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/

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Ref No. 1

AP-42 Section 11.5
Reference 3
Report Sect.
Reference

NSPS DEVELOPMENT
PARTICULATE AND PARTICLE SIZING EMISSIONS TESTING
CLAY ROTARY DRYER SYSTEM

NORTH AMERICAN REFRACTORIES
FARBER, MISSOURI
MARCH 12-15, 1984

Compiled by:

ENTROPY
Post Office Box 12291
Research Triangle Park, N. C. 27709

68-02-3852
ESED No. 81/08
EMB No. 84-CDR-14

Task Manager

Dennis Holzschuh
Emission Measurement Branch
Emissions Standards and Engineering Division

OFFICE OF AIR QUALITY PLANNING AND STANDARDS
OFFICE OF AIR, NOISE, AND RADIATION
U. S. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, N. C., 27711

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TABLE OF CONTENTS

1. INTRODUCTION 1-1
   1.1 Background 1-1
   1.2 Scope of the Project 1-1
   1.3 North American Refractories Company Testing Program . . . 1-1
   1.3.1 Source Applicability 1-1
   1.3.2 Outline of Testing Program 1-2
   1.4 Report Organization 1-2

2. SUMMARY AND DISCUSSION OF RESULTS 2-1
   2.1 Summary 2-1
   2.2 Discussion 2-1

3. PROCESS DESCRIPTION AND OPERATION 3-1
   3.1 General 3-1
   3.2 Calcining Process 3-1
   3.2.1 Raw Material 3-1
   3.2.2 Rotary Dryer 3-1
   3.2.2.1 Dryer Design Capacity 3-1
   3.2.2.2 Dryer Exhaust Gases 3-3
   3.2.3 Storage 3-3
   3.3 Process Conditions During Testing 3-3
   3.3.1 Monitoring Procedures 3-3
   3.3.2 Test Interruptions 3-4
   3.3.3 Control Equipment 3-4
   3.3.4 Production Rates 3-4
   3.3.5 Moisture Content 3-5
   3.4 Discussion/Conclusions 3-5

4. SAMPLING LOCATIONS 4-1
   4.1 Suitability of Sampling Sites 4-1
   4.2 Rotary Dryer Inlet (Sample Location A) 4-1
   4.3 Rotary Dryer Inlet (Observation Location B) 4-1
   4.4 Rotary Dryer Outlet (Observation Location C) 4-1
   4.5 Rotary Dryer Outlet (Sample Location D) 4-1
   4.6 Cyclone Inlet (Sample Location E) 4-1

(continued next page)

TABLE OF CONTENTS

(continued)

4.7 Scrubber Inlet (Sample Location F) 4-3

4.8 Scrubber Outlet Stack (Sample Location G) 4-3

4.9 Scrubber Outlet Stack (Observation Location H) 4-3

5. SAMPLING AND ANALYTICAL METHODS 5-1

5.1 Sampling Objectives 5-1

5.2 Particulate Emissions Testing 5-1

5.3 Trace Metals Analysis 5-1

5.4 Sieve and Moisture Content Analysis 5-1

5.5 Plume Opacity and Fugitive Emissions 5-1

5.6 Particle Size Testing 5-1

6. QUALITY ASSURANCE 6-1

6.1 Introduction 6-1

6.2 Sampling Train Components 6-1

6.3 Preseparator and Cascade Impactors 6-1

6.4 Sample Collection Substrates 6-2

6.5 Substrate Weighting 6-2

6.6 Sample Analysis 6-2

6.7 EPA Method 3 6-2

6.8 EPA Method 9 6-2

7. APPENDICES 1

7.1 Plastic Clay Test Results and Example Calculations 2

7.1.1 Particulate 2

Cyclone Inlet & Example Calculations for Run 1 3

Scrubber Inlet (Cyclone Outlet) 8

Scrubber Outlet Stack 10

7.1.2 Particle Sizing 12

Cyclone Inlet 13

Scrubber Inlet (Cyclone Outlet) 24

(continued next page)

TABLE OF CONTENTS

(continued)

7.2 Flint Clay Test Results 36

7.2.1 Particulate 36

Cyclone Inlet 37

Scrubber Inlet (Cyclone Outlet) 39

Scrubber Outlet Stack 41

7.2.2 Particle Sizing 43

Cyclone Inlet 44

Scrubber Inlet (Cyclone Outlet) 58

7.3 Plastic Clay Field and Analytical Data 68

7.3.1 Particulate 68

Cyclone Inlet 69

Scrubber Inlet (Cyclone Outlet) 80

Scrubber Outlet Stack 92

7.3.2 Particle Sizing 104

Cyclone Inlet 105

Scrubber Inlet (Cyclone Outlet). 111

7.3.3 Visible Emissions Results and Reader Certification . . . 117

7.3.4 Trace Metals Analytical Results 138

7.4 Flint Clay Field and Analytical Data 140

7.4.1 Particulate 140

Cyclone Inlet & Example Calculations for Run 1 141

Scrubber Inlet (Cyclone Outlet) 151

Scrubber Outlet Stack 163

7.4.2 Particle Sizing 175

Cyclone Inlet 176

Scrubber Inlet (Cyclone Outlet) 184

7.4.3 Visible Emissions Results and Reader Certification . . . 188

7.4.4 Trace Metals Analytical Results 221

7.5 Sampling and Analytical Procedures 223

7.6 Feed and Product Analytical Data 319

7.7 Calibration Data 386

7.8 Entropy Test Participants 415

LIST OF TABLES

Number	Title	Page
1-1	Testing Protocol and Run/Sample Numbering Cross-Reference	1-3
2-1	Particulate Emission Rates and Concentrations and Control Equipment Efficiencies (Plastic Clay)	2-2
2-2	Particulate Emission Rates and Concentrations and Control Equipment Efficiencies (Flint Clay)	2-3
	Particulate Tests Summary - Plastic Clay:	
2-3	Cyclone Inlet	2-4
2-4	Scrubber Inlet (Cyclone Outlet)	2-5
2-5	Scrubber Outlet Stack	2-6
	Particulate Tests Summary - Flint Clay:	
2-6	Cyclone Inlet	2-7
2-7	Scrubber Inlet (Cyclone Outlet)	2-8
2-8	Particulate Tests Summary Scrubber Outlet Stack	2-9
	Particle Sizing Tests Summary - Plastic Clay:	
2-9	Cyclone Inlet	2-10
2-10	Scrubber Inlet (Cyclone Outlet)	2-12
	Particle Sizing Summary - Flint Clay:	
2-11	Cyclone Inlet	2-14
2-12	Scrubber Inlet (Cyclone Outlet)	2-16
	Six Minute Summary of Visible Emissions - Flint Clay:	
2-13	Scrubber Outlet Stack - Run 2	2-18
2-14	Scrubber Outlet Stack - Run 3	2-19
2-15	Scrubber Outlet Stack - Run 4	2-20
	Six Minute Summary of Visible Emissions - Plastic Clay:	
2-16	Scrubber Outlet Stack - Run 5	2-21
2-17	Scrubber Outlet Stack - Run 6	2-22
	Operating Conditions	
3-1	Run No. 1 - Plastic Clay	3-6
3-2	Run No. 2 - Flint Clay	3-7
3-3	Run No. 3 - Flint Clay	3-8
3-4	Run No. 4 - Flint Clay	3-9
3-5	Run No. 5 - Plastic Clay	3-10
3-6	Run No. 6 - Plastic Clay	3-11
3-7	NARCO Test Production Summary	3-12

LIST OF FIGURES

Number	Title	Page
3-1	Plastic and Flint Clay Processing	3-2
4-1	Process Flow Schematic Showing Sampling Locations	4-2
4-2	Rotary Dryer Cyclone Inlet	4-4
4-3	Rotary Dryer Scrubber Inlet (Cyclone Outlet)	4-5
4-4	Rotary Dryer Scrubber Outlet Stack	4-6

1. INTRODUCTION

1.1 Background. The Emission Measurement Branch (EMB) of the U.S. Environmental Protection Agency (EPA) is directing a project designed to generate support data for New Source Performance Standards (NSPS) for calciners and dryers in the mineral industries. Emission standards for the various industries may be developed based upon process-related emission factors determined from the testing of controlled sources.

1.2 Scope of the Project. The EMB is responsible for coordinating the efforts of Entropy and Midwest Research Institute (MRI) to achieve the goals of the testing program. Entropy has been retained under the EMB Contract No. 68-02-3852, Work Assignment No. 2 to conduct testing programs at designated industrial facilities. Entropy is to perform emission measurements at the recommended sampling locations, obtain process feed and product samples, and, in conjunction with Research Triangle Institute (RTI), conduct sample analyses. MRI will monitor process and operating conditions in order to designate suitable testing conditions for the respective processes and to provide a record of process and operational data during the testing.

1.3 North American Refractories Company (NARCO) Source Testing Program. The present report covers stationary source sampling performed at the NARCO manufacturing plant in Farber, Missouri on March 12-15, 1984 to characterize emissions from the refractory manufacturing processes and pollution control equipment. Steve Sutton of NARCO and Dennis Holzschuh of EPA EMB were present to coordinate the testing. Amy J. Kowalski of MRI monitored the plant process and recorded operational data during the testing.

1.3.1 Source Applicability. NARCO operates a McDermott, direct-fired, rotary dryer. The raw clay is placed in a hopper which feeds the clay into an Eagle crusher. Emissions from the rotary dryer system are controlled by a cyclone and a scrubber. The reasons for selecting this plant are as follows: NARCO is considered to be a well-maintained facility; no EMB approved data exists on a rotary fire clay dryer drying a worst-case clay type; and NARCO processes Missouri plastic and flint clays which are both reported to be the most difficult to control.

1.3.2 Outline of Testing Program. EPA Method 5 testing was conducted simultaneously at the cyclone inlet, at the scrubber inlet (cyclone outlet), and at the scrubber outlet stack to determine the particulate emissions from two types of fire clay: flint clay (Brohard) and Missouri plastic clay. During the processing of each of the two clays, three sets of EPA Method 5 runs were performed for a total of six sets. Each set consisted of three simultaneous runs, i.e., one run at each of the three sampling locations. The impinger reagents from one Method 5 run at each location were analyzed for trace metals.

Concurrent with five of the six sets of Method 5 runs, Method 9 opacity readings were taken at the dryer inlet conveyor belt and at the scrubber outlet stack. Eight particle sizing runs were performed at the cyclone inlet, while seven were performed at the scrubber inlet (cyclone outlet). One reactivity run was performed as a control measure at the cyclone inlet. Feed and product samples were taken for moisture content and sieve analysis. Table 1-1 presents a test log which summarizes the test dates, sampling locations, run or sample numbers, and the types of testing performed.

1.4 Report Organization. Section 1, "Introduction," briefly describes the purpose of the testing program, the responsibilities of the project participants, the NARCO facility, and the specific tests that were conducted. Section 2 presents a comprehensive summary of all test results, including pollutant emission rates and concentrations, control equipment collection efficiencies, and particle sizing results. Detailed information describing the process and operating conditions during the test is contained in Section 3. Section 4 describes the various sampling locations used in the testing program. Section 5 contains the sampling and analytical procedures employed at the NARCO facility. The quality assurance procedures utilized in this testing program are included in Section 6.

Section 7, "Appendices," contains all relevant supporting documentation for the testing program. Appendices 7.1 and 7.2 present detailed results for the plastic and flint clay tests, respectively. Appendices 7.3 and 7.4 contain all sampling and analytical data for the plastic and flint clay emissions testing, respectively. Descriptions of sampling and analytical procedures are provided in Appendix 7.5. Analytical results for feed and product samples are included as Appendix 7.6. Equipment calibration data are included in Appendix 7.7; Appendix 7.8 contains a list of Entropy test participants.

TABLE 1-1

TESTING PROTOCOL AND

RUN/SAMPLE NUMBERING CROSS-REFERENCE

			Plastic Clay			Flint Clay		
			--- Test Set ---			--- Test Set ---		
-----	Sampling	-----	1	2	3	1	2	3
Objective	Method	Location*	3/12	3/15	3/15	3/13	3/14	3/14
Particulate	EPA 5	CI	1	11tm	12	2	3tm	10
		SI	4	14tm	15	5	6tm	13
		SO	7	17tm	18	8	9tm	16
Particle Sizing	Cascade Impactor	CI	X	S11A&B	S12A&B	S2A&B	S3A	S10A
		SI	X	S14A&B	S15A&B	S5A	S6A&B	X
Sieving/ Moisture	Grab Sample	DI	1	5	6	2	3	4
		DO	1	5	6	2	3	4
Opacity	EPA 9	DI	X	5	6	2	3	4
		SO	X	5	6	2	3	4

* DI - Dryer Inlet

DO - Dryer Outlet

CI - Cyclone Inlet

SI - Scrubber Inlet

SO - Scrubber Outlet Stack

X - Testing not performed

tm - Method 5 particulate catch and distilled water from impingers analyzed for trace metals.

2. SUMMARY AND DISCUSSION OF RESULTS

2.1 Summary. Tables 2-1 and 2-2 present the emission rates and concentrations and control equipment efficiencies for the particulate testing performed during the processing of plastic clay and flint clay, respectively. Run-by-run summaries of the particulate results for the plastic clay testing are presented in Tables 2-3 through 2-5, while Tables 2-6 through 2-8 present run-by-run summaries of the flint clay testing; detailed results appear in Appendix 7.1. Particle sizing summations are given in Tables 2-9 through 2-12. Individual run summaries of the visible emissions observations are presented in Tables 2-13 through 2-17.

2.2 Discussion of Results. The emissions rates at the scrubber outlet stack varied inversely with the efficiency of the cyclone; the scrubber efficiency was only slightly lower during the flint clay condition than the plastic clay condition.

Due to equipment problems and the length of process time available on the first day of testing, no particle sizing runs performed at any of the sampling locations; throughout the testing program no particle sizing runs were performed at the scrubber outlet stack due to the presence of water droplets in the exhaust gases. Test times at certain locations varied due to the length of process time available.

EMB chose to perform EPA Method 9 (visible emissions) instead of EPA Method 22 (fugitive emissions) at the rotary dryer inlet observation location; due to adverse weather conditions, no visible emissions readings were taken at either observation location during the first day of testing. Opacity measurements were planned at the rotary dryer outlet; however, during a presurvey of the sampling locations, it was discovered that from the dryer outlet to the scrubber outlet stack, the process was a closed system.

After the completion of run 7 at the scrubber outlet stack, it was discovered that the thermocouple temperature readout was measuring low by approximately 38°F. The scrubber inlet/outlet temperatures for the subsequent runs were reviewed, and a representative stack temperature of 130°F was used for the emissions calculations. However, the temperature adjustment resulted in an over isokinetic sampling rate of 113.7%.

During the first particulate run (run 1) at the cyclone inlet, heavy particulate loading caused the positive pitot to plug, making it necessary to back-calculate a velocity from the scrubber inlet; limited process time restricted the run to the horizontal sampling traverse only.

TABLE 2-1

PARTICULATE EMISSIONS & CONCENTRATIONS SUMMARY

AND CONTROL EQUIPMENT EFFICIENCIES

Plastic Clay

	Test Set 1	Test Set 2	Test Set 3	Average
Emission Rates, lb/hr:				
Cyclone Inlet	1,907	2,435	1,989	2,109
Scrubber Inlet (Cyclone Outlet)	389.5	343.4	196.0	309.6
Scrubber Outlet Stack	3.57	2.55	1.67	2.60
Emission Rates, kg/hr:				
Cyclone Inlet	864.8	1,104	902.3	957.0
Scrubber Inlet (Cyclone Outlet)	176.7	155.8	88.9	140.5
Scrubber Outlet Stack	1.62	1.16	0.757	1.18
Concentration, gr/DSCF:				
Cyclone Inlet	42.03	59.35	50.09	50.49
Scrubber Inlet (Cyclone Outlet)	6.26	5.65	3.19	5.03
Scrubber Outlet Stack	0.051	0.038	0.024	0.038
Collection Efficiency, %:				
Cyclone	85.11	90.48	93.63	89.74
Scrubber	99.19	99.33	99.25	99.26
Concentration, mg/DSCM:				
Cyclone Inlet	96,171	135,807	114,601	115,526
Scrubber Inlet (Cyclone Outlet)	14,329	6,911	5,791	9,010
Scrubber Outlet Stack	115.5	86.2	53.6	85.1

TABLE 2-2

PARTICULATE EMISSIONS & CONCENTRATIONS SUMMARY

AND CONTROL EQUIPMENT EFFICIENCIES

Flint Clay

	Test Set 1	Test Set 2	Test Set 3	Average
Emission Rates, lb/hr:				
Cyclone Inlet	1,543	906.8	1,608	1,352
Scrubber Inlet (Cyclone Outlet)	174.5	143.9	384.9	234.4
Scrubber Outlet Stack	2.03	2.61	3.18	2.61
Emission Rates, kg/hr:				
Cyclone Inlet	699.9	411.3	729.5	613.6
Scrubber Inlet (Cyclone Outlet)	79.2	65.3	174.6	106.4
Scrubber Outlet Stack	0.921	1.18	1.44	1.18
Concentration, gr/DSCF:				
Cyclone Inlet	36.78	23.64	38.36	32.93
Scrubber Inlet (Cyclone Outlet)	3.02	2.53	6.40	4.99
Scrubber Outlet Stack	0.030	0.039	0.046	0.038
Collection Efficiency, %:				
Cyclone	91.79	89.30	83.32	88.14
Scrubber	99.01	98.46	99.28	98.92
Concentration, mg/DSCM:				
Cyclone Inlet	84,156	54,082	87,770	75,336
Scrubber Inlet (Cyclone Outlet)	6,911	5,791	14,634	9,112
Scrubber Outlet Stack	68.0	89.8	105.0	87.6

TABLE 2-3

PARTICULATE TESTS SUMMARY OF RESULTS

Plastic Clay - Cyclone Inlet

	1	11	12
Run Date	03/12/84	03/15/84	03/15/84
Test Train Parameters:			
Volume of Dry Gas Sampled, SCF*	13.613	9.777	9.534
Percent Isokinetic	103.3	102.5	103.3
Stack Parameters:			
Temperature, Deg. F	160	139	138
Air Flow Rates SCFM*, Dry	5,292	4,787	4,633
ACFM, Wet	7,412	6,857	6,613
Method 5 Results (English):			
Catch, milligrams	37,075.7	37,602.9	30,942.6
Concen., grains/DSCF*	42.03	59.35	50.09
Emissions, pounds/hour	1,906.6	2,435.1	1,989.3
Method 5 Results (Metric):			
Concen., milligrams/DSCM*	96,170.6	135,807.1	114,601.0
Emissions, kilograms/hour	864.8	1,104.5	902.3

* 68 Deg. F. - 29.92 in. Hg.

TABLE 2-4

PARTICULATE TESTS SUMMARY OF RESULTS

Plastic Clay - Scrubber Inlet

	4	14	15
Run Date	03/12/84	03/15/84	03/15/84
Test Train Parameters:			
Volume of Dry Gas Sampled, SCF*	26.393	16.412	16.508
Percent Isokinetic	100.4	98.8	98.1
Stack Parameters:			
Temperature, Deg. F	132	132	133
Air Flow Rates SCFM*, Dry	7,256	7,086	7,176
ACFM, Wet	10,109	9,776	9,962
Method 5 Results (English):			
Catch, milligrams	10,709.9	6,012.2	3,408.9
Concen., grains/DSCF*	6.26	5.65	3.19
Emissions, pounds/hour	389.5	343.4	196.0
Method 5 Results (Metric):			
Concen., milligrams/DSCM*	14,328.6	12,935.4	7,291.7
Emissions, kilograms/hour	176.7	155.8	88.9

* 68 Deg. F. - 29.92 in. Hg.

TABLE 2-5

PARTICULATE TESTS SUMMARY OF RESULTS

Plastic Clay - Scrubber Outlet Stack

	7	17	18
Run Date	03/12/84	03/15/84	03/15/84
Test Train Parameters:			
Volume of Dry Gas Sampled, SCF*	82.266	61.237	60.702
Percent Isokinetic	113.7	110.5	105.1
Stack Parameters:			
Temperature, Deg. F	130	134	132
Air Flow Rates SCFM*, Dry	8,258	7,904	8,240
ACFM, Wet	10,748	10,366	10,677
Method 5 Results (English):			
Catch, milligrams	269.2	149.5	92.9
Concen., grains/DSCF*	0.051	0.038	0.024
Emissions, pounds/hour	3.57	2.55	1.67
Method 5 Results (Metric):			
Concen., milligrams/DSCM*	115.5	86.2	53.6
Emissions, kilograms/hour	1.62	1.16	0.757

* 68 Deg. F. - 29.92 in. Hg.

TABLE 2-6

PARTICULATE TESTS SUMMARY OF RESULTS

Flint Clay - Cyclone Inlet

	2	3	10
Run Date	03/13/84	03/14/84	03/14/84
Test Train Parameters:			
Volume of Dry Gas Sampled, SCF*	10.148	9.521	9.797
Percent Isokinetic	104.0	106.8	100.5
Stack Parameters:			
Temperature, Deg. F	150	153	149
Air Flow Rates SCFM*, Dry	4,895	4,476	4,891
ACFM, Wet	6,776	6,566	6,952
Method 5 Results (English):			
Catch, milligrams	24,185.8	14,582.4	24,352.0
Concen., grains/DSCF*	36.78	23.64	38.36
Emissions, pounds/hour	1,543.1	906.8	1,608.2
Method 5 Results (Metric):			
Concen., milligrams/DSCM*	84,156.3	54,082.1	87,770.4
Emissions, kilograms/hour	699.9	411.3	729.5

* 68 Deg. F. - 29.92 in. Hg.

TABLE 2-7

PARTICULATE TESTS SUMMARY OF RESULTS

Flint Clay - Scrubber Inlet

	5	6	13
Run Date	03/13/84	03/14/84	03/14/84
Test Train Parameters:			
Volume of Dry Gas Sampled, SCF*	25.581	25.203	16.578
Percent Isokinetic	103.6	103.7	100.7
Stack Parameters:			
Temperature, Deg. F	136	140	145
Air Flow Rates SCFM*, Dry	6,741	6,634	7,022
ACFM, Wet	9,440	9,506	10,126
Method 5 Results (English):			
Catch, milligrams	5,006.4	4,133.0	6,870.3
Concen., grains/DSCF*	3.02	2.53	6.40
Emissions, pounds/hour	174.5	143.9	384.9
Method 5 Results (Metric):			
Concen., milligrams/DSCM*	6,910.6	5,790.6	14,633.6
Emissions, kilograms/hour	79.2	65.3	174.6

* 68 Deg. F. - 29.92 in. Hg.

TABLE 2-8

PARTICULATE TESTS SUMMARY OF RESULTS

Flint Clay - Scrubber Outlet Stack

	8	9	16
Run Date	03/13/84	03/14/84	03/14/84
Test Train Parameters:			
Volume of Dry Gas Sampled, SCF*	67.713	58.717	46.662
Percent Isokinetic	108.5	108.0	109.9
Stack Parameters:			
Temperature, Deg. F	134	132	133
Air Flow Rates SCFM*, Dry	7,964	7,759	8,078
ACFM, Wet	10,645	10,262	10,909
Method 5 Results (English):			
Catch, milligrams	130.4	149.4	138.8
Concen., grains/DSCF*	0.030	0.039	0.046
Emissions, pounds/hour	2.03	2.61	3.18
Method 5 Results (Metric):			
Concen., milligrams/DSCM*	68.0	89.8	105.0
Emissions, kilograms/hour	0.921	1.18	1.44

* 68 Deg. F. - 29.92 in. Hg.

TABLE 2-9

SUMMARY OF PARTICLE SIZING TEST RESULTS

Plastic Clay - Cyclone Inlet

SAMPLING DATA	PS Run 11	PS Run 12	Average
Date	3/15/84	3/15/84	—
Start Time	1256, 1325	1512,1546	—
Finish Time	1256, 1325	1512,1546	—
Impactor Flow Rate (l/min)	21.81	22.06	—
Isokinetic Ratio (%)	105.3	109.9	—
STACK DATA			
Temperature (degress C)	61.3	58.3	59.8
Moisture (%)	20.0	19.5	19.8
Velocity (m/min)	1,154	1,118	1,136
EMISSION DATA			
Concentration (mg/dscm)	80,250	22,570	51,410
Percent Recovery (PS conc./ M-5 conc.)	59.0	19.7	39.3
Cumulative % Mass less than 10 microns	15.55	9.03	12.29
Concentration < 10 microns: From PS runs, mg/dscm	12,400	1,740	7,070
From M-5 runs, mg/dscm	20,371	10,314	15,342
Emission Rate < 10 microns (kg/hr, from M-5 runs)	165.7	81.2	123.4

PS: Particle Size Run
M-5: Method 5 Particulate Run

PARTICLE SIZE DISTRIBUTION

COMPANY NAME North American Refractories Company

ADDRESS Farber, Missouri

SAMPLING LOCATION Cyclone Inlet

DATE(S) 3-15-84

AVERAGE OF RUNS 11A, 11B, 12A & 12B

DENSITY = 1 GM/CM^3

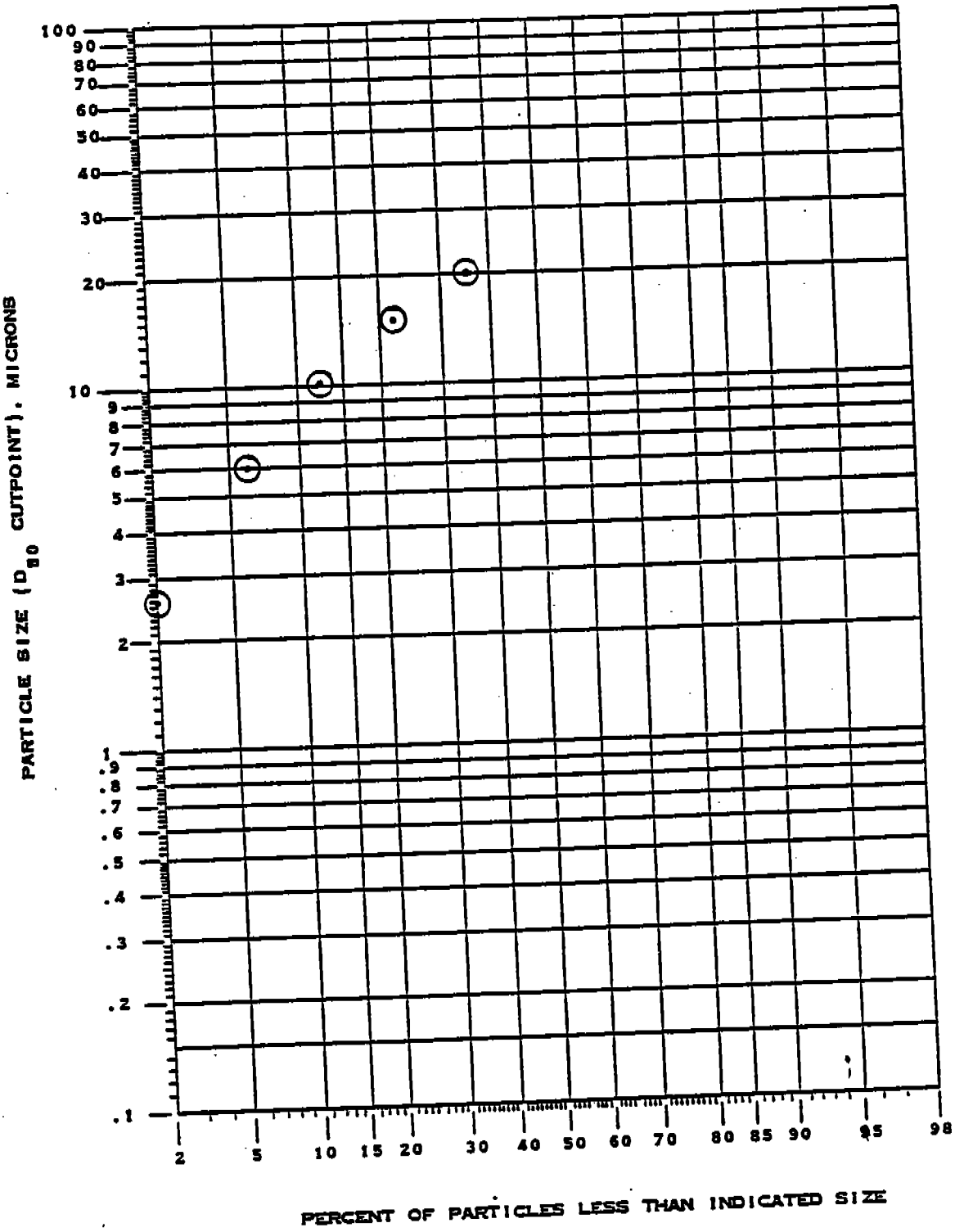


TABLE 2-10

SUMMARY OF PARTICLE SIZING TEST RESULTS

Plastic Clay - Scrubber Inlet

SAMPLING DATA	PS Run 14	PS Run 15	Average
Date	3/15/84	3/15/84	—
Start Time	1305, 1338	1535, 1557	—
Finish Time	1307, 1340	1536, 1558	—
Impactor Flow Rate (l/min)	19.46	21.72	—
Isokinetic Ratio (%)	102.5	111.5	—
STACK DATA			
Temperature (degrees C)	58.6	58.6	58.6
Moisture (%)	18.9	16.6	17.8
Velocity (m/min)	1,056	1,086	1,071
EMISSION DATA			
Concentration (mg/dscm)	10,590	3,913	7,251
Percent Recovery (PS conc./ M-5 conc.)	81.8	53.6	67.7
Cumulative % Mass less than 10 microns	41.62	34.81	38.21
Concentration < 10 microns: From PS runs, mg/dscm	4,270	1,570	2,920
From M-5 runs, mg/dscm	5,302	2,478	3,890
Emission Rate < 10 microns (kg/hr, from M-5 runs)	64.8	30.2	47.5

PS: Particle Size Run
M-5: Method 5 Particulate Run

PARTICLE SIZE DISTRIBUTION

COMPANY NAME North American Refractories Company

ADDRESS Farber, Missouri

SAMPLING LOCATION Scrubber Inlet

DATE(S) 3/15/84

AVERAGE OF RUNS 14A, 14B, 15A & 15B

DENSITY = 1 GM/CM^3

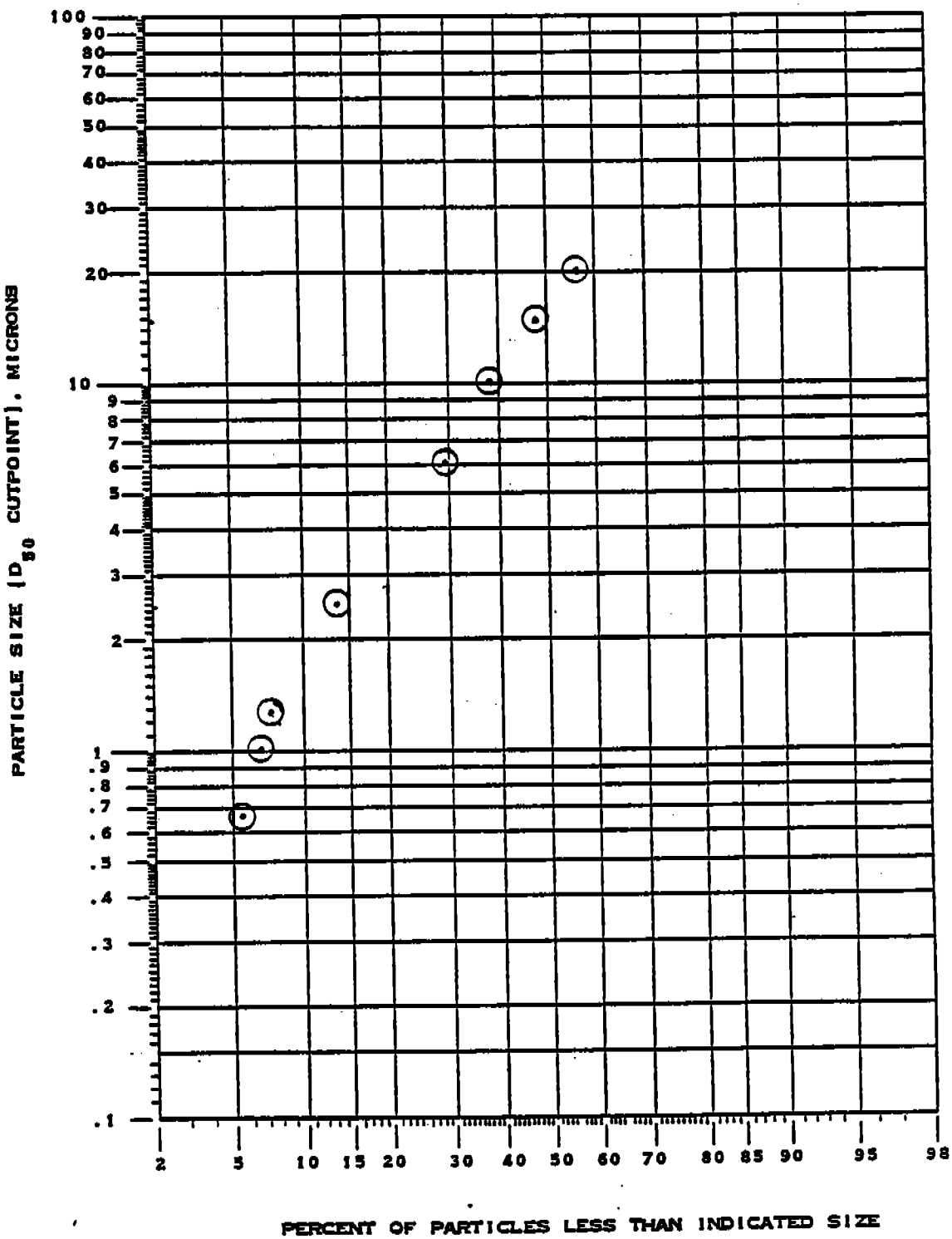


TABLE 2-11

SUMMARY OF PARTICLE SIZING TEST RESULTS

Flint Clay - Cyclone Inlet

SAMPLING DATA	PS Run 2	PS Run 3	PS Run 10	Average
Date	3/13/84	3/14/84	3/14/84	—
Start Time	1730	1527	1736	—
Finish Time	1732	1527	1736	—
Impactor Flow Rate (l/min)	31.35	20.73	22.68	—
Isokinetic Ratio (%)	156.0	105.4	107.3	—
STACK DATA				
Temperature (degrees C)	62.5	62.0	65.5	63.3
Moisture (%)	14.8	19.5	17.5	17.3
Velocity (m/min)	1,119	1,095	1,178	1,131
EMISSION DATA				
Concentration (mg/dscm)	18,510	57,870	57,950	44,776
Percent Recovery (PS conc./ M-5 conc.)	21.9	107	66	64.9
Cumulative % Mass less than 10 microns	80.91	4.0	23.71	36.20
Concentration < 10 microns: From PS runs, mg/dscm	14,973	2,314	13,742	10,343
From M-5 runs, mg/dscm	67,325	2,163	20,187	29,891
Emission Rate < 10 microns (kg/hr, from M-5 runs)	559.92	16.45	167.78	248.05

PS: Particle Size Run
M-5: Method 5 Particulate Run

PARTICLE SIZE DISTRIBUTION

COMPANY NAME North American Refractories Company
ADDRESS Farber, Missouri
AVERAGE OF RUNS 2B, 3A, & 1(
SAMPLING LOCATION Cyclone Inlet
DATE(S) 3/13/84 & 3/14/84

