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Sodium Carbonate

Section 5.16

Reference #34

Emission Test Report Kerr-McGee Chemical Corporation Trona, California

SET #2671-01-0979

Final Report

Particulate Emissions from the
Kerr-McGee Chemical Corporation
Sodium Carbonate Plant
Trona, California
EMB Report No. 79-SOD-3

EPA Contract No. 68-02-2313
Work Assignment No. 34

Prepared For
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ESED Mail Drop #13
Research Triangle Park, N.C. 27711

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1.0 INTRODUCTION

Testing to determine particulate emissions from the Kerr-McGee Chemical Corporation sodium carbonate plant was conducted by Scott Environmental Technology, Inc. for the United States Environmental Protection Agency under Contract No. 68-02-2813, Work Assignment No. 34. The testing was conducted from July 16 through July 21, 1979 at the Kerr-McGee plant in Trona, California.

Particulate control systems on two processes were evaluated for efficiency:

- o Cyclone and venturi scrubber on the sodium carbonate predrier system
- o Cyclone and electrostatic precipitation on the sodium carbonate bleacher drier system

Sampling locations used for each system are shown in Figures 1 and 2 respectively. These figures also present a general description of each process involved.

Total particulates were measured using EPA Reference Method #5 at the inlet and outlet of control equipment controlling emissions from the sodium carbonate bleacher driers and sodium carbonate predriers. The particle size distribution was also determined at each of the sampling locations using an Andersen cascade impactor. The opacity of the gas emitted from the bleacher electrostatic precipitator and the predrier venturi scrubber was monitored during each test by a smoke reader. Table 1 presents a summary of test points sampled and number of tests conducted at each test point.

TABLE 1
SUMMARY OF TEST POINTS AND TESTS CONDUCTED

<u>Process</u>	<u>Test Points</u>	<u>Number of Tests Conducted</u>
Predrier	Cyclone Inlet No. 1	3
Predrier	Cyclone Inlet No. 2	3
Predrier	Venturi Scrubber Outlet	4
Bleacher Drier	Cyclone Inlet No. 1	3
Bleacher Drier	Cyclone Inlet No. 2	2
Bleacher Drier	Electrostatic Precipitator Outlet	3



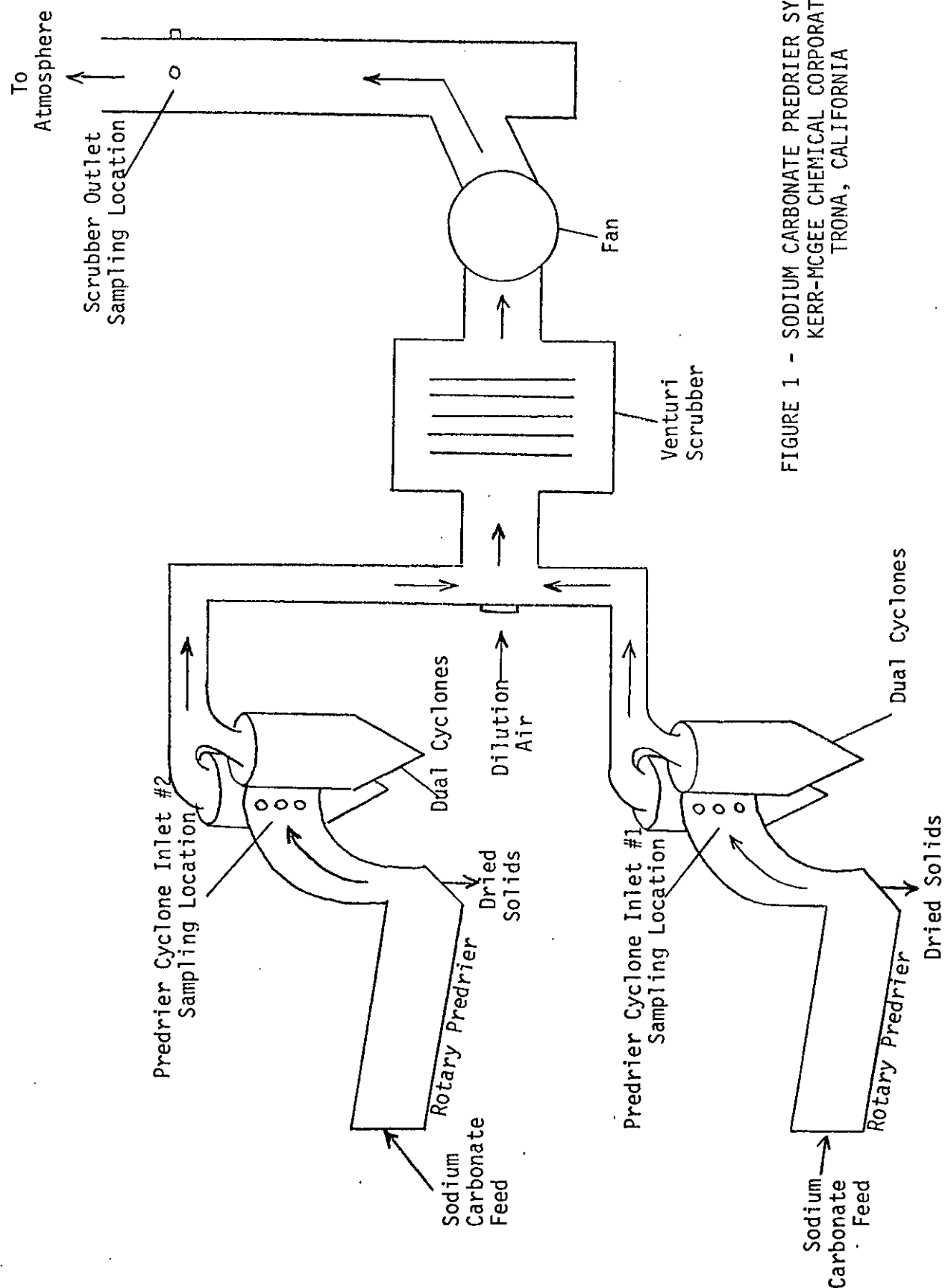


FIGURE 1 - SODIUM CARBONATE PREDRIER SYSTEM
KERR-MCGEE CHEMICAL CORPORATION
TRONA, CALIFORNIA



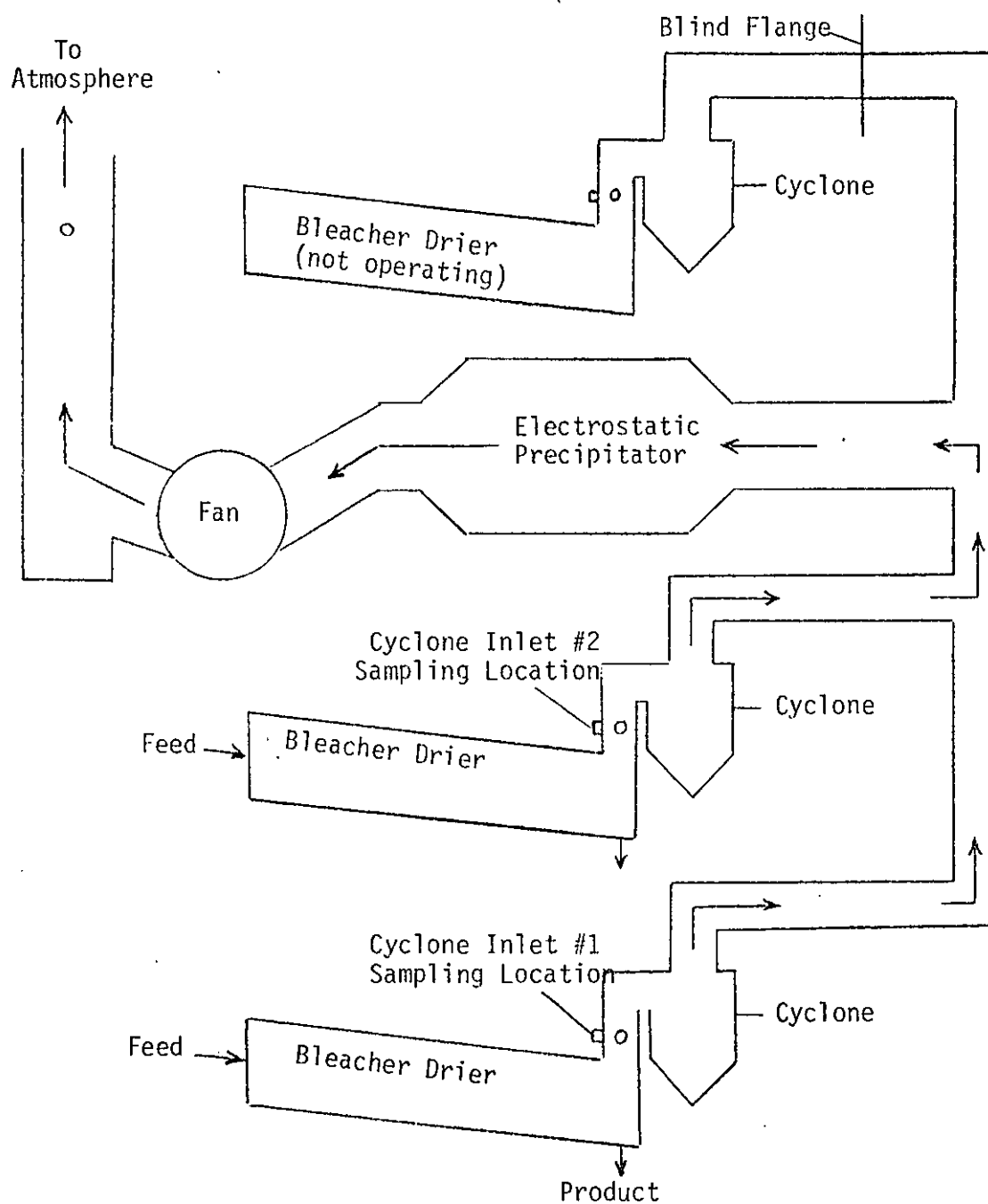


FIGURE 2 - SODIUM CARBONATE BLEACHER DRIER
SYSTEM - KERR-MCGEE CHEMICAL
CORPORATION, TRONA, CALIFORNIA



Test arrangements were made through Mr. Stan Clift of Kerr-McGee. The following is a list of individuals present during test operations:

<u>Individual</u>	<u>Organization</u>
Dennis Holzschuh	EPA
Allan Seacrest	Radian Corporation
James Reese	Scott Environmental Technology
Maynard Johnson	Scott Environmental Technology
Tim Sharp	Scott Environmental Technology
Amerino Cipollone	Scott Environmental Technology
Tom Bernstiel	Scott Environmental Technology
Tony Guastella	Scott Environmental Technology
Al Ramos	Scott Environmental Technology
Bernard Roth	Scott Environmental Technology



2.0 SUMMARY AND DISCUSSION OF TEST RESULTS

The results of the total particulate tests at the bleacher drier cyclone inlet no. 1 and cyclone inlet no. 2 are summarized below in Table 2. The results of test run no. 1 at the cyclone inlet no. 2 were discarded because a leak developed in the sampling train during the test. Results from the testing at the bleacher drier electrostatic precipitator outlet are summarized in Table 3.

