molecular weight of stack gas (wet basis), lb/lb-mole = $M_d(1-B_{wo}) + 18(B_{wo})$

$M_s = (\quad)(1-\quad) + 18(\quad) =$

$G_m = \frac{M_d}{28.96} = \frac{\quad}{28.96} =$, $G_s = \frac{M_s}{28.96} = \frac{\quad}{28.96} =$, $\frac{G_m}{G_s} = \frac{\quad}{\quad} =$

Clayton Environmental Consultants, Inc.

DRY MOLECULAR WEIGHT DETERMINATION (M_d)

Plant: Empire mining
Date: ~~7/23~~ 11/19/75
Sampling Time (24-hour Clock): 16:05
Sampling Location:: Outppt
Comments: Precipitator Outlet

Sample Type (bag, integrated, continuous) ______
Analytical Method: ______
Ambient Temperature: ______
Operator: [illegible]

Gas \ Run	1 Actual Reading	1 Net	2 Actual Reading	2 Net	3 Actual Reading	3 Net	Average Net Volume	Multiplier	Molecular Weight Of Stack Gas (dry basis) M_d, lb/lb-mole
CO_2	1.7	1.7	1.9	1.9	1.8	1.8	1.8	44/100	0.792
O_2 (Net is actual O_2 reading minus actual CO_2 reading)	17.8	16.1	18.0	16.1	18.1	16.3	16.2	32/100	5.184
CO (net is actual CO reading minus actual O_2 reading)								28/100	
N_2 (Net is 100 minus actual CO reading)		82.2		82.0		81.9	82.0	28/100	22.960
								Total	28.936 = M_d

WET MOLECULAR WEIGHT DETERMINATION (M_s)

B_{wo} = Proportion by volume of water vapor in the gas stream

M_s = Molecular weight of stack gas (wet basis), lb/lb-mole = $M_d(1-B_{wo}) + 18(B_{wo})$

M_s = (   )(1-   ) + 18(   ) =

$G_m = \frac{M_d}{28.96} = \frac{\quad}{28.96} =$, $G_s = \frac{M_s}{28.96} = \frac{\quad}{28.96} =$, $\frac{G_m}{G_s} = \frac{\quad}{\quad} =$

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: EMPIRE MINING C. — EPA TASK 20
Source Designation: No. 3 Kiln Precip Outlet
Date: 11/20/75
Test Number: P-4
Field Person: JBB, GDS
Filter Number: GM-182-71
Barometric Pressure ("Hg): 28.2
Stack Static Pressure ("H_2O): -0.43
Stack Dimensions: 147" ϕ
Plume Appearance: <10%
Ambient Temperature (°F): 40
Record all Data Every 2 Minutes

Filter Heater Setting: 185 °F
Probe Heater Setting: 185 °F
Nozzle Number: ____, Dia. (in.): 0.249
Pitot Tube No. 12, Corr. Factor: 0.824
Meter Box No. MB-5, Corr. Factor: 1.011
Meter Isokinetic Factor: ~~18~~ 1730
Assumed Moisture (%): 15.5%
Condensate Volume (ml): 190
Silica Gel Weight Gain (g): 20
Leak Rate 0.020 CFM at 12 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
N-12	0	8:38	0.31	225	120.400	40	39	0.80	160	40	0.1
11	2	8:40	0.34	225	121.3	42	40	0.88	145	38	0.1
10	4	8:42	0.45	230	122.3	42	40	1.2	139	39	0.1
9	6	8:44	0.50	230	123.4	42	40	1.3	159	40	0.5
8	8	8:46	0.57	230	124.6	43	40	1.5	145	40	0.5
7	10	8:48	0.71	230	125.8	43	40	1.85	145	40	0.5
6	12	8:50	0.82	230	127.2	44	40	2.1	163	42	1.0
5	14	8:52	0.86	230	128.6	45	40	2.2	160	44	1.0
4	16	8:54	0.88	230	130.2	46	41	2.3	148	46	1.0
3	18	8:56	0.81	230	131.7	47	41	2.1	140	48	1.0
2	20	8:58	0.67	230	133.2	47	41	1.75	155	50	0.5
1	22	9:00	0.28	230	134.6	48	42	0.74	162	50	
	24	9:02			135.568						
						0.020 at 16" Hg					
AVERAGE (TOTAL)					( )						

SAMPLING TRAIN DATA

Company: EMPIRE MINING CO. EPA TASK 20
Source Designation: No. 3 Kiln Precip Outlet
Date: 11/20/75
Test Number: P-4
Field Person: JBS, GJS
Filter Number: GA4-182-71
Barometric Pressure ("Hg): 28.2
Stack Static Pressure ("H_2O): -0.43
-0.614
Stack Dimensions: 142"φ
Plume Appearance: <10%
Ambient Temperature (°F): 40
Record all Data Every 2 Minutes

Filter Heater Setting: 185°F
Probe Heater Setting: 185°F
Nozzle Number: ____, Dia. (in.): 0.249
Pitot Tube No. 12, Corr. Factor: 0.8247
Meter Box No. M-5, Corr. Factor: 1.011
Meter Isokinetic Factor: ~~1869~~ 1730
Assumed Moisture (%): 15.5
Condensate Volume (ml): ____
Silica Gel Weight Gain (g): ____
Leak Rate 0.015 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
E-12	24	9:09	0.32	230	136.182	46	42	0.83	140	46	0.1
11	26	9:11	0.46	230	137.1	46	42	1.2	142	44	0.1
10	28	9:13	0.59	230	138.2	46	42	1.5	135	44	0.1
9	30	9:15	0.75	230	139.5	46	42	1.95	153	46	0.5
8	32	9:17	0.88	230	140.9	47	42	2.3	166	[illegible]	1.0
7	34	9:19	0.94	230	142.[illegible]	48	43	2.45	150	50	1.0
6	36	9:21	0.92	230	144.1	49	43	2.4	155	52	1.0
5	38	9:23	0.94	230	145.7	49	43	2.45	170	52	1.0
4	40	9:25	0.92	230	147.3	49	43	2.4	168	54	1.0
3	42	9:27	0.89	230	148.9	50	43	2.3	154	56	1.0
2	44	9:29	0.70	230	150.5	50	44	1.8	150	56	0.5
1	46	9:31	0.27	230	152.0	50	44	0.7	156	55	0.1
	48	9:33			152.963						
			0.015 at 15 "Hg								
AVERAGE (TOTAL)					( )						

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: EMPIRE MINING CO. - EPA TASK 20
Source Designation: No. 3 Kiln Precip Outlet
Date: 11/20/75
Test Number: P-4
Field Person: JBS, GTS
Filter Number: GA4-281-71
Barometric Pressure ("Hg): 28.2
Stack Static Pressure ("H_2O): -0.43
Stack Dimensions: 147"ϕ
Plume Appearance: <10%
Ambient Temperature(°F): 40
Record all Data Every 2 Minutes

Filter Heater Setting: 185°F
Probe Heater Setting: 185°F
Nozzle Number: ____, Dia.(in.): 0.249
Pitot Tube No. 12, Corr.Factor: 0.824
Meter Box No. M-5, Corr.Factor: 1.011
Meter Isokinetic Factor: ~~1867~~ 1730
Assumed Moisture(%): 15.5
Condensate Volume(ml): ____
Silica Gel Weight Gain(g): ____
Leak Rate 0.018 CFM at 16 "Hg

-0.508

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
S-12	48	9:37	0.27	230	153.471	48	44	0.70	152	44	0.1
11	50	9:39	0.26	225	154.3	48	44	0.67	166	46	0.1
10	52	9:41	0.28	225	155.2	48	44	0.73	164	48	0.1
9	54	9:43	0.31	230	156.1	48	45	0.80	159	49	0.1
8	56	9:45	0.34	230	157.0	48	45	0.89	150	48	0.1
7	58	9:47	0.55	230	158.0	48	45	1.45	160	48	0.5
6	60	9:49	0.59	230	159.2	48	45	1.55	165	50	0.5
5	62	9:51	0.68	231	160.6	49	45	1.8	151	52	0.5
4	64	9:53	0.70	235	161.8	49	45	1.8	145	52	0.5
3	66	9:55	0.69	225	163.2	49	45	1.8	155	52	0.5
2	68	9:57	0.64	225	164.6	49	45	1.65	170	53	0.5
1	70	9:59	0.36	215	166.0	49	45	0.94	160	52	0.1
	72	10:01			167.082						
						0.015 at 15" Hg					
AVERAGE (TOTAL)					( )						

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: EMPIRE MINING CO. - EPA TASK 20
Source Designation: No. 3 Kiln Precip Outlet
Date: 11/20/75
Test Number: P-4
Field Person: JBB, GJS
Filter Number: GA4-182-71
Barometric Pressure ("Hg): 28.2
Stack Static Pressure ("H_2O): -0.43
Stack Dimensions: 147"d
Plume Appearance: <10%
Ambient Temperature (°F): 40
Record all Data Every 2 Minutes

Filter Heater Setting: 185°F
Probe Heater Setting: 185°F
Nozzle Number: ____, Dia. (in.): 0.249
Pitot Tube No. 12, Corr. Factor: 0.824
Meter Box No. M-5, Corr. Factor: 1.011
Meter Isokinetic Factor: 1730.7
Assumed Moisture (%): 15.5
Condensate Volume (ml):
Silica Gel Weight Gain (g):
Leak Rate 0.015 CFM at 15 "Hg

-0.420

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
W-12	72	10:09	0.28	220	167.502	48	45	0.73	120	40	0.1
11	74	10:11	0.27	220	168.3	48	45	0.70	120	44	0.1
10	76	10:13	0.28	225	169.3	48	46	0.73	125	44	0.1
9	78	10:15	0.30	225	170.2	48	46	0.88	136	46	0.1
8	80	10:17	0.33	225	171.1	48	46	0.86	150	46	0.1
7	82	10:19	0.35	226	172.0	48	46	0.91	156	48	0.1
6	84	10:21	0.38	225	173.1	48	46	0.99	170	48	0.1
5	86	10:23	0.39	225	174.1	49	46	1.00	175	49	0.1
4	88	10:25	0.37	225	175.2	48	46	0.96	176	49	0.1
3	90	10:27	0.32	225	176.2	48	46	0.84	148	48	0.1
2	92	10:29	0.30	225	177.2	48	46	0.78	145	48	0.1
1	94	10:31	0.20	220	178.2	48	46	0.52	150	48	0.1
	96	10:33			178.905						
								0.019	at	17	"Hg
AVERAGE (TOTAL)				225	(57.590)	47	43	1.4	152	47	0.4

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: EPA — Empire Mining Co
Source Designation: Empire #3 out Electrostatic Precipitator Outlet
Date: 11/18/75
Test Number: (EP-1) Special Test-1
Field Person: RGK
Filter Number: rec-A-317-02/A-318-01
Barometric Pressure ("Hg):
Stack Static Pressure ("H_2O): -.43
Stack Dimensions: 147" ED
Potentiometer No. SN 877453-3
Ambient Temperature(°F):
Record all Data Every 2 Minutes

Filter Heater Setting:
Probe Heater Setting: 100%
Nozzle Number: — , Dia.(in.): .251
Pitot Tube No. 17, Corr.Factor: 0.830
Meter Box No. RAC-3, Corr.Factor: 0.989
Meter Isokinetic Factor: ~~2.54~~ 1756
Assumed Moisture(%): 14
Condensate Volume(ml):
Silica Gel Weight Gain(g):
Leak Rate .015 CFM at 15 "Hg

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Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
S 12	0	1519	.25	230	422.192	65	65	.73	165	58	3
11	2		.25	230	423.1	66	65	.73	165	58	3
10	4		.25	230	424.0	67	65	.73	165	58	3
9	6		.30	230	425.0	69	66	.87	165	58	3
8	8		.36	230	426.0	70	66	1.04	170	56	3
7	10		.46	230	427.1	72	66	1.3	170	56	4
6	12		.55	230	428.4	75	67	1.6	170	56	4
5	14		.56	230	429.8	78	68	1.6	170	56	4
4	16		.63	230	431.2	80	69	1.8	170	56	4
3	18		.65	230	432.7	83	68	1.9	170	56	4
2	20		.59	230	434.2	84	69	1.7	170	56	4
1	22		.13	230	435.6	84	71	.38	170	62	1
E 12	24	1559	.35	230	436.432	80	70	1.0	165	55	3
11	26		.40	230	437.5	81	74	1.16	165	63	3
10	28		.62	230	438.7	84	76	1.8	165	63	4
9	30		.82	230	440.2	88	76	2.4	170	64	5
8	32		.93	230	441.9	91	76	2.7	170	64	5
AVERAGE (TOTAL)					( )						

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: EPA – Empire Mining Co

Source Designation: Empire #3 out – Electrostatic Precipitator Outlet

Date: 11/15/75

Test Number: EP-1 ~~[illegible]~~ page 2

Field Person: RGK

Filter Number:

Barometric Pressure ("Hg):

Stack Static Pressure ("H_2O):

Stack Dimensions:

Plume Appearance:

Ambient Temperature(°F):

Record all Data Every ______ Minutes

Filter Heater Setting:

Probe Heater Setting:

Nozzle Number: ____, Dia.(in.):

Pitot Tube No. ____, Corr.Factor:

Meter Box No. ____, Corr.Factor:

Meter Isokinetic Factor:

Assumed Moisture(%):

Condensate Volume(ml):

Silica Gel Weight Gain(g):

Leak Rate ______ CFM at ______ "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
~~8~~	~~32~~		~~.93~~	~~230~~	~~441.9~~	~~91~~	~~76~~	~~2.7~~	~~170~~	~~64~~	~~5~~
7	34		.91	230	443.7	92	78	2.6	170	64	5
6	36		.91	230	445.5	93	78	2.6	170	64	5
5	38		.90	230	447.3	94	78	2.6	170	64	5
4	40		.90	230	449.0	96	80	2.6	170	64	5
3	42		.84	230	450.8	96	80	2.4	170	64	5
2	44		.74	230	452.5	96	80	2.15	170	64	5
1	46		.45	230	454.1	96	80	1.3	170	64	4
W 12	48	1630	.38	230	455.425	86	80	1.1	170	64	4
11	50		.38	230	456.6	88	82	1.1	160	58	4
10	52		.42	230	457.8	90	82	1.2	160	58	4
9	54		.52	230	459.0	92	82	1.5	160	58	4
8	56		.61	330	460.4	92	82	1.8	160	58	4
7	58		.70	230	461.9	92	82	2.0	165	51	4
6	60		.79	230	463.4	94	82	2.3	165	51	4
5	62		.79	230	465.1	94	82	2.3	165	51	4
4	64		.81	230	466.8	96	83	2.3	165	51	4
AVERAGE (TOTAL)					( )						

SAMPLING TRAIN DATA

Company: EPA - Empire Mining Co

Source Designation: Empire #3 out - Electrostatic Precipitator Outlet

Date: 11/18/75

Test Number: EP-1 page 3

Field Person: RGH

Filter Number:

Barometric Pressure ("Hg): 29.6

Stack Static Pressure ("H_2O):

Stack Dimensions:

Plume Appearance:

Ambient Temperature(°F):

Record all Data Every ______ Minutes

Filter Heater Setting:

Probe Heater Setting:

Nozzle Number: ____, Dia. (in.):

Pitot Tube No. ____, Corr. Factor:

Meter Box No. ____, Corr. Factor:

Meter Isokinetic Factor:

Assumed Moisture (%):

Condensate Volume (ml): 204

Silica Gel Weight Gain (g): 23.7

Leak Rate .04 CFM at 15 "Hg
~~.010~~ .010 from Front of cyclone

Traverse Point No.	Time		Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter			Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
	Sampling (min)	Clock			Volume (ft^3)	Temp (°F) Inlet	Temp (°F) Outlet				
~~4~~	~~64~~		~~.81~~	~~230~~	~~466.8~~	~~96~~	~~83~~	~~2.3~~	~~165~~	~~51~~	~~4~~
3	66		.79	230	468.5	96	83	2.3	164	51	4
2	68		.49	230	470.2	94	82	1.4	170	54	4
1	70		.46	230	471.5	94	82	1.3	170	54	4
N 12	72	1715	.25	220	472.823	84	82	.73	170	54	3
11	74		.27	220	474.3	86	82	.78	170	54	3
10	76		.28	220	475.3	87	82	.81	170	54	3
9	78		.28	220	476.3	88	82	.81	160	48	3
8	80		.31	220	477.3	88	82	.90	160	48	3
7	82		.31	220	478.4	88	82	.90	160	48	3
6	84		.31	220	479.5	88	82	.90	160	48	3
5	86		.31	220	480.5	90	82	.90	165	52	3
4	88		.31	220	481.6	90	82	.90	165	52	3
3	90		.30	220	482.7	90	82	.87	165	52	3
2	92		.36	220	483.7	90	82	.75	165	52	3
1	94		.19	220	484.7	90	82	.55	165	52	3
	96			~~215~~	485.603						
AVERAGE (TOTAL)				230	(62.713)	86	77	1.5	165	56	4

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Special Test - 2

Company: EPA - Empire Mining Co

Source Designation: Empire #3 out - Electrostatic Precipitator Outlet

Date: 11/19/75

Test Number: EP-2 page 1

Field Person: RGK

Filter Number: ICC A-317-03/A-318-02

Barometric Pressure ("Hg): 28.43

Stack Static Pressure ("H_2O): -.43

Stack Dimensions: 147" ID

Plume Appearance:

Ambient Temperature(°F): 48

Record all Data Every 2 Minutes

Filter Heater Setting: 170

Probe Heater Setting: 100%

Nozzle Number: -, Dia.(in.): .257

Pitot Tube No. 17, Corr. Factor: 0.820

Meter Box No. RAC-3, Corr. Factor: 0.989

Meter Isokinetic Factor: ~~1.73~~ 1756

Assumed Moisture(%): 15.5

Condensate Volume(ml):

Silica Gel Weight Gain(g):

Leak Rate .016 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
S 12	0	1039	.25	220	486.583	64	60	.70	160	64	3
11	2		.25	215	487.6	64	60	.70	160	64	3
10	4		.25	215	488.6	65	60	.70	160	64	3
9	6		.28	215	489.5	66	60	.78	165	58	3
8	8		.35	215	490.5	68	60	.98	168	58	3
7	10		.43	215	491.6	70	61	1.2	165	58	3
6	12		.50	215	492.5	72	62	1.4	165	58	3
5	14		.58	215	494.1	76	63	1.6	165	58	3
4	16		.68	215	495.5	77	64	1.9	165	58	3
3	18		.71	215	497.0	80	65	2.0	165	58	3
2	20		.65	215	498.5	81	66	1.8	165	58	3
1	22		.18	215	500.0	82	66	.50	165	58	2
[illegible]	24		[illegible]		500.912		leak test		.03	CFM	
W 12	24	1115	.28	215	-0.230 501.142	76	70	.78	165	58	3
10	26		.28	215	502.0	78	70	.78	165	58	3
9	28		.28	215	503.0	79	70	.78	165	58	3
9	30		.33	215	504.0	79	71	.92	165	60	3
AVERAGE (TOTAL)					( )						

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: EPA – Empire Mining Co.
Source Designation: Empire #3 o-t – Electrostatic Precipitator Outlet
Date: 11/19/75
Test Number: EP-2 page 2
Field Person: RGK
Filter Number:
Barometric Pressure ("Hg):
Stack Static Pressure ("H_2O):
Stack Dimensions:
Plume Appearance:
Ambient Temperature (°F):
Record all Data Every ______ Minutes

Filter Heater Setting:
Probe Heater Setting:
Nozzle Number: ____, Dia. (in.):
Pitot Tube No. ___, Corr. Factor:
Meter Box No. ____, Corr. Factor:
Meter Isokinetic Factor:
Assumed Moisture (%):
Condensate Volume (ml):
Silica Gel Weight Gain (g):
Leak Rate ______ CFM at ______ "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
8	32		.30	215	505.1	79	71	.84	165	64	3
7	34		.35	215	506.1	81	72	.98	165	64	3
6	36		.37	215	507.2	82	72	1.04	165	68	3
5	38		.37	215	508.3	83	73	1.04	165	68	3
4	40		.35	215	509.5	84	73	.98	170	70	3
3	42		.31	215	510.6	85	74	.87	170	70	3
2	44		.30	215	511.7	88	75	.84	170	70	3
1	46		.19	215	512.7	89	75	.53	170	72	3
					513.572		leak	test .025 CFM			
E12	48	11 49	.33	215	-0.222 513.794	80	76	.96	160	58	3
11	50		.47	215	514.9	82	76	1.4	160	58	3
10	52		.67	215	516.2	84	78	1.9	160	58	3
9	54		.78	215	517.7	85	78	2.3	160	58	4
8	56		.88	215	519.4	90	78	2.6	160	58	4
7	58		.93	215	521.2	92	78	2.7	160	58	4
6	60		.94	215	523.0	93	78	2.7	175	56	4
5	62		.93	215	524.8	94	78	2.9	175	56	4
AVERAGE (TOTAL)					( )						

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: EPA - Empire Mining Co.
Source Designation: Empire #3 out - Electrostatic Precipitator Outlet
Date: 11/19/75
Test Number: EP-2 page 3
Field Person: RGK
Filter Number:
Barometric Pressure ("Hg):
Stack Static Pressure ($"H_2O$):
Stack Dimensions:
Plume Appearance:
Ambient Temperature(°F):
Record all Data Every ______ Minutes

Filter Heater Setting:
Probe Heater Setting:
Nozzle Number: ____, Dia.(in.):
Pitot Tube No. ____, Corr.Factor:
Meter Box No. ____, Corr.Factor:
Meter Isokinetic Factor:
Assumed Moisture(%):
Condensate Volume(ml): 211
Silica Gel Weight Gain(g): 31.4
Leak Rate .018 Final CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ($"H_2O$)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ($"H_2O$)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
4	64		.94	215	526.6	96	80	2.7	175	60	4
3	66		.91	215	528.5	98	82	2.6	175	60	4
2	68		.80	215	530.3	99	82	2.3	175	60	4
1	70		.55	215	532.0	99	83	1.6	175	60	3
N12	72	1221	.32	215	533.333	86	82	.93	175	60	3
11	74		.35	215	534.4	89	82	1.0	165	62	3
10	76		.40	215	535.6	90	83	1.16	165	62	3
9	78		.50	220	536.8	91	83	1.45	165	63	3
8	80		.59	220	538.1	92	83	1.7	165	63	3
7	82		.72	220	539.6	94	83	2.1	165	63	3
6	84		.77	220	541.2	94	83	2.2	165	63	3
5	86		.83	220	542.8	94	83	2.4	165	63	4
4	88		.88	220	544.5	94	83	2.6	175	64	4
3	90		.88	220	546.3	94	83	2.6	175	64	4
2	92		.80	220	548.1	95	83	2.3	175	64	3
1	94		.50	220	549.8	95	83	1.45	175	64	3
	96				551.170			~~.018~~ CFM			
AVERAGE (TOTAL)				215	(63.430)	84	74	1.5	165	61	3

Clayton Environmental Consultants, Inc.

Special Test - 3

SAMPLING TRAIN DATA

Company: EPA - Empire Mining Co.