DENSITY = 1 GM/CM^3

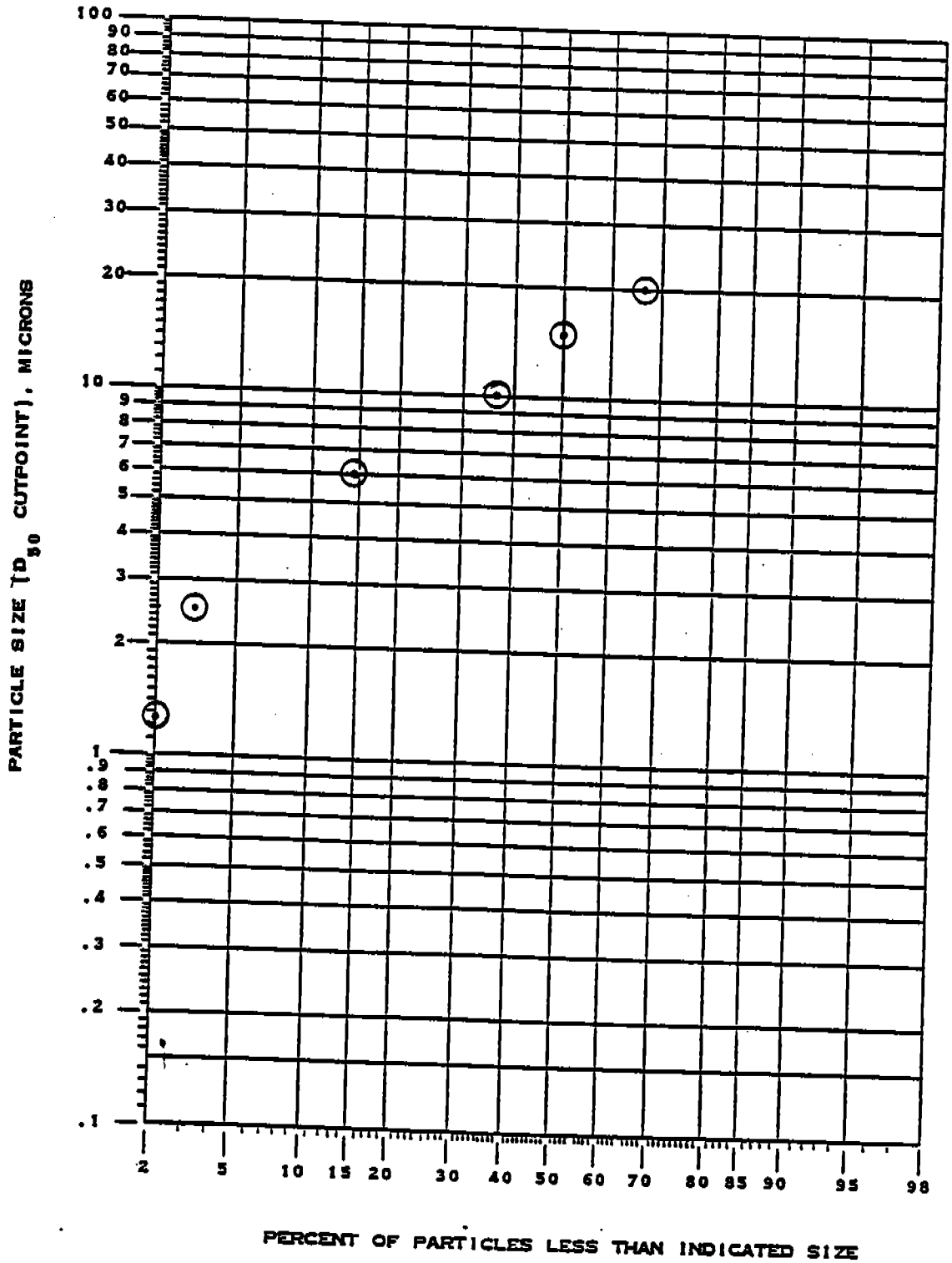


TABLE 2-12

SUMMARY OF PARTICLE SIZING TEST RESULTS

Flint Clay - Scrubber Inlet

SAMPLING DATA	PS Run 5	PS Run 6	Average
Date	3/13/84	3/14/84	—
Start Time	1703	1546,1623	—
Finish Time	1705	1548,1625	—
Impactor Flow Rate (l/min)	20.05	20.12	—
Isokinetic Ratio (%)	107.1	112.6	—
STACK DATA			
Temperature (degrees C)	58.8	58.6	58.7
Moisture (%)	17.0	18.7	17.9
Velocity (m/min)	1,043	995	1,019
EMISSION DATA			
Concentration (mg/dscm)	4,862	8,780	6,821
Percent Recovery (PS conc./ M-5 conc.)	70.3	151.6	110.9
Cumulative % Mass less than 10 microns	70.44	46.40	58.42
Concentration < 10 microns: From PS runs, mg/dscm	3,424	4,090	3,757
From M-5 runs, mg/dscm	4,837	2,663	3,750
Emission Rate < 10 microns (kg/hr, from M-5 runs)	55.44	30.03	42.73

PS: Particle Size Run
M-5: Method 5 Particulate Run

PARTICLE SIZE DISTRIBUTION

COMPANY NAME North American Refractories Company AVERAGE OF RUNS 5A, 6A, & 6B

ADDRESS Farber, Missouri

SAMPLING LOCATION Scrubber Inlet

DATE(S) 3/13/84 & 3/14/84

DENSITY = 1 GM/CM^3

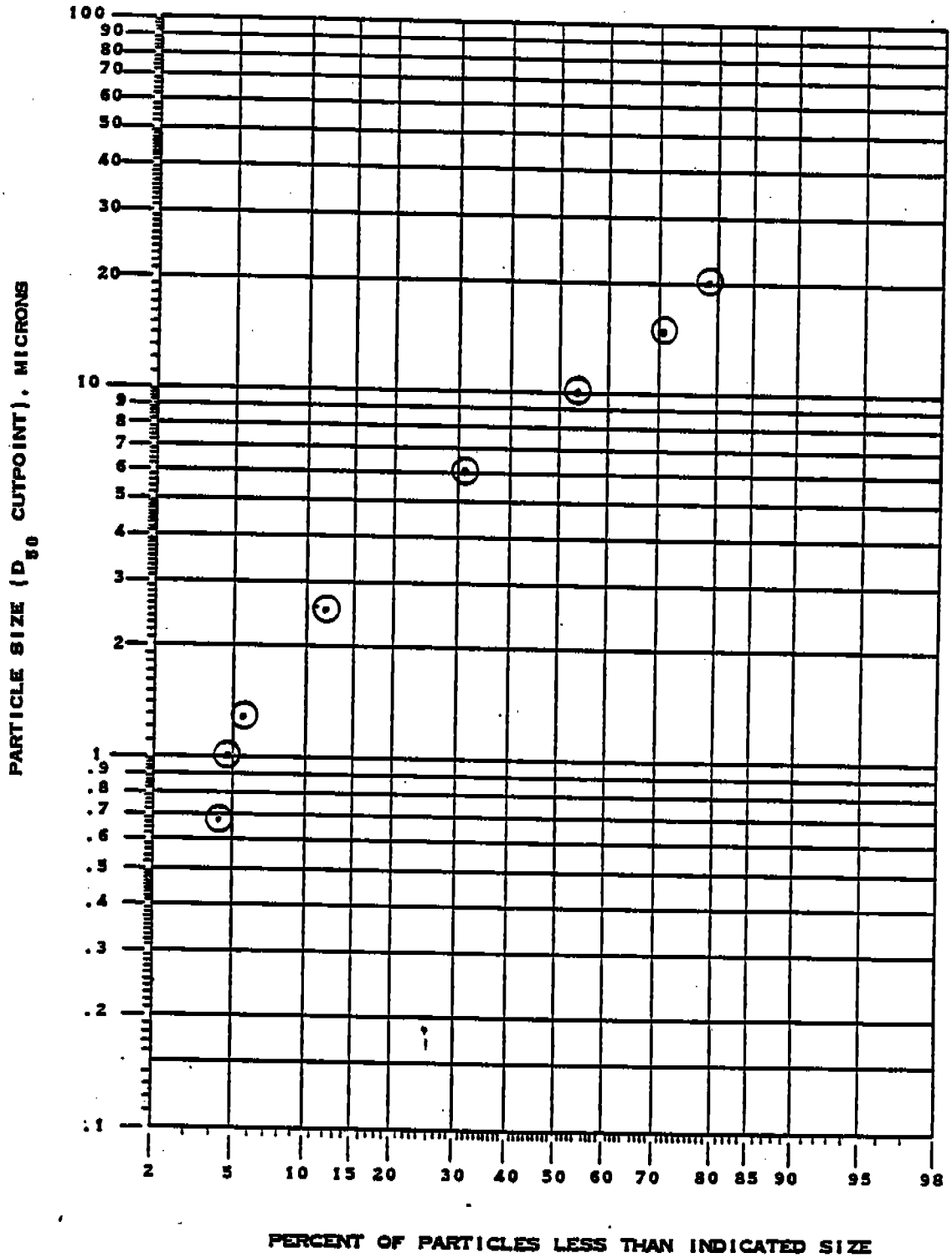


TABLE 2-13

SUMMARY OF VISIBLE EMISSIONS

Run 2

Date: 3/13/84
Type of Discharge: Stack
Height of Point of Discharge: 60'
Wind Direction: East
Color of Plume: White
Observer: J. R. Iserman
Type of Plant: Drying Kiln - Clay
Location of Discharge: Scrub. Outlet
Description of Sky: Overcast
Wind Velocity: 0-5
Detached Plume: Slighty detached
Duration of Observation: 166 min.
Distance from Observer to Discharge Point: 150'
Direction of Observer from Point: West
Height of Observation Point: Ground level
Description of Background: Light Gray

SUMMARY OF AVERAGE OPACITY

Set	Time		Opacity		Set	Time		Opacity	
Number	Start	End	Sum	Average	Number	Start	End	Sum	Average
1	1445	1451	10	0.42	15	1609	1615	45	1.88
2	1451	1457	25	1.04	16	1615	1621	65	2.71
3	1457	1503	30	1.25	17	1621	1627	35	1.46
4	1503	1509	35	1.46	18	1627	1633	30	1.25
5	1509	1515	45	1.88	19	1633	1639	50	2.08
6	1515	1521	35	1.46	20	1639	1645	65	2.71
7	1521	1527	70	2.92	21	1647	1653	35	1.46
8	1527	1533	60	2.50	22	1653	1659	25	1.04
9	1533	1539	65	2.71	23	1659	1705	45	1.88
10	1539	1545	60	2.50	24	1705	1711	50	2.08
11	1545	1551	85	3.54	25	1711	1717	60	2.50
12	1551	1557	20	0.83	26	1717	1723	65	2.71
13	1557	1603	10	0.42	27	1723	1729	40	1.67
14	1603	1609	25	1.04	28	1729	1731	30	*3.75

*Represents 2 minutes of readings

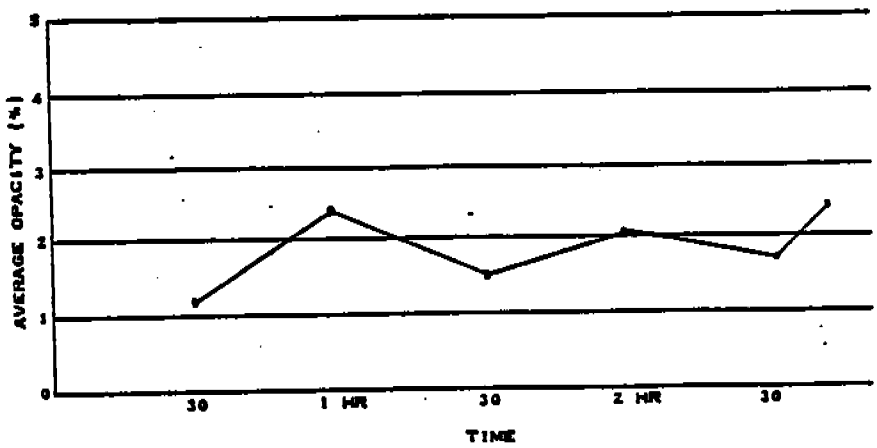


TABLE 2-14

SUMMARY OF VISIBLE EMISSIONS

Run 3

Date: 3/14/84
Type of Discharge: Stack
Height of Point of Discharge: 60'
Wind Direction: North
Color of Plume: White
Observer: J. R. Iserman
Type of Plant: Drying Kiln - Clay
Location of Discharge: Scrub. Outlet
Description of Sky: Overcast
Wind Velocity: 5-10
Detached Plume: No
Duration of Observation: 150 min.
Distance from Observer to Discharge Point: 150'
Direction of Observer from Point: West
Height of Observation Point: Ground level
Description of Background: Light Gray

SUMMARY OF AVERAGE OPACITY

Set	Time		Opacity		Set	Time		Opacity	
Number	Start	End	Sum	Average	Number	Start	End	Sum	Average
1	1315	1321	60	2.50	11	1445	1451	60	2.50
2	1321	1327	60	2.50	12	1451	1457	50	2.08
3	1327	1333	60	2.50	13	1457	1503	45	1.87
4	1333	1339	65	2.71	14	1503	1509	50	2.08
5	1339	1345	50	2.08	15	1509	1515	60	2.50
6	1345	1349	55	*3.24	16	1515	1521	55	2.08
7	1420	1426	35	**4.38	17	1521	1527	60	2.50
8	1426	1432	70	2.92	18	1527	1533	50	2.08
9	1432	1438	55	2.29	19	1533	1539	35	1.46
10	1438	1444	55	2.29	20	1539	1545	30	1.25

*Due to overcast conditions this reading represents only 4 minutes & 15 seconds
**Represents two minutes of readings

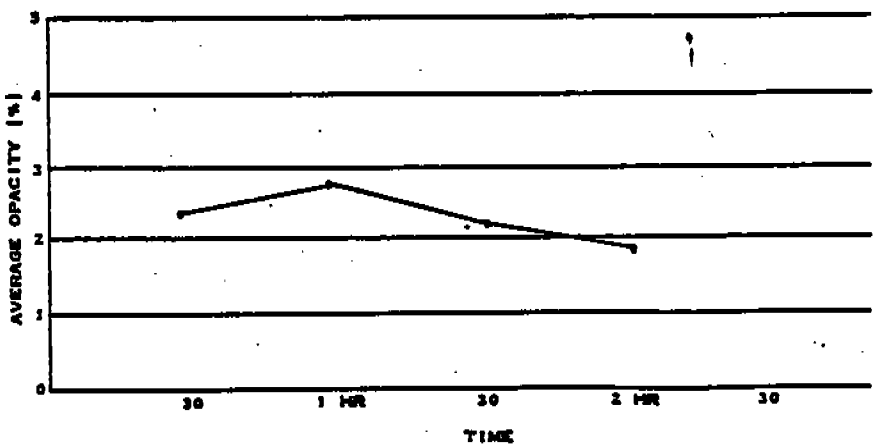


TABLE 2-15

SUMMARY OF VISIBLE EMISSIONS

Run 4

Date: 3/14/84
Type of Discharge: Stack
Height of Point of Discharge: 60'
Wind Direction: North
Color of Plume: White
Observer: J. R. Iserman
Type of Plant: Drying Kiln - Clay
Location of Discharge: Scrub. Outlet
Description of Sky: Overcast
Wind Velocity: 10-15
Detached Plume: No
Duration of Observation: 112 min.
Distance from Observer to Discharge Point: 150'
Direction of Observer from Point: West
Height of Observation Point: Ground level
Description of Background: Light Gray

SUMMARY OF AVERAGE OPACITY

Set	Time		Opacity		Set	Time		Opacity	
Number	Start	End	Sum	Average	Number	Start	End	Sum	Average
1	1615	1621	60	2.50	11	1745	1751	55	2.29
2	1621	1627	70	2.92	12	1751	1757	60	2.50
3	1627	1633	65	2.71	13	1757	1803	70	2.92
4	1633	1639	50	2.08	14	1803	1807	40	*2.50
5	1639	1645	55	2.29					
6	1715	1721	80	3.33					
7	1721	1727	70	2.92					
8	1727	1733	55	2.29					
9	1733	1739	55	2.29					
10	1739	1745	50	2.08					

*Due to overcast conditions this reading represents only 4 minutes

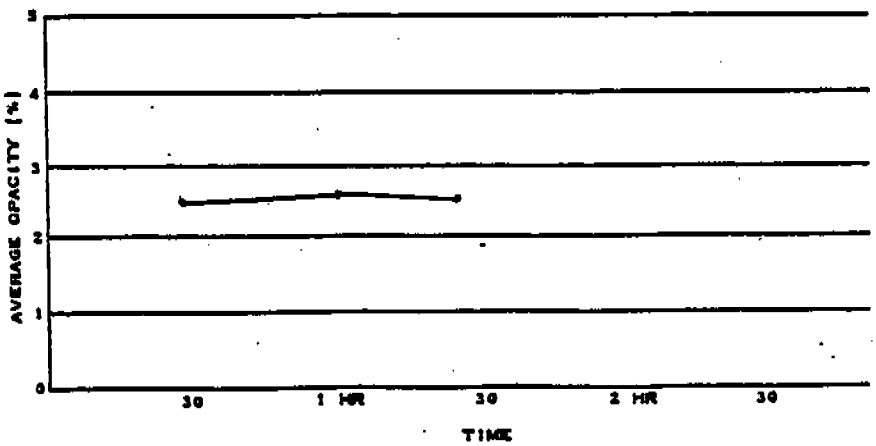


TABLE 2-16

SUMMARY OF VISIBLE EMISSIONS

Run 5

Date: 3/15/84
Type of Discharge: Stack
Height of Point of Discharge: 60'
Wind Direction: North
Color of Plume: White
Observer: J. R. Iserman
Type of Plant: Drying Kiln - Clay
Location of Discharge: Scrub. Outlet
Description of Sky: Overcast
Wind Velocity: 5-10
Detached Plume: No
Duration of Observation: 165 min.
Distance from Observer to Discharge Point: 150'
Direction of Observer from Point: West
Height of Observation Point: Ground level
Description of Background: Gray

SUMMARY OF AVERAGE OPACITY

Set	Time		Opacity		Set	Time		Opacity	
Number	Start	End	Sum	Average	Number	Start	End	Sum	Average
1	1100	1106	50	2.08	11	1245	1251	65	2.71
2	1106	1112	35	1.46	12	1251	1257	65	2.71
3	1112	1118	45	1.87	13	1257	1303	35	1.46
4	1118	1124	60	2.50	14	1303	1309	50	2.08
5	1124	1130	50	2.08	15	1309	1315	70	2.92
6	1130	1136	45	1.87	16	1315	1321	55	2.29
7	1136	1142	50	2.08	17	1321	1327	65	2.71
8	1142	1148	70	2.92	18	1327	1333	35	1.46
9	1148	1154	35	1.46	19	1333	1339	55	2.29
10	1154	1155	15	*3.00	20	1339	1345	45	1.87

*Represents 1.25 minutes of readings

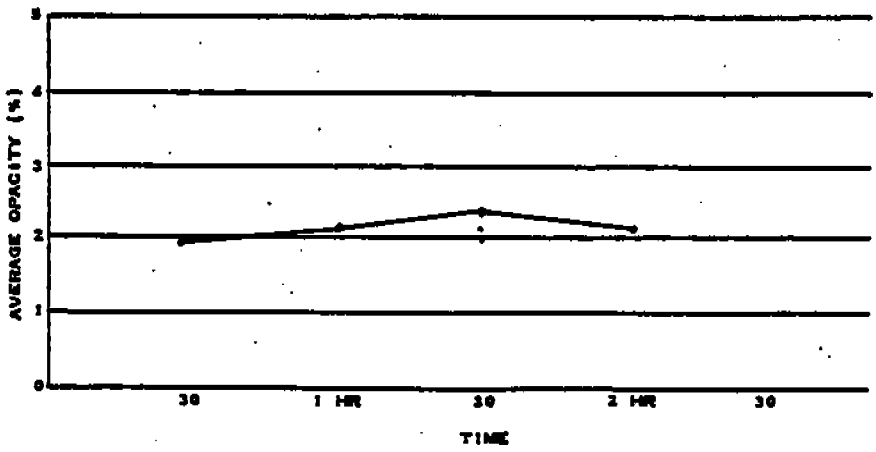


TABLE 2-17

SUMMARY OF VISIBLE EMISSIONS

Run 6

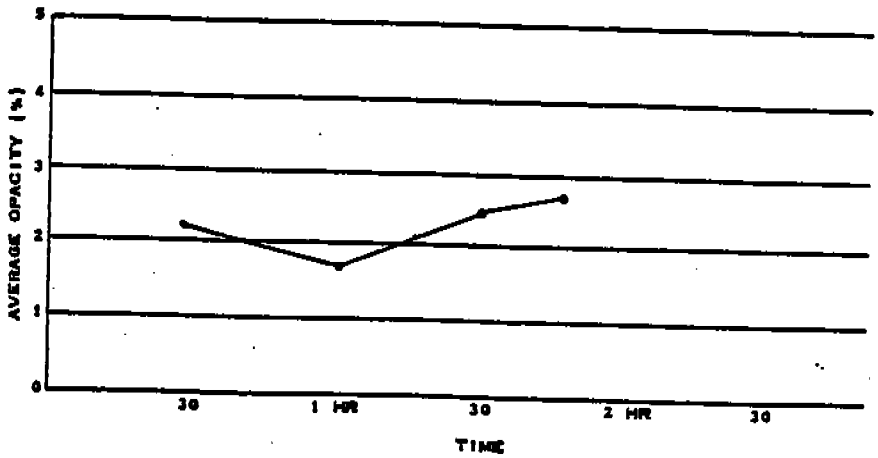
Date: 3/15/84
Type of Discharge: Stack
Height of Point of Discharge: 60'
Wind Direction: North-North-East
Color of Plume: White
Observer: J. R. Iserman
Distance from Observer to Discharge Point: 150'
Direction of Observer from Point: West
Height of Observation Point: Ground level
Description of Background: Gray

Type of Plant: Drying Kiln - Clay
Location of Discharge: Scrub. Outlet
Description of Sky: Overcast
Wind Velocity: 5-10
Detached Plume: No
Duration of Observation: 105 min.

SUMMARY OF AVERAGE OPACITY

Set Number	Time Start	Time End	Opacity Sum	Opacity Average	Set Number	Time Start	Time End	Opacity Sum	Opacity Average
1	1415	1421	80	3.33	11	1515	1521	75	3.13
2	1421	1427	35	1.46	12	1521	1527	75	3.13
3	1427	1433	65	2.71	13	1527	1533	35	1.46
4	1433	1439	30	1.25	14	1533	1539	50	2.08
5	1439	1445	60	2.50	15	1539	1545	65	2.71
6	1445	1451	35	1.46	16	1545	1551	45	1.87
7	1451	1457	40	1.67	17	1551	1557	85	3.54
8	1457	1503	50	2.08	18	1557	1600	35	*2.92
9	1503	1509	60	2.50					
10	1509	1515	25	1.04					

*Represents three minutes of readings



3. PROCESS DESCRIPTION AND OPERATION

3.1 General. NARCO produces a variety of refractory brick and specialty products using an assortment of raw materials. A complete description of NARCO's process operations was provided in an earlier MRI trip report (final November 10, 1983). The following discussion describes the processing of plastic and flint clays. Figure 3-1 is a general process flow diagram of the clay process tested.

3.2 Calcining Process.

3.2.1 Raw Material. NARCO maintains an open-pit mine near Martinsburg, Missouri, approximately 30 miles from Farber, which serves as the source of Missouri plastic clay. Flint clay is purchased from a mine in Wheelersburg, Ohio, and is called "Brohard" by plant personnel. The two raw materials are stored in outdoor stockpiles and are moved by front-end loader into a hopper. A drag feeder moves the clay from the hopper into an eagle crusher, which reduces the material to less than 10.2 cm (4 in.) in size. A partially covered conveyor belt carries the material to a chute where it is gravity-fed into a rotary dryer.

3.2.2 Rotary Dryer. The McDermott, direct-fired, rotary dryer is 2.4 m (8 ft) in diameter and 18.3 m (60 ft) long. It rotates at a speed of 5 rpm and has an average material retention time of about 16 minutes. Actual retention times vary with each raw material. The maximum drying temperature provided by natural gas firing (combustion chamber) is 927°C (1700°F). The actual gas temperature in the dryer is 149° to 204°C (300° to 400°F). Gas flow is cocurrent to process material flow, and there are no heat recovery or recirculation systems associated with this dryer. The amount of moisture removed by the dryer ranges from 2 to 10 percent.

3.2.2.1 Dryer Design Capacity. The design capacity of the dryer also varies with each material processed. The final moisture content required for a usuable product dictates the rate at which the raw material can be processed through the dryer. Typical maximum production capacities for plastic and flint clay are 27 Mg/h (30 tph) and 18 Mg/h (20 tph) respectively.

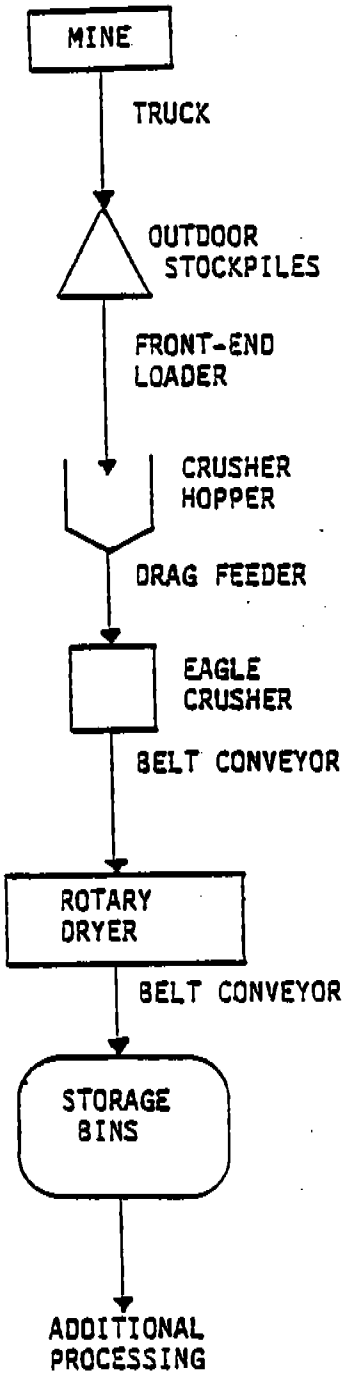


Figure 3-1 Plastic and flint clay processing.
NARCO, Farber, Mo.

3.2.2.2 Dryer Exhaust Gases. The exhaust gases from the rotary dryer pass through a cyclone (W.W. Sly, No. 48, Series 230) and a vane-type scrubber (Entoleter, Model CF2-0511-11) before being emitted to the atmosphere. The particulate captured by the cyclone is recycled onto the product conveyor belt at the dryer outlet. The scrubber has a design gas flow rate of 312 m^3/min (11,100 acfm). The inlet gas temperature is 93°C (200°F), and the moisture content of the inlet gas is 0.08 lb H_2O/lb dry gas. The liquid flow rate is 75 l/min (20 gpm), and the gas pressure drop across the scrubber is 2.7 to 3.2 kPa (11 to 13 in. w.c.). The pressure drop across the entire cyclone/scrubber system is 4.2 to 4.5 kPa (17 to 180in. w.c.).

3.2.3 Storage. After drying, the material is belt-conveyed to the main plant. Storage bins, rated at 68 Mg (75 tons) each, are filled and emptied as needed to meet NARCO production schedules. There are no scales or other monitors for determining production rate; however, the loader operator is aware of how many "dips" of material fed to the dryer will fill each bin. The actual bin capacity varies for each raw material. For flint and plastic clay, each bin holds approximately 54 Mg (60 tons) of dried material.

3.3 PROCESS CONDITIONS DURING TESTING

3.3.1 Monitoring Procedures. All processes were operating normally and at maximum capacity during the emission testing. Test run Nos. 1, 5, and 6 were conducted during plastic clay processing. Run Nos. 2, 3, and 4 were conducted during flint clay processing. The dryer operation was monitored by recording the combustion chamber temperature at 15-minute intervals. This temperature gauge was located in a shed at the feed end of the dryer. The furnace temperature ranged from 888° to 927°C (1630° to 1700°F) during the testing. The fuel usage rate was determined by taking natural gas meter readings at the start and finish of each test run. The fuel usage rate was determined by taking natural gas meter readings at the start and finish of each test run. The fuel usage rate was constant so more frequent gas readings were not required. The average fuel usuage rate during the testing was approximately 7.1 m^3/min (250 ft^3/min) for both clays. This corresponds to a fuel to product ratio of approximately 600,000 Btu/ton of

flint clay and 465,000 Btu/ton of plastic clay. A sample calculation for flint clay is shown below:

$$\frac{975\ \text{Btu}}{\text{ft}^3} \times \frac{249.8\ \text{ft}^3}{\text{min}} \times \frac{60\ \text{min}}{\text{h}} \times \frac{\text{h}}{24.2\ \text{tons}} = 604{,}389\ \text{Btu/ton}$$

3.3.2 Test Interruptions. On several occasions during test runs, the dryer was shut off for employee break periods. Testing was also discontinued during dryer shutoffs. In some cases the furnance was left on during the break to avoid lighting it again and waiting for the dryer to reach its proper operating temperature. In these cases, the incremental gas usuage was determined for the nontesting periods and was subtracted from the total gas usage given by the meter reading.

3.3.3 Control Equipment. The operation of the air pollution control equipment was monitored by recording the gas pressure drop across the system from a manometer installed by NARCO inside the scrubber building. The pressure drop across the cyclone/scrubber system ranged from 4.1 to 4.5 kPa (16.5 to 18 in. w.c.) throughout the testing. The average gas flow rate from the scrubber stack was 10,500 acfm at 135°F.

3.3.4 Production Rates. The production rate was measured by recording the number of loads (dips) fed to the eagle crusher. The actual count was provided to MRI by the front-end loader operator at various times throughout each test run. The crusher operator maintained a steady stream of raw material to the dryer. The conveyor belt feeding the dryer only operates at one speed, so the production rate is varied by the depth and quantity of raw material on the belt.

In some cases, the final moisture content of the dried material is too high for proper milling. In these cases the crusher operator shuts off the conveyor belt for 3 minutes to allow the dryer temperature to increase slightly and to allow additional drying to occur. This occurred twice during run No. 2 (flint clay), at 2:30 p.m. and 3:10 p.m. During all other test runs the conveyor belt operated continuously.

The actual production rate for each run was calculated using the weight

of an average load and the dip count given by the loader operator. For test runs on March 12, 14, and 15, a small loader owned by NARCO was used. Due to an electrical fire in this loader on March 13, a larger loader was rented for use on the 13th. The original loader was repaired by the 14th and was used the rest of the week. Each loader was weighed when full and empty to determine the weight of an average load. The average production rates during testing of flint and plastic clay were 21.9 Mg/h (24.2 tph) and 28.6 Mg/h (31.5 tph), respectively. The dryer was operating at capacity at all times to produce products with suitable final moisture contents. Tables 3-1 through 3-6 present the actual operating conditions during each test run. Table 3-7 summarizes the production data.

3.3.5 Moisture Content. The initial and final moisture contents of the two clays were measured by NARCO personnel at the request of MRI. The initial moisture content of the flint clay (Brohard) was 12.9 percent and the final moisture content was 1.9 percent. The plastic clay had initial and final moisture contents of 11.9 and 4.1 percent, respectively.

3.4 DISCUSSION/CONCLUSIONS

Plant processes were operated at maximum capacity during all test runs. Collected data are representative of normal process conditions and are useful for NSPS development. All scheduled emission test runs were completed, except for particle size sampling at the scrubber outlet stack. Particle size testing was not possible at this location because of excessive moisture in the gas stream. Visible emissions observations were made at the outlet stack and the process feed inlet during five of the six runs; darkness prevented any readings from being taken during run No. 1. All fugitive emission readings were zero percent opacity. Most of the stack opacity readings were also zero percent; however, an occasional 5 to 10 percent reading was recorded. The average opacity for all test runs was 1.5 to 2 percent. Mr. Sutton and other NARCO personnel were very helpful in maintaining a consistent process operation throughout the week of testing.

TABLE 3-1 OPERATING CONDITIONS
RUN NO. 1--MISSOURI PLASTIC CLAY--MARCH 12, 1984

Time	Dryer furnace temp. (°F)	Scrubber system, ΔP (in. w.c.)	Natural gas meter reading, (MCF)[a]	Cumulative No. loads into hopper
6:00 p.m.	1700	18.0	93,276	1
6:15	1700	17.0		
6:30	1700	17.0		
6:45	1700	17.0		
7:00	1700	17.0		13
7:15	1700	18.0		
7:30	1700	17.0		
7:45	1700	17.0		
8:00	1700	17.0		
8:15	1700	18.0	93,309	22

Weight per load = 2.9 tons

Production rate = 22 loads $\times \frac{2.9 \text{ tons}}{\text{load}} \times \frac{1}{135 \text{ min}} \times \frac{60 \text{ min}}{\text{h}} = \frac{28.2 \text{ tons}}{\text{h}}$

Natural gas used = 93,309 - 93,276 MCF $= \frac{33{,}000 \text{ ft}^3}{135 \text{ min}} = \frac{244.4 \text{ ft}^3}{\text{min}}$

[a]MCF = 1,000 ft^3.

TABLE 3-2 OPERATING CONDITIONS
RUN NO. 2--FLINT CLAY--MARCH 13, 1984

Time	Dryer furnace temp. (°F)	Scrubber system, ΔP (in. w.c.)	Natural gas meter reading, (MCF)[a]	Cumulative No. loads into hopper[b]
2:45 p.m.	1700	16.8	93,411	1
3:00	1700	17.3		
3:15	1700	17.0		
3:30	1700	16.8		5
3:45	BREAK PERIOD--DRYER AND GAS SHUT OFF TESTING DISCONTINUED			
4:00				
4:15	1700	17.0		6
4:30	1700	17.0		9
4:45	1700	17.3		11
5:00	1700	17.5		
5:15	1700	17.8		
5:30	1700	18.0	93,445	15

Weight per load = 4.6 tons

Production rate $= 15 \text{ loads} \times \frac{4.6 \text{ tons}}{\text{load}} \times \frac{1}{135 \text{ min}} \times \frac{60 \text{ min}}{\text{h}} = \frac{30.4 \text{ tons}}{\text{h}}$

Natural gas used $= 93{,}445 - 93{,}411 \text{ MCF} = \frac{34{,}000 \text{ ft}^3}{135 \text{ min}} = \frac{251.9 \text{ ft}^3}{\text{min}}$

[a]MCF = 1,000 ft³.
[b]Different front-end loader used for this run because of electrical problem with original loader.

TABLE 3-3 OPERATING CONDITIONS
RUN NO. 3--FLINT CLAY--MARCH 14, 1984

Time	Dryer furnace temp. (°F)	Scrubber system, ΔP (in. w.c.)	Natural gas meter reading, (MCF)[a]	Cumulative No. loads into hopper[b]
1:15 p.m.	1680	16.5	93,581	1
1:30	1680	17.0		
1:45	1680	17.8		8
2:00	30 MIN BREAK PERIOD--DRYER SHUT OFF (GAS STILL ON) TESTING DISCONTINUED			
2:15	1670	17.3		
2:30	1670	17.5		
2:45	1670	17.5		
3:00	1670	17.5		15
3:15	1670	17.5		
3:30	1680	17.8	93,624	21

Weight per load = 2.2 tons

Production rate $= 21 \text{ loads} \times \frac{2.23 \text{ tons}}{\text{load}} \times \frac{1}{105 \text{ min}} \times \frac{60 \text{ min}}{\text{h}} = \frac{26.8 \text{ tons}}{\text{h}}$

Natural gas used $= 93{,}624 - 93{,}581 \text{ MCF} = \frac{43{,}000 \text{ ft}^3}{135 \text{ min}} = 260.6 \text{ ft}^3/\text{min}$

$$\frac{260.6 \text{ ft}^3}{\text{min}} \times 30 \text{ min.} = 7{,}818 \text{ ft}^3$$

$43{,}000 - 7{,}818 = 35{,}182 \text{ ft}^3$ used during testing

[a]MCF = 1,000 ft³.
[b]Original loader.