TABLE 2
SUMMARY OF PARTICULATE RESULTS
BLEACHER DRIER CYCLONE INLETS

Location	<u>Cyclone Inlet No. 1</u>		
Date	7-16	7-17	7-18
Time Started	1750	1150	0815
Time Ended	1950	1255	0930
Run No.	1	2	3
Gas Flow Rate, dscfm	13660	13760	14760
Actual Gas Flow Rate, acfm	23290	23660	24810
Particulate			
Concentration, gr/scf	165.8	130.2	133.9
Particulate Mass			
Flow Rate, lbs./hr.	19400	15400	16900
Location	<u>Cyclone Inlet No. 2</u>		
Date	7-16	7-17	7-18
Time Started	1750	1115	0755
Time Ended	1950	1830	0915
Run No.	1	2	3
Gas Flow Rate, dscfm	15130	14140	15530
Actual Gas Flow Rate, acfm	28610	24980	26310
Particulate			
Concentration, gr/scf	-	120.7	45.6
Particulate Mass			
Flow Rate, lbs./hr.	-	14600	6070



TABLE 3
SUMMARY OF PARTICULATE RESULTS
BLEACHER DRIER ELECTROSTATIC PRECIPITATOR OUTLET

Location	<u>Precipitator Outlet</u>		
Date	7-16	7-17	7-18
Time Started	1738	1102	0744
Time Ended	1935	1742	1000
Run No.	1	2	3
Gas Flow Rate, dscfm	69480	75340	74320
Actual Gas Flow Rate, acfm	98900	99200	96530
Particulate			
Concentration, gr/scf	0.0102	0.0054	0.0039
Particulate Mass			
Flow Rate, lbs./hr.	6.1	3.5	2.5

Results of the particulate tests at the predrier cyclone inlet no. 1 and cyclone inlet no. 2 are summarized below in Table 4. Results from the predrier scrubber outlet are shown in Table 5. The only available sampling locations at the cyclone inlets were in ducts of non-uniform cross section and just following bends in the ducts. However, the velocity distribution was very uniform across the duct. Due to a large amount of particulate build-up in the bottom of the ducts, sampling could not be performed at the bottom sampling ports. Run no. 1 at the scrubber outlet was stopped in the middle of the test due to the shutdown of one of the driers. Although the stack was traversed in only one direction, the results are included. As shown in the results, a significantly lower gas flow rate was measured at the scrubber outlet during run no. 4. The data sheets show generally lower readings for all of the points and very low velocity head readings for four of the twelve sample points. The results are shown for run no. 4 with the points of very low velocity included and excluded.



TABLE 4
SUMMARY OF PARTICULATE RESULTS
PREDRIER CYCLONE INLETS

Location	<u>Cyclone Inlet No. 1</u>			
Date	7-19	7-20	7-21	
Time Started	1715	1045	1015	
Time Ended	2050	1238	1205	
Run No.	1	2	3	
Gas Flow Rate, dscfm	36030	34810	35550	
Actual Gas Flow Rate, acfm	43900	42570	44300	
Particulate				
Concentration, gr/scf	3.57	0.271	0.123	
Particulate Mass				
Flow Rate, lbs./hr.	1100	80.9	37.5	
Location	<u>Cyclone Inlet No. 2</u>			
Date	7-19	7-19*	7-20	7-21
Time Started	1147	1540	1100	1035
Time Ended	1412	1734	1302	1227
Run No.	1	2	3	4
Gas Flow Rate, dscfm	37270	37520	35590	39180
Actual Gas Flow Rate, acfm	45800	45710	43590	47780
Particulate				
Concentration, gr/scf	0.114	0.211	0.653	0.625
Particulate Mass				
Flow Rate, lbs./hr.	36.4	67.9	199.2	209.9

*Isokinetic sampling rate during this run was 80.1%. Except for a higher meter temperature, no explanation for the low value could be determined.



TABLE 5
SUMMARY OF PARTICULATE RESULTS
PREDRIER SCRUBBER OUTLET

Location	Scrubber Outlet				
Date	7-19	7-20	7-20	7-21	
Time Started	1040	1200	2025	0928	
Time Ended	1743	1420	2246	1154	
Run No.	1	2	3	4	4*
Gas Flow Rate, dscfm	91440	97430	93980	66660	84010
Actual Gas Flow Rate, acfm	110000	116200	115400	81550	102800
Particulate					
Concentration, gr/scf	0.0112	0.0041	0.0041	0.0079	-
Particulate Mass					
Flow Rate, lbs./hr.	8.8	3.4	3.3	4.5	5.7

*Points of low velocity excluded from gas flow rate calculations.

Complete particulate results are presented in Appendix A. Field data sheets are included in Appendix B.

Results of the particle size analyses are shown in Tables 6 and 7 and Figure 3 for testing at the bleacher drier cyclone inlet no. 1, and Tables 8 and 9 and Figure 4 for testing at the bleacher drier cyclone inlet no. 2. Results of the particle size analysis at the bleacher drier precipitator outlet are shown in Table 10 and Figure 5.

Results of the particle size analysis at the predrier cyclone inlet no. 1 are shown in Tables 11 through 13 and Figure 6, and results at the predrier cyclone inlet no. 2 are included in Tables 14 through 16, and Figure 7. Particle size analysis for the predrier scrubber outlet is shown in Table 17 and Table 18, and Figure 8.

Due to the very low particulate concentration at the bleacher precipitator outlet, a very small particle size sample was collected during the one hour sampling time. A small sample was also collected during run no. 1 at the predrier scrubber outlet. Sampling during this run was stopped after 26 minutes due to the shut down of one of the predriers. A larger sample was



TABLE 6
PARTICLE SIZE DISTRIBUTION ANALYSIS

Date: 7-17-79	P _{bar} (in. Hg): 28.31
Time: 1325 to 1328	Stack Temp. (°F): 345
Sampling Location: Bleacher Cyclone Inlet #1	Sample Time (Min): 3
Traverse Point No. Sampled: 18	Sample Volume (cf): 1.93
Run No.: 1	Moisture (% H ₂ O): 6.1
	Meter Temperature (°F): 119
	Flow Setting, ΔH (in. H ₂ O): 120
	Nozzle Diameter (In.): 2 0.250

Sample Flow Rate (at stack conditions) - 0.69 cfm

Plate No.	Net Wt. (mg)	%	Cumulative %	ECD ¹ (Micrometers)
1	16945.3 ²	97.65	100.0	13.62 and larger
2	245.6	1.41	2.34	8.63
3	95.00	0.54	0.92	5.70
4	30.20	0.17	0.38	3.94
5	22.15	0.12	0.20	2.51
6	9.80	0.05	0.08	1.29
7	3.30	0.01	0.02	0.78
8	0.90	0.00	0.00	0.52
Back-up Filter	0.00	0.00	0.00	< 0.52
Total	17352.2			

¹ECD - Effective Cutoff Diameter of preceding plate.

²Weight includes particulate collected on Plate No. 0 and in nozzle and head of sampler upstream of the collection plates.



TABLE 7
PARTICLE SIZE DISTRIBUTION ANALYSIS

Date: 7-17-79	P_{bar} (in. Hg):	28.31
Time: 1800	Stack Temp. ($^{\circ}\text{F}$):	345
Sampling Location: Bleacher Cyclone Inlet #1	Sample Time (Min):	0.75
Traverse Point No. Sampled: 18	Sample Volume (cf):	0.49
Run No.: 2	Moisture (% H_2O):	6.1
	Meter Temperature ($^{\circ}\text{F}$):	119
	Flow Setting, ΔH (in. H_2O):	1.20
	Nozzle Diameter (In.):	0.250

Sample Flow Rate (at stack conditions) - 0.70 cfm

Plate No.	Net Wt. (mg)	%	Cumulative %	ECD ¹ (Micrometers)
1	7229.15 ²	98.49	100.00	13.52 and larger
2	20.55	0.27	1.50	8.57
3	38.90	0.53	1.22	5.66
4	22.80	0.31	0.69	3.91
5	17.35	0.23	0.38	2.50
6	8.65	0.11	0.14	1.28
7	1.90	0.02	0.02	0.77
8	0.00	0.00	0.00	0.52
Back-up Filter	0.05	0.00	0.00	<0.52
Total	7339.35			

¹ECD - Effective Cutoff Diameter of preceding plate.

²Weight includes particulate collected on Plate No. 0 and in nozzle and head of sampler upstream of the collection plates.



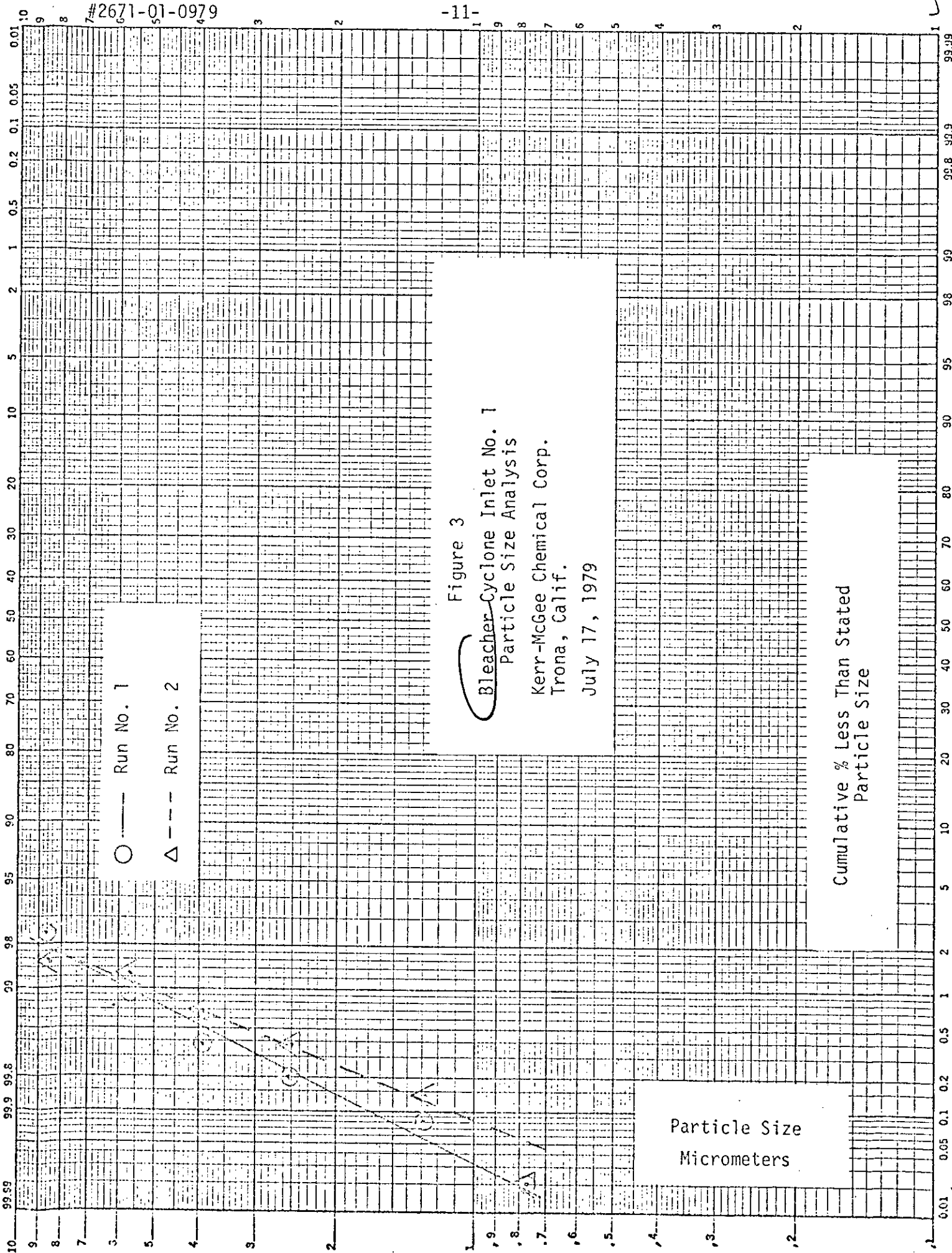


Figure 3
 Bleacher Cyclone Inlet No. 1
 Particle Size Analysis
 Kerr-McGee Chemical Corp.
 Trona, Calif.
 July 17, 1979

