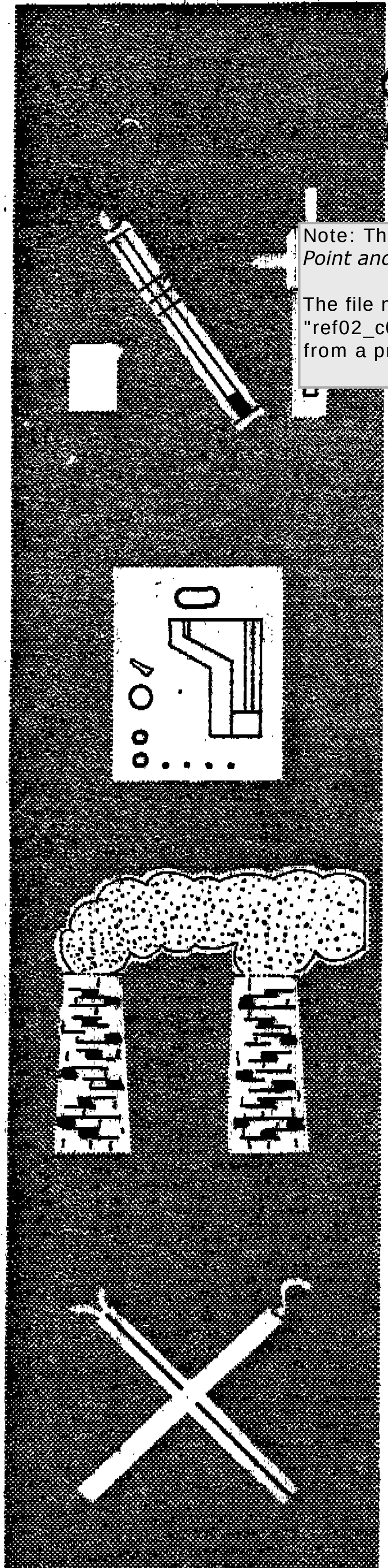
Part I

EPA PROJECT

AP-42 Section 11.6
Reference 16
Report Sect. 4
Reference 9

Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.



AIR POLLUTION EMISSION TEST

ARIZONA PORTLAND CEMENT

Rillito, Arizona

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Emission Measurement Branch
Research Triangle Park, North Carolina

Source category:	Portland Cement	Date:	01/15/93
Plant name :	Arizona Portland Cement	Location:	Rillito, AZ
Test date :	6/4 - 6/12/74	Ref. No.:	9
Process :	N/A	Basis for process rate :	feed

Source	Type of control	Pollutant	Run No.	Emission rate, lb/hr	Process rate, ton/hr	Emission factor		Volumetric flow rate, DSCFM	Co p
						kg/Mg	lb/ton		
primary limestone crushing	fabric filter	filt. PM	1	0.77	978	0.000394	0.000787		
		filt. PM	2	0.9	994	0.000453	0.000905		
		filt. PM	3	0.96	1,028	0.000467	0.000934		
		filt. PM	4	1.4	1,010	0.000693	0.00139		
					average	0.000502	0.00100	Rating:	B
		con. inorg. PM	1	0.08	978	4.09E-05	8.18E-05		
		con. inorg. PM	2	(a)	994	(a)	(a)		
		con. inorg. PM	3	0.17	1,028	8.27E-05	0.000165		
		con. inorg. PM	4	0.22	1,010	0.000109	0.000218		
					average	7.75E-05	1.55E-04	Rating:	B
primary limestone screening	fabric filter	filt. PM	1	0.17	967	8.79E-05	0.000176		
		filt. PM	2	0.22	965	0.000114	0.000228		
		filt. PM	3	0.23	1,023	0.000112	0.000225		
		filt. PM	4	0.27	1,056	0.000128	0.000256		
					average	0.000111	0.000221	Rating:	C
		con. inorg. PM	1	0.02	967	1.03E-05	2.07E-05		
		con. inorg. PM	2	(a)	965	(a)	(a)		
		con. inorg. PM	3	0.06	1,023	2.93E-05	5.87E-05		
		con. inorg. PM	4	0.12	1,056	5.68E-05	1.14E-04		
					average	3.22E-05	6.43E-05	Rating:	C
primary limestone transfer (conveying)	fabric filter	filt. PM	1	0.0155	909	8.53E-06	1.71E-05		
		filt. PM	2	0.0266	914	1.46E-05	2.91E-05		
		filt. PM	3	0.0356	873	2.04E-05	4.08E-05		
					average	1.45E-05	2.90E-05	Rating:	B
		con. inorg. PM	1	(a)	909	(a)	(a)		
		con. inorg. PM	2	0.0046	914	2.52E-06	5.03E-06		
		con. inorg. PM	3	0.0089	873	5.10E-06	1.02E-05		
					average	3.81E-06	7.61E-06	Rating:	B
secondary limestone screening & crushing	fabric filter	filt. PM	1	0.0287	170	8.44E-05	1.69E-04		
		filt. PM	2	0.056	162	0.000173	0.000346		
		filt. PM	3	0.0618	152	0.000203	0.000407		
					average	0.000154	0.000307	Rating:	B
		con. inorg. PM	1	0.0088	170	2.59E-05	5.18E-05		
		con. inorg. PM	2	0.0253	162	7.81E-05	1.56E-04		
		con. inorg. PM	3	(a)	152	(a)	(a)		
					average	5.20E-05	1.04E-04	Rating:	B

Notes: 1. (a) Impinger water discarded.

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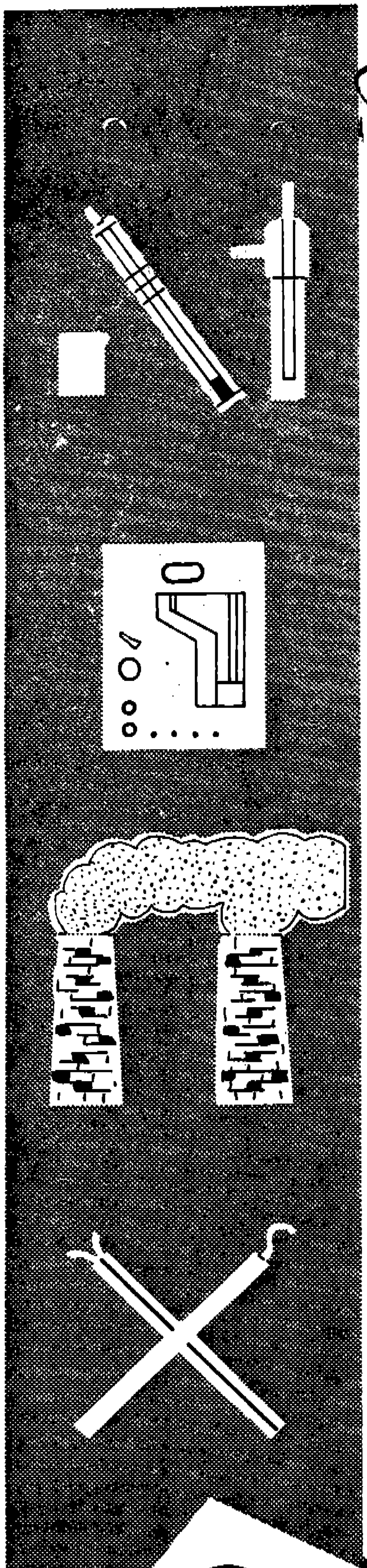
Part I



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PREFACE

The work reported herein was conducted by Valentine, Fisher & Tomlinson Consulting Engineers (VF&T), pursuant to Task Order No. 16 issued by the Environmental Protection Agency (EPA), under the terms of EPA Contract No. 68-02-0236. Mr. Wesley D. Snowden served as the contractor Project Engineer and directed the VF&T field sampling participation as well as the sample analyses performed at the VF&T laboratories.

Mr. Clyde Riley, Office of Air Quality Planning and Standards, Emission Measurement Branch, served as Project Officer and was responsible for coordinating the performance program.

Mr. Alfred E. Vervaert, Office of Air Quality Planning and Standards, Industrial Studies Branch, served as Project Engineer and was responsible for monitoring process operations.

VF&T submitted a draft document to EPA from which EPA personnel prepared this final report (74-STN-1).

Note: Mention of trade names or commercial products in this publication does not constitute endorsement or recommendation for use by the Environmental Protection Agency.

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I. INTRODUCTION

In accordance with Section 111 of the Clean Air Act of 1970, the Environmental Protection Agency is charged with the responsibility of developing standards of performance for emissions from new stationary sources which may contribute significantly to air pollution. A standard of performance developed under the Act for emissions of air pollutants must be based on the best emission reduction systems that have been adequately demonstrated, taking into account economic considerations.

The development of standards of performance utilizes emissions data for pollutant sources in the particular industry being studied. In the stone crushing industry, the emission control systems (baghouses) of the Arizona Portland Cement Company, Rillito, Arizona, were selected by EPA for an emission testing program to provide a portion of the data base to be used for developing "best technology" and for developing emission standards for stone crushing operations. This report presents the results of the testing performed during the weeks of June 2, 1974, and June 9, 1974.

The Arizona Portland Cement Company crushes and processes limestone for the manufacturing of cement. The limestone is taken from an on-site open quarry and processed through several crushing and screening steps prior to entering the kiln. Except for the original trucking of the raw materials from the quarry, the materials are handled by an automated system of enclosed conveyor belts and process buildings. This is an extremely well-controlled stone crushing operation with particulate (dust) control systems throughout. These control systems consist of Mikropul* pulse jet baghouses located at the primary crusher, primary screen, conveyor transfer points, and secondary screening and crushing plant.

A total of fourteen particulate tests using EPA Method 5 were conducted to determine outlet emissions from each of the four baghouses. These consisted of four tests at the primary crusher, four tests at the primary screen, and three tests at the No. 2 overland conveyor transfer point and three tests at the secondary screen and crushing plant. Eight particle size determinations were performed on the outlet stream from the primary crusher discharge and five particle size determinations were performed on the inlet to the primary screen baghouse. All tests were conducted using a Brinks Cascade* impactor modified for in-stack collection. In addition, to compliment the particle size data, samples of captured dust were collected from the primary crusher and secondary screen and crusher plant baghouses for subsequent analysis by a centrifugal classifier.

Visible emission readings were recorded at the exhaust of each of the four baghouses mentioned above. Also five test runs using experimental high-volume sampling equipment were conducted at the primary screen baghouse exhaust to determine the comparability of the equipment to EPA Method 5 equipment. The operational and emission data gathered during these five runs are treated as an experimental effort and are not to be used as data to support new source standards of performance.

*Mention of a specific company or product does not constitute endorsement by EPA.

The VF&T field team arrived at the plant on June 3, 1974, and performed a series of velocity traverses on the exhaust stack of the primary crusher and primary screen baghouses. Preliminary tests and measurements were completed by June 4, 1974, and formal test runs on these sources were conducted on June 4, 5, 10, 11, 12, and 13. The remaining test runs were conducted at the No. 2 conveyor transfer site and at the secondary screen and crushing plant on June 6, 7, 8, 10, 11, and 12.

Many of the runs were discontinuous due to process delays and shutdowns encountered throughout the test program. As indicated in Appendix F (Sampling Log), a two- or three-day sampling period was required for each of the particulate runs conducted, except for the three runs at the secondary plant and runs 2 and 3 at the conveyor transfer site. This was due to the process delays and the fact that the plant only operated approximately six hours each day. Also, the extremely low concentration of emissions forced an unusually long sampling time (400 minutes) to collect a sample which would permit an accurate analysis.

All particulate samples were returned to the VF&T Laboratories in Seattle, Washington, for analysis. Particle size analyses were performed on the collected baghouse dust by EPA at its Research Triangle Park Laboratories.

The following sections of this report cover the summary of results, process description and operation, sampling point locations, and test procedures.

II. SUMMARY OF RESULTS

A summary of the test results for the gas flows and particulate results relative to each of the baghouse outlets is presented in Table 1.

Primary Crusher

The results of the particulate analysis of the samples collected at the primary crusher for each of the four test runs are presented in Table 2. Included are pertinent data concerning sample volume and test conditions. Averaging the results of the four runs indicates an average concentration of particulate matter in the probe and filter catch of 0.00514 grains per dry standard cubic foot. The corresponding average emission rate was measured as 1.01 pounds per hour. The average concentration and emission rate based on the total catch is not reported because the impinger water samples were inadvertently discarded after the chloroform-ether extraction analysis.

The first test run at the primary crusher was above the desired maximum of 110 percent isokinetic condition, so a fourth test run was performed. The emission rates (pounds per hour) for this high isokinetic run were determined by averaging the results of two independent calculating procedures - the concentration method and the area-ratio method. Additional information concerning the particulate testing at the primary crusher baghouse is presented in Section VI, "Test Procedures", and Tables A-I and A-II of the Appendices.

TABLE 1
SUMMARY OF PARTICULATE EMISSIONS

	Primary Crusher (Average for Four Runs)	Primary Screen (Average for Four Runs)		Primary Transfer Conveyor (Average for Three Runs)	Secondary Screen and Crusher (Average for Three Runs)
Method	EPA-5	EPA-5	Hi-Volume	EPA-5	EPA-5
Gas Flow					
Standard Cubic Feet/Minute, Dry	22,615	13,361	12,421	1,935	9,214
Actual Cubic Feet/Minute, Wet	26,856	15,779	14,656	2,346	10,532
Particulate (Probe and Filter)					
Grains/SCF, Dry[1]	0.00514	0.00179	0.00132	0.00155	0.00062
Grains/ACF, Stack Conditions[2]	0.00432	0.00151	0.00112	0.00128	0.00054
Pounds/Hour	1.01	0.22[5]	0.14	0.03	0.05
Pounds/Ton[3]	0.00101	0.00022	0.0014	0.00003	0.00031
Particulates (Total Catch)[4]					
Grains/SCF, Dry	---	---	---	---	---
Grains/ACF, Stack Conditions	---	---	---	---	---
Pounds/Hour	---	---	---	---	---
Pounds/Ton	---	---	---	---	---

1 Grains per Dry Standard Cubic Foot, Standard Conditions of 70°F, 29.92 in. Hg.

2 Grains per Actual Cubic Foot, Stack Conditions

3 Based on Raw Materials Entering Primary Crusher

4 Average Data Not Presented Due to Impinger Water Being Erroneously Discarded

5 Calculated by Averaging the Concentration and Area Ratio Results

TABLE 2
SUMMARY OF TEST RESULTS
PRIMARY CRUSHER

Run Number	1	2	3	4
Date	6-4-74	6-10-74	6-11-74	6-12-74
Volume of Gas Sampled - DSCF[a]	286.20	245.71	186.74	141.82
Percent Moisture by Volume	2.4	2.5	3.0	3.3
Average Stack Temperature - °F	79.0	81.0	88.0	88.0
Stack Volumetric Flow Rate - DSCFM[b]	23,469	22,351	22,140	22,502
Stack Volumetric Flow Rate - ACFM[c]	27,198	26,430	26,653	27.142
Percent Isokinetic	114.3	109.1	104.7	104.3
Percent Excess Air	---	---	---	---
Percent Opacity	0	0	0	0
Feed Rate - ton/hr	978.0	994.0	1028.0	1010.0
Particulates - probe, and filter catch				
mg	66.06	75.13	61.13	66.91
gr/DSCF	0.00355	0.00471	0.00504	0.00727
gr/ACF	0.00307	0.00398	0.00419	0.00602
lb/hr	0.77[d]	0.90	0.96	1.40
lb/ton feed	0.00079	0.00091	0.00093	0.00139
Particulates - total catch				
mg	72.61	e	72.34	77.25
gr/DSCF	0.00391	e	0.00597	0.00839
gr/ACF	0.00337	e	0.00495	0.00695
lb/hr	0.85[d]	e	1.13	1.62
lb/ton feed	0.00087	e	0.00110	0.00160
Percent impinger catch	9.0	e	15.5	13.4

[a] Dry standard cubic feet at 70°F, 29.92 in. Hg.

[b] Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.

[c] Actual cubic feet per minute

[d] Calculated by averaging the concentration and area ratio results

[e] Impinger water erroneously discarded

Primary Screen

Table 3 summarizes the results of the particulate sampling at the primary screen baghouse outlet. The average particulate concentration for the four test runs (based on the probe and filter catch) was 0.00179 grains per dry standard cubic foot, and the average emission rate was 0.22 pounds per hour. The primary screen test runs were affected by several operational problems. The runs were discontinuous due to process upsets and/or shutdowns. In addition, several other problems were encountered with malfunctions of the testing equipment. An incorrect metering orifice coefficient was used to determine the sampling conditions. This error resulted in sampling conditions that again exceeded the maximum of 110 percent isokinetic. The emission rates (pounds per hour) were therefore computed by the average of two methods - the concentration method and the area-ratio method. Additional information concerning the particulate testing at the primary screen baghouse is presented in Section VI, "Test Procedures", and Tables A-III and A-IV of the Appendices.

Primary Transfer Conveyor

Table 4 presents a summary of the results for the three particulate test runs at the No. 2 overland primary transfer conveyor baghouse outlet. The average particulate concentration for the probe and filter catch was 0.00155 grains per dry standard cubic foot, and the average emission rate was measured as 0.03 pounds per hour. The concentrations of particulate ranged from 0.00095 to 0.00207 grain per dry standard cubic foot. These variations in the particulate results can possibly

TABLE 3
SUMMARY OF TEST RESULTS
PRIMARY SCREEN

Run Number	1	2	3	4
Date	6-4-74	6-10-74	6-11-74	6-12-74
Volume of Gas Sampled - DSCF[a]	328.07	331.80	257.81	196.69
Percent Moisture by Volume	1.7	1.4	2.1	2.5
Average Stack Temperature - °F	82.0	90.0	90.0	94.0
Stack Volumetric Flow Rate - DSCFM[b]	13,636	13,368	13,246	13,196
Stack Volumetric Flow Rate - ACFM[c]	15,682	15,797	15,771	15,866
Percent Isokinetic	116.8	115.1	111.5	113.8
Percent Excess Air	---	---	---	---
Percent Opacity	0	0	0	0
Feed Rate - ton/hr	967.0	965.0	1023.0	1056.0
Particulates - probe, and filter catch				
mg	27.82	37.94	31.51	28.34
gr/DSCF	0.00131	0.00176	0.00188	0.00222
gr/ACF	0.00113	0.00149	0.00158	0.00184
lb/hr	0.17[d]	0.22[d]	0.23[d]	0.27[d]
lb/ton feed	0.00018	0.00023	0.00022	0.00026
Particulates - total catch				
mg	30.38	e	39.28	40.11
gr/DSCF	0.00143	e	0.00235	0.00314
gr/ACF	0.00124	e	0.00197	0.00261
lb/hr	0.19[d]	e	0.29[d]	0.39[d]
lb/ton feed	0.00020	e	0.00028	0.00037
Percent impinger catch	8.4	e	19.8	29.3

[a] Dry standard cubic feet at 70°F, 29.92 in. Hg.

[b] Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.

[c] Actual cubic feet per minute

[d] Calculated by averaging the concentration and area ratio results

[e] Impinger water erroneously discarded

TABLE 4
SUMMARY OF TEST RESULTS
PRIMARY TRANSFER CONVEYOR

Run Number	1	2	3
Date	6-10-74	6-11-74	6-12-74
Volume of Gas Sampled - DSCF[a]	273.32	223.12	231.50
Percent Moisture by Volume	2.4	2.4	2.3
Average Stack Temperature - °F	98.0	101.0	97.0
Stack Volumetric Flow Rate - DSCFM[b]	1,900.	1,902.	2,003.
Stack Volumetric Flow Rate - ACFM[c]	2,303.	2,313.	2,422.
Percent Isokinetic	105.9	107.9	106.3
Percent Excess Air	---	---	---
Percent Opacity	0	0	0
Feed Rate - ton/hr	909.0	914.0	873.0
Particulates - probe, and filter catch			
mg	16.83	23.54	31.14
gr/DSCF	0.00095	0.00162	0.00207
gr/ACF	0.00078	0.00134	0.00171
lb/hr	0.02	0.03	0.04
lb/ton feed	0.00002	0.00003	0.00004
Particulates - total catch			
mg	d	27.59	38.93
gr/DSCF	d	0.00190	0.00259
gr/ACF	d	0.00156	0.00214
lb/hr	d	0.03	0.04
lb/ton feed	d	0.00003	0.00005
Percent impinger catch	d	14.7	20.0

[a] Dry standard cubic feet at 70°F, 29.92 in. Hg.

[b] Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.

[c] Actual cubic feet per minute

[d] Impinger water erroneously discarded

be attributed to process production rates and/or the inaccuracies that accompany measurement of gas streams which have low concentration of particulate emission. Additional information concerning the particulate testing at the primary transfer conveyor baghouse outlet is presented in Section VI, "Test Procedures", and in Tables A-V and A-VI of the Appendices.

Secondary Screen and Crusher

The results of the particulate analysis of the samples collected at the secondary screen and crusher plant baghouse outlet are presented in Table 5. The average concentration of particulate matter (probe and filter catch) for the three runs was 0.00062 grains per dry standard cubic foot. The corresponding average emission rate was measured as 0.05 pounds per hour. The stack volumetric flow rates were reasonably uniform and the isokinetic sampling rates were within the specified tolerances. The variation between the particulate loadings can possibly be attributed to the process and flow variables encountered during the testing. Additional information concerning the particulate testing at the secondary screen and crusher plant baghouse outlet is presented in Section VI, "Test Procedures", and in Tables A-VII and A-VIII of the Appendices.

Particle Size

Particle size distribution tests were conducted on the baghouse inlet ducts of the primary crusher and the primary screen. Tests 1 through 5 were on the primary screening device and tests 6 through 13 were on the primary crusher. The test equipment consisted of a cutting

TABLE 5
SUMMARY OF TEST RESULTS
SECONDARY SCREEN AND CRUSHER

Run Number	1	2	3
Date	6-6-74	6-7-74	6-8-74
Volume of Gas Sampled - DSCF[a]	201.05	173.87	216.14
Percent Moisture by Volume	2.3	2.2	2.1
Average Stack Temperature - °F	81.0	77.0	80.0
Stack Volumetric Flow Rate - DSCFM[b]	9,277.	8,711.	9,656.
Stack Volumetric Flow Rate - ACFM[c]	10,579.	9,971.	11,045.
Percent Isokinetic	102.2	99.8	105.6
Percent Excess Air	---	---	---
Percent Opacity	0	0	0
Feed Rate - ton/hr	170.0	162.0	152.0
Particulates - probe, and filter catch			
mg	4.69	8.44	10.44
gr/DSCF	0.00036	0.00075	0.00074
gr/ACF	0.00031	0.00065	0.00065
lb/hr	0.03	0.06	0.06
lb/ton feed	0.00017	0.00034	0.00041
Particulates - total catch			
mg	6.12	12.25	d
gr/DSCF	0.00047	0.00109	d
gr/ACF	0.00041	0.00095	d
lb/hr	0.04	0.08	d
lb/ton feed	0.00022	0.00050	d
Percent impinger catch	23.4	31.1	d

[a] Dry standard cubic feet at 70°F, 29.92 in. Hg.

[b] Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.

[c] Actual cubic feet per minute

cyclone, a Brinks* Model B cascade impactor, and a back-up glass fiber filter. In addition, the cyclone catches from runs 7 through 9 were analyzed using a Bahco particle sizer. A summary of the test data is given in Tables 6, 7, and 8 and Figures 1 through 4. The test results are presented in the following three different forms.

1. Cumulative Mass Percent Less Than or Equal to Effective Particle Diameter - All stages with cyclone (Tables 6-7, Figure 1). This is the most widely used method for presenting particle size data. It is based on the mass percentage of total particulate collected on each stage.

2. Cumulative Mass Percent Less Than or Equal to Effective Particle Diameter - All stages excluding cyclone (Tables 6-7, Figure 2). The data is presented in this manner because the weight percentage collected in the cyclone often varies widely from test run to test run. This is especially true at a control device inlet. When working with the small amounts of mass collected by the cascade impactor, a few extremely large particles collected in the cyclone may make a large difference in weight percentage. Using a cumulative basis of data presentation, this variance in weight percentage in the cyclone is propagated to the lower stages. Therefore, eliminating the cyclone from the data reduction eliminates any bias introduced during data reduction due to the fact that some extremely large and heavy particles may have collected in the cyclone. A better correlation of the weight percentages on the stages would tend to indicate that some of the variance indicated when all five stages and the cyclone are plotted is

*Mention of a specific company or product does not constitute endorsement by EPA.

TABLE 6

PARTICLE SIZE
SUMMARY OF RESULTS - PRIMARY SCREEN

Collection Stage	Dp 50 Microns	Run 1	Run 2	Run 3*	Run 4	Run 5	Ave.	Cumulative Percent Less than Dp - Ave.
Cyclone	6.8	97.69	96.73	91.94	97.76	93.68	96.46	3.54
1	3.4	1.53	1.54	1.30	1.59	3.67	2.08	1.46
2	2.0	0.47	0.61	6.37	0.50	1.41	0.75	0.71
3	1.4	0.14	0.14	0.000	0.03	0.52	0.21	0.50
4	0.7	0.07	0.58	0.15	0.10	0.36	0.28	0.22
5	0.4	0.00	0.10	0.00	0.02	0.05	0.04	0.18
Filter	0.3	0.10	0.30	0.24	0.00	0.31	0.18	----

Results Omitting Cyclone

1	3.4	66.35	47.16	16.14	71.24	58.02	60.69	39.31
2	2.0	20.12	18.79	79.01	22.22	22.22	20.84	18.47
3	1.4	6.19	4.26	0.00	1.31	8.23	5.00	13.47
4	0.7	3.09	17.73	1.90	4.58	5.76	7.79	5.68
5	0.4	0.00	2.84	0.00	0.65	0.82	1.08	4.60
Filter	0.3	4.25	9.22	2.95	0.00	4.94	4.60	----

*Results not used in average values

TABLE 7

PARTICLE SIZE

SUMMARY OF RESULTS — PRIMARY CRUSHER

Collection Stage	Dp 50 Microns	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12*	Run 13*	Ave.	Cumulative Per cent Less than Dp - Avg.
Cyclone	6.8	97.23	97.43	97.55	97.31	98.46	98.22	97.65	98.94	97.70	2.30
1	3.4	2.20	2.13	1.92	2.12	1.05	1.29	1.78	0.77	1.79	0.51
2	2.0	0.41	0.33	0.35	0.49	0.29	0.37	0.49	0.21	0.37	0.14
3	1.4	0.09	0.06	0.07	0.03	0.07	0.06	0.06	0.03	0.06	0.08
4	0.7	0.03	0.00	0.02	0.01	0.03	0.03	0.01	0.01	0.02	0.06
5	0.4	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05
Filter	0.3	0.00	0.04	0.09	0.04	0.10	0.03	0.01	0.04	0.05	----

Results Omitting Cyclone

Collection Stage	Dp 50 Microns	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12*	Run 13*	Ave.	Cumulative Per cent Less than Dp - Avg.
1	3.4	79.26	82.85	78.34	78.79	68.10	72.09	75.88	72.48	76.57	23.43
2	2.0	14.88	12.66	14.44	18.27	19.01	20.71	20.80	19.42	16.66	6.77
3	1.4	3.34	2.29	2.92	1.05	4.46	3.63	2.35	3.20	2.95	3.82
4	0.7	1.17	0.00	0.80	0.37	1.82	1.65	0.53	0.80	0.97	2.85
5	0.4	1.34	0.18	0.00	0.00	0.00	0.18	0.00	0.40	0.28	2.57
Filter	0.3	0.00	2.02	3.50	1.52	6.61	1.74	0.44	3.70	2.57	----

*Results not used in average values.

III. PROCESS DESCRIPTION AND OPERATION

The Arizona Portland Cement Company installation at Rillito, Arizona, was extensively modernized in 1972. Included in the modernization was the construction of an entirely new raw material processing and handling system incorporating a new primary crushing and screening system, surge storage and blending facilities, a four-mile overland belt conveying system and a new secondary crushing and raw milling

TABLE 7

PARTICLE SIZE

SUMMARY OF RESULTS - PRIMARY CRUSHER

Collection Stage	Dp 50 Microns	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12*	Run 13*	Ave.	Cumulative Percent Less than Dp - Avg.
Cyclone	6.8	97.23	97.43	97.55	97.31	98.46	98.22	97.65	98.94	97.70	2.30
1	3.4	2.20	2.13	1.92	2.12	1.05	1.29	1.78	0.77	1.79	0.51
2	2.0	0.41	0.33	0.35	0.49	0.29	0.37	0.49	0.21	0.37	0.14
3	1.4	0.09	0.06	0.07	0.03	0.07	0.06	0.06	0.03	0.06	0.08
4	0.7	0.03	0.00	0.02	0.01	0.03	0.03	0.01	0.01	0.02	0.06
5	0.4	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05
Filter	0.3	0.00	0.04	0.09	0.04	0.10	0.03	0.01	0.04	0.05	----
Results Omitting Cyclone											
1	3.4	79.26	82.85	78.34	78.79	68.10	72.09	75.88	72.48	76.57	23.43
2	2.0	14.88	12.66	14.44	18.27	19.01	20.71	20.80	19.42	16.66	6.77
3	1.4	3.34	2.29	2.92	1.05	4.46	3.63	2.35	3.20	2.95	3.82
4	0.7	1.17	0.00	0.80	0.37	1.82	1.65	0.53	0.80	0.97	2.85
5	0.4	1.34	0.18	0.00	0.00	0.00	0.18	0.00	0.40	0.28	2.57
Filter	0.3	0.00	2.02	3.50	1.52	6.61	1.74	0.44	3.70	2.57	----

*Results not used in average values.