Source Designation: Empire #3 out - Electrostatic Precipitator Outlet

Date: 11/19/75

Test Number: EP-3 page 1

Field Person: RGK

Filter Number: rrc A-317-04/A-318-04

Barometric Pressure ("Hg): 28.3

Stack Static Pressure ("H_2O): -.43

Stack Dimensions: 147" ID

Plume Appearance:

Ambient Temperature(°F): 50

Record all Data Every 2 Minutes

Filter Heater Setting: 170

Probe Heater Setting: 100%

Nozzle Number: -, Dia.(in.): .251

Pitot Tube No. 17, Corr. Factor: 0.820

Meter Box No. RAC-3, Corr. Factor: 0.989

Meter Isokinetic Factor: ~~1775~~ 1756

Assumed Moisture(%): 15.5%

Condensate Volume(ml):

Silica Gel Weight Gain(g):

Leak Rate .012 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
N 12	0	1603	.33	228	551.691	64	64	.92	170	60	3
11	2		.33	228	552.8	66	64	.92	170	62	3
10	4		.40	228	553.8	68	65	1.1	170	62	3
9	6		.50	228	555.0	70	65	1.4	170	62	3
8	8		.58	228	556.3	72	66	1.6	170	62	3
7	10		.70	228	557.7	76	66	2.0	170	62	3
6	12		.79	228	559.2	78	66	2.2	170	62	4
5	14		.88	228	560.9	80	66	2.5	170	62	4
4	16		.90	228	562.6	85	69	2.5	170	62	4
3	18		.90	228	564.3	86	70	2.5	170	62	4
2	20		.75	228	566.0	88	70	2.1	170	62	4
1	22		.44	228	567.6	89	72	1.2	170	62	4
E 12	24	1634	.33	228	568.858	80	70	.92	170	62	3
11	26		.44	228	569.9	84	75	1.2	170	62	3
10	28		.60	228	571.1	86	75	1.7	170	62	3
9	30		.78	225	572.6	88	75	2.2	170	62	3
8	32		.83	225	574.2	91	77	2.4	170	62	4
AVERAGE (TOTAL)					( )						

SAMPLING TRAIN DATA

Company: EPA – Empire Mining Co.
Source Designation: Empire #3 out – Electrostatic Precipitator Outlet
Date: 11/19/75
Test Number: EP-3 page 2
Field Person: RGK
Filter Number: ______
Barometric Pressure ("Hg): ______
Stack Static Pressure ("H_2O): ______
Stack Dimensions: ______
Plume Appearance: ______
Ambient Temperature (°F): ______
Record all Data Every ______ Minutes

Filter Heater Setting: ______
Probe Heater Setting: ______
Nozzle Number: ______, Dia. (in.): ______
Pitot Tube No. ______, Corr. Factor: ______
Meter Box No. ______, Corr. Factor: ______
Meter Isokinetic Factor: ______
Assumed Moisture (%): ______
Condensate Volume (ml): ______
Silica Gel Weight Gain (g): ______
Leak Rate ______ CFM at ______ "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
7	34		.91	228	575.9	92	77	2.6	175	56	4
6	36		.93	228	577.7	94	78	2.7	175	56	4
5	38		.92	225	579.5	95	78	2.6	175	56	4
4	40		.92	228	581.3	95	78	2.6	175	56	4
3	42		.86	228	583.1	96	78	2.5	175	56	4
2	44		.77	228	584.8	96	78	2.2	175	56	4
1	46		.50	228	586.5	96	82	1.45	175	56	4
S 12	48	1703	.25	228	587.883	88	81	.73	175	56	3
11	50		.25	225	588.9	90	82	.73	175	56	3
10	52		.30	228	589.8	92	82	.87	165	56	3
9	54		.32	228	590.9	93	82	.93	165	56	3
8	56		.37	228	592.0	93	82	1.1	165	56	3
7	58		.50	228	593.2	94	82	1.45	165	56	3
6	60		.55	228	594.5	93	82	1.6	165	56	3
5	62		.64	225	595.9	93	82	1.9	165	56	3
4	64		.71	225	597.4	93	82	2.1	165	56	3
3	66		.69	225	599.0	93	83	2.0	165	60	
AVERAGE (TOTAL)					( )						

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: EPA - Empire Mining Co.
Source Designation: Empire #3 out - Electrostatic Precipitator Outlet
Date: 11/19/75
Test Number: EP-3 page 3
Field Person: RGK
Filter Number:
Barometric Pressure ("Hg):
Stack Static Pressure ("H_2O):
Stack Dimensions:
Plume Appearance:
Ambient Temperature (°F):
Record all Data Every ______ Minutes

Filter Heater Setting:
Probe Heater Setting:
Nozzle Number: ____, Dia. (in.):
Pitot Tube No. ____, Corr. Factor:
Meter Box No. ____, Corr. Factor:
Meter Isokinetic Factor:
Assumed Moisture (%):
Condensate Volume (ml): 204
Silica Gel Weight Gain (g): 30
Leak Rate .02 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
2	68		.55	228	600.6	93	83	1.6	165	60	3
1	70		.26	228	602.0	93	83	.75	165	60	3
	72				603.043		~~.02 CFM~~				
W 12	72	1735	.25	220	-0.220 603.263	84	80	.73	165	70	3
11	74		.25	220	604.4	86	80	.73	165	70	3
10	76		.28	220	605.4	86	80	.81	165	70	3
9	78		.30	220	606.4	86	80	.87	150	65	3
8	80		.30	220	607.4	86	80	.87	150	65	3
7	82		.35	220	608.5	86	81	1.0	150	65	3
6	84		.35	220	609.7	86	81	1.0	150	65	3
5	86		.35	220	610.8	86	81	1.0	150	65	3
4	88		.35	220	611.9	86	81	1.0	150	65	3
3	90		.35	220	613.0	86	81	1.0	150	65	3
2	92		.25	220	614.2	86	81	.73	170	70	3
1	94		.25	220	615.2	86	81	.73	170	70	3
	96				616.173						
AVERAGE (TOTAL)				226	(63.555)	86	77	1.5	165	61	3

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA $\Delta m = 4.61 \frac{\Delta m}{\Delta s} H$

Company: EPA TASK 20 EMPIRE MINING

Source Designation: ROTOCLONE INLET

Date: 11/20/75

Test Number: P-1

Field Person: HPF GMS

Filter Number: Ga 4-281-15

Barometric Pressure ("Hg): 28.26

Stack Static Pressure ("H_2O): -1.05

Stack Dimensions: 28x28

Plume Appearance:

Ambient Temperature (°F): 80°

Record all Data Every 5 Minutes

Filter Heater Setting: 80%

Probe Heater Setting: 70%

Nozzle Number: ____, Dia. (in.): .251

Pitot Tube No. 10, Corr. Factor: 0.816

Meter Box No. Ract, Corr. Factor: 0.998

Meter Isokinetic Factor: ~~1430~~ 1753

Assumed Moisture (%): 0%

Condensate Volume (ml): 6.0

Silica Gel Weight Gain (g): 11.3

Leak Rate 0.000 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
A-4	0	17:43	.41	250	816.614	83	82	1.4	130	64	<1
A-3	5	17:48	.43	300	819.92	88	82	1.4	130	76	<1
A-2	10	17:53	.36	260	823.18	90	84	1.3	145	60	<1
A-1	15	17:58	.34	290	826.36	93	84	1.1	160	62	<1
B-4	20	18:03	.50	270	829.34	94	85	1.7	160	63	<1
B-3	25	18:08	.54	265	832.95	94	86	1.9	165	64	<1
B-2	30	18:13	.49	245	836.85	96	86	1.8	170	65	<1
B-1	35	18:18	.42	280	840.59	96	87	1.4	175	66	<1
C-4	40	18:23	.55	250	843.96	96	88	2.0	170	67	<1
C-3	45	18:28	.63	270	847.95	97	88	2.2	175	67	<1
C-2	50	18:33	.59	270	852.07	98	88	2.1	175	67	<1
C-1	55	18:38	.46	260	856.07	98	89	1.6	175	63	<1
	60				859.616						
AVERAGE (TOTAL)				270	(42.916)	94	86	1.6	160	65	<1

FINAL LEAK 0.000 @ 15 "Hg

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

$\Delta m = 4.61 \frac{T_m}{T_s} H$

Company: EPA TASK 20 EMPIRE MINING

Source Designation: ROTOCLONE INLET

Date: 11/21/75

Test Number: D-2

Field Person: HPF GMS RJG

Filter Number: Ga 4 281 - #59

Barometric Pressure ("Hg): 28.23

Stack Static Pressure ("H_2O): -1.05

Stack Dimensions: 28" X 28"

Plume Appearance:

Ambient Temperature (°F): 85°

Record all Data Every 5 Minutes

Filter Heater Setting: 70%

Probe Heater Setting: 60%

Nozzle Number: ____, Dia. (in.): .251

Pitot Tube No. 10, Corr. Factor: 0.816

Meter Box No. RAC-1, Corr. Factor: 0.998

Meter Isokinetic Factor: ~~1.930~~ 1753

Assumed Moisture (%): 0%

Condensate Volume (ml): 0.0

Silica Gel Weight Gain (g): 9.7

Leak Rate .013 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
A-4	0	9:54	.42	260	859.935	77	76	1.4	165	70	<1
A-3	5	9:59	.45	265	863.15	78	76	1.5	165	72	<1
A-2	10	10:04	.39	270	866.46	81	76	1.3	170	62	<1
A-1	15	10:09	.32	280	869.64	84	76	1.1	160	62	<1
B-4	20	10:14	.53	270	872.73	86	78	1.8	150	62	<1
B-3	25	10:19	.54	260	876.48	89	78	1.9	150	62	<1
B-2	30	10:24	.48	280	880.22	91	80	1.6	155	64	<1
B-1	35	10:29	.39	250	883.69	92	82	1.4	155	64	<1
C-4	40	10:34	.56	270	886.33	93	83	1.9	160	64	<1
C-3	45	10:39	.59	270	890.86	94	84	2.0	160	64	<1
C-2	50	10:44	.56	270	894.74	96	85	1.9	165	64	<1
C-1	55	10:49	.48	265	898.56	96	86	1.7	165	64	<1
	60	10:54			902.191						
AVERAGE (TOTAL)				270	(42.171)	78	80	1.6	160	64	<1

FINAL LEAK .008 CFM @ 15 "HG

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SAMPLING TRAIN DATA

Company: EPA TASK 20 EMPIRE MINING

Source Designation: ROTOCLONE INLET

Date: 11/21/75

Test Number: P-3

Field Person: HPE GDS RJG

Filter Number: Ga4 - 281 - 98

Barometric Pressure ("Hg): 28.23

Stack Static Pressure ("H_2O): -1.05

Stack Dimensions: 28 X 28

Plume Appearance:

Ambient Temperature (°F): 70

Record all Data Every 5 Minutes

Filter Heater Setting: 75%

Probe Heater Setting: 60%

Nozzle Number: ___, Dia. (in.): .251

Pitot Tube No. 10, Corr. Factor: 0.816

Meter Box No. RM-1, Corr. Factor: 0.998

Meter Isokinetic Factor: ~~1930~~ 1753

Assumed Moisture (%): 0%

Condensate Volume (ml): 0

Silica Gel Weight Gain (g): 8.0

Leak Rate .006 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
A-4	0	12:53	.41	290	902.595	75	74	1.3	100	60	<1
A-3	5	12:58	.50	250	905.70	78	74	1.7	115	54	<1
A-2	10	13:03	.36	250	909.20	82	75	1.3	130	54	<1
A-1	15	13:08	.30	275	912.42	85	76	1.0	135	57	<1
B-4	20	13:13	.58	275	915.18	88	78	1.9	155	60	<1
B-3	25	13:18	.53	265	918.89	90	79	1.8	160	60	<1
B-2	30	13:23	.45	255	922.54	92	82	1.6	160	60	<1
B-1	35	13:28	.33	260	926.02	92	82	1.2	160	60	<1
C-4	40	13:33	.62	275	928.44	92	82	2.1	160	60	<1
C-3	45	13:38	.67	275	932.80	92	83	2.3	165	51	<1
C-2	50	13:43	.50	275	936.96	94	84	1.6	170	60	<1
C-1	55	13:48	.41	265	940.46	94	84	1.4	170	60	<1
	60	13:53			943.806						
AVERAGE (TOTAL)				270	(41.148)	88	79	1.6	150	58	<1

FINAL LEAK 0.010 @ 15 Hg

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SAMPLING TRAIN DATA

Company: EMPIRE MINING CO. EPA Task #20

Source Designation: Rotoclone Outlet

Date: 11/20/75

Test Number: P-1

Field Person: JBS, GJS

Filter Number: GA4 182-51

Barometric Pressure ("Hg): 28.2

Stack Static Pressure ("H_2O): +0.4

Stack Dimensions: 31 3/4" φ

Plume Appearance: <10%

Ambient Temperature (°F): 40

Record all Data Every 5 Minutes

Filter Heater Setting: 185°F

Probe Heater Setting: 185°F

Nozzle Number: ____, Dia. (in.): 3/16

Pitot Tube No. 22, Corr. Factor: 0.833

Meter Box No. M5, Corr. Factor: 1.011

Meter Isokinetic Factor: ~~[illegible]~~ 1730

Assumed Moisture (%): 1%

Condensate Volume (ml): 4.0

Silica Gel Weight Gain (g): 17

Leak Rate 0.005 CFM at 16 "Hg

$\Delta M = 1.64\ T_m/T_s\ H$ 50 = 510 / 615 = .155 460

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
N-6	0	17:40	1.5	155	183.791	46	45	2.0	175	36	0.5
5	5	17:45	1.5	155	187.5	48	45	2.0	185	38	0.5
4	10	17:50	1.65	162	191.2	49	45	2.2	170	40	0.5
3	15	17:55	1.55	158	195.8	50	45	2.1	162	42	0.5
2	20	18:00	1.5	155	199.2	50	45	2.0	165	42	0.5
1	25	18:05	1.2	155	203.9	49	45	2.0	155	45	0.5
	30	18:10			206.7 / .734	49	45				
					-0.133		0.005 / 0.005 at 16 "Hg / 15 "Hg				
E-6	30	18:17	1.6	160	206.867	48	45	2.15	160	35	0.5
5	35	18:22	1.5	158	210.7	48	45	2.2	155	40	0.5
4	40	18:27	1.4	160	214.6	48	45	1.9	160	45	0.5
3	45	18:32	1.4	160	218.3	48	45	1.9	160	42	0.5
2	50	18:37	1.3	162	221.9	48	45	1.8	155	41	0.5
1	55	18:42	1.1	158	225.5	49	45	1.5	155	41	0.5
	60	18:47			228.725						
						0.012 at 15.5 "Hg					
AVERAGE (TOTAL)				158	(45.344)	48	45	2.0	163	40	0.5

SAMPLING TRAIN DATA

Company: EMPIRE MINING CO - EPA TASE 20
Source Designation: Rotoclone Outlet
Date: 11/21/75
Test Number: P-2
Field Person: HBS SJS
Filter Number: GA 281-10
Barometric Pressure ("Hg): 28.2
Stack Static Pressure ("H_2O): -0.4
Stack Dimensions: 31 3/4" ⌀
Plume Appearance: <10%
Ambient Temperature (°F): 30
Record all Data Every 5 Minutes

Filter Heater Setting: 185°F
Probe Heater Setting: 185°F
Nozzle Number: ____, Dia. (in.): 3/16
Pitot Tube No. 22, Corr. Factor: 0.833
Meter Box No. M-5, Corr. Factor: 1.011
Meter Isokinetic Factor: 1.730
Assumed Moisture (%): 1%
Condensate Volume (ml): -4
Silica Gel Weight Gain (g): +9
Leak Rate 0.005 CFM at 20 "Hg

$\Delta m = 1.64\ T_m/T_s\ H$ 50 = 510/615 = 155

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter Volume (ft^3)	Dry Gas Meter Temp (°F) Inlet	Dry Gas Meter Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
N-6	0	9:50	1.5	155	230.154	46	46	2.05	170	35	0.5
5	5	9:55	1.55	158	233.8	46	46	2.1	145	35	0.5
4	10	10:00	1.6	155	237.7	47	46	2.2	170	37	0.5
3	15	10:05	1.5	155	241.5	48	46	2.05	150	40	0.5
2	20	10:10	1.4	155	245.4	48	46	1.9	170	40	0.5
1	25	10:15	1.3	152	248.9	48	46	1.8	150	42	0.5
	30	10:20			252.436						
					-0.6	0.038		at 16" Hg / 0.038 at 15" Hg			
E-6	30	10:28	1.5	165	253.030	48	46	2.0	135	36	0.5
5	35	10:33	1.45	167	256.7	48	46	1.95	165	42	0.5
4	40	10:38	1.4	155	260.4	48	46	1.9	150	38	0.5
3	45	10:43	1.4	160	264.0	48	46	1.9	170	42	0.5
2	50	10:58	1.4	155	267.6	48	46	1.9	150	42	0.5
1	55	11:03	1.2	155	271.2	48	46	1.6	180	42	0.5
	60	11:08			274.503						
						0.020			at		8" Hg
AVERAGE (TOTAL)				157	(44.230)	48	46	1.9	160	39	0.5

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SAMPLING TRAIN DATA

Company: EMPIRE MINING CO. - EPA TASK 20
Source Designation: Rotoclone Outlet
Date: 11/21/75
Test Number: O-3
Field Person: JBS GJS
Filter Number: GA4-281-07
Barometric Pressure ("Hg): ~~29~~ 28.2
Stack Static Pressure ("H_2O): -0.4
Stack Dimensions: 31 3/4" ϕ
Plume Appearance: <10%
Ambient Temperature (°F): 30
Record all Data Every 5 Minutes

Filter Heater Setting: 185°F
Probe Heater Setting: 185°F
Nozzle Number: ____, Dia. (in.): 3/16
Pitot Tube No. 22, Corr. Factor: 0.833
Meter Box No. M-5, Corr. Factor: 1.011
Meter Isokinetic Factor: 1730
Assumed Moisture (%): 1%
Condensate Volume (ml): +1
Silica Gel Weight Gain (g): 9
Leak Rate 0.001 CFM at 18 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
N-6	0	12:48	1.55	155	274.729	47	46	2.0	170	36	0.5
5	5	12:53	1.6	165	278.4	48	46	2.15	155	38	0.5
4	10	12:58	1.6	165	282.2	48	46	2.15	175	40	0.5
3	15	13:03	1.4	155	286.0	49	46	1.9	155	41	0.5
2	20	13:08	1.3	155	289.6	50	46	1.8	170	41	0.5
1	25	13:13	1.2	150	293.0	50	46	1.65	160	42	0.5
	30	13:18			296.367			0.004 ~~0.004~~	at ~~at~~	16 ~~16~~	.5 "Hg ~~.5 "Hg~~
E-6	30	13:21	1.65	150	-0.101 296.468	49	46	2.2	130	38	0.5
5	35	13:26	1.55	150	300.3	50	46	2.05	170	42	0.5
4	40	13:31	1.5	155	304.0	50	46	2.0	145	42	0.5
3	45	13:36	1.4	158	307.6	50	46	1.9	170	43	0.5
2	50	13:41	1.3	158	311.2	50	46	1.8	150	42	0.5
1	55	13:46	1.2	148	314.6	50	46	1.65	120	43	0.5
	60	13:51			317.982						
								0.005	at	16	"Hg
AVERAGE (TOTAL)				155	(43.596)	49	46	1.9	160	41	0.5

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APPENDIX D

PARTICLE SIZING FIELD DATA SHEETS

PA[redacted]C[redacted]SI[redacted]DA[redacted]S[redacted]T

PPT.
Source: #3 Kiln Inlet Empire Mine Electrostatic Precipitator Inlet

Static Pressure: 0.9" Hg

Field Person: K.D. Shoemaker

Traverse Point	VH	T_s	$P_{Barr.}$	Sampling Rate	Sampling Train	nozzle size	T_m	Date	Test No.	Start / Stop	Filter No.	Comments
A-3	0.71	210	28.20	5.0	Brinks Instack	2mm	65	11-20-75	1A	1436 / 1506	A-286-25	static pressure 0.9" Hg Set Hg reading at 4.1
D-3	0.56	210	28.20	3.9	Brink Instack	2mm	65	11-20-75	1B	1730 / 1830	A-286-22	static pressure 0.9" Hg Set Hg reading at 3.0
A-3	0.71	210	28.05	5.0	Brinks In stack	2mm	60	11-21-75	2A	1025 / 1125	A-286-08	static pressure 0.9" Hg Set Hg reading at 4.1
D-3	0.56	210	28.00	3.9	Brinks Instack	2mm	60	11-21-75	2B	1247 / 1417	A-286-10	static pressure 0.9" Hg Set Hg reading at 3.0
C-2	0.59	215	28.00	4.2	Brinks In stack	2mm	70	11-21-75	2C	1545 / 1715	A-286-11	static pressure 0.9" Hg Set Hg rate at 3.3

SAMPLING TRAIN DATA

Company: EPA — Empire Mining Co

Source Designation: Empire #3 out PPT Electrostatic Precipitator Outlet

Date: 11/20/75

Test Number: PS-1

Field Person: RGK

Filter Number:

Barometric Pressure ("Hg): 28.07

Stack Static Pressure ("H_2O): - .4

Stack Dimensions: 147" ID

Plume Appearance:

Ambient Temperature(°F): 30°

Record all Data Every 30 Minutes

Filter Heater Setting:

Probe Heater Setting:

Nozzle Number: , Dia.(in.): .315

Pitot Tube No. 17, Corr.Factor: 0.830

Meter Box No. RAC-3, Corr.Factor: 0.989

Meter Isokinetic Factor: ~~1175~~ 1756

Assumed Moisture(%): 15.5

Condensate Volume(ml): 1179

Silica Gel Weight Gain(g): —

Leak Rate .01 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
S 8	0	1200	.35	215	616.428	40	40	2.35	—	36	8
	30		.35	215	641.2	72	55	2.4	—	38	8
	60	1300	.35	215		80	63	2.4	—	38	10
	90		.35	215	692.18	81	66	2.46	—	38	12
	120	1400	.34	215		81	67	2.46	—	38	12
	150		.33	215	743.75	82	68	2.46	—	38	12
	180	1500	.35	215	769.76	82	68	2.46	—	38	12
	210		.35	215		82	68	2.46	—	38	12
	240	1600	.35	215	821.25	82	68	2.46	—	38	12
	270		.34	215	847.0	82	69	2.46	—	38	12
	300	1700	.34	215		82	69	2.46	—	37	11
	330		.34	215	898.52	82	69	2.46	—	37	11
	360	1800	.35	215	924.3	84	70	2.46	—	36	11
	390		.35	215		86	72	2.50	—	36	11
	420	1900	~~.35~~	~~215~~	976.930	~~89~~	~~74~~	~~2.50~~	—	36	~~11~~
AVERAGE (TOTAL)				215	(356.54)	78	65	2.4	—	37	11

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SAMPLING TRAIN DATA

Company: EPA – Empire Mining Co.