Particle Size
Micrometers

Cumulative % Less Than Stated
Particle Size

TABLE 8
PARTICLE SIZE DISTRIBUTION ANALYSIS

Date: 7-17-79	P _{bar} (in. Hg):	28.31
Time: 1907	Stack Temp. (°F):	350
Sampling Location: Bleacher Cyclone Inlet #2	Sample Time (Min):	0.5
Traverse Point No. Sampled: 5	Sample Volume (cf):	0.41
Run No.: 1	Moisture (% H ₂ O):	4.4
	Meter Temperature (°F):	127.5
	Flow Setting, ΔH (in. H ₂ O):	1.90
	Nozzle Diameter (In.):	0.250

Sample Flow Rate (at stack conditions) - 0.87 cfm

Plate No.	Net Wt. (mg)	%	Cumulative %	ECD ¹ (Micrometers)
1	4891.05 ²	98.83	100.00	12.15
2	7.05	0.14	1.16	7.73
3	15.60	0.31	1.02	5.09
4	13.25	0.26	0.70	3.52
5	12.20	0.24	0.43	2.25
6	9.10	0.18	0.19	1.15
7	0.35	0.00	0.00	0.69
8	0.00	0.00	0.00	0.46
Back-up Filter	0.00	0.00	0.00	0.46

Total

¹ECD - Effective Cutoff Diameter of preceding plate.

²Weight includes particulate collected on Plate No. 0 and in nozzle and head of sampler upstream of the collection plates.



TABLE 9

PARTICLE SIZE DISTRIBUTION ANALYSIS

Date: 7-18-79	P _{bar} (in. Hg):	28.3
Time: 9:55	Stack Temp. (°F):	350
Sampling Location: Bleacher Cyclone Inlet #2	Sample Time (Min):	0.5
Traverse Point No. Sampled: 5	Sample Volume (cf):	0.38
Run No.: 2	Moisture (% H ₂ O):	4.4
	Meter Temperature (°F):	127.5
	Flow Setting, ΔH (in. H ₂ O):	1.90
	Nozzle Diameter (in.):	0.250

Sample Flow Rate (at stack conditions) - 0.80 cfm

Plate No.	Net Wt. (mg)	%	Cumulative %	ECD ¹ (Micrometers)
1	2228.85 ²	97.29	100.00	12.67 and larger
2	3.80	0.16	2.70	8.05
3	13.00	0.56	2.54	5.31
4	14.35	0.62	1.97	3.67
5	18.00	0.78	1.34	2.34
6	12.15	0.53	0.56	1.20
7	0.75	0.03	0.03	0.72
8	0.00	0.00	0.00	0.48
Back-up Filter	0.00	0.00	0.00	<0.48
Total	2290.90			

¹ECD - Effective Cutoff Diameter of preceding plate.

²Weight includes particulate collected on Plate No. 0 and in nozzle and head of sampler upstream of the collection plates.



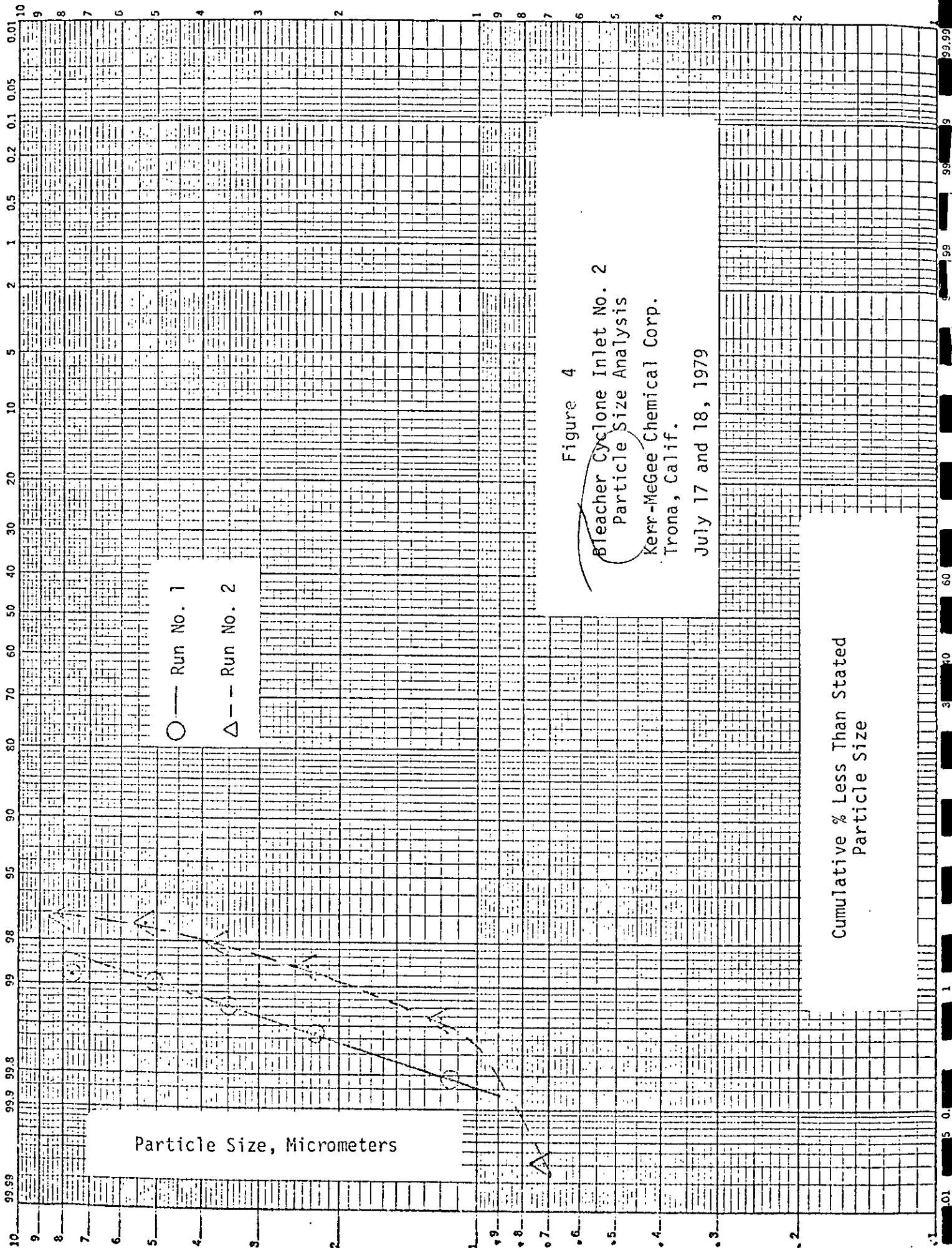


Figure 4

Bleacher Cyclone Inlet No. 2

Particle Size Analysis

Kerr-McGee Chemical Corp.

Trona, Calif.

July 17 and 18, 1979

TABLE 10
PARTICLE SIZE DISTRIBUTION ANALYSIS

Date: 7-17-79	P _{bar} (in. Hg):	28.31
Time: 1110 to 1210	Stack Temp. (°F):	173
Sampling Location: Bleacher Pptr. Outlet	Sample Time (Min):	60
Traverse Point No. Sampled: 3	Sample Volume (cf):	59.24
Run No.:	Moisture (% H ₂ O):	2.4
	Meter Temperature (°F):	135
	Flow Setting, ΔH (in. H ₂ O):	2.50
	Nozzle Diameter (In.):	0.250

Sample Flow Rate (at stack conditions) - 1.01 cfm

Plate No.	Net Wt. (mg)	%	Cumulative %	ECD ¹ (Micrometers)
1	4.45 ²	74.78	100.00	10.23
2	.55	9.24	25.21	6.53
3	.60	10.08	15.97	4.29
4	.00	.00	5.88	2.97
5	.30	5.04	5.88	1.90
6	.00	.00	.84	.96
7	.00	.00	.84	.58
8	.00	.00	.84	
Back-up Filter	0.00	0.84	0.84	<0.38
Total	5.95			

¹ECD - Effective Cutoff Diameter of preceding plate.

²Weight includes particulate collected on Plate No. 0 and in nozzle and head of sampler upstream of the collection plates.



NEUFFEL & ESSER CO. MADE IN U.S.A. 2 CYCLES

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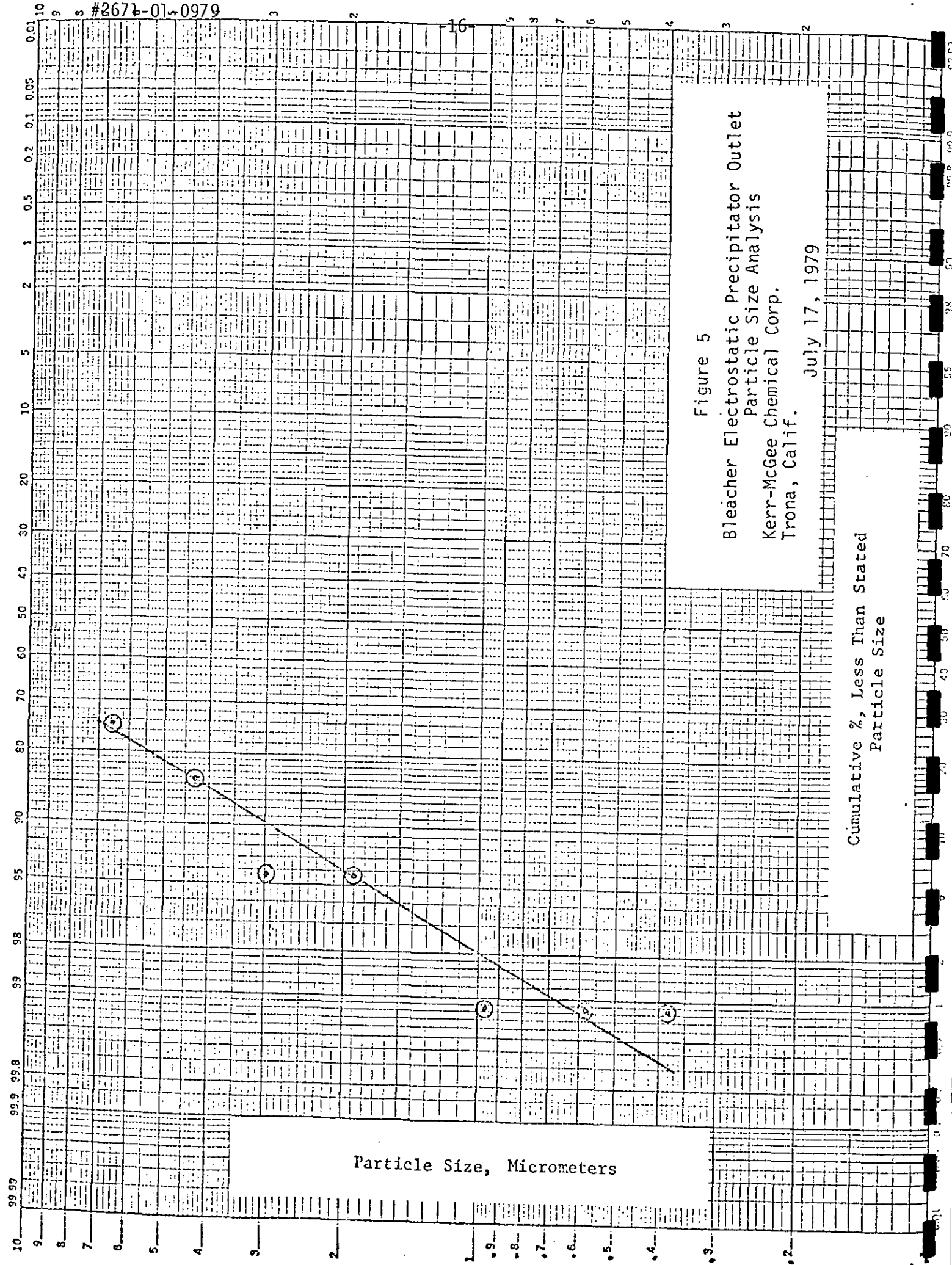


Figure 5
Bleacher Electrostatic Precipitator Outlet
Particle Size Analysis
Kerr-McGee Chemical Corp.
Trona, Calif.