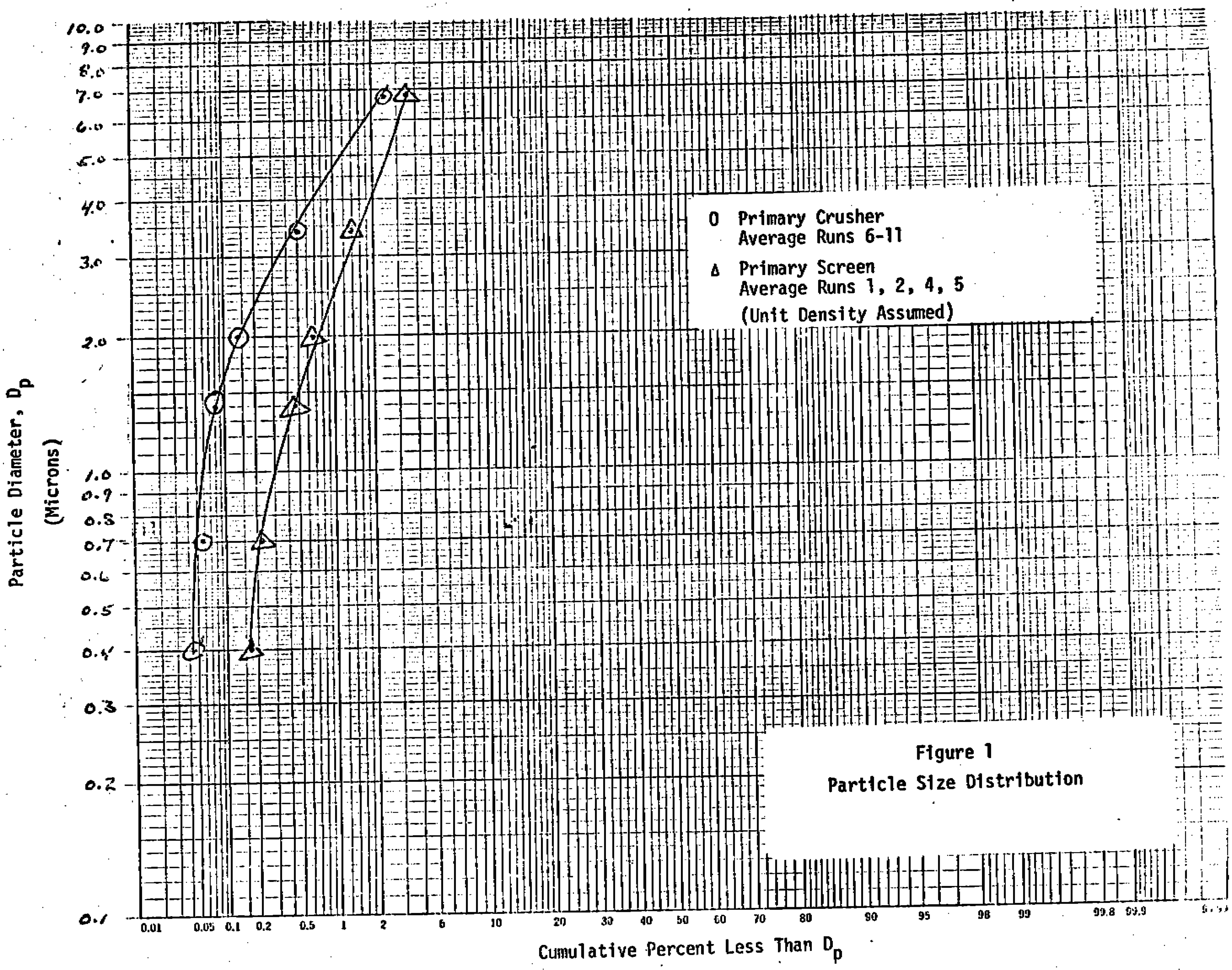


Figure 1
Particle Size Distribution

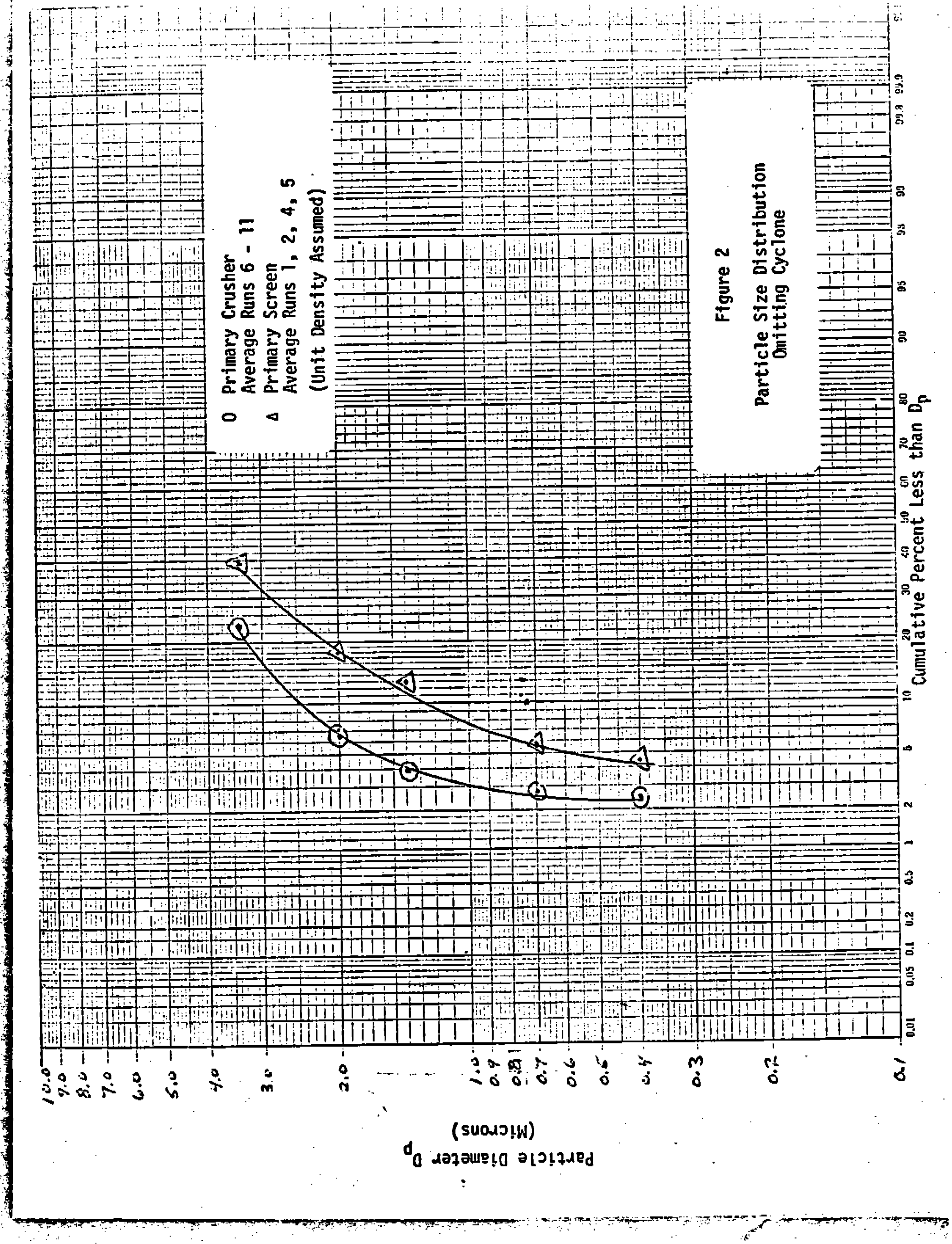


Figure 2
Particle Size Distribution
Omitting Cyclone

due to the bias introduced by abnormally large particles impacting in the cyclone. Therefore, the data is presented in this manner only to indicate whether or not a large amount of bias has been introduced due to abnormally large particles collecting in the cyclone.

3. Mass Loading as a Function of Effective Particle Size (Table 8, and Figure 3). Although particle size distribution data is usually presented in a cumulative percent form, in some cases this presents a biased view. This is because any error introduced either during sampling or analytical procedures on any single collection stage is propagated to the other stages by the nature of the data reduction. This is due to the fact that each data point is based on the total mass and consequently introduces error to every other data point. Presenting the data in the form of mass loading as a function of particle size permits the results of each size range to be computed independently of the other size ranges.

The dry particulate material from the cyclone catches of test runs 7 through 9 were combined to provide a sufficient sample for a Bahco particle size analysis. These results are illustrated in Figure 4.

Several problems concerning sampling and sample conditions were experienced during the particle size testing. On test run #3, the orifice of the second stage clogged with a small piece of gasket material. This invalidated the run; however, the results are reported but are not used to calculate the average values. During test run #12, the first stage was overloaded; therefore, the results are reported but are not used in the average values. For test runs #12 and #13 a large

TABLE 8

SUMMARY OF PARTICLE SIZE RESULTS
DIFFERENTIAL MASS LOADING BASIS
[dM/d Log D (gr/scf)]

PRIMARY SCREEN

Collection Stage	Run 1	Run 2	Run 3*	Run 4	Run 5	Avg.
Cyclone	19.16	6.87	7.86	3.69	2.22	7.99
1	1.87	0.69	0.83	0.38	0.55	0.87
2	0.75	0.36	4.64	0.15	0.27	0.38
3	0.32	0.11	0.000	0.013	0.14	0.15
4	0.094	0.28	0.091	0.026	0.058	0.11
5	0.000	0.060	0.000	0.005	0.011	0.019
Filter	0.022	0.024	0.025	0.000	0.008	0.029

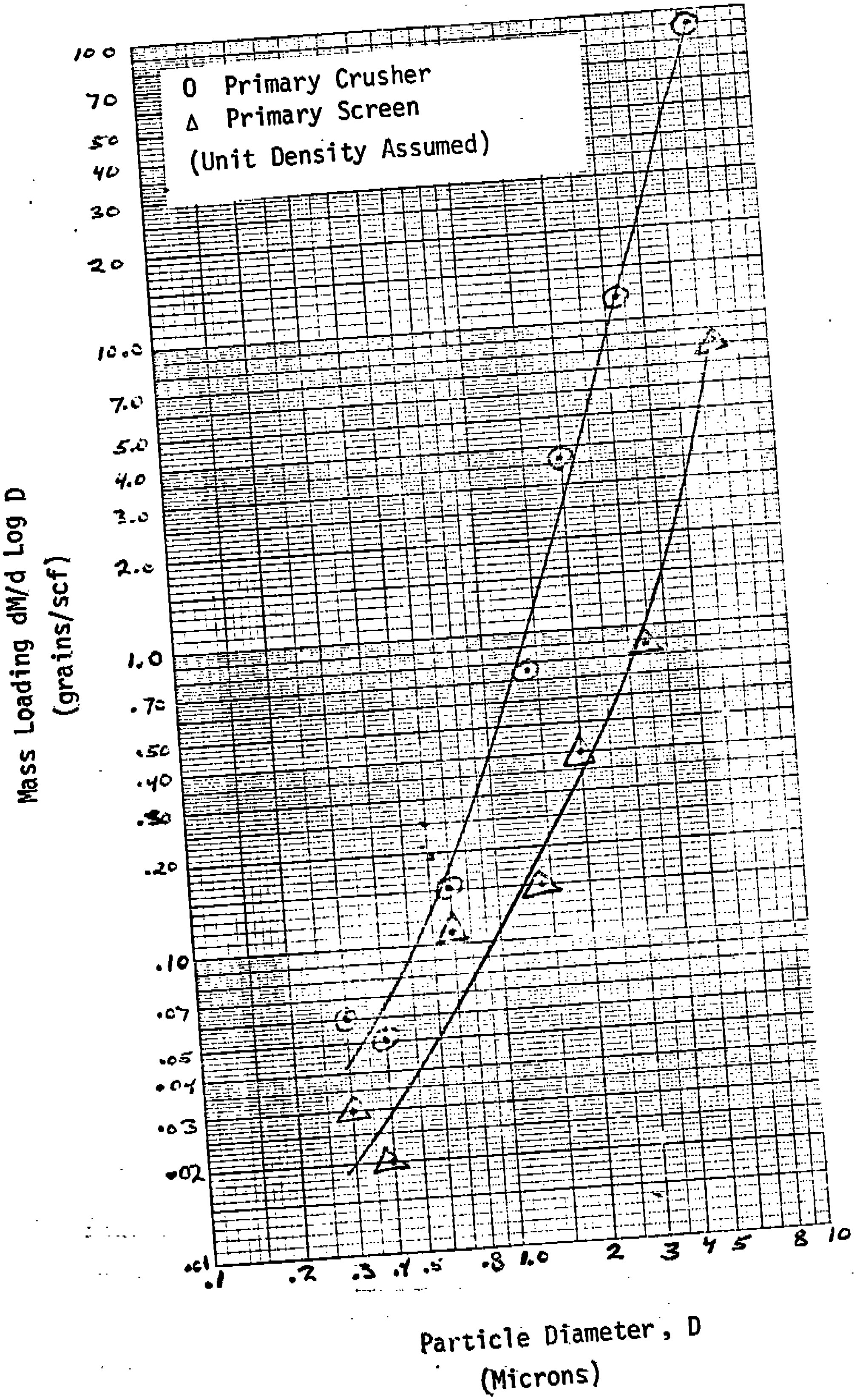
CRUSHER

	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12*	Run 13*	Avg.
Cyclone	66.76	78.89	94.94	126.97	67.53	191.09	484.93	272.45	90.12
1	9.50	10.80	11.75	17.40	4.51	15.72	55.36	13.39	11.61
2	2.32	2.17	2.83	5.27	1.64	5.90	19.82	4.67	3.36
3	0.72	0.54	0.79	0.42	0.53	1.43	3.10	1.07	0.74
4	0.15	0.000	0.13	0.087	0.13	0.39	0.41	0.16	0.15
5	0.23	0.033	0.000	0.00	0.000	0.058	0.000	0.11	0.053
Filter	0.000	0.048	0.09	0.060	0.079	0.068	0.057	0.12	0.058

* Results not used in average values.

Figure 3

Particle Size Distribution



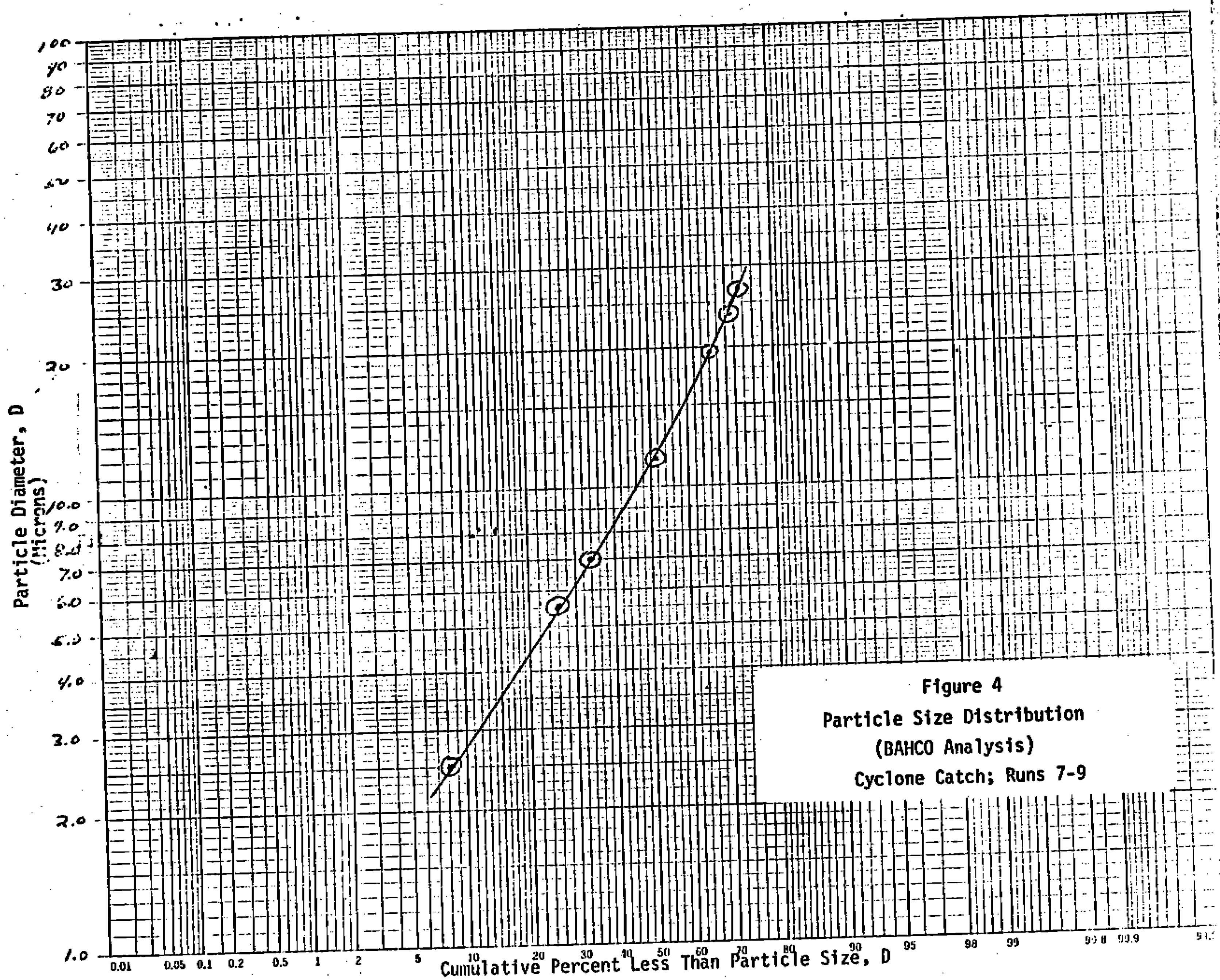


Figure 4
Particle Size Distribution
(BAHCO Analysis)
Cyclone Catch; Runs 7-9

diameter nozzle was used resulting in extreme under-isokinetic sampling. This was done intentionally for experimental purposes. These values are reported for comparison, but are not included in average values.

Eight representative samples of the captured baghouse dust were collected. A Bahco* centrifugal classifier was used by EPA laboratory personnel to determine the terminal velocity distribution of the samples. Graphical presentations of the data showing the percent (by weight) of those particles in the dust samples with terminal velocities less than various indicated values can be found in Appendix B.

Visible Emissions

The summary of visible emission test results for each of the 4-hour test periods are provided in Appendix C for the four processes evaluated. Opacity readings were recorded simultaneously by two certified observers for 15-second intervals during the particulate testing. At no time did either of the two observers note any visible emissions (all runs had zero opacity) from either of the four baghouse fan outlets. Additional information concerning visible emissions may be found in the "Test Procedures" section of this report. Visible emissions field data sheets are located in Appendix C.

High-Volume Sampling

The high-volume train used in these tests was developed within EPA and is still in the experimental stage.

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*Mention of a specific company or product does not constitute endorsement by EPA.

During the weeks of June 3 and June 10, 1974, five comparison tests were conducted between the Method 5 particulate train and an experimental high-volume sampler developed by the Emission Measurement Branch. The purpose of these tests was to try and establish the precision and accuracy of the high-volume train; i.e., whether or not it yields grain loadings consistent (from one run to the next) with those of a Method 5 train. The sampling location was the outlet duct from the baghouse serving the primary screening operation.

A comparison summary of the particulate analysis for the two sampling trains is presented in Table 9. The average particulate concentration for the probe and filter catch was 0.00132 grains per dry standard cubic foot, and the average emission rate was measured as 0.14 pounds per hour. The concentrations of particulate for the five runs ranged from 0.0010 to 0.0017 grains per dry standard cubic foot. The results from each of the individual high-volume runs compared favorably to EPA-5 test runs. The volumetric flow data showed a slight discrepancy between the measured results of the two trains. This can be explained by the fact that erroneous flow measurements were recorded during the first two EPA-5 test runs and, subsequently, averages were substituted for these data. Additional information concerning the high-volume sampling may be found in Appendix E.

TABLE 9

SUMMARY OF COMPARISON TEST

BETWEEN

HIGH VOLUME AND METHOD 5 SAMPLING

Dates	Run No.		Total Sampling Time		Percent Isokinetic		Particulate Grain Loading*	
	EPA 5	Hi-vol	EPA 5	Hi-vol	EPA 5	Hi-vol	EPA 5	Hi-vol
6/4-5/74	1	1	400	120	116.8	104.1	0.0013	0.0010
		2		120		99.8		0.0010
6/10-11/74	2	3	400	340	115.1	98.1	0.0018	0.0017
6/11-12/74	3	4	320	300	111.5	98.8	0.0019	0.0013
6/12-13/74	4	5	240	264	113.8	98.8	0.0022	0.0016

*Comparison between front half of EPA 5 and hi-vol; units are grains/dscf

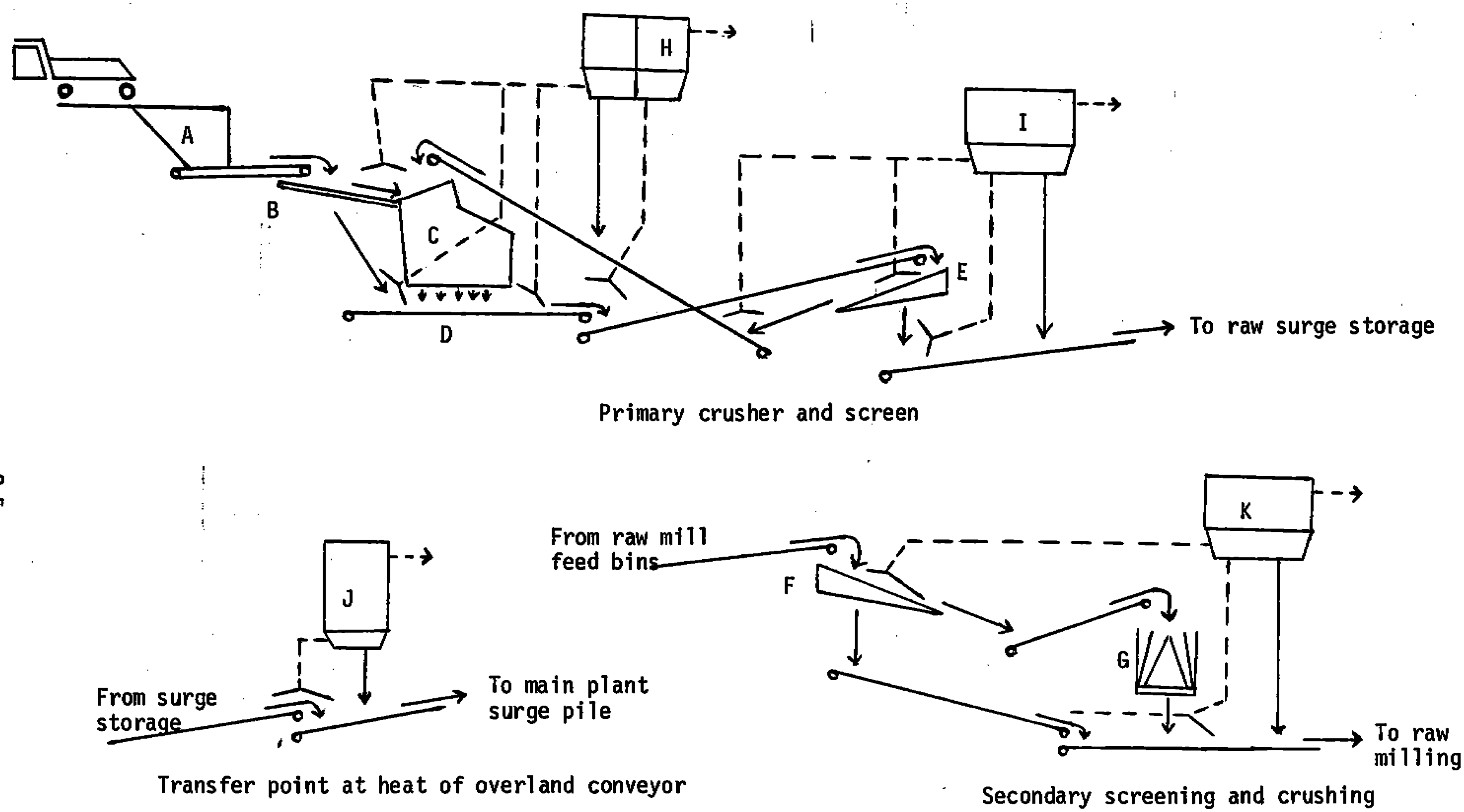
III. PROCESS DESCRIPTION AND OPERATION

The Arizona Portland Cement Company installation at Rillito, Arizona, was extensively modernized in 1972. Included in the modernization was the construction of an entirely new raw material processing and handling system incorporating a new primary crushing and screening system, surge storage and blending facilities, a four-mile overland belt conveying system and a new secondary crushing and raw milling circuit. In addition to production and energy considerations, air pollution control has been highly emphasized. Control systems for particulate emissions are evident throughout the plant.

Tests for particulate emissions were conducted on specific process operations which could be considered similar to those found in a typical crushed stone plant. These operations are illustrated in Figure 5 and consist of the primary crusher system, primary screens, secondary screening and crushing plant and a transfer point at the head of the overland conveyor.

Process Description

The quarry and closed-circuit primary crushing plant are located on a 100-acre site. Rock is blasted from narrow benches along a small mountainside and from a small pit. Type of rock quarried and processed consists primarily of limestone but is somewhat variable depending upon the quarry location from which it is extracted and raw material blending requirements. A rainbird watering system is used during excessively dry periods to wet the broken stone prior to loading to reduce fugitive dust emissions. The stone moisture is maintained at approximately 1.5 percent.



Legend

⟶	Rock Flow
---<	Ducting and pickup points
A	Pan feeder
B	Vibrating grizzly
C	Impact crusher
D	T-bar feeder
E.	Vibrating screen (primary)
F	Vibrating screen (secondary
G	Cone crusher
H	Baghouse
I	Baghouse
J	Baghouse
K	Baghouse

Figure 5. Process Flow Diagram

Seventy-five-ton capacity haul trucks are used to transport the broken stone to the primary plant (Figure 5). The stone is dumped onto a hoppered 84-inch pan feeder which feeds a 7 x 12-foot vibrating grizzly. Plus 2 1/2-inch material is fed to the primary crusher, a Hazemag-1000* impactor driven by a 1000-hp motor. A 60-inch T-bar belt feeder receives both the grizzly throughs and the crusher discharge and supplies a 42-inch enclosed belt conveyor which transports the stone out of the crusher building to an enclosed screening tower. The flow is discharged to an 8 x 18-foot screen from which plus 2 1/2-inch oversize is returned via a 30-inch enclosed conveyor to the primary crusher for recrushing. Screen throughs (2 1/2-inch minus) are transferred via a 42-inch conveyor to a 7,800-ton capacity raw surge storage building and are discharged to a shuttle belt which feeds 12 surge bins. A reclaim tunnel under the bins houses a battery of 12 Eriez* vibrating feeders which discharge to a 46-inch collecting/reclaim belt according to flow and raw blending requirements.

Material on the reclaim belt is transferred to a 30-inch accelerating transfer belt which transfers the flow to the first flight of a 30-inch covered overland conveyor. In this way, the flow from the reclaim belt is accelerated to the 700 fpm speed of the overland conveyor prior to being discharged to it. The overland conveyor transports about 900 tons of crushed stone per hour in two flights a distance of about four miles to a storage structure at the terminus, capable of housing two 30,000-ton linear piles.

*Mention of a specific company or product does not constitute endorsement by EPA.

Reclaimed material from the storage structure is transferred by 30-inch conveyor flights to a shuttle belt which feeds three of six 300-ton raw mill feed bins. The other three contain higher lime rock, iron oxide, and shale. The mix components are reclaimed and conveyed by a 30-inch collecting belt to the secondary crushing and screening building. Here the flow is discharged to a 5 x 10-foot screen from which oversize (plus 3/4-inch) is conveyed to an El-Jay 56 Rollerone* for secondary reduction. The crusher product and screen throughs (3/4-inch minus) are then conveyed directly to the raw mill circuit and subsequently reduced to kiln feed.

Emissions Control Systems

Dust emissions are controlled by hooding emission points and venting emissions via ducting to four baghouse units for collection. All hoods are designed for a capture velocity of not less than 200 fpm and ductwork sized for a conveying velocity of not less than 3,600 fpm. Specifications for each collector are summarized in Table 10.

The primary crusher system incorporates a pan feeder, vibrating grizzly, Hazemag* impact crusher, T-bar belt feeder, and primary belt conveyor. Emissions are collected at various points and vented to a Mikropul* pulse jet baghouse for collection. Collection points include (a) the top of the impact crusher (almost blanked off); (b) the grizzly throughs discharge chute; (c) the crusher discharge; and (d) the T-bar feeder to primary belt conveyor transfer.

Emissions from the primary screen are vented to a second Mikropul unit for collection. Dust emissions are collected at the top of the

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TABLE 10

DUST COLLECTOR SPECIFICATIONS

Collector Designation	Primary Crusher	Primary Screen	Conveyor Transfer	Secondary crusher & screen
Manufacturer	MikroPul	MikroPul	MikroPul	MikroPul
Type	Pulse Jet	Pulse Jet	Pulse Jet	Pulse Jet
Model	2G3-96	IF3-24	36S-8-30	1F3
Number of Bags	528	240	36	216
Bag Material	Polypropylene HCE	Polypropylene HCE	Polypropylene HCE	Polypropylene HCE
Capacity (c.f.m.)	26,856	15,779	2,346	10,532
Pressure Drop (in H_2O)	1.5	2.6	1.5	1.8
Filtering Ratio	5.4:1	7.0:1	6.9:1	5.2:1
Cloth Area, (sq. ft.)	4,973	2,262	339	2,036
Expected Efficiency	99.99	99.99	99.99	99.99
Fan Horsepower	75 @ 1800 rpm	40 @ 1800 rpm	7.5 @ 1800 rpm	40 @ 1800 rpm

totally enclosed screen and two conveyor transfer points where the oversize and screen throughs are discharged. A small baghouse unit effectively controls the No. 2 transfer point at the head of the overland conveyor.

A fourth unit services the secondary screening and crushing plant. Here, emissions are vented from the top of the screen enclosure and the cone crusher discharge. Fines collected by this unit, as well as the other three, are discharged by rotary feeders onto the belt leading to the next process step.

Process Operation

Tests were conducted to determine particulate emission levels during normal plant operation. Process conditions were carefully observed and tests performed only when facilities tested appeared to be operating normally. Operating data relevant to the operation of the process equipment and control units tested appear in Table 11 and Appendix G.