Source Designation: Empire #3 Electrostatic Precipitator Outlet

Date: 11/21/75

Test Number: PS-2

Field Person: RGK

Filter Number: avg = 28.11

Barometric Pressure ("Hg): 28.02 - 28.20

Stack Static Pressure ("H_2O): -.14

Stack Dimensions: 147

Plume Appearance:

Ambient Temperature (°F):

Record all Data Every 30 Minutes

Filter Heater Setting:

Probe Heater Setting:

Nozzle Number: –, Dia. (in.): .395

Pitot Tube No. 17, Corr. Factor: 0.830

Meter Box No. RAC-3, Corr. Factor: 0.989

Meter Isokinetic Factor: 1756

Assumed Moisture (%): 15.5

Condensate Volume (ml): 529+238+215+175

Silica Gel Weight Gain (g): 202+111+167

Leak Rate ______ CFM at ______ "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
N 3	0	1025	.60	212	977.088 ~~977.088~~	60	40	6.72	–	33	16
	30	1055	.60	215	018.3	90	59	7.0	–	33	16
	60	1125	.61	215	061.17	100	73	7.1	–	36	16
	90	1155	.59	218	104.30	100	76	7.1	–	34	16
	120	1225	.60	217	147.20	102	78	7.1	–	34	16
	150	1255	.60	217	190.015	100	77	7.0	–	34	16
		1329	~~.59~~	~~217~~	-0.107 190.122	~~62~~	63 Leak	test	–	~~34~~	~~16~~
	180	1359	.60	217	229.35	94	67	7.1	–	34	16
	210	1429	.60	217	272.148	100	74	7.1	–	34	16
	240	1459	.61	220	314.86	100	75	7.1	–	34	16
	270	1529	.59	220	357.55	104	81	7.0	–	32	17
	300	1559	.59	220	400.24	104	81	7.0	–	32	17
	330	1629	.60	220	442.29	97	75	6.7	–	32	17
	352 ~~360~~	1651 ~~1659~~	~~.60~~	~~220~~	472.722				~~–~~	~~32~~	~~17~~
AVERAGE (TOTAL)				217	(490.08)	94	71	7.0	–	34	16

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APPENDIX E

SAMPLE LOG

SAMPLE LOG

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

EPA Sample No.	1975 Date	Source	Run No.	Fraction Identification
S-75-004-178	11/18	No. 3 Kiln ESP Inlet	P-1	Front half rinse and brush suspended solids
S-75-004-179	11/18	No. 3 Kiln ESP Outlet	P-1	Front half rinse and brush suspended solids
S-75-004-180	11/19	No. 3 Kiln ESP Inlet	P-2	Front half rinse only suspended solids
S-75-004-181	11/19	No. 3 Kiln ESP Inlet	P-2	Front half rinse and brush suspended solids
S-75-004-182	11/19	No. 3 Kiln ESP Outlet	P-2	Front half rinse only suspended solids
S-75-004-183	11/19	No. 3 Kiln ESP Outlet	P-2	Front half rinse and brush suspended solids
S-75-004-184	11/19	No. 3 Kiln ESP Inlet	P-3	Front half rinse only suspended solids
S-75-004-185	11/19	No. 3 Kiln ESP Inlet	P-3	Front half rinse and brush suspended solids
S-75-004-186	11/20	No. 3 Kiln ESP Inlet	P-4	Front half rinse only suspended solids
S-75-004-187	11/20	No. 3 Kiln ESP Inlet	P-4	Front half rinse and brush suspended solids
S-75-004-188	11/20	No. 3 Kiln ESP Outlet	P-4	Front half rinse only suspended solids
S-75-004-189	11/20	No. 3 Kiln ESP Outlet	P-4	Front half rinse and brush suspended solids
S-75-004-190	11/20	Rotoclone Inlet	P-1	Front half rinse only suspended solids
S-75-004-191	11/20	Rotoclone Inlet	P-1	Front half rinse and brush suspended solids
S-75-004-192	11/20	Rotoclone Outlet	P-1	Front half rinse only suspended solids
S-75-004-193	11/20	Rotoclone Outlet	P-1	Front half rinse and brush suspended solids
S-75-004-194	11/21	Rotoclone Inlet	P-2	Front half rinse only suspended solids
S-75-004-195	11/21	Rotoclone Inlet	P-2	Front half rinse and brush suspended solids
S-75-004-196	11/21	Rotoclone Outlet	P-2	Front half rinse only suspended solids
S-75-004-197	11/21	Rotoclone Outlet	P-2	Front half rinse and brush suspended solids
S-75-004-198	11/21	Rotoclone Inlet	P-3	Front half rinse only suspended solids
S-75-004-199	11/21	Rotoclone Inlet	P-3	Front half rinse and brush suspended solids
S-75-004-200	11/21	Rotoclone Outlet	P-3	Front half rinse only suspended solids
S-75-004-201	11/21	Rotoclone Outlet	P-3	Front half rinse and brush suspended solids
S-75-004-202	11/18	No. 3 Kiln ESP Outlet	FP-1	Nozzle and filter holder (H_2O) rinse suspended solids
S-75-004-203	11/18	No. 3 Kiln ESP Outlet	FP-1	Probe and cyclone (H_2O) rinse suspended solids
S-75-004-204	11/19	No. 3 Kiln ESP Outlet	FP-2	Nozzle wash (acetone) suspended solids
S-75-004-205	11/19	No. 3 Kiln ESP Outlet	FP-2	Probe and cyclone (acetone) suspended solids
S-75-004-206	11/19	No. 3 Kiln ESP Outlet	FP-3	Nozzle wash (acetone) suspended solids
S-75-004-207	11/19	No. 3 Kiln ESP Outlet	FP-3	Probe and cyclone (acetone) suspended solids

SAMPLE LOG

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

EPA Sample No.	1975 Date	Source	Run No.	Fraction Identification
S-75-004-208	11/18	H_2O Blank		Filtrate residue
S-75-004-209	11/19	H_2O Blank		Filtrate residue
S-75-004-210	11/20	H_2O Blank		Filtrate residue
S-75-004-211	11/21	H_2O Blank		Filtrate residue
S-75-004-212	11/18	No. 3 Kiln ESP Inlet	P-1	Front half rinse and brush filtrate residue
S-75-004-213	11/18	No. 3 Kiln ESP Outlet	P-1	Front half rinse and brush filtrate residue
S-75-004-214	11/19	No. 3 Kiln ESP Inlet	P-2	Front half rinse and brush filtrate residue
S-75-004-215	11/19	No. 3 Kiln ESP Outlet	P-2	Front half rinse and brush filtrate residue
S-75-004-216	11/19	No. 3 Kiln ESP Inlet	P-3	Front half rinse and brush filtrate residue
S-75-004-217	11/20	No. 3 Kiln ESP Inlet	P-4	Front half rinse and brush filtrate residue
S-75-004-218	11/20	No. 3 Kiln ESP Outlet	P-4	Front half rinse and brush filtrate residue
S-75-004-219	11/20	Rotoclone Inlet	P-1	Front half rinse and brush filtrate residue
S-75-004-220	11/20	Rotoclone Outlet	P-1	Front half rinse and brush filtrate residue
S-75-004-221	11/21	Rotoclone Inlet	P-2	Front half rinse and brush filtrate residue
S-75-004-222	11/21	Rotoclone Outlet	P-2	Front half rinse and brush filtrate residue
S-75-004-223	11/21	Rotoclone Inlet	P-3	Front half rinse and brush filtrate residue
S-75-004-224	11/21	Rotoclone Outlet	P-3	Front half rinse and brush filtrate residue
S-75-004-225	11/18	No. 3 Kiln ESP Outlet	FP-1	Nozzle and filter holder rinse filtrate residue
S-75-004-226	11/18	No. 3 Kiln ESP Outlet	FP-1	Probe and cyclone rinse filtrate residue
S-75-004-227	11/19	No. 3 Kiln ESP Outlet	FP-2	Nozzle rinse filtrate residue
S-75-004-228	11/19	No. 3 Kiln ESP Outlet	FP-2	Probe and cyclone rinse filtrate residue
S-75-004-229	11/19	No. 3 Kiln ESP Outlet	FP-3	Nozzle rinse filtrate residue
S-75-004-230	11/19	No. 3 Kiln ESP Outlet	FP-3	Probe and cyclone rinse filtrate residue
S-75-004-231	11/18	No. 3 Kiln ESP Inlet	P-1	Impinger catch aqueous residue
S-75-004-232	11/18	No. 3 Kiln ESP Outlet	P-1	Impinger catch aqueous residue
S-75-004-233	11/19	No. 3 Kiln ESP Inlet	P-2	Impinger catch aqueous residue
S-75-004-234	11/19	No. 3 Kiln ESP Outlet	P-2	Impinger catch aqueous residue
S-75-004-235	11/19	No. 3 Kiln ESP Inlet	P-3	Impinger catch aqueous residue
S-75-004-236	11/20	No. 3 Kiln ESP Inlet	P-4	Impinger catch aqueous residue
S-75-004-237	11/20	No. 3 Kiln ESP Outlet	P-4	Impinger catch aqueous residue

SAMPLE LOG

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

EPA Sample No.	1975 Date	Source	Run No.	Fraction Identification
S-75-004-238	11/20	Rotoclone Inlet	P-1	Impinger catch aqueous residue
S-75-004-239	11/20	Rotoclone Outlet	P-1	Impinger catch aqueous residue
S-75-004-240	11/21	Rotoclone Inlet	P-2	Impinger catch aqueous residue
S-75-004-241	11/21	Rotoclone Outlet	P-2	Impinger catch aqueous residue
S-75-004-242	11/21	Rotoclone Inlet	P-3	Impinger catch aqueous residue
S-75-004-243	11/21	Rotoclone Outlet	P-3	Impinger catch aqueous residue
S-75-004-244	11/18	No. 3 Kiln ESP Outlet	FP-1	Impinger catch aqueous residue
S-75-004-245	11/19	No. 3 Kiln ESP Outlet	FP-2	Impinger catch aqueous residue
S-75-004-246	11/19	No. 3 Kiln ESP Outlet	FP-3	Impinger catch aqueous residue
S-75-004-247	11/18	No. 3 Kiln ESP Inlet	P-1	Impinger catch organic extraction residue
S-75-004-248	11/18	No. 3 Kiln ESP Outlet	P-1	Impinger catch organic extraction residue
S-75-004-249	11/19	No. 3 Kiln ESP Inlet	P-2	Impinger catch organic extraction residue
S-75-004-250	11/19	No. 3 Kiln ESP Outlet	P-2	Impinger catch organic extraction residue
S-75-004-251	11/19	No. 3 Kiln ESP Inlet	P-3	Impinger catch organic extraction residue
S-75-004-252	11/20	No. 3 Kiln ESP Inlet	P-4	Impinger catch organic extraction residue
S-75-004-253	11/20	No. 3 Kiln ESP Outlet	P-4	Impinger catch organic extraction residue
S-75-004-254	11/20	Rotoclone Inlet	P-1	Impinger catch organic extraction residue
S-75-004-255	11/20	Rotoclone Outlet	P-1	Impinger catch organic extraction residue
S-75-004-256	11/21	Rotoclone Inlet	P-2	Impinger catch organic extraction residue
S-75-004-257	11/21	Rotoclone Outlet	P-2	Impinger catch organic extraction residue
S-75-004-258	11/21	Rotoclone Inlet	P-3	Impinger catch organic extraction residue
S-75-004-259	11/21	Rotoclone Outlet	P-3	Impinger catch organic extraction residue
S-75-004-260	11/18	No. 3 Kiln ESP Outlet	FP-1	Impinger catch organic extraction residue
S-75-004-261	11/19	No. 3 Kiln ESP Outlet	FP-2	Impinger catch organic extraction residue
S-75-004-262	11/19	No. 3 Kiln ESP Outlet	FP-3	Impinger catch organic extraction residue
S-75-004-263	11/18	H_2O Blank		Aqueous extraction residue
S-75-004-264	11/19	H_2O Blank		Aqueous extraction residue
S-75-004-265	11/20	H_2O Blank		Aqueous extraction residue
S-75-004-266	11/21	H_2O Blank		Aqueous extraction residue

SAMPLE LOG

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

EPA Sample No.	1975 Date	Source	Run No.	Fraction Identification
S-75-004-267	11/18	H_2O Blank		Organic extraction residue
S-75-004-268	11/19	H_2O Blank		Organic extraction residue
S-75-004-269	11/20	H_2O Blank		Organic extraction residue
S-75-004-270	11/21	H_2O Blank		Organic extraction residue
S-75-004-271	11/20	Acetone Blank	PS-1A,B	
S-75-004-272	11/20	Acetone Blank	PS-2	
S-75-004-273	11/21	Acetone Blank	PS-2A,B,C	
S-75-004-274	11/21	Acetone Blank	PS-1	
S-75-004-275	11/20	No. 3 Kiln ESP Inlet	PS-1A	Cyclone, acetone rinse
S-75-004-276	11/20	No. 3 Kiln ESP Inlet	PS-1A	Stage 1, acetone rinse
S-75-004-277	11/20	No. 3 Kiln ESP Inlet	PS-1A	Stage 2, acetone rinse
S-75-004-278	11/20	No. 3 Kiln ESP Inlet	PS-1A	Stage 3, acetone rinse
S-75-004-279	11/20	No. 3 Kiln ESP Inlet	PS-1A	Stage 4, acetone rinse
S-75-004-280	11/20	No. 3 Kiln ESP Inlet	PS-1A	Stage 5, acetone rinse
S-75-004-281	11/20	No. 3 Kiln ESP Inlet	PS-1A	Stage out, acetone rinse
S-75-004-282	11/20	No. 3 Kiln ESP Inlet	PS-1B	Cyclone, acetone rinse
S-75-004-283	11/20	No. 3 Kiln ESP Inlet	PS-1B	Stage 1, acetone rinse
S-75-004-284	11/20	No. 3 Kiln ESP Inlet	PS-1B	Stage 2, acetone rinse
S-75-004-285	11/20	No. 3 Kiln ESP Inlet	PS-1B	Stage 3, acetone rinse
S-75-004-286	11/20	No. 3 Kiln ESP Inlet	PS-1B	Stage 4, acetone rinse
S-75-004-287	11/20	No. 3 Kiln ESP Inlet	PS-1B	Stage 5, acetone rinse
S-75-004-288	11/20	No. 3 Kiln ESP Inlet	PS-1B	Stage out, acetone rinse
S-75-004-289	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 0-1, acetone rinse
S-75-004-290	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 2, acetone rinse
S-75-004-291	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 3, acetone rinse
S-75-004-292	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 4, acetone rinse
S-75-004-293	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 5, acetone rinse
S-75-004-294	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 6, acetone rinse
S-75-004-295	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 7, acetone rinse
S-75-004-296	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 8, acetone rinse
S-75-004-297	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 9, acetone rinse

SAMPLE LOG

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

EPA Sample No.	1975 Date	Source	Run No.	Fraction Identification
S-75-004-298	11/21	No. 3 Kiln ESP Inlet	PS-2A	Cyclone, acetone rinse
S-75-004-299	11/21	No. 3 Kiln ESP Inlet	PS-2A	Stage 1, acetone rinse
S-75-004-300	11/21	No. 3 Kiln ESP Inlet	PS-2A	Stage 2, acetone rinse
S-75-004-301	11/21	No. 3 Kiln ESP Inlet	PS-2A	Stage 3, acetone rinse
S-75-004-302	11/21	No. 3 Kiln ESP Inlet	PS-2A	Stage 4, acetone rinse
S-75-004-303	11/21	No. 3 Kiln ESP Inlet	PS-2A	Stage 5, acetone rinse
S-75-004-304	11/21	No. 3 Kiln ESP Inlet	PS-2A	Stage out, acetone rinse
S-75-004-305	11/21	No. 3 Kiln ESP Inlet	PS-2B	Cyclone, acetone rinse
S-75-004-306	11/21	No. 3 Kiln ESP Inlet	PS-2B	Stage 1, acetone rinse
S-75-004-307	11/21	No. 3 Kiln ESP Inlet	PS-2B	Stage 2, acetone rinse
S-75-004-308	11/21	No. 3 Kiln ESP Inlet	PS-2B	Stage 3, acetone rinse
S-75-004-309	11/21	No. 3 Kiln ESP Inlet	PS-2B	Stage 4, acetone rinse
S-75-004-310	11/21	No. 3 Kiln ESP Inlet	PS-2B	Stage 5, acetone rinse
S-75-004-311	11/21	No. 3 Kiln ESP Inlet	PS-2B	Stage out, acetone rinse
S-75-004-312	11/21	No. 3 Kiln ESP Inlet	PS-2C	Cyclone, acetone rinse
S-75-004-313	11/21	No. 3 Kiln ESP Inlet	PS-2C	Stage 1, acetone rinse
S-75-004-314	11/21	No. 3 Kiln ESP Inlet	PS-2C	Stage 2, acetone rinse
S-75-004-315	11/21	No. 3 Kiln ESP Inlet	PS-2C	Stage 3, acetone rinse
S-75-004-316	11/21	No. 3 Kiln ESP Inlet	PS-2C	Stage 4, acetone rinse
S-75-004-317	11/21	No. 3 Kiln ESP Inlet	PS-2C	Stage 5, acetone rinse
S-75-004-318	11/21	No. 3 Kiln ESP Inlet	PS-2C	Stage out, acetone rinse
S-75-004-319	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 0-1, acetone rinse
S-75-004-320	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 2, acetone rinse
S-75-004-321	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 3, acetone rinse
S-75-004-322	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 4, acetone rinse
S-75-004-323	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 5, acetone rinse
S-75-004-324	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 6, acetone rinse
S-75-004-325	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 7, acetone rinse
S-75-004-326	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 8, acetone rinse
S-75-004-327	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 9, acetone rinse
S-75-004-328	11/20	Filter Blank		Andersen particle size filter
S-75-004-329	11/20	Filter Blank		Andersen particle size filter

SAMPLE LOG

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

EPA Sample No.	1975 Date	Source	Run No.	Fraction Identification
S-75-004-330	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 1, Andersen particle size filter
S-75-004-331	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 2, Andersen particle size filter
S-75-004-332	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 3, Andersen particle size filter
S-75-004-333	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 4, Andersen particle size filter
S-75-004-334	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 5, Andersen particle size filter
S-75-004-335	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 6, Andersen particle size filter
S-75-004-336	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 7, Andersen particle size filter
S-75-004-337	11/20	No. 3 Kiln ESP Outlet	PS-1	Stage 8, Andersen particle size filter
S-75-004-338	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 1, Andersen particle size filter
S-75-004-339	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 2, Andersen particle size filter
S-75-004-340	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 3, Andersen particle size filter
S-75-004-341	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 4, Andersen particle size filter
S-75-004-342	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 5, Andersen particle size filter
S-75-004-343	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 6, Andersen particle size filter
S-75-004-344	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 7, Andersen particle size filter
S-75-004-345	11/21	No. 3 Kiln ESP Outlet	PS-2	Stage 8, Andersen particle size filter
S-75-004-346	11/20	Filter Blank		47-mm A filter
S-75-004-347	11/20	No. 3 Kiln ESP Inlet	PS-1A	Backup, 47-mm A filter
S-75-004-348	11/20	No. 3 Kiln ESP Inlet	PS-1B	Backup, 47-mm A filter
S-75-004-349	11/20	No. 3 Kiln ESP Outlet	PS-1	Backup, 47-mm A filter
S-75-004-350	11/21	No. 3 Kiln ESP Inlet	PS-2A	Backup, 47-mm A filter
S-75-004-351	11/21	No. 3 Kiln ESP Inlet	PS-2B	Backup, 47-mm A filter
S-75-004-352	11/21	No. 3 Kiln ESP Inlet	PS-2C	Backup, 47-mm A filter
S-75-004-353	11/21	No. 3 Kiln ESP Outlet	PS-2	Backup, 47-mm A filter

SAMPLE LOG

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

EPA Sample No.	1975 Date	Source	Run No.	Fraction Identification
S-75-004-150	11/18	Blank Filter		115-mm Ga4 filter
S-75-004-151	11/20	Blank Filter		115-mm Ga4 filter
S-75-004-152	11/18	No. 3 Kiln ESP Inlet	P-1	115-mm Ga4 filter
S-75-004-153	11/18	No. 3 Kiln ESP Outlet	P-1	115-mm Ga4 filter
S-75-004-154	11/19	No. 3 Kiln ESP Inlet	P-2	115-mm Ga4 filter
S-75-004-155	11/19	No. 3 Kiln ESP Outlet	P-2	115-mm Ga4 filter
S-75-004-156	11/19	No. 3 Kiln ESP Inlet	P-3	115-mm Ga4 filter
S-75-004-157	11/20	No. 3 Kiln ESP Inlet	P-4	115-mm Ga4 filter
S-75-004-158	11/20	No. 3 Kiln ESP Outlet	P-4	115-mm Ga4 filter
S-75-004-159	11/20	Rotoclone Inlet	P-1	115-mm Ga4 filter
S-75-004-160	11/20	Rotoclone Outlet	P-1	115-mm Ga4 filter
S-75-004-161	11/21	Rotoclone Inlet	P-2	115-mm Ga4 filter
S-75-004-162	11/21	Rotoclone Outlet	P-2	115-mm Ga4 filter
S-75-004-163	11/21	Rotoclone Inlet	P-3	115-mm Ga4 filter
S-75-004-164	11/21	Rotoclone Outlet	P-3	115-mm Ga4 filter
S-75-004-165	11/18	Blank Filter		1-9/16" x 6-3/4" rec-A filter
S-75-004-166	11/18	Blank Filter		1-9/16" x 6-3/4" rec-A filter
S-75-004-167	11/18	No. 3 Kiln ESP Outlet	FP-1	1-9/16" x 6-3/4" rec-A filter
S-75-004-168	11/19	No. 3 Kiln ESP Outlet	FP-2	1-9/16" x 6-3/4" rec-A filter
S-75-004-169	11/19	No. 3 Kiln ESP Outlet	FP-3	1-9/16" x 6-3/4" rec-A filter
S-75-004-170	11/18	Blank Filter		110-mm A filter
S-75-004-171	11/18	No. 3 Kiln ESP Outlet	FP-1	110-mm A filter
S-75-004-172	11/19	No. 3 Kiln ESP Outlet	FP-2	110-mm A filter
S-75-004-173	11/19	No. 3 Kiln ESP Outlet	FP-3	110-mm A filter
S-75-004-174	11/18	H_2O Blank		Suspended solids
S-75-004-175	11/19	H_2O Blank		Suspended solids
S-75-004-176	11/20	H_2O Blank		Suspended solids
S-75-004-177	11/21	H_2O Blank		Suspended solids

APPENDIX F

SAMPLING SUMMARY SHEETS

SAMPLING SUMMARY SHEET

Plant Empire Mining Company

Location Palmer, Michigan

Sampled source No. 3 Kiln Precipitator Inlet

Run	Date	N_p	P_m	P_b	V_m	T_m	$V_{m_{std}}$	V_w	$V_{w_{gas}}$	%M	M_d
P-1	11-18-75	16	2.1	28.84	73.787	94	68.160	260.7	12.279	15.26	0.847
P-2	11-19-75	16	1.8	28.41	69.195	98	62.470	252.7	11.902	16.00	0.840
P-3	11-19-75	16	1.8	28.41	70.760	98	63.883	244	11.492	15.25	0.848
P-4	11-20-75	16	1.9	28.35	69.636	60	67.338	245	11.540	14.63	0.854

Run	MW_d	MW	P_{st}	P_s	C_p	$\sqrt{\Delta P_s \times (T_s + 460)}$ [c]	V_s	T_s	T_t	D_n	%I
P-1	28.972	27.29	-0.98	27.86	0.818	20.254	3076.9	214	96	0.251	108.0
P-2	28.960	27.21	-0.98	27.43	0.818	20.416	3130.3	210	96	0.251	99.0
P-3	28.952	27.29	-0.98	27.43	0.818	20.831	3189.2	217	96	0.251	99.5
P-4	28.961	27.36	-0.98	27.37	0.818	20.885	3196.9	209	96	0.251	102.9

$$V_{m_{std}} = \frac{17.55 \times V_m \left(P_b + \frac{P_m}{13.6}\right)}{(T_m + 460)}$$

$$\%M = \frac{100 \times V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}}$$

$$V_{w_{gas}} = 0.0471 \times V_w$$

$$M_d = \frac{100 - \%M}{100}$$

$$MW_d = \left(\%CO_2 \times \frac{44}{100}\right) + \left(\%O_2 \times \frac{32}{100}\right) + (\%CO + \%N_2) \times \frac{28}{100}$$

$$MW = MW_d \times M_d + 18\,(1 - M_d)$$

$$P_s = P_b \pm P_{st}$$

$$V_s = 5120.8 \times C_p \times \sqrt{\Delta P_s \times (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

$$\%I = \frac{1{,}032 \times (T_s + 460) \times V_{m_{std}}}{V_s \times T_t \times P_s \times M_d \times (D_n)^2}$$

N_p Total No. of Sampling Points

P_m Average Orifice Pressure Drop, in. H_2O

P_b Barometric Pressure, in. Hg. Absolute

V_m Volume of Dry Gas at Meter Conditions, DCF

T_m Average Meter Temperature, °F

$V_{m_{std}}$ Volume of Dry Gas at STP, DSCF[a]

V_w Total H_2O Collected in Impingers and Silica Gel, ml

$V_{w_{gas}}$ Volume of Water Vapor Collected at STP, SCF[b]

% M % Moisture by Volume

M_d Mole Fraction of Dry Gas

% CO_2 Volume % Dry

% O_2 Volume % Dry

% CO Volume % Dry

% N_2 Volume % Dry

MW_d Molecular Weight of Stack Gas, Dry Basis

MW Molecular Weight of Stack Gas, Wet Basis

P_{st} Static Pressure of Stack Gas, in. Hg

P_s Stack Gas Pressure, in. Hg Absolute

C_p Pitot Tube Coefficient

V_s Stack Gas Velocity at Stack Conditions, fpm.