July 17, 1979

TABLE 11

PARTICLE SIZE DISTRIBUTION ANALYSIS

Date: 7-19-79	P _{bar} (in. Hg):	28.05
Time: 2130 to 2200	Stack Temp. (°F):	116
Sampling Location: Predrier Cyclone Inlet #1	Sample Time (Min):	30
Traverse Point No. Sampled: 4	Sample Volume (cf):	13.46
Run No.: 1	Moisture (% H ₂ O):	4.3
	Meter Temperature (°F):	104
	Flow Setting, ΔH (in. H ₂ O):	0.52
	Nozzle Diameter (In.):	0.250

Sample Flow Rate (at stack conditions) - 0.46 cfm

Plate No.	Net Wt. (mg)	%	Cumulative %	ECD ¹ (Micrometers)
1	23.86 ²	98.34	100.00	14.73 and larger
2	.00	.00	1.65	9.27
3	.05	.20	1.65	6.15
4	.00	.00	1.44	4.26
5	.15	.61	1.44	2.71
6	.20	.82	.82	1.40
7	.00	.00	.00	.85
8	.00	.00	.00	.58
Back-up Filter	24.25	.00	.00	<0.58
Total				

¹ECD - Effective Cutoff Diameter of preceding plate.²Weight includes particulate collected on Plate No. 0 and in nozzle and head of sampler upstream of the collection plates.

TABLE 12

PARTICLE SIZE DISTRIBUTION ANALYSIS

Date: 7-20-79	P _{bar} (in. Hg):	28.17
Time: 1329 to 1359	Stack Temp. (°F):	92
Sampling Location: Predrier Cyclone Inlet #1	Sample Time (Min):	120
Traverse Point No. Sampled: 4	Sample Volume (cf):	30
Run No.: 2	Moisture (% H ₂ O):	12.09
	Meter Temperature (°F):	4.4
	Flow Setting, ΔH (in. H ₂ O):	92
	Nozzle Diameter (In.):	0.41
		0.250

Sample Flow Rate (at stack conditions) - 0.42

Plate No.	Net Wt. (mg)	%	Cumulative %	ECD ¹ (Micrometers)
1	154.7 ²	99.87	100.00	15.59
2	0.05	0.03	0.12	9.79
3	0.10	0.06	0.09	6.50
4	0.00	0.00	0.03	4.50
5	0.00	0.00	0.03	2.86
6	0.00	0.00	0.03	1.48
7	0.00	0.00	0.03	0.90
8	0.05	0.03	0.03	0.62
Back-up Filter	0.00	0.00	0.00	< 0.62
Total	154.90			

¹ECD - Effective Cutoff Diameter of preceding plate.

²Weight includes particulate collected on Plate No. 0 and in nozzle and head of sampler upstream of the collection plates.



TABLE 13

PARTICLE SIZE DISTRIBUTION ANALYSIS

Date: 7-21-79	P _{bar} (in. Hg):	28.20
Time: 1500 to 1530	Stack Temp. (°F):	128
Sampling Location: Predrier Cyclone Inlet #1	Sample Time (Min):	30
Traverse Point No. Sampled: 4	Sample Volume (cf):	15.30
Run No.: 3	Moisture (% H ₂ O):	5.0
	Meter Temperature (°F):	103
	Flow Setting, ΔH (in. H ₂ O):	0.63
	Nozzle Diameter (In.):	0.250

Sample Flow Rate (at stack conditions) - 0.53 cfm

Plate No.	Net Wt. (mg)	%	Cumulative %	ECD ¹ (Micrometers)
1	20.20 ²	92.23	100.00	13.83 and larger
2	0.75	3.42	7.76	8.72
3	0.05	0.22	4.33	5.78
4	0.10	0.45	4.11	4.00
5	0.00	0.00	3.65	2.55
6	0.10	0.45	3.65	1.31
7	0.25	1.14	3.19	0.79
8	0.10	0.45	2.05	0.54
Back-up Filter	0.35	1.59	1.59	< 0.54
Total	21.90			

¹ECD - Effective Cutoff Diameter of preceding plate.

²Weight includes particulate collected on Plate No. 0 and in nozzle and head of sampler upstream of the collection plates.



#2671501-Q979

Figure 6

Predrier Cyclone Inlet No. 1
Particle Size Analysis
Kerr-McGee Chemical Corp.
Trona, Calif.

July 19-21, 1979

○ Run No. 1
△ Run No. 2
□ Run No. 3

Particle Size,
Micrometers

Cumulative % Less Than Stated
Particle Size

2 CYCLES

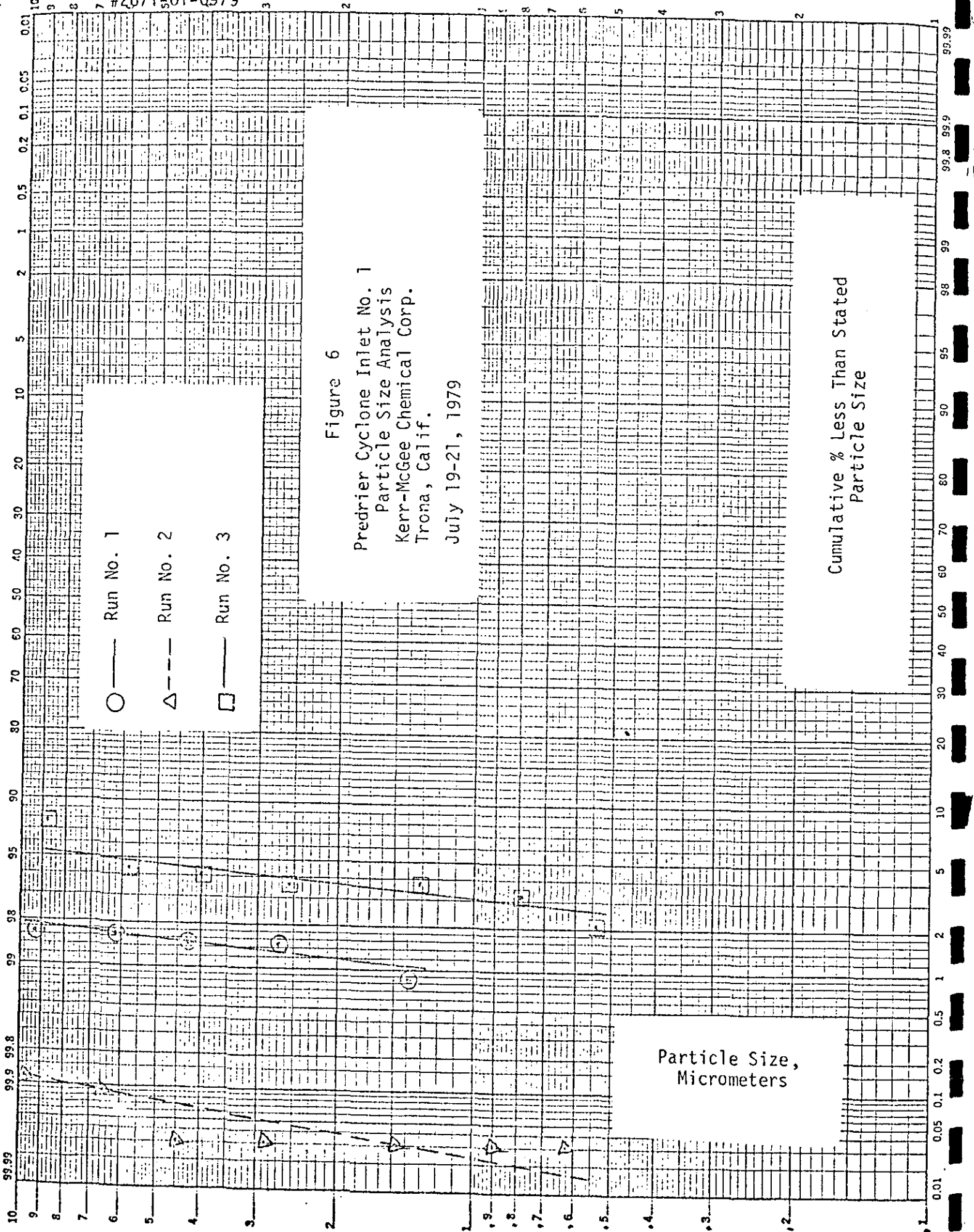


TABLE 14

PARTICLE SIZE DISTRIBUTION ANALYSIS

Date: 7-19-79	P _{bar} (in. Hg):	28.05
Time: 1516 to 1527	Stack Temp. (°F):	109
Sampling Location: Predrier Cyclone Inlet #2	Sample Time (Min):	4.71
Traverse Point No. Sampled: 4	Sample Volume (cf):	5.3
Run No.: 1	Moisture (% H ₂ O):	133
	Meter Temperature (°F):	0.39
	Flow Setting, ΔH (in. H ₂ O):	0.250
	Nozzle Diameter (In.):	

Sample Flow Rate (at stack conditions) - 0.45 cfm

Plate No.	Net Wt. (mg)	%	Cumulative %	ECD ¹ (Micrometers)
1	50.95 ²	93.82	100.00	14.97 and larger
2	2.00	3.68	6.17	9.41
3	0.30	0.55	2.48	6.25
4	0.70	1.28	1.93	4.32
5	0.00	0.00	0.64	2.75
6	0.00	0.00	0.64	1.42
7	0.00	0.00	0.64	0.86
8	0.35	0.64	0.64	0.59
Back-up Filter	0.00	0.00	0.00	<0.59
Total	54.30			

¹ECD - Effective Cutoff Diameter of preceding plate.

²Weight includes particulate collected on Plate No. 0 and in nozzle and head of sampler upstream of the collection plates.



TABLE 15

PARTICLE SIZE DISTRIBUTION ANALYSIS

Date: 7-20-79	#2	P _{bar} (in. Hg):	28.17
Time: 2140 to 2157		Stack Temp. (°F):	110
Sampling Location: Predrier Cyclone Inlet		Sample Time (Min):	17
Traverse Point No. Sampled: 4		Sample Volume (cf):	7.98
Run No.: 2		Moisture (% H ₂ O):	6.2
		Meter Temperature (°F):	89
		Flow Setting, ΔH (in. H ₂ O):	0.53
		Nozzle Diameter (In.): ²	0.250

Sample Flow Rate (at stack conditions) - 0.49 cfm

Plate No.	Net Wt. (mg)	%	Cumulative %	ECD ¹ (Micrometers)
1	136.30 ²	95.54	100.00	14.20 and larger
2	5.55	3.89	4.45	8.94
3	0.30	0.21	0.56	5.93
4	0.05	0.03	0.35	4.10
5	0.00	0.00	0.31	2.61
6	0.15	0.10	0.31	1.35
7	0.00	0.00	0.21	0.82
8	0.00	0.00	0.21	0.56
Back-up Filter	0.30	0.21	0.21	< 0.56
Total	142.65			

¹ECD - Effective Cutoff Diameter of preceding plate.