The rated capacity of the primary plant is 1000 tph. Throughput was determined by the number of truck dumps per hour. Each truck is assumed to carry 72 tons/load. The accuracy of this assumption should be within ±5 percent. It should be noted that this does not reflect the actual impactor throughput but the amount of material dumped, scalped, crushed, screened, and recrushed. No method was available to monitor the actual tonnage of rock crushed. The operation was closely monitored and tests conducted only when a minimum throughput of 900 tph was attained. The rocks processed varied between a high limestone rock (90% Ca and $MgCO_3$)

TABLE 11. PROCESS WEIGHT RATES

LOCATION	RUN	DATE	TIME BEGAN	TIME ENDED	ELAPSED TIME (MIN)	TONS	PROCESS WEIGHT (TPH)
1. Primary Crusher	1	6/4	0803	1447	259	4058	940
		6/5	0759	1020	141	2465	1049
					400	6523	978
	2	6/10	0822	1439	295	4987	1015
		6/11	0826	1011	105	1640	937
					400	6627	994
	3	6/11	1134	1435	136	2016	889
		6/12	0750	1109	184	3465	1130
					320	5481	1028
	4	6/12	1220	1434	120	2030	1015
		6/13	0755	1407	120	2010	1005
					240	4040	1010
2. Primary Screen	1	6/4	0839	1439	214	3448	966
		6/5	0754	1100	186	3001	968
					400	6449	967
	2	6/10	0827	1442	300	4867	973
		6/11	0828	1008	100	1570	942
					400	6437	965
	3	6/11	1117	1439	148	2280	924
		6/12	0755	1050	172	3175	1108
					320	5455	1023

TABLE 11. PROCESS WEIGHT RATES (Continued)

LOCATION	RUN	DATE	TIME BEGAN	TIME ENDED	ELAPSED TIME (MIN)	TONS	PROCESS WEIGHT (TPH)
	4	6/12	1220	1434	120	2155	1078
		6/13	0755	1407	120	2070	1035
					240	4225	1056
3. Conveyor Transfer	1	6/10	0913	1440	315	4750	905
		6/11	0746	0920	45	703	936
					360	5453	909
	2	6/11	0940	1442	288	4389	914
	3	6/12	0733	1237	288	4190	873
4. Secondary Screen and Crusher	1	6/6	1103	1635	320	906	170
	2	6/7	0727	1312	320	864	162
	3	6/8	0751	1331	320	810	152

and a low rock (70% carbonates - 10% silicates). The moisture content of the stone was very low averaging 0.62% and ranging from 0.16 to 1.22% during the testing at the primary plant.

Although designed to transport 900 tph, the overland conveyor currently handles only 800 tph under normal operating conditions. The amount of material passing the conveyor transfer point at the head of the conveyor is monitored by a load-cell belt scale upstream in the raw surge storage building. Testing at this point was conducted only when a minimum of 800 tph was being reclaimed and transferred to the overland conveyor.

The secondary screening and crushing plant is rated at about 185 tph. However, the plant is seldom operated in excess of 165 tph because its output is transported directly to a raw mill rated at 165 tph. The feed to the plant is monitored by a series of belt scales at the discharge of the raw mill feed bins and consists of the actual blended cement mix components. The amount of material processed through the plant ranged from a low of 150 to a high of 170 tph during the three test runs. Again, these figures do not reflect the amount of stone crushed by the secondary cone crusher but rather the amount of material processed through the secondary plant.

The pressure drop across each baghouse unit was monitored during each test run to assure proper operation. With the exception of an increase in the pressure drop across the baghouse unit servicing the secondary plant during the latter part of run 2, all units operated properly throughout the tests. Also, visual observations were constantly made at collection points throughout the test program. Essentially no visible dust emissions were observed with the exception of one location at the primary screen. Although not severe, puffs of dust were observed under the screen where "throughs" were discharged to a belt feeder.

IV. LOCATION OF SAMPLING POINTS

The outlet ducts on the primary crusher and primary screen operations were somewhat eliptical in shape. The dimensions referred to in the following are a representative average of the duct diameters.

Primary Crusher Baghouse

Particulate samples were collected on the baghouse outlet uuct serving the primary crusher. The two sampling ports were located 113 inches downstream from the 90° baghouse outlet, and 126 inches upstream from the 45° fan inlet. Two 4-inch I.D. sampling ports were welded to the 33 7/8 inch I.D. sloping duct at right angles to each other. The port locations did not meet the "eight diameters" criteria as outlined in EPA Method 1[a]; consequently, 20 sampling points were chosen according to method instructions for each traverse axis for a total of 40 sampling points. Figure 6 shows the sampling port locations and the dumensions of the outlet stack. Information concerning the particle size sampling locations can be found in Appendix B.

Primary Screen Baghouse

The primary screen 23 3/4 inch I.D. outlet duct was fitted with two 4-inch I.D. sampling ports in a manner similar to the primary crusher site. The downstream distance of 129 inches and the upstream distance of 147 inches again did not meet the Method 1 criteria; therefore a total of 30 sampling points were selected to satisfy the minimum number of traverse points. However, these were reduced to 20 points as specified

[a]EPA Standards of Performance for New Stationary Sources, Federal Register, Volume 36, No. 247, December 23, 1971.

in Method 1 (diameters less than 24 inches). The two high volume sampling ports were located 135 inches downstream of the above referenced EPA-5 test ports. Figure 7 shows duct dimensions and port locations. Information concerning the particle size sampling locations can be found in Appendix B.

Primary Screen Baghouse

The primary screen 23 3/4 inch I.D. outlet duct was fitted with two 4-inch I.D. sampling ports in a manner similar to the primary crusher site. The downstream distance of 129 inches and the upstream distance of 147 inches again did not meet the Method 1 criteria therefore, a total of 30 sampling points were selected to satisfy the minimum number of traverse points. However, these were reduced to 20 points as specified in Method 1 (diameters less than 24 inches). The two high volume sampling ports were located 135 inches downstream of the above referenced EPA-5 test ports. Figure 7 shows duct dimensions and port locations. Information concerning the particle size sampling locations can be found in Appendix B.

Primary Conveyor Transfer Baghouse

The primary conveyor transfer baghouse was sampled at the outlet of the baghouse and prior to the fan. The 8-3/4 inch I.D. duct was fitted with two 4-inch I.D. sampling ports in a manner similar to the other test sites. The downstream distance of 168 inches and the upstream distance of 20 inches did meet the Method 1 criteria, but due to the diameter of the duct (8 3/4 I.D.) and the fact that several

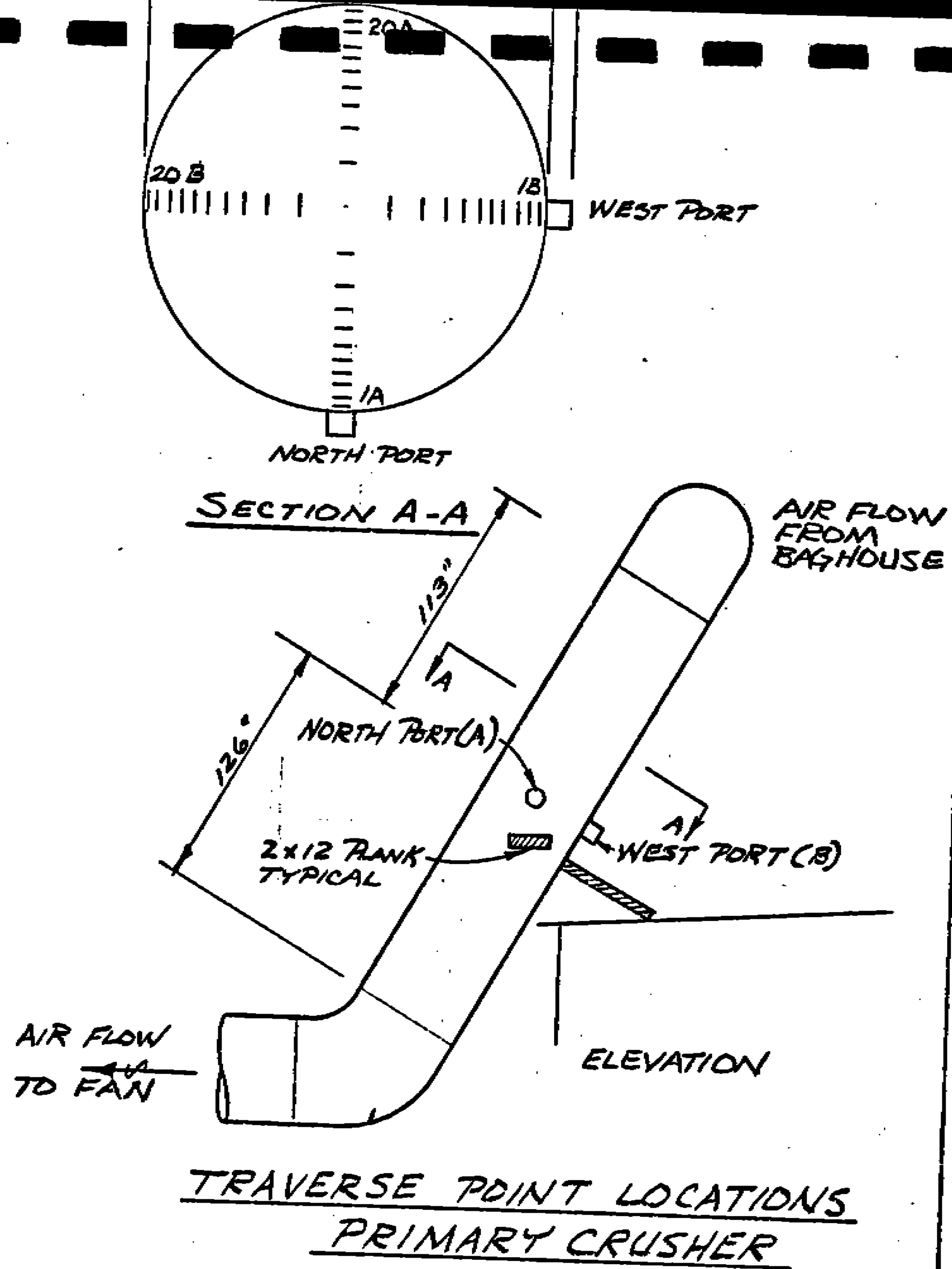

Figure 6

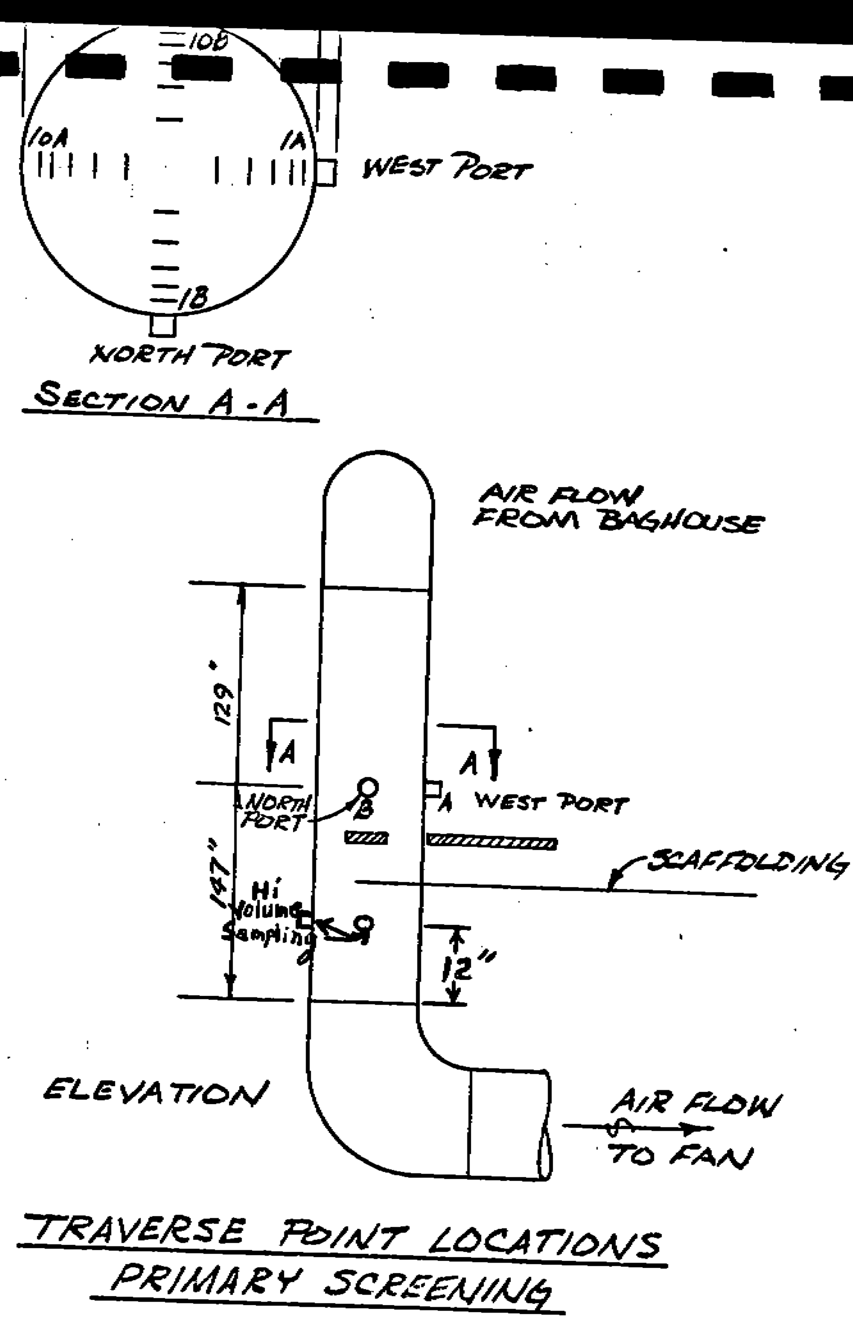

Figure 7

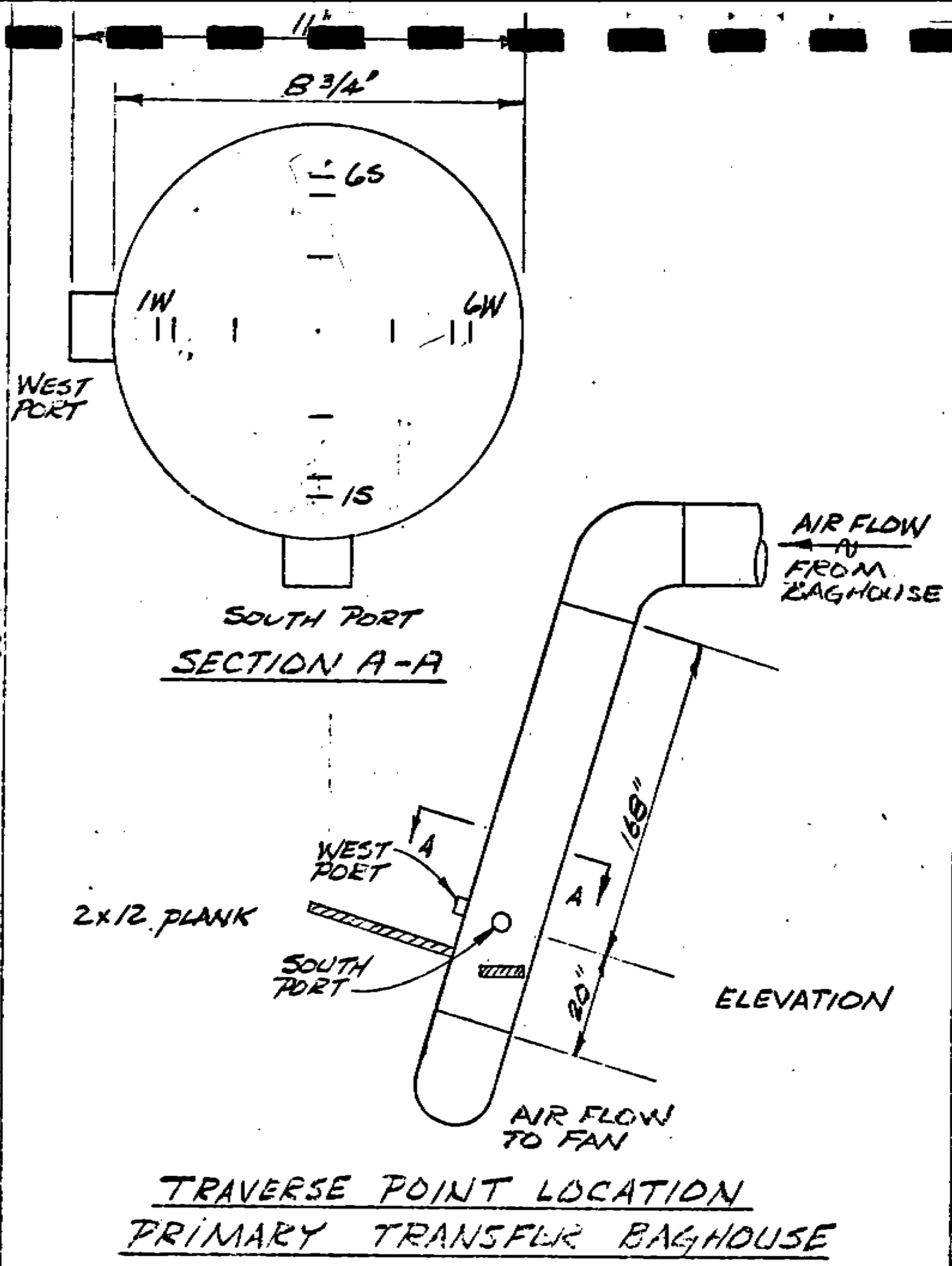

Figure 8

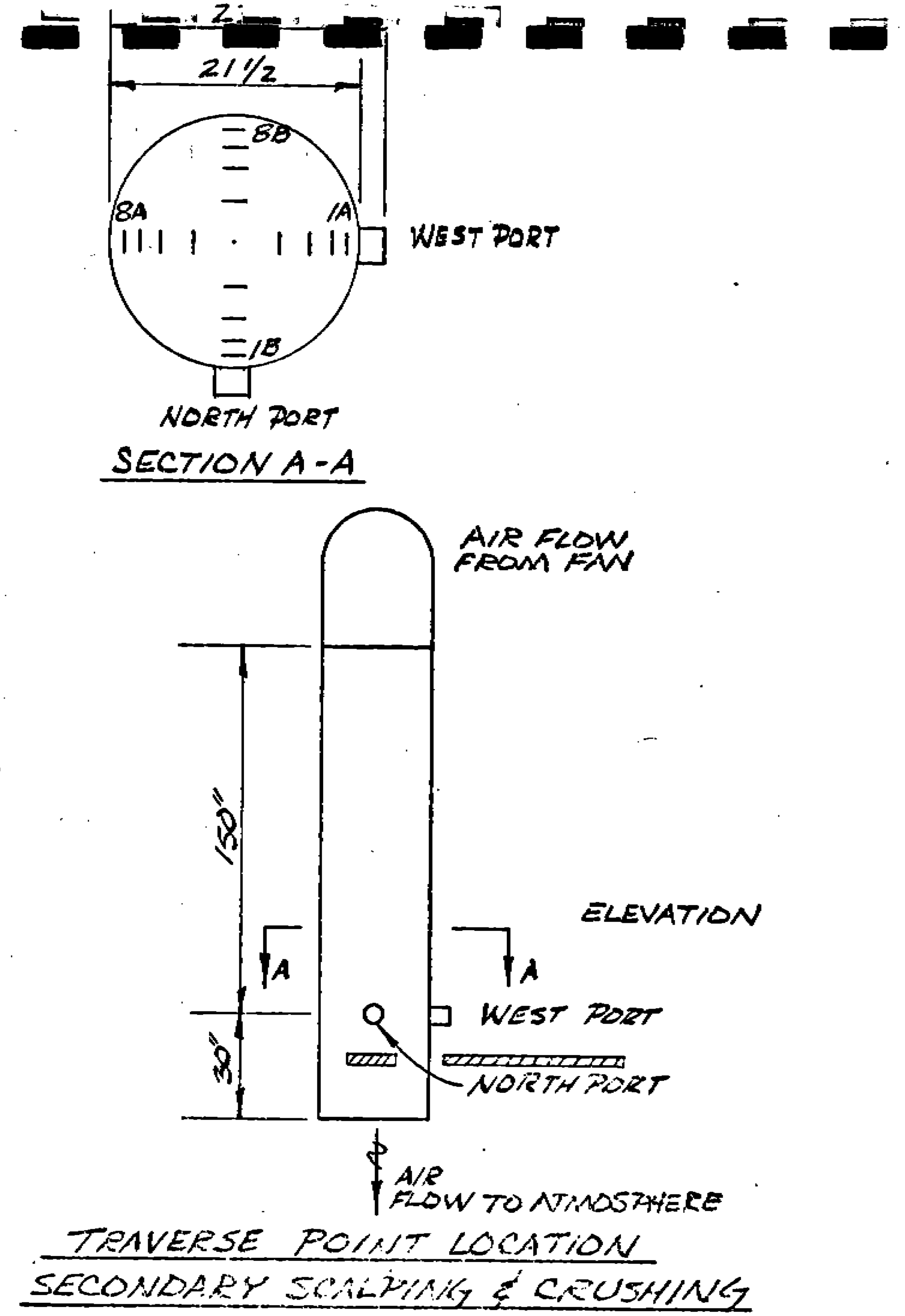

Figure 9

nozzles in the 6" diameter wind tunnel. Calibration of pitobes without nozzles in the 6" diameter conforms to published EPA Method 2 procedures. A February 1974 EPA Quality Assurance document on velocity measurements[1] states that a wind tunnel of 12" diameter or greater should be used for the calibration of pitot tubes. Valentine, Fisher & Tomlinson feels that the pitobes should be calibrated with the nozzles in place and operating at isokinetic velocities during calibration. Due to the above considerations, accepted Cp factors of 0.90 to 0.85 have been used for calculations and reporting of data.

A leak test was performed on the assembled sampling train. The leak rate did not exceed 0.025 cfm at a vacuum of 22.5 inches HG. The probe and filter were not heated as this was an ambient air source with very low humidity. Crushed ice was placed around the impingers at the beginning of the test with new ice being added as required to keep the gases leaving the sampling train as much as possible below 70°F.

The train was operated as follows: The probe was inserted into the stack to the first traverse point with the nozzle tip pointing directly into the gas stream. The pump was started and immediately adjusted to sample at isokinetic conditions. Equal time was spent at selected points of equal elemental areas of the duct with the

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[1] U.S. Environmental Protection Agency, Office of Research and Development, EPA - 650/4-74-005-a.

pertinent data being recorded from each time interval. The EPA nomograph was used to maintain isokinetic sampling throughout the sampling period. At the conclusion of the run, the pump was turned off, the probe was removed, and the final readings were recorded. Clean-up of the EPA train was performed by carefully removing the filter and placing it in a container marked "Run X, Container A". Reagent grade acetone along with brushes were used to clean the nozzle, glass probe, and pre-filter connections. The acetone wash was placed in a container marked "Run X, Container B". The volume of water in the impinger and bubblers (glassware) was weighed in their respective containers to the nearest 0.1 gram, The original weights which included approximately 100 ml. in the bubbler and 100 milliliters in the impinger were then subtracted and the difference added with the water weight gain from the silica gel. This constituted the amount of water collected during the run. The water from the glassware and water rinse of the glassware were placed in a container marked "Run X, Container C". An acetone rinse of the glassware and all post-filter glassware (not including the silica gel container) was performed and placed in a container marked "Run X, Container D". Because of the possible insolvability of the particulate in acetone, a water wash was conducted on the front half of the sampling train (prior to filter). This was placed in a container marked "Run X, Container E".

The water samples after the ether-chloroform extraction were inadvertently discarded on the first four runs analyzed. The runs included Run No. Two primary crusher, Run No. Two primary screen, Run

No. One conveyor transfer point and Run No. Three secondary screen and crusher.

Total particulate emissions were calculated using the water clean-up following the acetone clean-up of the probe. Front half particulate emissions were calculated using the filter and acetone clean-up of the prefilter portions of the sampling train.

The amount of hydrocarbons collected in the sampling train on this project appears higher than we have found for similar rock handling operations. On similar baghouse emission collection systems, we have discovered hydrocarbons entering the sampling train from the oil seals of the air compressors which are used for bag cleaning. For additional details concerning hydrocarbon analysis, please refer to Appendix J.

The visible emissions observations were scheduled to coincide with the particulate sampling test runs. Opacity readings were recorded simultaneously by two certified observers during a period of four hours on each of the four processes evaluated on this project. Zero visible emissions were recorded for each 15-second interval contained in the 32 total hours of observation. Opacity observations were made at the fan outlets from the baghouse control systems. The procedures adhered to EPA Method 9. Data sheets are provided in Appendix C.

Particle size distribution tests were conducted on the baghouse inlet ducts of the primary stone crusher and the primary screen. Tests 1-5 were on the primary screening device and tests 6-13 were on the primary stone crusher. The test equipment consisted of a Brinks Model B cascade impactor used with a cutting cyclone and a back-up filter.

Prior to testing, a full velocity traverse was conducted at each sample location. At both test sites, each test run was conducted at a single point. The velocity at this point was measured immediately preceeding each test run. The locations of the test points are indicated in Appendix B.

The configuration of the sampling train is shown in Figures B-7 and B-8. The impactor was placed in the stack and the nozzle was then turned downstream and the vacuum pump started. The flow rate through the impactor was kept constant throughout each run. This was accomplished by operating at a constant vacuum. (The particulate build-up on the filter is not great enough to cause a significant increase in pressure drop across the filter; therefore, a constant vacuum is indicative of a constant flow rate.)

At the termination of each run, the nozzle was turned upstream and removed from the stack and the pump was turned off. This was necessary due to high negative pressure in the stacks. After each test, the impactor was disassembled and the collection plates and filter were removed, placed in dessicators, and returned to the field laboratory. The cyclone was washed with acetone, and the collected material was returned to the laboratory for drying and weighing. For test runs 7-9, the cyclone catch was collected, dried, and weighed. The dry particulate from the cyclone of the three test runs was then combined so that a Bahco particle size analysis could be performed. The results are shown in Figure B-4.

The impaction plates provided with the impactor each weighed approximately 3 grams. In order to reduce this tare weight, aluminum foil discs were inserted on the steel plates. The substrates were treated in the field laboratory with silicon grease dissolved in benzene and then baked at 110°C for 1 1/2 hours. The substrates were then dessicated and weighed. After testing, the substrates were returned to the field laboratory, dessicated, and reweighed. All weighing was done on an electronic balance accurate to .001 mg.

Dry molecular weight and moisture content was obtained by averaging the results of the EPA Method 3 and Method 5 tests conducted by Valentine, Fisher, and Tomlinson.

Preliminary Velocity Traverse

A series of velocity traverses were conducted on June 3-4, 1974, in accordance with procedures detailed in EPA Method 1[1]. Two testing teams, provided with "S" type pitot tubes and inclined manometers, performed velocity measurements at the primary crusher and screen baghouse outlet ducts. A static pressure for each stack was obtained, and stack gas temperature confirmed by utilizing a metal-steam dial thermometer. Stack gas moisture content was measured by wet and dry bulk thermometers

[1] Standards of Performance for New Stationary Sources, Federal Register, Volume 36, No. 247, December 23, 1971.

and determined from standard psychometric tables. U-tube manometers were used to measure the pressure drop across each baghouse unit. These data were recorded during the test periods and are presented in Appendix G.

Particulate Sampling

Primary Crusher Baghouse

The sampling train designed to perform the particulate sampling of the emissions was a modified EPA Method 5 train. The modifications consisted of the removal of the cyclone from the train and the omission of heating the sampling probe and filter holder compartment. A 0.175" I.D. stainless steel nozzle was attached to the 5/8" diameter pyrex probe. The probe was connected directly to the glass filter holder containing a pre-weighed glass fiber filter (MSA 1106-BH). A small glass 90° elbow was used between the filter holder and the first of four Greenburg-Smith impingers.

The first impinger was modified by replacing the orifice with a 1/2" open tube. The second impinger was a standard type Greenburg-Smith, and the remaining two were modified. Each of the first two impingers contained 100 ml. of distilled water, the third was dry, and the final impinger contained 200 grams of pre-weighed dry indicator-type, 6-16 mesh silica gel. To complete the train, a control console provided a leakless vacuum pump, a dry test meter, and a calibrated orifice connected to an inclined manometer. Stack gas velocity measurements were accomplished by means of a calibrated "S" type pitot tube attached to the sampling probe, and positioned so that the measurements were made at the nozzle tip. The sampling train is illustrated in Figure 10. Detailed information for the particulate testing are presented in Appendices D and K.

Before the start of each test, leak checks were made on the assembled sampling train (excluding the probe). The first and second test samples at the primary crusher were withdrawn from the gas stream for ten minutes per each of the 40 sampling points, providing a total test time of 400 minutes. The gas velocity was observed immediately after positioning the probe at each sampling point, and sampling rates were adjusted to maintain isokinetic sampling conditions. Temperature measurements were obtained of the stack gas of the impinger gas stream, and at the inlet and outlet of the dry test meter. Test data were recorded every five minutes throughout the sampling periods. The duct was sampled at each point by moving the probe across and then reversing the direction. This actually represents 20 sampling points per traverse. It was felt that a more representative velocity profile of the duct would be obtained over the 4-hour sampling period if this procedure was followed.

Due to the number of process equipment malfunctions and/or shutdowns, the project officer decided to reduce the sampling time to eight minutes per each of the 40 sampling points, providing a total test time of 320 minutes for the third test sample. For the fourth test the sampling time was reduced to six minutes per each of the 40 sampling points, providing a total test time of 240 minutes.