TABLE 3-4 OPERATING CONDITIONS
RUN NO. 4--FLINT CLAY--MARCH 14, 1984

Time	Dryer furnace temp. (°F)	Scrubber system, ΔP (in. w.c.)	Natural gas meter reading, (MCF)[a]	Cumulative No. loads into hopper[b]
4:00 p.m.	1680	17.5	93,624	1
4:15	1680	17.3		
4:30	1680	17.3		
4:45	1680	17.3		7
5:00	30 MIN BREAK PERIOD--DRYER SHUT OFF (GAS STILL ON) TESTING DISCONTINUED			
5:15	1630	16.8		
5:30	1630	17.8		9
5:45	1650	16.8		10
6:00	1650	17.0		
6:15	1650	17.0	93,656	12

Weight per load = 2.2 tons

Production rate $= 12 \text{ loads} \times \frac{2.2 \text{ tons}}{\text{load}} \times \frac{1}{105 \text{ min}} \times \frac{60 \text{ min}}{\text{h}} = \frac{15.3 \text{ tons}}{\text{h}}$

Natural gas used $= 93{,}656 - 93{,}624 \text{ MCF} = \frac{32{,}000 \text{ ft}^3}{135 \text{ min}} = \frac{237.0 \text{ ft}^3}{\text{min}}$

$$\frac{237.0 \text{ ft}^3}{135 \text{ min}} \times 30 \text{ min} = 7{,}110 \text{ ft}^3$$

$32{,}000 - 7{,}110 = 24{,}890 \text{ ft}^3$ used during testing

[a]MCF = 1,000 ft³.
[b]Original loader.

TABLE 3-5 OPERATING CONDITIONS
RUN NO. 5--MISSOURI PLASTIC CLAY--MARCH 15, 1984

Time	Dryer furnace temp. (°F)	Scrubber system, ΔP (in. w.c.)	Natural gas meter reading, (MCF)[a]	Cumulative No. loads into hopper[b]
11:00 a.m.	1650	17.4	93,735	1
11:15	1680	17.4		
11:30	1680	17.0		7
11:45	1680	17.2		
12:00	LUNCH BREAK--DRYER AND GAS OFF 12-12:30 p.m. GAS ON 12:30-12:45 p.m. TESTING DISCONTINUED			
12:30				
12:45 p.m.	1650	16.8		13
1:00	1660	17.0		
1:15	1660	17.0		
1:30	1660	17.0		19
1:45	1660	17.0	93,769	22

Weight per load = 2.9 tons

Production rate $= 22 \text{ loads} \times \frac{2.9 \text{ tons}}{\text{load}} \times \frac{1}{120 \text{ min}} \times \frac{60 \text{ min}}{\text{h}} = \frac{31.7 \text{ tons}}{\text{h}}$

Natural gas used $= 93{,}769 - 93{,}735 \text{ MCF} = \frac{34{,}000 \text{ ft}^3}{135 \text{ min}} = \frac{251.9 \text{ ft}^3}{\text{min}}$

$\frac{251.9 \text{ ft}^3}{\text{min}} \times 15 \text{ min} = 3{,}779 \text{ ft}^3$

$34{,}000 - 3{,}779 \text{ ft}^3 = 30{,}221 \text{ ft}^3$ used during testing

[a]MCF = 1,000 ft³.
[b]Original loader.

TABLE 3-6 OPERATING CONDITIONS
RUN NO. 6--MISSOURI PLASTIC CLAY--MARCH 15, 1984

Time	Dryer furnace temp. (°F)	Scrubber system, ΔP (in. w.c.)	Natural gas meter reading, (MCF)[a]	Cumulative No. loads into hopper[b]
2:15 p.m.	1650	17.0	93,775	1
2:30	1650	17.0		
2:45	1650	17.0		7
3:00	1650	17.2		
3:15	1660	17.2		14
3:30	1660	17.1		
3:45	1660	17.0		18
4:00	1660	17.5	93,802	21

Weight per load = 2.9 tons

Production rate $= 21 \text{ loads} \times \frac{2.9 \text{ tons}}{\text{load}} \times \frac{1}{105 \text{ min}} \times \frac{60 \text{ min}}{\text{h}} = \frac{34.6 \text{ tons}}{\text{h}}$

Natural gas used $= 93{,}802 - 93{,}775 \text{ MCF} = \frac{27{,}000 \text{ ft}^3}{105 \text{ min}} = \frac{257.1 \text{ ft}^3}{\text{min}}$

[a]MCF = 1,000 ft³.
[b]Original loader.

TABLE 3-7 NARCO TEST PRODUCTION SUMMARY

Test run	Process material	Production rate (tons/h)	Fuel usage (ft^3/min)
1	Plastic clay	28.2	244.4
2	Flint clay	30.4	251.9
3	Flint clay	26.8	260.6
4	Flint clay	15.3	237.0
5	Plastic clay	31.7	251.9
6	Plastic clay	34.6	257.1

AVERAGE PRODUCTION RATES:
FLINT CLAY = 24.2 tons/h
PLASTIC CLAY = 31.5 tons/h

4. SAMPLING LOCATIONS

4.1 Suitability of Sampling Sites. The primary goal of the testing program was to characterize emissions from the clay drying process pollution control equipment. Additionally, physical properties of the process feed stock and the product were investigated. Sampling sites appropriate to these objectives were approved prior to testing. Each sampling location is discussed individually, and the position of each site within the system is illustrated in Figure 4-1.

4.2 Rotary Dryer Inlet (Sampling Location A). Grab samples of the feed to the rotary dryer were collected for sieve analysis and moisture content determination. Samples were taken during each set of simultaneous Method 5 runs.

4.3 Rotary Dryer Inlet (Observation Location B). Method 9 visible emissions were performed at the conveyor belt just as it enters the rotary dryer.

4.4 Rotary Dryer Outlet (Observation Location C). Method 22 visible emissions were planned for this location; however, during the presurvey of the sampling locations, it was decided by the EPA EMB that, from the dryer outlet through the scrubber outlet stack, the process was a closed system.

4.5 Rotary Dryer Outlet (Sampling Locations D). Grab samples of the product from the dryer were collected for sieve analysis and moisture content determination. Samples were taken during each set of simultaneous Method 5 runs.

4.6 Cyclone Inlet (Sampling Location E). Particulate emissions and particle size distribution determinations were made in the 19-inch diameter duct accessed through two sampling ports spaced 90 degrees apart. The sampling ports were located 71 inches (i.e., 3.7 duct diameters) downstream from the dryer hopper and 70 inches (i.e., 3.7 duct diameters) upstream from the inlet to the cyclone. Figure 4-2 illustrates the cyclone inlet sampling location.

The original test plan was to sample 24 points for five minutes each (giving a total test time of 120 minutes), but the high particulate loading

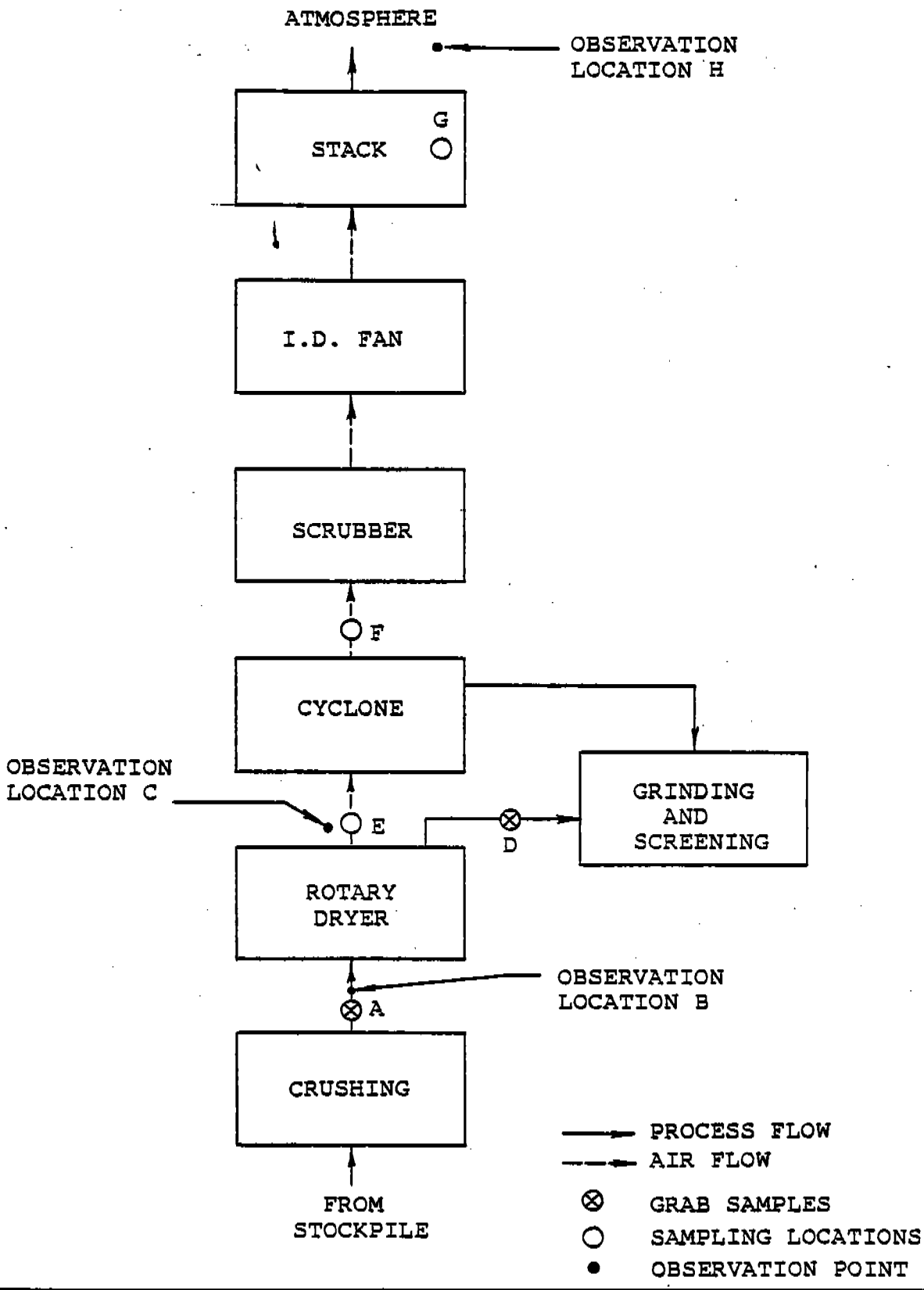


FIGURE 4-1 PROCESS FLOW SCHEMATIC SHOWING SAMPLING LOCATIONS

in the duct made this plan impractical. EPA EMB and Entropy jointly approved a revised particulate sampling plan in which 12 points (six points on each of two traverse axes labeled A and B) were sampled for two minutes each, for a net run time of 24 minutes.

4.7 Scrubber Inlet-Cyclone Outlet (Sampling Location F). Particulate emissions and particle size distribution determinations were made in the 17-inch by 25-inch rectangular duct accessed through a rectangular slot in the duct. Five traverse access points were located in the slot 73 inches (i.e., 3.6 equivalent duct diameters) downstream from the cyclone outlet and 22 inches (i.e., 1.1 equivalent duct diameters) upstream from the inlet to the scrubber. Figure 4-3 illustrates the scrubber inlet sampling location.

The original plan was to divide the duct cross section into 25 equal areas and sample the centroid of each equal area for 2.5 minutes for a net run time of 62.5 minutes; however, due to the high negative pressure encountered at the location, only 20 of the 25 equal areas were sampled. For runs 4-6, the first point on each traverse axis was not sampled, and the second point was sampled twice, as approved by EPA EMB. During runs 13-15, the second point was sampled only once anad the sampling time at each point was dropped to two minutes for a net run time of 40 minutes as per EPA EMB.

4.8 Scrubber Outlet Stack (Sampling Location G). Particulate emissions determinations were made in the 18.5-inch (depth) by 19-inch (width) rectangular stack accessed through a rectangular slot in the stack. Five traverse access points were located in the slot located 58 inches (i.e., 3.1 equivalent duct diameters) downstream from the scrubber outlet and 48 inches (i.e., 2.6 equivalent duct diameters) upstream from the stack outlet. The scrubber outlet stack sampling location is illustrated in Figure 4-4.

4.9 Scrubber Outlet Stack (Observation Location H). Method 5 particulate emissions and Method 9 visible emissions were performed at the stack outlet.

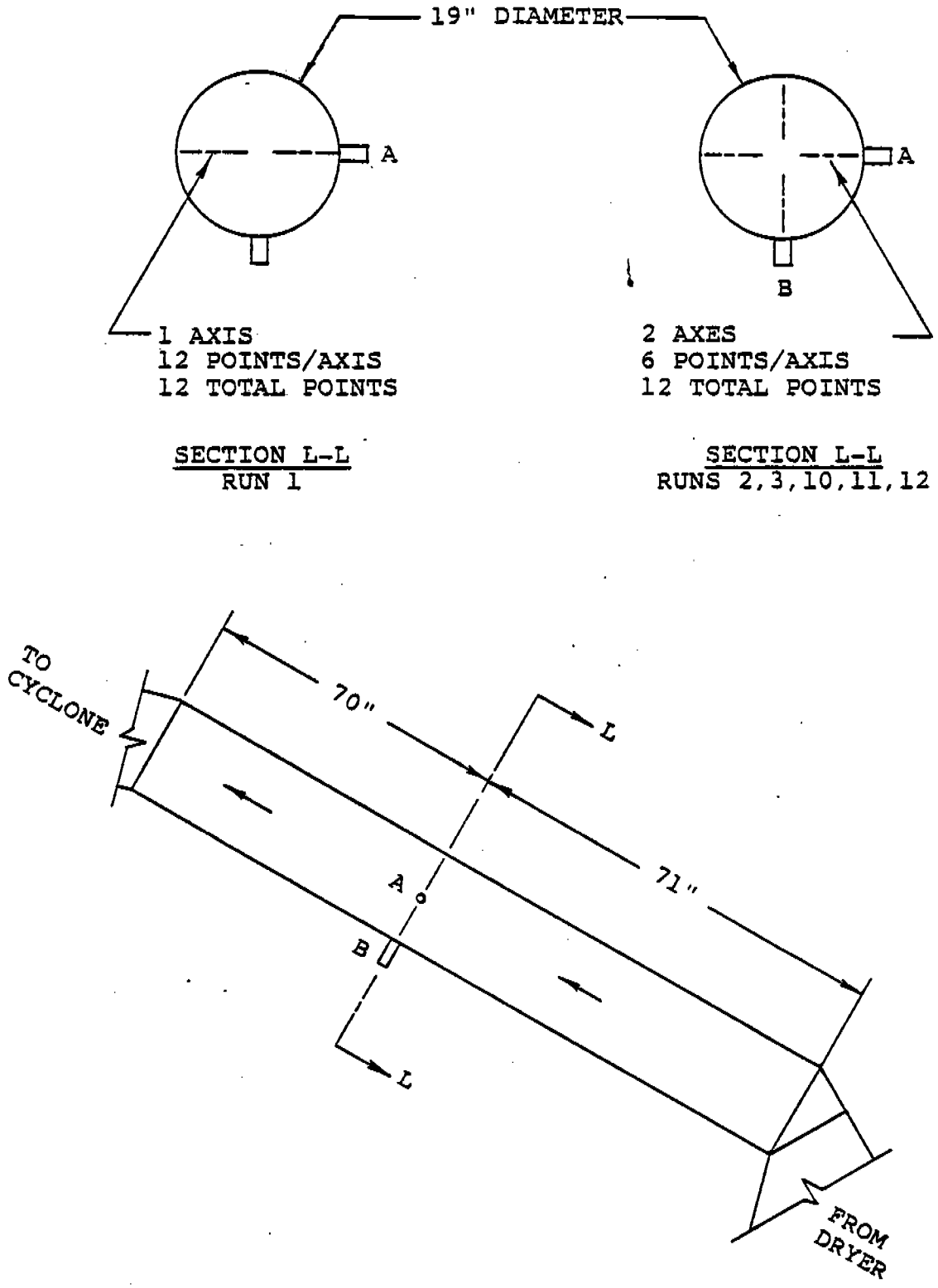


FIGURE 4-2 CYCLONE INLET DIMENSIONS WITH SAMPLING PORT AND POINT LOCATIONS

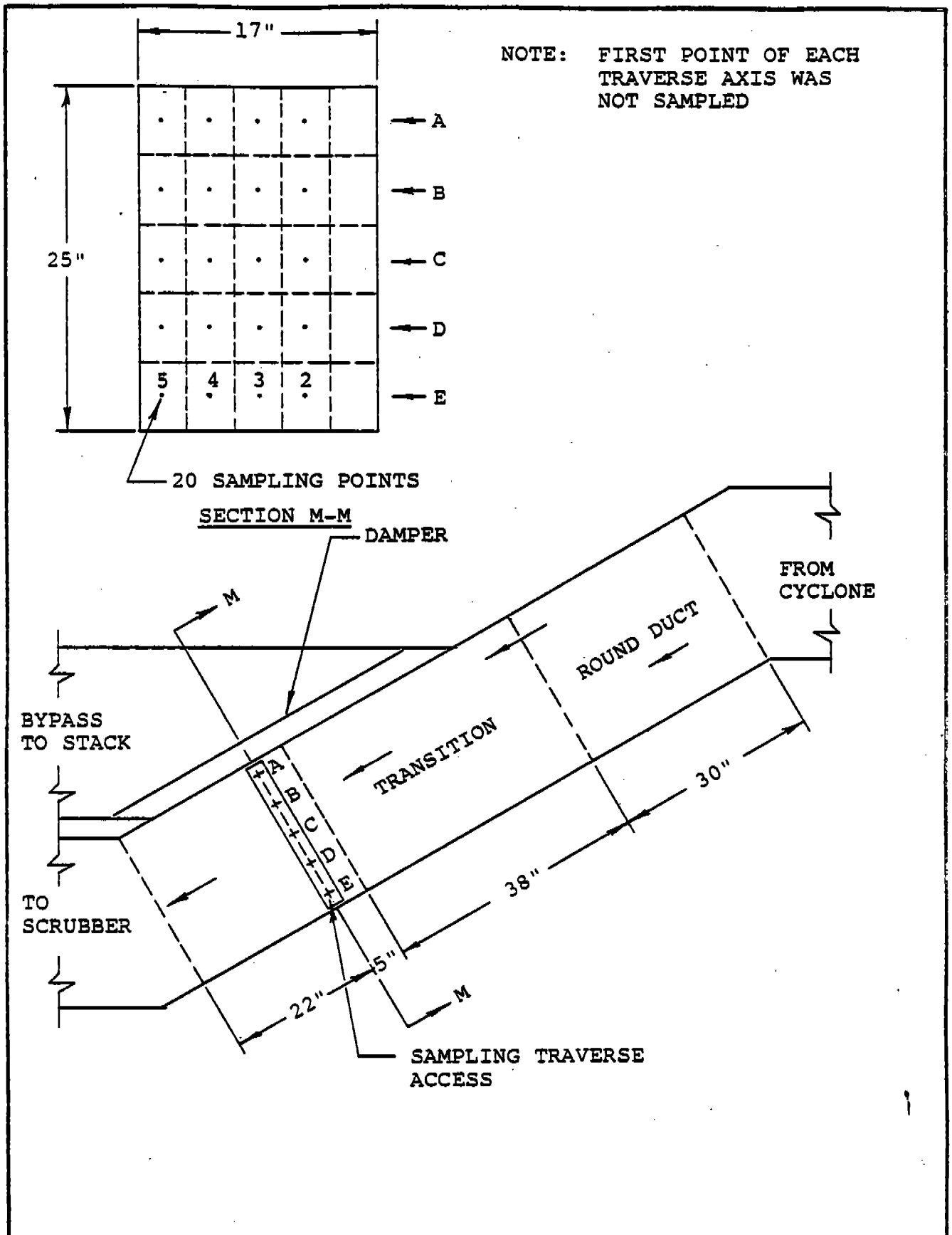


FIGURE 4-3 SCRUBBER INLET DIMENSIONS WITH SAMPLING PORT AND POINT LOCATIONS

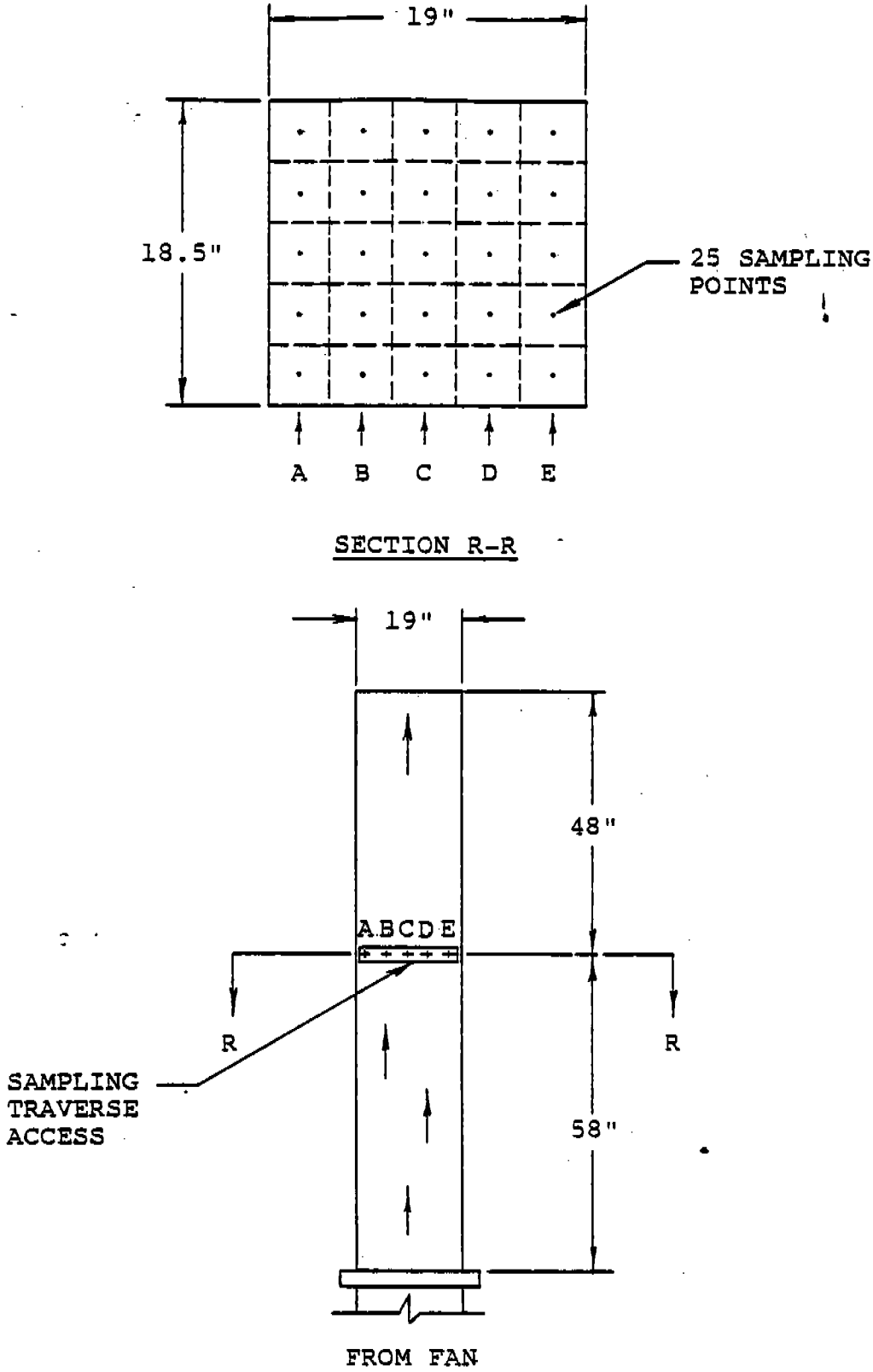


FIGURE 4-4 SCRUBBER EXHAUST STACK DIMENSIONS WITH SAMPLING PORT AND POINT LOCATIONS

5. SAMPLING AND ANALYTICAL METHODS

5.1 Sampling Objectives. This section describes the sampling and analytical procedures which were employed at the North American Refractories Company facility in order to gather data concerning emissions from the clay drying pollution control equipment and to investigate physical properties of the process feed stock and the product. The sampling program included tests for particulate emissions and trace metals, sieve and moisture analysis on feed and product samples, plume opacity, and particle size distribution.

5.2 Particulate Emissions Testing. Where appropriate, particulate emissions sampling conformed to the standards and procedures set forth by EPA Reference Methods 1-5 and described in 40 CFR Part 60, Appendix 7.3. It was necessary at some locations to modify the test procedures in order to cope with heavy particulate loading and/or high negative pressure.

5.3 Trace Metals Analysis. For one run at each location, the Method 5 particulate catch and the distilled water reagent from the impingers were analyzed for trace metals by using atomic absorption or inductively coupled argon plasma spectrometry. These metals are zinc, nickel, iron, manganese, vanadium, calcium, silicon, aluminum, magnesium, fluorine, beryllium, uranium, lead, and mercury.

5.4 Sieve Analysis and Moisture Content. Sieve analysis and moisture content determinations were performed on all feed and product samples. ASTM Method D 2216 was used to analyze the samples for moisture content, while ASTM Method D 422 was used for sieve analysis.

5.5 Plume Opacity and Fugitive Emissions. Plume opacity observations were performed in accordance with EPA Reference Method 9 as described in 40 CFR Part 60. Fugitive emissions observations were made using EPA Reference Method 9 instead of EPA Reference Method 22 as per EPA EMB.

5.6 Particle Size Tests. Particle size determinations were made using a right angle inlet preseparator, followed by an Andersen Mark III cascade impactor. The test procedures were based upon the publication, "Procedures for Cascade Impactor Calibration and Operation in Process Streams - Revised 1979," developed by the Industrial Environmental Research Laboratory (IERL) and Southern Research Institute.

6. QUALITY ASSURANCE

6.1 Introduction. The goal of quality assurance for the project was to ensure the accuracy of all data collected. The procedures used are contained in Entropy's "Quality Assurance Program Plan," which was approved by the U.S. EPA EMB in the contract agreement governing the project.

In order to ensure continuity among field testing personnel, daily meetings were held before each day of the field testing. At the meetings, results from the testing conducted on the previous day were reviewed. Responsibilities were clearly delineated for each member of the testing team, and questions were addressed and resolved immediately. In situations where more than one person was performing similar activities, consistency was ensured through communication at the meetings.

In addition to the general quality assurance measures, specific quality assurance activities were conducted for several of the individual test methods performed.

6.2 Sampling Train Components. Entropy's sampling equipment, including nozzles, pitot tubes, dry gas meters, orifices, and thermocouples, was uniquely identified and calibrated in accordance with documented procedures and acceptance criteria prior to and at the completion of the field testing program. All sampling equipment was manufactured by Nutech Corporation, Andersen 2000 or by Entropy. Calibration data for the sampling equipment are contained in Appendix 7.6.

6.3 Preseparator and Cascade Impactors. All internal components and surfaces of the impactors were cleaned in an ultrasonic bath to ensure that all surface impurities were removed, and visual inspections for cleanliness were made prior to shipment to the field. After each sample recovery, the preseparator, the impactor body, and the plates were rinsed with acetone to ensure that all organic residuals and/or particulate matter were removed.

6.4 Sample Collection Substrates. Schleicker & Schuell #30 glass fiber sample collection substrates were used for particle size testing. To prevent contamination of the substrate surface, all filters were handled with laboratory tweezers. This procedure was used during impactor assembly, sample recovery, and weighing of the substrates.

6.5 Substrate Weighing. An analytical balance capable of weighing to the nearest 0.01 milligram (mg) was used. To ensure that no weight bias was produced from the preparation, transportation, recovery, or weighing procedures, two control samples were obtained during the test program. A reactivity run was performed to ensure that the flue gases did not interact with the substrate to produce extraneous results. For the reactivity run, a solid filter was placed in the front section of the impactor, and the impactor was introduced into the stack, and a sample was pulled through the head using the parameters outlined for a normal particle sizing run. The average difference between the pre- and post-test weights was 0.000053 milligrams, based upon weight differences ranging from 0.00001 to 0.00017 milligrams. A blank run was also performed to demonstrate that the impactor could be assembled and disassembled without affecting the weight of the substrate. The average difference between the pre- and post-assembly weights was 0.000021 milligrams, based upon a difference ranging from 0.00001 to 0.00006 milligrams.

6.6 Sample Analysis. In order to reduce the probability of errors or inconsistent results, one member of the field crew had sole responsibility for the sample analysis procedure. Sample analysis was performed in a room dedicated exclusively to filter weighing.

6.7 EPA Method 3. All Method 3 analyses were performed in triplicate. Each analyzer was checked for leaks prior to any analysis as specified in the method. Samples were analyzed within four hours of collection.

6.8 EPA Method 9. The visible emissions observers held current certifications issued within the last 6 months. Documentation verifying the observer's certifications are provided in Appendix 7.2.4.

APPENDICES

7.1 PLASTIC CLAY TEST RESULTS AND EXAMPLE CALCULATIONS

7.1.1 PARTICULATE

PARTICULATE FIELD DATA & RESULTS TABULATION

PLANT: North American Refractories Company, Farber, Missouri

RUN	SAMPLING LOCATION	TEST TEAM LEADER
1	Cyclone Inlet	B. Dwain Ritchie
11	Cyclone Inlet	B. Dwain Ritchie
12	Cyclone Inlet	B. Dwain Ritchie

		1 (P1)	11 (P2)	12 (P3)
	RUN DATE	03/12/84	03/15/84	03/15/84
	RUN START TIME	1800	1110	1421
	RUN FINISH TIME	1928	1151	1459
	NET SAMPLING POINTS	12	12	12
Theta	NET RUN TIME, MINUTES	30.00	24.00	24.00
Dia	NOZZLE DIAMETER, INCHES	0.173	0.173	0.173
Cp	PITOT TUBE COEFFICIENT	0.840	0.840	0.840
Y	DRY GAS METER CAL. FACTOR	0.994	0.994	0.994
Pbar	BAROMETRIC PRESSURE, IN. HG.	29.90	29.50	29.40
Delta H	AVG. PRESS. DIFFERENTIAL OF ORIFICE METER, IN. H2O	0.656	0.542	0.510
Vm	VOLUME OF METERED GAS SAMPLE DRY ACTUAL CUBIC FEET	14.025	10.288	9.974
tm	DRY GAS METER TEMP., DEG. F	81	85	80
Vm(std)	VOLUME OF METERED GAS SAMPLE @ DRY STD. COND., DSCF*	13.613	9.777	9.534
Vlc	VOLUME OF WATER CATCH IN IMPINGERS & SIL. GEL.,ML	54.5	52.0	58.0
Vw(std)	VOLUME OF WATER VAPOR, SCF*	2.565	2.448	2.730
%H2O	MOISTURE, PERCENT BY VOLUME			
	FROM MEASURED WATER CATCH	15.9**	20.0	22.3
	SATURATION AT STACK TEMP.	32.3	19.4**	19.0**
Mfd	DRY MOLE FRACTION	0.841	0.806	0.810

** ACTUAL %H2O USED IN CALCULATIONS (continued next page)

		1 (P1)	11 (P2)	12 (P3)
%CO2	PERCENT CO2 BY VOLUME, DRY	1.9	1.8	1.5
%O2	PERCENT O2 BY VOLUME, DRY	16.6	18.3	18.5
%CO+N2	PERCENT CO + N2 BY VOLUME, DRY	81.5	79.9	80.0
Md	DRY MOLECULAR WT, LB/LB-MOLE	28.97	29.02	28.98
Ms	WET MOLECULAR WT, LB/LB-MOLE	27.23	26.88	26.89
Pg	STACK STATIC PRESS., IN H2O	-1.0	-1.0	-1.0
Ps	ABSOLUTE STACK PRESS., IN HG	29.83	29.43	29.33
ts	STACK TEMPERATURE, DEG. F	160	139	138
Delta p	AVG VELOCITY HEAD. IN. H2O	1.0000	0.8627	0.8016
vs	STACK GAS VELOCITY, FT/SEC	62.7	58.0	56.0
A	STACK AREA, SQUARE INCHES	283.5	283.5	283.5
Qsd	STACK FLOW RATE, DRY SCFM*	5,292	4,787	4,633
Qaw	STACK FLOW RATE, WET ACFM	7,412	6,857	6,613
%I	PERCENT ISOKINETIC	103.3	102.5	103.3
	METHOD 5 RESULTS (ENGLISH):			
mg	CATCH, MILLIGRAMS	37,075.7	37,602.9	30,942.6
gr/DSCF	CONCEN., GRAINS/DSCF*	42.03	59.35	50.09
lb/hr	EMISSIONS, POUNDS/HOUR	1,906.6	2,435.1	1,989.3
	METHOD 5 RESULTS (METRIC):			
mg/DSCM	CONCEN., MILLIGRAMS/DSCM*	96,170.6	135,807.1	114,601.0
kg/hr	EMISSIONS, KILOGRAMS/HOUR	864.8	1,104.5	902.3

* 68 Deg. F - 29.92 in. Hg.