²Weight includes particulate collected on Plate No. 0 and in nozzle and head of sampler upstream of the collection plates.



#2671-01-0979

TABLE 16
PARTICLE SIZE DISTRIBUTION ANALYSIS

Date: 7-21-79	P _{bar} (in. Hg):	28.20
Time: 0935 to 0948	Stack Temp. (°F):	113
Sampling Location: Predrier Cyclone Inlet #2	Sample Time (Min):	13
Traverse Point No. Sampled: 4	Sample Volume (cf):	5.83
Run No.: 3	Moisture (% H ₂ O):	5.4
	Meter Temperature (°F):	98
	Flow Setting, ΔH (in. H ₂ O):	0.53
	Nozzle Diameter (In.):	0.250

Sample Flow Rate (at stack conditions) - 0.47 cfm

Plate No.	Net Wt. (mg)	%	Cumulative %	ECD ¹ (Micrometers)
1	9.85 ²	81.74	100.00	14.62 and larger
2	0.80	6.63	18.25	9.20
3	0.30	2.48	11.61	6.10
4	0.00	0.00	9.12	4.22
5	0.05	0.41	9.12	2.69
6	0.10	0.82	8.71	1.39
7	0.55	4.56	7.88	0.84
8	0.05	0.41	3.31	0.57
Back-up Filter	0.35	2.90	2.90	<0.57
Total	12.05			

¹ECD - Effective Cutoff Diameter of preceding plate.

²Weight includes particulate collected on Plate No. 0 and in nozzle and head of sampler upstream of the collection plates.



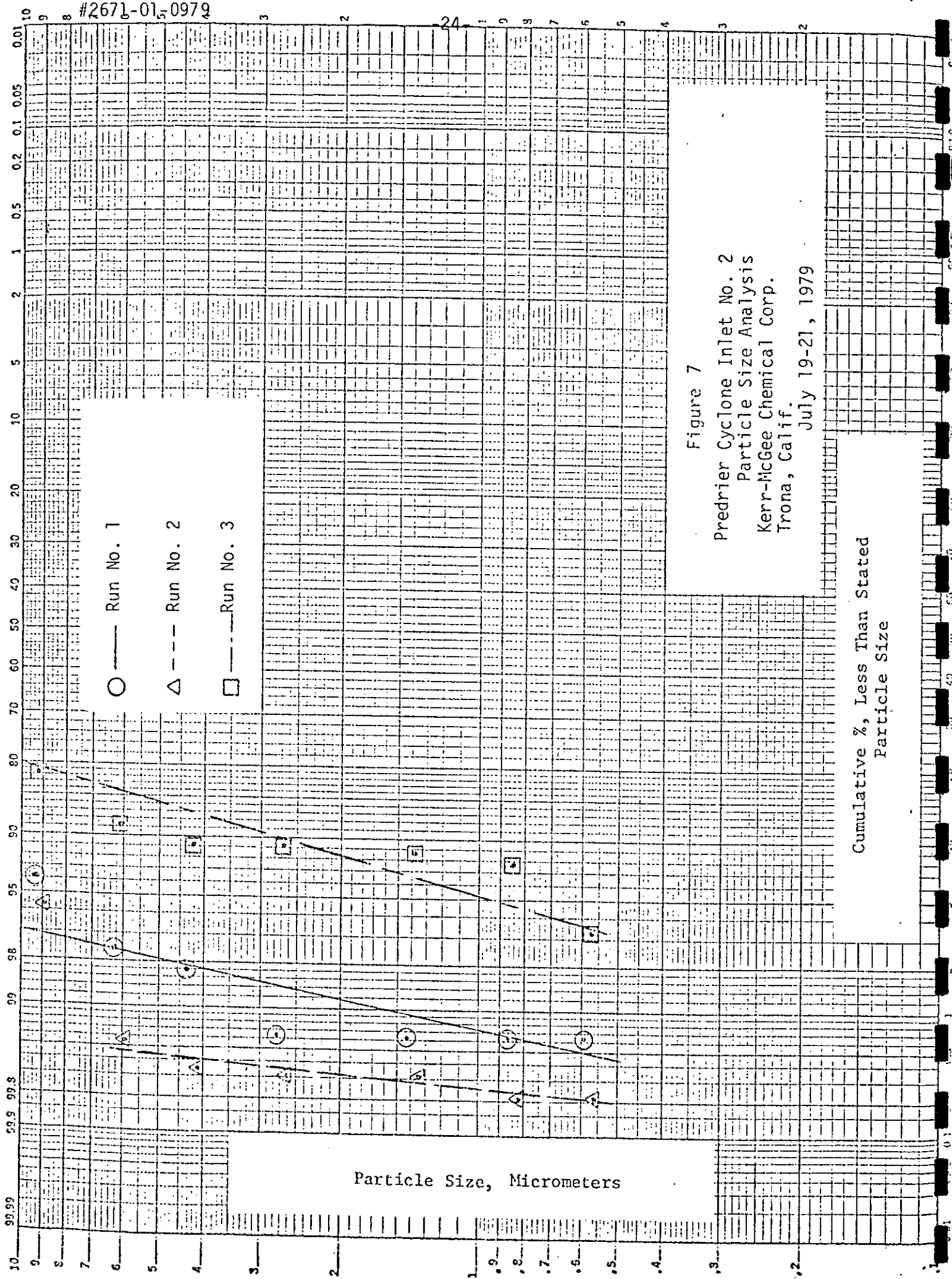


Figure 7

Predrier Cyclone Inlet No. 2
Particle Size Analysis
Kerr-McGee Chemical Corp.
Trona, Calif.

July 19-21, 1979

TABLE 17

PARTICLE SIZE DISTRIBUTION ANALYSIS

Date: 7-19-79	P _{bar} (in. Hg):	28.17
Time: 1600 to 1626	Stack Temp. (°F):	111
Sampling Location: Predrier Scrubber Outlet	Sample Time (Min):	26
Traverse Point No. Sampled: 3	Sample Volume (cf):	19.45
Run No.: 1	Moisture (% H ₂ O):	4.5
	Meter Temperature (°F):	90.5
	Flow Setting, ΔH (in. H ₂ O):	1.40
	Nozzle Diameter (In.):	0.250

Sample Flow Rate (at stack conditions) - 0.78 cfm

Plate No.	Net Wt. (mg)	%	Cumulative %	ECD ¹ (Micrometers)
1	6.80 ²	76.06	100.00	11.27 and larger
2	0.15	1.67	23.93	7.15
3	0.05	0.55	22.26	4.72
4	0.40	4.47	21.70	3.26
5	0.35	3.91	17.22	2.08
6	0.34	3.80	13.31	1.06
7	0.65	7.27	9.50	0.64
8	0.20	2.23	2.23	0.43
Back-up Filter	0.00	0.00	0.00	<0.43
Total	8.94			

¹ECD - Effective Cutoff Diameter of preceding plate.

²Weight includes particulate collected on Plate No. 0 and in nozzle and head of sampler upstream of the collection plates.



TABLE 18

PARTICLE SIZE DISTRIBUTION ANALYSIS

Date: 7-21-79	P _{bar} (in. Hg):	28.20
Time: 1430 to 1600	Stack Temp. (°F):	112
Sampling Location: Predrier Scrubber Outlet	Sample Time (Min):	90
Traverse Point No. Sampled: 3	Sample Volume (cf):	45.59
Run No.: 2	Moisture (% H ₂ O):	6.2
	Meter Temperature (°F):	104.5
	Flow Setting, ΔH (in. H ₂ O):	0.64
	Nozzle Diameter (In.):	0.250

Sample Flow Rate (at stack conditions) - 0.53 cfm

Plate No.	Net Wt. (mg)	%	Cumulative %	ECD ¹ (Micrometers)
1	5.15 ²	20.68	100.00	13.68
2	0.70	2.81	79.31	8.62
3	0.00	0.00	76.50	5.71
4	0.70	2.81	76.50	3.95
5	1.45	5.82	73.69	2.52
6	1.35	5.42	67.87	1.30
7	0.25	1.00	62.44	0.79
8	3.50	14.05	61.44	0.53
Back-up Filter	11.80	47.38	47.38	<0.53
Total	24.90			

¹ECD - Effective Cutoff Diameter of preceding plate.

²Weight includes particulate collected on Plate No. 0 and in nozzle and head of sampler upstream of the collection plates.



○ — Run No. 1

△ — Run No. 2

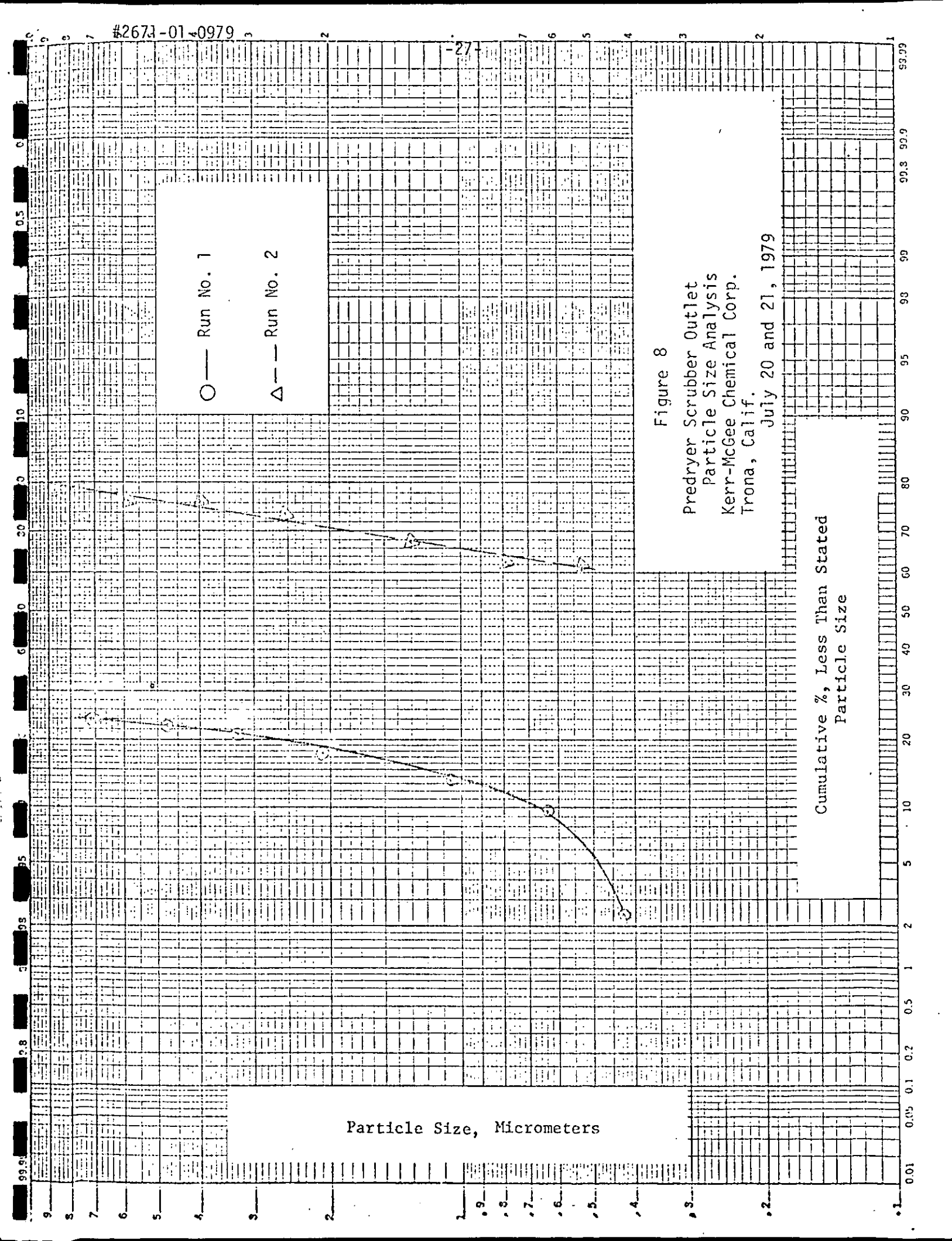
Particle Size, Micrometers

Cumulative %, Less Than Stated
Particle Size

Figure 8

Predryer Scrubber Outlet
Particle Size Analysis
Kerr-McGee Chemical Corp.
Trona, Calif.