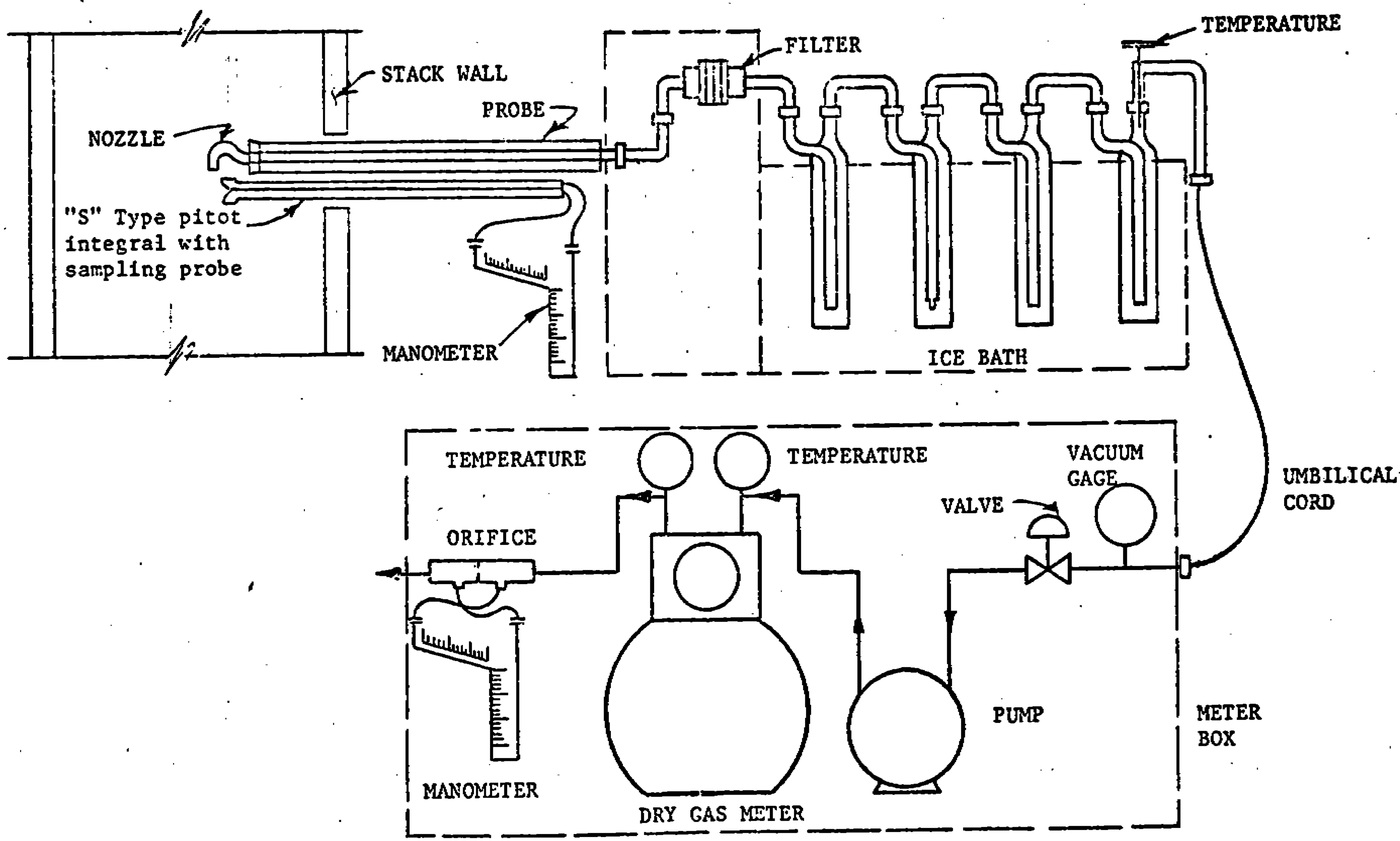

Figure 10
VALENTINE, FISHER & TOMLINSON STACK GAS SAMPLING TRAIN

The test procedures for sampling particulate conform to Method 5 of the EPA Standards of Performance for New Stationary Sources[1] (See Appendix K). The procedures for performing velocity traverses and determining volumetric flow rates were in conformance with EPA Methods 1 and 2. The composition of the gas stream was assumed to be air.

The first primary crusher sample was collected at an isokinetic sampling rate of 114 percent and an additional sample was therefore collected. This high isokinetic condition was the result of an incorrect nomograph setting after the initial set point had been determined and positioned.

Runs 3 on the primary crusher and primary screen operations were found upon review of the data as presented in the Valentine, Fisher, and Tomlinson draft report to have been cleaned up into mis-marked clean-up containers. The particulate concentration stack gas moisture, and comparison with the EPA high-volume data provided the insight, evidence, and conclusion for the clean-up being placed in mis-marked containers. This error was corrected and the data as reported is correct.

Primary Screen Baghouse

The sampling train configuration utilized for particulate sampling of the emissions from the primary screen baghouse was identical to the

[1] Federal Register, Volume 36, No. 247, December 23, 1971.

train used for the primary crusher tests. The test procedures also conformed to EPA Methods 1, 2, and 5. All field data sheets can be found in Appendix D.

Run Nos. One, Two, Three, and Four on the primary screening operations were collected with a Valentine, Fisher, and Tomlinson meter box which had just been calibrated. The metering orifice had been modified during calibration. The new calibration coefficient was not placed on the meter box before shipment to the field. Primary screen Run Nos. One, Two, Three, and Four are therefore approximately 5% over the desired isokinetic nozzle velocity range. Atmospheric emission calculations have been performed by two independent calculation procedures (concentration and area ratio) to determine the most accurate emissions whenever the isokinetic velocities are outside the 110% range (see Appendix A).

The first two tests performed at the primary screen were plagued by erroneous pitot measurements at the manometer. Several discrepancies were discovered in the values of ΔP recorded on June 4 and 5, 1974; the values recorded on June 5 were substantially higher than those recorded on June 4. It is believed that either the hot ambient temperature caused the pitot tube lines to sag or that the Swagelok fittings on the static pressure line were not sealed properly. This would account for the unusually high velocity measurements. Run No. Two was plagued by erroneous velocity data during the first 12 of 79 sampling points. Run Nos. One and Two air flows were calculated using the average air flow readings from Run Nos. Three and Four. Four samples were collected on the primary screen operation because the unusually high velocity readings were recognized in the field to be unrepresentative. The sampling times were identical to those used at the primary crusher.

A high volume sampling train was run for shorter time periods collecting samples from the primary screen operation. Valentine, Fisher, and Tomlinson provided the filters and analysis services on the high volume train. The calculations and data are contained in Appendix E.

Conveyor Transfer Point Baghouse

The sampling train configuration utilized for particulate sampling of the emissions from the primary transfer conveyor baghouse was identical to the trains used at the two other primary sites. The test procedures also conformed to EPA Methods 1, 2, and 5. Except for the unusual small diameter duct (8 3/4" I.D.), no problems were realized during the three test runs. The first sample was withdrawn from the gas stream for 30 minutes per each of the 12 sampling points, providing a total test time of 360 minutes. This was conducted by traversing each axis twice during the sampling period. Test data were recorded every five minutes throughout the sampling period. The remaining two runs were conducted using 24 minutes per each of the 12 sampling points, providing a total test time of 288 minutes. These runs were also conducted by traversing each of the axes twice. Test data were recorded every four minutes throughout the sampling periods. All field data sheets are presented in Appendix D.

Secondary Screen and Crusher Baghouse

The sampling train configuration utilized for particulate sampling of the emissions from the secondary screen and crusher baghouse was identical to the trains used for the other three sampling locations. The test procedures also conformed to EPA Methods 1, 2, and 5. Some of the velocity measurements recorded during Run No. Two indicate that the total baghouse volumetric flow was reduced because of the dust (cake) buildup on the bag filters. (See secondary screen and crusher run Appendix A). This is also noted in Appendix G under operating data at the secondary plant that the baghouse pressure drop (ΔP) was unusually high at the beginning of the work day (07:30/6-8-74). The total sampling period for each of the three runs was 320 minutes or 20 minutes per sampling point. Test data were recorded every five minutes throughout the sampling periods. Field data sheets are presented in Appendix D.

APPENDICES

APPENDIX A

COMPLETE PARTICULATE RESULTS
WITH
SAMPLE CALCULATION

Includes:

Primary Crusher Results
Primary Screen Results
Primary Conveyor Transfer Results
Secondary Screen and Crusher Results

PARTICULATE CALCULATION PROCEDURES

The total particulate grain loading is calculated using the particulate collected in both the front and back half of the sampling train. This includes the ether-chloroform extractions and water wash of the impingers and probe. The front half grain loading number reported in the summary includes the acetone wash of the pre-filter glassware and the filter catch. The water wash of the pre-filter with an ether-chloroform extraction is not included.

Whenever the percent isokinetic was found to be in excess of the desired ± 10%, the reported grain loading and particulate mass rate were calculated by averaging two methods, the concentration and area ratio methods. The following is the procedure and calculations.

1. The Concentration Method:

The concentration of dust entering the sampling nozzle is calculated and then multiplied by the volumetric flow rate of the stack gases to obtain the Pollutant Mass Rate (PMR).

Concentration in Nozzle x Volumetric Flow Rate = Pollutant Mass Rate On Concentration Basis.

$$(P_t/Vol_{std}) \times Q_{os} = PMR_p$$

Assuming the nozzle velocity is greater than the average stack gas velocity (V_n greater than V_o), the calculated Pollutant Mass Rate will be less than the true Pollutant Mass Rate because the heavier dust particles will leave their streamline and not enter the nozzle. If V_n is less than V_o then the calculated PMP will be greater than the true PMR.

2. The Area Ratio Method:

The weight of dust collected is divided by the sampling time and multiplied by the ratio of the Stack Area to the nozzle area to obtain the calculated Pollutant Mass Rate (PMR_{ar}).

$$\frac{\text{Weight Collected}}{\text{Sample Time}} \times \frac{\text{Area of Stack}}{\text{Area of Nozzle}} = \text{Pollutant Mass Rate on Area Ratio Basis.}$$

$$(P_t/T) \times A_s/A_n = PMR_{ar}$$

Assuming the nozzle velocity is greater than the average stack gas velocity (V_n greater than V_o), the calculated Pollutant Mass Rate will be greater than the true Pollutant Mass Rate because the lighter particles in the dust laden stream follow their streamlines and enter the sampling nozzle resulting in P_t/T being greater than true. If V_n is less than V_o, the calculated PMR_{ar} will be less than the true PMR.

To obtain a more true Pollutant Mass Rate, the two calculated pollutant mass rates are averaged. This allows some of the bias introduced because of non-isokinetic sampling calculated by one method to offset the bias of the other method.

PLANT: ARIZONA PORTLAND CEMENT
LOCATION: PRIMARY CRUSHER
OPERATOR: V F T

TABLE A-I

PARTICULATE SUMMARY IN ENGLISH UNITS

DESCRIPTION	UNITS	1	2	3	4	AVERAGE
DATE OF RUN		6-4-74	6-10-74	6-11-74	6-12-74	
STACK AREA	FT2	6.259	6.259	6.259	6.259	
NET TIME OF RUN	MIN	400.0	400.0	320.0	240.0	
BAROMETRIC PRESSURE	IN.HG	27.68	27.25	27.25	27.30	
AVG ORIFICE PRES DROP	IN.H2O	1.750	1.360	1.250	1.290	
VOL DRY GAS-METER COND	DCF	330.66	290.16	221.75	166.91	
AVG GAS METER TEMP	DEG.F	109.0	112.0	115.0	111.0	
VOL DRY GAS-STD COND	DSCF	286.20	245.71	186.74	141.82	
TOTAL H2O COLLECTED	ML	151.4	131.9	116.1	103.5	
VOL H2O VAPOR-STD COND	SCF	7.18	6.25	5.50	4.91	
PERCENT MOISTURE BY VOL		2.4	2.5	3.0	3.3	
MOLE FRACTION DRY GAS		0.976	0.975	0.970	0.967	
PERCENT CO2 BY VOL, DRY		0.0	0.0	0.0	0.0	
PERCENT O2 BY VOL, DRY		0.0	0.0	0.0	0.0	
PERCENT CO BY VOL, DRY		0.0	0.0	0.0	0.0	
PERCENT N2 BY VOL, DRY		0.0	0.0	0.0	0.0	
MOLECULAR WT-DRY STK GAS		28.95	28.95	28.95	28.95	
MOLECULAR WT-STK GAS		28.68	28.68	28.62	28.58	
AVG STACK TEMPERATURE	DEG.F	79.0	81.0	88.0	88.0	
NET SAMPLING POINTS		80	80	80	80	
STACK PRESSURE, ABSOLUTE	IN.HG	26.92	26.49	26.49	26.54	
AVG STACK GAS VELOCITY	FPS	72.430	70.385	70.978	72.281	71.519
STK FLOWRATE, DRY,STD CN	DSCFM	23469.	22351.	22140.	22502.	22615.
ACTUAL STACK FLOWRATE	ACFM	27198.	26430.	26653.	27142.	26856.
PERCENT ISOKINETIC		114.3	109.1	104.7	104.3	108.1
PARTICULATE WT-PARTIAL	MG	66.06	75.13	61.13	66.91	67.31
PARTICULATE WT-TOTAL	MG	72.61		72.34	77.25	
PERC IMPINGER CATCH		9.0		15.5	13.4	
PART. LOAD-PTL,STD CN	GR/DSCF	0.00355	0.00471	0.00504	0.00727	0.00514
PART. LOAD-TTL,STD CN	GR/DSCF	0.00391		0.00597	0.00839	
PART. LOAD-PTL,STK CN	GR/ACF	0.00307	0.00398	0.00419	0.00602	0.00432
PART. LOAD-TTL,STK CN	GR/ACF	0.00337		0.00495	0.00695	
PARTIC EMIS-PARTIAL	LB/HR	0.77 (1)	0.90	0.96	1.40	1.01
PARTIC EMIS-TOTAL	LB/HR	0.85 (1)		1.13	1.62	
PART EMIS/WT PRD FD PTL	LB/TON	0.00079	0.00091	0.00093	0.00139	0.00101
PART EMIS/WT PRD FD TTL	LB/TON	0.00087		0.00110	0.00160	

(1) Calculated by averaging the concentration and area ratio results.

PLANT: ARIZONA PORTLAND CEMENT
LOCATION: PRIMARY CRUSHER
OPERATOR: V F T

TABLE A-II

PARTICULATE SUMMARY IN METRIC UNITS

DESCRIPTION	UNITS	1	2	3	4	AVERAGE
DATE OF RUN		6-4-74	6-10-74	6-11-74	6-12-74	
STACK AREA	M2	0.581	0.581	0.581	0.581	
NET TIME OF RUN	MIN	400.0	400.0	320.0	240.0	
BAROMETRIC PRESSURE	MM.HG	703.07	692.15	692.15	693.42	
AVG ORIFICE PRES DROP	MM.H2O	44.450	34.544	31.750	32.766	
VOL DRY GAS-METER COND	DM3	9.36	8.22	6.28	4.73	
AVG GAS METER TEMP	DEG.C	42.8	44.4	46.1	43.9	
VOL DRY GAS-STD COND	DNM3	8.10	6.96	5.29	4.02	
TOTAL H2O COLLECTED	ML	151.4	131.9	116.1	103.5	
VOL H2O VAPOR-STD COND	NM3	0.20	0.18	0.16	0.14	
PERCENT MOISTURE BY VOL		2.4	2.5	3.0	3.3	
MOLE FRACTION DRY GAS		0.976	0.975	0.970	0.967	
PERCENT CO2 BY VOL, DRY		0.0	0.0	0.0	0.0	
PERCENT O2 BY VOL, DRY		0.0	0.0	0.0	0.0	
PERCENT CO BY VOL, DRY		0.0	0.0	0.0	0.0	
PERCENT N2 BY VOL, DRY		0.0	0.0	0.0	0.0	
MOLECULAR WT-DRY STK GAS		28.95	28.95	28.95	28.95	
MOLECULAR WT-STK GAS		28.68	28.66	28.62	28.58	
AVG STACK TEMPERATURE	DEG.C	26.1	27.2	31.1	31.1	
NET SAMPLING POINTS		80	80	80	80	
STACK PRESSURE, ABSOLUTE	MM.HG	683.77	672.85	672.85	674.12	
AVG STACK GAS VELOCITY	M/S	22.077	21.453	21.634	22.031	21.799
STK FLOWRATE, DRY,STD CN	DNM3/M	665.	633.	627.	637.	641.
ACTUAL STACK FLOWRATE	AM3/M	770.	748.	755.	769.	761.
PERCENT ISOKINETIC		114.3	109.1	104.7	104.3	108.1
PARTICULATE WT-PARTIAL	MG	66.06	75.13	61.13	66.91	67.31
PARTICULATE WT-TOTAL	MG	72.61		72.34	77.25	
PERC IMPINGER CATCH		9.0		15.5	13.4	
PART. LOAD-PTL,STD CN	MG/NM3	8.13	10.78	11.54	16.63	11.77
PART. LOAD-TTL,STD CN	MG/NM3	8.94		13.65	19.20	
PART. LOAD-PTL,STK CN	MG/AM3	7.01	9.11	9.58	13.78	9.87
PART. LOAD-TTL,STK CN	MG/AM3	7.71		11.33	15.91	
PARTIC EMIS-PARTIAL	KG/HR	0.34(1)	0.41	0.43	0.64	0.46
PARTIC EMIS-TOTAL	KG/HR	0.38(1)		0.51	0.73	
PART EMIS/WT PRD FD PTL	KG/MTON	0.00039	0.00043	0.00044	0.00066	0.00048
PART EMIS/WT PRD FD TTL	KG/MTON	0.00043		0.00052	0.00076	

(1) Calculated by averaging the concentration and area ratio results.

PLANT: ARIZONA PORTLAND CEMENT
LOCATION: PRIMARY SCREEN
OPERATOR: V F T

TABLE A-III

PARTICULATE SUMMARY IN ENGLISH UNITS

DESCRIPTION	UNITS	1	2	3	4	AVERAGE
DATE OF RUN		6-4-74	6-10-74	6-11-74	6-12-74	
STACK AREA	FT2	3.060	3.060	3.060	3.060	
NET TIME OF RUN	MIN	400.0	395.0	320.0	240.0	
BAROMETRIC PRESSURE	IN.HG	27.68	27.25	27.25	27.30	
AVG ORIFICE PRES DROP	IN.H2O	2.350	2.280	2.050	2.080	
VOL DRY GAS-METER COND	DCF	375.11	390.18	304.95	230.59	
AVG GAS METER TEMP	DEG.F	104.0	111.0	114.0	110.0	
VOL DRY GAS-STD COND	DSCF	328.07	331.80	257.81	196.69	
TOTAL H2O COLLECTED	ML	119.3	96.1	120.6	107.4	
VOL H2O VAPOR-STD COND	SCF	5.65	4.56	5.71	5.09	
PERCENT MOISTURE BY VOL		1.7	1.4	2.1	2.5	
MOLE FRACTION DRY GAS		0.983	0.986	0.979	0.975	
PERCENT CO2 BY VOL, DRY		0.0	0.0	0.0	0.0	
PERCENT O2 BY VOL, DRY		0.0	0.0	0.0	0.0	
PERCENT CO BY VOL, DRY		0.0	0.0	0.0	0.0	
PERCENT N2 BY VOL, DRY		0.0	0.0	0.0	0.0	
MOLECULAR WT-DRY STK GAS		28.95	28.95	28.95	28.95	
MOLECULAR WT-STK GAS		28.76	28.80	28.72	28.67	
AVG STACK TEMPERATURE	DEG.F	82.0	90.0	90.0	94.0	
NET SAMPLING POINTS		80	79	80	80	
STACK PRESSURE, ABSOLUTE	IN.HG	27.07	26.64	26.64	26.69	
AVG STACK GAS VELOCITY	FPS	85.405	86.036	85.894	86.410	85.936
STK FLOWRATE, DRY,STD CN	DSCFM	13636.	13368.	13246.	13196.	13361.
ACTUAL STACK FLOWRATE	ACFM	15682.	15797.	15771.	15866.	15779.
PERCENT ISOKINETIC		116.8	115.1	111.5	113.8	114.3
PARTICULATE WT-PARTIAL	MG	27.82	37.94	31.51	28.34	31.40
PARTICULATE WT-TOTAL	MG	30.38		39.28	40.11	
PERC IMPINGER CATCH		8.4		19.8	29.3	
PART. LOAD-PTL,STD CN	GR/DSCF	0.00131	0.00176	0.00188	0.00222	0.00179
PART. LOAD-TTL,STD CN	GR/DSCF	0.00143		0.00235	0.00314	
PART. LOAD-PTL,STK CN	GR/ACF	0.00113	0.00149	0.00158	0.00184	0.00151
PART. LOAD-TTL,STK CN	GR/ACF	0.00124		0.00197	0.00261	
PARTIC EMIS-PARTIAL	LB/HR	0.17 (1)	0.22 (1)	0.23 (1)	0.27 (1)	0.22 (1)
PARTIC EMIS-TOTAL	LB/HR	0.19 (1)		0.29 (1)	0.39 (1)	
PART EMIS/WT PRD FD PTL	LB/TON	0.00018	0.00023	0.00022	0.00026	0.00022
PART EMIS/WT PRD FD TTL	LB/TON	0.00020		0.00028	0.00037	

(1) Calculated by averaging the concentration and area ratio results.

PLANT: ARIZONA PORTLAND CEMENT
LOCATION: PRIMARY SCREEN
OPERATOR: V F T

TABLE A-IV

PARTICULATE SUMMARY IN METRIC UNITS

DESCRIPTION	UNITS	1	2	3	4	AVERAGE
DATE OF RUN		6-4-74	6-10-74	6-11-74	6-12-74	
STACK AREA	M2	0.284	0.284	0.284	0.284	
NET TIME OF RUN	MIN	400.0	395.0	320.0	240.0	
BAROMETRIC PRESSURE	MM.HG	703.07	692.15	692.15	693.42	
AVG ORIFICE PRES DROP	MM.H2O	59.690	57.912	52.070	52.832	
VOL DRY GAS-METER COND	DM3	10.62	11.05	8.64	6.53	
AVG GAS METER TEMP	DEG.C	40.0	43.9	45.6	43.3	
VOL DRY GAS-STD COND	DNM3	9.29	9.40	7.30	5.57	
TOTAL H2O COLLECTED	ML	119.3	96.1	120.6	107.4	
VOL H2O VAPOR-STD COND	NM3	0.16	0.13	0.16	0.14	
PERCENT MOISTURE BY VOL		1.7	1.4	2.1	2.5	
MOLE FRACTION DRY GAS		0.983	0.986	0.979	0.975	
PERCENT CO2 BY VOL, DRY		0.0	0.0	0.0	0.0	
PERCENT O2 BY VOL, DRY		0.0	0.0	0.0	0.0	
PERCENT CO BY VOL, DRY		0.0	0.0	0.0	0.0	
PERCENT N2 BY VOL, DRY		0.0	0.0	0.0	0.0	
MOLECULAR WT-DRY STK GAS		28.95	28.95	28.95	28.95	
MOLECULAR WT-STK GAS		28.76	28.80	28.72	28.67	
AVG STACK TEMPERATURE	DEG.C	27.8	32.2	32.2	34.4	
NET SAMPLING POINTS		80	79	80	80	
STACK PRESSURE, ABSOLUTE	MM.HG	687.58	676.66	676.66	677.93	
AVG STACK GAS VELOCITY	M/S	26.032	26.224	26.181	26.338	26.194
STK FLOWRATE, DRY,STD CN	DNM3/M	386.	379.	375.	374.	379.
ACTUAL STACK FLOWRATE	AM3/M	444.	447.	447.	449.	447.
PERCENT ISOKINETIC		116.8	115.1	111.5	113.8	114.3
PARTICULATE WT-PARTIAL	MG	27.82	37.94	31.51	28.34	31.40
PARTICULATE WT-TOTAL	MG	30.38		39.26	40.11	
PERC IMPINGER CATCH		8.4		19.8	29.3	
PART. LOAD-PTL,STD CN	MG/NM3	2.99	4.03	4.31	5.08	4.10
PART. LOAD-TTL,STD CN	MG/NM3	3.26		5.37	7.19	
PART. LOAD-PTL,STK CN	MG/AM3	2.60	3.41	3.62	4.22	3.46
PART. LOAD-TTL,STK CN	MG/AM3	2.84		4.51	5.97	
PARTIC EMIS-PARTIAL	KG/HR	0.08 (1)	0.10 (1)	0.10 (1)	0.12 (1)	0.10
PARTIC EMIS-TOTAL	KG/HR	0.09 (1)		0.13 (1)	0.18 (1)	
PART EMIS/WT PRD FD PTL	KG/MTON	0.00009	0.00012	0.00011	0.00013	0.00011
PART EMIS/WT PRD FD TTL	KG/MTON	0.00010		0.00014	0.00019	

(1) Calculated by averaging the concentration and area ratio results.

TABLE A-V

PLANT: ARIZONA PORTLAND CEMENT
LOCATION: PRIMARY TRANSFER CONVEYER
OPERATOR: V F T

PARTICULATE SUMMARY IN ENGLISH UNITS

DESCRIPTION	UNITS	1	2	3	AVERAGE
DATE OF RUN		6-10-74	6-11-74	6-12-74	
STACK AREA	FT2	0.418	0.418	0.418	
NET TIME OF RUN	MIN	360.0	288.0	288.0	
BAROMETRIC PRESSURE	IN.HG	27.25	27.30	27.25	
AVG ORIFICE PRES DROP	IN.H2O	2.030	2.070	2.200	
VOL DRY GAS-METER COND	DCF	322.19	263.42	271.34	
AVG GAS METER TEMP	DEG.F	112.0	114.0	109.0	
VOL DRY GAS-STD COND	DSCF	273.32	223.12	231.50	
TOTAL H2O COLLECTED	ML	142.9	117.0	117.5	
VOL H2O VAPOR-STD COND	SCF	6.77	5.55	5.57	
PERCENT MOISTURE BY VOL		2.4	2.4	2.3	
MOLE FRACTION DRY GAS		0.976	0.976	0.977	
PERCENT CO2 BY VOL, DRY		0.0	0.0	0.0	
PERCENT O2 BY VOL, DRY		0.0	0.0	0.0	
PERCENT CO BY VOL, DRY		0.0	0.0	0.0	
PERCENT N2 BY VOL, DRY		0.0	0.0	0.0	
MOLECULAR WT-DRY STK GAS		28.95	28.95	28.95	
MOLECULAR WT-STK GAS		28.69	28.68	28.69	
AVG STACK TEMPERATURE	DEG.F	98.0	101.0	97.0	
NET SAMPLING POINTS		72	72	72	
STACK PRESSURE, ABSOLUTE	IN.HG	26.64	26.69	26.64	
AVG STACK GAS VELOCITY	FPS	91.922	92.338	96.668	93.643
STK FLOWRATE, DRY,STD CN	DSCFM	1900.	1902.	2003.	1935.
ACTUAL STACK FLOWRATE	ACFM	2303.	2313.	2422.	2346.
PERCENT ISOKINETIC		105.9	107.9	106.3	106.7
PARTICULATE WT-PARTIAL	MG	16.83	23.54	31.14	23.84
PARTICULATE WT-TOTAL	MG		27.59	38.93	
PERC IMPINGER CATCH			14.7	20.0	
PART. LOAD-PTL,STD CN	GR/DSCF	0.00095	0.00162	0.00207	0.00155
PART. LOAD-TTL,STD CN	GR/DSCF		0.00190	0.00259	
PART. LOAD-PTL,STK CN	GR/ACF	0.00078	0.00134	0.00171	0.00128
PART. LOAD-TTL,STK CN	GR/ACF		0.00156	0.00214	
PARTIC EMIS-PARTIAL	LB/HR	0.02	0.03	0.04	0.03
PARTIC EMIS-TOTAL	LB/HR		0.03	0.04	
PART EMIS/WT PRD FD PTL	LB/TON	0.00002	0.00003	0.00004	0.00003
PART EMIS/WT PRD FD TTL	LB/TON		0.00003	0.00005	

TABLE A-VI

PLANT: ARIZONA PORTLAND CEMENT
LOCATION: PRIMARY TRANSFER CONVEYER
OPERATOR: V F T

PARTICULATE SUMMARY IN METRIC UNITS

DESCRIPTION	UNITS	1	2	3	AVERAGE
DATE OF RUN		6-10-74	6-11-74	6-12-74	
STACK AREA	M2	0.039	0.039	0.039	
NET TIME OF RUN	MIN	300.0	288.0	288.0	
BAROMETRIC PRESSURE	MM.HG	692.15	693.42	692.15	
AVG ORIFICE PRES DROP	MM.H2O	51.562	52.578	55.880	
VOL DRY GAS-METER COND	DM3	9.12	7.46	7.68	
AVG GAS METER TEMP	DEG.C	44.4	45.6	42.8	
VOL DRY GAS-STD COND	DNM3	7.74	6.32	6.56	
TOTAL H2O COLLECTED	ML	142.9	117.0	117.5	
VOL H2O VAPOR-STD COND	NM3	0.19	0.16	0.16	
PERCENT MOISTURE BY VOL		2.4	2.4	2.3	
MOLE FRACTION DRY GAS		0.976	0.976	0.977	
PERCENT CO2 BY VOL, DRY		0.0	0.0	0.0	
PERCENT O2 BY VOL, DRY		0.0	0.0	0.0	
PERCENT CO BY VOL, DRY		0.0	0.0	0.0	
PERCENT N2 BY VOL, DRY		0.0	0.0	0.0	
MOLECULAR WT-DRY STK GAS		28.95	28.95	28.95	
MOLECULAR WT-STK GAS		28.69	28.68	28.69	
AVG STACK TEMPERATURE	DEG.C	36.7	38.3	36.1	
NET SAMPLING POINTS		72	72	72	
STACK PRESSURE, ABSOLUTE	MM.HG	676.66	677.93	676.66	
AVG STACK GAS VELOCITY	M/S	28.018	28.144	29.464	28.542
STK FLOWRATE, DRY,STD CN	DNM3/M	54.	54.	57.	55.
ACTUAL STACK FLOWRATE	AM3/M	65.	66.	69.	66.
PERCENT ISOKINETIC		105.9	107.9	106.3	106.7
PARTICULATE WT-PARTIAL	MG	16.83	23.54	31.14	23.84
PARTICULATE WT-TOTAL	MG		27.59	38.93	
PERC IMPINGER CATCH			14.7	20.0	
PART. LOAD-PTL,STD CN	MG/NM3	2.17	3.72	4.74	3.54
PART. LOAD-TTL,STD CN	MG/NM3		4.36	5.93	
PART. LOAD-PTL,STK CN	MG/AM3	1.79	3.06	3.92	2.92
PART. LOAD-TTL,STK CN	MG/AM3		3.58	4.90	
PARTIC EMIS-PARTIAL	KG/HR	0.01	0.01	0.02	0.01
PARTIC EMIS-TOTAL	KG/HR		0.01	0.02	
PART EMIS/WT PRD FD PTL	KG/MTON	0.00001	0.00001	0.00002	0.00001
PART EMIS/WT PRD FD TTL	KG/MTON		0.00002	0.00003	