T_s Average Stack Temperature °F

T_t Net Time of Test, Min.

D_n Sampling Nozzle Diameter,

% I Percent Isokinetic

[a] Dry standard cubic feet at 68°F, 29.92 in. Hg.

[b] Standard conditions at 68°F, 29.92 in. Hg.

[c] $\sqrt{\Delta P_s \times (T_s + 460)}$ is determined by averaging the square root of the product of the velocity head (ΔP_s) and the absolute stack temperature from each sampling point.

SAMPLING SUMMARY SHEET

Plant Empire Mining Company Location Palmer, Michigan

Sampled source No. 3 Kiln Precipitator Outlet

Run	Date	N_p	P_m	P_b	V_m	T_m	$V_{m_{std}}$	V_w	$V_{w_{gas}}$	%M	M_d
P-1	11-18-75	48	1.4	28.84	59.268	64	57.780	222	10.456	15.32	0.847
P-2	11-19-75	48	1.4	28.43	58.517	64	56.240	212	9.985	15.08	0.849
P-4	11-20-75	48	1.4	28.2	57.590	45	56.968	210	9.891	14.79	0.852

Run	MW_d	MW	P_{st}	P_s	C_p	$\sqrt{\Delta P_s \times (T_s + 460)}$[c]	V_s	T_s	T_t	D_n	%I
P-1	28.900	27.23	-0.03	28.81	0.824	18.121	2729.9	230	96	0.249	103.8
P-2	28.936	27.28	-0.03	28.40	0.824	17.999	2728.6	220	96	0.249	100.8
P-4	28.924	27.31	-0.03	28.17	0.824	18.528	2818.6	225	96	0.249	100.0

$$V_{m_{std}} = \frac{17.65 \times V_m \left(P_b + \frac{P_m}{13.6}\right)}{(T_m + 460)}$$

$$\% M = \frac{100 \times V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}}$$

$$V_{w_{gas}} = 0.0471 \times V_w$$

$$M_d = \frac{100 - \% M}{100}$$

$$MW_d = (\% CO_2 \times \tfrac{44}{100}) + (\% O_2 \times \tfrac{32}{100}) + (\% CO + \% N_2) \times \tfrac{28}{100}$$

$$MW = MW_d \times M_d + 18\,(1 - M_d)$$

$$P_s = P_b \pm P_{st}$$

$$V_s = 5120.8 \times Cp \times \sqrt{\Delta P_s \times (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

$$\% I = \frac{1{,}032 \times (T_s + 460) \times V_{m_{std}}}{V_s \times T_t \times P_s \times M_d \times (D_n)^2}$$

N_p	Total No. of Sampling Points
P_m	Average Orifice Pressure Drop, in. H_2O
P_b	Barometric Pressure, in. Hg. Absolute
V_m	Volume of Dry Gas at Meter Conditions, DCF
T_m	Average Meter Temperature, °F
$V_{m_{std}}$	Volume of Dry Gas at STP, DSCF[a]
V_w	Total H_2O Collected in Impingers and Silica Gel, ml
$V_{w_{gas}}$	Volume of Water Vapor Collected at STP, SCF[b]
% M	% Moisture by Volume
M_d	Mole Fraction of Dry Gas
% CO_2	Volume % Dry
% O_2	Volume % Dry
% CO	Volume % Dry
% N_2	Volume % Dry
MW_d	Molecular Weight of Stack Gas, Dry Basis
MW	Molecular Weight of Stack Gas, Wet Basis
P_{st}	Static Pressure of Stack Gas, in. Hg
P_s	Stack Gas Pressure, in. Hg Absolute
C_p	Pitot Tube Coefficient
V_s	Stack Gas Velocity at Stack Conditions, fpm.
T_s	Average Stack Temperature °F
T_t	Net Time of Test, Min.
D_n	Sampling Nozzle Diameter,
% I	Percent Isokinetic

[a] Dry standard cubic feet at 68°F, 29.92 in. Hg.

[b] Standard conditions at 68°F, 29.92 in. Hg.

[c] $\sqrt{\Delta P_s \times (T_s + 460)}$ is determined by averaging the square root of the product of the velocity head (ΔP_s) and the absolute stack temperature from each sampling point.

SAMPLING SUMMARY SHEET

Plant Empire Mining Company

Location Palmer, Michigan

Sampled source No. 3 Kiln Precipitator Outlet - Special Tests

Run	Date	N_p	P_m	P_b	V_m	T_m	$V_{m_{std}}$	V_w	$V_{w_{gas}}$	%M	M_d
FP-1	11-18-75	48	1.5	29.6	62.713	82	60.675	227.7	10.725	15.02	0.850
FP-2	11-19-75	48	1.5	28.43	63.430	79	59.280	242.4	11.417	16.15	0.838
FP-3	11-19-75	48	1.5	28.3	63.555	82	58.799	234	11.021	15.78	0.842

Run	MW_d	MW	P_{st}	P_s	C_p	$\sqrt{\Delta P_s \times (T_s+460)}$ [c]	V_s	T_s	T_t	D_n	%I
FP-1	28.900	27.26	-0.03	29.6	0.820	18.142	2681.8	230	96	0.251	105.9
FP-2	28.936	27.16	-0.03	28.40	0.820	18.435	2787.2	215	96	0.251	102.9
FP-3	28.936	27.21	-0.03	28.3	0.820	18.539	2805.3	226	96	0.251	103.0

$$V_{m_{std}} = \frac{17.65 \times V_m \left(P_b + \frac{P_m}{13.6}\right)}{(T_m + 460)} \qquad \%M = \frac{100 \times V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}}$$

$$V_{w_{gas}} = 0.0471 \times V_w \qquad M_d = \frac{100 - \%M}{100}$$

$$MW_d = (\%CO_2 \times \tfrac{44}{100}) + (\%O_2 \times \tfrac{32}{100}) + (\%CO + \%N_2) \times \tfrac{28}{100}$$

$$MW = MW_d \times M_d + 18\,(1 - M_d)$$

$$P_s = P_b \pm P_{st}$$

$$V_s = 5120.8 \times Cp \times \sqrt{\Delta P_s \times (T_s + 460)}\left[\frac{1}{P_s \times MW}\right]^{1/2}$$

$$\%I = \frac{1{,}032 \times (T_s + 460) \times V_{m_{std}}}{V_s \times T_t \times P_s \times M_d \times (D_n)^2}$$

N_p Total No. of Sampling Points

P_m Average Orifice Pressure Drop, in. H_2O

P_b Barometric Pressure, in. Hg. Absolute

V_m Volume of Dry Gas at Meter Conditions, DCF

T_m Average Meter Temperature, °F

$V_{m_{std}}$ Volume of Dry Gas at STP, DSCF[a]

V_w Total H_2O Collected in Impingers and Silica Gel, ml

$V_{w_{gas}}$ Volume of Water Vapor Collected at STP, SCF[b]

%M % Moisture by Volume

M_d Mole Fraction of Dry Gas

% CO_2 Volume % Dry

% O_2 Volume % Dry

% CO Volume % Dry

% N_2 Volume % Dry

MW_d Molecular Weight of Stack Gas, Dry Basis

MW Molecular Weight of Stack Gas, Wet Basis

P_{st} Static Pressure of Stack Gas, in. Hg

P_s Stack Gas Pressure, in. Hg Absolute

C_p Pitot Tube Coefficient

V_s Stack Gas Velocity at Stack Conditions, fpm.

T_s Average Stack Temperature °F

T_t Net Time of Test, Min.

D_n Sampling Nozzle Diameter, [illegible]

%I Percent Isokinetic

[a] Dry standard cubic feet at 68°F, 29.92 in. Hg.

[b] Standard conditions at 68°F, 29.92 in. Hg.

[c] $\sqrt{\Delta P_s \times (T_s + 460)}$ is determined by averaging the square root of the product of the velocity head (ΔP_s) and the absolute stack temperature from each sampling point.

SAMPLING SUMMARY SHEET

Plant Empire Mining Company   Location Palmer, Michigan

Sampled source Rotoclone Inlet

Run	Date	N_p	P_m	P_b	V_m	T_m	$V_{m_{std}}$	V_w	$V_{w_{gas}}$	%M	M_d
P-1	11-20-75	12	1.6	28.26	42.916	90	39.082	17.3	0.815	2.04	0.980
P-2	11-21-75	12	1.6	28.23	42.171	84	38.786	9.7	0.457	1.16	0.988
P-3	11-21-75	12	1.6	28.23	41.148	84	37.845	8	0.377	0.99	0.990

Run	MW_d	MW	P_{st}	P_s	C_p	$\sqrt{\Delta P_s \times (T_s + 460)}^c$	V_s	T_s	T_t	D_n	%I
P-1	29	28.78	-0.08	28.18	0.816	18.539	2720.2	270	60	0.251	103.7
P-2	29	28.87	-0.08	28.15	0.816	18.521	2714.7	270	60	0.251	102.4
P-3	29	28.89	-0.08	28.15	0.816	18.397	2695.6	270	60	0.251	100.4

$$V_{m_{std}} = \frac{17.65 \times V_m \left(P_b + \frac{P_m}{13.6}\right)}{(T_m + 460)}$$

$$\%M = \frac{100 \times V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}}$$

$$V_{w_{gas}} = 0.0471 \times V_w$$

$$M_d = \frac{100 - \%M}{100}$$

$$MW_d = (\%CO_2 \times \tfrac{44}{100}) + (\%O_2 \times \tfrac{32}{100}) + (\%CO + \%N_2) \times \tfrac{28}{100}$$

$$MW = MW_d \times M_d + 18\,(1 - M_d)$$

$$P_s = P_b \pm P_{st}$$

$$V_s = 5120.8 \times C_p \times \sqrt{\Delta P_s \times (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

$$\%I = \frac{1{,}032 \times (T_s + 460) \times V_{m_{std}}}{V_s \times T_t \times P_s \times M_d \times (D_n)^2}$$

N_p Total No. of Sampling Points

P_m Average Orifice Pressure Drop, in. H_2O

P_b Barometric Pressure, in. Hg. Absolute

V_m Volume of Dry Gas at Meter Conditions, DCF

T_m Average Meter Temperature, °F

$V_{m_{std}}$ Volume of Dry Gas at STP, DSCF[a]

V_w Total H_2O Collected in Impingers and Silica Gel, ml

$V_{w_{gas}}$ Volume of Water Vapor Collected at STP, SCF[b]

% M % Moisture by Volume

M_d Mole Fraction of Dry Gas

% CO_2 Volume % Dry

% O_2 Volume % Dry

% CO Volume % Dry

% N_2 Volume % Dry

MW_d Molecular Weight of Stack Gas, Dry Basis

MW Molecular Weight of Stack Gas, Wet Basis

P_{st} Static Pressure of Stack Gas, in. Hg

P_s Stack Gas Pressure, in. Hg Absolute

C_p Pitot Tube Coefficient

V_s Stack Gas Velocity at Stack Conditions, fpm.

T_s Average Stack Temperature °F

T_t Net Time of Test, Min.

D_n Sampling Nozzle Diameter,

% I Percent Isokinetic

[a] Dry standard cubic feet at 68°F, 29.92 in. Hg.

[b] Standard conditions at 68°F, 29.92 in. Hg.

[c] $\sqrt{\Delta P_s \times (T_s + 460)}$ is determined by averaging the square root of the product of the velocity head (ΔP_s) and the absolute stack temperature from each sampling point.

SAMPLING SUMMARY SHEET

Plant Empire Mining Company   Location Palmer, Michigan

Sampled source Rotoclone Outlet

Run	Date	N_p	P_m	P_b	V_m	T_m	$V_{m_{std}}$	V_w	$V_{w_{gas}}$	%M	M_d
P-1	11-20-75	12	2.0	28.2	45.344	46	44.836	21	0.989	2.16	0.978
P-2	11-21-75	12	1.9	28.2	44.230	47	43.636	5	0.236	0.54	0.995
P-3	11-21-75	12	1.9	28.2	43.596	48	42.926	10	0.471	1.08	0.989

Run	MW_d	MW	P_{st}	P_s	C_p	$\sqrt{\Delta P_s \times (T_s + 460)}$ [c]	V_s	T_s	T_t	D_n	%I
P-1	29	28.76	-0.03	28.2	0.833	29.720	4451.6	158	60	0.188	109.8
P-2	29	28.94	-0.03	28.2	0.833	29.725	4438.4	157	60	0.188	105.2
P-3	29	28.88	-0.03	28.2	0.833	29.701	4439.5	155	60	0.188	103.8

$$V_{m_{std}} = \frac{17.65 \times V_m \left(P_b + \frac{P_m}{13.6}\right)}{(T_m + 460)}$$

$$\% M = \frac{100 \times V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}}$$

$$V_{w_{gas}} = 0.0471 \times V_w$$

$$M_d = \frac{100 - \% M}{100}$$

$$MW_d = (\%CO_2 \times \tfrac{44}{100}) + (\%O_2 \times \tfrac{32}{100}) + (\%CO + \%N_2) \times \tfrac{28}{100}$$

$$MW = MW_d \times M_d + 18\,(1 - M_d)$$

$$P_s = P_b \pm P_{st}$$

$$V_s = 5120.8 \times C_p \times \sqrt{\Delta P_s \times (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

$$\% I = \frac{1{,}032 \times (T_s + 460) \times V_{m_{std}}}{V_s \times T_t \times P_s \times M_d \times (D_n)^2}$$

- N_p Total No. of Sampling Points
- P_m Average Orifice Pressure Drop, in. H_2O
- P_b Barometric Pressure, in. Hg. Absolute
- V_m Volume of Dry Gas at Meter Conditions, DCF
- T_m Average Meter Temperature, °F
- $V_{m_{std}}$ Volume of Dry Gas at STP, DSCF[a]
- V_w Total H_2O Collected in Impingers and Silica Gel, ml
- $V_{w_{gas}}$ Volume of Water Vapor Collected at STP, SCF[b]
- % M % Moisture by Volume
- M_d Mole Fraction of Dry Gas
- % CO_2 Volume % Dry
- % O_2 Volume % Dry
- % CO Volume % Dry
- % N_2 Volume % Dry
- MW_d Molecular Weight of Stack Gas, Dry Basis
- MW Molecular Weight of Stack Gas, Wet Basis
- P_{st} Static Pressure of Stack Gas, in. Hg
- P_s Stack Gas Pressure, in. Hg Absolute
- C_p Pitot Tube Coefficient
- V_s Stack Gas Velocity at Stack Conditions, fpm.
- T_s Average Stack Temperature °F
- T_t Net Time of Test, Min.
- D_n Sampling Nozzle Diameter, in.
- % I Percent Isokinetic

[a] Dry standard cubic feet at 68°F, 29.92 in. Hg.

[b] Standard conditions at 68°F, 29.92 in. Hg.

[c] $\sqrt{\Delta P_s \times (T_s + 460)}$ is determined by averaging the square root of the product of the velocity head (ΔP_s) and the absolute stack temperature from each sampling point.

APPENDIX G

PARTICULATE WEIGHT DATA

SUMMARY OF PARTICULATE WEIGHT FRACTIONS
ELECTROSTATIC PRECIPITATOR INLET

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Test No.	Fraction			Final Weight (gm)	Tare Weight (gm)	Weight of Particulate (gm)	Applicable Blank Value (gm)	Blank-Corrected Particulate (gm)
1	Probe Rinse	Filtered acetone & water with brush washes		0.64136 1.47166	0.07475 0.08751	0.56661 1.38415	<0.00005 <0.00005	0.5666 1.3842
		Filtered water wash without brush		--	--	--	--	--
		Filtrate for all washes		84.6945	84.6387	0.0558	0.0157	0.0401
	Front filter			0.43840	0.32392	0.11448	<0.00005	0.1145
	Front-half Total			--	--	--	--	2.1054
	Impingers & Back Rinses	Aqueous		92.0626	92.0398	0.0228	<0.0005	0.0228
		C-E Extract		98.4417	98.4380	0.0037	0.0017	0.0020
	Back-half Total			--	--	--	--	0.0248
	Total Particulate			--	--	--	--	2.1302
2	Probe Rinse	Filtered acetone & water with brush washes		0.20155	0.07233	0.12922	0.00098	0.1282
		Filtered water wash without brush		1.26773	0.08870	1.17903	0.00069	1.1783
		Filtrate for all washes		95.7788	95.7196	0.0592	0.0162	0.0430
	Front filter			0.42163	0.31120	0.11043	<0.00005	0.1104
	Front-half Total			--	--	--	--	1.4599
	Impingers & Back Rinses	Aqueous		88.2760	88.2517	0.0243	0.0045	0.0198
		C-E Extract		92.4949	92.4915	0.0034	0.0012	0.0022
	Back-half Total			--	--	--	--	0.0220
	Total Particulate			--	--	--	--	1.4819

SUMMARY OF PARTICULATE WEIGHT FRACTIONS
ELECTROSTATIC PRECIPITATOR INLET (continued)

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Test No.	Fraction		Final Weight (gm)	Tare Weight (gm)	Weight of Particulate (gm)	Applicable Blank Value (gm)	Blank-Corrected Particulate (gm)
3	Probe Rinse	Filtered acetone & water with brush washes	0.19116	0.07428	0.11688	0.00108	0.1158
		Filtered water wash without brush	1.04731	0.09228	0.95503	0.00087	0.9542
		Filtrate for all washes	97.5222	97.4615	0.0607	0.0189	0.0418
	Front filter		0.42242	0.33600	0.08642	<0.00005	0.0864
	Front-half Total		--	--	--	--	1.1982
	Impingers & Back Rinses	Aqueous	81.8403	81.8145	0.0258	0.0037	0.0221
		C-E Extract	97.5749	97.5710	0.0039	0.0012	0.0027
	Back-half Total		--	--	--	--	0.0248
	Total Particulate		--	--	--	--	1.2230
4	Probe Rinse	Filtered acetone & water with brush washes	0.33091	0.08183	0.24908	<0.00005	0.2491
		Filtered water wash without brush	0.47154	0.08755	0.38399	<0.00005	0.3840
		Filtrate for all washes	94.6168	94.5505	0.0663	0.0212	0.0451
	Front filter		0.39250	0.31234	0.08016	<0.00005	0.0802
	Front-half Total		--	--	--	--	0.7584
	Impingers & Back Rinses	Aqueous	86.0700	86.0488	0.0212	0.0047	0.0165
		C-E Extract	98.7018	98.6987	0.0031	0.0017	0.0014
	Back-half Total		--	--	--	--	0.0179
	Total Particulate		--	--	--	--	0.7763

SUMMARY OF PARTICULATE WEIGHT FRACTIONS
ELECTROSTATIC PRECIPITATOR OUTLET

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Test No.	Fraction		Final Weight (gm)	Tare Weight (gm)	Weight of Particulate (gm)	Applicable Blank Value (gm)	Blank-Corrected Particulate (gm)
1	Probe Rinse	Filtered acetone & water with brush washes	0.08160	0.07513	0.00647	<0.00005	0.0065
	Probe Rinse	Filtered water wash without brush	--	--	--	--	--
	Probe Rinse	Filtrate for all washes	90.2461	90.2431	0.0030	0.0018	0.0012
	Front filter		0.31010	0.31077	<0.00005	<0.00005	<0.00005
	Front-half Total		--	--	--	--	0.0077
	Impingers & Back Rinses	Aqueous	89.1734	89.1448	0.0286	<0.0005	0.0286
	Impingers & Back Rinses	C-E Extract	95.3781	95.3740	0.0041	0.0017	0.0024
	Back-half Total		--	--	--	--	0.0310
	Total Particulate		--	--	--	--	0.0387
2	Probe Rinse	Filtered acetone & water with brush washes	0.08370	0.07270	0.01100	0.00097	0.0100
	Probe Rinse	Filtered water wash without brush	0.07738	0.07600	0.00138	0.00077	0.0006
	Probe Rinse	Filtrate for all washes	95.9242	95.9113	0.0129	0.0168	<0.0005
	Front filter		0.29768	0.29787	<0.00005	<0.00005	<0.00005
	Front-half Total		--	--	--	--	0.0106
	Impingers & Back Rinses	Aqueous	89.3415	89.3191	0.0224	0.0061	0.0163
	Impingers & Back Rinses	C-E Extract	93.6984	93.6940	0.0044	0.0012	0.0032
	Back-half Total		--	--	--	--	0.0195
	Total Particulate		--	--	--	--	0.0301

SUMMARY OF PARTICULATE WEIGHT FRACTIONS
ELECTROSTATIC PRECIPITATOR OUTLET (continued)

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Test No.	Fraction		Final Weight (gm)	Tare Weight (gm)	Weight of Particulate (gm)	Applicable Blank Value (gm)	Blank-Corrected Particulate (gm)
4	Probe Rinse	Filtered acetone & water with brush washes	0.07624	0.07219	0.00405	<0.00005	0.0040
		Filtered water wash without brush	0.07268	0.07187	0.00081	<0.00005	0.0008
		Filtrate for all washes	95.2623	95.2542	0.0081	0.0109	<0.0005
	Front filter		0.30183	0.30390	<0.00005	<0.00005	<0.00005
	Front-half Total		--	--	--	--	0.0048
	Impingers & Back Rinses	Aqueous	94.1596	94.1425	0.0171	0.0058	0.0113
		C-E Extract	95.8719	95.8700	0.0019	0.0017	0.0002
	Back-half Total		--	--	--	--	0.0115
	Total Particulate		--	--	--	--	0.0163
	Probe Rinse	Filtered acetone & water with brush washes					
		Filtered water wash without brush					
		Filtrate for all washes					
	Front filter						
	Front-half Total						
	Impingers & Back Rinses	Aqueous					
		C-E Extract					
	Back-half Total						
	Total Particulate						

SUMMARY OF PARTICULATE WEIGHT FRACTIONS
SPECIAL TESTS ON NO. 3 KILN PRECIPITATOR OUTLET

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Test No.	Fraction		Final Weight (gm)	Tare Weight (gm)	Weight of Particulate (gm)	Applicable Blank Value (gm)	Blank-Corrected Particulate (gm)
1	Nozzle Rinse	Filtered water	0.10651	0.08483	0.02168	<0.00005	0.0217
		Filtered acetone	--	--	--	--	--
		Filtrate	90.3068	90.3031	0.0037	0.0017	0.0020
	Front filter		0.41833	0.43548	-0.01715	0.00017	-0.0173*
	Front-half Total		--	--	--	--	0.0064
	Probe Rinse	Filtered water	0.09191	0.08702	0.00489	<0.00005	0.0049
		Filtered acetone	--	--	--	--	--
		Filtrate	96.6663	96.6488	0.0175	0.0011	0.0164
	Second filter		0.68068	0.66436	0.01632	0.00016	0.0162
	Impingers & Back Rinses	Aqueous	95.5079	95.4784	0.0295	<0.0005	0.0295
		C-E Extract	99.1663	99.1620	0.0043	0.0017	0.0026
	Back-half Total		--	--	--	--	0.0696
	Total Particulate		--	--	--	--	0.0760

* Negative weight used due to technique of transferring sample per R. Keller.