July 20 and 21, 1979



collected during the 90 minute sampling period at run no. 2 at the scrubber outlet, and this sample would appear to be more representative of the particle size distribution.

Table 19 presents a summary of particulate control efficiencies calculated for the two systems tested.

TABLE 19
SUMMARY OF SYSTEM EFFICIENCIES

Sodium Carbonate Bleacher Drier

Run No.	Inlet Mass Loadings (lbs/hr)		Outlet Mass Loadings (lbs/hr)
	Cyclone Inlet No. 1	Cyclone Inlet No. 2	
1	19,400	N/R	6.1
2	15,400	14,600	3.5
3	16,900	6,070	2.5
Average	17,233	10,335	4.0

$$\% \text{ Control Efficiency} = \left[1 - \frac{4.0}{17,233 + 10,335} \right] \times 100 = 99.99\%$$

Sodium Carbonate Predrier

Run No.	Inlet Mass Loadings (lbs/hr)		Outlet Mass Loadings (lbs/hr)
	Cyclone Inlet No. 1	Cyclone Inlet No. 2	
1	1100.0	36.4 ¹	8.8
2	80.9	67.4 ¹	3.4 ¹
3	37.5	119.2	3.3 ¹
4	N/R	209.9	5.7 ²
Average	406.1	127.0	6.0

$$\% \text{ Control Efficiency} = \left[1 - \frac{6.0}{406.1 + 127.0} \right] \times 100 = 98.87\%$$

NOTES:

1. When two tests were conducted on the same day, the average of the two tests was used in calculating the system efficiency.
2. See Table 5 and text for discussion of this result.



Results of the opacity readings taken at the bleacher drier precipitator outlet are summarized in Tables 20 through 22. Opacity readings at the predrier scrubber outlet are shown in Tables 23 through 25. No readings were taken during test run no. 3 at the scrubber outlet since the run was made at night. All readings were 0% opacity at both the precipitator outlet and the scrubber outlet. Opacity field data sheets are included in Appendix C.



TABLE 20
SUMMARY OF RESULTS OF OPACITY READINGS

Location: Bleacher Precipitator Outlet
Test Run No.: 1
Date: 7-16-79
Color of Plume: None

Stack Height: 60 feet
Distance to Stack: 150 feet
Wind Direction: Variable Speed: 5-15 mph
Sky Description: Clear

Set Number	Time		Opacity		Set Number	Time		Opacity	
	Start	End	Sum	Average		Start	End	Sum	Average
1	1740	1746	0	0					
2	1746	1752	0	0					
3	1752	1758	0	0					
4	1758	1804	0	0					
5	1804	1810	0	0					
6	1810	1816	0	0					
7	1816	1822	0	0					
8	1822	1828	0	0					
9	1828	1834	0	0					
10	1834	1840	0	0					
11	1840	1846	0	0					
12	1846	1852	0	0					
13	1852	1858	0	0					
14	1858	1904	0	0					
15	1904	1910	0	0					
16	1910	1916	0	0					
17	1916	1922	0	0					
18	1922	1928	0	0					
19	1928	1934	0	0					
20	1934	1940	0	0					



TABLE 21

SUMMARY OF RESULTS OF OPACITY READINGS

Location: Bleacher Precipitator Outlet

Test Run No.: 2

Date: 7-17-79

Color of Plume: None

Stack Height: 60 feet

Distance to Stack: 150 feet

Wind Direction: Variable Speed: 0-5 mph

Sky Description: Clear

Set Number	Time		Opacity		Set Number	Time		Opacity	
	Start	End	Sum	Average		Start	End	Sum	Average
1	1100	1106	0	0					
2	1106	1112	0	0					
3	1112	1118	0	0					
4	1118	1124	0	0					
5	1124	1130	0	0					
6	1130	1136	0	0					
7	1136	1142	0	0					
8	1142	1148	0	0					
9	1148	1154	0	0					
10	1154	1156	0	0					
11	1640	1646	0	0					
12	1646	1652	0	0					
13	1652	1658	0	0					
14	1658	1704	0	0					
15	1704	1710	0	0					
16	1710	1715	0	0					



TABLE 22

SUMMARY OF RESULTS OF OPACITY READINGS

Location: Bleacher Precipitator Outlet

Test Run No.: 3

Date: 7-18-79

Color of Plume: None

Stack Height: 60 feet

Distance to Stack: 150 feet

Wind Direction: Variable Speed: 0-5 mph

Sky Description: Clear

Set Number	Time		Opacity		Set Number	Time		Opacity	
	Start	End	Sum	Average		Start	End	Sum	Average
1	0800	0806	0	0					
2	0806	0812	0	0					
3	0812	0818	0	0					
4	0818	0824	0	0					
5	0824	0830	0	0					
6	0830	0836	0	0					
7	0836	0842	0	0					
8	0842	0848	0	0					
9	0848	0854	0	0					
10	0854	0900	0	0					
11	0900	0906	0	0					
12	0906	0912	0	0					
13	0912	0918	0	0					
14	0918	0924	0	0					
15	0924	0930	0	0					
16	0930	0936	0	0					
17	0936	0942	0	0					
18	0942	0948	0	0					
19	0948	0954	0	0					
20	0954	1000	0	0					



TABLE 23

SUMMARY OF RESULTS OF OPACITY READINGS

Location: Predrier Scrubber Outlet

Test Run No.: 1

Date: 7-19-79

Color of Plume: None

Stack Height: 75 feet

Distance to Stack: 150 feet

Wind Direction: Variable Speed: 0-5 mph

Sky Description: 75% Cloudy

Set Number	Time		Opacity	
	Start	End	Sum	Average
1	1100	1106	0	0
2	1106	1112	0	0
3	1112	1118	0	0
4	1118	1123	0	0
5	1710	1716	0	0
6	1716	1722	0	0
7	1722	1728	0	0
8	1728	1734	0	0
9	1734	1740	0	0
10	1740	1746	0	0
11	1746	1750	0	0

Set Number	Time		Opacity	
	Start	End	Sum	Average



TABLE 24

SUMMARY OF RESULTS OF OPACITY READINGS

Location: Predrier Scrubber Outlet

Test Run No.: 2

Date: 7-20-79

Color of Plume: None

Stack Height: 75 feet

Distance to Stack: 150 feet

Wind Direction: Variable Speed: 0-5 mph

Sky Description: 100% Cloudy

Set Number	Time		Opacity	
	Start	End	Sum	Average
1	1215	1221	0	0
2	1221	1227	0	0
3	1227	1233	0	0
4	1233	1239	0	0
5	1239	1245	0	0
6	1245	1251	0	0
7	1251	1257	0	0
8	1257	1303	0	0
9	1303	1309	0	0
10	1309	1315	0	0
11	1315	1321	0	0
12	1321	1327	0	0
13	1327	1333	0	0
14	1333	1339	0	0
15	1339	1345	0	0
16	1345	1351	0	0
17	1351	1357	0	0
18	1357	1403	0	0
19	1403	1490	0	0
20	1409	1415	0	0

Set Number	Time		Opacity	
	Start	End	Sum	Average



TABLE 25

SUMMARY OF RESULTS OF OPACITY READINGS

Location: Predrier Scrubber Outlet

Test Run No.: 3

Date: 7-21-79

Color of Plume: None

Stack Height: 75 feet

Distance to Stack: 150 feet

Wind Direction: Variable Speed: 0-5 mph

Sky Description: Clear

Set Number	Time		Opacity		Set Number	Time		Opacity	
	Start	End	Sum	Average		Start	End	Sum	Average
1	9030	9036	0	0					
2	9036	9042	0	0					
3	9042	9048	0	0					
4	9048	9054	0	0					
5	9054	1000	0	0					
6	1000	1006	0	0					
7	1006	1012	0	0					
8	1012	1018	0	0					
9	1018	1024	0	0					
10	1024	1030	0	0					
11	1100	1106	0	0					
12	1106	1112	0	0					
13	1112	1118	0	0					
14	1118	1124	0	0					
15	1124	1130	0	0					
16	1130	1136	0	0					
17	1136	1142	0	0					
18	1142	1148	0	0					
19	1148	1154	0	0					
20	1154	1200	0	0					



3.0 SAMPLING AND ANALYTICAL PROCEDURES

Presented in this section is a summary of sampling and analytical procedures used during testing. For further details the reader is referred to the description of each EPA Reference Method published in the Federal Register.

3.1 SAMPLING PROCEDURES

3.1.1 Selection of Sampling Location - EPA Method #1

The sampling locations were selected in accordance with EPA Method #1. This method requires that the sampling location be a minimum of two stack diameters downstream and a half a diameter upstream from any flow disturbances. This method also allows the smallest stack diameter to be 12 inches. For rectangular ducts, an equivalent duct size is calculated. The number of sampling points is specified in the method, depending upon the length of undisturbed flow upstream and downstream from the sampling location. The number of sampling points varies from eight to forty-eight.

Each sampling location was selected so as to provide the maximum length of undisturbed flow upstream and downstream from the sampling locations and, thus, the minimum number of required sampling points. The number of sampling points at each location was then selected based on EPA Method #1 criteria.

- o Sodium Carbonate Predrier System - Figure 1 presents a description of the two inlet and one outlet sampling locations associated with the predrier. A description of the inlet and outlet sampling points are presented in Figure 9.

- o Sodium Carbonate Bleacher Drier System - Figure 2 presents a description of the two inlet and one outlet sampling locations associated with the bleacher drier. A description of the inlet and outlet sampling points are presented in Figure 10.

3.1.2 Measurement of Gas Volume Flow Rate - EPA Method #2

The gas volume flow rate was measured at each sampling location in accordance with EPA Method #2. This method uses a Type S Pitot tube and an inclined manometer to measure the velocity pressure, and a thermocouple to measure gas temperature at each sampling point.

Preliminary velocity measurements were made at each sampling location followed by velocity measurements as a part of each particulate test run.

The Pitot tubes used are within the dimensional limitations of Method #2. A calibration factor from 0.834 to 0.838 was used for the Pitots.