EXAMPLE PARTICULATE TEST CALCULATIONS NO. 1

Cyclone Inlet

VOLUME OF DRY GAS SAMPLED AT STANDARD CONDITIONS

$$Vm(std) = 17.64 * Y * Vm * \frac{(Pbar + Delta\ H/13.6)}{(460 + tm)}$$

$$Vm(std) = 17.64 * 0.994 * 14.025 * \frac{(29.90 + 0.656/13.6)}{(460 + 81)} = 13.613\ DS$$

VOLUME OF WATER VAPOR AT STANDARD CONDITIONS

$$Vw(std) = 0.04707 * Vlc$$

$$Vw(std) = 0.04707 * 54.5 = 2.565\ SCF$$

PERCENT MOISTURE, BY VOLUME, AS MEASURED IN STACK GAS

$$\%H2O = 100 * Vw(std) / (Vw(std) + Vm(std))$$

$$\%H2O = \frac{2.565}{2.565 + 13.613} * 100 = 15.9\ \%$$

DRY MOLE FRACTION OF STACK GAS

$$Mfd = 1 - \%H2O/100$$

$$Mfd = 1 - 15.9/100 = 0.841$$

DRY MOLECULAR WEIGHT OF STACK GAS

$$Md = \%CO2 * 0.44 + \%O2 * 0.32 + \%CO+N2 * 0.28$$

$$Md = 1.9*0.44 + 16.6*0.32 + 81.5*0.28 = 28.97\ LB/LB\text{-}MOLE$$

WET MOLECULAR WEIGHT OF STACK GAS

$$Ms = (Md * Mfd) + (0.18 * \%H2O)$$

$$Ms = 28.97 * 0.841 + (0.18 * 15.9) = 27.23\ LB/LB\text{-}MOLE$$

ABSOLUTE STACK GAS PRESSURE

$$Ps = Pbar + Ps / 13.6$$

$$Ps = 29.90 + (-1.0 / 13.6) = 29.83 \text{ IN. HG.}$$

AVERAGE STACK GAS VELOCITY [Note: (Delta p)avg is square of avg sq. root]

$$vs = 85.49 * Cp * SQRT\left[\frac{(Delta\ p)avg * (460 + ts)}{Ps * Ms}\right]$$

$$vs = 85.49 * 0.840 * SQRT\left[\frac{1.0000 * (460 + 160)}{29.83 * 27.23}\right] = 62.7 \text{ FT/SEC}$$

DRY VOLUMETRIC STACK GAS FLOW RATE @ STANDARD CONDITIONS

$$Qsd = \frac{60}{144} * Mfd * vs * A * \frac{Tstd}{ts + 460} * \frac{Ps}{Pstd}$$

$$Qsd = \frac{60}{144} * 0.841 * 62.7 * 283.5 * \frac{528}{160 + 460} * \frac{29.83}{29.92}$$

$$Qsd = 5,292 \text{ SCFM}$$

WET VOLUMETRIC STACK GAS FLOW RATE @ STACK CONDITIONS

$$Qaw = 60 / 144 * vs * A$$

$$Qaw = 60 / 144 * 62.7 * 283.5 = 7,412 \text{ ACFM}$$

PERCENT ISOKINETIC OF SAMPLING RATE

$$\%I = \frac{Pstd}{Tstd} * \frac{100}{60} * \frac{(ts + 460) * Vm(std)}{Ps * vs * Mfd * Theta * Area\text{-}nozzle,\ sq.ft.}$$

$$\%I = \frac{29.92}{528} * \frac{100}{60} * \frac{(160 + 460) * 13.613}{29.83 * 62.7 * 0.841 * 30.00 * 0.0001632}$$

$$\%I = 103.3 \ \%$$

GRAINS PER DRY STANDARD CUBIC FOOT

$$gr/DSCF = \frac{7,000}{453,592} * \frac{mgs}{Vm(std)}$$

$$gr/DSCF = \frac{7,000}{453,592} * \frac{37,075.7}{13.613} = 42.03 \text{ gr/DSCF}$$

MILLIGRAMS PER DRY STANDARD CUBIC METER

ms/DSCM = mg / (Vm(std) * 0.02832)

ms/DSCM = 37,075.7 / (13.613 * 0.02832) = 96,170.6 ms/DSCM

POUNDS PER HOUR

Lb/Hr = (60/7000) * Gn/DSCF * Qsd

Lb/Hr = (60/7000) * 42.03 * 5,292 = 1,906.6 Lb/Hr

KILOGRAMS PER HOUR

Kg/Hr = .453592 * Lb/Hr

Kg/Hr = .453592 * 1,906.6 = 864.8 kg/Hr

PARTICULATE FIELD DATA & RESULTS TABULATION

PLANT: North American Refractories Company, Farber, Missouri

RUN	SAMPLING LOCATION	TEST TEAM LEADER
4	Scrubber Inlet	Frank J. Phoenix
14	Scrubber Inlet	Willis S. Nesbit
15	Scrubber Inlet	Willis S. Nesbit

		4 (P1)	14 (P2)	15 (P3)
	RUN DATE	03/12/84	03/15/84	03/15/84
	RUN START TIME	1800	1102	1415
	RUN FINISH TIME	2009	1257	1509
	NET SAMPLING POINTS	25	20	20
Theta	NET RUN TIME, MINUTES	62.50	40.00	40.00
Dia	NOZZLE DIAMETER, INCHES	0.177	0.178	0.178
Cp	PITOT TUBE COEFFICIENT	0.840	0.840	0.840
Y	DRY GAS METER CAL. FACTOR	0.992	0.992	0.992
Pbar	BAROMETRIC PRESSURE, IN. HG.	29.00	29.40	29.40
Delta H	AVG. PRESS. DIFFERENTIAL OF ORIFICE METER, IN. H2O	0.568	0.534	0.550
Vm	VOLUME OF METERED GAS SAMPLE DRY ACTUAL CUBIC FEET	27.941	17.490	17.720
tm	DRY GAS METER TEMP., DEG. F	78	89	93
Vm(std)	VOLUME OF METERED GAS SAMPLE @ DRY STD. COND., DSCF*	26.393	16.412	16.508
Vlc	VOLUME OF WATER CATCH IN IMPINGERS & SIL. GEL.,ML	106.5	81.0	70.0
Vw(std)	VOLUME OF WATER VAPOR, SCF*	5.013	3.813	3.295
%H2O	MOISTURE, PERCENT BY VOLUME			
	FROM MEASURED WATER CATCH	16.0**	18.9	16.6**
	SATURATION AT STACK TEMP.	16.6	16.4**	16.8
Mfd	DRY MOLE FRACTION	0.840	0.836	0.834

** ACTUAL %H2O USED IN CALCULATIONS (continued next page)

		4	14	15
%CO2	PERCENT CO2 BY VOLUME, DRY	1.9	1.8	1.5
%O2	PERCENT O2 BY VOLUME, DRY	16.6	18.3	18.5
%CO+N2	PERCENT CO + N2 BY VOLUME, DRY	81.5	79.9	80.0
Md	DRY MOLECULAR WT, LB/LB-MOLE	28.97	29.02	28.98
Ms	WET MOLECULAR WT, LB/LB-MOLE	27.22	27.22	27.15
Ps	STACK STATIC PRESS., IN H20	-4.6	-4.2	-4.8
Ps	ABSOLUTE STACK PRESS., IN HG	28.66	29.09	29.05
ts	STACK TEMPERATURE, DEG. F	132	132	133
Delta P	AVG VELOCITY HEAD. IN. H20	0.8328	0.7903	0.8163
vs	STACK GAS VELOCITY, FT/SEC	57.1	55.2	56.3
A	STACK AREA, SQUARE INCHES	425.0	425.0	425.0
Qsd	STACK FLOW RATE, DRY SCFM*	7,256	7,086	7,176
Qaw	STACK FLOW RATE, WET ACFM	10,109	9,776	9,962
%I	PERCENT ISOKINETIC	100.4	98.8	98.[illegible]
	METHOD 5 RESULTS (ENGLISH):			
mg	CATCH, MILLIGRAMS	10,709.9	6,012.2	3,408.[illegible]
gr/DSCF	CONCEN., GRAINS/DSCF*	6.26	5.65	3.19
lb/hr	EMISSIONS, POUNDS/HOUR	389.5	343.4	196.0
	METHOD 5 RESULTS (METRIC):			
mg/DSCM	CONCEN., MILLIGRAMS/DSCM*	14,328.6	12,932.4	7,291.7
kg/hr	EMISSIONS, KILOGRAMS/HOUR	176.7	155.8	88.9

* 68 Deg. F - 29.92 in. Hg.

PARTICULATE FIELD DATA & RESULTS TABULATION

PLANT: North American Refractories Company, Farber, Missouri

RUN	SAMPLING LOCATION	TEST TEAM LEADER
7	Scrubber Outlet	John J. Maxwell
17	Scrubber Outlet Stack	John J. Maxwell
18	Scrubber Outlet Stack	John J. Maxwell

		7 (P1)	17 (P2)	18 (P3)
	RUN DATE	03/12/84	03/15/84	03/15/84
	RUN START TIME	1802	1100	1415
	RUN FINISH TIME	2014	1343	1605
	NET SAMPLING POINTS	25	25	25
Theta	NET RUN TIME, MINUTES	125.00	100.00	100.00
Dia	NOZZLE DIAMETER, INCHES	0.177	0.177	0.177
Cp	PITOT TUBE COEFFICIENT	0.840	0.840	0.840
Y	DRY GAS METER CAL. FACTOR	0.994	0.994	0.994
Pbar	BAROMETRIC PRESSURE, IN. HG.	29.40	29.50	29.50
Delta H	AVG. PRESS. DIFFERENTIAL OF ORIFICE METER, IN. H2O	1.420	1.124	1.208
Vm	VOLUME OF METERED GAS SAMPLE DRY ACTUAL CUBIC FEET	90.800	65.994	66.574
tm	DRY GAS METER TEMP., DEG. F	111	99	109
Vm(std)	VOLUME OF METERED GAS SAMPLE @ DRY, STD. COND., DSCF*	82.266	61.237	60.702
Vlc	VOLUME OF WATER CATCH IN IMPINGERS & SIL. GEL., ML	253.5	195.5	181.0
Vw(std)	VOLUME OF WATER VAPOR, SCF*	11.932	9.202	8.520
%H2O	MOISTURE, PERCENT BY VOLUME	12.7	13.1	12.3
Mfd	DRY MOLE FRACTION	0.873	0.869	0.877

(continued next page)

		7 (P1)	17 (P2)	18 (P3)
%CO2	PERCENT CO2 BY VOLUME, DRY	1.7	1.6	1.4
%O2	PERCENT O2 BY VOLUME, DRY	17.7	18.5	18.6
%CO+N2	PERCENT CO + N2 BY VOLUME, DRY	80.6	79.9	80.0
Md	DRY MOLECULAR WT, LB/LB-MOLE	28.98	29.00	28.97
Ms	WET MOLECULAR WT, LB/LB-MOLE	27.59	27.56	27.62
Ps	STACK STATIC PRESS., IN H20	0.40	0.50	0.50
Ps	ABSOLUTE STACK PRESS., IN HG	29.43	29.53	29.54
ts	STACK TEMPERATURE, DEG. F	130	134	132
Delta p	AVG VELOCITY HEAD. IN. H20	1.4370	1.3310	1.4200
vs	STACK GAS VELOCITY, FT/SEC	73.4	70.8	72.9
A	STACK AREA, SQUARE INCHES	351.5	351.5	351.5
Qsd	STACK FLOW RATE, DRY SCFM*	8,258	7,904	8,240
Qaw	STACK FLOW RATE, WET ACFM	10,748	10,366	10,677
%I	PERCENT ISOKINETIC	113.7	110.5	105.1
	METHOD 5 RESULTS (ENGLISH):			
mg	CATCH, MILLIGRAMS	269.2	149.5	92.9
gr/DSCF	CONCEN., GRAINS/DSCF*	0.051	0.038	0.024
lb/hr	EMISSIONS, POUNDS/HOUR	3.57	2.55	1.67
	METHOD 5 RESULTS (METRIC):			
mg/DSCM	CONCEN., MILLIGRAMS/DSCM*	115.5	86.2	53.6
kg/hr	EMISSIONS, KILOGRAMS/HOUR	1.62	1.16	0.757

* 68 Deg. F - 29.92 in. Hg.

7.1.2 PARTICLE SIZING
(PLASTIC CLAY TEST RESULTS)

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 11A

PLANT: North American Refractories Company, Farber, Missouri

SAMPLING LOCATION: Cyclone Inlet

DATE: 0315

	START-FINISH TIME:	1256-1256		VOLUME METERED, ACF:	0.2
SR)	SAMPLING RATE, ACFM	0.765		NOZZLE DIA., INCHES:	0.1
ST)	SAMPLING TIME, MINUTES:	0.50	Y)	METER CAL. FACTOR:	0.9
PB)	BARO. PRESS., IN.HG.:	29.50	TM)	METER TEMP., DEG F:	8
PSI)	STATIC PRESS., IN. H2O:	-1.00	DH)	DELTA H AVG., IN. H2O:	0.8
TS)	STACK GAS TEMP., DEG F:	147	DEN)	PARTICLE DENSITY, GM/CC:	1.0
PMV)	MOISTURE % BY VOLUME:	20.0	VCF)	VISCOSITY CORR. FACTOR:	1.05
DCF)	DENSITY CORR. FACTOR:	1.000	MD)	MOL WT, DRY LB/LB-MOLE:	29.0
	ISOKINETICS, %	104.3		CONCENT., GR/DSCF:	41.550

STAGE NO.	PARTICLE DIAMETER (microns) FROM GRAPH	AERODYNAMIC	CATCH WEIGHT (msms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
PreSep	9.65	10.13	598.50	85.0	14.9
0	10.99	11.54	28.95	4.1	10.8
1	6.91	7.26	17.00	2.4	8.4
2	4.60	4.83	18.46	2.6	5.8
3	3.19	3.35	17.17	2.4	3.4
4	2.02	2.12	14.59	2.1	1.3
5	1.03	1.08	7.02	1.0	0.3
6	0.63	0.66	1.63	0.2	0.1
7	0.42	0.44	0.58	0.1	0.0
FILTER	< 0.42	< 0.44	0.32	0.0	

TOTAL CATCH 704.22

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 11B

PLANT: North American Refractories Company, Farber, Missouri

SAMPLING LOCATION: Cyclone Inlet DATE: 031584

	START-FINISH TIME:	1325-1325		VOLUME METERED, ACF:	0.282
SR)	SAMPLING RATE, ACFM	0.775		NOZZLE DIA., INCHES:	0.188
ST)	SAMPLING TIME, MINUTES:	0.50	Y)	METER CAL. FACTOR:	0.994
PB)	BARO. PRESS., IN.HG.:	29.40	TM)	METER TEMP., DEG F:	83
PSI)	STATIC PRESS., IN. H2O:	-1.00	DH)	DELTA H AVG., IN. H2O:	0.84
TS)	STACK GAS TEMP., DEG F:	138	DEN)	PARTICLE DENSITY, GM/CC:	1.00
PMV)	MOISTURE % BY VOLUME:	20.0	VCF)	VISCOSITY CORR. FACTOR:	1.044
DCF)	DENSITY CORR. FACTOR:	1.000	MD)	MOL WT, DRY LB/LB-MOLE:	29.02
	ISOKINETICS, %	106.3		CONCENT., GR/DSCF:	28.8500

STAGE NO.	PARTICLE DIAMETER (microns) FROM GRAPH	AERODYNAMIC	CATCH WEIGHT (mgms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
PreSep	9.59	10.01	419.60	83.7	16.3
0	10.92	11.40	21.78	4.3	12.0
1	6.86	7.16	14.08	2.8	9.2
2	4.57	4.77	15.54	3.1	6.1
3	3.17	3.31	14.94	3.0	3.1
4	2.00	2.09	10.38	2.1	1.0
5	1.02	1.06	3.60	0.7	0.3
6	0.62	0.65	0.72	0.1	0.2
7	0.42	0.44	0.33	0.1	0.1
FILTER	< 0.42	< 0.44	0.57	0.1	

TOTAL CATCH 501.54

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 12A

PLANT: North American Refractories Company, Farber, Missouri

SAMPLING LOCATION: Cyclone Inlet DATE: 031584

	START-FINISH TIME:	1512-1512		VOLUME METERED, ACF:	0.275
SR)	SAMPLING RATE, ACFM	0.779		NOZZLE DIA., INCHES:	0.188
ST)	SAMPLING TIME, MINUTES:	0.50	Y)	METER CAL. FACTOR:	0.994
PB)	BARO. PRESS., IN.HG.:	29.40	TM)	METER TEMP., DEG F:	80
PSI)	STATIC PRESS., IN. H2O:	-1.00	DH)	DELTA H AVG., IN. H2O:	0.8
TS)	STACK GAS TEMP., DEG F:	135	DEN)	PARTICLE DENSITY, GM/CC:	1.0
PMV)	MOISTURE % BY VOLUME:	22.3	VCF)	VISCOSITY CORR. FACTOR:	1.04
DCF)	DENSITY CORR. FACTOR:	1.000	MD)	MOL WT, DRY LB/LB-MOLE:	28.9
	ISOKINETICS, %	109.8		CONCENT., GR/DSCF:	5.158

STAGE NO.	PARTICLE DIAMETER (microns) FROM GRAPH	AERODYNAMIC	CATCH WEIGHT (msms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
PreSep	9.56	9.97	77.60	88.3	11.7
0	10.89	11.36	1.41	1.6	10.1
1	6.85	7.14	2.27	2.6	7.5
2	4.56	4.76	3.19	3.6	3.9
3	3.16	3.30	1.89	2.1	1.8
4	2.00	2.09	0.99	1.1	0.7
5	1.02	1.06	0.50	0.6	0.1
6	0.62	0.65	0.01	0.0	0.1
7	0.42	0.44	0.07	0.1	0.0
FILTER	< 0.42	< 0.44	0.00	0.0	

TOTAL CATCH 87.93

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 12B

PLANT: North American Refractories Company, Farber, Missouri

SAMPLING LOCATION: Cyclone Inlet DATE: 031584

	START-FINISH TIME:	1546-1546		VOLUME METERED, ACF:	0.276
SR)	SAMPLING RATE, ACFM	0.778		NOZZLE DIA., INCHES:	0.188
ST)	SAMPLING TIME, MINUTES:	0.50	Y)	METER CAL. FACTOR:	0.994
PB)	BARO. PRESS., IN.HG.:	29.40	TM)	METER TEMP., DEG F:	80
PSI)	STATIC PRESS., IN. H2O:	-1.00	DH)	DELTA H AVG., IN. H2O:	0.83
TS)	STACK GAS TEMP., DEG F:	132	DEN)	PARTICLE DENSITY, GM/CC:	1.00
PMV)	MOISTURE % BY VOLUME:	22.3	VCF)	VISCOSITY CORR. FACTOR:	1.041
DCF)	DENSITY CORR. FACTOR:	1.000	MD)	MOL WT, DRY LB/LB-MOLE:	28.98
	ISOKINETICS, %	109.9		CONCENT., GR/DSCF:	14.6470

STAGE NO.	- PARTICLE DIAMETER (microns) - FROM GRAPH	AERODYNAMIC	CATCH WEIGHT (mgms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
PreSep	9.57	9.96	234.90	93.7	6.3
0	10.90	11.35	4.21	1.7	4.6
1	6.85	7.13	2.57	1.0	3.6
2	4.57	4.76	2.04	0.8	2.8
3	3.16	3.29	2.14	0.9	1.9
4	2.00	2.08	2.55	1.0	0.9
5	1.02	1.06	1.70	0.7	0.2
6	0.62	0.65	0.25	0.1	0.1
7	0.42	0.44	0.00	0.0	0.1
FILTER	< 0.42	< 0.44	0.23	0.1	

TOTAL CATCH 250.59

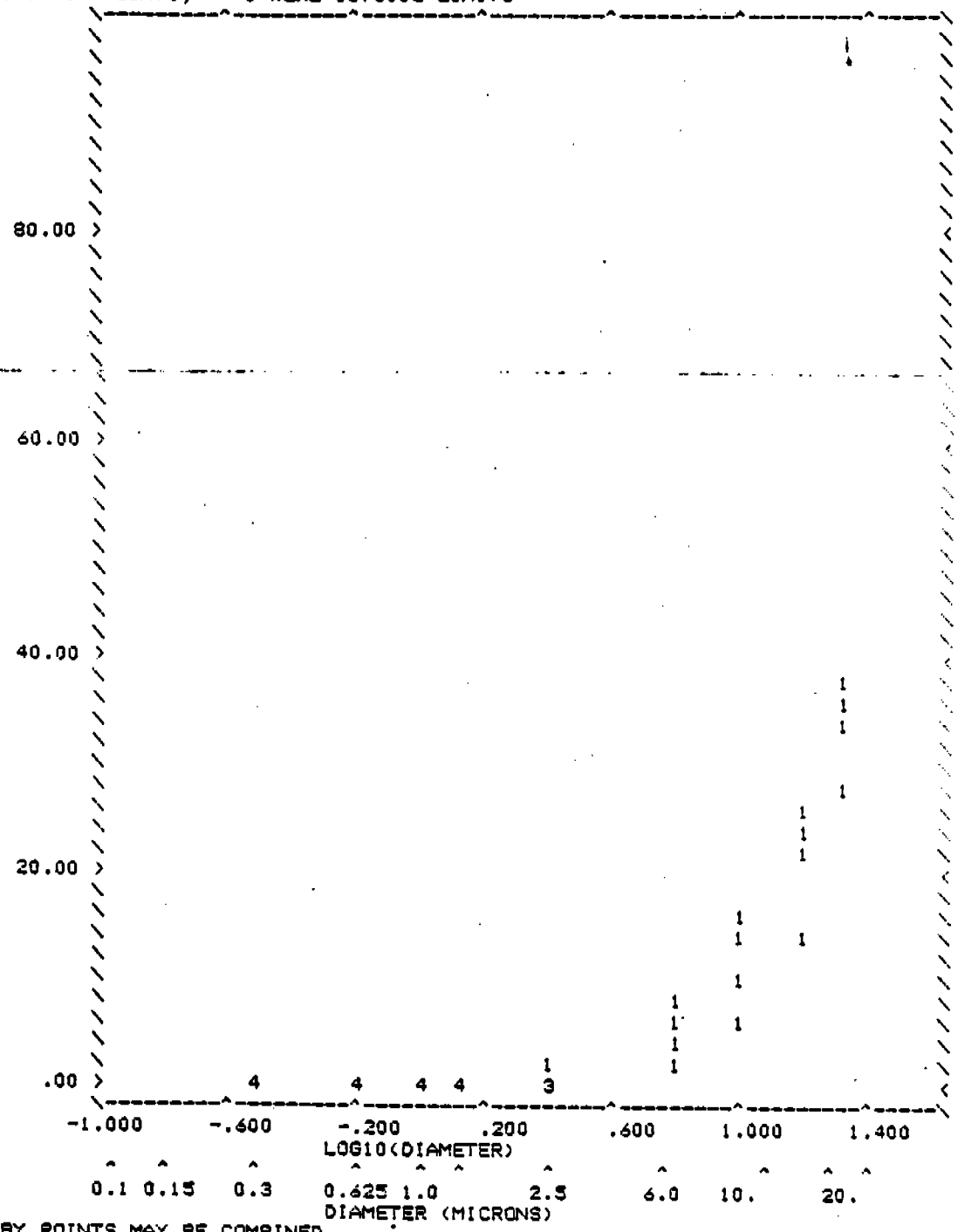
11A, 11B, 12A, 12B

```
NARC
ENTER TEST DATE, IDATE, (MMDDYY)
>031584

DO YOU WISH TO REVIEW ALL RUNS IN A TEST?  ENTER Y OR N?
>N

 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>2
THE TGLD AERODYNAMIC DIAM. WILL BE USED
 DO YOU WANT STATISTICS FOR 1=DM/DLOGD, 2=CUM. MASS, OR 3=CUM. % MASS?
>3
THE STD.DEV., MINIMUM, AND MAXIMUM OF THE CUM. % MASS WILL BE PRINTED
ENTER THE NO. OF STD. DEV. TO BE USED TO IDENTIFY POTENTIAL OUTLIERS.
>3
ENTER INDICES OF RUNS TO BE COMPARED SEPARATED BY BLANKS OR
   ENTER IN TO COMPARE ALL INLET RUNS IN THE TEST OR
   ENTER OUT TO COMPARE ALL OUTLET RUNS IN THE TEST
>IN

   *** MASS ON STAGE                1  IS HIGH
   *** MASS ON STAGE                2  IS HIGH
   *** MASS ON STAGE                3  IS HIGH
   *** MASS ON STAGE                4  IS HIGH
   *** MASS ON STAGE                5  IS HIGH
   *** SAMPLING DURATION    .50000000      IS SHORT
REDUCE DATA FOR RUN              1
SAMPLING AT  104.5 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .28348087      .54790600
   *** MASS ON STAGE                1  IS HIGH
   *** MASS ON STAGE                2  IS HIGH
   *** MASS ON STAGE                3  IS HIGH
   *** MASS ON STAGE                4  IS HIGH
   *** MASS ON STAGE                5  IS HIGH
   *** SAMPLING DURATION    .50000000      IS SHORT
REDUCE DATA FOR RUN              2
SAMPLING AT  106.5 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .28018280      .54137444
   *** LINEAR INTERPOLATION USED BETWEEN   .89110739      1.3513324
*** WEIGHT  9 SHOULD BE POSITIVE, NOT        .000
   *** MASS ON STAGE                7  IS LOW
   *** MASS ON STAGE                8  IS LOW
   *** MASS ON STAGE                9  IS LOW
   *** SAMPLING DURATION    .50000000      IS SHORT
REDUCE DATA FOR RUN              3
SAMPLING AT  110.1 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .53615456      .88241681
   *** LINEAR INTERPOLATION USED BETWEEN   1.8331097      3.3156837
*** WEIGHT  8 SHOULD BE POSITIVE, NOT        .000
   *** MASS ON STAGE                8  IS LOW
   *** SAMPLING DURATION    .50000000      IS SHORT
REDUCE DATA FOR RUN              4
SAMPLING AT  110.3 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .27757046      .53582413
   *** LINEAR INTERPOLATION USED BETWEEN   .53582413      .88161223
   *** LINEAR INTERPOLATION USED BETWEEN   4.9642313      9.9600000
TEST SITE      NARC       NARC       NARC       NARC
TEST DATE     31584      31584      31584      31584
RUN NUMBER        1          2          3          4
RUN DATE      31584      31584      31584      31584
START TIME     1256       1325       1512       1546
TOTAL MASS 9.470E+04 6.580E+04 1.176E+04 3.338E+04

STD. DIAM.  CUM. % MASS < D50
 3    .30       .06        .12        .01        .09
 4    .63       .16        .19        .08        .12
 5   1.00       .41        .44        .12        .26
 6   1.25       .60        .66        .25        .44
 7   2.50      2.15       1.75       1.25       1.37
 8   6.00      7.38       8.08       5.19       3.70
 9  10.00     14.78      16.32      11.78       6.28
10  15.00     25.23      27.26      22.18      15.47
11  20.00     37.52      39.51      34.83      28.49
```

STD. DIAM. (MICRONS)	NO. RUNS	DM/DLOGD (MG/DNCM)	CUMULATIVE MASS < D50	CUM. % MASS < D50 AVG.	STD. DEV.	MIN.	MAX.
3 .30	0	.00	4.30E+01	.07	.05	.01	.12
4 .63	4	2.63E+02	8.33E+01	.14	.05	.08	.19
5 1.00	4	8.02E+02	1.94E+02	.31	.14	.12	.44
6 1.25	4	1.27E+03	2.94E+02	.49	.18	.25	.66
7 2.50	4	3.68E+03	9.48E+02	1.63	.41	1.25	2.15
8 6.00	4	1.19E+04	3.54E+03	6.09	2.01	3.70	8.08
9 10.00	4	1.89E+04	7.05E+03	12.29	4.43	6.28	16.32
10 15.00	4	4.40E+04	1.24E+04	22.54	5.15	15.47	27.26
11 20.00	4	5.68E+04	1.88E+04	35.09	4.80	28.49	39.51

DO YOU WANT TO PLOT CUM % MASS? ENTER Y OR N
>Y
COMPARISON OF CUM. % MASS FROM 4 RUNS AT STD. DIAM.

36 INPUT POINTS, 0 WERE OUTSIDE LIMITS



NEARBY POINTS MAY BE COMBINED.

```
DO YOU WISH TO CALCULATE PENETRATION AND EFFICIENCY? ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>2
THE TGLD AERODYNAMIC DIAM. WILL BE USED
ENTER INDICES OF RUNS TO BE USED, SEPARATED BY BLANKS, OR
ENTER 0 (ZERO) TO USE ALL RUNS IN THE TEST
>IN
***** ERROR DECODING IN

*FTN ERROR   SUBPROGRAM BSORT          ARGUMENT LIST DOESN'T MATCH CALLER
BSORT  REFERENCED AT LN.   120  OF  PENEFF
FOLLOWING ARGUMENT TYPES DO NOT MATCH:
ARGUMENT NO. 01, CALLERS TYPE: INTEGER     SUBPROGRAMS TYPE: REAL*4

*** WEIGHT  8 SHOULD BE POSITIVE, NOT       .000
   *** MASS ON STAGE              8  IS LOW
   *** SAMPLING DURATION    .50000000      IS SHORT .
REDUCE DATA FOR RUN            4
SAMPLING AT  110.3 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .27757046      .53582413
   *** LINEAR INTERPOLATION USED BETWEEN   .53582413      .38161223
   *** LINEAR INTERPOLATION USED BETWEEN   4.9642313      9.9600000
   STD. DIAM.  PENETR.    ERR.   EFFICIENCY   ERR.
*** NO OUTLET RUN IN THIS TEST
```

Run No. 11A + 11B

```
NARC
ENTER TEST DATE, IDATE, (MMDDYY)
>031584

DO YOU WISH TO REVIEW ALL RUNS IN A TEST?  ENTER Y OR N?
>N

 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>2
THE TGLD AERODYNAMIC DIAM. WILL BE USED
 DO YOU WANT STATISTICS FOR 1=CM/DLOGD, 2=CUM. MASS, OR 3=CUM. % MASS?
>3
THE STD.DEV., MINIMUM, AND MAXIMUM OF THE CUM. % MASS WILL BE PRINTED
ENTER THE NO. OF STD. DEV. TO BE USED TO IDENTIFY POTENTIAL OUTLIERS.
>3
ENTER INDICES OF RUNS TO BE COMPARED SEPARATED BY BLANKS OR
   ENTER IN TO COMPARE ALL INLET RUNS IN THE TEST OR
   ENTER OUT TO COMPARE ALL OUTLET RUNS IN THE TEST
> 1 2

*FTN ERROR   SUBPROGRAM BSORT           ARGUMENT LIST DOESN'T MATCH CALLER
BSORT  REFERENCED AT LN.  143  OF  COMPAR
FOLLOWING ARGUMENT TYPES DO NOT MATCH:
ARGUMENT NO. 01, CALLERS TYPE: INTEGER     SUBPROGRAMS TYPE: REAL*4

   *** MASS ON STAGE              1  IS HIGH
   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** SAMPLING DURATION   .50000000      IS SHORT
REDUCE DATA FOR RUN             1
SAMPLING AT  104.5 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .28348087      .54790600

   *** MASS ON STAGE              1  IS HIGH
   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** SAMPLING DURATION   .50000000      IS SHORT
REDUCE DATA FOR RUN             2
SAMPLING AT  106.5 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN - .28018280      .54137444
   *** LINEAR INTERPOLATION USED BETWEEN   .89110739      1.8513324
```

	11A	11B
TEST SITE	NARC	NARC
TEST DATE	31584	31584
RUN NUMBER	1	2
RUN DATE	31584	31584
START TIME	1256	1325
TOTAL MASS	9.470E+04	6.580E+04

STD.	DIAM.	CUM. % MASS < D50	
3	.30	.06	.12
4	.63	.16	.19
5	1.00	.41	.44
6	1.25	.60	.66
7	2.50	2.15	1.75
8	6.00	7.38	8.08
9	10.00	14.78	16.32
10	15.00	25.23	27.26
11	20.00	37.52	39.51

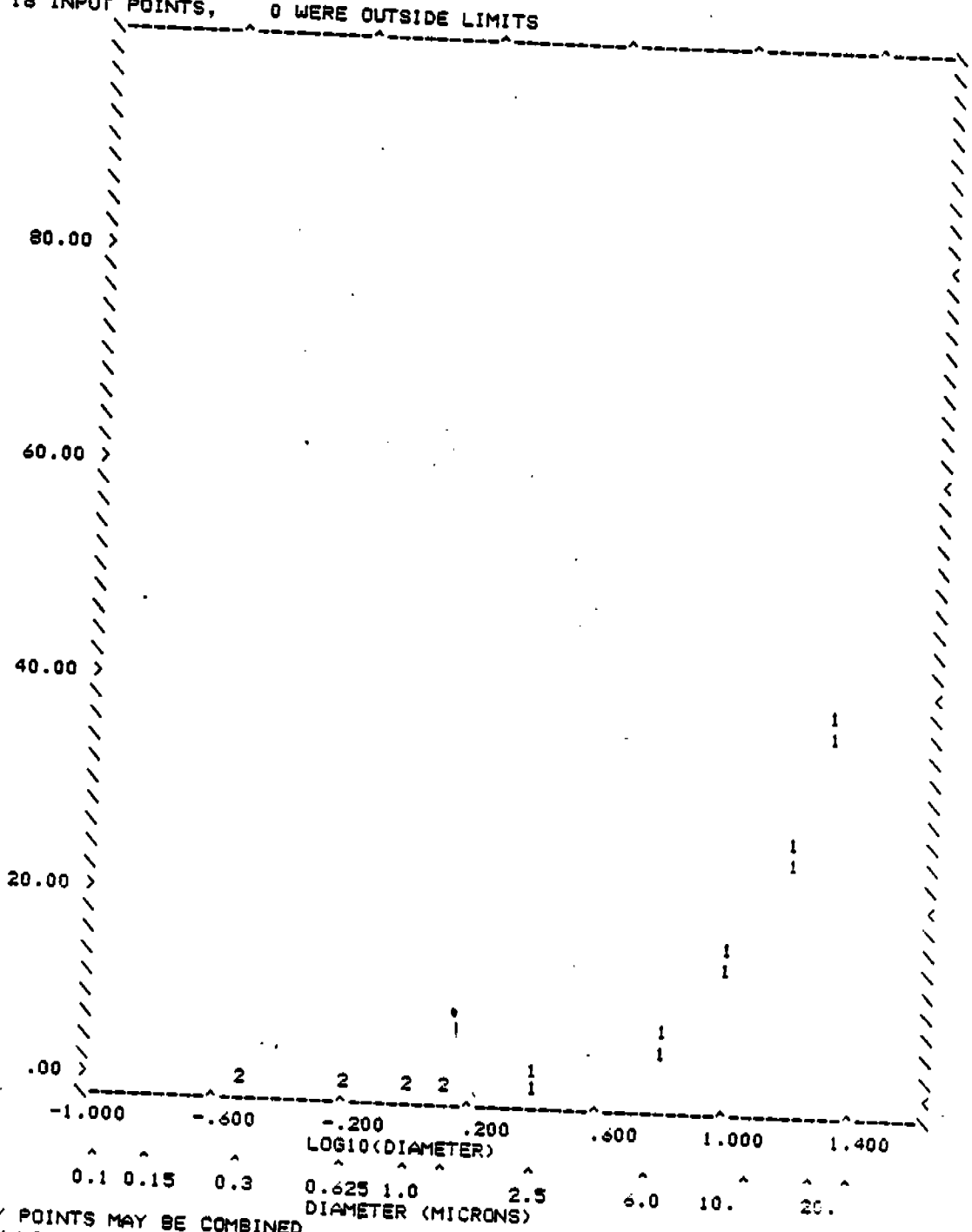
DATA COMPARISON FOR 2 INLET RUNS BY ENT

STD. DIAM. (MICRONS)	NO. RUNS	DM/DLOGD (MG/DNCM)	CUMULATIVE MASS < D50	CUM. % MASS < D50 AVG.	STD. DEV.	MIN.	MAX.
3 .30	0	.00	6.99E+01	.09	.04	.06	.12
4 .63	2	4.47E+02	1.41E+02	.18	.02	.16	.19
5 1.00	2	1.31E+03	3.36E+02	.42	.02	.41	.44
6 1.25	2	2.09E+03	5.01E+02	.63	.04	.60	.66
7 2.50	2	6.43E+03	1.59E+03	1.95	.28	1.75	2.15
8 6.00	2	2.08E+04	6.15E+03	7.73	.50	7.38	8.08
9 10.00	2	3.28E+04	1.24E+04	15.55	1.09	14.78	16.32
10 15.00	2	6.84E+04	2.09E+04	26.25	1.43	25.23	27.26
11 20.00	2	8.71E+04	3.08E+04	38.52	1.41	37.52	39.51

DO YOU WANT TO PLOT CUM % MASS? ENTER Y OR N
>Y

COMPARISON OF CUM. % MASS FROM 2 RUNS AT STD. DIAM.