TABLE A-VII

PLANT: ARIZONA PORTLAND CEMENT
LOCATION: SECONDARY SCREENING AND CRUSHING PLANT
OPERATOR: V F T

PARTICULATE SUMMARY IN ENGLISH UNITS

DESCRIPTION	UNITS	1	2	3	AVERAGE
DATE OF RUN		6-6-74	6-7-74	6-8-74	
STACK AREA	FT2	2.521	2.521	2.521	
NET TIME OF RUN	MIN	320.0	320.0	320.0	
BAROMETRIC PRESSURE	IN.HG	27.40	27.07	27.20	
AVG ORIFICE PRES DROP	IN.H2O	1.480	1.110	1.630	
VOL DRY GAS-METER COND	DCF	239.36	205.74	254.18	
AVG GAS METER TEMP	DEG.F	120.0	109.0	109.0	
VOL DRY GAS-STD COND	DSCF	201.05	173.87	216.14	
TOTAL H2O COLLECTED	ML	100.2	83.2	96.4	
VOL H2O VAPOR-STD COND	SCF	4.75	3.94	4.57	
PERCENT MOISTURE BY VOL		2.3	2.2	2.1	
MOLE FRACTION DRY GAS		0.977	0.978	0.979	
PERCENT CO2 BY VOL, DRY		0.0	0.0	0.0	
PERCENT O2 BY VOL, DRY		0.0	0.0	0.0	
PERCENT CO BY VOL, DRY		0.0	0.0	0.0	
PERCENT N2 BY VOL, DRY		0.0	0.0	0.0	
MOLECULAR WT-DRY STK GAS		28.95	28.95	28.95	
MOLECULAR WT-STK GAS		28.70	28.71	28.72	
AVG STACK TEMPERATURE	DEG.F	81.0	77.0	80.0	
NET SAMPLING POINTS		64	64	64	
STACK PRESSURE, ABSOLUTE	IN.HG	27.42	27.09	27.22	
AVG STACK GAS VELOCITY	FPS	69.935	65.918	73.018	69.624
STK FLOWRATE, DRY,STD CN	DSCFM	9277.	8711.	9656.	9214.
ACTUAL STACK FLOWRATE	ACFM	10579.	9971.	11045.	10532.
PERCENT ISOKINETIC		102.2	99.8	105.6	102.5
PARTICULATE WT-PARTIAL	MG	4.69	8.44	10.44	7.86
PARTICULATE WT-TOTAL	MG	6.12	12.25		
PERC IMPINGER CATCH		23.4	31.1		
PART. LOAD-PTL,STD CN	GR/DSCF	0.00036	0.00075	0.00074	0.00062
PART. LOAD-TTL,STD CN	GR/DSCF	0.00047	0.00109		
PART. LOAD-PTL,STK CN	GR/ACF	0.00031	0.00065	0.00065	0.00054
PART. LOAD-TTL,STK CN	GR/ACF	0.00041	0.00095		
PARTIC EMIS-PARTIAL	LB/HR	0.03	0.06	0.06	0.05
PARTIC EMIS-TOTAL	LB/HR	0.04	0.08		
PART EMIS/WT PRD FD PTL	LB/TON	0.00017	0.00034	0.00041	0.00031
PART EMIS/WT PRD FD TTL	LB/TON	0.00022	0.00050		

TABLE A-VIII

PLANT: ARIZONA PORTLAND CEMENT
LOCATION: SECONDARY SCREENING AND CRUSHING PLANT
OPERATOR: V F T

PARTICULATE SUMMARY IN METRIC UNITS

DESCRIPTION	UNITS	1	2	3	AVERAGE
DATE OF RUN		6-6-74	6-7-74	6-8-74	
STACK AREA	M2	0.234	0.234	0.234	
NET TIME OF RUN	MIN	320.0	320.0	320.0	
BAROMETRIC PRESSURE	MM.HG	695.96	687.58	690.88	
AVG ORIFICE PRES DROP	MM.H20	37.592	28.194	41.402	
VOL DRY GAS-METER COND	DM3	6.78	5.83	7.20	
AVG GAS METER TEMP	DEG.C	48.9	42.8	42.8	
VOL DRY GAS-STD COND	DNM3	5.69	4.92	6.12	
TOTAL H20 COLLECTED	ML	100.2	83.2	96.4	
VOL H20 VAPOR-STD COND	NM3	0.13	0.11	0.13	
PERCENT MOISTURE BY VOL		2.3	2.2	2.1	
MOLE FRACTION DRY GAS		0.977	0.978	0.979	
PERCENT CO2 BY VOL, DRY		0.0	0.0	0.0	
PERCENT O2 BY VOL, DRY		0.0	0.0	0.0	
PERCENT CO BY VOL, DRY		0.0	0.0	0.0	
PERCENT N2 BY VOL, DRY		0.0	0.0	0.0	
MOLECULAR WT-DRY STK GAS		28.95	28.95	28.95	
MOLECULAR WT-STK GAS		28.70	28.71	28.72	
AVG STACK TEMPERATURE	DEG.C	27.2	25.0	26.7	
NET SAMPLING POINTS		64	64	64	
STACK PRESSURE, ABSOLUTE	MM.HG	696.47	688.09	691.39	
AVG STACK GAS VELOCITY	M/S	21.316	20.092	22.256	21.221
STK FLOWRATE, DRY,STD CN	DNM3/M	263.	247.	273.	261.
ACTUAL STACK FLOWRATE	AM3/M	300.	282.	313.	298.
PERCENT ISOKINETIC		102.2	99.8	105.6	102.5
PARTICULATE WT-PARTIAL	MG	4.69	8.44	10.44	7.86
PARTICULATE WT-TOTAL	MG	6.12	12.25		
PERC IMPINGER CATCH		23.4	31.1		
PART. LOAD-PTL,STD CN	MG/NM3	0.82	1.71	1.70	1.41
PART. LOAD-TTL,STD CN	MG/NM3	1.07	2.48		
PART. LOAD-PTL,STK CN	MG/AM3	0.72	1.49	1.49	1.23
PART. LOAD-TTL,STK CN	MG/AM3	0.94	2.17		
PARTIC EMIS-PARTIAL	KG/HR	0.01	0.03	0.03	0.02
PARTIC EMIS-TOTAL	KG/HR	0.02	0.04		
PART EMIS/WT PRD FD PTL	KG/MTON	0.00008	0.00017	0.00020	0.00015
PART EMIS/WT PRD FD TTL	KG/MTON	0.00011	0.00025		

PARTICULATE CONCENTRATION AND PMR CALCULATION TERMINOLOGY

VOL_m = Dry gas meter volume @ meter temperature and pressure, dry - acf

P_m = Dry gas meter pressure (recorded as inlet deflection accross orifice meter) - "Hg

T_m = Dry gas meter temperature (average of inlet and outlet)

P_{STD} = Standard atmospheric pressure (29.92" Hg)

T_{STD} = Standard Temperature (520 or 530° R)

VOL_w = Volume of water collected (expressed as vapor at standard temperature and pressure) - scf

M = % water, calculated from amount the train collected in impinger, bubblers, and on silica gel

MF = Mole fraction of dry gas

W_D = Molecular weight of dry stack gas - lb/lb mole

W_W = Molecular weight of wet stack gas - lb/lb mole

W_a = Molecular weight of air - lb/lb mole

C_D = Velocity correction coefficient for gas density

P_{SN} = Stack pressure (static + barometric) - "Hg

C_S = Velocity correction coefficient for stack pressure

VH_n = Pitot tube pressure differential - "H_2O

V_o = Stack velocity @ stack conditions - fps

Q_o = Stack flow rate at stack conditions - acfm

T_s = Average stack temperature - °R

Q_{OS} = Stack flow rate at standard conditions - scfm

T = Time over which sample was collected - minutes

V_n = Velocity of gases inside nozzle during sampling - fps

I = % isokinetic (± 10% desirable)

C_O = Particulate concentration - grains/scf

N = % CO_2 by volume in stack (12 indicates no % CO_2 correction is to be made)

PARTICULATE CONCENTRATION AND PMR CALCULATION TERMINOLOGY

C	=	Particulate concentration corrected to 12% CO_2
PMR_p	=	Pollutant mass rate - "concentration method" - lb/hr
PMR_{AR}	=	Pollutant mass rate - "area ratio method" - lb/hr
PMR_{AVG}	=	Average pollutant mass rate - lb/hr
C'	=	Particulate concentration corrected for non-isokinetic sampling condition -grains/scf
P_T	=	Total Particulate collected by sampling train - mg
A_s	=	Area of Stack - FT^2
A_n	=	Area of Nozzle - FT^2
VH	=	Velocity head readings for pitot tube - inches water
VOL_{STD}	=	Standardized gas that passed through the sampling train - cubic feet, 70° F., 1 atmosphere pressure, and dry.
C_p	=	Velocity correction coefficient for type pitot tube - dimensionless

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[a] Dry standard cubic feet at 70°F, 29.92 in. Hg.

[b] Standard conditions at 70°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 (ΔPs) and the absolute stack temperature from each sampling point.

[d] Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.

PARTICULATE CONCENTRATION & PMR CALCULATIONS

1. $VOL_{STD} = \dfrac{(VOL_m)\ (P_m)\ (T_{STD})}{(P_{STD}*)\ (T_m)}$

2. $M = \dfrac{(100)\ (VOL_w)}{VOL_{STD} + VOL_w}$

3. $MF = \dfrac{100 - M}{100}$

4. $W_w = (W_D)\ (MF) + 18\ (1-MF)$

5. $C_D = \sqrt{\dfrac{W_a*}{W_w}}$

6. $C_S = \sqrt{\dfrac{P_{STD}}{P_{SN}}}$

7. $K = \dfrac{\sum\sqrt{VH_n \times TS_n}}{n}$

8. $V_o = 2.9\ (K_a)\ (C_p)\ (C_D)\ (C_S)$

9. $Q_o = (V_o)\ (A_S)\ (60)$

10. $Q_{OS} = \dfrac{Q_o\ (T_{STD})\ (P_{SN})\ (MF)}{(T_S)\ (P_{STD})}$

11. $V_n = \dfrac{(VOL_{STD})\ (P_{STD})(T_S)}{(MF)\ (T_{STD})\ (P_{SN})\ (T)\ (A_N)\ (60)}$

12. $I = (100)\ \dfrac{V_n}{V_o}$

13. $C_O = \dfrac{P_T}{VOL_{STD}}\ (0.0154)$

14. $C = \dfrac{C_O\ (12\%)}{N}$

15. $PMR_p = (C_O)\ (Q_{OS})\ (0.008571)$

16. $PMR_{AR} = \dfrac{P_T}{T}\ \dfrac{A_s}{A_n}\ (0.000132)$

17. $PMR_{AVG} = \dfrac{PMR_p + PMR_{AR}}{2}$

18. $C' = \dfrac{PMR_{AVG}}{Q_{OSN}}\ (1400)$

* P_{STD} = 29.92" Hg.

* W_a = 28.95 LB/LB MOLE

APPENDIX B

PARTICLE SIZE RESULTS

Includes:

Particle Size Distribution for Primary Screen
Particle Size Distribution for Primary Crusher
Particle Size Results (Bahco) Primary Crusher
Particle Size Results Baghouse Dust
Particle Size Results (Bahco) Secondary Screen and Crusher
Particle Size Results Baghouse Dust

PARTICLE SIZE DISTRIBUTION ANALYSIS

BY

BRINKS MODEL B IMPACTOR

Introduction

During the period of June 3 - 7, 1974, particle size distribution tests were conducted at the Arizona Portland Cement Company, Tucson, Arizona. The tests were conducted by Roy Neulicht of the Emission Measurement Branch, EPA, and James McReynolds, TRW Environmental Services.

Particle size distribution tests were conducted on the baghouse inlet ducts of the primary stone crusher and the primary screen. Tests 1 - 5 were on the primary screening device and tests 6 - 13 were on the primary stone crusher. The test equipment consisted of a Brink* Model B cascade impactor used with a cutting cyclone and a back-up filter. In addition, the cyclone catch from runs 7 - 9 was analyzed using a Bahco particle sizer. A summary of test conditions is given in Tables B1 and B2. Tables B3-B5 and Figures B1-B4 summarize the test results.

Discussion

The Brink Model B impactor has five collection stages. For these tests a cutting cyclone was used prior to the first stage to remove the large particles and a glass fiber filter was used after the final stage. The cyclone was used to avoid overloading of the first stage due to the excessive number of large particles encountered in the gas stream. The impactor was operated at a constant pressure drop giving characteristic particle diameter (Dp_{50}) size cuts ranging from 6.8 to 0.4 microns. The characteristic particle diameter, Dp_{50} is the diameter of a spherical particle of unit density (1 g/cc) for which 50% of the particles will impact on a given stage and 50% will pass

* Mention of brand name does not indicate EPA endorsement.

TABLE B1

TEST SUMMARY

PRIMARY SCREEN

Run	Preliminary	1	2	3	4	5
Date	6/4/74	6/5/74	6/5/74	6/5/74	6/5/74	6/5/74
Sample Time, Sec.	-	63	67	61	100	90
Sample Volume, CF (Stack Cond.)	-	0.104	0.111	0.120	0.165	0.150
Stack Temp., °F	73	73	73	73	73	86
Stack Pressure, In. H_2O	- 4.5	- 4.5	- 4.5	- 4.5	- 4.5	- 4.5
Molecular Weight, Dry	28.84					
% Moisture	2.2					
$\sqrt{\Delta p}$	1.3	1.5	1.5	1.5	1.5	1.5
Velocity, FPS	81	94	94	94	94	94
Stack Area, FT^2	2.29					
Nozzle Diam, Inch	-	0.069	0.069	0.069	0.069	0.069
Stack Flow, SCFM	8745					
% Isokinetic	-					
Gr/SCF	-	36	13	16	7	4

TABLE B2

TEST SUMMARY

PRIMARY CRUSHER

Run	Preliminary	6	7	8	9	10	11	12	13
Date	6/4/74	6/7/74	6/7/74	6/7/74	6/7/74	6/7/74	6/7/74	6/7/74	6/7/74
Sample Time, Sec.	–	35	30	32	30	32	35	31	19
Sample Volume, CF (Stack Condition)	–	0.058	0.050	0.053	0.050	0.053	0.058	0.051	0.032
Stack Temp, °F	80	85	73	80	80	80	80	80	85
Stack Pressure, In. H_2O	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5
Molecular Weight, Dry	28.84								
% Moisture	2.4								
$\sqrt{\Delta p}$	1.23	1.1	1.4	1.2	1.2	1.2	1.4	1.3	1.3
Velocity, FPS	77.6	69.7	87.8	75.3	75.3	75.3	87.9	81.6	82.4
Stack Area, FT^2	1.31								
Nozzle Diam., Inch	–	0.069	0.069	0.069	0.069	0.069	0.069	0.19	0.19
Stack Flow, SCFM	4700								
% Isokinetic	–	92	73	85	85	85	73	10	10
Gr/SCF	–	125	148	182	239	125	355	906	502

TABLE B3

SUMMARY OF RESULTS - PRIMARY SCREEN

Collection Stage	Dp 50 Microns	Run 1	Run 2	Run 3*	Run 4	Run 5	Ave.	Cumulative Percent Less than Dp - Ave.
Cyclone	6.8	97.69	96.73	91.94	97.76	93.68	96.46	3.54
1	3.4	1.53	1.54	1.30	1.59	3.67	2.08	1.46
2	2.0	0.47	0.61	6.37	0.50	1.41	0.75	0.71
3	1.4	0.14	0.14	0.000	0.03	0.52	0.21	0.50
4	0.7	0.07	0.58	0.15	0.10	0.36	0.28	0.22
5	0.4	0.00	0.10	0.00	0.02	0.05	0.04	0.18
Filter	0.3	0.10	0.30	0.24	0.00	0.31	0.18	----

Results Omitting Cyclone

1	3.4	66.35	47.16	16.14	71.24	58.02	60.69	39.31
2	2.0	20.12	18.79	79.01	22.22	22.22	20.84	18.47
3	1.4	6.19	4.26	0.00	1.31	8.23	5.00	13.47
4	0.7	3.09	17.73	1.90	4.58	5.76	7.79	5.68
5	0.4	0.00	2.84	0.00	0.65	0.82	1.08	4.60
Filter	0.3	4.25	9.22	2.95	0.00	4.94	4.60	----

*Results not used in average values

TABLE B4

SUMMARY OF RESULTS - CRUSHER

Collection Stage	Dp 50 Microns	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12*	Run 13*	Ave.	Cumulative Percent Less than Dp - Avg.
Cyclone	6.8	97.23	97.43	97.55	97.31	98.46	98.22	97.65	98.94	97.70	2.30
1	3.4	2.20	2.13	1.92	2.12	1.05	1.29	1.78	0.77	1.79	0.51
2	2.0	0.41	0.33	0.35	0.49	0.29	0.37	0.49	0.21	0.37	0.14
3	1.4	0.09	0.06	0.07	0.03	0.07	0.06	0.06	0.03	0.06	0.08
4	0.7	0.03	0.00	0.02	0.01	0.03	0.03	0.01	0.01	0.02	0.06
5	0.4	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05
Filter	0.3	0.00	0.04	0.09	0.04	0.10	0.03	0.01	0.04	0.05	----

Results Omitting Cyclone

Collection Stage	Dp 50 Microns	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12*	Run 13*	Ave.	Cumulative Percent Less than Dp - Avg.
1	3.4	79.26	82.85	78.34	78.79	68.10	72.09	75.88	72.48	76.57	23.43
2	2.0	14.88	12.66	14.44	18.27	19.01	20.71	20.80	19.42	16.66	6.77
3	1.4	3.34	2.29	2.92	1.05	4.46	3.63	2.35	3.20	2.95	3.82
4	0.7	1.17	0.00	0.80	0.37	1.82	1.65	0.53	0.80	0.97	2.85
5	0.4	1.34	0.18	0.00	0.00	0.00	0.18	0.00	0.40	0.28	2.57
Filter	0.3	0.00	2.02	3.50	1.52	6.61	1.74	0.44	3.70	2.57	----

*Results not used in average values.

TABLE B5

SUMMARY OF RESULTS

DIFFERENTIAL MASS LOADING BASIS
[dM/d Log D (gr/scf)]

PRIMARY SCREEN

Collection Stage	Run 1	Run 2	Run 3*	Run 4	Run 5	Avg.
Cyclone	19.16	6.87	7.86	3.69	2.22	7.99
1	1.87	0.69	0.83	0.38	0.55	0.87
2	0.75	0.36	4.64	0.15	0.27	0.38
3	0.32	0.11	0.000	0.013	0.14	0.15
4	0.094	0.28	0.091	0.026	0.058	0.11
5	0.000	0.060	0.000	0.005	0.011	0.019
Filter	0.022	0.024	0.025	0.000	0.008	0.029

CRUSHER

	Run 6	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12*	Run 13*	Avg.
Cyclone	66.76	78.89	94.94	126.97	67.53	191.09	484.93	272.45	90.12
1	9.50	10.80	11.75	17.40	4.51	15.72	55.36	13.39	11.61
2	2.32	2.17	2.83	5.27	1.64	5.90	19.82	4.67	3.36
3	0.72	0.54	0.79	0.42	0.53	1.43	3.10	1.07	0.74
4	0.15	0.000	0.13	0.087	0.13	0.39	0.41	0.16	0.15
5	0.23	0.033	0.000	0.00	0.000	0.058	0.000	0.11	0.053
Filter	0.000	0.048	0.09	0.060	0.079	0.068	0.057	0.12	0.058

* Results not used in average values.

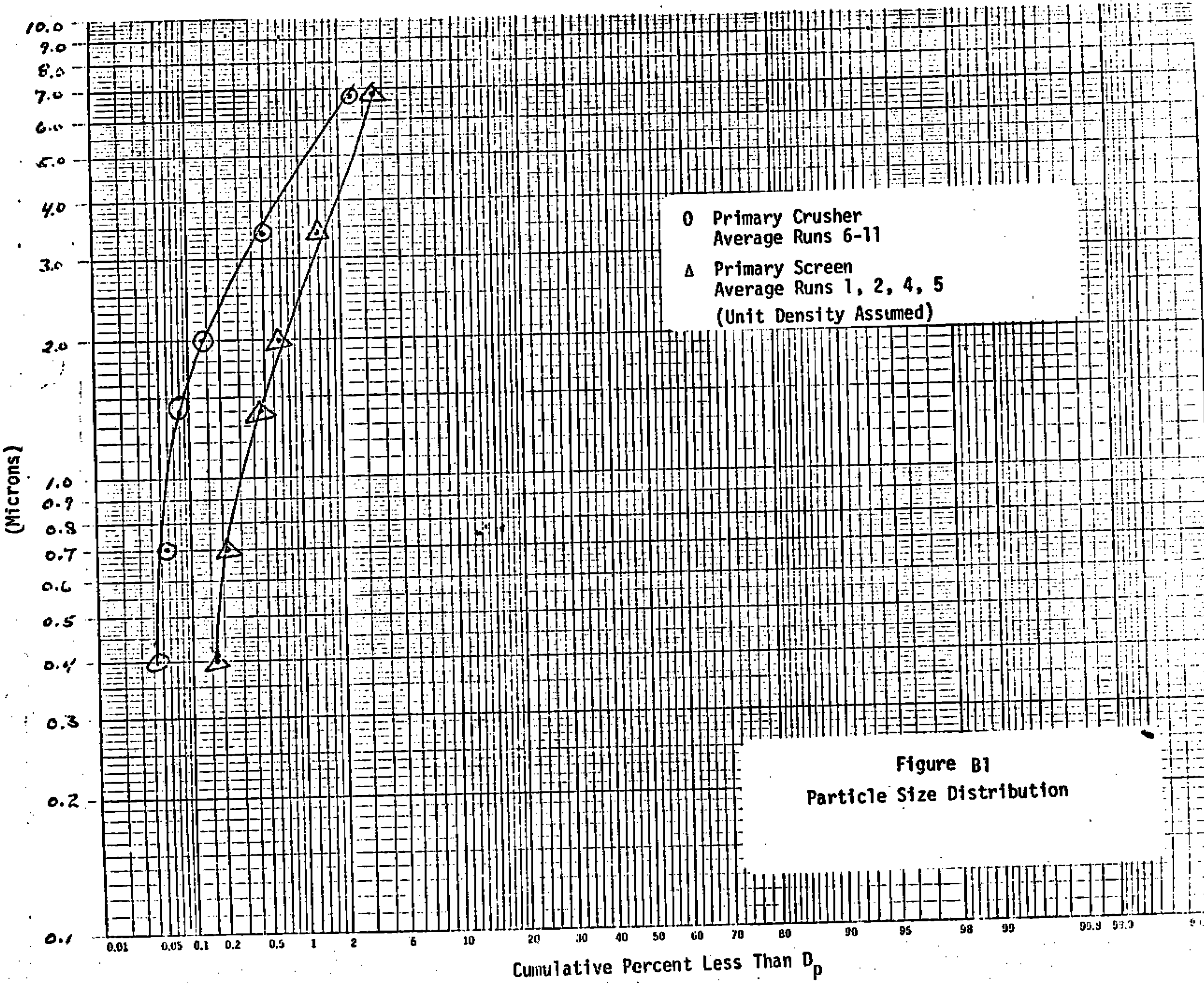


Figure B1
Particle Size Distribution

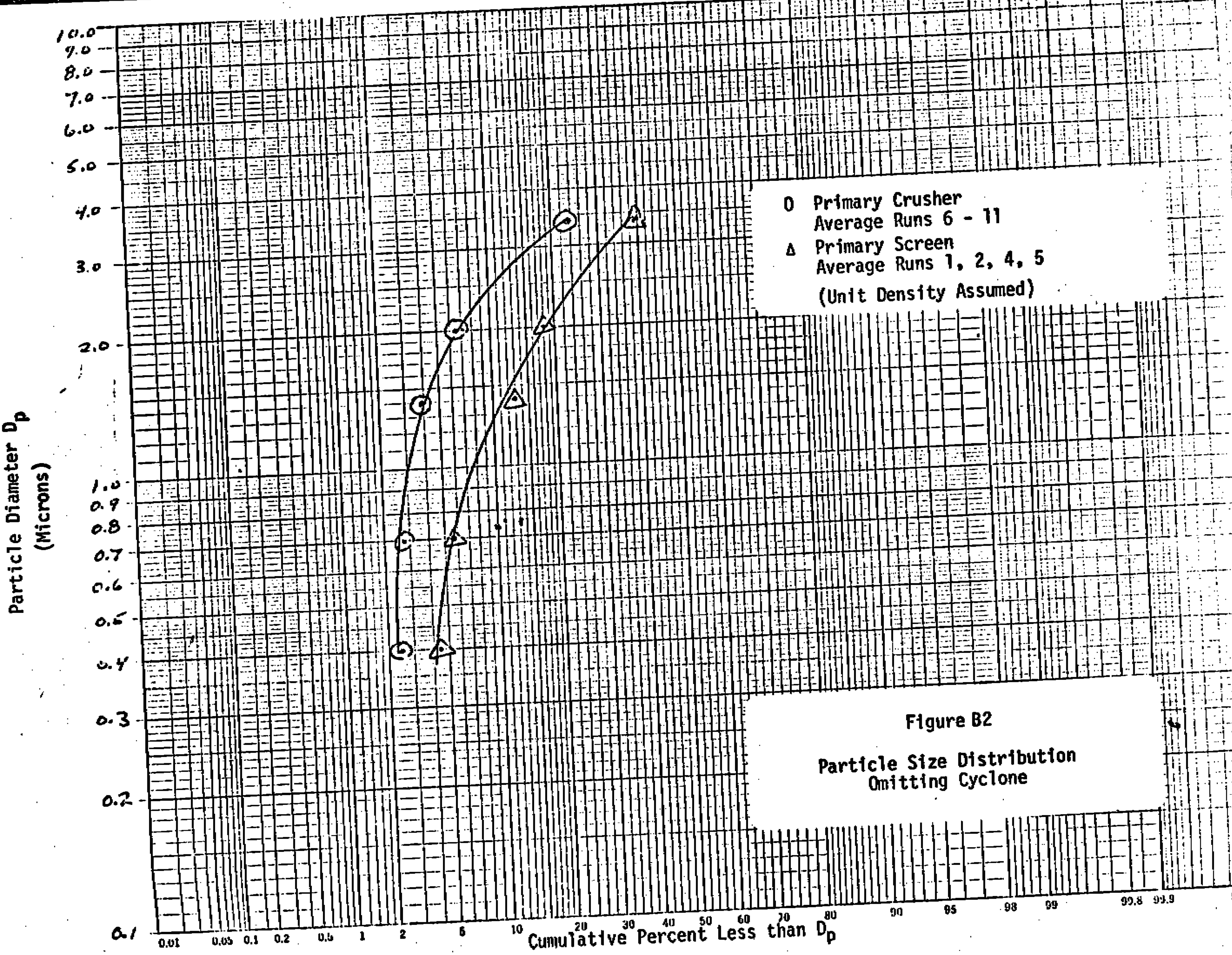
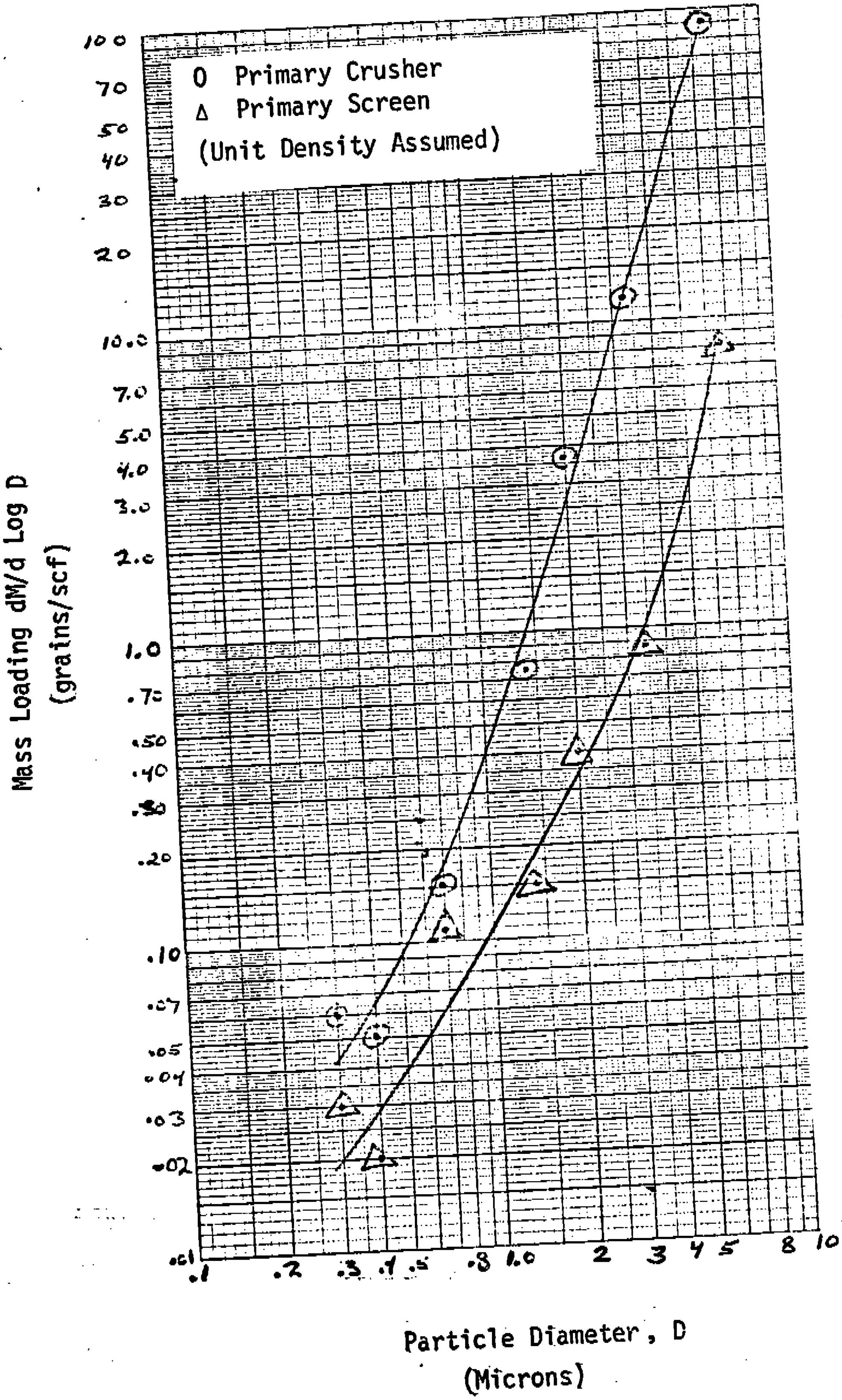