SUMMARY OF PARTICULATE WEIGHT FRACTIONS
SPECIAL TESTS ON NO. 3 KILN PRECIPITATOR OUTLET (continued)

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Test No.	Fraction		Final Weight (gm)	Tare Weight (gm)	Weight of Particulate (gm)	Applicable Blank Value (gm)	Blank-Corrected Particulate (gm)
2	Nozzle Rinse	Filtered water	--	--	--	--	--
		Filtered acetone	0.09077	0.09077	<0.00005	0.00006	<0.00005
		Filtrate	99.2785	99.2771	0.0014	0.0006	0.0008
	Front filter		0.44237	0.43740	0.00497	0.00017	0.0048
	Front-half Total		--	--	--	--	0.0056
	Probe Rinse	Filtered water	--	--	--	--	--
		Filtered acetone	0.07347	0.07244	0.00103	0.00014	0.0009
		Filtrate	91.6884	91.6857	0.0027	0.0014	0.0013
	Second filter		0.67309	0.66023	0.01286	0.00016	0.0127
	Impingers & Back Rinses	Aqueous	96.3471	96.3300	0.0171	0.0053	0.0118
		C-E Extract	93.5573	93.5537	0.0036	0.0012	0.0024
	Back-half Total		--	--	--	--	0.0291
	Total Particulate		--	--	--	--	0.0347

SUMMARY OF PARTICULATE WEIGHT FRACTIONS
SPECIAL TESTS ON NO. 3 KILN PRECIPITATOR OUTLET (continued)

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Test No.	Fraction		Final Weight (gm)	Tare Weight (gm)	Weight of Particulate (gm)	Applicable Blank Value (gm)	Blank-Corrected Particulate (gm)
3	Nozzle Rinse	Filtered water	--	--	--	--	--
		Filtered acetone	0.07382	0.07360	0.00022	0.00004	0.0002
		Filtrate	95.4967	95.4944	0.0023	0.0003	0.0020
	Front filter		0.42474	0.42588	<0.00005	0.00017	<0.00005
	Front-half Total		--	--	--	--	0.0022
	Probe Rinse	Filtered water	--	--	--	--	--
		Filtered acetone	0.09022	0.08846	0.00176	0.00018	0.0016
		Filtrate	85.0968	85.0923	0.0045	0.0017	0.0028
	Second filter		0.69559	0.68315	0.01244	0.00016	0.0123
	Impingers & Back Rinses	Aqueous	95.4358	95.4186	0.0172	0.0052	0.0120
		C-E Extract	94.7988	94.7960	0.0028	0.0012	0.0016
	Back-half Total		--	--	--	--	0.0303
	Total Particulate		--	--	--	--	0.0325

SUMMARY OF PARTICULATE WEIGHT FRACTIONS
ROTOCLONE INLET

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Test No.	Fraction		Final Weight (gm)	Tare Weight (gm)	Weight of Particulate (gm)	Applicable Blank Value (gm)	Blank-Corrected Particulate (gm)
1	Probe Rinse	Filtered acetone & water with brush washes	0.10161	0.07320	0.02841	<0.00005	0.0284
		Filtered water wash without brush	1.66821	0.07242	1.59579	<0.00005	1.5958
		Filtrate for all washes	95.6875	95.6669	0.0206	0.0107	0.0099
	Front filter		0.36500	0.30636	0.05864	<0.00005	0.0586
	Front-half Total		--	--	--	--	1.6927
	Impingers & Back Rinses	Aqueous	95.5214	95.5185	0.0029	0.0018	0.0011
		C-E Extract	93.5123	93.5108	0.0015	0.0014	0.0001
	Back-half Total		--	--	--	--	0.0012
	Total Particulate		--	--	--	--	1.6939
2	Probe Rinse	Filtered acetone & water with brush washes	0.09048	0.08659	0.00389	0.00080	0.0031
		Filtered water wash without brush	1.79392	0.07507	1.71885	0.00064	1.7182
		Filtrate for all washes	72.8046	72.7909	0.0137	0.0112	0.0025
	Front filter		0.33554	0.29109	0.04445	<0.00005	0.0444
	Front-half Total		--	--	--	--	1.7682
	Impingers & Back Rinses	Aqueous	86.4538	86.4502	0.0036	0.0018	0.0018
		C-E Extract	93.7593	93.7572	0.0021	0.0014	0.0007
	Back-half Total		--	--	--	--	0.0025
	Total Particulate		--	--	--	--	1.7707

SUMMARY OF PARTICULATE WEIGHT FRACTIONS
ROTOCLONE INLET (continued)

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Test No.	Fraction		Final Weight (gm)	Tare Weight (gm)	Weight of Particulate (gm)	Applicable Blank Value (gm)	Blank-Corrected Particulate (gm)
3	Probe Rinse	Filtered acetone & water with brush washes	0.09253	0.07220	0.02033	0.00078	0.0196
		Filtered water wash without brush	1.63315	0.07371	1.55944	0.00059	1.5588
		Filtrate for all washes	87.1262	87.1161	0.0101	0.0107	<0.0005
	Front filter		0.40337	0.34690	0.05647	<0.00005	0.0565
	Front-half Total		--	--	--	--	1.6349
	Impingers & Back Rinses	Aqueous	83.5944	83.5890	0.0054	0.0020	0.0034
		C-E Extract	94.2326	94.2309	0.0017	0.0014	0.0003
	Back-half Total		--	--	--	--	0.0037
	Total Particulate		--	--	--	--	1.6386
	Probe Rinse	Filtered acetone & water with brush washes					
		Filtered water wash without brush					
		Filtrate for all washes					
	Front filter						
	Front-half Total						
	Impingers & Back Rinses	Aqueous					
		C-E Extract					
	Back-half Total						
	Total Particulate						

SUMMARY OF PARTICULATE WEIGHT FRACTIONS
ROTOCLONE OUTLET

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Test No.	Fraction		Final Weight (gm)	Tare Weight (gm)	Weight of Particulate (gm)	Applicable Blank Value (gm)	Blank-Corrected Particulate (gm)
1	Probe Rinse	Filtered acetone & water with brush washes	0.09033	0.07644	0.01389	<0.00005	0.0139
	Probe Rinse	Filtered water wash without brush	1.07119	0.07983	0.99136	<0.00005	0.9914
	Probe Rinse	Filtrate for all washes	87.5821	87.5736	0.0085	0.0141	<0.0005
	Front filter		0.34044	0.32118	0.01926	<0.00005	0.0193
	Front-half Total		--	--	--	--	1.0246
	Impingers & Back Rinses	Aqueous	96.6971	96.6940	0.0031	0.0023	0.0008
	Impingers & Back Rinses	C-E Extract	97.0238	97.0238	0.0000	0.0014	<0.0005
	Back-half Total		--	--	--	--	0.0008
	Total Particulate		--	--	--	--	1.0254
2	Probe Rinse	Filtered acetone & water with brush washes	0.09052	0.08663	0.00389	0.00059	0.0033
	Probe Rinse	Filtered water wash without brush	0.94647	0.07937	0.86710	0.00113	0.8660
	Probe Rinse	Filtrate for all washes	97.5487	97.5399	0.0088	0.0134	<0.0005
	Front filter		0.33990	0.31554	0.02436	<0.00005	0.0244
	Front-half Total		--	--	--	--	0.8937
	Impingers & Back Rinses	Aqueous	97.6974	97.6941	0.0033	0.0022	0.0011
	Impingers & Back Rinses	C-E Extract	86.6368	86.6347	0.0021	0.0014	0.0007
	Back-half Total		--	--	--	--	0.0018
	Total Particulate		--	--	--	--	0.8955

SUMMARY OF PARTICULATE WEIGHT FRACTIONS
ROTOCLONE OUTLET (continued)

Empire Mining Company
Palmer, Michigan
November 18-21, 1975

Test No.	Fraction		Final Weight (gm)	Tare Weight (gm)	Weight of Particulate (gm)	Applicable Blank Value (gm)	Blank-Corrected Particulate (gm)
3	Probe Rinse	Filtered acetone & water with brush washes	0.07731	0.07315	0.00416	0.00054	0.0036
		Filtered water wash without brush	0.93113	0.08767	0.84346	0.00097	0.8425
		Filtrate for all washes	69.1635	69.1560	0.0075	0.0118	<0.0005
	Front filter		0.33800	0.31108	0.02692	<0.00005	0.0269
	Front-half Total		--	--	--	--	0.8730
	Impingers & Back Rinses	Aqueous	98.2528	98.2500	0.0028	0.0022	0.0006
		C-E Extract	90.6485	90.6471	0.0014	0.0014	<0.0005
	Back-half Total		--	--	--	--	0.0006
	Total Particulate		--	--	--	--	0.8736
	Probe Rinse	Filtered acetone & water with brush washes					
		Filtered water wash without brush					
		Filtrate for all washes					
	Front filter						
	Front-half Total						
	Impingers & Back Rinses	Aqueous					
		C-E Extract					
	Back-half Total						
	Total Particulate						

APPENDIX H

CALIBRATION DATA

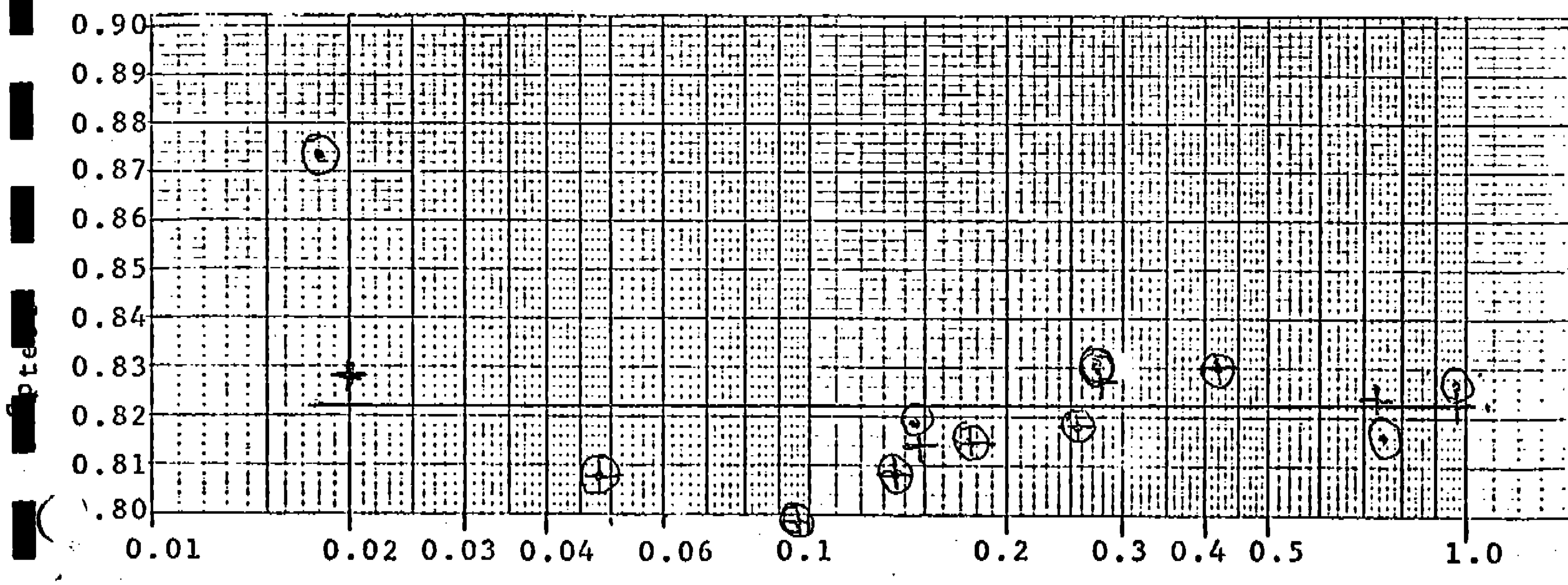
$$C_{p\,test} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$$

Pitot Tube Type 5 Pitot Tube No. 10

Standard Pitot Tube No. ____________

Calibrator: GEH Date: 9/12/75 Client: ____________

Anticipated ΔP_{std}	ΔP_{std}	A ⊙		B +	
		ΔP_{test}	$\Delta C_{p\,test}$	ΔP_{test}	$\Delta C_{p\,test}$
0.02	0.014	0.028	0.873	0.020	0.828
0.04	0.032	0.048	0.808	0.048	0.808
0.06	0.062	0.096	0.796	0.096	0.796
0.08	0.088	0.132	0.808	0.132	0.808
0.10	0.100	0.146	0.819	0.148	0.814
0.12	0.118	0.174	0.815	0.174	0.815
0.16	0.172	0.252	0.818	0.252	0.818
0.20	0.194	0.276	0.830	0.278	0.827
0.30	0.294	0.418	0.830	0.418	0.830
0.50	0.508	0.748	0.816	0.734	0.824
0.70	0.684	0.966	0.827	0.968	0.826
0.80	0.	0.	0.	0.	0.



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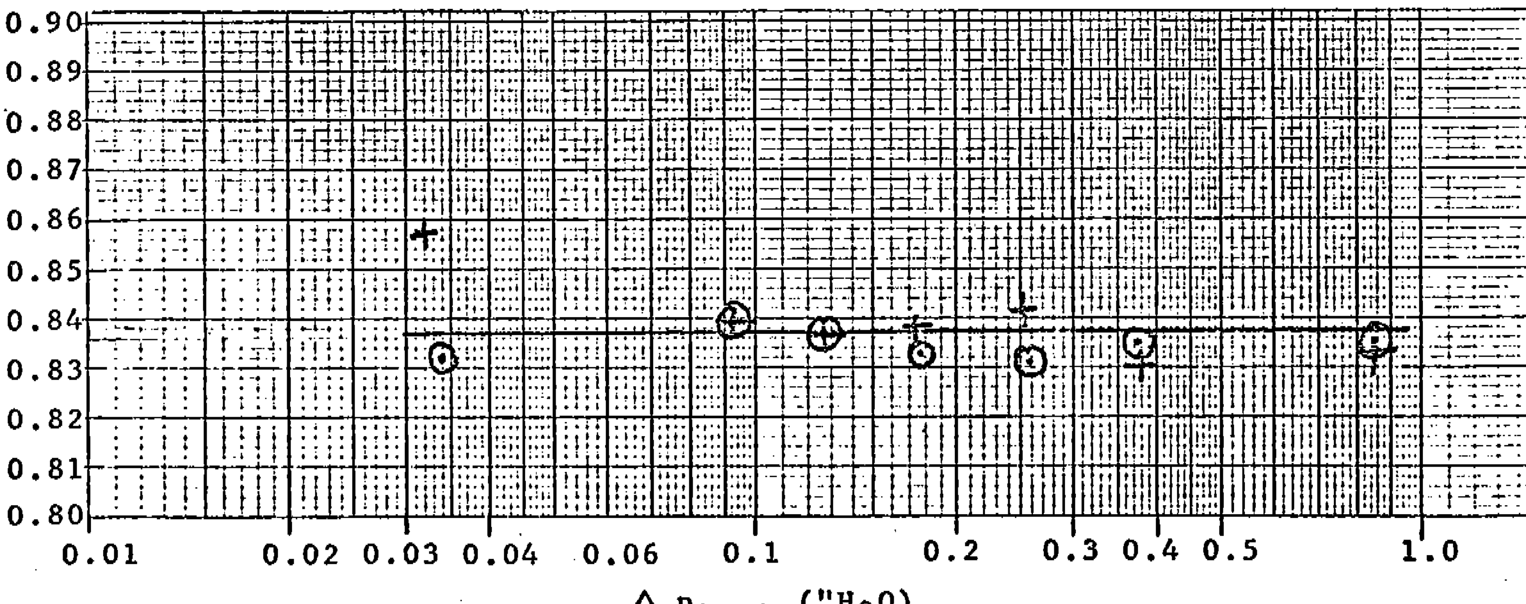
$$C_{p_{test}} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$$

Pitot Tube Type S Pitot Tube No. 12

Standard Pitot Tube No. ______

Calibrator: H. FLOOD Date: 11/3/75 Client: POST - HANNA

Anticipated ΔP_{std}	ΔP_{std}	A ⊙		B +	
		ΔP_{test}	$\Delta C_{p_{test}}$	ΔP_{test}	$\Delta C_{p_{test}}$
0.02	0.024	0.034	0.832	0.032	0.857
0.04	0.___	0.___	0.___	0.___	0.___
0.06	0.066	0.092	0.839	0.092	0.839
0.08	0.090	0.126	0.837	0.126	0.837
0.10	0.___	0.___	0.___	0.___	0.___
0.12	0.126	0.178	0.833	0.176	0.838
0.16	0.182	0.258	0.831	0.252	0.841
0.20	0.___	0.___	0.___	0.___	0.___
0.30	0.266	0.374	0.835	0.378	0.830
0.50	0.___	0.___	0.___	0.___	0.___
0.70	0.600	0.844	0.835	0.848	0.833
0.80	0.___	0.___	0.___	0.___	0.___



Clayton Environmental Consultants

$$C_{p_{test}} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$$

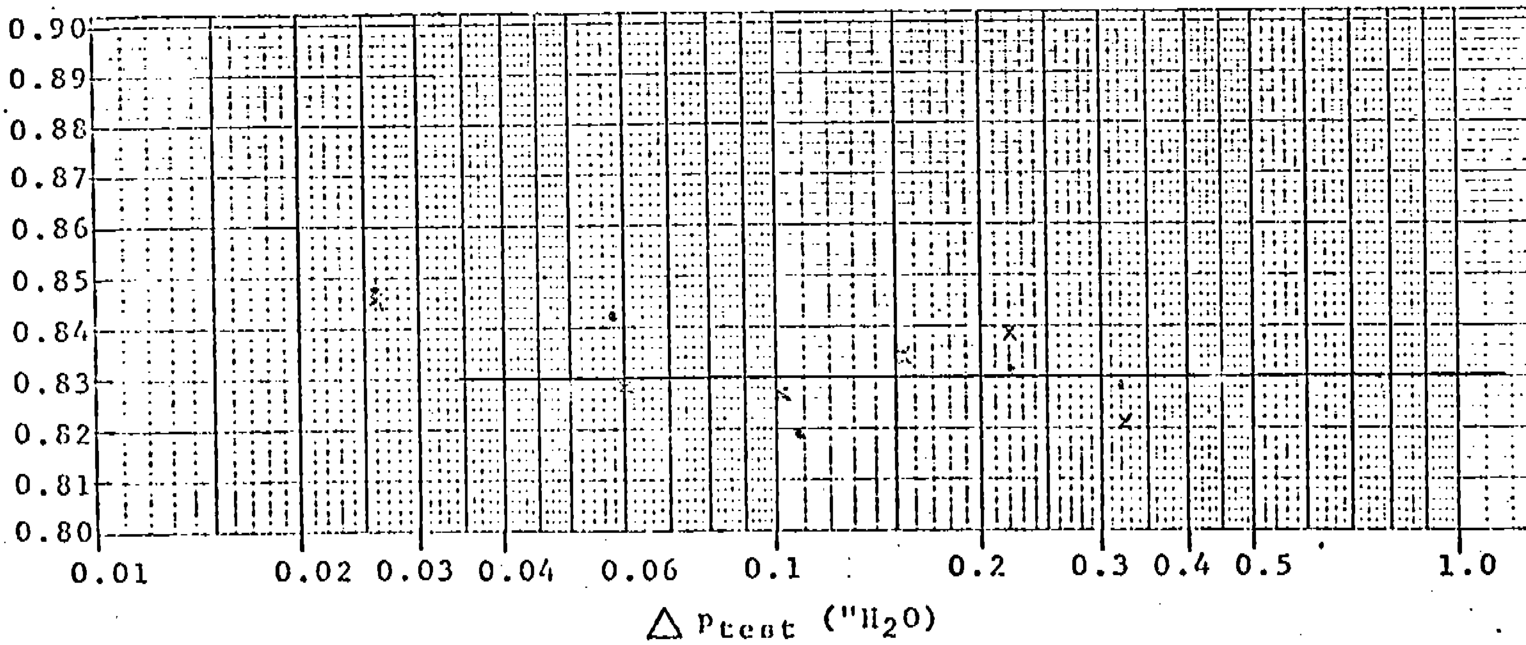
Pitot Tube Type [illegible] Pitot Tube No. 11

Standard Pitot Tube No. ______

Calibrator: [illegible] Date: 11/14/7[illegible] Client: [illegible]

Post [illegible] Pickels Task 20

Anticipated ΔP_{std}	ΔP_{std}	A X ΔP_{test}	A X $\Delta C_{p_{test}}$	B • ΔP_{test}	B • $\Delta C_{p_{test}}$
0.02	0.019	0.026	0.8463	0.026	0.8463
0.04	0.042	0.066	0.8283	0.058	0.8424
0.06	0.	0.	0.	0.	0.
0.08	0.074	0.106	0.8272	0.108	0.8195
0.10	0.113	0.162	0.8393	0.156	0.8345
0.12	0.	0.	0.	0.	0.
0.16	0.155	0.221	0.8390	0.224	0.8313
0.20	0.224	0.328	0.8200	0.320	0.82[illegible]
0.30	0.	0.	0.	0.	0.
0.50	0.[illegible]	0.256	0.8296	0.29	0.[illegible]
0.70	0.25	0.	0.	0.	0.
0.80	0.[illegible]	0.	0.	0.	0.