18 INPUT POINTS, 0 WERE OUTSIDE LIMITS



NEARBY POINTS MAY BE COMBINED
DO YOU WISH TO REPEAT THE COMPARISON EXCLUDING SOME RUNS? ENTER Y OR N
>

Run No. 12A + 12B

```
NARC
ENTER TEST DATE, IDATE, (MMDDYY)
>031584

DO YOU WISH TO REVIEW ALL RUNS IN A TEST?  ENTER Y OR N?
>N

 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>2
THE TGLD AERODYNAMIC DIAM. WILL BE USED
 DO YOU WANT STATISTICS FOR 1=DM/DLOGD, 2=CUM. MASS, OR 3=CUM. % MASS?
>3
THE STD.DEV., MINIMUM, AND MAXIMUM OF THE CUM. % MASS WILL BE PRINTED
ENTER THE NO. OF STD. DEV. TO BE USED TO IDENTIFY POTENTIAL OUTLIERS.
>3
ENTER INDICES OF RUNS TO BE COMPARED SEPARATED BY BLANKS OR
   ENTER IN TO COMPARE ALL INLET RUNS IN THE TEST OR
   ENTER OUT TO COMPARE ALL OUTLET RUNS IN THE TEST
>3 4

*FTN ERROR   SUBPROGRAM BSORT            ARGUMENT LIST DOESN'T MATCH CALLER
BSORT  REFERENCED AT LN.   143  OF  COMPAR
FOLLOWING ARGUMENT TYPES DO NOT MATCH:
ARGUMENT NO. 01, CALLERS TYPE: INTEGER     SUBPROGRAMS TYPE: REAL*4

*** WEIGHT  9 SHOULD BE POSITIVE, NOT        .000
   *** MASS ON STAGE              7  IS LOW
   *** MASS ON STAGE              8  IS LOW
   *** MASS ON STAGE              9  IS LOW
   *** SAMPLING DURATION   .50000000      IS SHORT
REDUCE DATA FOR RUN            3
SAMPLING AT  110.1 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .53615456      .88241681
   *** LINEAR INTERPOLATION USED BETWEEN   1.8331097      3.3156837

*** WEIGHT  8 SHOULD BE POSITIVE, NOT        .000
   *** MASS ON STAGE              8  IS LOW
   *** SAMPLING DURATION   .50000000      IS SHORT
REDUCE DATA FOR RUN            4
SAMPLING AT  110.3 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .27757046      .53582413
   *** LINEAR INTERPOLATION USED BETWEEN   .53582413      .88161223
   *** LINEAR INTERPOLATION USED BETWEEN   4.9642313      9.9600000
```

	12A	12B
TEST SITE	NARC	NARC
TEST DATE	31584	31584
RUN NUMBER	3	4
RUN DATE	31584	31584
START TIME	1512	1546
TOTAL MASS	1.176E+04	3.338E+04

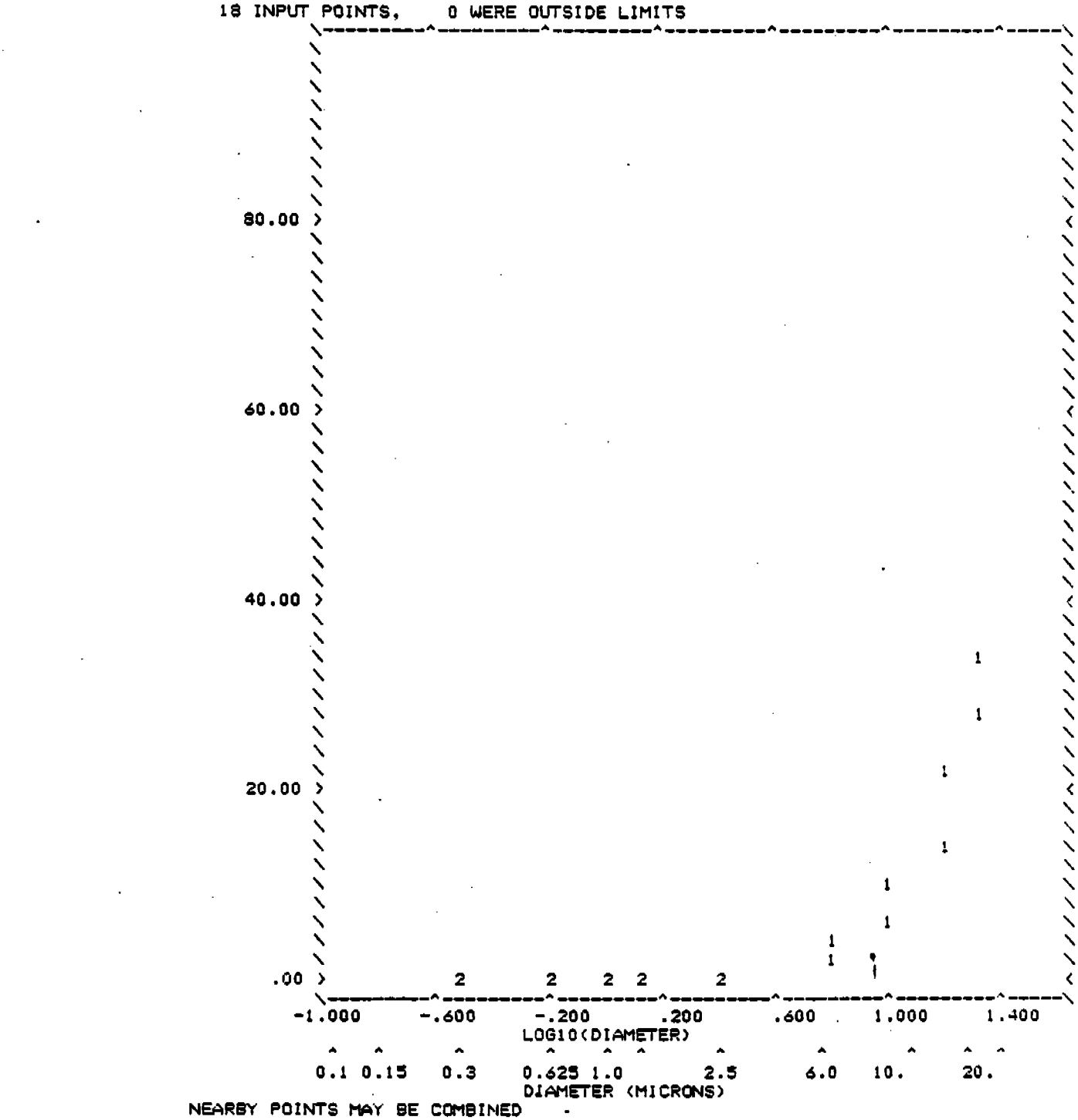
STD.	DIAM.	CUM. % MASS < D50	
3	.30	.01	.09
4	.63	.08	.12
5	1.00	.12	.26
6	1.25	.25	.44
7	2.50	1.25	1.37
8	6.00	5.19	3.70
9	10.00	11.79	6.28
10	15.00	22.19	15.47
11	20.00	34.83	28.49

DATA COMPARISON FOR 2 INLET RUNS BY ENT

STD. DIAM. (MICRONS)	NO. RUNS	DM/DLOGD (MG/DNCM)	CUMULATIVE MASS < D50	CUM. % MASS < D50 AVG.	STD. DEV.	MIN.	MAX.
3 .30	0	.00	1.61E+01	.05	.06	.0[illegible]	.09
4 .63	2	8.01E+01	2.54E+01	.10	.03	.0[illegible]	.12
5 1.00	2	2.97E+02	5.12E+01	.19	.10	.12	.26
6 1.25	2	4.51E+02	8.74E+01	.34	.13	.2[illegible]	.44
7 2.50	2	9.22E+02	3.02E+02	1.31	.09	1.2[illegible]	1.37
8 6.00	2	3.07E+03	9.22E+02	4.44	1.05	3.7[illegible]	5.19
9 10.00	2	5.02E+03	1.74E+03	9.03	3.89	6.2[illegible]	11.78
10 15.00	2	1.95E+04	3.89E+03	18.83	4.74	15.47	22.18
11 20.00	2	2.65E+04	6.80E+03	31.66	4.49	28.4[illegible]	34.83

DO YOU WANT TO PLOT CUM % MASS? ENTER Y OR N
>Y
COMPARISON OF CUM. % MASS FROM 2 RUNS AT STD. DIAM.

18 INPUT POINTS, 0 WERE OUTSIDE LIMITS



NEARBY POINTS MAY BE COMBINED
DO YOU WISH TO REPEAT THE COMPARISON EXCLUDING SOME RUNS? ENTER Y OR N
>

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 14A

PLANT: North American Refractories Company, Farber, Missouri

SAMPLING LOCATION: Scrubber Inlet DATE: 031584

	START-FINISH TIME:	1305-1307		VOLUME METERED, ACF:	1.218
SR)	SAMPLING RATE, ACFM	0.817		NOZZLE DIA., INCHES:	0.188
ST)	SAMPLING TIME, MINUTES:	2.00	Y)	METER CAL. FACTOR:	0.992
PB)	BARO. PRESS.,IN.HG.:	29.40	TM)	METER TEMP., DEG F:	92
PSI)	STATIC PRESS., IN. H2O:	-4.30	DH)	DELTA H AVG., IN. H2O:	0.74
TS)	STACK GAS TEMP., DEG F:	138	DEN)	PARTICLE DENSITY, GM/CC:	1.00
PMV)	MOISTURE % BY VOLUME:	18.9	VCF)	VISCOSITY CORR. FACTOR:	1.044
DCF)	DENSITY CORR. FACTOR:	1.000	MD)	MOL WT, DRY LB/LB-MOLE:	29.02
	ISOKINETICS, %	120.2		CONCENT., GR/DSCF:	3.9108

STAGE NO.	PARTICLE DIAMETER (microns) FROM GRAPH	PARTICLE DIAMETER (microns) AERODYNAMIC	CATCH WEIGHT (msms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
PreSep	9.32	9.73	146.30	50.8	49.2
PreImp	8.12	8.48	7.73	2.7	46.5
1	5.32	5.55	25.49	8.8	37.7
2	3.42	3.57	28.79	10.0	27.7
3	2.20	2.30	34.67	12.0	15.7
4	1.31	1.37	24.27	8.4	7.3
5	0.87	0.91	14.27	5.0	2.3
6	0.53	0.55	5.47	1.9	0.4
7	0.31	0.32	0.40	0.1	0.3
FILTER	< 0.31	< 0.32	0.82	0.3	

TOTAL CATCH 288.21

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 14B

PLANT: North American Refractories Company, Farber, Missouri

SAMPLING LOCATION: Scrubber Inlet DATE: 03158

	START-FINISH TIME:	1338 - 1340		VOLUME METERED, ACF:	0.83
SR)	SAMPLING RATE, ACFM	0.557		NOZZLE DIA., INCHES:	0.18
ST)	SAMPLING TIME, MINUTES:	2.00	Y)	METER CAL. FACTOR:	0.99
PB)	BARO. PRESS., IN.HG.:	29.40	TM)	METER TEMP., DEG F:	9
PSI)	STATIC PRESS., IN. H2O:	-4.30	DH)	DELTA H AVG., IN. H2O:	0.7
TS)	STACK GAS TEMP., DEG F:	137	DEN)	PARTICLE DENSITY, GM/CC:	1.0
PMV)	MOISTURE % BY VOLUME:	18.9	VCF)	VISCOSITY CORR. FACTOR:	1.04
DCF)	DENSITY CORR. FACTOR:	1.000	MD)	MOL WT, DRY LB/LB-MOLE:	29.0
	ISOKINETICS, %	84.7		CONCENT., GR/DSCF:	5.374

STAGE NO.	PARTICLE DIAMETER (microns) FROM GRAPH	PARTICLE DIAMETER (microns) AERODYNAMIC	CATCH WEIGHT (msms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
PreSep	11.39	11.89	171.80	63.5	36.5
PreImp	9.92	10.36	6.60	2.4	34.1
1	6.51	6.80	18.70	6.9	27.2
2	4.14	4.32	20.00	7.4	19.8
3	2.67	2.79	19.17	7.1	12.7
4	1.58	1.65	13.99	5.2	7.5
5	1.05	1.10	7.05	2.6	4.9
6	0.65	0.68	1.38	0.5	4.4
7	0.38	0.40	0.47	0.2	4.2
FILTER	< 0.38	< 0.40	11.29	4.2	

TOTAL CATCH 270.45

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 15A

PLANT: North American Refractories Company, Farber, Missouri

SAMPLING LOCATION: Scrubber Inlet DATE: 031584

	START-FINISH TIME:	1535-1536		VOLUME METERED, ACF:	0.584
SR)	SAMPLING RATE, ACFM	0.761		NOZZLE DIA., INCHES:	0.188
ST)	SAMPLING TIME, MINUTES:	1.00	Y)	METER CAL. FACTOR:	0.992
PB)	BARO. PRESS., IN.HG.:	29.40	TM)	METER TEMP., DEG F:	92
PSI)	STATIC PRESS., IN. H2O:	-4.80	DH)	DELTA H AVG., IN. H2O:	0.78
TS)	STACK GAS TEMP., DEG F:	136	DEN)	PARTICLE DENSITY, GM/CC:	1.00
PMV)	MOISTURE % BY VOLUME:	16.6	VCF)	VISCOSITY CORR. FACTOR:	1.043
DCF)	DENSITY CORR. FACTOR:	1.000	MD)	MOL WT, DRY LB/LB-MOLE:	28.98
	ISOKINETICS, %	110.3		CONCENT., GR/DSCF:	1.2194

STAGE NO.	- PARTICLE DIAMETER - (microns) FROM GRAPH	AERODYNAMIC	CATCH WEIGHT (mgms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
PreSep	9.68	10.10	36.10	83.8	16.3
0	11.02	11.49	0.18	0.4	15.9
1	6.93	7.23	0.52	1.2	14.7
2	4.62	4.82	1.66	3.9	10.8
3	3.20	3.34	1.93	4.5	6.3
4	2.02	2.11	1.65	3.8	2.5
5	1.03	1.07	0.65	1.5	1.0
6	0.63	0.66	0.11	0.3	0.7
7	0.42	0.44	0.11	0.3	0.4
FILTER	< 0.42	< 0.44	0.18	0.4	

TOTAL CATCH 43.09

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 15B

PLANT: North American Refractories Company, Farber, Missouri

SAMPLING LOCATION: Scrubber Inlet DATE: 03158

	START-FINISH TIME:	1557-1558		VOLUME METERED, ACF:	0.59
SR)	SAMPLING RATE, ACFM	0.773		NOZZLE DIA., INCHES:	0.16
ST)	SAMPLING TIME, MINUTES:	1.00	Y)	METER CAL. FACTOR:	0.99
PB)	BARO. PRESS., IN.HG.:	29.40	TM)	METER TEMP., DEG F:	9
PSI)	STATIC PRESS., IN. H2O:	-4.70	DH)	DELTA H AVG., IN. H2O:	0.6
TS)	STACK GAS TEMP., DEG F:	139	DEN)	PARTICLE DENSITY, GM/CC:	1.0
PMV)	MOISTURE % BY VOLUME:	16.6	VCF)	VISCOSITY CORR. FACTOR:	1.04
DCF)	DENSITY CORR. FACTOR:	1.000	MD)	MOL WT, DRY LB/LB-MOLE:	28.9
	ISOKINETICS, %	112.6		CONCENT., GR/DSCF:	2.029

STAGE NO.	PARTICLE DIAMETER (microns) FROM GRAPH	PARTICLE DIAMETER (microns) AERODYNAMIC	CATCH WEIGHT (msms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
PreSep	9.60	10.03	36.70	50.6	49.4
PreImp	8.36	8.74	0.00	0.0	49.4
1	5.48	5.73	7.56	10.4	39.0
2	3.52	3.68	7.55	10.4	28.6
3	2.26	2.36	6.38	8.8	19.8
4	1.34	1.40	1.46	2.0	17.8
5	0.89	0.93	0.27	0.4	17.4
6	0.55	0.57	0.00	0.0	17.4
7	0.32	0.33	1.21	1.7	15.7
FILTER	< 0.32	< 0.33	11.39	15.7	

TOTAL CATCH 72.52

```
ENTER TEST DATE, IDATE, (MMDDYY)
>031584
DO YOU WISH TO REVIEW ALL RUNS IN A TEST?  ENTER Y OR N?
>N

 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>2
THE TGLD AERODYNAMIC DIAM. WILL BE USED
 DO YOU WANT STATISTICS FOR 1=DM/DLOGD, 2=CUM. MASS, OR 3=CUM. % MASS?
>3
THE STD.DEV., MINIMUM, AND MAXIMUM OF THE CUM. % MASS WILL BE PRINTED
ENTER THE NO. OF STD. DEV. TO BE USED TO IDENTIFY POTENTIAL OUTLIERS.
>3
ENTER INDICES OF RUNS TO BE COMPARED SEPARATED BY BLANKS OR
   ENTER IN TO COMPARE ALL INLET RUNS IN THE TEST OR
   ENTER OUT TO COMPARE ALL OUTLET RUNS IN THE TEST
>OUT
   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** MASS ON STAGE              6  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN              5
SAMPLING AT  120.3 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .37866067      .65712356
   *** LINEAR INTERPOLATION USED BETWEEN   .97211983      1.7347353
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5839.66
   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** MASS ON STAGE              9  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN              6
SAMPLING AT   84.8 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .47716916      .81352165
   *** LINEAR INTERPOLATION USED BETWEEN   1.1945851      2.1180792
   *** SAMPLING DURATION   1.0000000      IS SHORT
REDUCE DATA FOR RUN              7
SAMPLING AT  110.6 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .55036415      .90587363
   *** LINEAR INTERPOLATION USED BETWEEN   .90587363      1.8819839
*** WEIGHT  7 SHOULD BE POSITIVE, NOT        .000
   *** MASS ON STAGE              7  IS LOW
   *** MASS ON STAGE              9  IS HIGH
   *** SAMPLING DURATION   1.0000000      IS SHORT
REDUCE DATA FOR RUN              8
SAMPLING AT  112.7 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .68208049      1.0080095
   *** LINEAR INTERPOLATION USED BETWEEN   1.0080095      1.7972410
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5521.01
```

14A, 14B, 15A, 15B

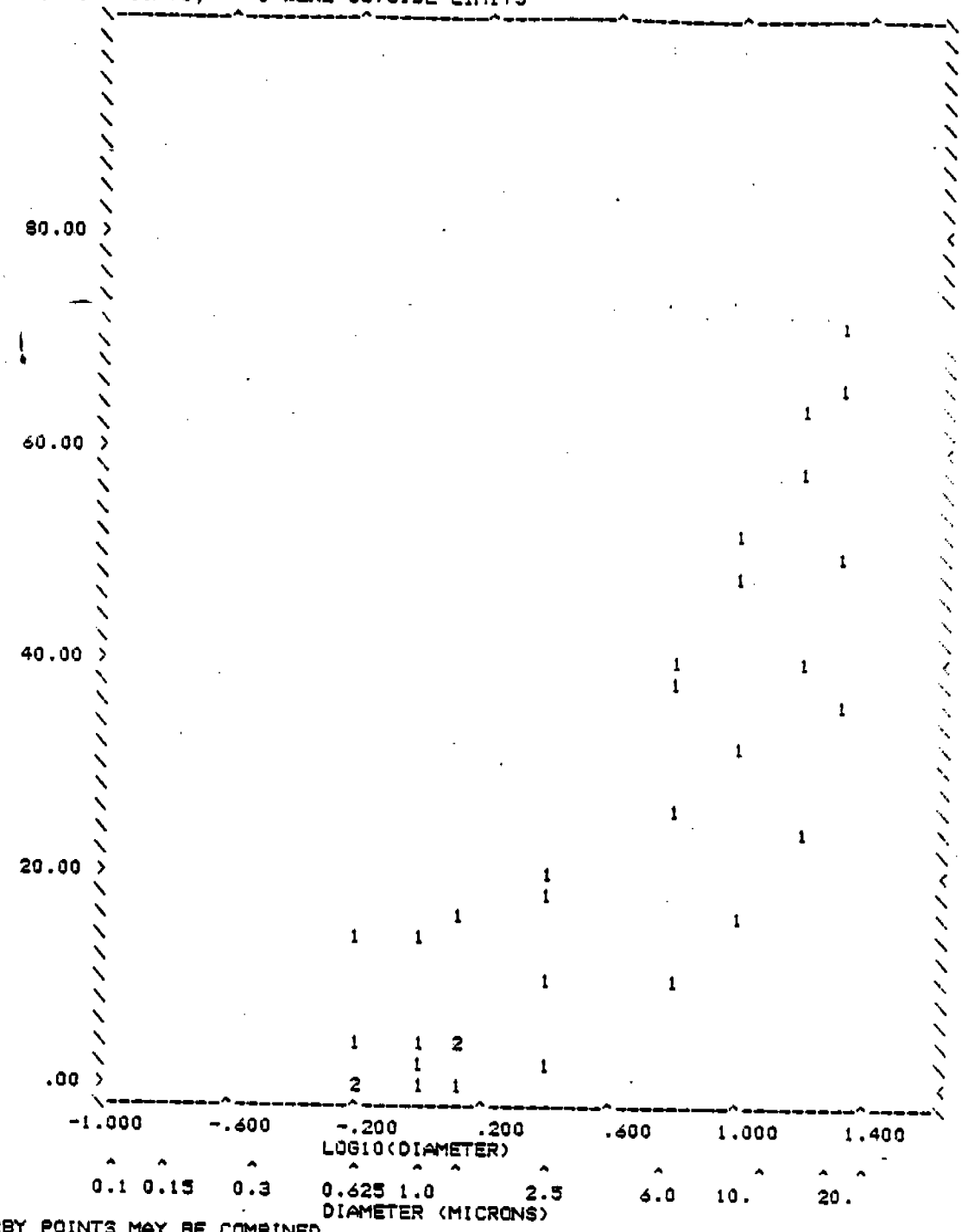
TEST SITE	NARC	NARC	NARC	NARC
TEST DATE	31584	31584	31584	31584
RUN NUMBER	5	6	7	8
RUN DATE	31584	31584	31584	31584
START TIME	1305	1348	1535	1557
TOTAL MASS	8.920E+03	1.226E+04	2.779E+03	5.047E+03

STD.	DIAM.	CUM. % MASS < D50			
4	.63	.41	4.26	.74	15.80
5	1.00	2.56	4.50	1.13	15.93
6	1.25	4.47	5.06	1.59	16.05
7	2.50	19.41	10.70	3.87	20.56
8	6.00	40.27	26.31	11.24	39.01
9	10.00	49.75	33.49	16.08	53.53
10	15.00	59.12	41.30	25.01	65.25
11	20.00	67.12	50.38	36.81	73.36

DATA COMPARISON FOR 4 OUTLET RUNS BY ENT

STD. DIAM. (MICRONS)		NO. RUNS	DM/DLOGD (MG/DNCM)	CUMULATIVE MASS < D50	CUM. % MASS < D50 AVG.	STD. DEV.	MIN.	MAX.
4	.63	4	1.31E+02	3.44E+02	5.30	7.21	.41	15.80
5	1.00	4	5.36E+02	4.04E+02	6.03	6.74	1.13	15.93
6	1.25	4	7.71E+02	4.68E+02	6.80	6.35	1.59	16.05
7	2.50	4	3.46E+03	1.05E+03	13.64	7.86	3.87	20.56
8	6.00	4	2.94E+03	2.27E+03	29.20	13.54	11.24	40.27
9	10.00	4	3.17E+03	2.92E+03	38.21	17.13	16.08	53.53
10	15.00	4	4.58E+03	3.58E+03	47.67	18.20	25.01	65.25
11	20.00	4	5.55E+03	4.22E+03	56.92	16.55	36.81	73.36

32 INPUT POINTS, 0 WERE OUTSIDE LIMITS



NEARBY POINTS MAY BE COMBINED

```
DO YOU WISH TO CALCULATE PENETRATION AND EFFICIENCY? ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>2
THE TGLD AERODYNAMIC DIAM. WILL BE USED
ENTER INDICES OF RUNS TO BE USED, SEPARATED BY BLANKS, OR
ENTER 0 (ZERO) TO USE ALL RUNS IN THE TEST
>5 6 7 8

*FTN ERROR   SUBPROGRAM BSORT          ARGUMENT LIST DOESN'T MATCH CALLER
BSORT  REFERENCED AT LN.   120  OF  PENEFF
FOLLOWING ARGUMENT TYPES DO NOT MATCH:
ARGUMENT NO. 01, CALLERS TYPE: INTEGER     SUBPROGRAMS TYPE: REAL*4

   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** MASS ON STAGE              6  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            5
SAMPLING AT  120.3 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .37866067      .65712356
   *** LINEAR INTERPOLATION USED BETWEEN   .97211983      1.7347353
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5839.66

   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** MASS ON STAGE              9  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            6
SAMPLING AT   84.8 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .47716916      .81352165
   *** LINEAR INTERPOLATION USED BETWEEN   1.1945851      2.1180792

   *** SAMPLING DURATION   1.0000000      IS SHORT
REDUCE DATA FOR RUN            7
SAMPLING AT  110.6 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .55036415      .90587363
   *** LINEAR INTERPOLATION USED BETWEEN   .90587363      1.8819839

*** WEIGHT  7 SHOULD BE POSITIVE, NOT       .000
   *** MASS ON STAGE              7  IS LOW
   *** MASS ON STAGE              9  IS HIGH
   *** SAMPLING DURATION   1.0000000      IS SHORT
REDUCE DATA FOR RUN            8
SAMPLING AT  112.7 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .68208049      1.0080095
   *** LINEAR INTERPOLATION USED BETWEEN   1.0080095      1.7972410
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5521.01
  STD. DIAM.  PENETR.    ERR.   EFFICIENCY   ERR.
*** NO INLET  RUN IN THIS TEST
```

Run No. 14A + 14B

```
NARC
ENTER TEST DATE, IDATE, (MMDDYY)
>031584

DO YOU WISH TO REVIEW ALL RUNS IN A TEST?  ENTER Y OR N?
>N

 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>2
THE TGLD AERODYNAMIC DIAM. WILL BE USED
 DO YOU WANT STATISTICS FOR 1=DM/DLOGD, 2=CUM. MASS, OR 3=CUM. % MASS?
>3
THE STD.DEV., MINIMUM, AND MAXIMUM OF THE CUM. % MASS WILL BE PRINTED
ENTER THE NO. OF STD. DEV. TO BE USED TO IDENTIFY POTENTIAL OUTLIERS.
>3
ENTER INDICES OF RUNS TO BE COMPARED SEPARATED BY BLANKS OR
   ENTER IN TO COMPARE ALL INLET RUNS IN THE TEST OR
   ENTER OUT TO COMPARE ALL OUTLET RUNS IN THE TEST
>5 6

*FTN ERROR   SUBPROGRAM BSORT            ARGUMENT LIST DOESN'T MATCH CALLER
BSORT  REFERENCED AT LN.   143  OF  COMPAR
FOLLOWING ARGUMENT TYPES DO NOT MATCH:
ARGUMENT NO. 01, CALLERS TYPE: INTEGER     SUBPROGRAMS TYPE: REAL*4

   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** MASS ON STAGE              6  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            5
SAMPLING AT  120.3 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .37866067      .65712356
   *** LINEAR INTERPOLATION USED BETWEEN   .97211983      1.7347353
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5839.66

   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** MASS ON STAGE              9  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            6
SAMPLING AT   84.9 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .47716916      .81352165
   *** LINEAR INTERPOLATION USED BETWEEN   1.1945851      2.1180792
```

	14A	14B
TEST SITE	NARC	NARC
TEST DATE	31584	31584
RUN NUMBER	5	6
RUN DATE	31584	31584
START TIME	1305	1348
TOTAL MASS	8.920E+03	1.226E+04

STD.	DIAM.	CUM. % MASS	< D50
4	.63	.41	4.26
5	1.00	2.56	4.50
6	1.25	4.47	5.06
7	2.50	19.41	10.70
8	6.00	40.27	26.31

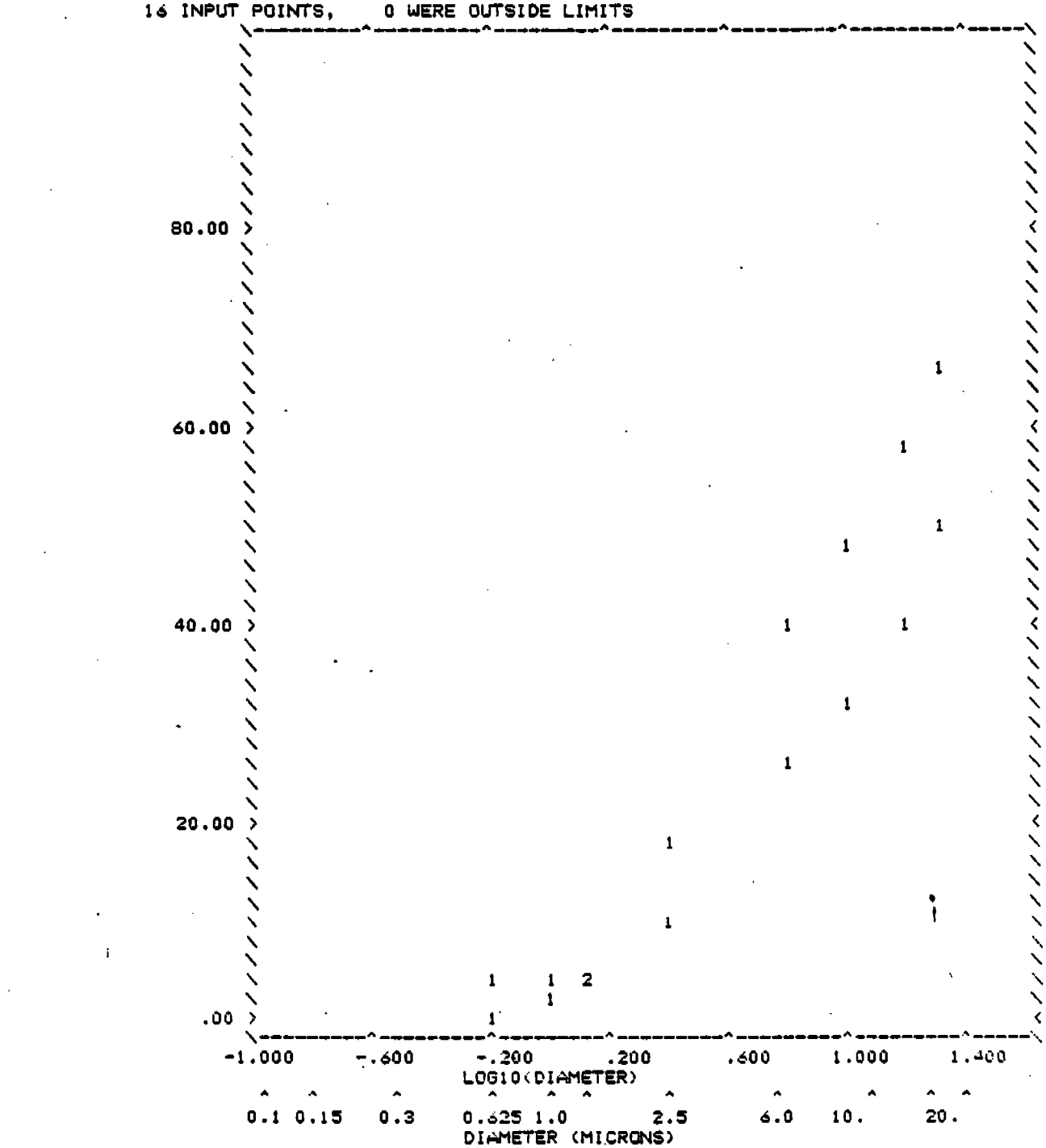
9	10.00	49.75	33.49
10	15.00	59.12	41.30
11	20.00	67.12	50.38

DATA COMPARISON FOR 2 OUTLET RUNS BY ENT

STD. DIAM. (MICRONS)	NO. RUNS	DM/DLOGD (MG/DNCM)	CUMULATIVE MASS < D50	CUM. % MASS < D50 AVG.	STD. DEV.	MIN.	MAX.
4 .63	2	1.52E+02	2.80E+02	2.34	2.72	.41	4.26
5 1.00	2	9.90E+02	3.90E+02	3.53	1.37	2.56	4.50
6 1.25	2	1.44E+03	5.10E+02	4.77	.42	4.47	5.06
7 2.50	2	5.85E+03	1.52E+03	15.06	6.16	10.70	19.41
8 6.00	2	4.00E+03	3.41E+03	33.29	9.87	26.31	40.27
9 10.00	2	4.31E+03	4.27E+03	41.62	11.50	33.49	49.75
10 15.00	2	6.40E+03	5.17E+03	50.21	12.60	41.30	59.12
11 20.00	2	8.03E+03	6.08E+03	58.75	11.84	50.38	67.12

DO YOU WANT TO PLOT CUM % MASS? ENTER Y OR N
>*TIMEOUT WARNING*
Y
COMPARISON OF CUM. % MASS FROM 2 RUNS AT STD. DIAM.

16 INPUT POINTS, 0 WERE OUTSIDE LIMITS



NEARBY POINTS MAY BE COMBINED
DO YOU WISH TO REPEAT THE COMPARISON EXCLUDING SOME RUNS? ENTER Y OR N
>

```
NARC
ENTER TEST DATE, IDATE, (MMDDYY)                    RUN NO. 15A + 15B
>031584

DO YOU WISH TO REVIEW ALL RUNS IN A TEST?  ENTER Y OR N?
>N

 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>2
THE TGLD AERODYNAMIC DIAM. WILL BE USED
 DO YOU WANT STATISTICS FOR 1=DM/DLOGD, 2=CUM. MASS, OR 3=CUM. % MASS?
>3
THE STD.DEV., MINIMUM, AND MAXIMUM OF THE CUM. % MASS WILL BE PRINTED
ENTER THE NO. OF STD. DEV. TO BE USED TO IDENTIFY POTENTIAL OUTLIERS.
>3
ENTER INDICES OF RUNS TO BE COMPARED SEPARATED BY BLANKS OR
   ENTER IN TO COMPARE ALL INLET RUNS IN THE TEST OR
   ENTER OUT TO COMPARE ALL OUTLET RUNS IN THE TEST
>7 8

*FTN ERROR   SUBPROGRAM BSORT          ARGUMENT LIST DOESN'T MATCH CALLER
BSORT  REFERENCED AT LN.   143  OF  COMPAR
FOLLOWING ARGUMENT TYPES DO NOT MATCH:
ARGUMENT NO. 01, CALLERS TYPE: INTEGER     SUBPROGRAMS TYPE: REAL*4

   *** SAMPLING DURATION   1.0000000      IS SHORT
REDUCE DATA FOR RUN            7
SAMPLING AT  110.6 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .55036415      .90587363
   *** LINEAR INTERPOLATION USED BETWEEN   .90587363      1.8819839

*** WEIGHT  7 SHOULD BE POSITIVE, NOT       .000
   *** MASS ON STAGE              7  IS LOW
   *** MASS ON STAGE              9  IS HIGH
   *** SAMPLING DURATION   1.0000000      IS SHORT
REDUCE DATA FOR RUN            8
SAMPLING AT  112.7 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .68208049      1.0080095
   *** LINEAR INTERPOLATION USED BETWEEN   1.0080095      1.7972410
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5521.01
```

	15A	15B
TEST SITE	NARC	NARC
TEST DATE	31584	31584
RUN NUMBER	7	8
RUN DATE	31584	31584
START TIME	1535	1557
TOTAL MASS	2.779E+03	5.047E+03

STD.	DIAM.	CUM. % MASS < D50
4	.63	.74	15.80
5	1.00	1.13	15.93
6	1.25	1.59	16.05
7	2.50	3.87	20.56
8	6.00	11.24	39.01
9	10.00	16.08	53.53
10	15.00	25.01	65.25
11	20.00	36.81	73.36

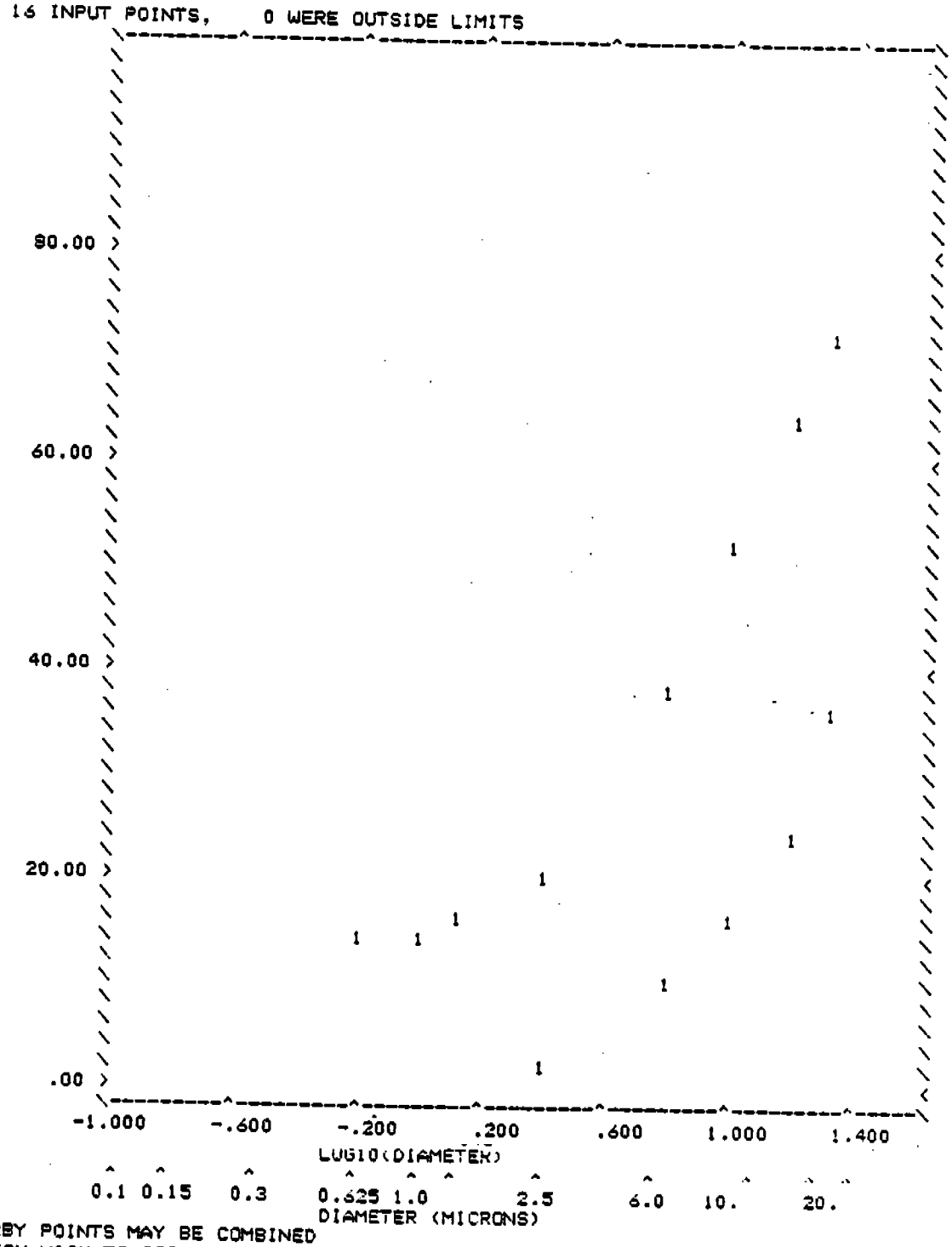
DATA COMPARISON FOR 2 OUTLET

STD. DIAM. (MICRONS)	NO. RUNS	DM/DLOGD (MG/DNCM)	CUMULATIVE MASS < D50	CUM. % MASS < D50 AVG.	STD. DEV.	MIN.	MAX.