Figure B2

Particle Size Distribution
Omitting Cyclone

Figure B3
Particle Size Distribution



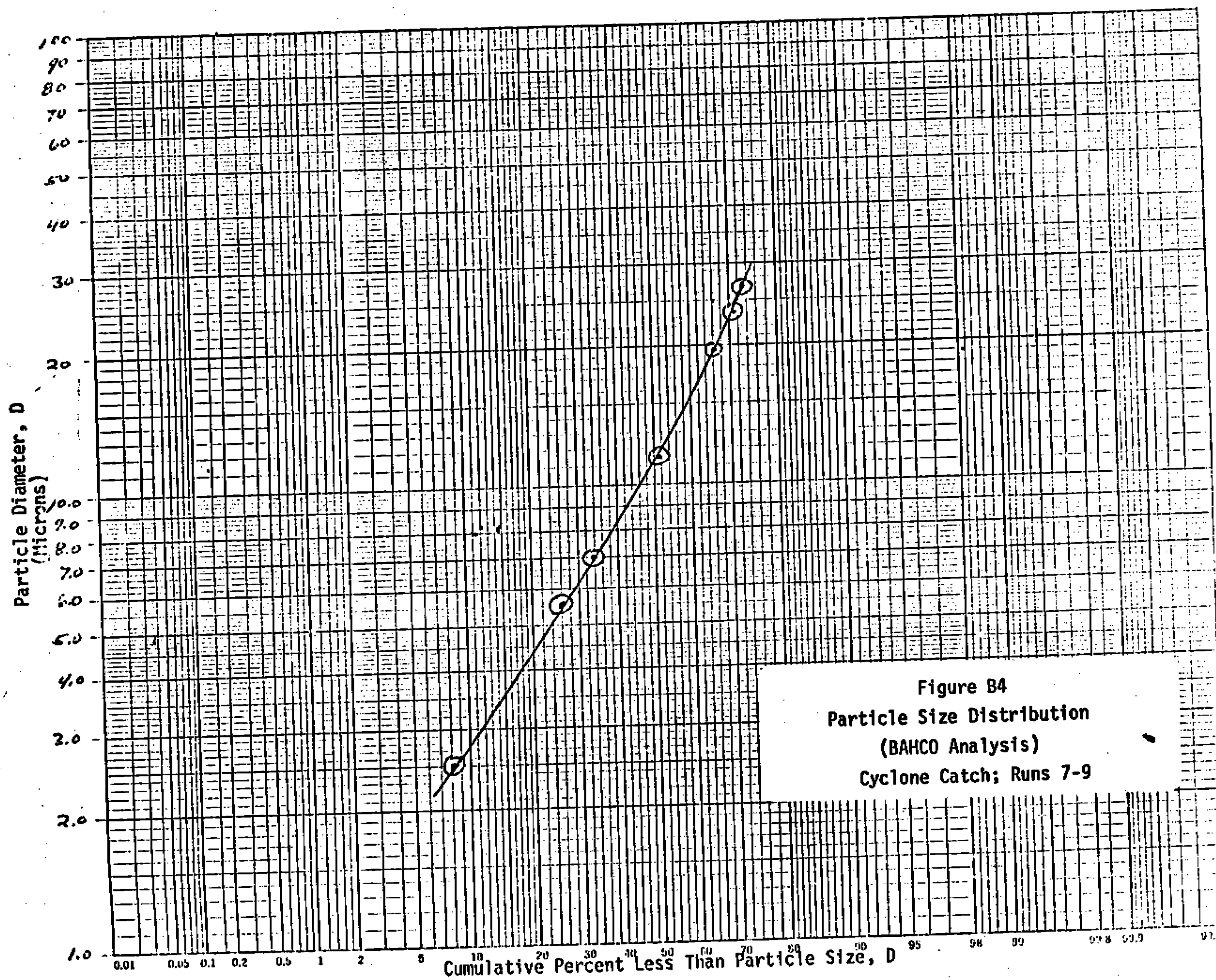


Figure B4
Particle Size Distribution
(BAHCO Analysis)
Cyclone Catch; Runs 7-9

around to the succeeding stage. It is the equivalent aerodynamic diameter (diameter based on a spherical particle of unit density) that the cascade impactor directly measures, and it is for this reason that the results are reported in terms of spherical particles of unit density. Not only does this method of reporting the data form a good standard for comparison between particles of varying shape and density, but it is generally the aerodynamic particle size which is of most interest.

Results

The test results are presented in three different forms:

1. Cumulative Mass Percent Less Than or Equal to Effective Particle Diameter - All Stages with cyclone (Tables B3-B4, Figure B1). This is the most widely used method for presenting particle size data. It is based on the mass percentage of total particulate collected on each stage.
2. Cumulative Mass Percent Less Than or Equal to Effective Particle Diameter - All stages excluding cyclone (Tables B3-B4, Figure B2). The data is presented in this manner because the weight percentage collected in the cyclone often varies widely from test run to test run. This is especially true at a control device inlet. When working with the small amounts of mass collected by the cascade impactor, a few extremely large particles collected in the cyclone may make a large difference in weight percentage. Using a cumulative basis of data presentation, this variance in weight percentage in the cyclone is propagated to the lower stages. Therefore, eliminating the cyclone from the data reduction eliminates any bias introduced during data reduction due to the fact that some extremely large and heavy parti-

cles may have collected in the cyclone. A better correlation of the weight percentages on the stages, would tend to indicate that some of the variance indicated when all five stages and the cyclone are plotted is due to the bias introduced by abnormally large particles impacting in the cyclone. Therefore, the data is presented in this manner only to help indicate whether or not a large amount of bias has been introduced due to abnormally large particles collecting in the cyclone.

3. Mass Loading as a Function of Effective Particle Size (Table B-5, Figure B3). Although particle size distribution data is usually presented in a cumulative percent form, in some cases this presents a biased view. This is because any error introduced either during sampling or analytical procedures on any single collection stage is propagated to the other stages by the nature of the data reduction. This is due to the fact that each data point is based on the total mass measured - an error on any one collection stage affects total mass and consequently introduces error to every other data point. Presenting the data in the form of mass loading as a function of particle size permits the results of each size range to be computed independently of the other size ranges.

Discussion of Results

Several areas should be noted concerning sampling and sample conditions. On test run #3, the orifice of the second stage clogged with a small piece of gasket material. This run is considered invalid; the results are reported but are not used in average values.

During test run #12 the first stage was overloaded; therefore, the results are reported but are not used in average values.

For test runs #12 and #13 a large diameter nozzle was used resulting in extremely under-isokinetic sampling. This was intentionally done for experimental purposes. These values are reported for comparison, and are not included in average values.

Sampling Procedure

Prior to testing, a full velocity traverse was conducted at each sample location. At both test sites, each test run was conducted at a single point. The velocity at this point was measured immediately preceeding each test run. The locations of the test points are indicated in Figures B5-B6.

The configuration of the sampling train used is shown in Figures B7 and B8. The impactor was placed in the stack and the nozzle was then turned downstream and the vacuum pump started. The flow rate through the impactor was kept constant throughout each run. This was accomplished by operating at a constant vacuum. (The particulate build-up on the filter is not great enough to cause a significant increase in pressure drop across the filter; therefore, a constant vacuum is indicative of a constant flow rate). At the termination of each run, the nozzle was turned upstream, and removed from the stack and the pump was turned off. This was necessary due to a high negative pressure in the stacks. After each test , the impactor was disassembled and the collection plates and filter were removed, placed in dessicators, and returned to the field laboratory. The cyclone was washed with acetone, and the collected material was returned to the laboratory for drying and weighing. For test runs 7-9, the cyclone catch was collected, dried,and weighed.The dry particulate from the cyclone of the three test runs was then combined so that a Bahco particle size analysis could be performed. The results are shown in Figure 4.

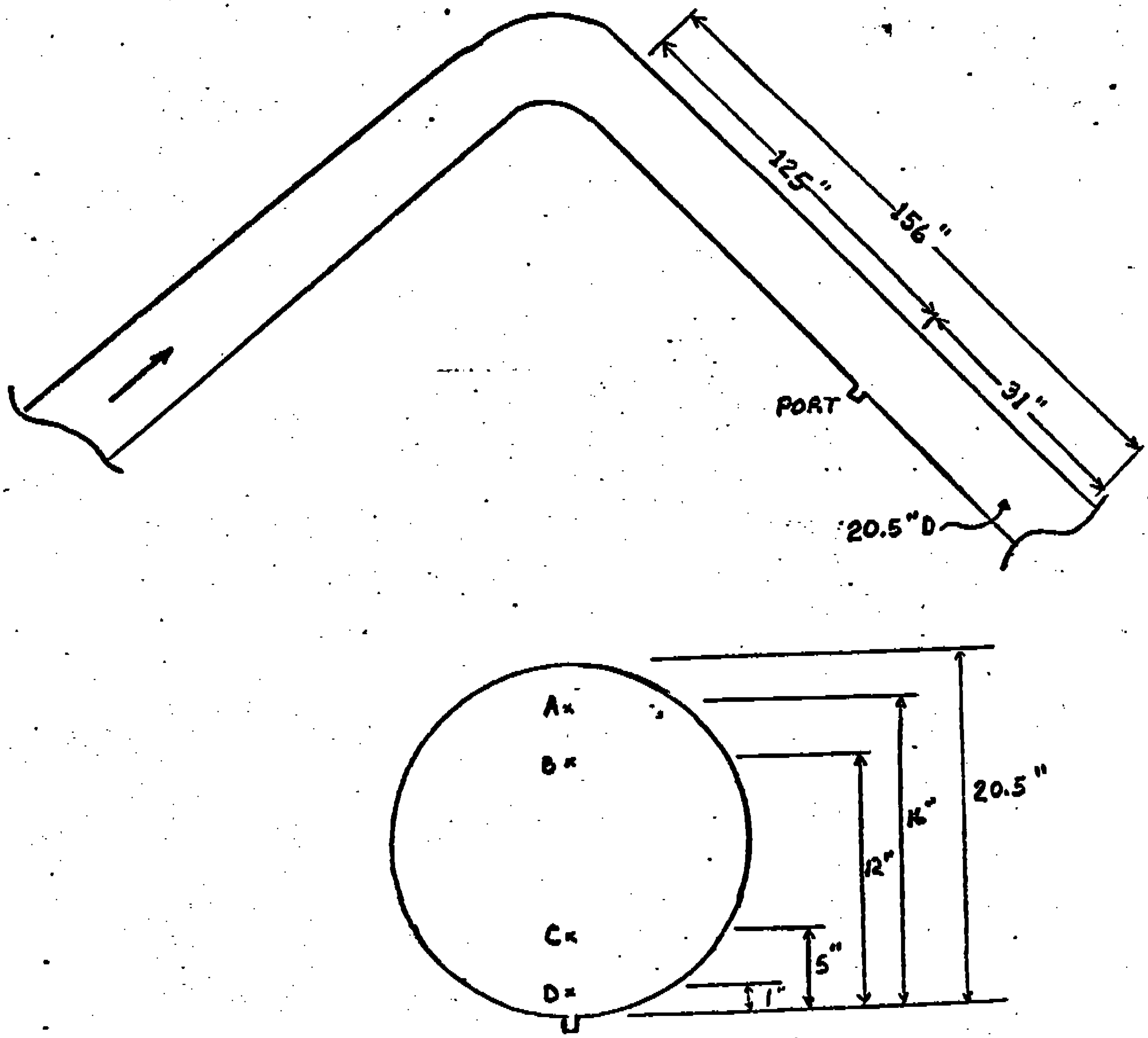


FIGURE B5
Sampling Location
Primary Screen

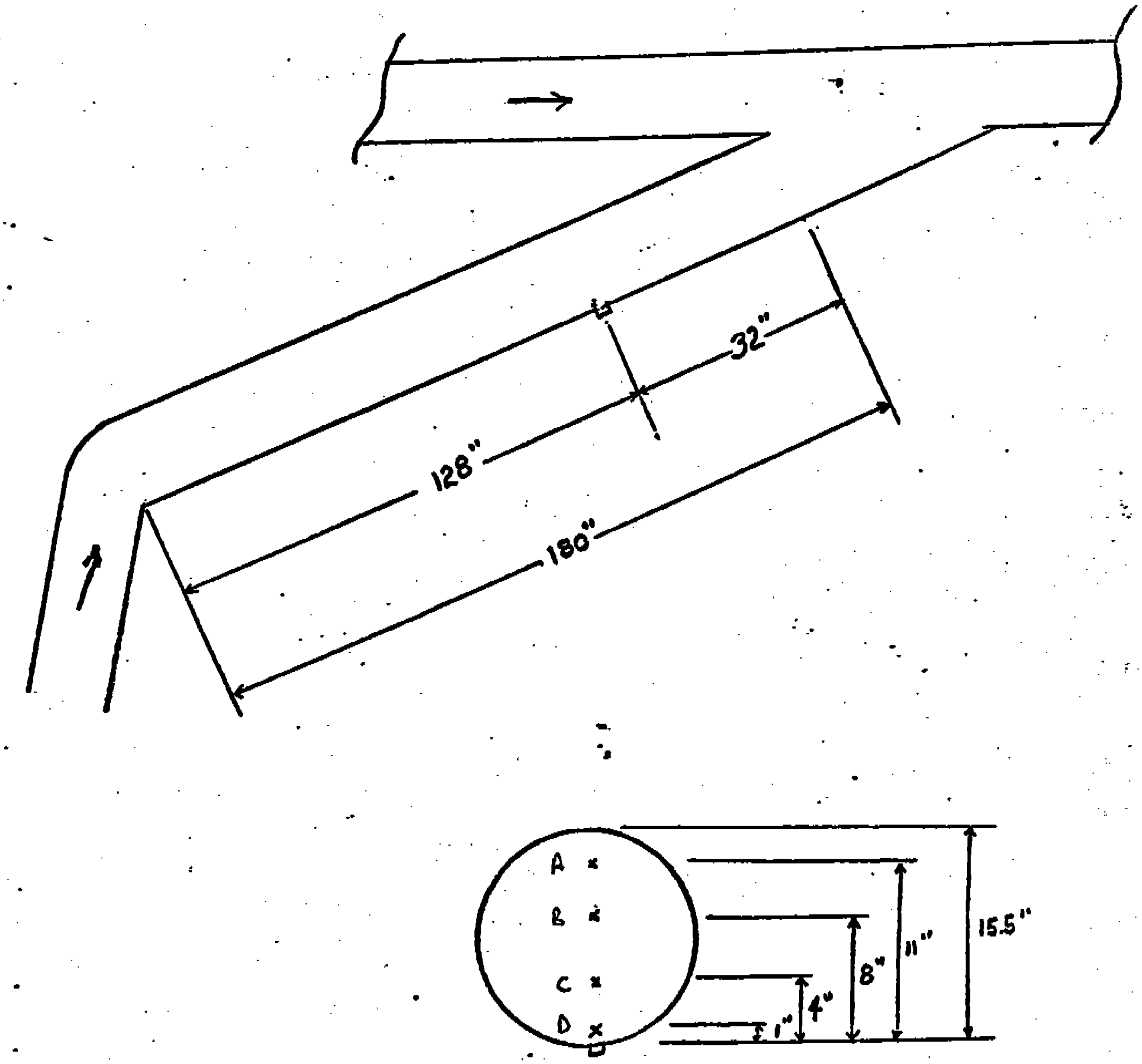


FIGURE B6
Sampling Location
Crusher

Figure B7

PARTICLE SIZE DISTRIBUTION SAMPLING TRAIN

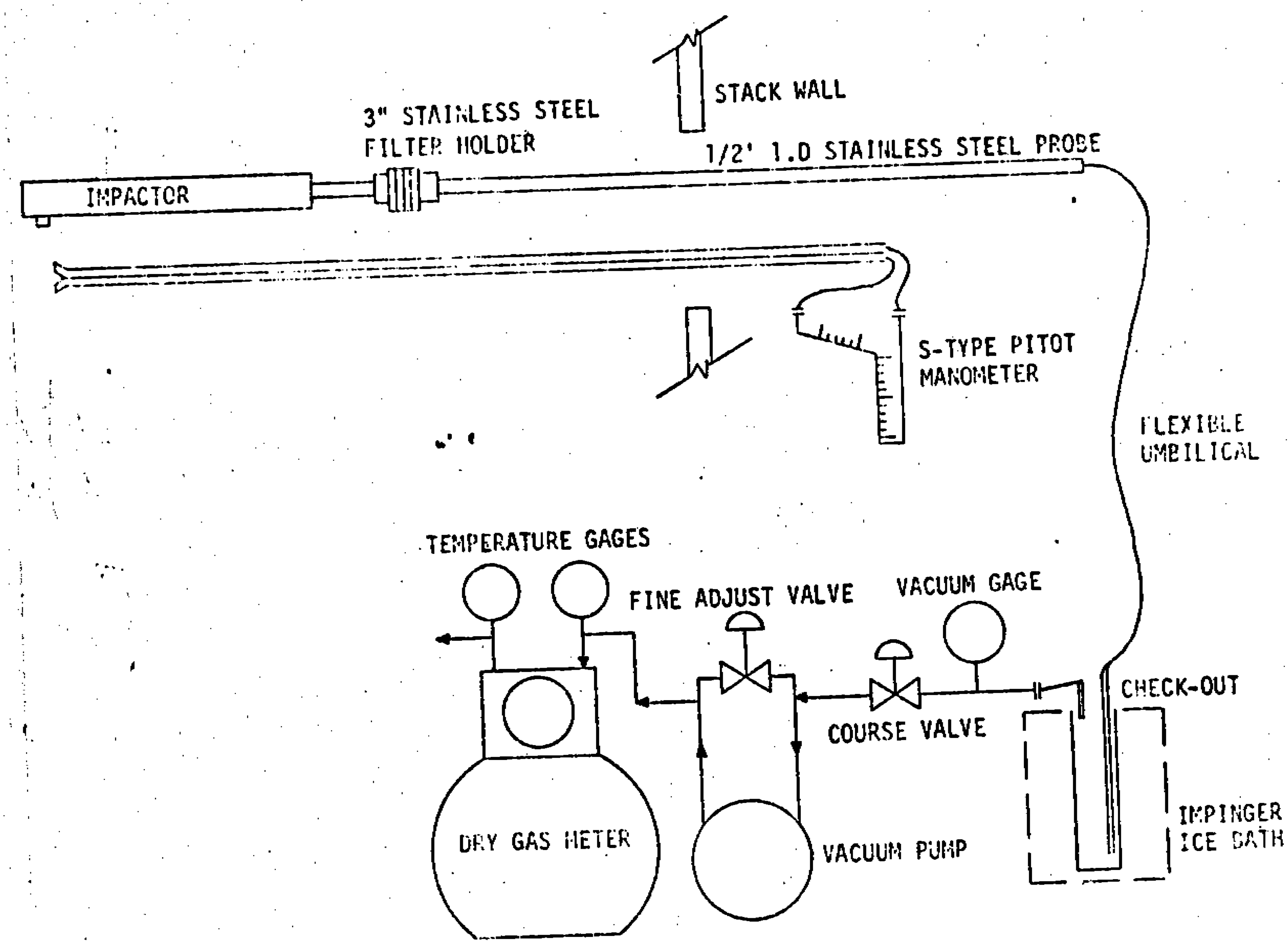
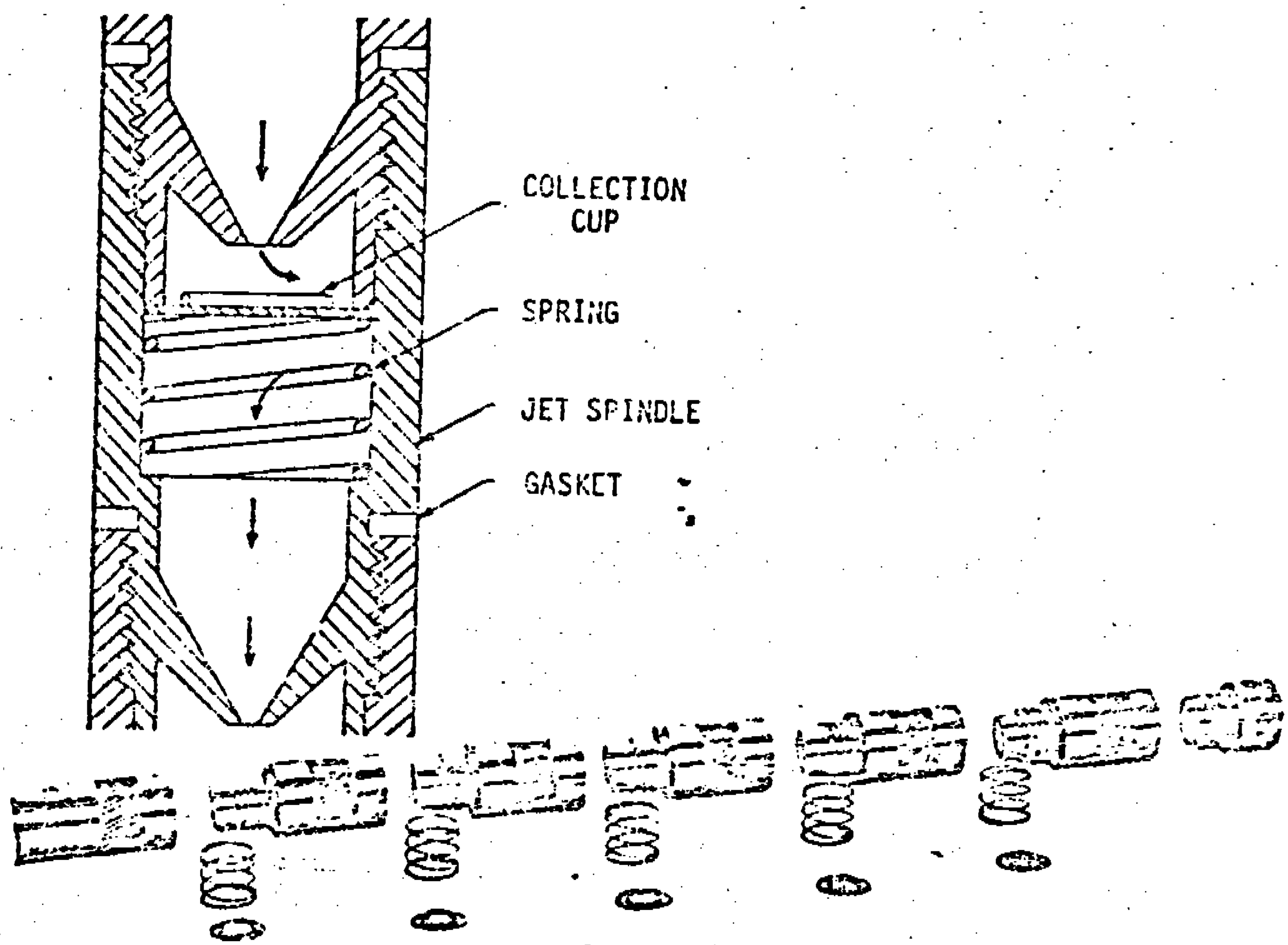


Figure B8

MODEL B CASCADE IMPACTOR



The impaction plates provided with the impactor each weigh approximately 3 grams. In order to reduce tare weight, aluminum foil discs were inserted on the steel plates. The substrates were treated in the field laboratory with silicon grease dissolved in benzene and then baked at 110°C for 1 1/2 hours. The substrates were then dessicated and weighed. After testing, the substrates were returned to the field laboratory, dessicated, and reweighed. All weighing was done on an electronic balance accurate to .001 mg.

Dry molecular weight and moisture content was obtained by averaging the results of the EPA Method 3 and Method 5 tests conducted by Valentine, Fisher and Tomlinson.

EQUATIONS AND SAMPLE CALCULATIONS

TEST RESULTS (TABLE B1)

Calculations for these values were done according to the equations of EPA Method 5, Federal Register, December 23, 1971.

PARTICLE SIZE DISTRIBUTION

1) Characteristic Particle Diameter, Dp_{50}

Calculation of the characteristic particle diameter was based on the generalized calibration curve determined by Ranz and Wong[1]. Ranz and Wong used dimensional analysis techniques to develop a dimensionless inertial impactor parameter, Ψ. From this work, the characteristic particle diameter can be developed:

$$Dp_{50} \sqrt{\frac{18\ \mu D\ \Psi_{50}}{C\ \rho_p\ V}} \times (10^4) \qquad (1)$$

where C, Cunningham Correction Factor, is a function of Dp_{50}:

$$C = 1 + \left[\frac{2L}{Dp}\right] \left[1.23 + 0.41e^{\frac{-.44Dp\ 10^{-4}}{L}}\right] \left[10^4\right] \qquad (2)$$

A computer program was used to obtain Dp by solving equations (1) and (2) simultaneously by iteration.

Dp = characteristic particle diameter, microns
μ = viscosity of gas, poise
D = diameter of impactor jet, cm
Ψ_{50} = inertial parameter for 50% stage efficiency
C = Cunningham Correction Factor
ρ_p = particle density, g/cc
V = jet velocity, cm/sec
L = gas mean free path, cm

[1] Ranz, W. E. and Wong, J. B., AMA Archives of Industrial Hygiene and Occupational Medicine, 5,464-77, 1952.

EQUATIONS AND SAMPLE CALCULATIONS

2) Weight Percent

$$\text{weight \% stage N} = \frac{\text{mass stage N}}{\text{all stages total mass}} \times 100$$

example, test 1

$$\text{weight \% stage 1} = \frac{.00343\text{g}}{.22478\text{g}} \times 100$$

$$= 1.53\%$$

3) Cumulative % $\leq Dp_{50}$

cum % $\leq Dp_{50}$, stage N = Total sum of mass percent on stages with $Dp_{50} \leq Dp_{50}$, stage N

example, test 1

Stage	Dp_{50}	Mass %
Cyclone	6.8	97.69
1	3.4	1.53
2	2.0	0.47
3	1.4	0.14
4	0.7	0.07
5	0.4	0.00
Filter	0.3	0.10

cum % Dp_{50}, stage 3 = mass % stage 4 + mass % stage 5 + mass % filter
= 0.10 + 0.00 + 0.07
+ 0.17%

4) dM/d Log D, gr/scf

$$\text{dM/d Log D}_{\text{stage N}} = \frac{\text{(gr/scf) stage N}}{\text{Log Dp}_{50}\text{ stage N-1} - \text{Log Dp}_{50}\text{ stage N}}$$

example, test 1

Stage	Dp_{50}	gr/scf
Cyclone	6.8	35.81
1	3.4	0.56
2	2.0	0.17
3	1.4	0.05
4	0.7	0.03
5	0.4	0.00
Filter	0.3	0.04

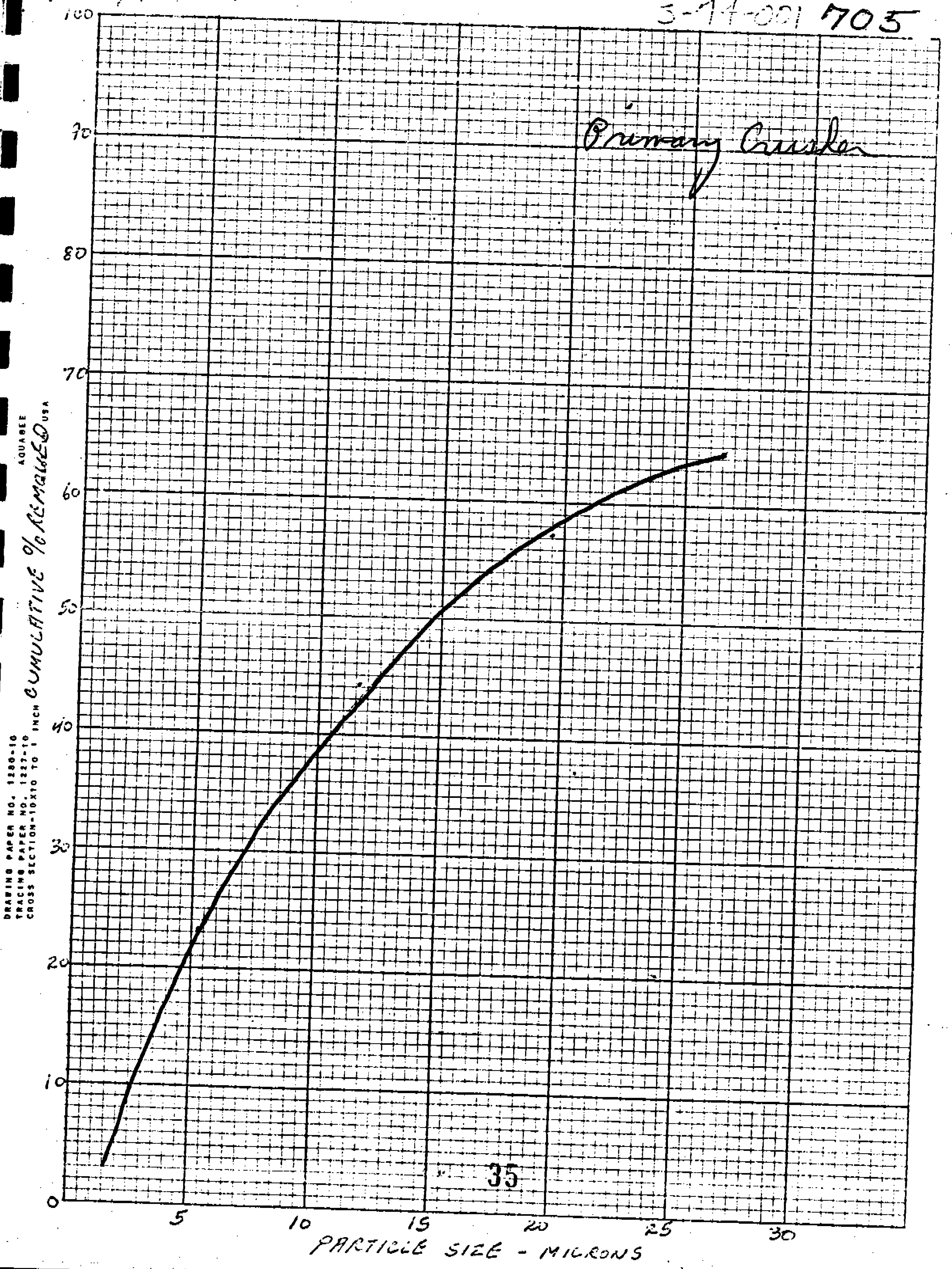
$$\text{dM/d Log D}_{\text{stage 3}} = \frac{.05}{\text{Log 2.0} - \text{Log 1.4}}$$
$$= 0.32$$