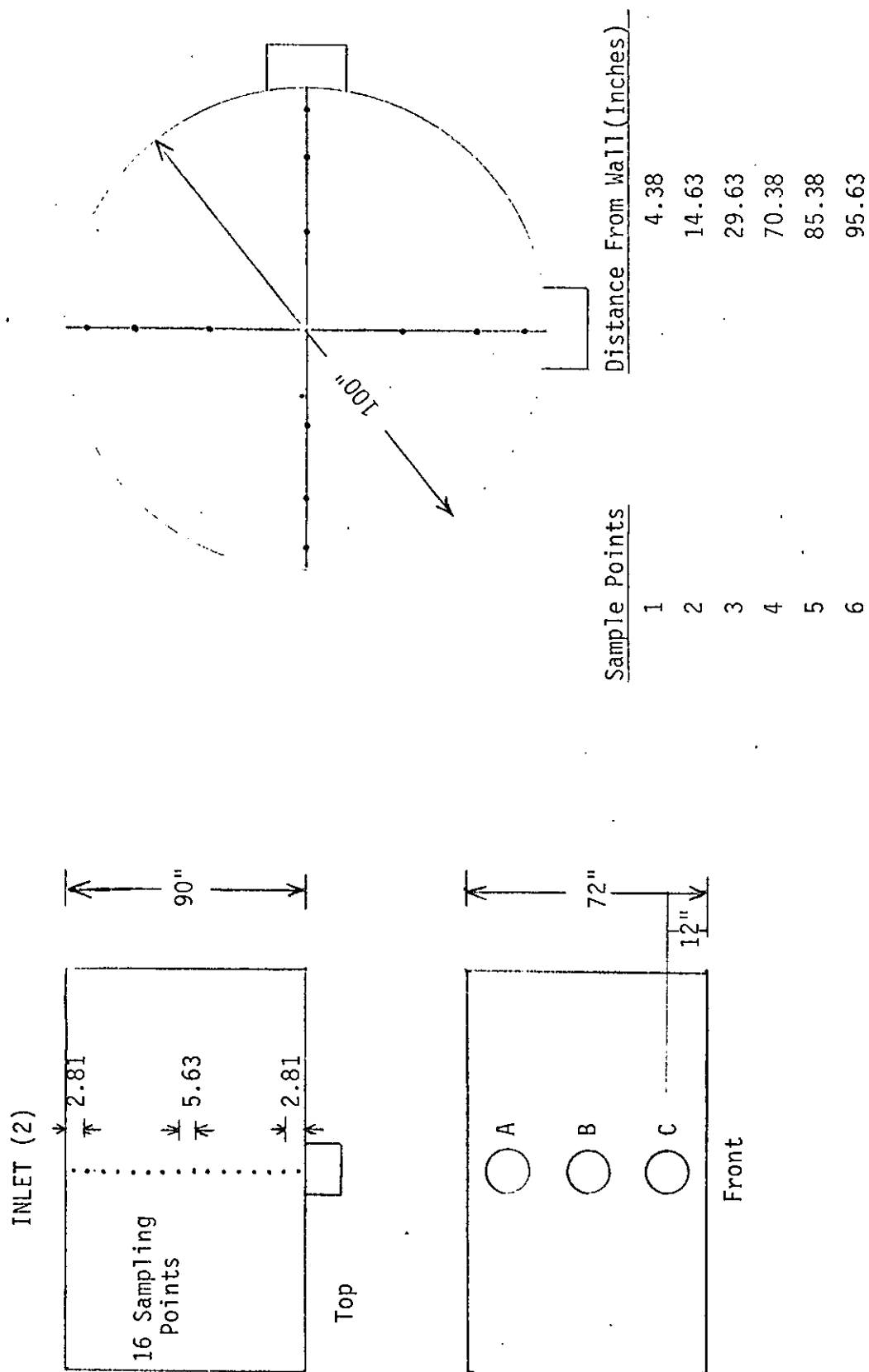
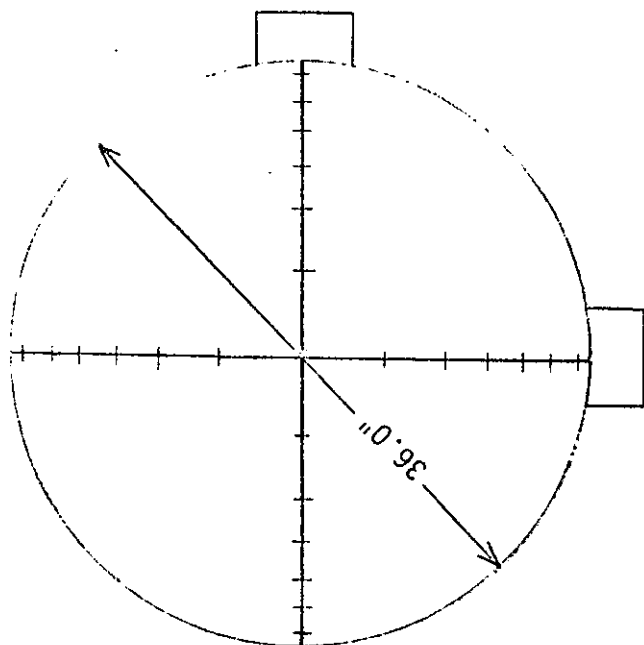


FIGURE 9 - PREDRIER SAMPLING POINTS

FIGURE 10 - BLEACHER SAMPLING POINTS

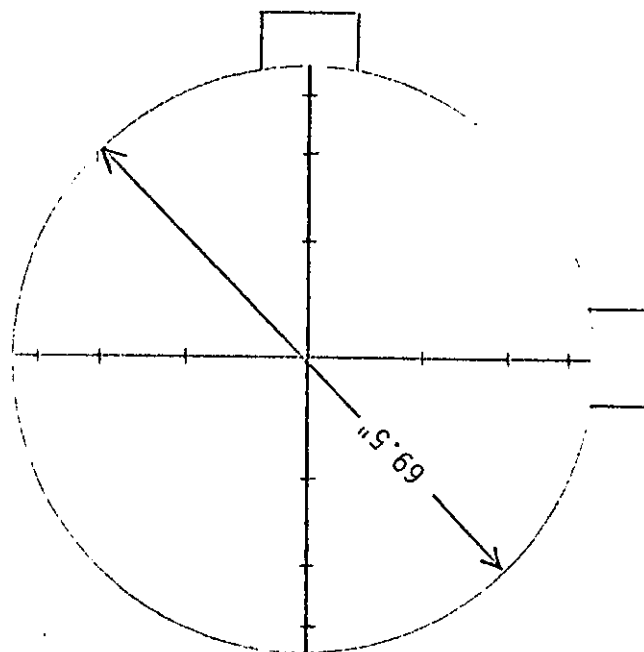
INLET (2)



Sample Point Distance From Wall (Inches)

1	0.76
2	2.41
3	4.25
4	6.37
5	9.00
6	12.82
7	23.18
8	27.00
9	29.63
10	31.75
11	33.59
12	35.24

OUTLET



Sample Point Distance From Wall (Inches)

1	3.06
2	10.13
3	20.56
4	48.94
5	59.38
6	66.48

3.1.3 Average Stack Gas Molecular Weight - EPA Method #3

The average molecular weight of the stack gas during each test was determined by Orsat analysis for CO_2 and O_2 content of the stack gas in accordance with EPA Method #4.

3.1.4 Determination of Stack Gas Moisture Content - EPA Method #4

Moisture content of the gases sampled was determined in accordance with EPA Method #4 as part of the particulate sampling train. Moisture in the gas sampled was collected in impingers in an ice bath followed by silica gel. The moisture collected was then measured volumetrically and gravimetrically.

3.1.5 Determination of Particulate Emissions - EPA Method #5

Particulate emissions were measured in accordance with EPA Method #5. This method involves the isokinetic extraction of a sample from the gas stream and collection of the particulate on a heated out-of-stack filter. A dry gas meter measures the volume of the gas sample. Figure 11 shows a diagram of the sampling train.

3.1.6 Determination of Particle Size - Andersen Cascade Impactor

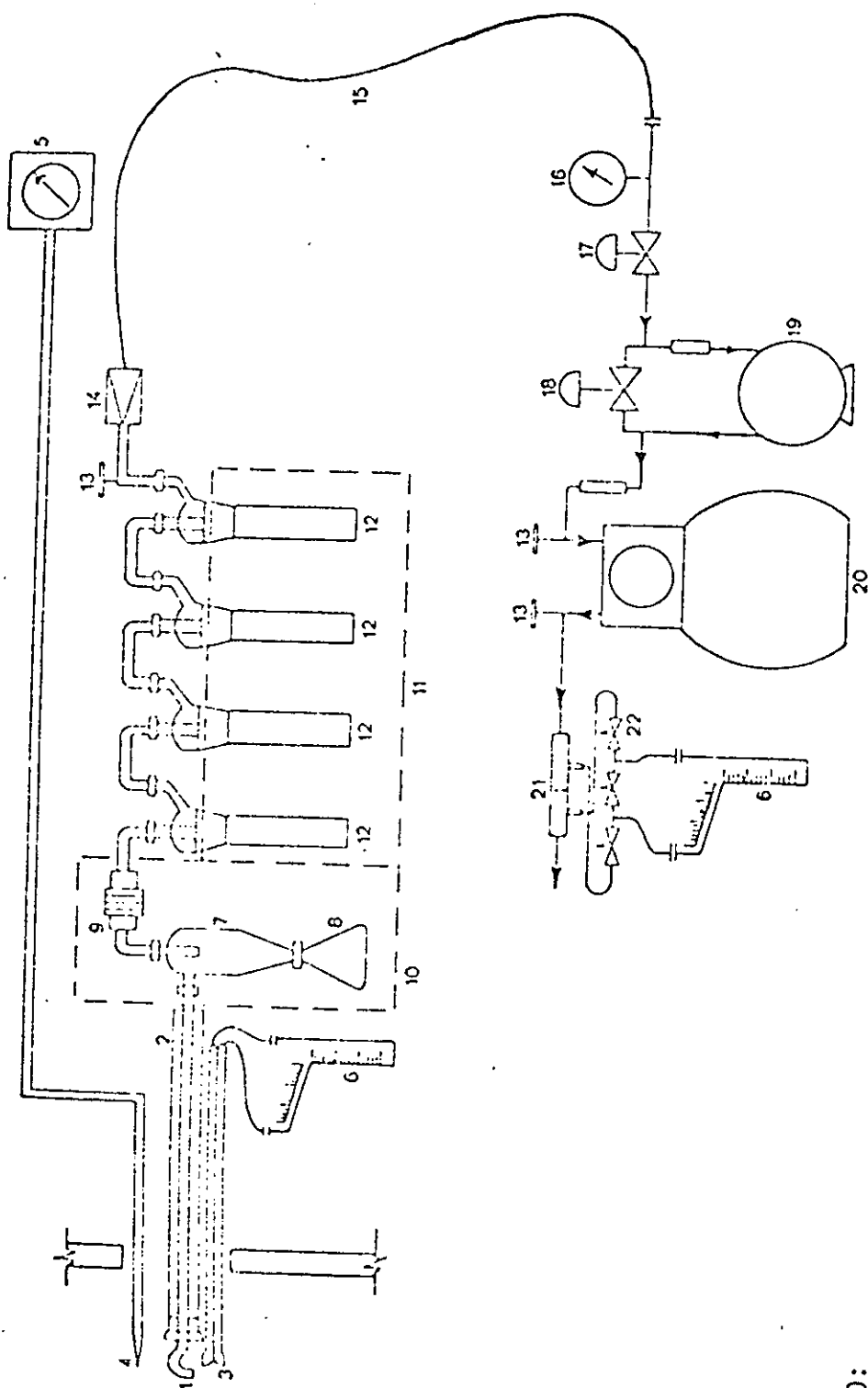
The samples for particle size distribution at each sampling location were collected using an Andersen 2000 cascade impactor. The particles are collected by impaction on a series of plates. The plates have increasingly smaller holes so that the velocity of the particles is increased from plate to plate, and smaller and smaller particles are impacted. The particulate weight collected on each plate is determined gravimetrically. The particle size distribution is based on the equivalent aerodynamic size of the particles based on spherical particles of 1 gram/cc density.