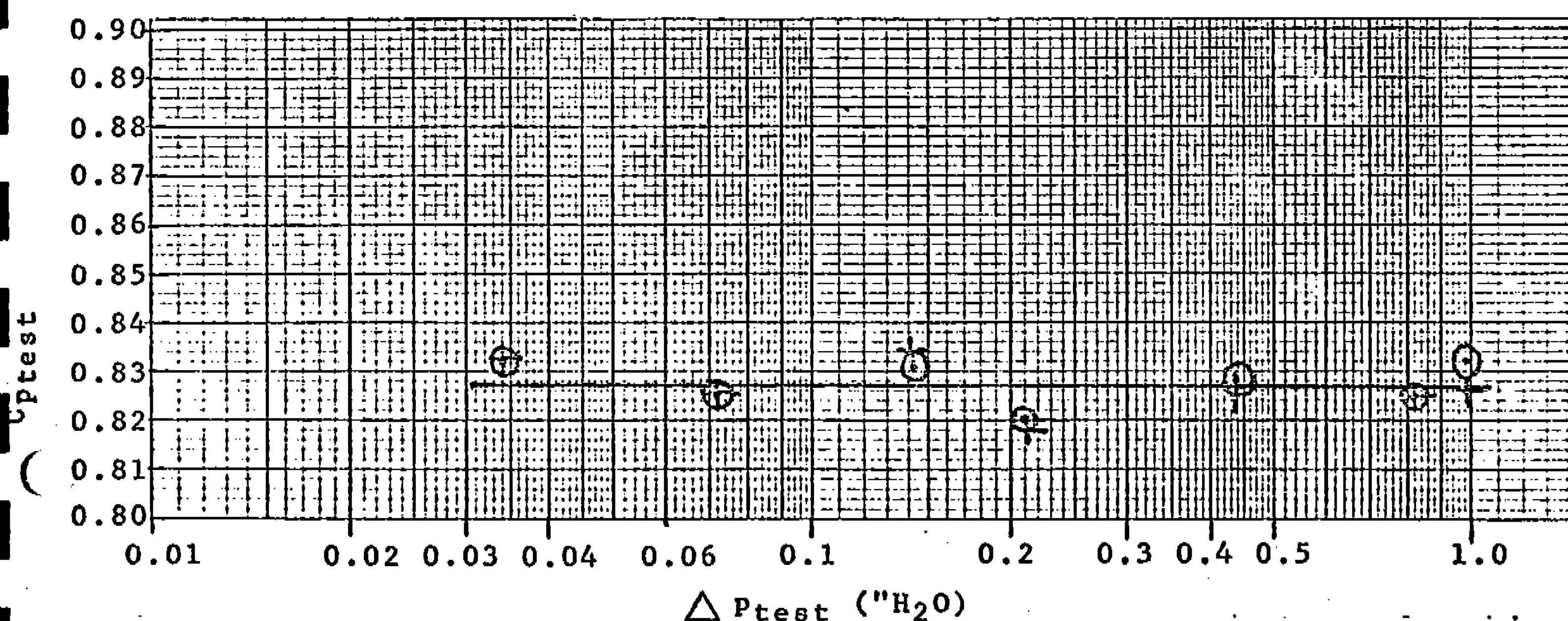
$$C_{ptest} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$$

Pitot Tube Type S Pitot Tube No. 19

Standard Pitot Tube No. ______

Calibrator: H. FLOOD Date: 11/3/75 Client: POST · HANNA

Anticipated ΔP_{std}	ΔP_{std}	A ⊙		B +	
		ΔP_{test}	ΔC_{ptest}	ΔP_{test}	ΔC_{ptest}
0.02	0.024	0.034	0.832	0.034	0.832
0.04	0.____	0.____	0.____	0.____	0.____
0.06	0.050	0.072	0.825	0.072	0.825
0.08	0.____	0.____	0.____	0.____	0.____
0.10	0.100	0.142	0.831	0.141	0.834
0.12	0.____	0.____	0.____	0.____	0.____
0.16	0.144	0.210	0.820	0.211	0.818
0.20	0.____	0.____	0.____	0.____	0.____
0.30	0.306	0.437	0.828	0.438	0.827
0.50	0.569	0.819	0.825	0.819	0.825
0.70	0.642	0.980	0.832	0.994	0.826
0.80	0.____	0.____	0.____	0.____	0.____



Clayton Environmental Consultants

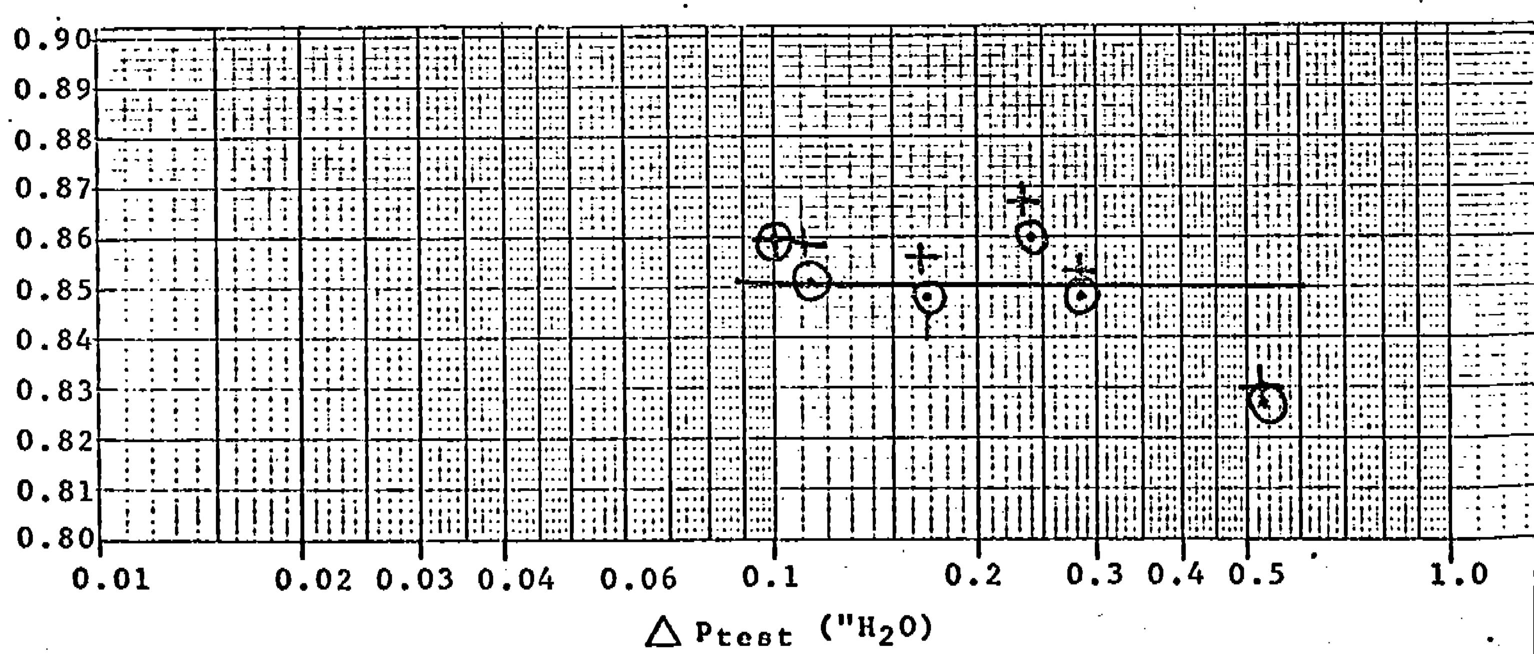
$$C_{ptest} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$$

Pitot Tube Type S Pitot Tube No. 22

Standard Pitot Tube No. ______

Calibrator: RJ Griffin Date: 10/29/75 Client: post EPA Hanna Mining

Anticipated ΔP_{std}	ΔP_{std}	A ⊙		B +	
		ΔP_{test}	ΔC_{ptest}	ΔP_{test}	ΔC_{ptest}
0.02	0.	0.	0.	0.	0.
0.04	0.	0.	0.	0.	0.
0.06	0.0755	0.100	0.860	0.100	0.860
0.08	0.0835	0.113	0.851	0.111	0.859
0.10	0.124	0.169	0.848	0.166	0.856
0.12	0.	0.	0.	0.	0.
0.16	0.181	0.240	0.860	0.236	0.867
0.20	0.210	0.286	0.848	0.283	0.853
0.30	0.368	0.527	0.827	0.524	0.830
0.50	0.	0.	0.	0.	0.
0.70	0.	0.	0.	0.	0.
0.80	0.	0.	0.	0.	0.



Date 5/14/75 Client FROM RSK EPA-14 [redacted] Meter Box Number [redacted]

Ba[redacted]etric P[redacted]ssure Pb ([redacted]Hg) [redacted] 29.45 [redacted] Calibrator GEH Gas Meter Number

RAC#, RAC#1

	Orifice Manometer Setting, Δm (in. H_2O)	Gas Volume Wet Test Meter V_w (ft^3)	Gas Volume Dry Gas Meter V_d (ft^3)	Temperature: Wet Test Meter t_w (°F)	Temperature: Dry Gas Meter Inlet t_{di} (°F)	Temperature: Dry Gas Meter Outlet t_{do} (°F)	Temperature: Dry Gas Meter Average t_d (°F)	Vacuum Wet Test Meter P_w (in. H_2O)	Time θ (min)	γ	K_m
Stop	0.5	1685.00	383.076						12.68		
Start		1680.00	377.904	72°	92°	88°		.10		0.998	0.13118
Average	29.49	(5) 5.00	5.172				90	29.44	12.41		
Stop	1.0	1690.00	388.228		92°	84°			9.35		
Start		1685.00	383.076	72°	92°	86°		.10		0.997	0.12580
Average	29.52	(5) 5.00	5.152				88	29.44	9.21		
Stop	2.0	1700.00	398.514		94°	86°			13.01		
Start		1690.00	388.228	72°	92°	84°		.10		0.998	0.12727
Average	29.60	(10) 10.00	10.286				89	29.44	13.04		
Stop	3.0	1710.00	408.782		96°	86°			10.83		
Start		1700.00	398.514	72	94°	86°		.12		0.999	0.12541
Average	29.67	(10) 10.00	10.268				90	29.44	10.50		
Stop	4.0	1720.00	419.050		96	86			9.52		
Start		1710.00	408.782	72	96°	86		.15		0.999	0.12355
Average	29.74	(10) 10.00	10.268				91	29.44	9.31		
Stop	5.0	1730.00	429.314		98	86°			8.63		
Start		1720.00	419.050	72	96	86		.15		0.998	0.0190
Average	29.82	(10) 10.00	10.264				92	29.44	8.38		
									AVERAGE	0.998	0.12585

$P_w = P_b - \frac{P_w}{13.6}$ $\quad P_d = P_b + \frac{\Delta m}{13.6}$ $\quad K_m = \frac{V_w}{\theta}\sqrt{\frac{P_w}{T_w \Delta m}}$

$\gamma = \frac{V_w P_w (t_d + 460)}{V_d P_d (t_w + 460)}$

Factor in isokinetic equation $= \frac{27.40}{(\overline{K_m})^2} = \frac{27.40}{(\quad)^2} =$ 1730

Date 11/14/75 Client Post Nichols - Detroit Meter Box Number RAC-2
Barometric Pressure Pb [redacted] (in. Hg) [redacted] 29.26 [redacted] Calibrator R.J.G. [redacted] Gas Meter Number [redacted]

RAC-2

	Orifice Manometer Setting, Δm (in. H_2O)	Gas Volume Wet Test Meter V_w (ft^3)	Gas Volume Dry Gas Meter V_d (ft^3)	Temperature: Wet Test Meter t_w (°F)	Temperature: Dry Gas Meter Inlet t_{di} (°F)	Temperature: Dry Gas Meter Outlet t_{do} (°F)	Temperature: Dry Gas Meter Average t_d (°F)	Vacuum Wet Test Meter P_w (in. H_2O)	Time θ (min)	γ	K_m
Stop	0.5	2725.500	727.551	71	98	92	95	0.08			
Start		2718.500	720.082	71	96	91	93.5	0.08	18.250	0.976	0.12731
Average		(5) 7.000	7.469	71	97	91.5	94	0.08			
Stop	1.0	2731.000	733.418	71	101	93	97	0.10			
Start		2726.000	728.081	71.5	98	92	95	0.10	9.350	0.978	0.12551
Average		(5) 5.000	5.337	71	99.5	92.5	96	0.10			
Stop	2.0	2742.500	745.671	71	106	94	100	0.10			
Start		2731.500	733.945	71	101	93	97	0.10	14.633	0.981	0.12476
Average		(10) 11.000	11.726	71	103.5	93.5	98.5	0.10			
Stop	3.0	2754.000	757.932	71	108	95	101.5	0.12			
Start		2743.000	746.199	71.5	105	94	99.5	0.12	12.050	0.982	0.12370
Average		(10) 11.000	11.733	71	106.5	94.5	100.5	0.12			
Stop	4.0	2768.500	773.402	71	110	97	103.5	0.14			
Start		2754.500	758.464	71	108	95	101.5	0.14	13.383	0.983	0.12276
Average		(10) 14.000	14.938	71	109	96	102.5	0.14			
Stop	5.0	2780.000	820.037	70.5	112	98	105	0.16			
Start		2769.000	808.278	71.5	112	98	105	0.16	9.433	0.983	0.12240
Average		(10) 11.000	11.759	71	112	98	105	0.16			
									AVERAGE	0.981	0.12441

$P_w = P_b - \frac{P_w}{13.6}$ $\quad P_d = P_b + \frac{\Delta m}{13.6}$ $\quad K_m = \frac{V_w}{\theta}\sqrt{\frac{P_w}{T_w\,\Delta m}}$

$\gamma = \frac{V_w\ P_w\ (t_d + 460)}{V_d\ P_d\ (t_w + 460)}$ $\quad$ Factor in isokinetic equation $= \frac{27.40}{(K_m)^2} = \frac{27.40}{(.12441)^2} = 1770$

Da[redacted] 10/28/75 [redacted] Client [redacted] Post EPA [redacted] Hanna Mining [redacted] Meter Box Number [redacted] RAC-3 [redacted]

Barometric [redacted]ressure Pb ("Hg) 29.42 Cal[redacted]rator RJG Gas Meter Number [redacted]

RAC-3

	Orifice Manometer Setting, Δm (in. H_2O)	Gas Volume Wet Test Meter V_w (ft^3)	Gas Volume Dry Gas Meter V_d (ft^3)	Temperature: Wet Test Meter t_w (°F)	Temperature: Dry Gas Meter Inlet t_{di} (°F)	Temperature: Dry Gas Meter Outlet t_{do} (°F)	Temperature: Dry Gas Meter Average t_d (°F)	Vacuum Wet Test Meter P_w (in. H_2O)	Time θ (min)	γ	K_m
Stop	0.5	2487.00	351.814	73	87	82	84.5	0.08			
Start		2482.00	346.625	73	83	81	82	0.08	12.950	0.9800	0.12826
Average	29.46	(5)	5.189	73	85	81.5	83	0.08			
Stop	1.0	2493.00	358.059	74	92	84	88	0.08			
Start		2488.00	352.855	74	89	83	86	0.08	9.317	0.9815	0.12594
Average	29.49	(5)	5.204	74	90.5	83.5	87	0.08			
Stop	2.0	2504.00	369.542	74	99	87	93	0.10			
Start		2494.00	359.114	74	93	85	89	0.10	13.450	0.9841	0.12338
Average	29.57	(10)10.00	10.428	74	96	86	91	0.10			
Stop	3.0	2516.00	382.093	75	102	90	96	0.12			
Start		2505.00	370.580	75	99	87	93	0.12	12.050	0.9826	0.12357
Average	29.64	(10)11.00	11.513	75	100.5	88.5	94.5	0.12			
Stop	4.0	2532.00	398.855	75	105	91	98	0.14			
Start		2517.00	383.137	75	101	89	95	0.14	14.367	0.9826	0.12240
Average	29.71	(10)15.00	15.718	75	103	90	96.5	0.14			
Stop	5.0	2548.00	415.608	75	106	92	99	0.16			
Start		2533.00	399.891	75	103	91	97	0.16	12.890	0.9827	0.12202
Average	29.79	(10)15.00	15.717	75	104.5	91.5	98	0.16			
									AVERAGE	0.9823	0.12426

$P_w = P_b - \frac{P_w}{13.6}$ $P_d = P_b + \frac{\Delta m}{13.6}$ $K_m = \frac{V_w}{\theta}\sqrt{\frac{P_w}{T_w \, \Delta m}}$

$\gamma = \frac{V_w \, P_w \, (t_d + 460)}{V_d \, P_d \, (t_w + 460)}$ Factor in isokinetic equation $= \frac{27.40}{(K_m)^2} = \frac{27.40}{(.12426)^2} = 1775$

G.D. Clayton & Associates

[redacted] Meter Box Number [redacted]

Barometri[redacted] Pressure Pb ("Hg) 29.36 Ca[redacted]brator G.E.H. Gas Meter Number [redacted]

MAC. # 5

	Orifice Manometer Setting, Δm (in. H_2O)	Gas Volume Wet Test Meter V_w (ft^3)	Gas Volume Dry Gas Meter V_d (ft^3)	Temperature: Wet Test Meter t_w (°F)	Temperature: Dry Gas Meter Inlet t_{di} (°F)	Temperature: Dry Gas Meter Outlet t_{do} (°F)	Temperature: Dry Gas Meter Average t_d (°F)	Vacuum Wet Test Meter p_w (in. H_2O)	Time θ (min)	γ	K_m
Stop	0.5	2555.00	880.012	71	68	64°	66		14.22		
Start		2550.00	874.700	71°	64°	62°	63	.10		0.927	0.11691
Average	29.40	(5) 5.00	5.312	71	66	63	64	29.35	14.13		
Stop	1.0	2560.00	885.045	71	68	66	67		9.65		
Start		2555.00	880.012	71°	68°	64°	66	.12		0.981	0.12181
Average	29.43	(5) 5.00	5.033	71	68	65	66	29.35	9.39		
Stop	2.0	2570.00	895.112	71	70	68	69		13.60		
Start		2560.00	885.045	71°	68	66	67	.15		0.982	0.12224
Average	29.51	(10) 10.00	10.067	71	69	67	68	29.35	13.36		
Stop	3.0	2580.00	905.172	71	72	68	70		11.18		
Start		2570.00	895.112	71°	70	68	69	.15		0.984	0.12141
Average	29.58	(10) 10.00	10.060	71	71	68	70	29.35	11.11		
Stop	4.0	2590.00	915.247	71	74	70	72		9.75		
Start		2580.00	905.172	71	72	68	70	.20		0.983	0.12057
Average	29.65	(10) 10.00	10.075	71	73	69	71	29.35	9.45		
Stop	5.0	2600.00	925.387		76	70	73		8.78		
Start		2590.00	915.247	71	74	70	72	.20		0.975	0.11975
Average	29.73	(10) 10.00	10.140	71	75	70	72	29.35	8.47		
									AVERAGE	0.981	0.12116

$$P_w = P_b - \frac{p_w}{13.6} \qquad P_d = P_b + \frac{\Delta m}{13.6} \qquad K_m = \frac{V_w}{\theta}\sqrt{\frac{P_w}{T_w \, \Delta m}}$$

$$\gamma = \frac{V_w \, P_w \, (t_d + 460)}{V_d \, P_d \, (t_w + 460)}$$

Factor in isokinetic equation $= \frac{27.40}{(K_m)^2} = \frac{27.40}{(\quad)^2} = 1867$

G.D. Clayton & Associates

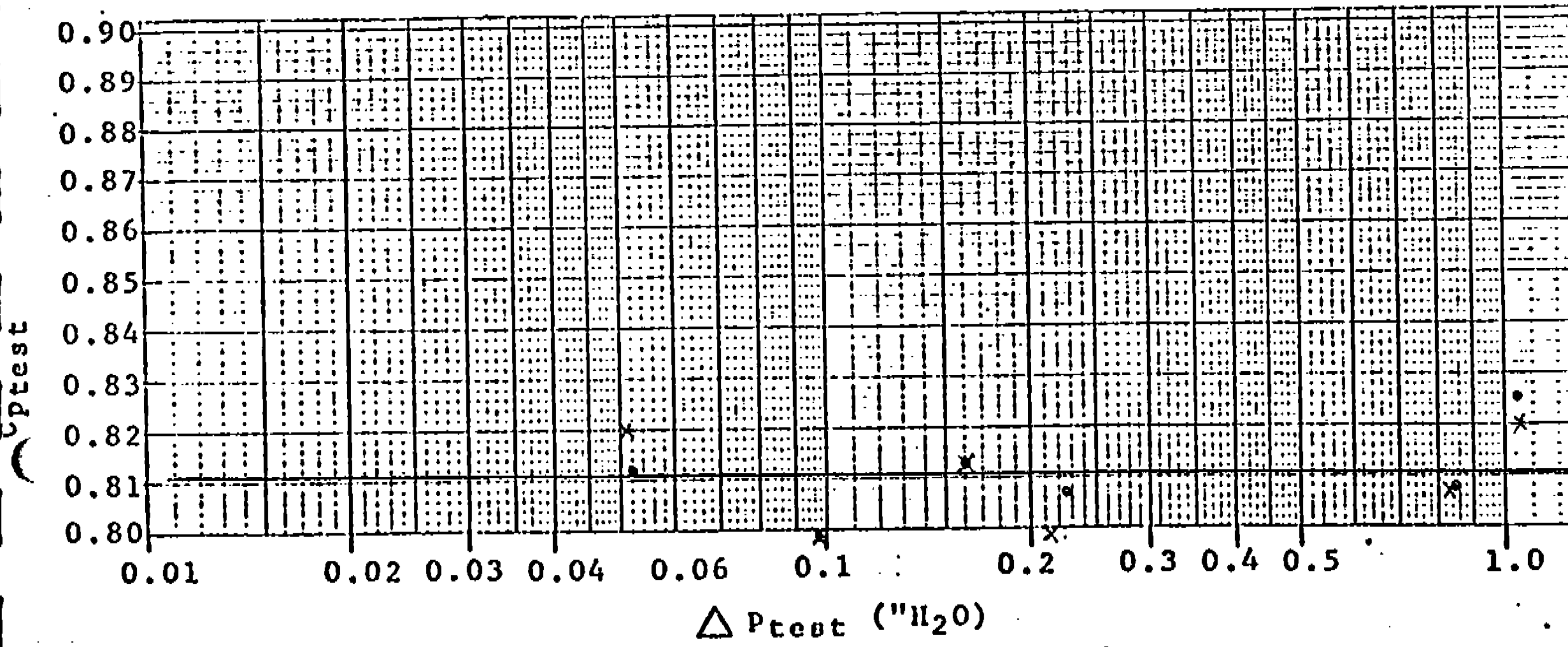
$$C_{p_{test}} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$$

Pitot Tube Type S Pitot Tube No. 10

Standard Pitot Tube No. ______

Calibrator: 9HPA Date: 11/25/71 Client: EPA TAST 20

Anticipated ΔP_{std}	ΔP_{std}	A • ΔP_{test}	A • $\Delta C_{p_{test}}$	B X ΔP_{test}	B X $\Delta C_{p_{test}}$
0.02	0.	0.	0.	0.	0.
0.04	0.035	0.052	0.812	0.051	0.820
0.06	0.062	0.097	0.791	0.096	0.796
0.08	0.	0.	0.	0.	0.
0.10	0.108	0.160	0.813	0.160	0.813
0.12	0.	0.	0.	0.	0.
0.16	0.150	0.226	0.807	0.230	0.799
0.20	0.	0.	0.	0.	0.
0.30	0.	0.	0.	0.	0.
0.50	0.552	0.828	0.808	0.830	0.807
0.70	0.708	~~0~~.020	0.825	~~0~~.032	0.820
0.80	0.	0.	0.	0.	0.