PARTICLE SIZE CUMULATIVE PERCENT

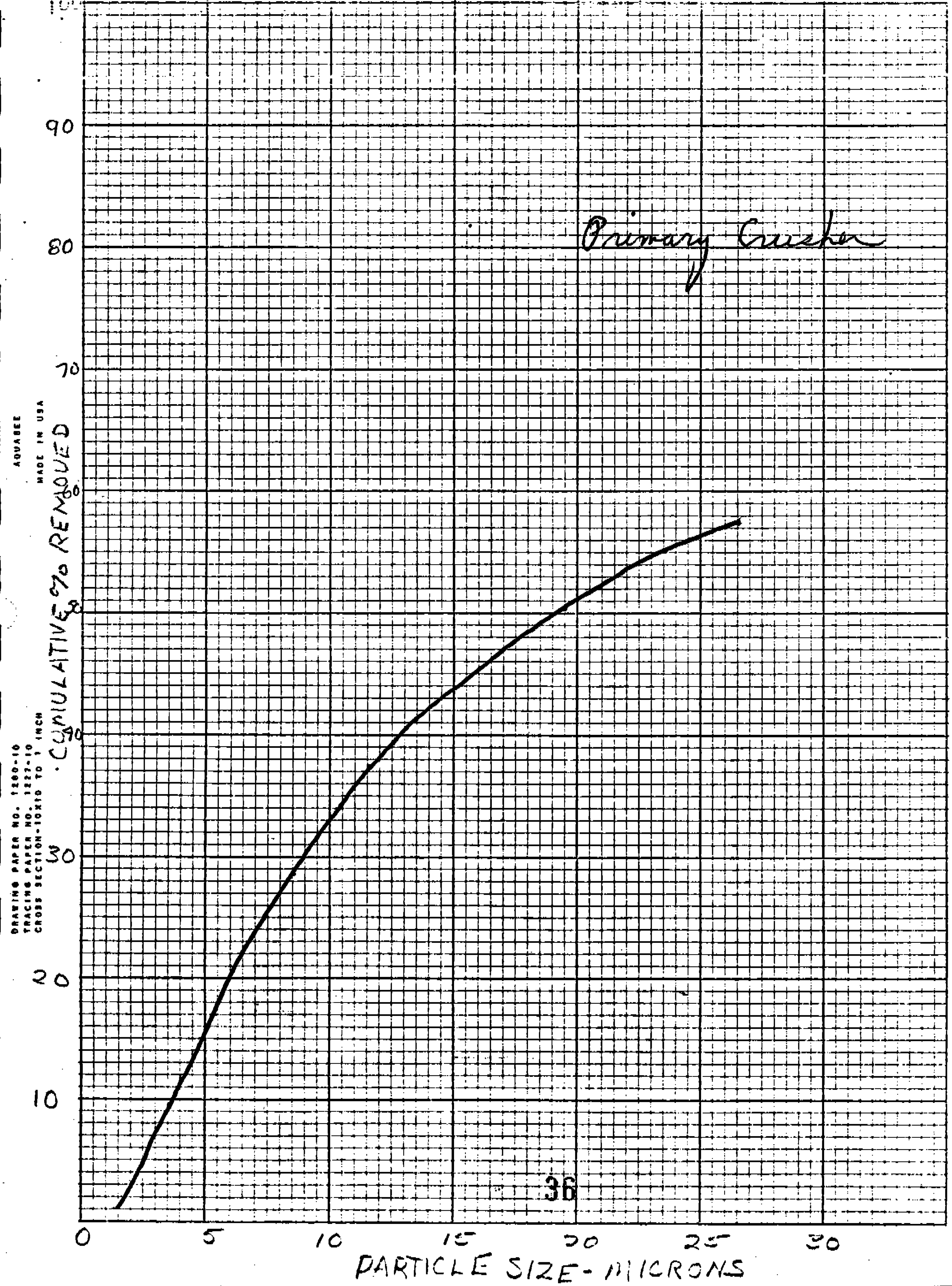
CENTRIFUGAL CLASSIFIER (BAHCO) ANALYSIS

7/16/74

3-74-001 705

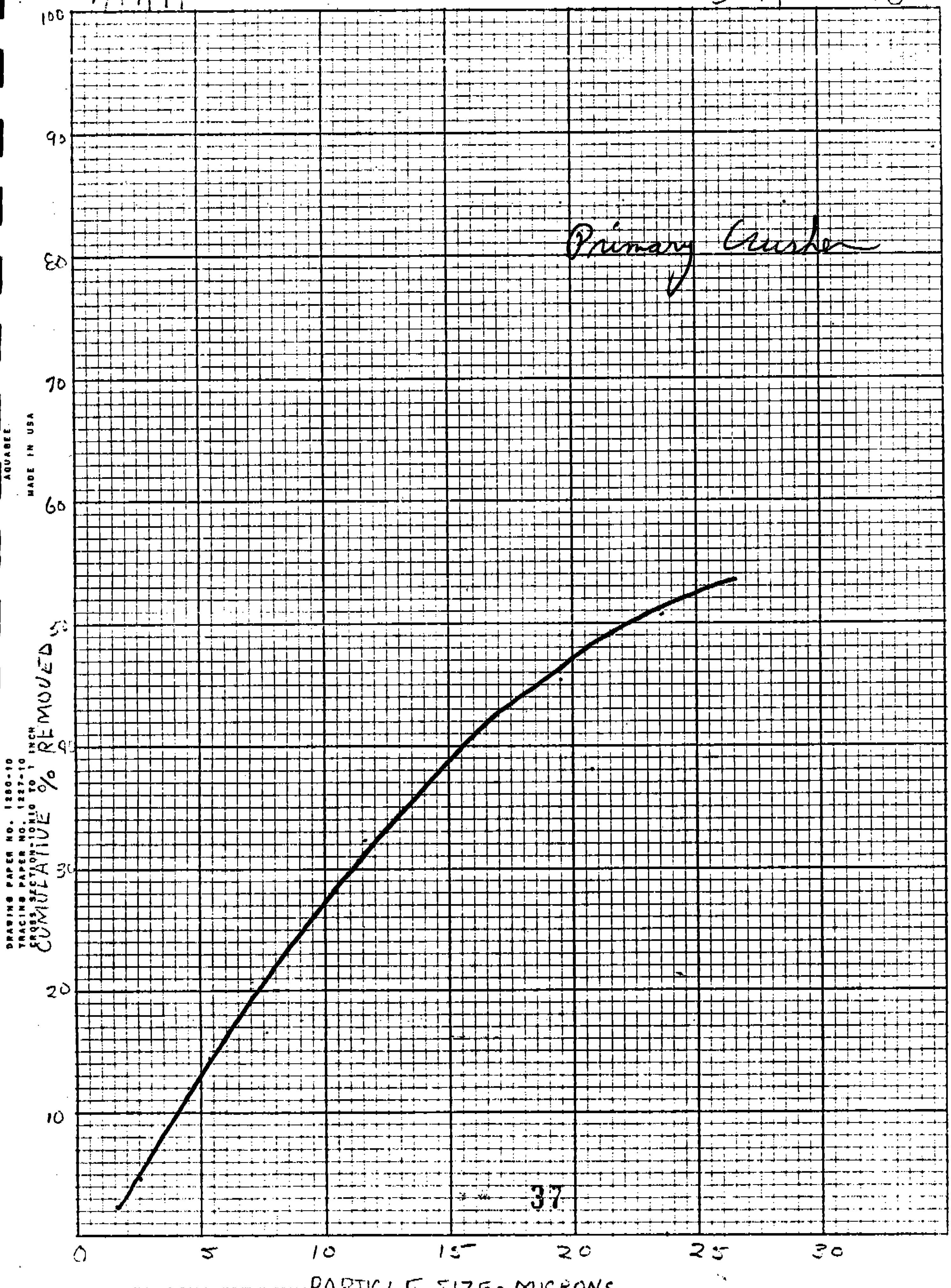


S-74-001706



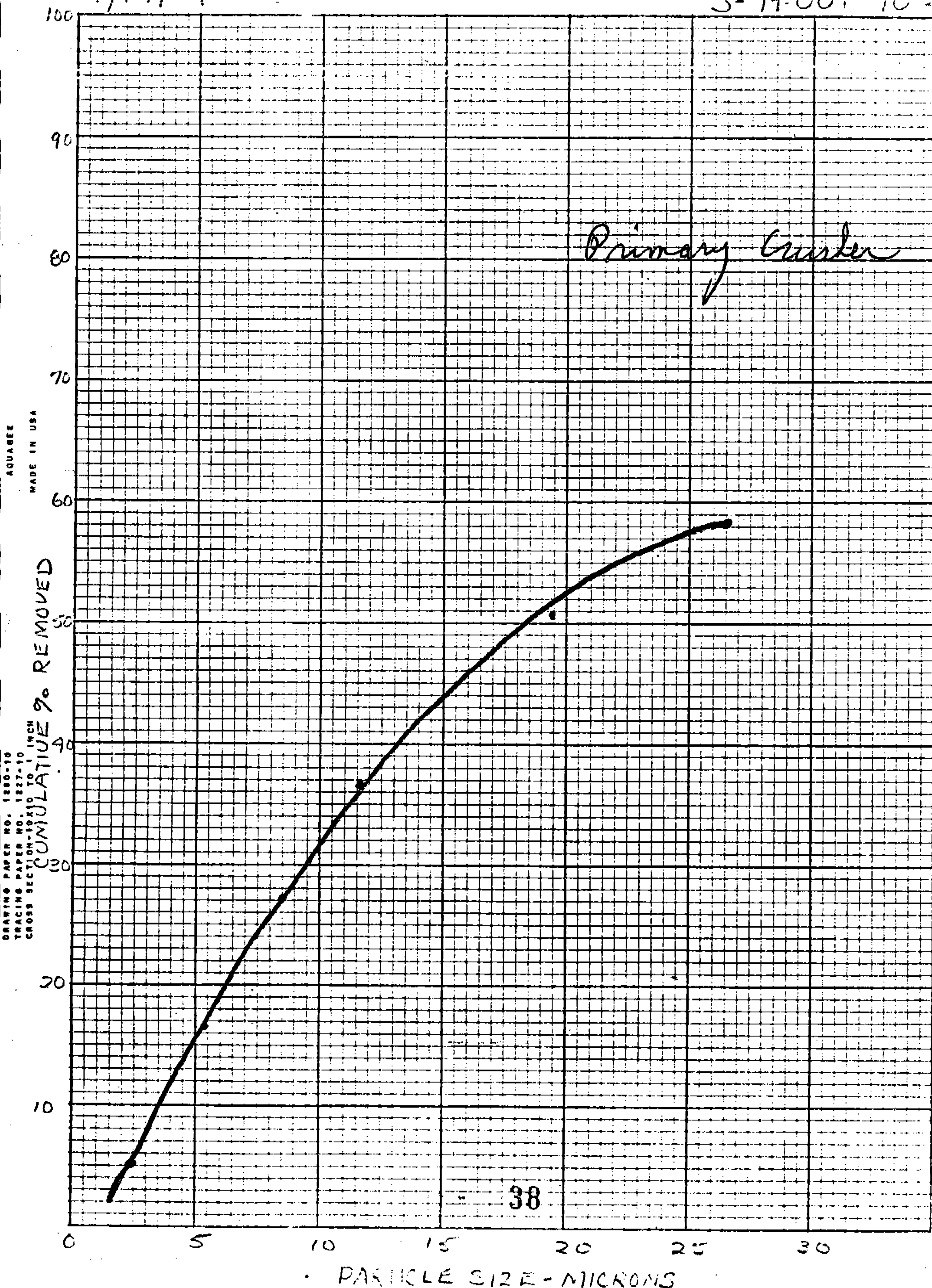
Primary Crusher
CUMULATIVE % REMOVED
PARTICLE SIZE - MICRONS
100
90
80
70
60
50
40
30
20
10
0
5
10
15
20
25
30
AQUABEE
MADE IN USA
DRAWING PAPER NO. 1200-10
TRACING PAPER NO. 1227-10
CROSS SECTION-10X10 TO 1 INCH

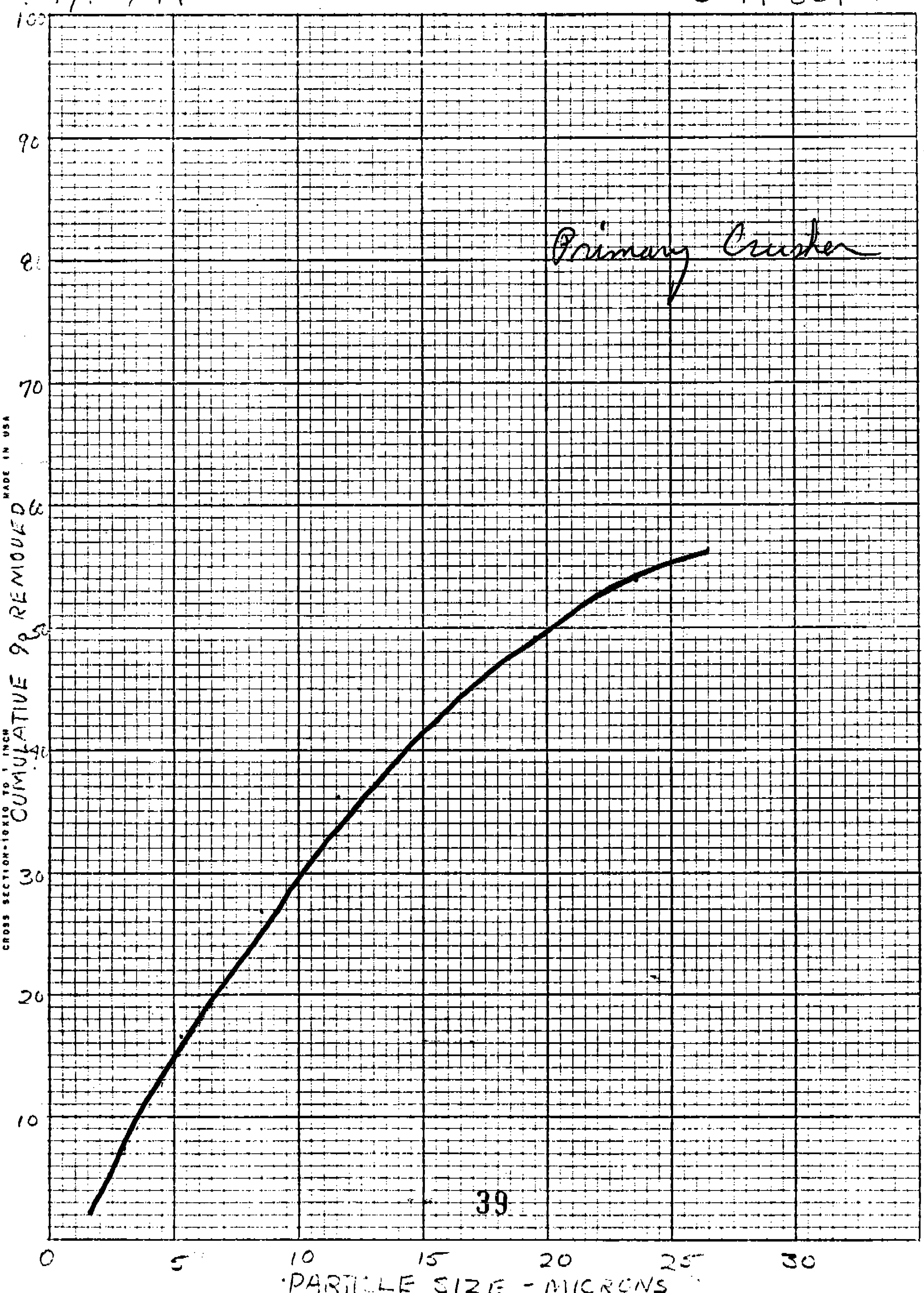
7/19/94 5-94-00190



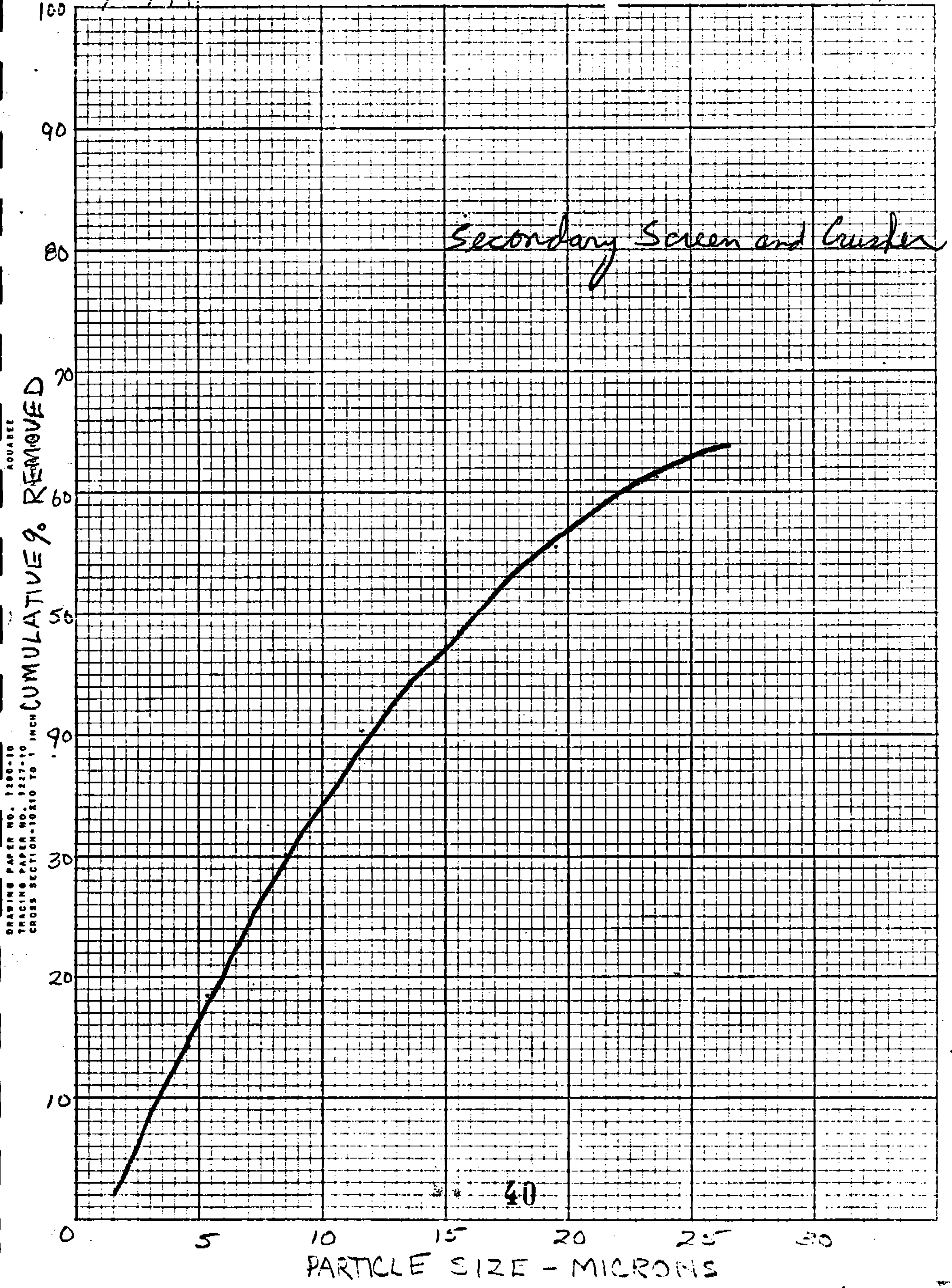
7/17/71

S-74-001 70-



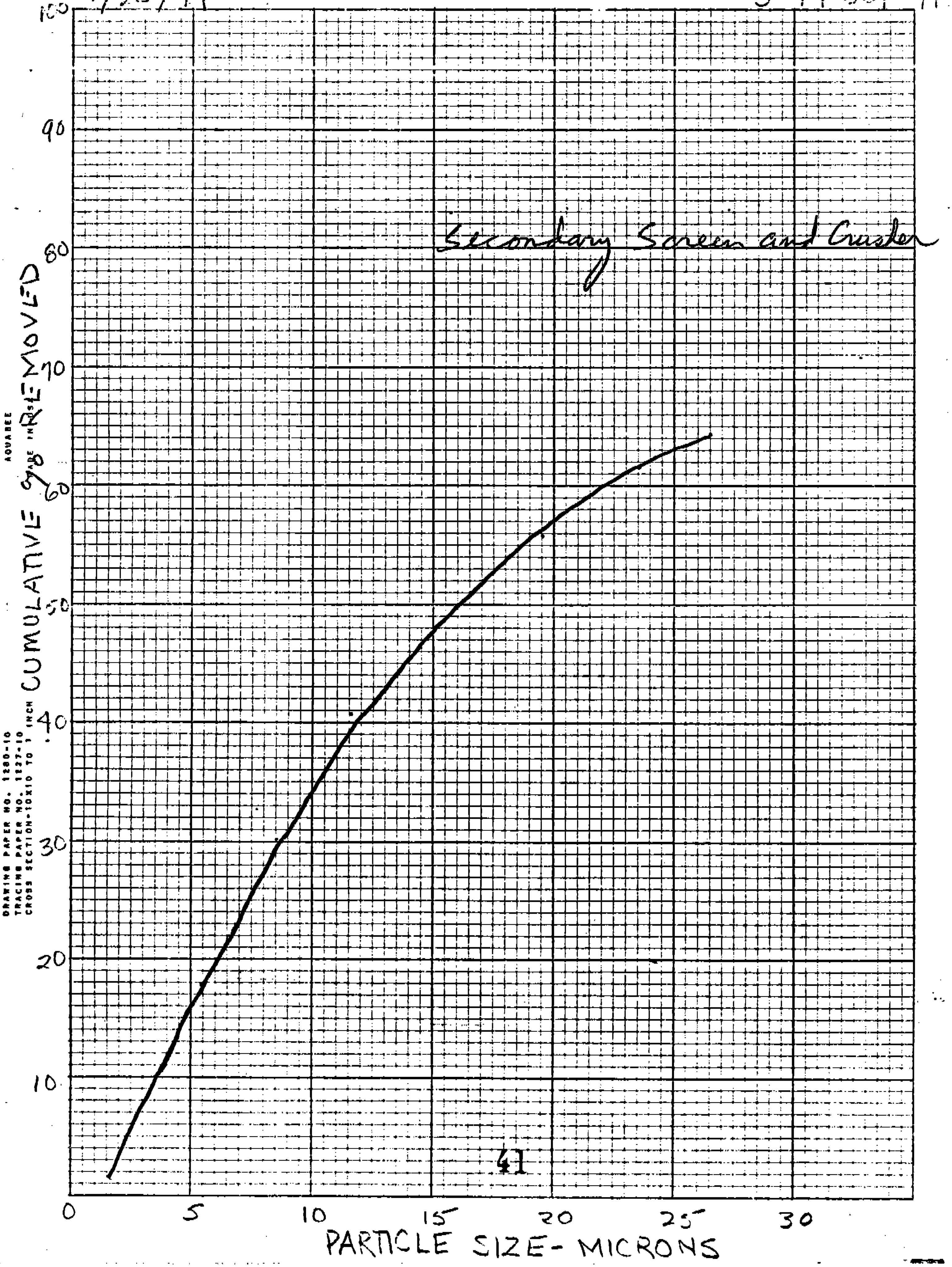

Primary Crusher
CUMULATIVE % REMOVED
100
90
80
70
60
50
40
30
20
10
0
5
10
15
20
25
30
PARTICLE SIZE - MICRONS
DRAWING PAPER NO. 1280-10
TRACING PAPER NO. 1227-10
CROSS SECTION-10X10 TO 1 INCH
AQUABEE
MADE IN USA

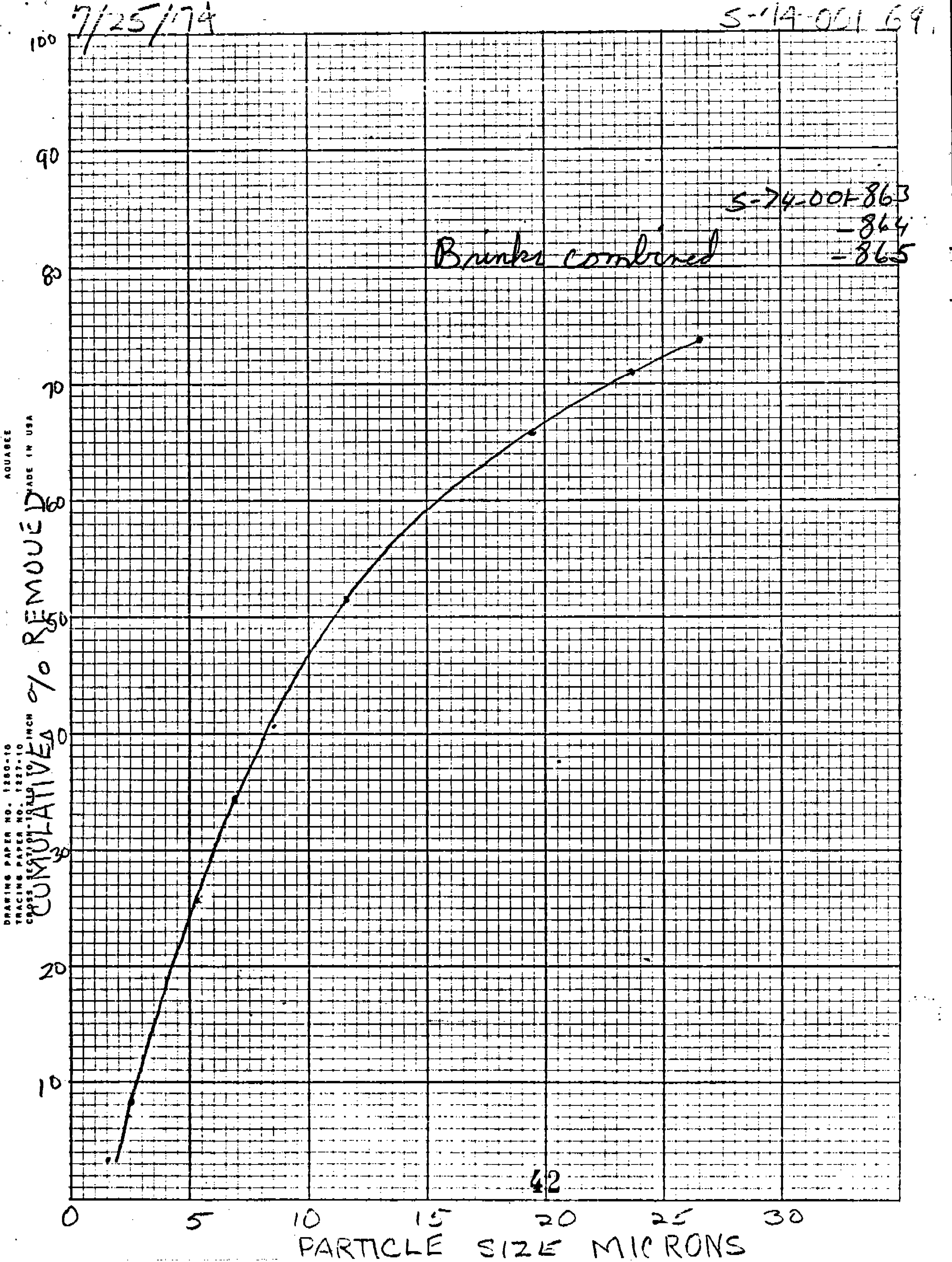
7/18/74 5-74 001 710



7/25/74

5-74 001 71




7/25/74
5-74-001 69.
5-74-001-863
-864
-865
Brinks combined
CUMULATIVE % REMOVED
100
90
80
70
60
50
40
30
20
10
0
5
10
15
20
25
30
PARTICLE SIZE MICRONS
DRAWING PAPER NO. 1280-10
TRACING PAPER NO. 1227-10
CROSS SECTION 10 TO INCH
AQUABEE
MADE IN USA

Dust samples
Primary Area

SAMPLE IDENTIFICATION LOG

EPA Number	Sample Location	Run	Contents	Comments
[illegible]4-001-705	Primary Crusher	1	Baghouse collected dust	6-4-74 @ 10:25
706	" "	2	" " "	6-7-74 @ 15:15
707	" "	3	" " "	6-11-74 @ 07:30
708	" "	4	" " "	6-12-74 @ 07:30
709	" "	5	" " "	6-13-74 @ 07:15

SAMPLE IDENTIFICATION LOG

EPA Number	Sample Location	Run	Contents	Comments
574-001-710	Secondary Blast	2	Baghouse dust @ 6-7-74 1400	No sample obtained for
-711	" / "	3	" " 6-8-74 1330	Run 1

SOURCE SAMPLE REQUEST & REPORT
(MUST BE FILLED OUT FOR EACH TEST RUN)

SAMPLING DATE: 74 (YR) 6 (MO) 4 (DAY)

FIRST IDENT. NO. USED: S74-001-705

LAST IDENT. NO. USED: S74-001-711

TEST NO: 1

RUN NO: 1

INDUSTRY: Stone Crushing (USE TABLE A)

COMPANY: Arizona Portland Cement

ADDRESS: Rillito, Arizona

SAMPLING METHOD: Grab sample!

UNIT PROCESS OPERATION: Primary & Secondary Crusher

AIR POLLUTION CONTROL: Baghouse

FUEL USED: N/A

☑ INLET ☐ OUTLET

GAS VOLUME SAMPLED (METER VOL IN FT³): N/A

IDENT NO	DESCRIPTION OF SAMPLE OR SAMPLE FRACTION	SAMPLE WT (SOLID) MG	SAMPLE VOL (LIQUID) ML	ANALYSIS REQUESTED - GENERAL COMMENTS (APPROX CONCENTRATIONS - POSSIBLE INTERFERENCES ETC) (INDICATE SPECIFIC ANALYSIS ON BACKSIDE)
S74-001-705	Stone crushing baghouse dust (primary)			Particle Size vs Cumulative % (Bahco)
-706	" " " " (primary)			" " " " " "
-707	" " " " (primary)			" " " " " "
-708	" " " " (primary)			" " " " " "
-709	" " " " (primary)			" " " " " "
-710	" " " " (secondary)			" " " " " "
-711	" " " " (secondary)			" " " " " "

COMMENTS: Please retain samples after analysis for storage!