Sampling and calculations of results were performed in accordance with the operating manual published by Andersen 2000. Figure 12 shows a diagram of the sampling train. The impactor was used out-of-stack at the inlet sampling locations due to the small diameter of these ducts. For this arrangement, a short probe was installed between the nozzle and cascade impactor. Figure 13 shows a stage diagram of the Andersen head.

3.1.7 Determination of Visible Emissions - EPA Method #9

Visible emissions were monitored by determining the smoke density using EPA Method #9. This method involves the measurement of smoke density by a smoke reader who has been previously certified against smoke measured by an opacity meter calibrated with neutral density filters.





LEGEND:

- 1. NOZZLE
- 2. PROBE
- 3. PITOT
- 4. THERMOCOUPLE
- 5. PYROMETER
- 6. INCLINE MANOMETER
- 7. CYCLONE
- 8. FLASK
- 9. FILTER ASSEMBLY
- 10. FILTER BOX

- 11. IMPINGER ICEBATH
- 12. IMPINGERS
- 13. THERMOMETER
- 14. CHECK VALVE
- 15. UMBILICAL CORD
- 16. VACUUM GAUGE

- 17. COARSE FLOW ADJUST VALVE
- 18. FINE FLOW ADJUST VALVE
- 19. VACUUM PUMP
- 20. DRY TEST METER
- 21. ORIFICE TUBE
- 22. SOLENOID VALVES

FIGURE 11 - PARTICULATE SAMPLING TRAIN



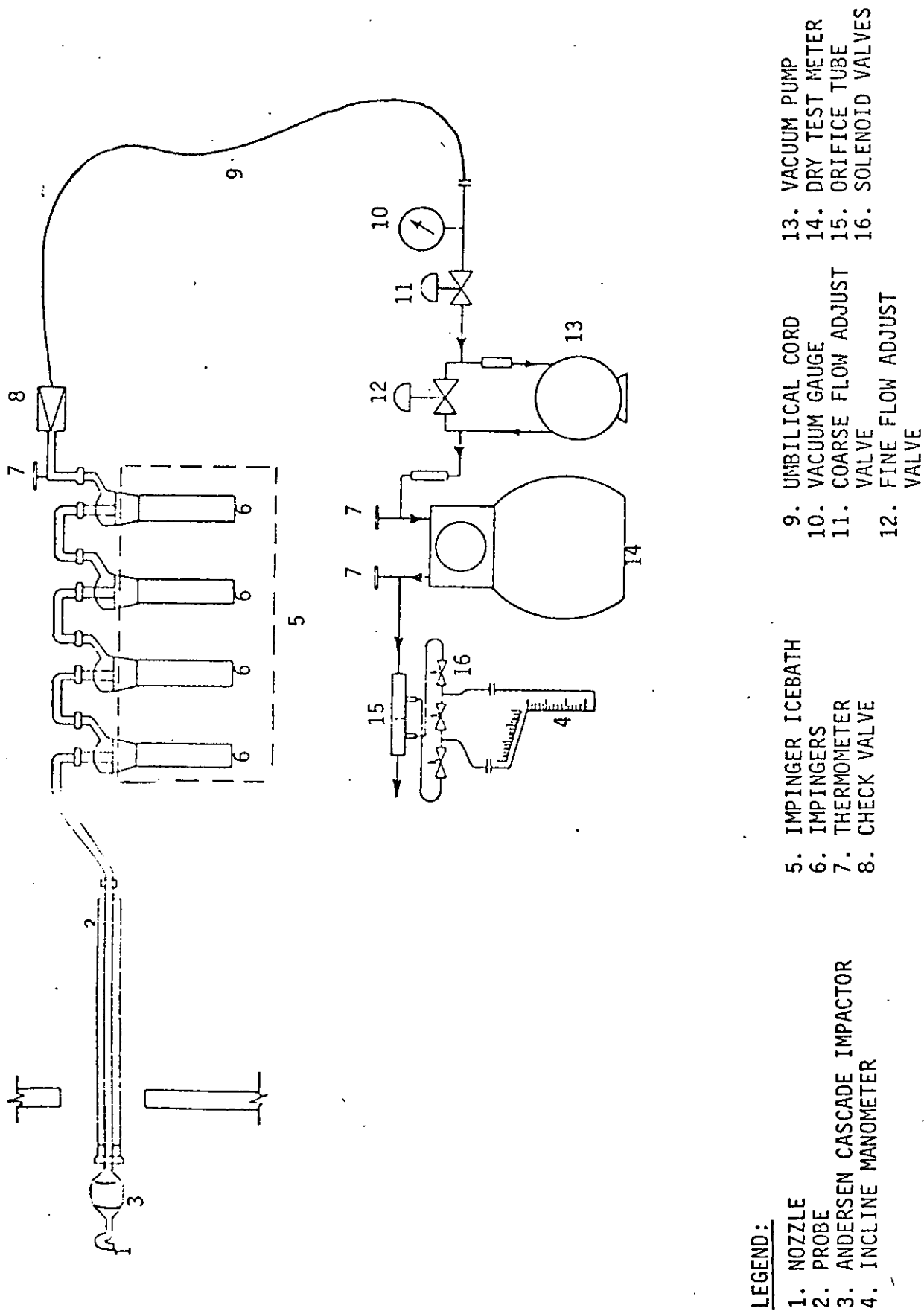


FIGURE 12 - PARTICLE SIZE DISTRIBUTION
SAMPLING TRAIN

LEGEND:

1. NOZZLE
2. PROBE
3. ANDERSEN CASCADE IMPACTOR
4. INCLINE MANOMETER

5. IMPINGER ICEBATH
6. IMPINGERS
7. THERMOMETER
8. CHECK VALVE
9. UNBILICAL CORD
10. VACUUM GAUGE
11. COARSE FLOW ADJUST VALVE
12. FINE FLOW ADJUST VALVE
13. VACUUM PUMP
14. DRY TEST METER
15. ORIFICE TUBE
16. SOLENOID VALVES



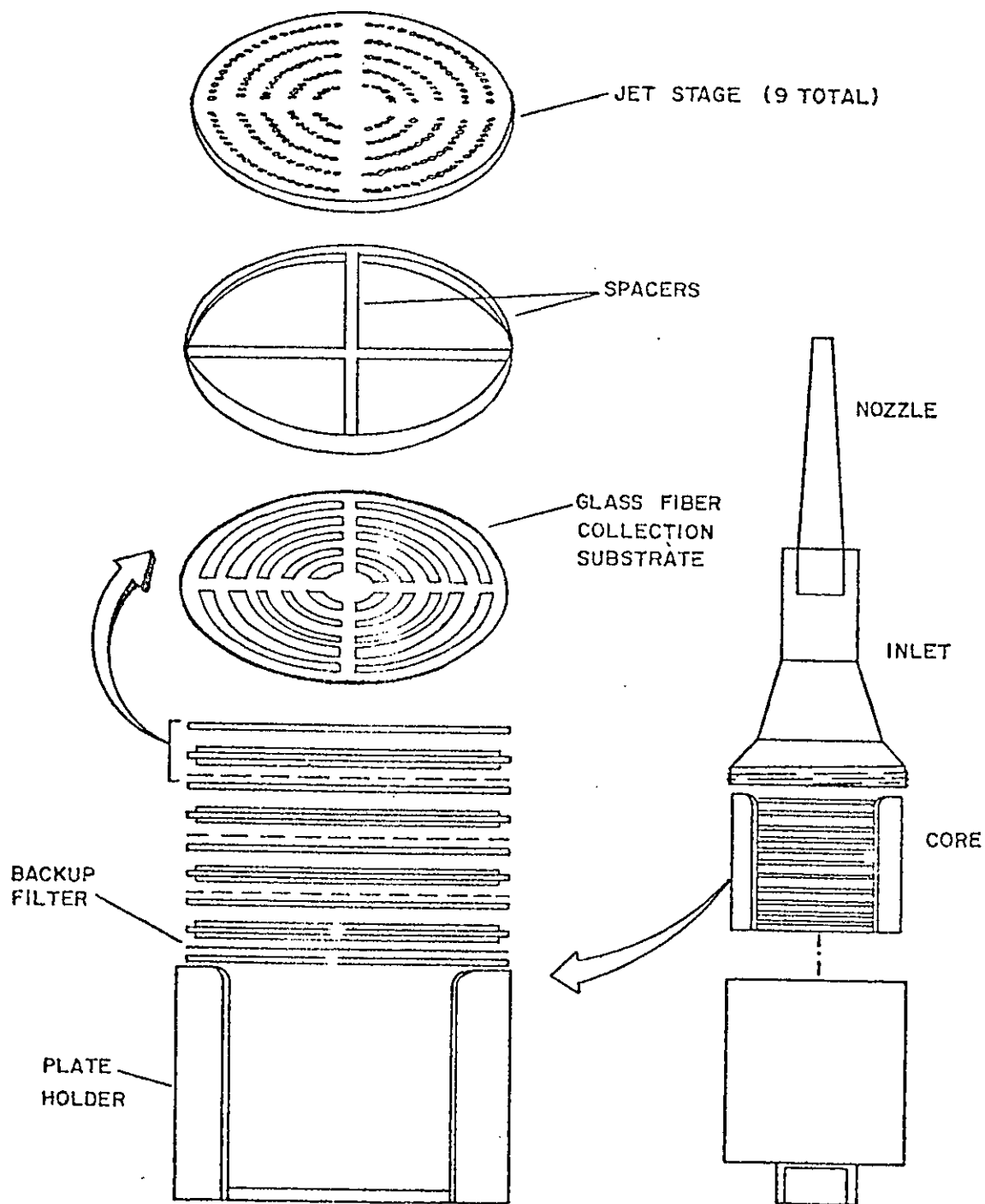


FIGURE 13 - ANDERSEN STACK SAMPLER



3.2 ANALYTICAL PROCEDURES

3.2.1 Particulate Emissions - EPA Method #5

Particulate emissions were determined gravimetrically in accordance with EPA Method #5. Prior to testing, absolute particulate filters were desicated, weighed and sealed in a container for transporting. Upon completion of field testing, each filter was desicated and reweighed to determine the amount of particulate collected.

3.2.2 Particulate Size - Andersen Cascade Impactor

Particulate size distributions were determined gravimetrically using Andersen cascade impactor substrates. Each substrate was prepared and analyzed using a method identical to that described for EPA Method #5 particulate filters.



APPENDIX A
Total Particulate Results



APPENDIX B
Field Data Sheets



APPENDIX C
Opacity Field Data Sheets



APPENDIX D

EQUIPMENT CALIBRATIONS AND
SMOKE READER CERTIFICATES



United States
Environmental Protection
Agency

Office of Air, Noise, and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

Official Business
Penalty for Private Use
\$300

Publication No. EMB Report 79-SOD-3

Postage and
Fees Paid
Environmental
Protection
Agency
EPA 335



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