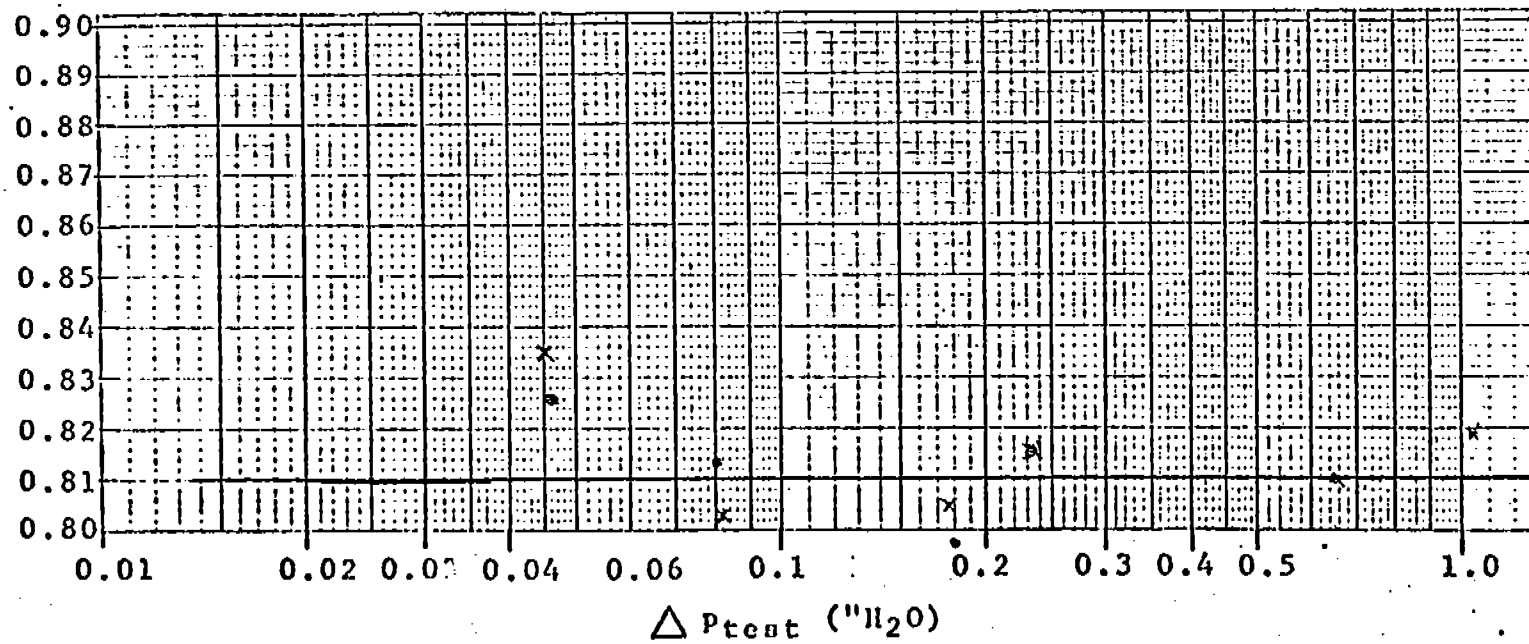
$$C_{p_{test}} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$$

Pitot Tube Type ___S___ Pitot Tube No. _12_

Standard Pitot Tube No. ________

Calibrator: _JHPA_ Date: _11/26/75_ Client: _EPA TASK 20_

Anticipated ΔP_{std}	ΔP_{std}	A • ΔP_{test}	A • $\Delta C_{p_{test}}$	B × ΔP_{test}	B × $\Delta C_{p_{test}}$
0.02	0.___	0.___	0.___	0.___	0.___
0.04	0.032	0.046	0.826	0.045	0.835
0.06	0.054	0.080	0.813	0.082	0.803
0.08	0.___	0.___	0.___	0.___	0.___
0.10	0.___	0.___	0.___	0.___	0.___
0.12	0.117	0.180	0.798	0.177	0.805
0.16	0.159	0.234	0.816	0.234	0.816
0.20	0.___	0.___	0.___	0.___	0.___
0.30	0.___	0.___	0.___	0.___	0.___
0.50	0.436	0.652	0.810	0.652	0.810
0.70	0.694	~~0~~.014	0.819	~~0~~.014	0.819
0.80	0.___	0.___	0.___	0.___	0.___



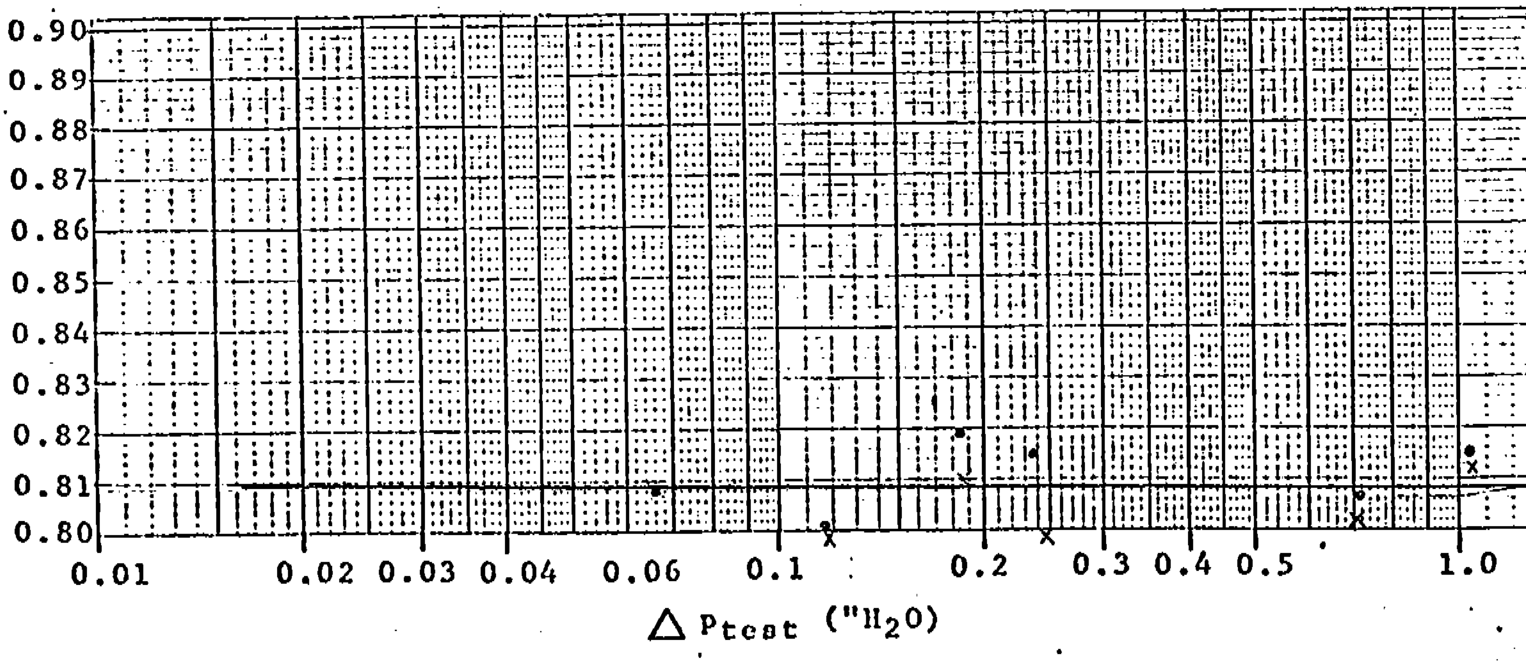
$C_{p_{test}} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$

Pitot Tube Type 5 Pitot Tube No. 17

Standard Pitot Tube No. ______

Calibrator: [illegible] Date: 11/25/75 Client: EPA TASK 20

Anticipated ΔP_{std}	ΔP_{std}	A • ΔP_{test}	A • $\Delta C_{p_{test}}$	B X ΔP_{test}	B X $\Delta C_{p_{test}}$
0.02	0.	0.	0.	0.	0.
0.04	0.044	0.066	0.808	0.066	0.808
0.06	0.	0.	0.	0.	0.
0.08	0.076	0.116	0.801	0.118	0.794
0.10	0.	0.	0.	0.	0.
0.12	0.126	0.184	0.819	0.188	0.810
0.16	0.160	0.236	0.815	0.246	0.798
0.20	0.	0.	0.	0.	0.
0.30	0.	0.	0.	0.	0.
0.50	0.474	0.714	0.807	0.712	0.802
0.70	0.702	1.036	0.815	1.041	0.813
0.80	0.	0.	0.	0.	0.



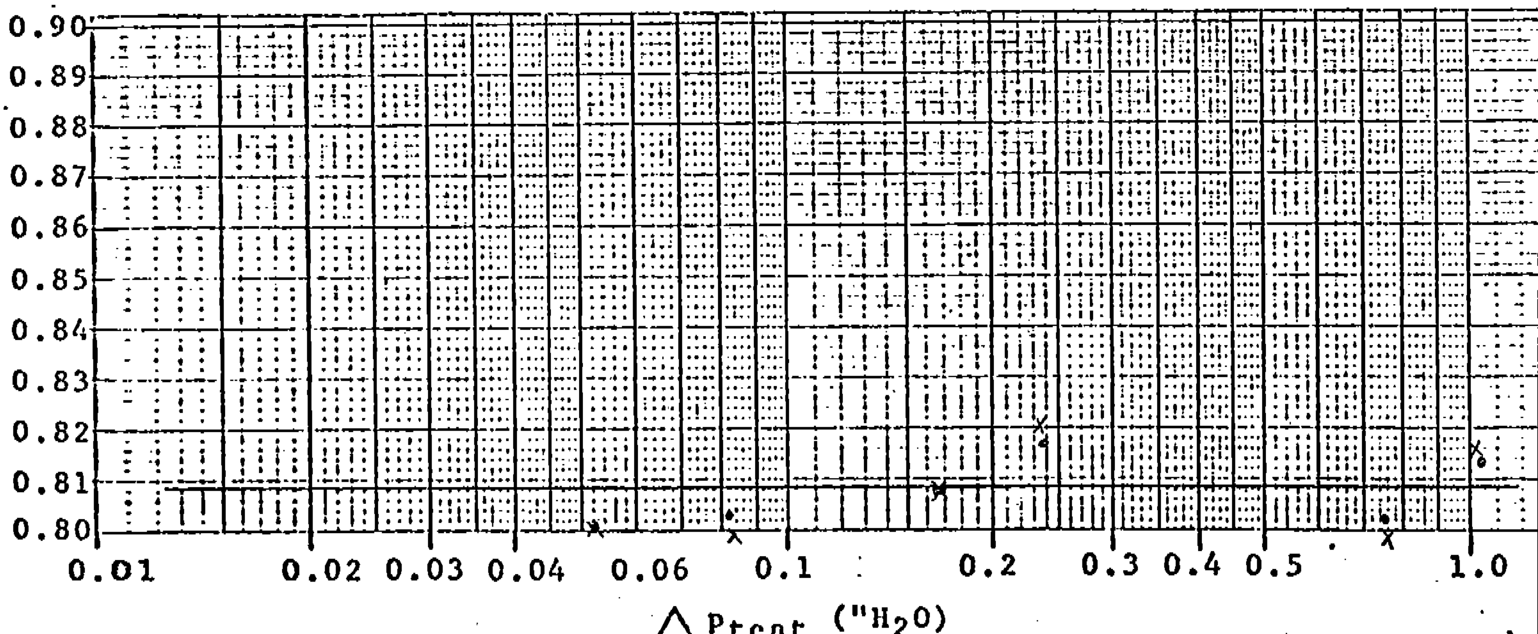
$$C_{p_{test}} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$$

Pitot Tube Type *S* Pitot Tube No. *19*

Standard Pitot Tube No. ____________

Calibrator: *[illegible]* Date: *11/25/75* Client: *EPA TASK 20*

Anticipated ΔP_{std}	ΔP_{std}	A		B	
		ΔP_{test}	$\Delta C_{p_{test}}$	ΔP_{test}	$\Delta C_{p_{test}}$
0.02	0.____	0.____	0.____	0.____	0.____
0.04	0.*034*	0.*052*	0.*801*	0.*052*	0.*801*
0.06	0.*054*	0.*082*	0.*803*	0.*08[illegible]*	0.*799*
0.08	0.____	0.____	0.____	0.____	0.____
0.10	0.*112*	0.*168*	0.*808*	0.*168*	0.*808*
0.12	0.____	0.____	0.____	0.____	0.____
0.16	0.*162*	0.*238*	0.*817*	0.*236*	0.*820*
0.20	0.____	0.____	0.____	0.____	0.____
0.30	0.____	0.____	0.____	0.____	0.____
0.50	0.*494*	0.*753*	0.*802*	0.*765*	0.*796*
0.70	0.*681*	~~0~~.*0[illegible]*	0.*813*	~~0~~.*002*	0.*816*
0.80	0.____	0.____	0.____	0.____	0.____



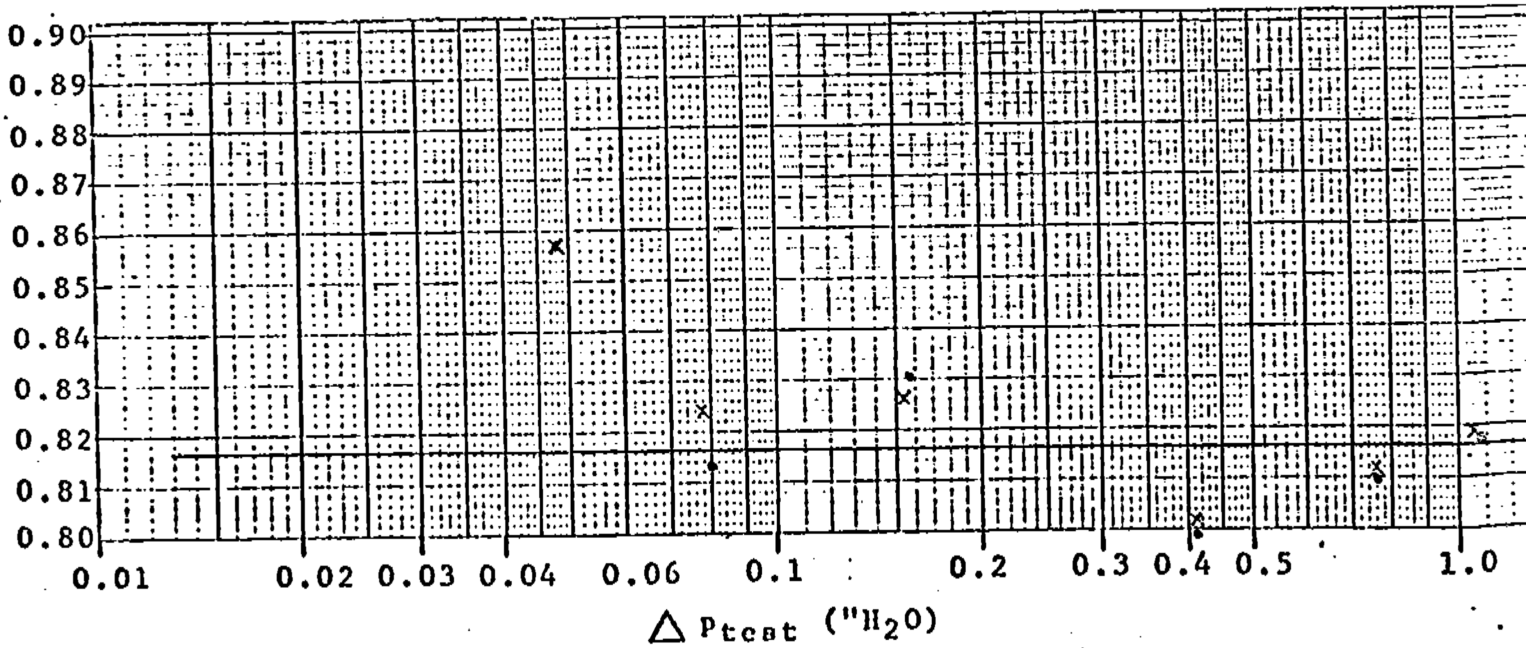
$C_{p_{test}} = 0.99 \sqrt{\dfrac{\Delta P_{std}}{\Delta P_{test}}}$

Pitot Tube Type 5 Pitot Tube No. 22

Standard Pitot Tube No. ______

Calibrator: [illegible] Date: 11/25/75 Client: EPA TASK 20

Anticipated ΔP_{std}	ΔP_{std}	A ●		B ×	
		ΔP_{test}	$\Delta C_{p_{test}}$	ΔP_{test}	$\Delta C_{p_{test}}$
0.02	0.___	0.___	0.___	0.___	0.___
0.04	0.036	0.048	0.857	0.048	0.857
0.06	0.054	0.080	0.813	0.078	0.824
0.08	0.___	0.___	0.___	0.___	0.___
0.10	0.___	0.___	0.___	0.___	0.___
0.12	0.110	0.156	0.831	0.158	0.826
0.16	0.___	0.___	0.___	0.___	0.___
0.20	0.___	0.___	0.___	0.___	0.___
0.30	0.272	0.418	0.799	0.414	0.802
0.50	0.510	0.762	0.810	0.759	0.812
0.70	0.722	~~0~~1.060	0.817	~~0~~1.054	0.819
0.80	0.___	0.___	0.___	0.___	0.___



Date 11/25/75

B[redacted]met[redacted]c P[redacted]su[redacted] Pb [redacted]"Hg [redacted] 29[redacted]5[redacted] Calibrator [redacted] GEL [redacted] Gas [redacted] Meter [redacted] Number [redacted]

RAC#1

FROM EPA TASK #20

	Orifice Manometer Setting, Δm (in. H_2O)	Gas Volume Wet Test Meter V_w (ft^3)	Gas Volume Dry Gas Meter V_d (ft^3)	Temperature: Wet Test Meter t_w (°F)	Temperature: Dry Gas Meter Inlet t_{di} (°F)	Temperature: Dry Gas Meter Outlet t_{do} (°F)	Temperature: Dry Gas Meter Average t_d (°F)	Vacuum Wet Test Meter p_w (in. H_2O)	Time θ (min)	γ	K_m
Stop	0.5	2860.00	023.108		86	80	83				
Start		2855.00	017.958	72	88	80	84		12.80	0.991	0.1293
Average		(5) 5.00	5.150	72	87	80	84	.10	12.48		
Stop	1.0	2865.00	028.254	70	88	80	84				
Start		2860.00	023.108	72	86	80	83	.10	9.32		0.1257
Average		(5) 5.00	5.146	71	87	80	84		9.19	0.993	
Stop	2.0	2875.00	038.516	71	90	84	87				
Start		2865.00	028.254	70	88	80	84	.12	13.30	0.998	0.1247
Average		(10) 10.00	10.262	70	98	82	86		13.18		
Stop	3.0	2885.00	048.774	71	92	84	91				
Start		2875.00	038.516	71	90	84	87	.12	11.00	1.000	0.1230
Average		(10) 10.00	10.258	71	91	84	89		11.00		
Stop	4.0	2895.00	059.036		94	84	89				
Start		2885.00	048.774	71	92	84	91	.15	9.65	0.999	0.1214
Average		(10) 10.00	10.262	71	93	84	90		9.39		
Stop	5.0	2905.00	069.273		94	84	89				
Start		2895.00	059.036	70	94	84	89	.15	8.68	0.999	0.1208
Average		(10) 10.00	10.237	70	94	84	89		8.41		
									AVERAGE	0.997	0.1242

$P_w = P_b - \frac{p_w}{13.6}$ 29.14 $\quad P_d = P_b + \frac{\Delta m}{13.6} \quad K_m = \frac{V_w}{\theta}\sqrt{\frac{P_w}{T_w \Delta m}}$

$\gamma = \frac{V_w P_w (t_d + 460)}{V_d P_d (t_w + 460)}$

Factor in isokinetic equation $= \frac{27.40}{(K_m)^2} = \frac{27.40}{(0.1242)^2} =$ 1776

G.D. Clayton & Associates

Date [illegible] Client

Barometri[redacted] P[redacted]su[redacted] Pb [redacted] Hg) [redacted] [redacted] [redacted] [redacted] [redacted]ibr[redacted]or [redacted] Ga[redacted]et[redacted]Nu[redacted] [redacted]

, FROM EPA TASK #20 Run #2

	Orifice Manometer Setting, Δm (in. H_2O)	Gas Volume Wet Test Meter V_w (ft^3)	Gas Volume Dry Gas Meter V_d (ft^3)	Temperature: Wet Test Meter t_w (°F)	Temperature: Dry Gas Meter Inlet t_{di} (°F)	Temperature: Dry Gas Meter Outlet t_{do} (°F)	Temperature: Dry Gas Meter Average t_d (°F)	Vacuum Wet Test Meter P_w (in. H_2O)	Time θ (min)	γ	K_m
Stop	0.5	2915.00	852.616	70	84	76	80				
Start		2910.00	847.500	70	80	70	75	.10	12.77 12.46	0.990	0.1301
Average		(5) 5.00	5.116	70	82	73	78				
Stop	1.0	2920.00	857.750	70	88	80	84				
Start		2915.00	852.616	70	84	76	80	.10	9.18 9.11	0.993	0.1280
Average		(5) 5.00	5.134	70	86	78	82				
Stop	2.0	2930.00	868.088	69	94	78	86				
Start		2920.00	857.750	70	88	80	84	.10	13.20 13.12	0.989	0.1258
Average		(10) 10.00	10.338	70	91	79	85				
Stop	3.0	2940.00	878.452		96	80	88				
Start		2930.00	868.088	69	94	78	86	.10	10.88 10.53	0.990	0.1248
Average		(10) 10.00	10.364	69	95	79	87				
Stop	4.0	2950.00	888.824		98	84	91				
Start		2940.00	878.452	69	96	80	88	.12	9.47 9.28	0.992	0.1242
Average		(10) 10.00	10.372	69	97	82	90				
Stop	5.0	2960.00	899.212		100	86	93				
Start		2950.00	888.824	69	98	84	91	.12	8.52 8.31	0.992	0.1234
Average		(10) 10.00	10.388	69	99	85	92				
									AVERAGE	0.991	0.1260

$P_w = P_b - \frac{P_w}{13.6}$ 29.25 $\quad P_d = P_b + \frac{\Delta m}{13.6} \quad K_m = \frac{V_w}{\theta}\sqrt{\frac{P_w}{T_w \Delta m}}$

$\gamma = \frac{V_w P_w (t_d + 460)}{V_d P_d (t_w + 460)}$

Factor in isokinetic equation $= \frac{27.40}{(K_m)^2} = \frac{27.40}{(0.1260)^2} = 1726$

G.D. Clayton & Associates

Date 11/18/75 [redacted]
Barometric Pressure [redacted] ("Hg) [redacted] Ca[redacted]bra[redacted] [redacted]E/1[redacted]as [redacted]te[redacted]umb[redacted]