4	.63	2	1.11E+02	4.09E+02	8.27	10.65	.74	15.80
5	1.00	2	8.17E+01	4.18E+02	8.53	10.46	1.13	15.93
6	1.25	2	1.00E+02	4.27E+02	8.82	10.22	1.59	16.05
7	2.50	2	1.08E+03	5.73E+02	12.22	11.81	3.87	20.56
8	6.00	2	1.89E+03	1.14E+03	25.12	19.64	11.24	39.01
9	10.00	2	2.03E+03	1.57E+03	34.81	26.49	16.08	53.53
10	15.00	2	2.77E+03	1.99E+03	45.13	28.45	25.01	65.25
11	20.00	2	3.08E+03	2.36E+03	55.08	25.85	36.81	73.36

DO YOU WANT TO PLOT CUM % MASS? ENTER Y OR N
>Y
COMPARISON OF CUM. % MASS FROM 2 RUNS AT STD. DIAM.

16 INPUT POINTS, 0 WERE OUTSIDE LIMITS



NEARBY POINTS MAY BE COMBINED
DO YOU WISH TO REPEAT THE COMPARISON EXCLUDING SOME RUNS? ENTER Y OR N
>

7.2 FLINT CLAY TEST RESULTS

7.2.1 PARTICULATE

PARTICULATE FIELD DATA & RESULTS TABULATION

PLANT: North American Refractories Company, Farber, Missouri

RUN	SAMPLING LOCATION	TEST TEAM LEADER
2	Cyclone Inlet	B. Dwain Ritchie
3	Cyclone Inlet	B. Dwain Ritchie
10	Cyclone Inlet	B. Dwain Ritchie

		2 (F1)	3 (F2)	10 (F3)
	RUN DATE	03/13/84	03/14/84	03/14/84
	RUN START TIME	1455	1322	1627
	RUN FINISH TIME	1653	1500	1757
	NET SAMPLING POINTS	12	12	12
Theta	NET RUN TIME, MINUTES	24.00	24.00	24.00
Dia	NOZZLE DIAMETER, INCHES	0.173	0.173	0.173
Cp	PITOT TUBE COEFFICIENT	0.840	0.840	0.840
Y	DRY GAS METER CAL. FACTOR	0.994	0.994	0.994
Pbar	BAROMETRIC PRESSURE, IN. HG.	29.40	29.50	29.50
Delta H	AVG. PRESS. DIFFERENTIAL OF ORIFICE METER, IN. H2O	0.588	0.507	0.552
Vm	VOLUME OF METERED GAS SAMPLE DRY ACTUAL CUBIC FEET	10.615	9.872	10.252
tm	DRY GAS METER TEMP., DEG. F	80	77	82
Vm(std)	VOLUME OF METERED GAS SAMPLE @ DRY STD. COND., DSCF*	10.148	9.521	9.797
Vlc	VOLUME OF WATER CATCH IN IMPINGERS & SIL. GEL.,ML	37.5	49.0	44.0
Vw(std)	VOLUME OF WATER VAPOR, SCF*	1.765	2.306	2.071
%H2O	MOISTURE, PERCENT BY VOLUME	14.8	19.5	17.5
Mfd	DRY MOLE FRACTION	0.852	0.805	0.825

(continued next page)

		2 (F1)	3 (F2)	10 (F3)
%CO2	PERCENT CO2 BY VOLUME, DRY	1.9	1.8	1.6
%O2	PERCENT O2 BY VOLUME, DRY	18.0	17.6	17.7
%CO+N2	PERCENT CO + N2 BY VOLUME, DRY	80.1	80.6	80.7
Md	DRY MOLECULAR WT, LB/LB-MOLE	29.02	28.99	28.96
Ms	WET MOLECULAR WT, LB/LB-MOLE	27.39	26.85	27.05
Ps	STACK STATIC PRESS., IN H2O	-1.0	-1.0	-1.0
Ps	ABSOLUTE STACK PRESS., IN HG	29.33	29.43	29.43
ts	STACK TEMPERATURE, DEG. F	150	153	149
Delta p	AVG VELOCITY HEAD. IN. H2O	0.8402	0.7722	0.8778
vs	STACK GAS VELOCITY, FT/SEC	57.4	55.6	58.8
A	STACK AREA, SQUARE INCHES	283.5	283.5	283.5
Qsd	STACK FLOW RATE, DRY SCFM*	4,895	4,476	4,891
Qaw	STACK FLOW RATE, WET ACFM	6,776	6,566	6,952
%I	PERCENT ISOKINETIC	104.0	106.8	100.5
	METHOD 5 RESULTS (ENGLISH):			
mg	CATCH, MILLIGRAMS	24,185.8	14,582.4	24,352.0
gr/DSCF	CONCEN., GRAINS/DSCF*	36.78	23.64	38.36
lb/hr	EMISSIONS, POUNDS/HOUR	1,543.1	906.8	1,608.2
	METHOD 5 RESULTS (METRIC):			
mg/DSCM	CONCEN., MILLIGRAMS/DSCM*	84,156.3	54,082.1	87,770.4
kg/hr	EMISSIONS, KILOGRAMS/HOUR	699.9	411.3	729.5

* 68 Deg. F - 29.92 in. Hg.

PARTICULATE FIELD DATA & RESULTS TABULATION

PLANT: North American Refractories Company, Farber, Missouri

RUN	SAMPLING LOCATION	TEST TEAM LEADER
5	Scrubber Inlet	Willis S. Nesbit
6	Scrubber Inlet	Willis S. Nesbit
13	Scrubber Inlet	Willis S. Nesbit

		5 (F1)	6 (F2)	13 (F3)
	RUN DATE	03/13/84	03/14/84	03/14/84
	RUN START TIME	1444	1315	1715
	RUN FINISH TIME	1638	1520	1804
	NET SAMPLING POINTS	25	25	20
Theta	NET RUN TIME, MINUTES	62.50	62.50	40.00
Dia	NOZZLE DIAMETER, INCHES	0.178	0.178	0.178
Cp	PITOT TUBE COEFFICIENT	0.840	0.840	0.840
Y	DRY GAS METER CAL. FACTOR	0.992	0.992	0.992
Pbar	BAROMETRIC PRESSURE, IN. HG.	29.40	29.50	29.50
Delta H	AVG. PRESS. DIFFERENTIAL OF ORIFICE METER, IN. H2O	0.491	0.479	0.522
Vm	VOLUME OF METERED GAS SAMPLE DRY ACTUAL CUBIC FEET	26.420	25.943	17.287
tm	DRY GAS METER TEMP., DEG. F	72	72	79
Vm(std)	VOLUME OF METERED GAS SAMPLE @ DRY STD. COND., DSCF*	25.581	25.203	16.578
Vlc	VOLUME OF WATER CATCH IN IMPINGERS & SIL. GEL.,ML	111.5	123.0	79.0
Vw(std)	VOLUME OF WATER VAPOR, SCF*	5.248	5.790	3.719
%H2O	MOISTURE, PERCENT BY VOLUME	17.0	18.7	18.3
Mfd	DRY MOLE FRACTION	0.830	0.813	0.817

(continued next page)

		5 (F1)	6 (F2)	13 (F3)
%CO2	PERCENT CO2 BY VOLUME, DRY	1.9	1.8	1.6
%O2	PERCENT O2 BY VOLUME, DRY	18.0	17.6	17.7
%CO+N2	PERCENT CO + N2 BY VOLUME, DRY	80.1	80.6	80.7
Md	DRY MOLECULAR WT, LB/LB-MOLE	29.02	28.99	28.96
Ms	WET MOLECULAR WT, LB/LB-MOLE	27.15	26.94	26.96
Pg	STACK STATIC PRESS., IN H2O	-4.4	-4.2	-5.2
Ps	ABSOLUTE STACK PRESS., IN HG	29.08	29.19	29.12
ts	STACK TEMPERATURE, DEG. F	136	140	145
Delta P	AVG VELOCITY HEAD. IN. H2O	0.7299	0.7323	0.8226
vs	STACK GAS VELOCITY, FT/SEC	53.3	53.7	57.2
A	STACK AREA, SQUARE INCHES	425.0	425.0	425.0
Qsd	STACK FLOW RATE, DRY SCFM*	6,741	6,634	7,022
Qaw	STACK FLOW RATE, WET ACFM	9,440	9,506	10,126
%I	PERCENT ISOKINETIC	103.6	103.7	100.7
	METHOD 5 RESULTS (ENGLISH):			
mg	CATCH, MILLIGRAMS	5,006.4	4,133.0	6,870.3
gr/DSCF	CONCEN., GRAINS/DSCF*	3.02	2.53	6.40
lb/hr	EMISSIONS, POUNDS/HOUR	174.5	143.9	384.9
	METHOD 5 RESULTS (METRIC):			
mg/DSCM	CONCEN., MILLIGRAMS/DSCM*	6,910.6	5,790.6	14,633.6
kg/hr	EMISSIONS, KILOGRAMS/HOUR	79.2	65.3	174.6

* 68 Deg. F - 29.92 in. Hg.

PARTICULATE FIELD DATA & RESULTS TABULATION

PLANT: North American Refractories Company, Farber, Missouri

RUN	SAMPLING LOCATION	TEST TEAM LEADER
8	Scrubber Outlet	John J. Maxwell
9	Scrubber Outlet	John J. Maxwell
16	Scrubber Outlet Stack	John J. Maxwell

		8 (F1)	9 (F2)	16 (F3)
	RUN DATE	03/13/84	03/14/84	03/14/84
	RUN START TIME	1450	1315	1610
	RUN FINISH TIME	1730	1550	1801
	NET SAMPLING POINTS	25	25	25
Theta	NET RUN TIME, MINUTES	111.85	100.00	75.00
Dia	NOZZLE DIAMETER, INCHES	0.177	0.177	0.177
Cp	PITOT TUBE COEFFICIENT	0.840	0.840	0.840
Y	DRY GAS METER CAL. FACTOR	0.994	0.994	0.994
Pbar	BAROMETRIC PRESSURE, IN. HG.	29.40	29.50	29.40
Delta H	AVG. PRESS. DIFFERENTIAL OF ORIFICE METER, IN. H2O	1.197	1.098	1.237
Vm	VOLUME OF METERED GAS SAMPLE DRY ACTUAL CUBIC FEET	74.910	64.414	51.165
tm	DRY GAS METER TEMP., DEG. F	112	109	107
Vm(std)	VOLUME OF METERED GAS SAMPLE @ DRY STD. COND., DSCF*	67.713	58.717	46.662
Vlc	VOLUME OF WATER CATCH IN IMPINGERS & SIL. GEL.,ML	241.5	203.5	180.5
Vw(std)	VOLUME OF WATER VAPOR, SCF*	11.367	9.579	8.496
%H2O	MOISTURE, PERCENT BY VOLUME	14.4	14.0	15.4
Mfd	DRY MOLE FRACTION	0.856	0.860	0.846

(continued next page)

		8 (F1)	9 (F2)	16 (F3)
%CO2	PERCENT CO2 BY VOLUME, DRY	1.4	1.4	1.8
%O2	PERCENT O2 BY VOLUME, DRY	18.7	18.0	18.0
%CO+N2	PERCENT CO + N2 BY VOLUME, DRY	79.9	80.6	80.2
Md	DRY MOLECULAR WT, LB/LB-MOLE	28.97	28.94	29.01
Ms	WET MOLECULAR WT, LB/LB-MOLE	27.39	26.41	27.31
Ps	STACK STATIC PRESS., IN H2O	0.30	0.20	0.40
Ps	ABSOLUTE STACK PRESS., IN HG	29.42	29.52	29.43
ts	STACK TEMPERATURE, DEG. F	134	132	133
Delta p	AVG VELOCITY HEAD. IN. H2O	1.3900	1.3010	1.4580
vs	STACK GAS VELOCITY, FT/SEC	72.7	70.1	74.5
A	STACK AREA, SQUARE INCHES	351.5	351.5	351.5
Qsd	STACK FLOW RATE, DRY SCFM*	7,964	7,759	8,078
Qaw	STACK FLOW RATE, WET ACFM	10,645	10,262	10,909
%I	PERCENT ISOKINETIC	108.5	108.0	109.9
	METHOD 5 RESULTS (ENGLISH):			
ms	CATCH, MILLIGRAMS	130.4	149.4	138.8
gr/DSCF	CONCEN., GRAINS/DSCF*	0.030	0.039	0.046
lb/hr	EMISSIONS, POUNDS/HOUR	2.03	2.61	3.18
	METHOD 5 RESULTS (METRIC):			
mg/DSCM	CONCEN., MILLIGRAMS/DSCM*	68.0	89.8	105.0
kg/hr	EMISSIONS, KILOGRAMS/HOUR	0.921	1.18	1.44

* 68 Deg. F - 29.92 in. Hg.

APPENDIX 7.2.2

PARTICLE SIZING

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 2-A

PLANT: North American Refractories Company, Farber, Missouri

SAMPLING LOCATION: Cyclone Inlet DATE: 0313 4

	START-FINISH TIME:	1505-1505		VOLUME METERED, ACF:	0.5 2
SR)	SAMPLING RATE, ACFM	1.485		NOZZLE DIA., INCHES:	0.188
ST)	SAMPLING TIME, MINUTES:	0.50	Y)	METER CAL. FACTOR:	0.9 4
PB)	BARO. PRESS., IN.HG.:	29.40	TM)	METER TEMP., DEG F:	75
PSI)	STATIC PRESS., IN. H2O:	-1.00	DH)	DELTA H AVG., IN. H2O:	0. 4
TS)	STACK GAS TEMP., DEG F:	143	DEN)	PARTICLE DENSITY, GM/CC:	1. 3
PMV)	MOISTURE % BY VOLUME:	14.8	VCF)	VISCOSITY CORR. FACTOR:	1.048
DCF)	DENSITY CORR. FACTOR:	1.000	MD)	MOL WT, DRY LB/LB-MOLE:	29. 2
	ISOKINETICS, %	209.2		CONCENT., GR/DSCF:	0.5547

STAGE NO.	PARTICLE DIAMETER (microns) FROM GRAPH	PARTICLE DIAMETER (microns) AERODYNAMIC	CATCH WEIGHT (mgms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
0	7.82	8.20	2.45	12.6	87.5
1	4.96	5.20	3.60	18.5	69.0
2	3.28	3.44	4.80	24.6	44.4
3	2.27	2.38	3.70	19.0	25.4
4	1.45	1.52	2.42	12.4	13.0
5	0.73	0.77	0.90	4.6	8.4
6	0.44	0.46	0.31	1.6	6.8
7	0.29	0.30	0.80	4.1	2.7
FILTER	< 0.29	< 0.30	0.53	2.7	

TOTAL CATCH 19.51

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 2B

PLANT: North American Refractories Company, Farber, Missouri

SAMPLING LOCATION: Cyclone Inlet DATE: 031384

	START-FINISH TIME:	1730-1732		VOLUME METERED, ACF:	1.090
SR)	SAMPLING RATE, ACFM	0.729		NOZZLE DIA., INCHES:	0.188
ST)	SAMPLING TIME, MINUTES:	2.00	Y)	METER CAL. FACTOR:	0.994
PB)	BARO. PRESS.,IN.HG.:	29.40	TM)	METER TEMP., DEG F:	71
PSI)	STATIC PRESS., IN. H2O:	-1.00	DH)	DELTA H AVG., IN. H2O:	0.86
TS)	STACK GAS TEMP., DEG F:	146	DEN)	PARTICLE DENSITY, GM/CC:	1.00
PMV)	MOISTURE % BY VOLUME:	14.8	VCF)	VISCOSITY CORR. FACTOR:	1.049
DCF)	DENSITY CORR. FACTOR:	1.000	MD)	MOL WT, DRY LB/LB-MOLE:	29.02
	ISOKINETICS, %	102.8		CONCENT., GR/DSCF:	8.1168

STAGE NO.	PARTICLE DIAMETER (microns) FROM GRAPH	PARTICLE DIAMETER (microns) AERODYNAMIC	CATCH WEIGHT (mgms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
PreSep	9.90	10.39	89.20	16.0	84.1
PreImp	8.62	9.04	276.26	49.5	34.6
1	5.65	5.93	68.53	12.3	22.3
2	3.62	3.80	53.40	9.6	12.7
3	2.33	2.44	45.13	8.1	4.6
4	1.38	1.45	17.67	3.2	1.4
5	0.92	0.97	6.10	1.1	0.3
6	0.57	0.60	0.85	0.2	0.1
7	0.33	0.35	0.18	0.0	0.1
FILTER	< 0.33	< 0.35	0.45	0.1	

TOTAL CATCH 557.77

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 3A

PLANT: North American Refractories Company, Farber, Missouri

SAMPLING LOCATION: Cyclone Inlet

DATE: 0314

	START-FINISH TIME:	1527-1527		VOLUME METERED, ACF:	0.39
SR)	SAMPLING RATE, ACFM	0.732		NOZZLE DIA., INCHES:	0.
ST)	SAMPLING TIME, MINUTES:	0.75	Y)	METER CAL. FACTOR:	0.99
PB)	BARO. PRESS., IN.HG.:	29.50	TM)	METER TEMP., DEG F:	
PSI)	STATIC PRESS., IN. H2O:	-1.00	DH)	DELTA H AVG., IN. H2O:	0.
TS)	STACK GAS TEMP., DEG F:	144	DEN)	PARTICLE DENSITY, GM/CC:	1.0
PMV)	MOISTURE % BY VOLUME:	19.5	VCF)	VISCOSITY CORR. FACTOR:	1.
DCF)	DENSITY CORR. FACTOR:	1.000	MD)	MOL WT, DRY LB/LB-MOLE:	2
	ISOKINETICS, %	105.4		CONCENT., GR/DSCF:	25.39

STAGE NO.	PARTICLE DIAMETER (microns) FROM GRAPH	AERODYNAMIC	CATCH WEIGHT (mgms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
PreSep	9.88	10.35	598.90	95.9	4.0
0	11.24	11.78	3.29	0.5	3.5
1	7.06	7.40	5.64	0.9	2.6
2	4.71	4.94	6.58	1.1	1.5
3	3.26	3.42	5.24	0.8	0.7
4	2.06	2.16	3.54	0.6	0.1
5	1.05	1.10	0.83	0.1	0.0
6	0.64	0.67	0.25	0.0	0.0
7	0.43	0.45	0.22	0.0	0.0
FILTER	< 0.43	< 0.45	0.17	0.0	

TOTAL CATCH 624.66

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 10A

PLANT: North American Refractories Company, Farber, Missouri

SAMPLING LOCATION: Cyclone Inlet DATE: 031484

	START-FINISH TIME:	1736-1736		VOLUME METERED, ACF:	0.441
SR)	SAMPLING RATE, ACFM	0.801		NOZZLE DIA., INCHES:	0.188
ST)	SAMPLING TIME, MINUTES:	0.75	Y)	METER CAL. FACTOR:	0.994
PB)	BARO. PRESS., IN.HG.:	29.50	TM)	METER TEMP., DEG F:	82
PSI)	STATIC PRESS., IN. H2O:	-1.00	DH)	DELTA H AVG., IN. H2O:	0.94
TS)	STACK GAS TEMP., DEG F:	150	DEN)	PARTICLE DENSITY, GM/CC:	1.00
PMV)	MOISTURE % BY VOLUME:	17.5	VCF)	VISCOSITY CORR. FACTOR:	1.052
DCF)	DENSITY CORR. FACTOR:	1.000	MD)	MOL WT, DRY LB/LB-MOLE:	28.96
	ISOKINETICS, %	107.3		CONCENT., GR/DSCF:	25.4111

STAGE NO.	- PARTICLE DIAMETER - (microns) FROM GRAPH	AERODYNAMIC	CATCH WEIGHT (mgms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
PreSep	9.42	9.91	531.30	76.5	23.5
0	10.73	11.29	45.03	6.5	17.0
1	6.75	7.10	29.14	4.2	12.8
2	4.50	4.73	30.55	4.4	8.4
3	3.11	3.27	26.01	3.7	4.7
4	1.97	2.07	17.85	2.6	2.1
5	1.01	1.06	11.43	1.6	0.5
6	0.61	0.64	2.39	0.3	0.2
7	0.41	0.43	0.50	0.1	0.1
FILTER	< 0.41	< 0.43	0.43	0.1	

TOTAL CATCH 694.63

```
ENTER TEST DATE, IDATE, (MMDDYY)
>031384

DO YOU WISH TO REVIEW ALL RUNS IN A TEST?  ENTER Y OR N?
>N

 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>2
THE TGLD AERODYNAMIC DIAM. WILL BE USED
 DO YOU WANT STATISTICS FOR 1=DM/DLOGD, 2=CUM. MASS, OR 3=CUM. % MASS?
>3
THE STD.DEV., MINIMUM, AND MAXIMUM OF THE CUM. % MASS WILL BE PRINTED
ENTER THE NO. OF STD. DEV. TO BE USED TO IDENTIFY POTENTIAL OUTLIERS.
>3
ENTER INDICES OF RUNS TO BE COMPARED SEPARATED BY BLANKS OR
   ENTER IN TO COMPARE ALL INLET RUNS IN THE TEST OR
   ENTER OUT TO COMPARE ALL OUTLET RUNS IN THE TEST
>2 3 7

*FTN ERROR   SUBPROGRAM BSORT          ARGUMENT LIST DOESN'T MATCH CALLER
BSORT  REFERENCED AT LN.   143  OF  COMPAR
FOLLOWING ARGUMENT TYPES DO NOT MATCH:
ARGUMENT NO. 01, CALLERS TYPE: INTEGER     SUBPROGRAMS TYPE: REAL*4

   *** MASS ON STAGE              1  IS HIGH
   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            2
SAMPLING AT  103.0 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .41181790      .71074441
   *** LINEAR INTERPOLATION USED BETWEEN   .71074441      1.0491081
   *** LINEAR INTERPOLATION USED BETWEEN   1.0491081      1.8686019
   *** LINEAR INTERPOLATION USED BETWEEN   3.6084235      5.5903736
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5202.71

   *** SAMPLING DURATION   .75000000      IS SHORT
REDUCE DATA FOR RUN            3
SAMPLING AT  105.7 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .92315032      1.9158944
   *** LINEAR INTERPOLATION USED BETWEEN   5.1920763      10.350000

   *** MASS ON STAGE              1  IS HIGH
   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** MASS ON STAGE              6  IS HIGH
   *** SAMPLING DURATION   .75000000      IS SHORT
REDUCE DATA FOR RUN            7
SAMPLING AT  107.5 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .27666961      .53711031
```

2A, 2B,
3A, 10A

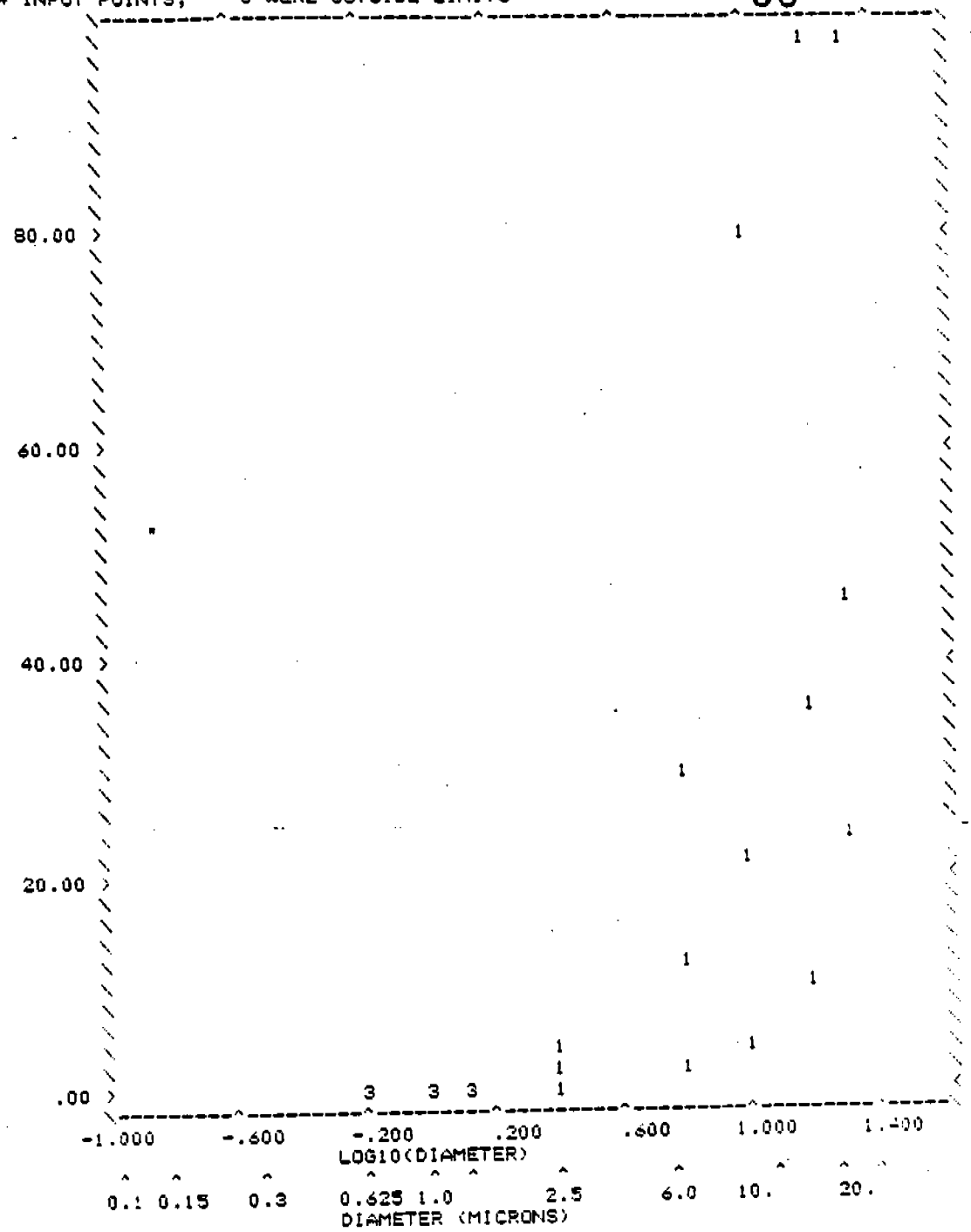
TEST DATA			
RUN NUMBER	2	3	7
RUN DATE	31384	31484	31484
START TIME	1730	1527	1736
TOTAL MASS	1.851E+04	5.798E+04	5.795E+04

STD.	DIAM.	CUM. % MASS < D50		
4	.63	.11	.07	.17
5	1.00	.25	.12	.63
6	1.25	.60	.16	1.04
7	2.50	5.88	.39	3.01
8	6.00	30.49	2.16	12.11
9	10.00	80.91	4.00	23.71
10	15.00	99.79	11.92	36.17
11	20.00	100.00	24.88	47.91

DATA COMPARISON FOR 3 INLET RUNS BY ENT

STD. DIAM. (MICRONS)		NO. RUNS	DM/DLOGD (MG/DNCM)	CUMULATIVE MASS < D50	CUM. % MASS < D50 AVG.	STD. DEV.	MIN.	MAX.
4	.63	3	2.29E+02	5.26E+01	.11	.05	.07	.17
5	1.00	3	8.43E+02	1.60E+02	.33	.27	.12	.63
6	1.25	3	1.32E+03	2.68E+02	.60	.44	.16	1.04
7	2.50	3	4.74E+03	1.02E+03	3.09	2.74	.39	5.88
8	6.00	3	2.54E+04	4.64E+03	14.92	14.37	2.16	30.49
9	10.00	3	2.50E+04	1.03E+04	36.21	39.95	4.00	80.91
10	15.00	3	3.37E+04	1.54E+04	49.29	45.38	11.92	99.79
11	20.00	2	4.25E+04	2.02E+04	57.60	38.49	24.88	100.00

24 INPUT POINTS, 0 WERE OUTSIDE LIMITS



NEARBY POINTS MAY BE COMBINED

```
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>2
THE TGLD AERODYNAMIC DIAM. WILL BE USED
ENTER INDICES OF RUNS TO BE USED, SEPARATED BY BLANKS, OR
ENTER 0 (ZERO) TO USE ALL RUNS IN THE TEST
>2 3 7

*FTN ERROR   SUBPROGRAM BSORT          ARGUMENT LIST DOESN'T MATCH CALLER
BSORT  REFERENCED AT LN.   120  OF  PENEFF
FOLLOWING ARGUMENT TYPES DO NOT MATCH:
ARGUMENT NO. 01, CALLERS TYPE: INTEGER     SUBPROGRAMS TYPE: REAL*4

   *** MASS ON STAGE            1  IS HIGH
   *** MASS ON STAGE            2  IS HIGH
   *** MASS ON STAGE            3  IS HIGH
   *** MASS ON STAGE            4  IS HIGH
   *** MASS ON STAGE            5  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            2
SAMPLING AT  103.0 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .41181790      .71074441
   *** LINEAR INTERPOLATION USED BETWEEN   .71074441      1.0491081
   *** LINEAR INTERPOLATION USED BETWEEN   1.0491081      1.8686019
   *** LINEAR INTERPOLATION USED BETWEEN   3.6084285      5.5903736
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5202.71

   *** SAMPLING DURATION   .75000000      IS SHORT
REDUCE DATA FOR RUN            3
SAMPLING AT  105.7 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .92315032      1.9158944
   *** LINEAR INTERPOLATION USED BETWEEN   5.1920763      10.350000

   *** MASS ON STAGE            1  IS HIGH
   *** MASS ON STAGE            2  IS HIGH
   *** MASS ON STAGE            3  IS HIGH
   *** MASS ON STAGE            4  IS HIGH
   *** MASS ON STAGE            5  IS HIGH
   *** MASS ON STAGE            6  IS HIGH
   *** SAMPLING DURATION   .75000000      IS SHORT
REDUCE DATA FOR RUN            7
SAMPLING AT  107.5 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .27666961      .53711081
  STD. DIAM.  PENETR.    ERR.   EFFICIENCY   ERR.
*** NO OUTLET RUN IN THIS TEST
```

Run No 2A + 2B

```
DO YOU WISH TO REVIEW ALL RUNS IN A TEST?  ENTER Y OR N?
>N

 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>2
THE TGLD AERODYNAMIC DIAM. WILL BE USED
 DO YOU WANT STATISTICS FOR 1=DM/DLOGD, 2=CUM. MASS, OR 3=CUM. % MASS?
>3
THE STD.DEV., MINIMUM, AND MAXIMUM OF THE CUM. % MASS WILL BE PRINTED
ENTER THE NO. OF STD. DEV. TO BE USED TO IDENTIFY POTENTIAL OUTLIERS.
>3
ENTER INDICES OF RUNS TO BE COMPARED SEPARATED BY BLANKS OR
   ENTER IN TO COMPARE ALL INLET RUNS IN THE TEST OR
   ENTER OUT TO COMPARE ALL OUTLET RUNS IN THE TEST
>1 2

*FTN ERROR   SUBPROGRAM BSORT           ARGUMENT LIST DOESN'T MATCH CALLER
BSORT  REFERENCED AT LN.   143  OF  COMPAR
FOLLOWING ARGUMENT TYPES DO NOT MATCH:
ARGUMENT NO. 01, CALLERS TYPE: INTEGER     SUBPROGRAMS TYPE: REAL*4

   *** MASS ON CYCLONE IS LOW
   *** SAMPLING DURATION   .50000000      IS SHORT
REDUCE DATA FOR RUN            1
SAMPLING AT  209.4 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .62982725      1.3337681
   *** JET VELOCITY > 5000 CM/SEC
STAGE        7       8
VALUE  5271.88 9074.92

   *** MASS ON STAGE              1  IS HIGH
   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            2
SAMPLING AT  103.0 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .41181790      .71074441
   *** LINEAR INTERPOLATION USED BETWEEN   .71074441      1.0491081
   *** LINEAR INTERPOLATION USED BETWEEN   1.0491081      1.8686019
   *** LINEAR INTERPOLATION USED BETWEEN   3.6084285      5.5903736
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5202.71
```

	2A	2B
TEST SITE	NARC	NARC
TEST DATE	31384	31384
RUN NUMBER	1	2
RUN DATE	31384	31384
START TIME	1505	1730
TOTAL MASS	1.266E+03	1.851E+04

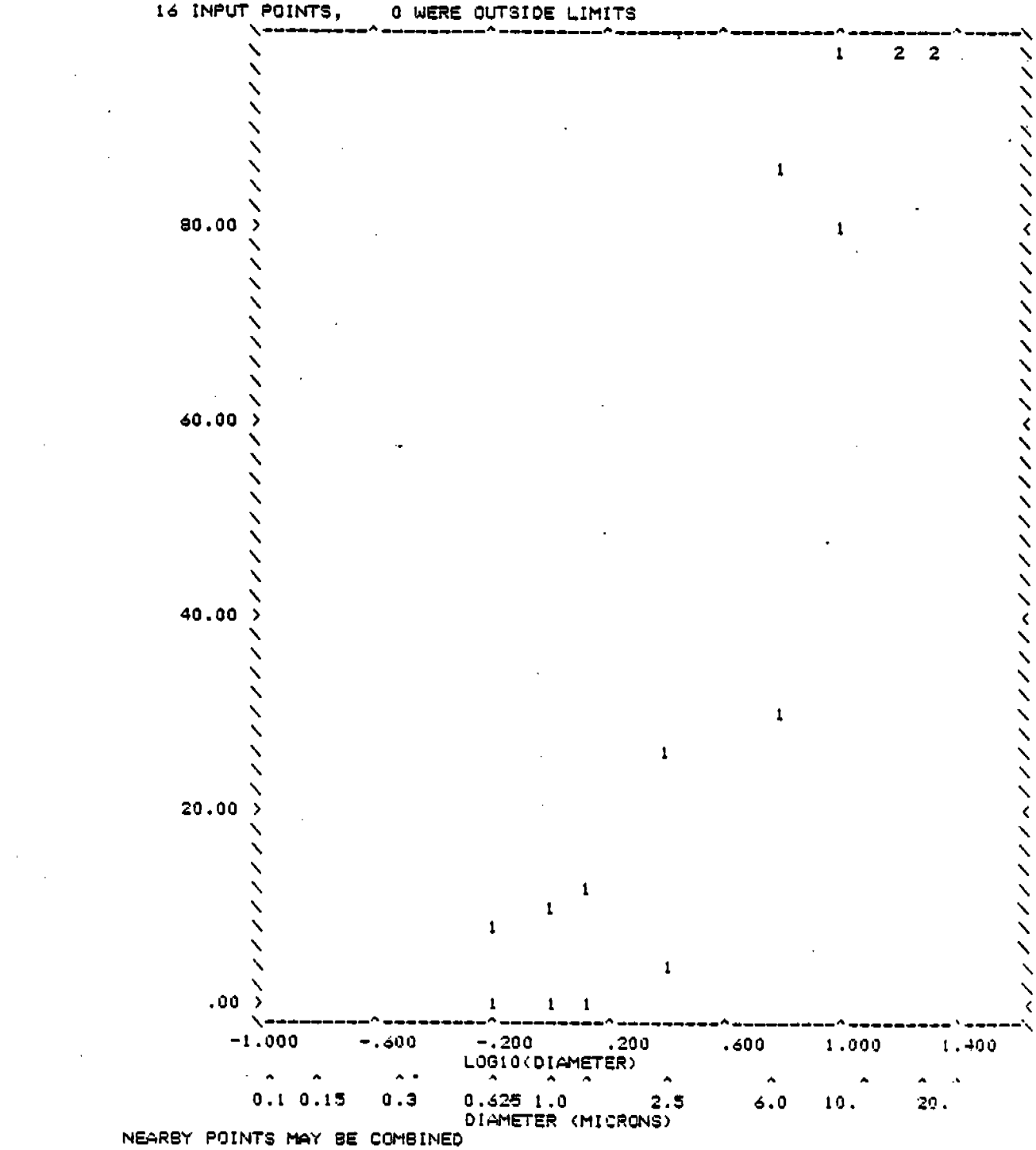
STD.	DIAM.	CUM. % MASS	< D50
4	.63	8.37	.11
5	1.00	11.24	.25
6	1.25	12.61	.60
7	2.50	26.34	5.88
8	6.00	87.58	30.49
9	10.00	100.00	80.91
10	15.00	100.00	99.79

DATA COMPARISON FOR 2 INLET RUNS BY ENT

STD. DIAM. (MICRONS)		NO. RUNS	DM/DLOGD (MG/DNCM)	CUMULATIVE MASS < D50	CUM. % MASS < D50 AVG.	STD. DEV.	MIN.	MAX.
4	.63	2	8.57E+01	6.27E+01	4.24	5.84	.11	8.37
5	1.00	2	2.53E+02	9.40E+01	5.74	7.78	.25	11.24
6	1.25	2	4.93E+02	1.35E+02	6.61	8.50	.60	12.61
7	2.50	2	4.10E+03	7.10E+02	16.11	14.47	5.88	26.34
8	6.00	2	2.29E+04	3.38E+03	59.04	40.37	30.49	87.58
9	10.00	1	1.82E+04	8.12E+03	90.45	13.50	80.91	100.00
10	15.00	1	1.47E+03	9.87E+03	99.89	.15	99.79	100.00
11	20.00	0	.00	9.89E+03	100.00	.00	100.00	100.00

DO YOU WANT TO PLOT CUM % MASS? ENTER Y OR N
>Y
COMPARISON OF CUM. % MASS FROM 2 RUNS AT STD. DIAM.