SAMPLING CONTRACTOR: Valentine, Fisher, Tomlinson (IF APPLICABLE)   PROJECT OFFICER: Clyde E. Riley (ext 583)   REQUEST REVIEWED BY: ______

DATE OF REQUEST: 7-8-74   DATE ANALYSIS REQUESTED: ______   DATE OF REQUEST: ______ (TO BE FILLED IN BY SSFAB)

EPA(DUR)245

45

SOURCE SAMPLE REQUEST & REPORT
(MUST BE FILLED OUT FOR EACH TEST RUN)

SAMPLING DATE: 74 (YR) 6 (MO) 7 (DAY)

FIRST IDENT. NO. USED: 574-001-691

LAST IDENT. NO. USED: 574-001-691

TEST NO: 1

RUN NO: 1

INDUSTRY: Stone Crushing (USE TABLE A)

COMPANY: Arizona Portland Cement

ADDRESS: Rillito, Arizona

SAMPLING METHOD: particle size ~~dust~~ sample / Brinks

UNIT PROCESS OPERATION: Primary Crusher

AIR POLLUTION CONTROL: Baghouse

FUEL USED: N/A

☒ INLET ☐ OUTLET

GAS VOLUME SAMPLED (METER VOL IN FT3): N/A

IDENT NO	DESCRIPTION OF SAMPLE OR SAMPLE FRACTION	SAMPLE WT (SOLID) MG	SAMPLE VOL (LIQUID) ML	ANALYSIS REQUESTED - GENERAL COMMENTS (APPROX CONCENTRATIONS - POSSIBLE INTERFERENCES ETC) (INDICATE SPECIFIC ANALYSIS ON BACKSIDE)
574-001-691	Brinks particle sizer cyclone catch			Particle Size vs Cumulative % (Bahco)
	No. 863			
	combined as — 864			
	one sample (691) 865			

46

COMMENTS: Please combine containers 573-004-863, 573-004-864, & 573-004-865 to make-up 574-001-691 (Individual samples less than 15 gms.)

SAMPLING CONTRACTOR: EPA (IF APPLICABLE)

PROJECT OFFICER: Roy Neulight (Clyde E. Riley)

REQUEST REVIEWED BY:

DATE OF REQUEST: 7-8-74

DATE ANALYSIS REQUESTED:

Phone - ext 583

DATE OF REQUEST: (TO BE FILLED IN BY SSFAB)

EPA(DUR)245

PARTICLE SIZE

FIELD DATA

FIELD LABORATORY DATA

Run	Stage	Balance Reading (Tare)*	Balance Reading (Final)*	Balance Reading (Net)	Net (mg)**
1	1	0.8042	0.9758	0.1716	3.4320
	2	0.8722	0.9246	0.0524	1.0480
	3	0.8012	0.8172	0.0160	0.3200
	4	0.7814	0.7894	0.0080	0.1600
	5	0.7644	0.7646	0.0002	0.0040
2	1	0.7478	0.8142	0.0664	1.328
	2	0.7312	0.7576	0.0264	0.528
	3	0.9838	0.9896	0.0058	0.116
	4	0.7634	0.7882	0.0248	0.496
	5	0.7014	0.7056	0.0042	0.084
3	1	0.8880	0.9646	0.0766	1.532
	2	0.7484	0.5614τ	N/A	7.488
	3	0.8086	0.8018	-	0
	4	0.8304	0.8392	0.0088	0.176
	5	0.8892	0.8810	-	0
4	1	0.8444	0.8990	0.0546	1.0920
	2	0.9814	0.9984	0.0170	0.3400
	3	0.7936	0.7946	0.0010	0.0200
	4	0.7724	0.7758	0.0034	0.0680
	5	0.7310	0.7316	0.0006	0.0120
5	1	0.8030	0.8736	0.0706	1.412
	2	0.7900	0.8168	0.0268	0.536
	3	0.7072	0.7170	0.0098	0.196
	4	0.8164	0.8232	0.0068	0.136
	5	0.7710	0.7720	0.0010	0.020

* Balance range 20 mg unless otherwise stated

** mg = Balance reading x balance range

τ Balance range 40 mg

N/A Not applicable

FIELD LABORATORY DATA
(Continued)

Run	Stage	Balance Reading (Tare)*	Balance Reading (Final)*	Balance Reading (Net)	Net (mg)**
6	1	0.6920	0.5830τ	N/A	9.48
	2	0.7762	0.8654	0.0892	1.784
	3	0.9466	0.9664	0.0198	0.396
	4	0.7616	0.7684	0.0068	0.136
	5	0.8150	0.8228	0.0078	0.156
7	1	0.7296	0.6002τ	N/A	9.416
	2	0.7574	0.8294	0.0720	1.440
	3	0.7714	0.7846	0.0132	0.264
	4	0.8640	0.8578	-	0.000
	5	0.7580	0.7592	0.0012	0.024
8	1	0.7098	0.6236τ	N/A	10.748
	2	0.7660	0.8652	0.0992	1.984
	3	0.8828	0.9030	0.0202	0.404
	4	0.7792	0.7848	0.0056	0.112
	5	0.7660	0.7576	-	0.000
9	1	0.8352	0.7928τ	N/A	15.008
	2	0.8000	0.9742	0.1742	3.484
	3	0.9648	0.9746	0.0098	0.196
	4	0.8148	0.8182	0.0034	0.068
	5	0.7668	0.7648	-	0.000
10	1	0.9348	0.5778τ	N/A	4.116
	2	0.9048	0.9622	0.0574	1.148
	3	0.7664	0.7798	0.0134	0.268
	4	0.9772	0.9828	0.0056	0.112
	5	0.2036ττ	0.2044ττ	-	0.000

* Balance range 20 mg unless otherwise stated

** mg = Balance reading x balance range

τ Balance range 40 mg

ττ Balance range 100 mg

N/A Not applicable

FIELD LABORATORY DATA
(Continued)

Run	Stage	Balance Reading (Tare)*	Balance Reading (Final)*	Balance Reading (Net)	Net (mg)**
11	1	0.9652	0.8758$^{\tau}$	N/A	15.728
	2	0.6524	0.8784	0.2260	4.520
	3	0.8400	0.8794	0.0394	0.788
	4	0.9074	0.9252	0.0178	0.356
	5	0.9592	0.9610	0.0018	0.036
12	1	0.9832	0.6846$^{\tau\tau}$	N/A	48.796
	2	0.8482	0.7580$^{\tau}$	N/A	13.356
	3	0.9938	0.5348$^{\tau}$	N/A	1.516
	4	0.9812	0.9980	0.0168	0.336
	5	0.8956	0.8868	-	0.000
13	1	0.8278	0.5950$^{\tau}$	N/A	7.244
	2	0.7216	0.8188	0.0972	1.944
	3	0.8724	0.8884	0.0160	0.320
	4	0.8338	0.8378	0.0040	0.080
	5	0.9972	0.9992	0.0020	0.040

* Balance range 20 mg unless otherwise stated

** mg = Balance reading x balance range

τ Balance range 40 mg

$\tau\tau$ Balance range 100 mg

N/A Not applicable

Cyclone Particulate
(excluding wash)

Run 7	0.2358 g.
Run 8	0.2887 g.
Run 9	0.5227 g.

Recorded by
Roy Neulicht
EPA, EMB

TRW ENVIRONMENTAL SERVICES

1421.75.31.003
January 6, 1975

U. S. Environmental Protection Agency
Emission Measurements Branch
Research Triangle Park, N. C. 27711

Att: Mr. Roy Neulicht

Dear Roy,

Enclosed are the lab sheets for the acetone wash and filters for the particle size tests conducted at Arizona Portland Cement Company, Tucson, Arizona in June 1974.

If we may be of further assistance please call upon us.

Very truly yours,

Tony

Tony E. Eggleston
Manager Source Testing

TEE/bc

TRANSPORTATION AND ENVIRONMENTAL OPERATIONS OF TRW INC.
VIRGINIA OFFICE • 800 FOLLIN LANE, SE, VIENNA, VIRGINIA 22180 (703) 893-2000

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

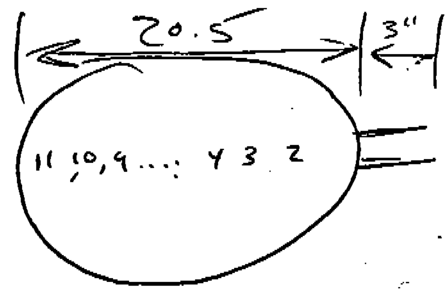
PLANT Ari. Port Cement
DATE 6/4/74
SAMPLING LOCATION Pri. Screen
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) 23.5
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE. (DISTANCE B) 3"
STACK I.D., (DISTANCE A - DISTANCE B) 20.5
NEAREST UPSTREAM DISTURBANCE 1.5 DiA
NEAREST DOWNSTREAM DISTURBANCE 6 Diam
CALCULATOR

SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1		20.5	.4	3"	—
2			1.4		4.4
3			2.4		5.4
4			3.6		6.6
5			5.1		8.1
6			7.3		10.3
7			13.2		16.2
8			15.4		18.4
9			16.9		19.9
10			18.1		21.1
11			19.1		22.1
12			20	—	—

EPA (Dur) 232
4/72

PRELIMINARY VELOCITY TRAVERSE



SCHEMATIC OF TRAVERSE POINT LAYOUT

PLANT Arizona Portland Cement
DATE 6/4/74
LOCATION Primary Screen
STACK I.D. 20.5
BAROMETRIC PRESSURE, in. Hg 27.68
STACK GAUGE PRESSURE, in. H_2O −4.5" H_2O
OPERATORS McReynolds

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	—	73°
2	1.4	
3	1.3	
4	1.5	
5	1.6	
6	1.8	
7	1.9	
8	2.0	
9	2.1	
10	2.1	
11	2.0	
12	—	
AVERAGE		73°

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
AVERAGE		

EPA (Dur) 233
4 72

AVE √ 1.3

TRW

Run # Preliminary PARTICLE SIZING Nozzle Area (in)^2 .00375

LOCATION Primary Screen DATE 6-4-74

TIME: START ~~[illegible]~~ 200P STOP ______ TOTAL ______

Δ P - "Hg 4.0 IMPACTOR 139

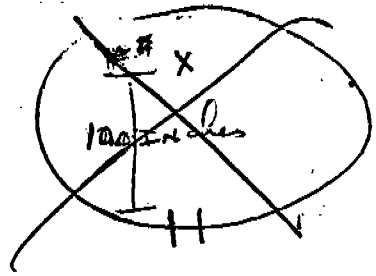
Stage	Plate #	Tare Insert Wt.	Gross Insert Wt.	Net Insert Wt.	%	% Less than Dpc
1						
2						
3						
4						
5						
Filter						
			TOTAL			

Plates not kept

30 – 60 Seconds Good

NOTES:

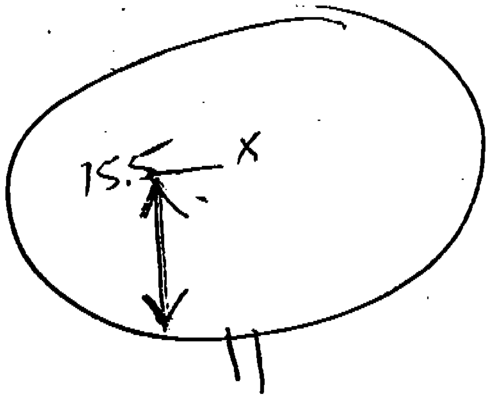
Test Time (SEC) → 30



Pitot ΔP 2.0 "H_2O prior to test

Stack temp 75°F

Bar Press. 27.68



PRELIMINARY VELOCITY TRAVERSE

PLANT: Ari. Port Cem
DATE: Wed 6/5
LOCATION: Prim Screen
STACK I.D.: 20.5
BAROMETRIC PRESSURE, in. Hg: 27.68
STACK GAUGE PRESSURE, in. H_2O: − 4.5 IN H_2O
OPERATORS:

800A

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	—	73
2	1.5	
3	2.2	
4	2.3	
5	2.2	
6	2.3	
7	2.2	
8	2.3	
9	2.3	
10	2.3	
11	2.4	
12		
AVERAGE		

SCHEMATIC OF TRAVERSE POINT LAYOUT

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
AVERAGE		

EPA (Dur) 233
4 72

TRW

PARTICLE SIZING

LOCATION Baghouse Inlet DATE 6-5-74

TIME: START 815A STOP ______ TOTAL ______

Δ P - "Hg 4.0" IMPACTOR 139

Sample Point A Run # 1

Stage	Plate #	Tare Insert Wt.	Gross Insert Wt.	Net Insert Wt.	%	% Less than Dpc
1	1					
2	2					
3	3					
4	4					
5	5					
Filter	50					
			TOTAL			

NOTES:

Run # 1

Test Time ~~[illegible]~~ 63 sec

Pitot Δp 2.4

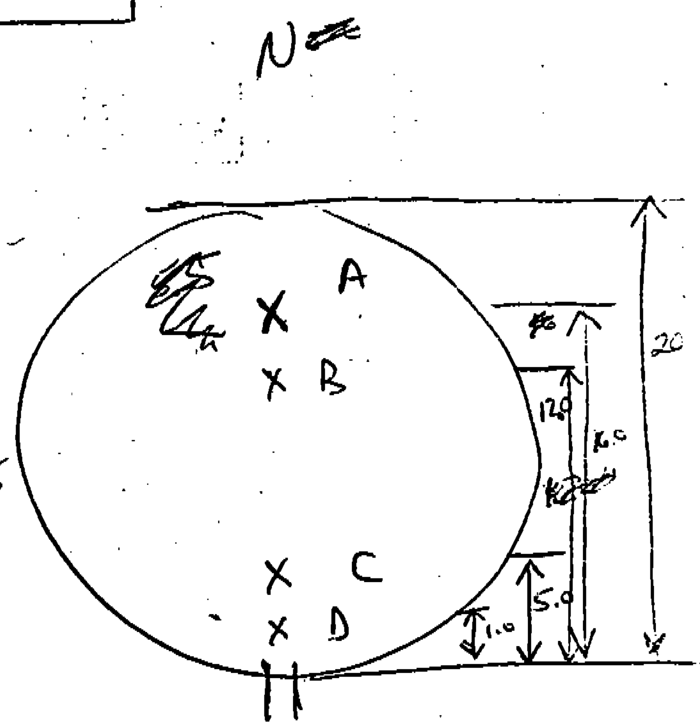
Stack T 73°

~~[illegible]~~

P_B 27.68

P_{STATIC} −4.5" H_2O

Nozzle ~~Diam~~ Area $(IN)^2$ .00375



Nozzle slightly turned off center from direction of flow

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TRW

PARTICLE SIZING

LOCATION Prim Screen DATE 6/5/74

TIME: START 835 STOP 847 TOTAL

Δ P - "Hg 4" IMPACTOR # 163

Sample Point A Run #2

Stage	Plate #	Tare Insert Wt.	Gross Insert Wt.	Net Insert Wt.	%	% Less than Dpc
1	16					
2	17					
3	18					
4	19					
5	20					
Filter	24					

TOTAL

NOTES:

ΔP 2.4

Ts 73

Test Time 67 sec

Nozz ~~Area~~ Area (in²) .00375

TRANSPORTATION AND ENVIRONMENTAL OPERATIONS OF TRW INC.
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TRW

PARTICLE SIZING

LOCATION Pri Screen DATE 6/5/74

TIME: START 925 STOP 0935 TOTAL

Δ P - "Hg 6"

Traverse Point C

IMPACTOR 162

Run 3

Stage	Plate #	Tare Insert Wt.	Gross Insert Wt.	Net Insert Wt.	%	% Less than Dpc
1	11					
2	12					
3	13					
4	14					
5	15					
Filter	23					
			TOTAL			

NOTES:

T_S 73°F

Time (sec) 61 sec

P_S

P_B 27.68

Nozzle Area (in)^2 .00375

ΔP 2.4

TRANSPORTATION AND ENVIRONMENTAL OPERATIONS OF TRW INC.
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TRW

PARTICLE SIZING

LOCATION Pri. Screen DATE 6/5/74

TIME: START 1000A STOP ________ TOTAL ________

Δ P - "Hg 4" IMPACTOR 137

Traverse Point C Run # 4

Stage	Plate #	Tare Insert Wt.	Gross Insert Wt.	Net Insert Wt.	%	% Less than Dpc
1	6					
2	7					
3	8					
4	9					
5	10					
Filter	47					
			TOTAL			

NOTES:

Test Time 100 Sec

T_s 73°

P_s

P_B 27.68

Nozzle ~~Diam~~ AREA (1/2)² = .00375

ΔP 2.3"

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TRW

PARTICLE SIZING

LOCATION Pri Screen DATE 6/5/74

TIME: START 145 STOP ______ TOTAL ______

Δ P - "Hg 4" IMPACTOR 137

Traverse Point C RUN 5

Stage	Plate #	Tare Insert Wt.	Gross Insert Wt.	Net Insert Wt.	%	% Less than Dpc
1	36					
2	37					
3	38					
4	39					
5	40					
Filter	59					
			TOTAL			

NOTES:

Δp 2.2

T_S 86°

P_S

P_B 27.68

Nozzle ~~Dia~~ Area $(in)^2$ .00375

Test time 90 sec

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

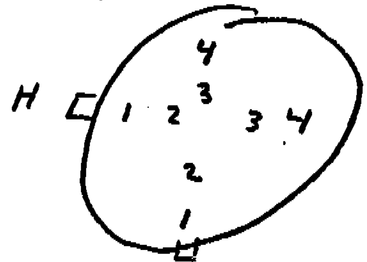
PLANT Arizona PorTland Cement
DATE 6-4-74
SAMPLING LOCATION Primary crusher
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) 17 ½
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) 2
STACK I.D., (DISTANCE A - DISTANCE B) 15½
NEAREST UPSTREAM DISTURBANCE 2
NEAREST DOWNSTREAM DISTURBANCE 8
CALCULATOR McReynolds

SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1				.3	
2				1.0	3.0
3				1.8	3.8
4				2.75	4.75
5				3.9	5.9
6				5.5	7.5
7				10.0	12.0
8				11.6	13.6
9				12.75	14.75
10				13.7	15.7
11				14.5	16.5
12				15.2	

PRELIMINARY VELOCITY TRAVERSE

PLANT Arizona Portland Cement
DATE 6-4-74
LOCATION Pri Crusher
STACK I.D. 15 ½" I.D
BAROMETRIC PRESSURE, in. Hg 27.68
STACK GAUGE PRESSURE, in. H_2O ~~.5~~ ~~.5"~~ -.4" Hg
OPERATORS Mc Reynolds



SCHEMATIC OF TRAVERSE POINT LAYOUT

9:00 AM

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
H - 2	1.5	
3	1.5	
4	1.6	
5	1.5	
6	1.6	
7	1.5	
8	1.7	
9	1.5	
10	1.6	
11	1.6	
V - 2	~~.85~~ 1.3	
3	~~.85~~ 1.2	
4	~~.80~~ 1.4	
5	~~.80~~ 1.5	
6	~~.55~~ 1.7	
7	~~.9~~ ~~1.6~~	
8	~~.9~~ 1.7	
9	~~.85~~ 1.5	
10	1.5	
11	1.5	
AVERAGE		$\sqrt{1.48}$

$= \sqrt{1.23}$ ave

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
AVERAGE		

EPA (Dur) 233
4 72

PRELIMINARY VELOCITY TRAVERSE

PLANT Arizona Portland Cement
DATE 6/?/74
LOCATION Primary Crusher
STACK I.D. 15.5 inches
BAROMETRIC PRESSURE, in. Hg
STACK GAUGE PRESSURE, in. H_2O
OPERATORS McReynolds

805A STATIC 5.5" H_2O

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1	—	85°
2	1.4	
3	1.3	
4	1.4	
5	1.3	
6	1.3	
7	1.3	
8	1.3	
9	1.4	
10	1.3	
11	1.4	
12	—	
AVERAGE	√ 1.16	

SCHEMATIC OF TRAVERSE POINT LAYOUT

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
AVERAGE		

EPA (Dur) 233
4-72

TRW

PARTICLE SIZING

LOCATION: Pri Crusher DATE: Fri 6/7/74

TIME: START 810A STOP 815A TOTAL

Δ P - "Hg: 4" IMPACTOR: 162

Traverse Point # A Run 6

Stage	Plate #	Tare Insert Wt.	Gross Insert Wt.	Net Insert Wt.	%	% Less than Dpc
1	31					
2	32					
3	33					
4	34					
5	35					
Filter	54					
			TOTAL			

NOTES:

Δp 1.3

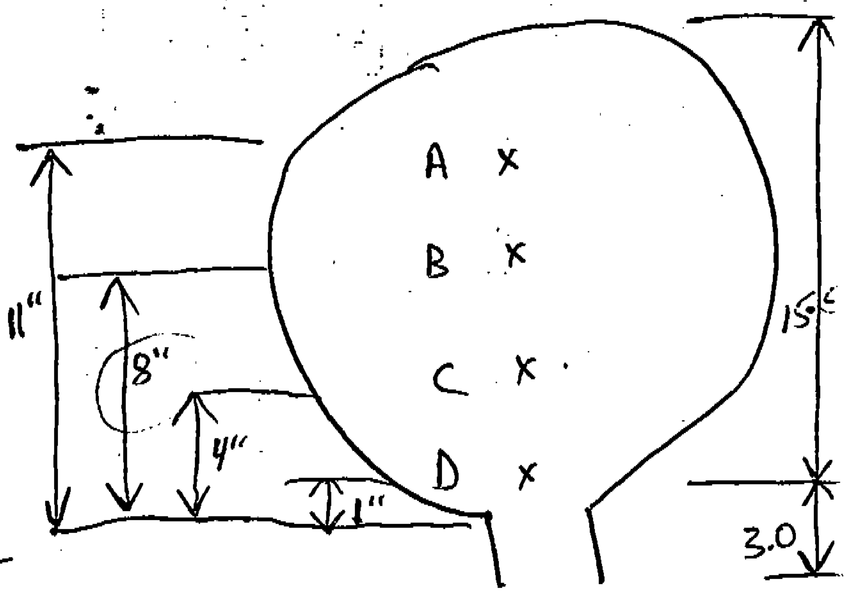
Ts 85

Time test (sec) 35SEC

P_B 27.68

P_{Static} 5.5" H_2O

Nozzle Area (in") .00375



According to federal register 4 point traverse.

1, 4, 11, 14.5

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TRW

PARTICLE SIZING

LOCATION Pri. Gousher DATE Fri 6/7/74

TIME: START Pitot 855 STOP 900 TOTAL

Δ P - "Hg 4" IMPACTOR 163

Traverse Point A RUN 7

Stage	Plate #	Tare Insert Wt.	Gross Insert Wt.	Net Insert Wt.	%	% Less than Dpc
1	26					
2	27					
3	28					
4	29					
5	30					
Filter						
			TOTAL			

NOTES:

ΔP 1.9

T_S 73

Time (sec) 30 sec

P_B 27.68

P_S

Nozzle ~~Area~~ $(in)^2$ .00375

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TRW

PARTICLE SIZING

LOCATION Pri Crusher DATE Fri 6/7/79

TIME: START Pitot 925 STOP 930 TOTAL

Δ P - "Hg 4" IMPACTOR 137

Point C Run 8

Stage	Plate #	Tare Insert Wt.	Gross Insert Wt.	Net Insert Wt.	%	% Less than Dpc
1	45					
2	44					
3	43					
4	42					
5	41					
Filter						
			TOTAL			

NOTES:

ΔP 1.4

TS 80

Time test (sec) 32

Nozzle ~~Dia~~ Area = .00375 $(in)^2$

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TRW

PARTICLE SIZING

LOCATION Pri Crusher DATE Fri 6/7/74

TIME: START 1125 STOP 1130 TOTAL

∆ P - "Hg 4" IMPACTOR 139

Point C Run #9

Stage	Plate #	Tare Insert Wt.	Gross Insert Wt.	Net Insert Wt.	%	% Less than Dpc
1	21					
2	22					
3	23					
4	24					
5	25					
Filter						
			TOTAL			

NOTES:

∆p 1.5

Ts 80

Time (sec) 30

Nozzle Area .00375 (in)^2

TRANSPORTATION AND ENVIRONMENTAL OPERATIONS OF TRW INC
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TRW

PARTICLE SIZING

LOCATION Pri Crusher DATE Fri 6/~~27~~/74

TIME: START 115 STOP 120 TOTAL

Δ P - "Hg 4.0 IMPACTOR 137

Point D Run # 10

Stage	Plate #	Tare Insert Wt.	Gross Insert Wt.	Net Insert Wt.	%	% Less than Dpc
1	46					
2	47					
3	48					
4	49					
5	50					
Filter						
			TOTAL			

NOTES:

ΔP 1.4

TB 80

Time (sec) 32

Nozzle ~~Diam~~ Area . (.02375" [illegible]) (10)²

TRW

PARTICLE SIZING

LOCATION Pri Crusher DATE Fri 6/7/74

TIME: START 140 STOP 145 TOTAL

Δ P - "Hg 4.0 IMPACTOR 139

Point A Run 11

Stage	Plate #	Tare Insert Wt.	Gross Insert Wt.	Net Insert Wt.	%	% Less than Dpc
1	TRW 11					
2	12					
3	13					
4	14					
5	15					
Filter						
			TOTAL			

NOTES:

ΔP 2.0 (Truck Just dumped)

Ts 80

Time sec 35

Nozzle Area — .00375 (inches)[2]

TRW

PARTICLE SIZING

LOCATION Pri Crusher DATE Fri 6/7/74

TIME: START 200 STOP 205 TOTAL

Δ P - "Hg 4" IMPACTOR 163

Point A Run 12

Stage	Plate #	Tare Insert Wt.	Gross Insert Wt.	Net Insert Wt.	%	% Less than Dpc
1	TAR 6					
2	7					
3	8					
4	9					
5	10					
Filter						
			TOTAL			

NOTES:

Δp 1.6

TB 80

Time(sec) 31

Nozzle ~~Diam~~ Area in² .0284

Diam inches = .19

TRW

PARTICLE SIZING

LOCATION Pri Crusher DATE Fri 6/7/74

TIME: START 215 STOP 220 TOTAL

Δ P - "Hg 4.0 IMPACTOR 162

Point A RUN 13

Stage	Plate #	Tare Insert Wt.	Gross Insert Wt.	Net Insert Wt.	%	% Less than Dpc
1	TRW 1					
2	2					
3	3					
4	4					
5	5					
Filter						
			TOTAL			

NOTES:

DP 1.7

Ts 85

Time sec 19

Nozzle Diam inches .19

Nozzle Area (inches)^2 .0284

TRW
Cyclone Acetone

PROJECT EPA [illegible]

le	B	C	D	E	F	G	H	J	K	
	Container # ACETONE	Sample Volume	Aliquot	Gross -Tare Net	Gross -Tare Net		C/D x Net = Total Wt Gn	C/N x S = Blank	H-J = Final Wt	Fina Wt
1	1		—	65.0735 64.8539 0.2196	✓		—	—	0.2196	
2	5		—	63.0427 62.9593 0.0834	✓				0.0834	
3	25		—	68.0674 67.9593 [illegible]	✓	subtraction	error	0.1081	~~0.9090~~	
4	26		—	63.4263 63.3599 [illegible]	63.4268 0.0669	✓			0.0669	
	32		—	63.9138 63.8778 [illegible]	✓	sub	traction error	0.0360	~~[illegible]~~	
	33			64.00[illegible] 63.5823 0.4197	✓				0.4197	
7	37		—	62.6483 62.4536 0.1947	✓				0.1947	
	42		—	63.5569 63.3003 0.2566	✓				0.2566	
	43		—	63.2447 63.0794 0.1653	✓				0.1653	
	50		—	62.4289 62.0410 [illegible]	✓				0.3879	
11	63		—	63.5925 62.3914 1.2011	✓				1.2011	
1	66		—	65.5498 62.8696 2.6802	✓ ✓				2.6802	
13	69		—	65.5434 64.6150 0.9284	✓				0.9284	

M	N	P	Q	R	S
Container #	Volume	Gross -Tare Net	Gross -Tare Net		Blank Wt
14	100	63.9431 63.9431	—		0.0000

Date 9/23/74
Analyst [illegible]
Wt Units gms

E:

SPORTATION AND ENVIRONMENTAL OPERATIONS OF TRW INC.
AN OFFICE • 7600 COLSHIRE DRIVE, McLEAN, VIRGINIA 22101 (703) 893-2000

Filters   PROJECT EPA/Tucson

B	C	D	E	F	G	H	J	K	
~~Container #~~ FILTER #	Sample Volume	Aliquot	Gross -Tare Net	Gross -Tare Net		C/D x Net = Total Wt Gn	C/N x S = Blank	H-J = Final Wt	Final Wt
50	—	—	0.11252 0.11230 0.00022	✓				0.00022	
24			0.11194 0.11168 0.00026	✓				0.00026	
23			0.11642 0.11614 0.00028	✓				0.00028	
47			0.10995 0.11185 —	×				—	
59			0.11629 0.11617 0.00012	✓				0.00012	
54			0.11132 0.11518 —	×				—	
16			0.13251 0.13228 0.00023					0.00023	
3d			0.11239 0.11199 0.00040	0.11247 0.00056	✓ Substitute [illegible]		0.00048	~~0.000[illegible]~~	
55			0.11320 0.11291 0.00029	✓				0.00029	
33			0.11676 0.11629 0.00047	0.11669 0.00040	✓			0.00043	
22			0.11338 0.11300 0.00038	✓				0.00038	
35			0.11730 0.11702 0.00028	✓				0.00028	
45			0.11219 0.11182 → 0.00037	✓				0.00037	

M	N	P	Q	R	S
Container #	Volume	Gross -Tare Net	Gross -Tare Net		Blank Wt

Date 9/23/76
Analyst [illegible]
Wt Units [illegible]

[redacted]