RM #3

FROM EPA #20

	Orifice Manometer Setting, Δm (in. H_2O)	Gas Volume Wet Test Meter V_w (ft^3)	Gas Volume Dry Gas Meter V_d (ft^3)	Temperature: Wet Test Meter t_w (°F)	Temperature: Dry Gas Meter Inlet t_{di} (°F)	Temperature: Dry Gas Meter Outlet t_{do} (°F)	Temperature: Dry Gas Meter Average t_d (°F)	Vacuum Wet Test Meter P_w (in. H_2O)	Time θ (min)	γ	K_m
Stop	0.5	2805.00	531.213	71°	80	76°	78°				
Start		2800.00	526.140	71°	76°	76°	76°		12.58	0.992	0.1317
Average		(5) 5.00	5.073	71	78	76	77	.10	12.35		
Stop	1.0	2810.00	536.312	71°	88	80	84°				
Start		2805.00	531.213	70°	80	76	78°		9.28	0.998	0.1263
Average		(5) 5.00	5.099	70	84	78	81	.10	9.17		
Stop	2.0	2820.00	546.573	72	96	84	90°				
Start		2810.00	536.312	71°	88	80	84°	.12	13.25	0.996	0.1249
Average		(10) 10.00	10.261	72	92	82	87		13.15		
Stop	3.0	2830.00	556.883	71	98	84	91				
Start		2820.00	546.573	72	96	84	90°	.15	10.83	0.995	0.1248
Average		(10) 10.00	10.310	72	97	84	90		10.50		
Stop	4.0	2840.00	567.228	71°	102	88	95				
Start		2830.00	556.883	71°	98	84	91	.15	9.52	0.996	0.1230
Average		(10) 10.00	10.345	71	100	86	93		9.31		
Stop	5.0	2850.00	577.573	71°	102	88	95				
Start		2840.00	567.228	71°	102	88	95	.20	8.52	0.997	0.1230
Average		(10) 10.00	10.345	71	102	88	95		8.31		
									AVERAGE	0.996	0.1256

$P_w = P_b - \frac{P_w}{13.6}$ 29.14 $\quad P_d = P_b + \frac{\Delta m}{13.6}$ $\quad K_m = \frac{V_w}{\theta}\sqrt{\frac{P_w}{T_w \Delta m}}$

$\gamma = \frac{V_w P_w (t_d + 460)}{V_d P_d (t_w + 460)}$ $\quad$ Factor in isokinetic equation $= \frac{27.40}{(K_m)^2} = \frac{27.40}{(0.1256)^2} = 1737$

G.D. Clayton & Associates

Date 11/26/[redacted] Client [redacted]

Barometric Pressure Pb ("Hg) 29.45 [redacted] Calibrator [illegible] [redacted]as [redacted]te[redacted]umb[redacted]

MAC 5

FROM EPA #20

	Orifice Manometer Setting, Δm (in. H_2O)	Gas Volume Wet Test Meter V_w (ft^3)	Gas Volume Dry Gas Meter V_d (ft^3)	Temperature: Wet Test Meter t_w (°F)	Temperature: Dry Gas Meter Inlet t_{di} (°F)	Temperature: Dry Gas Meter Outlet t_{do} (°F)	Temperature: Dry Gas Meter Average t_d (°F)	Vacuum Wet Test Meter P_w (in. H_2O)	Time θ (min)	γ	K_m
Stop	0.5	3015.00	439.828		74	74	74		12.58	1.040	0.1322
Start		3010.00	435.000	72	78°	74°	76°	.10	12.35		
Average	29.49	(5) 5.00	4.828	72	76	74	75	29.44			
Stop	1.0	3020.00	444.634		74	74	74		9.08	1.041	0.1295
Start		3015.00	439.828	72	74	74	74	.10	9.05		
Average	29.52	(5) 5.00	4.806	72	74	74	74	29.44			
Stop	2.0	3030.00	454.108		74	74	74		12.82	1.054	0.1298
Start		3020.00	444.634	72	74	74	74	.10	12.49		
Average	29.60	(10) 10.00	9.474	72	74	74	74	29.44			
Stop	3.0	3040.00	463.485		76	74	75		10.35	1.062	0.1312
Start		3030.00	454.108	72	74	74	74	.12	10.21		
Average	29.67	(10) 10.00	9.377	72	75	74	74	29.44			
Stop	4.0	3050.00	472.775		78	74	76		8.88	1.074	0.1324
Start		3040.00	463.485	72	76	74	75	.15	8.53		
Average	29.74	(10) 10.00	9.290	72	77	74	76	29.44			
Stop	5.0	3060.00	482.985		78°	74	76		7.95	0.974	0.1323
Start		3050.00	472.775	72	78	74	76	.20	7.57		
Average	29.82	(10) 10.00	10.210	72	[illegible]	74	76	29.44			
									AVERAGE	1.041	0.1312

$$P_w = P_b - \frac{P_w}{13.6} \qquad P_d = P_b + \frac{\Delta m}{13.6} \qquad K_m = \frac{V_w}{\theta}\sqrt{\frac{P_w}{T_w\,\Delta m}}$$

$$\gamma = \frac{V_w\,P_w\,(t_d + 460)}{V_d\,P_d\,(t_w + 460)}$$

Factor in isokinetic equation $= \frac{27.40}{(K_m)^2} = \frac{27.40}{(0.1312)^2} = 1592$

G.D. Clayton & Associates

APPENDIX I

EXAMPLE CALCULATIONS

Nomenclature

A_s = Stack area, $inches^2$

C_f = Front half (probe & filter) particulate concentration, gr/DSCF

C_p = Pitot tube correction factor, dimensionless

C_t = Total particulate concentration, gr/DSCF

CM_f = Front half (probe & filter) particulate concentration, mg/DNm^3

CM_t = Total particulate concentration, mg/DNm^3

D_n = Sampling nozzle diameter, inches

ER_f = Emission rate of front half particulate, lb/hr

ER_t = Emission rate of total particulate, lb/hr

ERM_f = Emission rate of front half particulate, kg/hr

ERM_t = Emission rate of total particulate, kg/hr

M_d = Mole fraction of dry gas, g/g-mole

MW = Molecular weight of wet stack gas

MW_d = Molecular weight of dry stack gas

P_b = Barometric pressure, inches mercury

P_m = Average orifice pressure drop, inches water

P_s = Absolute stack gas pressure, inches mercury

P_{st} = Static pressure of stack gas, inches mercury

Q_s = Dry stack gas flowrate at standard conditions, DSCFM

SW_f = Front half sample weight, mg

SW_t = Total sample weight, mg

T_m = Average meter temperature, °F

T_s = Stack temperature, °F

T_t = Net time of test, minutes

V_m = Volume of dry gas at meter conditions, ft^3

$V_{m_{std}}$ = Volume of dry gas at standard conditions, DSCF

V_s = Stack gas velocity at stack conditions, fpm

V_w = Total condensate collected in sampling train, ml

$V_{w_{gas}}$ = Volume of water vapor at standard conditions, SCF

ΔP_s = Velocity pressure, inches water

%I = Percent of isokinetic variation, dimensionless

%M = Percent moisture, dimensionless

Calculation of Particulate Emissions

The dry volume of sampled gas corrected to standard conditions of 20°C and 760 mm Hg (29.92 in. Hg) is calculated as follows:

$$V_{m_{std}} = \frac{17.65 * V_m * \left(P_b + \frac{P_m}{13.6}\right)}{T_m + 460}$$

The sampled volume for the first particulate test taken on the No. 3 Kiln Precipitator Outlet at the Empire Mining Company is:

$$V_{m_{std}} = \frac{17.65\ (59.268)\left(28.84 + \frac{1.4}{13.6}\right)}{(64 + 460)}$$

$$= 57.780$$

The dry stack gas flowrate corrected to standard conditions is calculated using the following set of equations sequentially:

$$V_{w_{gas}} = 0.0471 * V_w$$

$$\%M = \frac{100 * V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}}$$

$$M_d = \frac{100 - \%M}{100}$$

$$MW_d = (\%CO_2 * 44/100) + (\%O_2 * 32/100) + \left[(\%CO + \%N_2)*28/100\right]$$

$$MW = (MW_d * M_d) + 18(1 - M_d)$$

$$P_s = P_b + P_{st}$$

$$V_s = 5120.8 * C_p * \sqrt{\Delta P_s * (T_s + 460)} * \sqrt{\frac{1}{P_s * MW}}$$

$$Q_s = \frac{0.1225 * V_s * A_s * M_d * P_s}{(T_s + 460)}$$

The calculations for determining the flowrate for the first particulate test on the No. 3 Kiln Electrostatic Precipitator Outlet follow. This sampling location has a 147-inch interior diameter.

$$V_{w_{gas}} = 0.0471\ (222)$$

$$= 10.456$$

$$\%M = \frac{100 * 10.456}{57.780 + 10.456}$$

$$= 15.32$$

$$M_d = \frac{100 - 15.32}{100}$$

$$= 0.8468$$

$$MW_d = (1.7 * 44/100) + (15.7 * 32/100) + \left[(0 + 82.6)*28/100\right]$$

$$= 28.90$$

$$MW = (28.90 * 0.8468) + 18(1 - 0.8468)$$

$$= 27.23$$

$$P_s = 28.84 - 0.03$$

$$= 28.81$$

$$V_s = 5120.8\ (0.824)(18.121) \sqrt{\frac{1}{28.81\ (27.23)}}$$

$$= 2729.9$$

$$Q_s = \frac{0.1225\ (2729.9)(16{,}972)(0.8468)(28.81)}{(230 + 460)}$$

$$= 201{,}000$$

The equation employed to determine percent of isokinetic variation is:

$$\%I = \frac{1032 * (T_s + 460) * V_{m_{std}}}{V_s * T_t * P_s * M_d * (D_n)^2}$$

For the first particulate test taken at the No. 3 Kiln Electrostatic Precipitator Outlet,

$$\%I = \frac{1032\ (230 + 460)(57.780)}{(2729.9)(96)(28.81)(0.8468)(0.249)^2}$$

$$= 103.8$$

To determine the concentration of particulate matter in grains per dry standard cubic foot (gr/DSCF), one of the following equations is used:

$$C_f = 0.01543 * \frac{SW_f}{V_{m_{std}}} \quad \text{and}$$

$$C_t = 0.01543 * \frac{SW_t}{V_{m_{std}}} \quad .$$

When metric units are desired, the concentration is calculated in milligrams per dry normal cubic meter (mg/DNm^3) as follows:

$$CM_f = \frac{SW_f}{(0.02832)(V_{m_{std}})} \quad \text{and}$$

$$CM_t = \frac{SW_t}{(0.02832)(V_{m_{std}})} \quad .$$

Front half particulate concentrations are obtained by summing the weight of particulate matter collected on the filter and all portions of the train preceding it. Total particulate concentration includes, in addition, any particulate matter collected in the impingers.

The first particulate test taken at the No. 3 Kiln Electrostatic Precipitator Outlet yielded the following concentrations of filterable and total particulate:

$$C_f = 0.01543 * \frac{7.7}{57.8}$$

$$= 0.00206$$

$$C_t = 0.01543 * \frac{38.7}{57.8}$$

$$= 0.01033$$

$$CM_f = \frac{7.7}{(0.02832)(57.8)}$$

$$= 4.70$$

$$CM_t = \frac{38.7}{(0.02832)(57.8)}$$

$$= 23.64$$

The emission rate of particulate matter can be calculated from the filterable or total particulate concentration using one of the following equations:

$$ER_f = 0.00857 * C_f * Q_s \quad \text{and}$$

$$ER_t = 0.00857 * C_t * Q_s \quad .$$

For metric units,

$$ERM_f = (1.70 * 10^{-6}) * CM_f * Q_s \quad \text{and}$$

$$ERM_t = (1.70 * 10^{-6}) * CM_t * Q_s \quad .$$

To avoid rounding errors it is preferable to carry out the calculation of concentration and emission rate in one operation.

The emission rates of front half and total particulate matter for the first test taken at the No. 3 Kiln Electrostatic Precipitator Outlet are calculated as follows:

$$ER_f = 0.00857\ (0.00206)(201{,}000)$$
$$= 3.5$$

$$ER_t = 0.00857\ (0.01033)(201{,}000)$$
$$= 17.8$$

$$ERM_f = (1.70 * 10^{-6})(4.70)(201{,}000)$$
$$= 1.6$$

$$ERM_t = (1.70 * 10^{-6})(23.64)(201{,}000)$$
$$= 8.1$$

Particle Size Distribution Calculations

At Empire Mining Company, particle size distribution samples were collected by two methods. The first method, used at the inlet to the No. 3 Kiln Electrostatic Precipitator, utilized the Brink Cascade Impactor. In order to calculate the cut-off points for each stage as well as the distribution of particulate matter collected, the computer program published by the Office of Research and Development, U.S. EPA, in Particle Sizing Techniques for Control Device Evaluation was used. Input to this program includes the following:

PO = Gas pressure at impactor inlet, in. Hg

DP = Pressure drop across the impactor, in. Hg

T = Temperature of the impactor, °F

RHO = Particle density, gm/cc

DUR = Duration of impactor sampling, min

DMAX = Maximum diameter of material collected, μ

ACFM = Actual flowrate through the impactor, cfm.

In addition, the composition of the exhaust gas and the weight gain for each stage are read in.

For particle size test 1-A on the No. 3 Kiln Electrostatic Precipitator Inlet,

PO = 27.3

DP = 4.1

T = 210

RHO = 4.3

DUR = 30

DMAX = 100

ACFM = 0.096

The cut-offs for each stage and the distribution of the particulate matter that resulted from the use of the program are shown in Table IX.

The second method of collecting particle size distribution samples utilized the Andersen Stack Sampler. A sample volume was calculated similar to that of a particulate test and expressed in cubic feet at 70°F and 29.92 inches of mercury. The sample volume was then divided by the test duration, yielding a flowrate through the Andersen Sampler expressed in cubic feet per minute (cfm) for each test.

Figure I-1 is a plot of D_p' versus flowrate (cubic feet per minute) through the Andersen Sampler at 70°F. D_p' is the effective aerodynamic diameter of a spherical, unit density particle.

Figure I-2 shows the correction factor for determining the physical diameter of spherical particles having other than unit density. The effective aerodynamic diameter as determined from Figure I-1 is multiplied by the correction factor from Figure I-2 to determine the physical diameter for that density.

Figure I-3 shows the correction factor for determining the effective aerodynamic particle diameter for elevated temperatures. The effective aerodynamic diameter as determined from Figure I-1 is multiplied by the correction factor from Figure I-3 to determine the diameter for that temperature.

The quantities collected on each stage and on the final filter are each expressed as a percentage of the total amount recovered. A cumulative percentage smaller than the characteristic particle diameter (D_p) is then calculated for each stage.

The Andersen Stack Sampler was used at the outlet to the No. 3 Kiln Electrostatic Precipitator at Empire Mining Company. For the first particle size sample at this location, the flowrate through the sampler at 70°F was 0.93 cfm and the stack temperature averaged 215°F. The particle density was determined by laboratory analysis to be 4.3 gm/cc.

D_p' was determined for each stage from Figure I-1. From Figures I-2 and I-3 the correction factors for density and stack temperature were found to be 0.50 and 1.105, respectively. The characteristic diameter for each stage was then found by the following equation:

$$D_p = D_p' (0.50)(1.105).$$

The characteristic diameters for the various stages of this first test were:

	D'_p	D_p
Stage 0	10.0	5.5
Stage 1	6.3	3.5
Stage 2	4.2	2.3
Stage 3	2.9	1.6
Stage 4	1.8	0.99
Stage 5	0.94	0.52
Stage 6	0.57	0.31
Stage 7	0.38	0.21

These characteristic diameters were combined with the results of the laboratory analysis of the weight gain for each stage and distributed as shown in Table XIV.

FIGURE I-1

AERODYNAMIC DIAMETER VERSUS FLOW RATE THROUGH ANDERSEN STACK SAMPLER

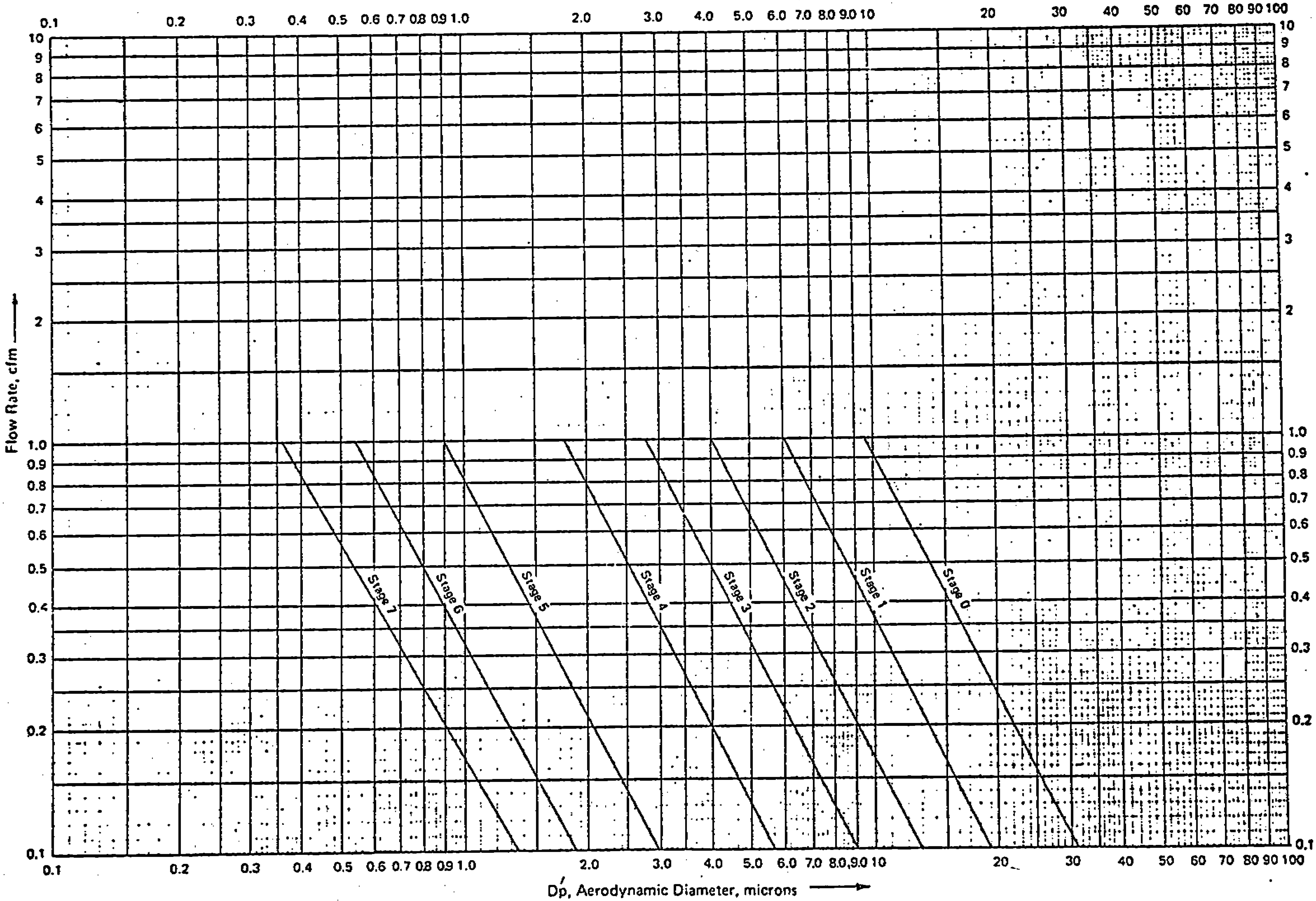


FIGURE I-2

DENSITY CORRECTION FACTOR FOR PHYSICAL SIZE OF PARTICLES CAPTURED IN ANDERSEN STACK SAMPLER

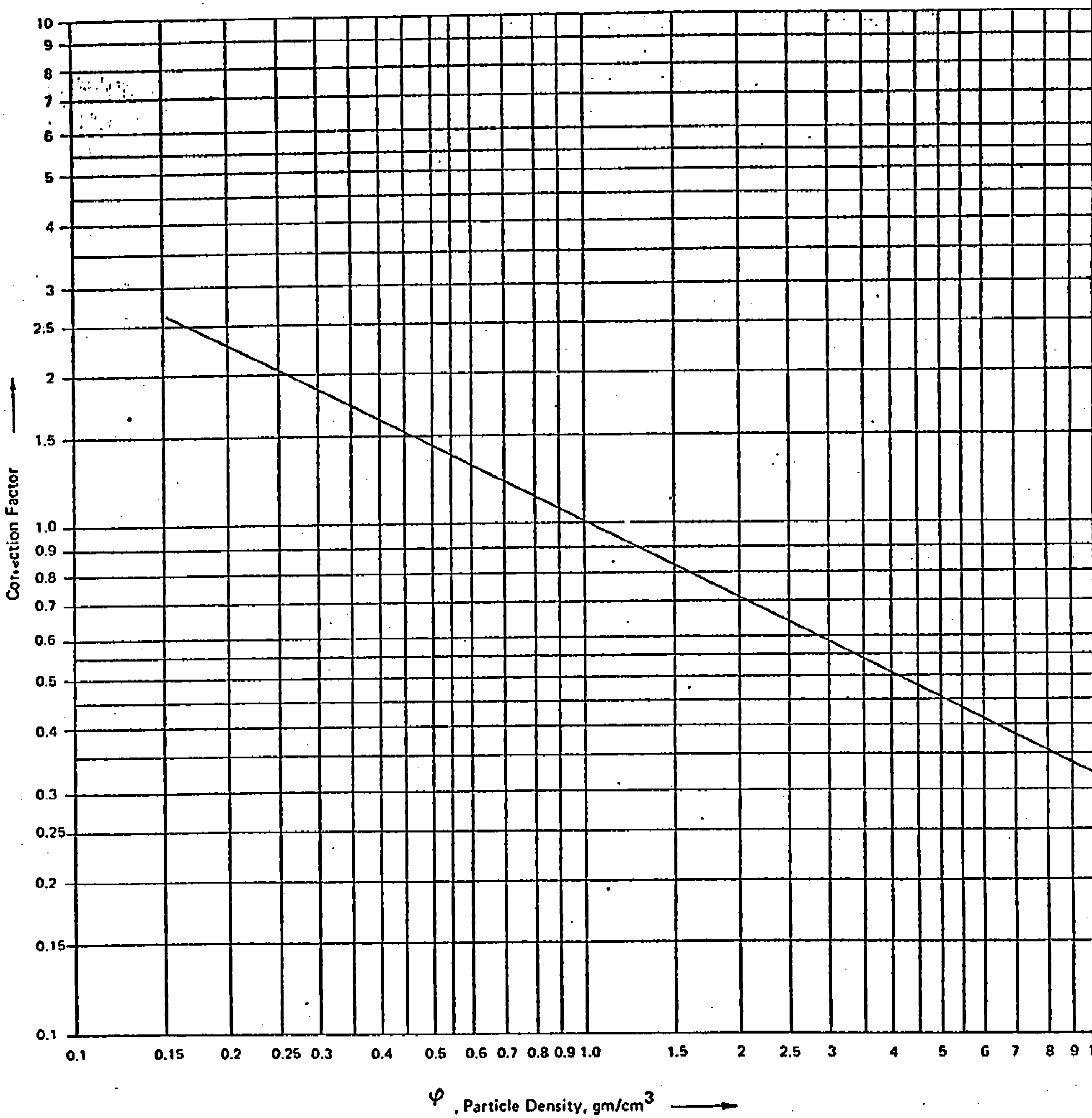


FIGURE I-3

TEMPERATURE CORRECTION FACTOR FOR AERODYNAMIC SIZE OF PARTICLES CAPTURED IN ANDERSEN STACK SAMPLER