16 INPUT POINTS, 0 WERE OUTSIDE LIMITS

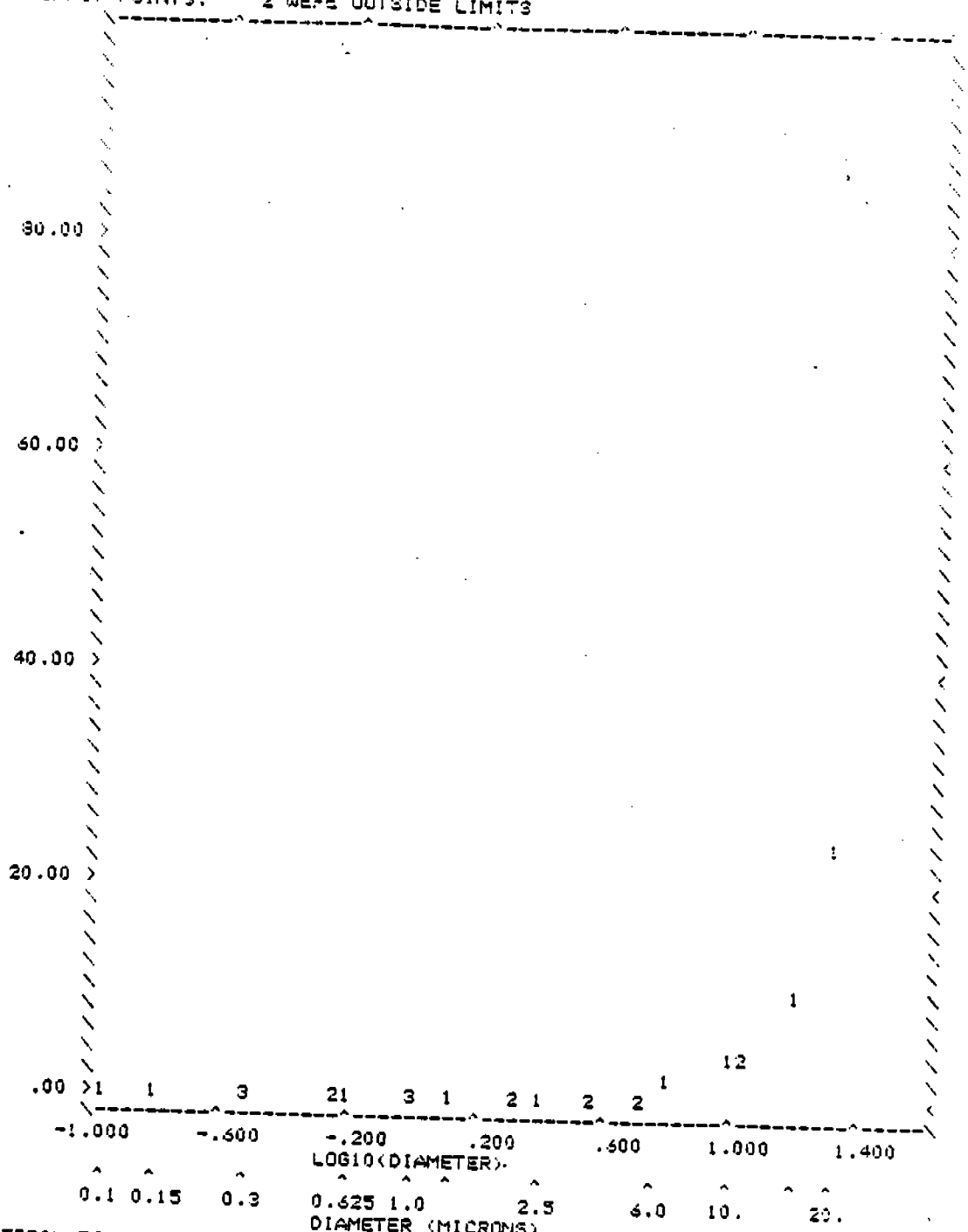


NEARBY POINTS MAY BE COMBINED
DO YOU WISH TO REPEAT THE COMPARISON EXCLUDING SOME RUNS? ENTER Y OR N
>

Run No. 3A

```
NARC
ENTER TEST DATE, IDATE (MMDDYY)
>031384
ENTER THE RUN NUMBER, IRUN
>3
   *** SAMPLING DURATION    .75000000       IS SHORT

DO YOU WISH TO LIST THE DATA FOR RUN? ENTER Y OR N
>N

DO YOU WISH TO MODIFY ANY RUN CONDITIONS?  ENTER Y OR N
>N
WANT TO RETRIEVE ANOTHER RUN?  ENTER Y OR N
>N

DO YOU WISH TO TO REDUCE THE DATA? ENTER Y OR N
>Y



 PARTICULATE DATA REDUCTION AND ENTRY SYSTEM      06/18/84          08:51:50
DATA FOR TEST BY CONTRACTOR ENT , AT SITE NARC, ON DATE  31384, RUN NO.  3 (3)
SAMPLING AT  105.7 % OF ISOKINETIC RATE
WANT TO SEE RESULTS USING CLASSICAL (STOKES) DEF. OF DIAM.?  ENTER Y OR N
>N
   *** LINEAR INTERPOLATION USED BETWEEN    .92315032       1.9158944
   *** LINEAR INTERPOLATION USED BETWEEN    5.1920763       10.350000
WANT TO SEE RESULTS USING THE TGLD DEF. OF AERO. DIAM.?  ENTER Y OR N
>Y

ANDERSEN 3A, Cyclone Inlet
TOTAL MASS  1.7559+001  2.5288+001  4.0181+004  5.7868+004       DMAX= 100.0
              GR/ACF       GR/DNCF      MG/ACM      MG/DNCM              MICRONS

 STAGE       MASS       MASS    CUM. MASS       D50     GEO. MEAN DM/DLOGD  DN/DLO
             (MG)    (MG/DNCM)  (MG/DNCM)   (MICRONS)  (MICRONS)  (MG/DNCM)  (NO/DNCM)
CYCLONE    598.90   55481.44    2386.38       10.35      32.17    5.63+004   3.23+009
    1        3.29     304.78    2081.60        8.83       9.56    4.43+003   9.68+00
    2        5.64     522.48    1559.11        7.80       8.30    9.66+003   3.23+01
    3        6.58     609.56     949.55        5.19       6.36    3.45+003   2.56+010
    4        5.24     485.43     464.12        3.46       4.24    2.76+003   6.92+010
    5        3.54     327.94     136.18        1.92       2.58    1.29+003   1.42+01
    6         .83      76.89      59.29         .92       1.33    2.42+002   1.97+01
    7         .25      23.16      36.13         .56        .72    1.07+002   5.49+01
    8         .22      20.38      15.75         .29        .40    7.16+001   2.06+012
FILTER        .17      15.75                                .21    5.23+001   1.14+013
   *** CUT POINTS FOR STAGES  0  1 ARE SIMILAR OR INVERTED
       MEASURED DATA FOR STAGE,  1 WITH D50=    8.83 OMITTED FROM INTERPOLATIO
   *** CUT POINTS FOR STAGES  1  2 ARE SIMILAR OR INVERTED
       MEASURED DATA FOR STAGE,  2 WITH D50=    7.80 OMITTED FROM INTERPOLATION
   *** LINEAR INTERPOLATION USED BETWEEN    .92315032       1.9158944
   *** LINEAR INTERPOLATION USED BETWEEN    5.1920763       10.350000
INTERPOLATED TO STD. INTERVALS: (VALUES AT DIAM. MARKED WITH * ARE EXTRAPOLATED)
                                 16.38        .30                .00
                                 39.12        .63               7.61+001
                                 67.71       1.00               2.36+002
                                 91.21       1.25               2.42+002
                                227.32       2.50               1.19+003
                               1250.78       6.00               4.80+003
                               2314.73      10.00               6.14+003
                               6895.82      15.00*              4.81+004
                              14398.29      20.00*              6.99+004
WANT TO PLOT CUM. % MASS?  ENTER Y OR N
```

27 INPUT POINTS. 2 WERE OUTSIDE LIMITS



1 INTERPOLATED POINTS 2 MEASURED POINTS 3 NEARBY POINTS

WANT TO SEE RESULTS USING MERCERS DEF. OF AERO. DIAM.? ENTER Y OR N.

>

Run No. 10A

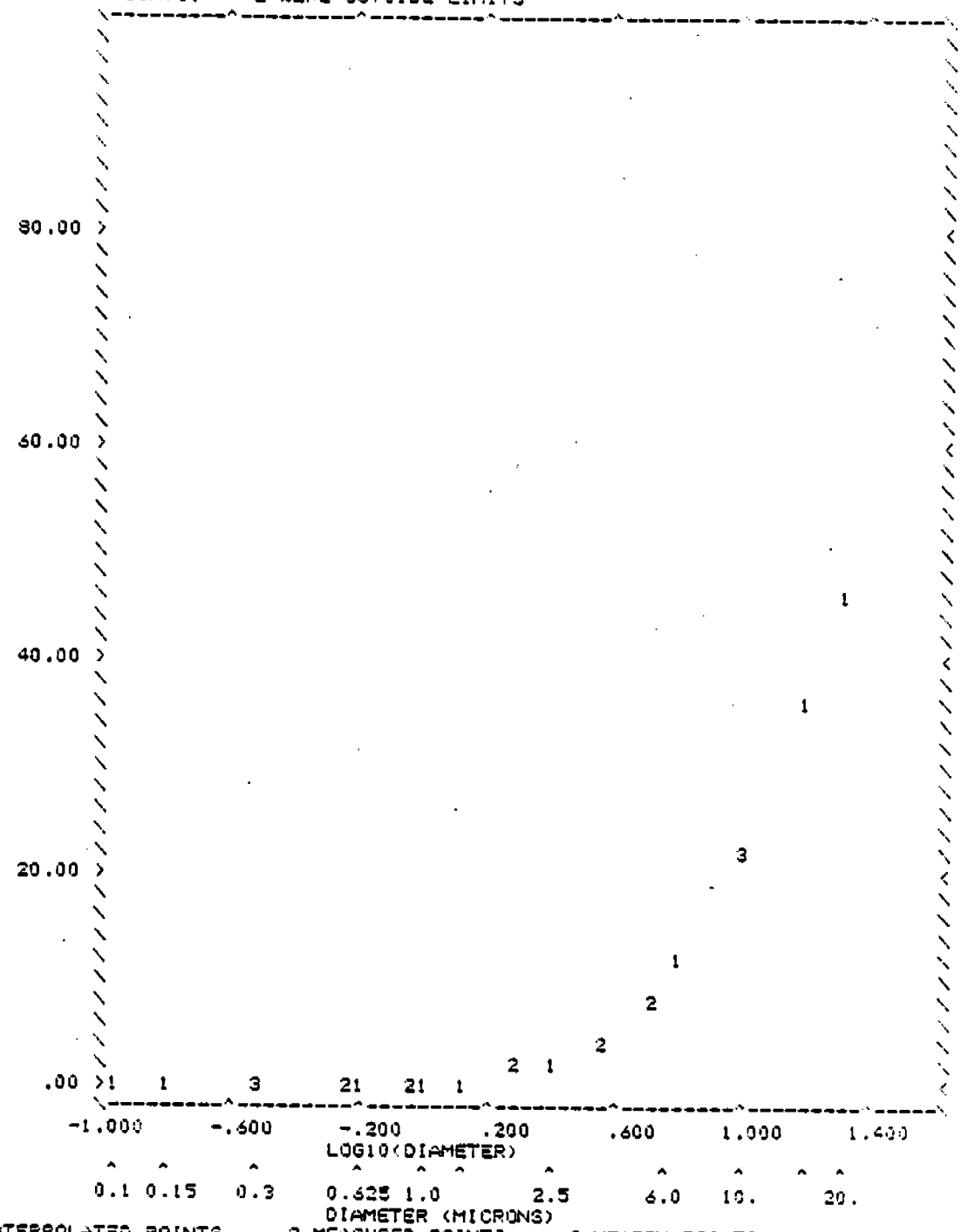
```
@ARC
TER TEST DATE, IDATE (MMDDYY)
>031384
ENTER THE RUN NUMBER, IRUN
>7
   *** MASS ON STAGE              1  IS HIGH
   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** MASS ON STAGE              6  IS HIGH
   *** SAMPLING DURATION    .75000000      IS SHORT

DO YOU WISH TO LIST THE DATA FOR RUN? ENTER Y OR N
>N

DO YOU WISH TO MODIFY ANY RUN CONDITIONS?  ENTER Y OR N
>N
WANT TO RETRIEVE ANOTHER RUN?  ENTER Y OR N
>N

DO YOU WISH TO TO REDUCE THE DATA? ENTER Y OR N
>Y
```

```
 PARTICULATE DATA REDUCTION AND ENTRY SYSTEM      06/18/84          09:13:26 (10A)
DATA FOR TEST BY CONTRACTOR ENT , AT SITE NARC, ON DATE  31384, RUN NO.  7
SAMPLING AT  107.5 % OF ISOKINETIC RATE
WANT TO SEE RESULTS USING CLASSICAL (STOKES) DEF. OF DIAM.?  ENTER Y OR N
>N
   *** LINEAR INTERPOLATION USED BETWEEN    .27666961       .53711081
WANT TO SEE RESULTS USING THE TGLD DEF. OF AERO. DIAM.?  ENTER Y OR N
>Y

ANDERSEN 10A, Cyclone Inlet
TOTAL MASS  1.7844+001  2.5325+001  4.0833+004  5.7951+004      DMAX= 100.0
              GR/ACF      GR/DNCF     MG/ACM      MG/DNCM            MICRONS
```

STAGE	MASS (MG)	MASS (MG/DNCM)	CUM. MASS (MG/DNCM)	D50 (MICRONS)	GEO. MEAN (MICRONS)	DM/DLOGD (MG/DNCM)	DN/DLOGD (NO/DNCM)
CYCLONE	531.30	44325.22	13626.27	9.91	31.48	4.42+004	2.70+009
1	45.03	3756.76	9869.51	8.51	9.19	5.70+004	1.40+011
2	29.14	2431.09	7438.43	7.52	8.00	4.49+004	1.67+011
3	30.55	2548.72	4889.71	5.00	6.13	1.44+004	1.19+011
4	26.01	2169.96	2719.75	3.34	4.09	1.23+004	3.45+011
5	17.85	1489.19	1230.56	1.84	2.48	5.78+003	7.24+011
6	11.43	953.58	276.98	.89	1.28	3.00+003	2.74+012
7	2.39	199.39	77.59	.54	.69	9.18+002	5.34+012
8	.50	41.71	35.87	.28	.39	1.45+002	4.83+012
FILTER	.43	35.87			.20	1.19+002	3.04+013

```
   *** CUT POINTS FOR STAGES  0  1 ARE SIMILAR OR INVERTED
       MEASURED DATA FOR STAGE,  1 WITH D50=    8.51 OMITTED FROM INTERPOLATION
   *** CUT POINTS FOR STAGES  1  2 ARE SIMILAR OR INVERTED
       MEASURED DATA FOR STAGE,  2 WITH D50=    7.52 OMITTED FROM INTERPOLATION
   *** LINEAR INTERPOLATION USED BETWEEN    .27666961       .53711081
INTERPOLATED TO STD. INTERVALS: (VALUES AT DIAM. MARKED WITH * ARE EXTRAPOLATED
                                 40.96        .30              .00
                                 99.28        .63             5.85+002
                                367.21       1.00             1.97+003
                                603.31       1.25             2.90+003
                               1744.94       2.50             5.89+003
                               7018.06       6.00             2.79+004
```

```
                                13742.96      10.00*          3.25+004
                                20959.11      15.00*          5.00+004
                                27762.06      20.00*          5.77+004
 WANT TO PLOT CUM. % MASS?  ENTER Y OR N
>Y

   27 INPUT POINTS.    2 WERE OUTSIDE LIMITS
```




```
1 INTERPOLATED POINTS      2 MEASURED POINTS      3 NEARBY POINTS
WANT TO SEE RESULTS USING MERCERS DEF. OF AERO. DIAM.?  ENTER Y OR N
```

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 5A

PLANT: North American Refractories Company, Farber, Missouri

DATE: 031384

SAMPLING LOCATION: Scrubber Inlet

START-FINISH TIME: 1703-1705

SR) SAMPLING RATE, ACFM 0.708

ST) SAMPLING TIME, MINUTES: 2.00

PB) BARO. PRESS., IN.HG.: 29.40

PSI) STATIC PRESS., IN. H2O: -4.50

TS) STACK GAS TEMP., DEG F: 137

PMV) MOISTURE % BY VOLUME: 17.0

DCF) DENSITY CORR. FACTOR: 1.000

ISOKINETICS, % 107.1

VOLUME METERED, ACF: 1.036

NOZZLE DIA., INCHES: 0.188

Y) METER CAL. FACTOR: 0.992

TM) METER TEMP., DEG F: 69

DH) DELTA H AVG., IN. H2O: 0.69

DEN) PARTICLE DENSITY, GM/CC: 1.00

VCF) VISCOSITY CORR. FACTOR: 1.044

MD) MOL WT, DRY LB/LB-MOLE: 29.02

CONCENT., GR/DSCF: 2.132

STAGE NO.	PARTICLE DIAMETER (microns) FROM GRAPH	PARTICLE DIAMETER (microns) AERODYNAMIC	CATCH WEIGHT (mgms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
PreSep	10.05	10.49	37.20	26.7	73.1
PreImp	8.75	9.14	53.70	38.5	34.6
1	5.74	5.99	9.64	6.9	27.7
2	3.67	3.83	9.95	7.1	20.6
3	2.36	2.46	13.97	10.0	10.6
4	1.40	1.46	7.70	5.5	5.1
5	0.93	0.97	3.67	2.6	2.5
6	0.58	0.61	1.18	0.8	1.7
7	0.33	0.34	0.31	0.2	1.5
FILTER	< 0.33	< 0.34	2.16	1.5	
		TOTAL CATCH	139.48		

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 6A

PLANT: North American Refractories Company, Farber, Missouri

SAMPLING LOCATION: Scrubber Inlet DATE: 031484

	START-FINISH TIME:	1546-1548		VOLUME METERED, ACF:	1.085
SR)	SAMPLING RATE, ACFM	0.752		NOZZLE DIA., INCHES:	0.188
ST)	SAMPLING TIME, MINUTES:	2.00	Y)	METER CAL. FACTOR:	0.992
PB)	BARO. PRESS., IN.HG.:	29.50	TM)	METER TEMP., DEG F:	72
PSI)	STATIC PRESS., IN. H2O:	-4.20	DH)	DELTA H AVG., IN. H2O:	0.64
TS)	STACK GAS TEMP., DEG F:	137	DEN)	PARTICLE DENSITY, GM/CC:	1.00
PMV)	MOISTURE % BY VOLUME:	18.7	VCF)	VISCOSITY CORR. FACTOR:	1.044
DCF)	DENSITY CORR. FACTOR:	1.000	MD)	MOL WT, DRY LB/LB-MOLE:	28.99
	ISOKINETICS, %	117.1		CONCENT., GR/DSCF:	4.0349

STAGE NO.	PARTICLE DIAMETER (microns) FROM GRAPH	PARTICLE DIAMETER (microns) AERODYNAMIC	CATCH WEIGHT (mgms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
PreSep	9.74	10.17	137.30	49.8	50.1
PreImp	8.48	8.85	60.76	22.0	28.1
1	5.56	5.80	20.91	7.6	20.5
2	3.57	3.73	18.19	6.6	13.9
3	2.29	2.39	16.94	6.1	7.8
4	1.36	1.42	5.31	1.9	5.9
5	0.90	0.94	2.57	0.9	5.0
6	0.56	0.58	0.48	0.2	4.8
7	0.32	0.33	9.31	3.4	1.4
FILTER	< 0.32	< 0.33	3.94	1.4	

TOTAL CATCH 275.71

PARTICLE SIZING FIELD DATA & RESULTS TABULATION

RUN 6B

PLANT: North American Refractories Company, Farber, Missouri

SAMPLING LOCATION: Scrubber Inlet DATE: 031484

	START-FINISH TIME:	1623-1625		VOLUME METERED, ACF:	0.971
SR)	SAMPLING RATE, ACFM	0.668		NOZZLE DIA., INCHES:	0.188
ST)	SAMPLING TIME, MINUTES:	2.00	Y)	METER CAL. FACTOR:	0.992
PB)	BARO. PRESS., IN.HG.:	29.50	TM)	METER TEMP., DEG F:	78
PSI)	STATIC PRESS., IN. H2O:	-4.20	DH)	DELTA H AVG., IN. H2O:	0.58
TS)	STACK GAS TEMP., DEG F:	139	DEN)	PARTICLE DENSITY, GM/CC:	1.00
PMV)	MOISTURE % BY VOLUME:	18.7	VCF)	VISCOSITY CORR. FACTOR:	1.045
DCF)	DENSITY CORR. FACTOR:	1.000	MD)	MOL WT, DRY LB/LB-MOLE:	28.99
	ISOKINETICS, %	108.0		CONCENT., GR/DSCF:	3.6711

STAGE NO.	PARTICLE DIAMETER (microns) FROM GRAPH	AERODYNAMIC	CATCH WEIGHT (mgms)	PERCENT OF TOTAL (%)	CUM. % LESS THAN GIVEN DIA
PreSep	10.36	10.83	122.20	55.1	44.9
PreImp	9.02	9.43	5.11	2.3	42.6
1	5.92	6.19	21.92	9.9	32.7
2	3.78	3.95	20.32	9.2	23.5
3	2.43	2.54	23.34	10.5	13.0
4	1.45	1.52	10.54	4.7	8.3
5	0.96	1.00	2.98	1.3	7.0
6	0.59	0.62	0.78	0.4	6.6
7	0.34	0.36	0.47	0.2	6.4
FILTER	< 0.34	< 0.36	14.30	6.4	
		TOTAL CATCH	221.96		

01

5A, 6A, 6B

```
NARC
ENTER TEST DATE, IDATE, (MMDDYY)
>031384

DO YOU WISH TO REVIEW ALL RUNS IN A TEST?  ENTER Y OR N?
>N

 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>2
THE TGLD AERODYNAMIC DIAM. WILL BE USED
 DO YOU WANT STATISTICS FOR 1=DM/DLOGD, 2=CUM. MASS, OR 3=CUM. % MASS?
>3
THE STD.DEV., MINIMUM, AND MAXIMUM OF THE CUM. % MASS WILL BE PRINTED
ENTER THE NO. OF STD. DEV. TO BE USED TO IDENTIFY POTENTIAL OUTLIERS.
>3
ENTER INDICES OF RUNS TO BE COMPARED SEPARATED BY BLANKS OR
   ENTER IN TO COMPARE ALL INLET RUNS IN THE TEST OR
   ENTER OUT TO COMPARE ALL OUTLET RUNS IN THE TEST
>OUT
   *** MASS ON STAGE              1  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            4
SAMPLING AT  107.3 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .41502500      .71495600
   *** LINEAR INTERPOLATION USED BETWEEN   1.0545096      1.8769431
   *** LINEAR INTERPOLATION USED BETWEEN   3.6229375      5.6113916
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5051.28
   *** MASS ON STAGE              1  IS HIGH
   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            5
SAMPLING AT  117.4 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .68855015      1.0166163
   *** LINEAR INTERPOLATION USED BETWEEN   1.0166163      1.8111010
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5368.88
   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** MASS ON STAGE              9  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            6
SAMPLING AT  108.2 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   1.0349708      1.9291741
```

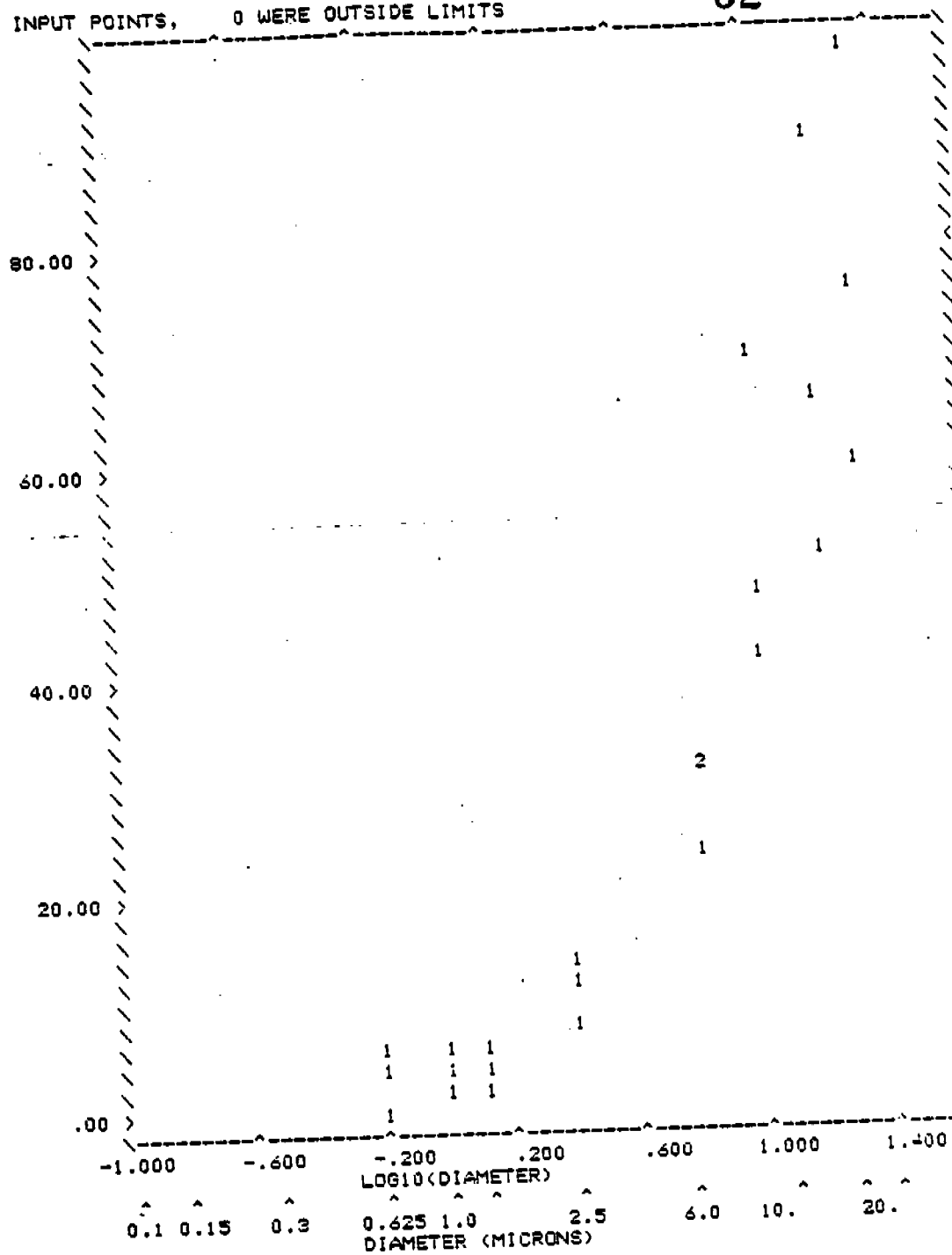
TEST SITE	NARC	NARC	NARC
TEST DATE	31384	31384	31384
RUN NUMBER	4	5	6
RUN DATE	31384	31484	31484
START TIME	1703	1546	1623
TOTAL MASS	4.862E+03	9.196E+03	8.364E+03

STD. DIAM.		CUM. % MASS < D50		
4	.63	1.72	4.47	6.56
5	1.00	2.46	4.97	6.89
6	1.25	3.39	5.31	7.34
7	2.50	12.73	9.59	14.59
8	6.00	33.56	25.84	33.50
9	10.00	70.44	49.49	43.32
10	15.00	91.78	66.61	52.72
11	20.00	98.10	76.46	61.42

DATA COMPARISON FOR 3 OUTLET RUNS BY ENT

STD. DIAM. (MICRONS)		NO. RUNS	DM/DLOGD (MG/DNCM)	CUMULATIVE MASS < D50	CUM. % MASS < D50 AVG.	STD. DEV.	MIN.	MAX.
4	.63	3	3.32E+02	3.48E+02	4.25	2.43	1.72	6.56
5	1.00	3	2.67E+02	3.85E+02	4.78	2.23	2.46	6.89
6	1.25	3	4.34E+02	4.22E+02	5.35	1.97	3.39	7.34
7	2.50	3	3.29E+03	9.07E+02	12.30	2.53	9.59	14.59
8	6.00	3	7.50E+03	2.27E+03	30.97	4.44	25.84	33.56
9	10.00	3	6.79E+03	3.87E+03	54.42	14.22	43.32	70.44
10	15.00	3	5.68E+03	5.00E+03	70.37	19.80	52.72	91.78
11	20.00	3	4.71E+03	5.65E+03	78.66	18.44	61.42	98.10

24 INPUT POINTS, 0 WERE OUTSIDE LIMITS



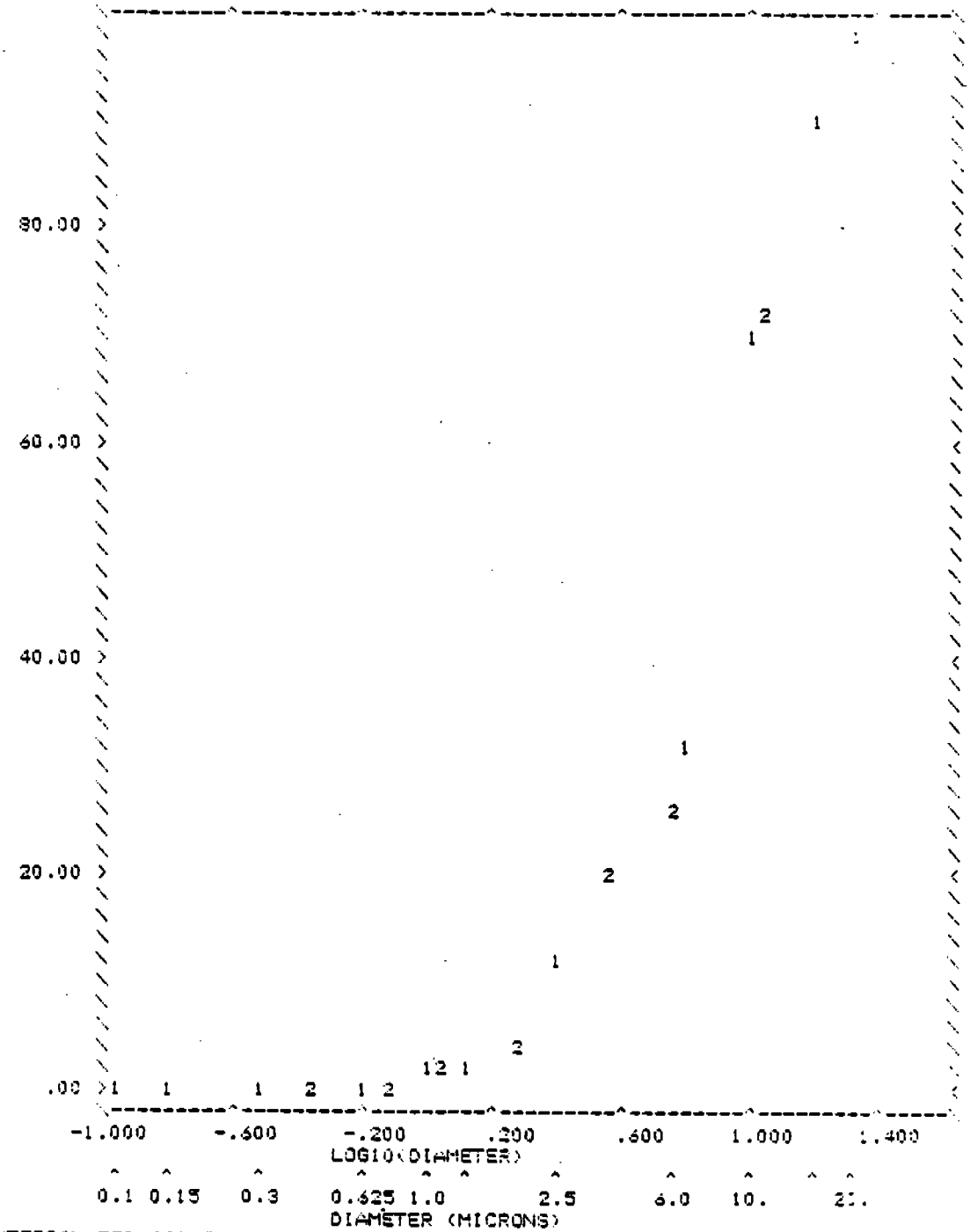
NEARBY POINTS MAY BE COMBINED

```
THE TGLD AERODYNAMIC DIAM. WILL BE USED
ENTER INDICES OF RUNS TO BE USED, SEPARATED BY BLANKS, OR
ENTER 0 (ZERO) TO USE ALL RUNS IN THE TEST
>4 5 6

*FTN ERROR   SUBPROGRAM BSORT          ARGUMENT LIST DOESN'T MATCH CALLER
BSORT  REFERENCED AT LN.   120  OF  PENEFF
FOLLOWING ARGUMENT TYPES DO NOT MATCH:
ARGUMENT NO. 01, CALLERS TYPE: INTEGER     SUBPROGRAMS TYPE: REAL*4

   *** MASS ON STAGE              1  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            4
SAMPLING AT  107.3 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .41502500      .71495600
   *** LINEAR INTERPOLATION USED BETWEEN   1.0545096      1.8769431
   *** LINEAR INTERPOLATION USED BETWEEN   3.6229375      5.6118916
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5051.28

   *** MASS ON STAGE              1  IS HIGH
   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            5
SAMPLING AT  117.4 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .68855015      1.0166163
   *** LINEAR INTERPOLATION USED BETWEEN   1.0166163      1.6111010
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5368.38

   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** MASS ON STAGE              9  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            6
SAMPLING AT  108.2 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   1.0849708      1.9231741
  STD. DIAM.  PENETR.    ERR.   EFFICIENCY   ERR.
*** NO INLET  RUN IN THIS TEST

DO YOU WANT EXPANDED OUTPUT MAILED TO YOU?  ENTER Y OR N.
>
```

Run No. 5A

```
NARC
ENTER TEST DATE, IDATE (MMDDYY), OR RETURN TO USE CURRENT VALUE
>031384
ENTER THE RUN NO., IRUN, OR RETURN TO USE CURRENT VALUE
>4
   *** MASS ON STAGE              1  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT

DO YOU WISH TO LIST THE DATA FOR RUN? ENTER Y OR N
>N

DO YOU WISH TO MODIFY ANY RUN CONDITIONS?  ENTER Y OR N
>N
WANT TO RETRIEVE ANOTHER RUN?  ENTER Y OR N
>N

DO YOU WISH TO TO REDUCE THE DATA? ENTER Y OR N
>Y



 PARTICULATE DATA REDUCTION AND ENTRY SYSTEM     06/18/84          08:51:50
DATA FOR TEST BY CONTRACTOR ENT , AT SITE NARC, ON DATE  31384, RUN NO.  4 (5A)
SAMPLING AT  107.3 % OF ISOKINETIC RATE
WANT TO SEE RESULTS USING CLASSICAL (STOKES) DEF. OF DIAM.?  ENTER Y OR N
>N
   *** LINEAR INTERPOLATION USED BETWEEN   .41502500      .71495600
   *** LINEAR INTERPOLATION USED BETWEEN   1.0545096      1.8769431
   *** LINEAR INTERPOLATION USED BETWEEN   3.6229375      5.6118916
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5051.28
WANT TO SEE RESULTS USING THE TGLD DEF. OF AERO. DIAM.?  ENTER Y OR N
>Y

HILL 5A. Scrubber Inlet
TOTAL MASS  1.5201+000  2.1245+000  3.4786+003  4.8615+003      DMAX= 100.0
              GR/ACF      GR/DNCF     MG/ACM      MG/DNCM            MICRONS

 STAGE       MASS       MASS    CUM. MASS      D50     GEO. MEAN DM/DLOGD  DN/DLOGD
             (MG)    (MG/DNCM) (MG/DNCM)   (MICRONS) (MICRONS) (MG/DNCM) (NO/DNCM)
CYCLONE     37.20    1296.59   3564.92      10.49     32.39   1.32+003  7.44+007
    1       53.70    1871.69   1693.23      11.04     10.76  -8.39+004 -1.28+011
    2        9.64     336.00   1357.23       5.61      7.87   1.14+003  4.47+009
    3        9.95     346.80   1010.43       3.62      4.51   1.82+003  3.80+010
    4       13.97     486.92    523.51       2.70      3.13   3.83+003  2.39+011
    5        7.70     268.38    255.13       1.88      2.25   1.69+003  2.83+011
    6        3.67     127.92    127.22       1.05      1.41   5.11+002  3.50+011
    7        1.18      41.13     86.09        .71       .87   2.44+002  7.11+011
    8         .31      10.80     75.29        .42       .54   4.57+001  5.41+011
FILTER       2.16      75.29                            .29   2.50+002  1.89+013
   *** CUT POINTS FOR STAGES  0  1 ARE SIMILAR OR INVERTED
       MEASURED DATA FOR STAGE,  1 WITH D50=   11.04 OMITTED FROM INTERPOLATION
   *** CUT POINTS FOR STAGES  3  4 ARE SIMILAR OR INVERTED
       MEASURED DATA FOR STAGE,  4 WITH D50=    2.70 OMITTED FROM INTERPOLATION
   *** LINEAR INTERPOLATION USED BETWEEN   .41502500      .71495600
   *** LINEAR INTERPOLATION USED BETWEEN   1.0545096      1.8769431
   *** LINEAR INTERPOLATION USED BETWEEN   3.6229375      5.6118916
INTERPOLATED TO STD. INTERVALS: (VALUES AT DIAM. MARKED WITH * ARE EXTRAPOLATED)
                                 83.42        .63              4.57+001
                                119.46       1.00              3.55+002
                                164.95       1.25              5.11+002
```

```
                                 618.91        2.50            2.71+003
                                1631.56        6.00            8.12+003
                                3424.43       10.00            7.19+003
                                4461.87       15.00*           3.73+003
                                4769.23       20.00*           1.42+003
 WANT TO PLOT CUM. % MASS?  ENTER Y OR N
>Y

   27 INPUT POINTS.    2 WERE OUTSIDE LIMITS
```




```
1 INTERPOLATED POINTS      2 MEASURED POINTS      3 NEARBY POINTS
   *** JET VELOCITY > 5000 CM/SEC
STAGE          8
VALUE  5051.28
WANT TO SEE RESULTS USING MERCERS DEF. OF AERO. DIAM.?  ENTER Y OR N
>
```

Run No. 6A + 6B

```
NARC
ENTER TEST DATE, IDATE, (MMDDYY)
>031384

DO YOU WISH TO REVIEW ALL RUNS IN A TEST?  ENTER Y OR N?
>N

 DO YOU WISH TO COMPARE SEVERAL RUNS? ENTER Y OR N
>Y
ENTER DIAMETER DEFINITION (1=PHYSICAL, 2=AERODYNAMIC, 3=AERODYNAMIC IMPACTION)
>2
THE TGLD AERODYNAMIC DIAM. WILL BE USED
 DO YOU WANT STATISTICS FOR 1=DM/DLOGD, 2=CUM. MASS, OR 3=CUM. % MASS?
>3
THE STD.DEV., MINIMUM, AND MAXIMUM OF THE CUM. % MASS WILL BE PRINTED
ENTER THE NO. OF STD. DEV. TO BE USED TO IDENTIFY POTENTIAL OUTLIERS.
>3
ENTER INDICES OF RUNS TO BE COMPARED SEPARATED BY BLANKS OR
   ENTER IN TO COMPARE ALL INLET RUNS IN THE TEST OR
   ENTER OUT TO COMPARE ALL OUTLET RUNS IN THE TEST
>5 6

*FTN ERROR   SUBPROGRAM BSORT            ARGUMENT LIST DOESN'T MATCH CALLER
BSORT  REFERENCED AT LN.   143  OF  COMPAR
FOLLOWING ARGUMENT TYPES DO NOT MATCH:
ARGUMENT NO. 01, CALLERS TYPE: INTEGER     SUBPROGRAMS TYPE: REAL*4

   *** MASS ON STAGE              1  IS HIGH
   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            5
SAMPLING AT  117.4 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   .68855015      1.0166163
   *** LINEAR INTERPOLATION USED BETWEEN   1.0166163      1.8111010
   *** JET VELOCITY > 5000 CM/SEC
STAGE        8
VALUE  5368.88

   *** MASS ON STAGE              2  IS HIGH
   *** MASS ON STAGE              3  IS HIGH
   *** MASS ON STAGE              4  IS HIGH
   *** MASS ON STAGE              5  IS HIGH
   *** MASS ON STAGE              9  IS HIGH
   *** SAMPLING DURATION   2.0000000      IS SHORT
REDUCE DATA FOR RUN            6
SAMPLING AT  108.2 % OF ISOKINETIC RATE
   *** LINEAR INTERPOLATION USED BETWEEN   1.0849708      1.9291741
```

	6A	6B
TEST SITE	NARC	NARC
TEST DATE	31384	31384
RUN NUMBER	5	6
RUN DATE	31484	31484
START TIME	1546	1623
TOTAL MASS	9.196E+03	8.364E+03

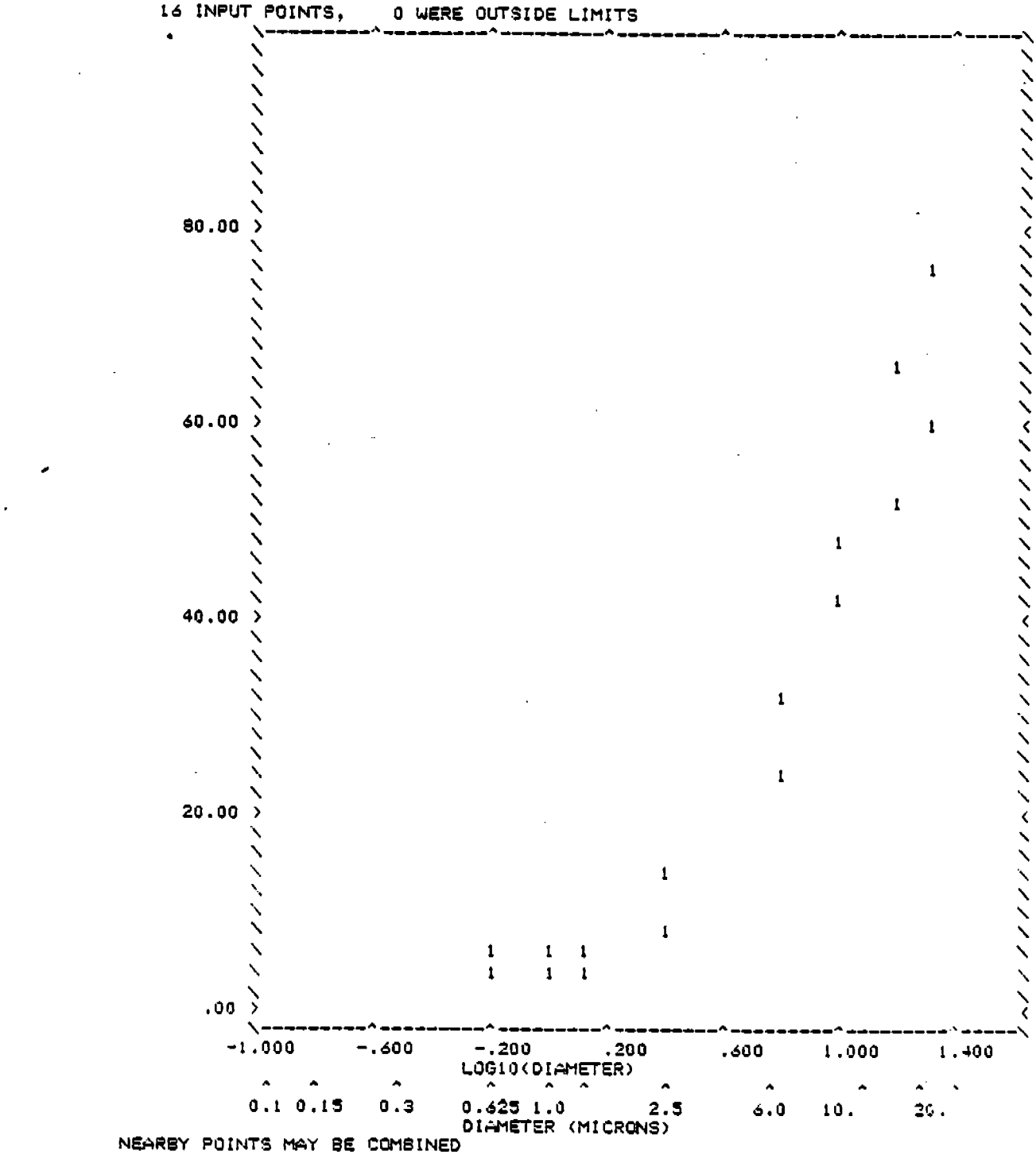
STD.	DIAM.	CUM. % MASS < D50	
4	.63	4.47	6.56
5	1.00	4.97	6.89
6	1.25	5.31	7.34
7	2.50	9.59	14.59
8	6.00	25.84	33.50
9	10.00	49.49	43.32
10	15.00	66.61	52.72

DATA COMPARISON FOR 2 OUTLET RUNS BY ENT

STD. DIAM. (MICRONS)	NO. RUNS	DM/DLOGD (MG/DNCM)	CUMULATIVE MASS < D50	CUM. % MASS < D50 AVG.	STD. DEV.	MIN.	MAX.
4 .63	2	4.75E+02	4.80E+02	5.52	1.47	4.47	6.56
5 1.00	2	2.24E+02	5.17E+02	5.93	1.36	4.97	6.89
6 1.25	2	3.96E+02	5.51E+02	6.33	1.43	5.31	7.34
7 2.50	2	3.36E+03	1.05E+03	12.09	3.53	9.59	14.59
8 6.00	2	7.19E+03	2.59E+03	29.67	5.42	25.84	33.50
9 10.00	2	6.60E+03	4.09E+03	46.40	4.36	43.32	49.49
10 15.00	2	6.65E+03	5.27E+03	59.67	9.82	52.72	66.61
11 20.00	2	6.36E+03	6.08E+03	68.94	10.64	61.42	76.46

DO YOU WANT TO PLOT CUM % MASS? ENTER Y OR N.
>Y
COMPARISON OF CUM. % MASS FROM 2 RUNS AT STD. DIAM.

16 INPUT POINTS, 0 WERE OUTSIDE LIMITS



NEARBY POINTS MAY BE COMBINED
DO YOU WISH TO REPEAT THE COMPARISON EXCLUDING SOME RUNS? ENTER Y OR N
>

TRACE METALS ANALYTICAL RESULTS

PLASTIC CLAY

TRACE METALS CONCENTRATIONS & ANALYTICAL RESULTS
Method 5 Impingers
Plastic Clay

Element	Run 11 mg.	Run 11 ppm	Run 14 mg.	Run 14 ppm	Run 17 mg.	Run 17 ppm
Aluminum (Al)	2310	7439	442	847.9	13.9	7.146
Beryllium (Be)	0.080	0.771	0.012	0.0690	BDL	BDL
Calcium (Ca)	70.5	152.8	12.6	16.271	5.23	1.81
Chromium (Cr)	5.420	9.0557	1.090	1.0849	0.0360	0.0960
Fluorine (F)	0.0	0.0	0.0	0.0	0.0	0.0
Iron (Fe)	190	295.6	32.3	29.933	1.46	0.363
Lead (Pb)	0.898	0.377	0.171	0.0427	0.0217	0.00145
Magnesium (Mg)	8.29	29.628	8.56	18.225	1.68	0.959
Manganese (Mn)	BDL	BDL	BDL	BDL	0.012	0.00303
Mercury (Hg)	0.0195	0.00845	0.0050	0.00129	0.0024	0.000166
Nickel (Ni)	2.800	4.144	0.816	0.719	0.042	0.00992
Silicon (Si)	0.0	0.0	0.0	0.0	0.0	0.0
Titanium (Ti)	2.5	4.535	0.67	0.724	0.22	0.0637
Uranium (U)	0.0	0.0	0.0	0.0	0.0	0.0
Vanadium (V)	3.560	6.0718	0.702	0.713	0.021	0.00572
Zinc (Zn)	2.060	2.737	0.288	0.228	0.113	0.0240

APPENDIX 7.4.1

7.4 FLINT CLAY FIELD AND ANALYTICAL DATA

7.4.1 PARTICULATE

Preliminary Field Data

PLANT NAME NARCO

LOCATION FARBER, Mo.

SAMPLING LOCATION CYCLONE INLET

DUCT DEPTH
FROM INSIDE FAR WALL TO OUTSIDE OF PORT 26"

NIPPLE LENGTH 7"

DEPTH OF DUCT 19"

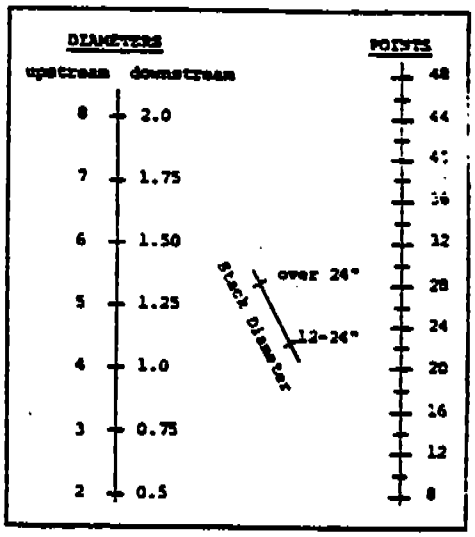
WIDTH (RECTANGULAR DUCT) _____

EQUIVALENT DIAMETER:

$$D_E = \frac{2 \times \text{DEPTH} \times \text{WIDTH}}{\text{DEPTH} + \text{WIDTH}} = \frac{2(\quad)(\quad)}{(\quad + \quad)} = \_\_\_\_$$

DISTANCE FROM PORTS TO NEAREST FLOW DISTURBANCE:	UPSTREAM	DOWNSTREAM
FEET	71"	70"
STACK DIAMETERS	3.7	3.7

STACK AREA = $\pi(9.5)^2$ = 283.5 IN^2



Point	% OF DIAMETER	DISTANCE FROM INSIDE WALL	DISTANCE FROM OUTSIDE OF PORT
1	4.4	1"	8"
2	14.6	2¾"	9¾"
3	29.6	5⅝"	12⅝"
4	70.4	13⅜"	20⅜"
5	85.4	16¼"	23¼"
6	95.6	18"	25"
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS

	4	6	8	10	12	14	16	18	20	22	24
1	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3	75.0	29.6	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4	93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5		85.4	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6		95.6	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7			89.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8			96.8	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9				91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10				97.4	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11					93.3	85.4	78.0	70.4	61.2	39.3	32.3
12					97.9	90.1	83.1	76.4	69.4	60.7	39.8
13						94.3	87.5	81.2	75.0	68.5	60.2
14						98.2	91.5	85.4	79.6	73.8	67.7
15							95.1	89.1	83.5	78.2	72.8
16							98.4	92.5	87.1	82.0	77.0
17								95.6	90.3	85.4	80.6
18								98.6	93.3	88.4	83.9
19									96.1	91.3	86.8
20									98.7	94.0	89.5
21										96.5	92.1
22										98.9	94.5
23											96.8
24											98.9

LOCATION OF TRAVERSE POINTS IN RECTANGULAR STACKS

	2	3	4	5	6	7	8	9	10	11	12
1	25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2	75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3		83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4			87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5				90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6					91.7	78.6	68.8	61.1	55.0	50.0	45.8
7						92.9	81.3	72.2	65.0	59.1	54.2
8							93.8	83.3	75.0	68.2	62.5
9								94.4	85.0	77.3	70.8
10									95.0	86.4	79.2
11										95.5	87.5
12											95.8

ENTROPY ENVIRONMENTALISTS, INC.

PARTICULATE FIELD DATA

COMPANY NAME NARCO
ADDRESS FARBER, MO.
SAMPLING LOCATION CYCLONE INLET
DATE 3-13-83 TEAM LEADER DR TECHNICIANS
BAROMETRIC PRESSURE, IN. HG 29.4 STATIC PRESSURE, IN. H_2O -1.00
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG 15 18 18 15 18
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. 0.003 0.003 0.005 0.006 0.005

RUN NUMBER 2
TIME START 1455
TIME FINISH 1653

EQUIPMENT CHECKS

- ✓ PITOTS, PRE-TEST
- ✓ PITOTS, POST-TEST
- ORSAT SAMPLING SYSTEM
- TEDLAR BAG
- ✓ THERMOCOUPLE @ 145 °F

IDENTIFICATION NUMBERS

REAGENT BOX 0215 NOZZLE 103 DIAMETER .173
METER BOX N-7 T/C READOUT 0009
UMBILICAL TEFLON 01 T/C PROBE 4-5
SAMPLE BOX 21 ORSAT PUMP —
PROBE 4-2 TEDLAR BAG —

FILTER #	TARE
EF1466	.7513
EF1883	.7121
EF1884	.7066

NOMOGRAPH SET-UP NOMOGRAPH # DR

$\Delta H@$ 1.78 C FACTOR 0.84-.05=0.79
METER TEMP 85 STACK TEMP ~~270~~ 145
% MOISTURE 15 REF. ΔP ~~3.23~~ 2.65

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LK. CHECK READINGS
A-1	0/0	832.407	0.62	0.43	0.43	92	6	250	33	142	833.807
2	2	833.15	0.63	0.44	0.44	91	10	250	33	145	834.127
	4	834.34	0.60	0.42	0.42	82	2	235	33	147	0.42
4	6	835.11	0.95	0.66	0.66	81	5	245	33	148	
5	8	836.07	0.93	0.65	0.65	81	7	250	33	146	
	10	837.08	0.90	0.62	0.62	81	9	250	33	143	
B-1	1/0	837.97	0.83	0.58	0.58	79	7	250	33	175	
2	2	838.86	0.87	.60	0.60	79	8	250	33	188	PLUG FILTER
3	4	839.74	0.90	0.62	0.62	75	10	235	33	164	840.863
4	6	840.63	0.97	0.64	0.64	75	1	235	32	134	841.143
5	8	841.97	1.06	0.74	0.74	74	7	235	32	134	0.28
6	10	842.82	0.95	0.66	0.66	74	13	235	32	135	
	24.08	843.717									
		9.315									

V_M	$(\sqrt{\Delta P})^2$	ΔH	T_M	T_S
10.615	0.8402	.588	80.	150

ENTROPY

PARTICULATE FIELD DATA

COMPANY NAME NARCO
ADDRESS FARBER, MO.
SAMPLING LOCATION CYCLONE INLET
DATE 3-14-84 TEAM LEADER JR TECHNICIANS TM
BAROMETRIC PRESSURE, IN. HG 29.50 STATIC PRESSURE, IN. H_2O -1.00
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG 15 17 17 17
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. 0.018 0.012 0.012 0.012

RUN NUMBER 3
TIME START 13:22
TIME FINISH 15:00

EQUIPMENT CHECKS

- ✓ PITOTS, PRE-TEST
- ✓ PITOTS, POST-TEST
- ✓ ORSAT SAMPLING SYSTEM
- ✓ TEDLAR BAG
- ✓ THERMOCOUPLE @ 145 °F

IDENTIFICATION NUMBERS

REAGENT BOX 0214 NOZZLE 103/101 DIAMETER .173
METER BOX N-7 T/C READOUT 0009
UMBILICAL TEFLON 01 T/C PROBE 5-5
SAMPLE BOX 23 ORSAT PUMP ~~SQUEEZE BULB~~
PROBE 4-1 TEDLAR BAG 1

FILTER #	TARE
EF1885	.6957

NOMOGRAPH SET-UP

NOMOGRAPH # JR
$\Delta H_@$ 1.78 C FACTOR 0.84 - .05 = 0.76
METER TEMP 80 STACK TEMP 150
% MOISTURE 16 REF. ΔP 2.83

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ORIFICE SETTING (ΔH), IN. H_2O ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LK. CHECK READINGS
A-1	0/0	847.627	0.73	0.47	0.47	73	1	265	38	138	848.37
2	2	848.50	0.50	0.33	0.33	77	1	250	34	136	848.44
3	4	849.17	0.66	0.43	0.43	78	2	250	32	142	
4	6	849.89	0.80	0.52	0.52	79	15	250	32	139	
5	8	850.77	0.71	0.46	0.46	80	18	250	32	143	
6	10	851.56	0.57	0.37	0.37	81	14	250	32	141	
B-1	12/0	852.25	0.80	0.52	0.52	86	3	250	32	142	
2	2	853.08	0.82	0.53	0.53	85	2	255	32	144	
3	4	853.90	0.80	0.52	0.52	72	1	235	32	165	853.94
4	6	854.80	1.00	0.65	0.65	72	4	240	32	178	854.00
5	8	855.72	0.97	0.63	0.63	73	5	245	32	205	
6	10	856.69	1.00	0.65	0.65	73	7	245	32	166	
	24/OFF	857.628									

V_M	$(\sqrt{\Delta P})^2$	ΔH	T_M	T_S
9.872	0.7722	0.5067	77	153

ENTROPY

CUSTODY SHEET FOR REAGENT BOX # 0214

Date of Makeup 3/8/84 Initials BD Locked? ✓

Individual Tare of Reagent: 200 mls. of Distilled H2O

Individual Tare of Reagent: _____ mls. of _____

Individual Silica Gel Tare Weight 200 gms.

PLANT NAME NARCO, Farber, Mo.

SAMPLING LOCATION Dryer Outlet

Run Number	Date Used	Initials	Locked?	Date Cleanup	% S. Gel Spent	Initials	Locked?
3	3/14/84	SSH	✓	3/19/84	20%	SSH	✓
10	3/15/84	SSH	✓	3/19/84	10%	SSH	✓
11	3/15/84	SSH	✓	3/19/84	15%	SSH	✓

Received in Lab Date 3/19/84 Initials MGJ Locked? ✓

Zero & Span Balance Initials MGJ

Sampling Method: EPA-17 WITH BACKHALVES

Filter #	Tare Weight (mgms)	Used on Test
EF 1885	.6957	3
EF 1887	.6830	10
EF 1888	.6715	10
EF 1889	.6995	11

Remarks:

ENTROPY ENVIRONMENTALISTS, INC.

PARTICULATE SAMPLING LABORATORY RESULTS

Plant Name NORTH AMERICAN REFRACTORIES EEI Ref. # 3002

Sampling Location CYCLONE INLET

Date Received 3/19/84 Date Analyzed 3/26/84 Reagent Box(es) 0215; 0214

Run Number	1	2	3
Run Date	3/12	3/13	3/14

SUMMARY OF PARTICULATE ANALYSES

Sum of Particulate, mg.	39228.4	26348.7	15280.2
Total Filter Tare mg.	2149.7	2160.0	695.7
Blank Residue, mg.	(1500 ml) 3.0	(1450 ml) 2.9	(1025 ml) 2.1
TOTAL PARTICULATE CATCH, mg.	37075.7	24185.8	14582.4

ANALYSIS OF MOISTURE CATCH

Reagent 1 (H_2O):			
Final Weight, g.	252.0	229.0	239.0
Tared Weight, g.	200.0	200.0	200.0
Water Catch, g.	52.0	29.0	39.0
Reagent 2 ( ):			
Final Weight, g.	-	-	-
Tared Weight, g.	-	-	-
Water Catch, g.	-	-	-
CONDENSED WATER, g.	52.0	29.0	39.0
Silica Gel:			
Final Weight, g.	202.5	208.5	210.0
Tared Weight, g.	200.0	200.0	200.0
ABSORBED WATER, g.	2.5	8.5	10.0
TOTAL WATER COLLECTED, g.	54.5	37.5	49.0

Blank Beaker # 21	— Legend —	Notes and Comments
Final wt. mg. 59637.6	✓ = Final Weight	
Tare wt. mg. 59637.2	L = Loose Particulate	
Residue, mg. .04	F = Filter D = Dish	
Volume, ml. 200	R = Rinse P = Pan	
Concen., mg/ml. .002		

PARTICULATE FIELD DATA

COMPANY NAME NARCO — RUN NUMBER #0
ADDRESS FARBER, MO. — TIME START 1627
SAMPLING LOCATION CYCLONE INLET — TIME FINISH 1757
DATE 3-14-84 — TEAM LEADER DR — TECHNICIANS TM
BAROMETRIC PRESSURE, IN. HG 29.50 — STATIC PRESSURE, IN. H_2O
SAMPLING TRAIN LEAK TEST VACUUM, IN. HG 15 17 17 17 17 17
SAMPLING TRAIN LEAK RATE, CU. FT./MIN. 0.012 0.015 0.014 0.010 0.011 0.007

EQUIPMENT CHECKS

- ✓ PITOTS, PRE-TEST
- ✓ PITOTS, POST-TEST
- ✓ ORSAT SAMPLING SYSTEM
- ✓ TEDLAR BAG
- ✓ THERMOCOUPLE @ 145 °F

IDENTIFICATION NUMBERS

REAGENT BOX 0214 — NOZZLE 103/101 — DIAMETER .173
METER BOX N-7 — T/C READOUT 0009
UMBILICAL TEFLON 01 — T/C PROBE 5-5
SAMPLE BOX 23 — ORSAT PUMP —
PROBE 4-1 — TEDLAR BAG —

FILTER #	TARE
EF1887	.6830
F1888	

NOMOGRAPH SET-UP — NOMOGRAPH # DR

$\Delta H_@$ 1.78 — C FACTOR 0.75 - .05 = 0.70
METER TEMP 80 — STACK TEMP 145
% MOISTURE 17 — REF. ΔP 295

SAMPLE POINT	CLOCK TIME, MIN.	DRY GAS METER READING, CU. FT.	PITOT READING (ΔP), IN. H_2O	ORIFICE SETTING (ΔH), IN. H_2O IDEAL	ACTUAL	GAS METER TEMP. °F	PUMP VACUUM IN. HG GAUGE	FILTER BOX TEMP. °F	IMP. EXIT TEMP. °F	STACK TEMP. °F	LK. CHECK READINGS
A-1	0/0	859.753	0.92	0.57	0.57	82	1	260	33	140	
2	2	860.64	0.63	0.39	0.39	82	5	260	33	142	
3	4	861.47	0.77	0.48	0.48	83	1	260	33	140	861.125
4	6	862.28	0.97	0.61	0.61	83	3	255	33	139	861.213
5	8	863.74	0.88	0.55	0.55	84	5	255	35	137	
6	10	864.14	0.87	0.51	0.51	85	6	255	35	141	
B-1	12/0	864.97	0.95	0.59	0.59	86	10	260	35	171	865.463
2	2	865.93	0.97	0.62	0.62	86	7	250	35	175	865.531
3	4	866.87	0.98	0.61	0.61	86	15	250	35	169	867.142
4	6	868.58	1.12	0.70	0.70	78	3	240	35	144	867.573
5	8	869.60	0.73	0.46	0.46	77	5	245	35	144	867.862
6	10	870.39	0.85	0.53	0.53	77	7	250	35	142	868.493
	24/00	871.257									868.505
											868.561

V_M	$(\sqrt{\Delta P})^2$	ΔH	T_M	T_S
10.252	0.8778	0.552	82	149

ENTROPY

CUSTODY SHEET FOR REAGENT BOX # 0215

Date of Makeup 3/8/84 Initials BD Locked? ✓

Individual Tare of Reagent: 200 mls. of Distilled H_2O

Individual Tare of Reagent: _____ mls. of _____

Individual Silica Gel Tare Weight 200 gms.

PLANT NAME NARCO

SAMPLING LOCATION Cyclone Inlet

Run Number	Date Used	Initials	Locked?	Date Cleanup	% S. Gel Spent	Initials	Locked?
1	3/12	DR	✓	3/12	40%	DR	✓
2	3/13	DR	✓	3/13	35%	SH	✓

Received in Lab Date 3/19/84 Initials MEJ Locked? ✓

Sampling Method: EPA -17

Zero & Span Balance Initials MEJ

Filter #	Tare Weight (mgms)	Used on Test
EF 1469	.7407	1
EF 1473	.7244	1
EF 1661	.6846	1
EF 1884	.6966	2
EF 1883	.7121	2
EF 1466	.7513	2

Remarks:

ENTROPY ENVIRONMENTALISTS, INC.

PARTICULATE SAMPLING LABORATORY RESULTS

Plant Name NORTH AMERICAN REFRACTORIES EEI Ref. # 3002

Sampling Location

Date Received 3/19/84 Date Analyzed 3/26/84 Reagent Box(es) 0214, 0202

Run Number	10	11	12
Run Date	3/15	3/15	3/15

SUMMARY OF PARTICULATE ANALYSES

Sum of Particulate, mg.	25708.1	38303.5	31646.8
Total Filter Tare mg.	1354.3	699.5	703.4
Blank Residue, mg.	(900 ml) 1.8	(525 ml) 1.1	(400 ml) 0.8
TOTAL PARTICULATE CATCH, mg.	24352.0	37602.9	30942.6

ANALYSIS OF MOISTURE CATCH

Reagent 1 (H_2O):			
Final Weight, g.	239.0	240.0	250.0
Tared Weight, g.	200.0	200.0	200.0
Water Catch, g.	39.0	40.0	50.0
Reagent 2 ( ):			
Final Weight, g.	–	–	–
Tared Weight, g.	–	–	–
Water Catch, g.	–	–	–
CONDENSED WATER, g.	39.0	40.0	50.0
Silica Gel:			
Final Weight, g.	205.0	212.0	208.0
Tared Weight, g.	200.0	200.0	200.0
ABSORBED WATER, g.	5.0	12.0	8.0
TOTAL WATER COLLECTED, g.	44.0	52.0	58.0

Blank Beaker # 21	—— Legend ——	Notes and Comments
Final wt. mg. 59637.6	✓ = Final Weight	
Tare wt. mg. 59637.2	L = Loose Particulate	
Residue, mg. 0.4	F = Filter D = Dish	
Volume, ml. 200	R = Rinse P = Pan	
Concen., mg/ml. .002		

LABORATORY SAMPLE WEIGHT CALCULATIONS

Plant Name NORTH AMERICAN REFRACTORIES EEI Ref. # 2002

Run Number	10	11	12
Run Date	3/15	3/15	
Sample ID/Container #	F&R-659	DISH-11	DISH-12
		105.7280	
		105.7176	85.6809
	198.7741	105.7227	85.6800
	198.7720	105.7379	85.6954
	198.7800	105.7820	85.7394
Tare Wt., g.	187.0154	72.7251	57.8355
SAMPLE WT., g.	11.7566	32.9925	27.8445
Sample ID/Container #	F&R-660	F&R-661	F&R-662
	199.6138		
	199.6050	190.2745	189.3045
	199.6070	190.2703	189.3006
	199.6186	190.2724	189.3035
Tare Wt., g.	185.6535	184.9593	185.4983
SAMPLE WT., g.	13.9515	5.3110	3.8023
Sample ID/Container #			
Tare Wt., g.			
SAMPLE WT., g.			
Sample ID/Container #			
Tare Wt., g.			
SAMPLE WT., g.			

LABORATORY SAMPLE WEIGHT CALCULATIONS

Plant Name NORTH AMERICAN REFRACTORIES EEI Ref. # 3002

Run Number	1	2	3
Run Date	3/12	3/13	3/14
Sample ID/Container #	FR-634	DISH-2	FR-640
	194.8173	73.3526	196.2168
	194.8132	73.3239	196.2158
	194.8280	73.3273	196.2230
	190.6159	73.3322	
		73.3520	
Tare Wt., g.	183.3040	57.2976	188.5650
SAMPLE WT., g.	11.5092	16.0263	7.6508
Sample ID/Container #	FR-635	FR-637	FR-642
	CONT'D BELOW 199.1423		
	199.1438		
	199.1512	190.2113	193.9972
	199.1614	190.2094	193.9947
	199.1672	190.2140	193.9993
Tare Wt., g.	185.5755	185.3133	186.3653
SAMPLE WT., g.		4.8961	7.6294
Sample ID/Container #	FR-636	FR-638	
	198.0800	184.6384	
	198.0774	184.6378	
	198.0909	184.6400	
Tare Wt., g.	183.9242	183.4370	
SAMPLE WT., g.	14.1532	1.2008	
Sample ID/Container #	635 CONT'D	FR-639	
		187.0101	
		187.0094	
	199.1432	187.0123	
Tare Wt., g.	199.1415	182.7839	
SAMPLE WT., g.	13.5660	4.2255	

APPENDIX 7.4.4

TRACE METALS ANALYTICAL RESULTS

FLINT CLAY

TRACE METALS CONCENTRATIONS & ANALYTICAL RESULTS
Method 5 Impingers
Flint Clay

Element	Run 3 mg.	Run 3 ppm	Run 6 mg.	Run 6 ppm	Run 9 mg.	Run 9 ppm
Aluminum (Al)	955	3158	209	261.1	13.5	7.239
Beryllium (Be)	0.010	0.0990	BDL	BDL	BDL	BDL
Calcium (Ca)	9.51	21.169	2.79	2.346	2.16	0.780
Chromium (Cr)	2.720	4.667	0.356	0.231	0.044	0.0122
Fluorine (F)	0.0	0.0	0.0	0.0	0.0	0.0
Iron (Fe)	105	167.7	28.4	17.139	2.08	0.539
Lead (Pb)	0.484	2.08	0.156	0.0254	0.0228	0.00159
Magnesium (Mg)	17.1	62.757	3.71	5.144	0.50	0.298
Manganese (Mn)	0.750	1.218	BDL	BDL	0.016	0.00421
Mercury (Hg)	0.0052	0.00213	0.0034	0.000571	0.0020	0.000144
Nickel (Ni)	5.460	8.297	0.206	0.118	0.028	0.00690
Silicon (Si)	0.0	0.0	0.0	0.0	0.0	0.0
Titanium (Ti)	1.29	2.402	0.68	0.478	0.33	0.0997
Uranium (U)	0.0	0.0	0.0	0.0	0.0	0.0
Vanadium (V)	0.990	1.734	0.262	0.173	0.028	0.00795
Zinc (Zn)	4.990	6.809	0.192	0.0990	0.076	0.0168