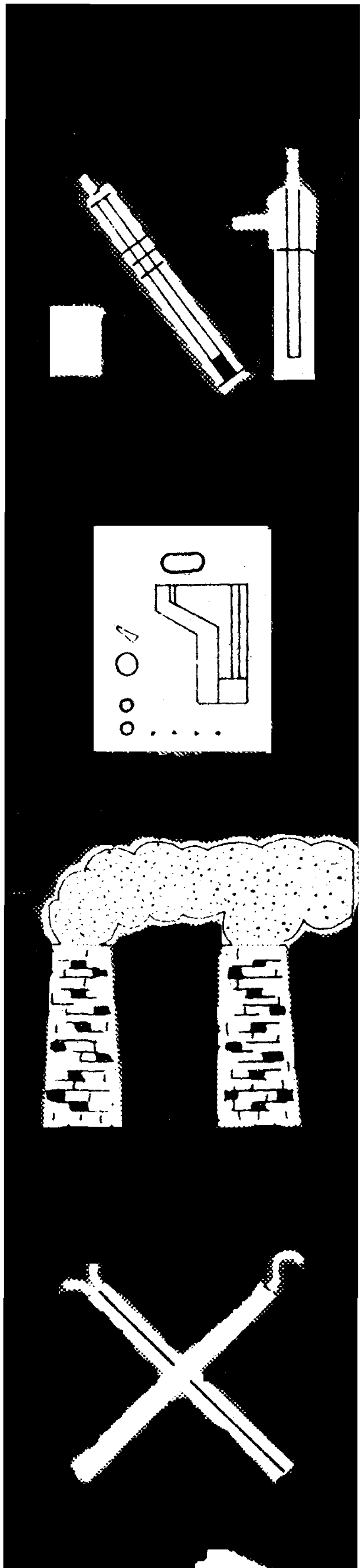
EMB Report No. 78-NMN-6



AIR POLLUTION EMISSION TEST

SOURCE EMISSIONS TEST REPORT

ENGLEHARD MINERALS & CHEMICALS CORPORATION

Attapulgus, Georgia

July 1978

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

SOURCE EMISSIONS TEST REPORT

ENGELHARD MINERALS & CHEMICALS CORPORATION
Attapulgus, Georgia

#2 Raymond Mill

and

#2 Fluid Energy Mill

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7/78

RFW Report No. 0300-81-02
Contract No. 68-02-2816
Work Assignment No. 1

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The Emission Measurement Branch of the U. S. Environmental Protection Agency contracted Roy F. Weston, Inc. to conduct a source testing and analysis program at Engelhard Minerals and Chemicals Corporation's, Attapulgus, Georgia clay processing facility.

The primary objective of the testing program was to quantify the particulate emissions to the atmosphere from two baghouse-controlled sources at the plant (No. 2 Raymond Mill and No. 2 Fluid Energy Mill). This objective was achieved by performing a series of three particulate tests utilizing EPA Method 17[(1)] procedures at each baghouse exhaust stack location. In addition, visual determinations of plume opacities were made simultaneously with each particulate test at both source discharge points according to EPA Method 9[(2)] protocol. Also, singular EPA Method 5[(3)] particulate and Anderson cascade impactor tests were executed at both baghouse inlet sites to measure the potential uncontrolled emissions and the particle size distribution at the entering particulate matter respectively.

The particulate matter emission results are summarized below:

No. 2 Raymond Mill Baghouse Exhaust Stack

Test Number	Date	Particulate Concentration, Grains/DSCF	Particulate Emission Rate, Pounds/Hour
1	6-14-78	0.002	0.03
2	6-15-78	0.002	0.04
3	6-15-78	0.001	0.02
Series Average		-	0.03

(1) Federal Register, Vol. 41, No. 187, September 24, 1976.

(2) Federal Register, Vol. 39, No. 219, November 12, 1974.

(3) Code of Federal Regulations, Title 40, Part 60, Appendix A, "Standards of Performance for New Stationary Sources", August 18, 1977.

No. 2 Raymond Mill Baghouse Inlet Duct[4]

Test Number	Date	Particulate Concentration, Grains/DSCF	Particulate Emission Rate, Pounds/Hour
1	6-15-78	5.24	97.4

No. 2 Fluid Energy Mill Baghouse Exhaust Stack

Test Number	Date	Particulate Concentration, Grains/DSCF	Particulate Emission Rate, Pounds/Hour
1	6-14-78	0.002	0.02
2	6-15-78	0.002	0.04
3	6-15-78	0.001	0.03
Series Average		-	0.03

No. 2 Fluid Energy Mill Baghouse Inlet Duct[5]

Test Number	Date	Particulate Concentration, Grains/DSCF	Particulate Emission Rate, Pounds/Hour
1	6-15-78	1.04	15.6

The particulate removal efficiency of No. 2 Raymond Mill Baghouse was measured at 99.98%; that of No. 2 Fluid Energy Mill was 99.87%. Both efficiencies were calculated based on one simultaneous inlet/outlet test only.

No visible emissions were observed emanating from either stack during the test program by the certified observer.

Figures 10 and 11 illustrate the particle size distribution of the particulate matter at the baghouse inlet locations.

Detailed summaries of test data and test results are presented in Tables 1 through 8 of this report.

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(4) Run performed simultaneously with Test Number 3 at exhaust stack.

(5) Run performed simultaneously with Test Number 2 at exhaust stack.

INTRODUCTION

The Emission Measurement Branch of the U.S. Environmental Protection Agency contracted Roy F. Weston, Inc. to conduct a source testing and analysis program at Engelhard Minerals and Chemicals Corporation's Attapulgus, Georgia clay processing facility. The objective of the testing program was to measure various emission parameters from two selected milling operations at the plant.

The locations tested, plus the number and types of tests performed at each site, are listed below:

1. No. 2 Raymond Mill Baghouse Exhaust Stack
   a. 3 particulate tests by EPA Method 17
   b. 3 opacity tests by EPA Method 9 simultaneous with each particulate test.
2. No. 2 Raymond Mill Baghouse Inlet Duct
   a. 1 particulate test by EPA Method 5 simultaneous with one of the exhaust stack tests.
   b. 1 particle size distribution test by cascade impaction. (Anderson®).
3. No. 2 Fluid Energy Mill Baghouse Exhaust Stack
   a. 3 particulate tests by EPA Method 17
   b. 3 opacity tests by EPA Method 9 simultaneous with each particulate test.
4. No. 2 Fluid Energy Mill Baghouse Inlet Duct
   a. 1 particulate test by EPA Method 5 simultaneous with one of the exhaust stack tests.
   b. 1 particle size distribution test by cascade impaction (Anderson®).

All tests were conducted during the period 14-15 June 1978 by Weston personnel and were observed by Mr. Dennis P. Holzschuh, EPA Technical Manager.

Test data and test result summaries are presented in Tables 1 through 8 of this report. Particle size distribution results are shown in Figures 10 and 11. Also incorporated herein is a description of the test locations, test equipment, test procedures, sample recovery, and analytical methods used during the test program. Raw test data, laboratory reports, sample calculations, equipment calibration data, baghouse details, and a list of project participants are provided in Appendices A through F, respectively.

No. 2 Raymond Mill

Figure 1 illustrates the process flow diagram for No. 2 Raymond Mill. Also shown are the baghouse inlet and outlet test locations. Note that a cyclone collector prior to the baghouse is used to capture most of the product.

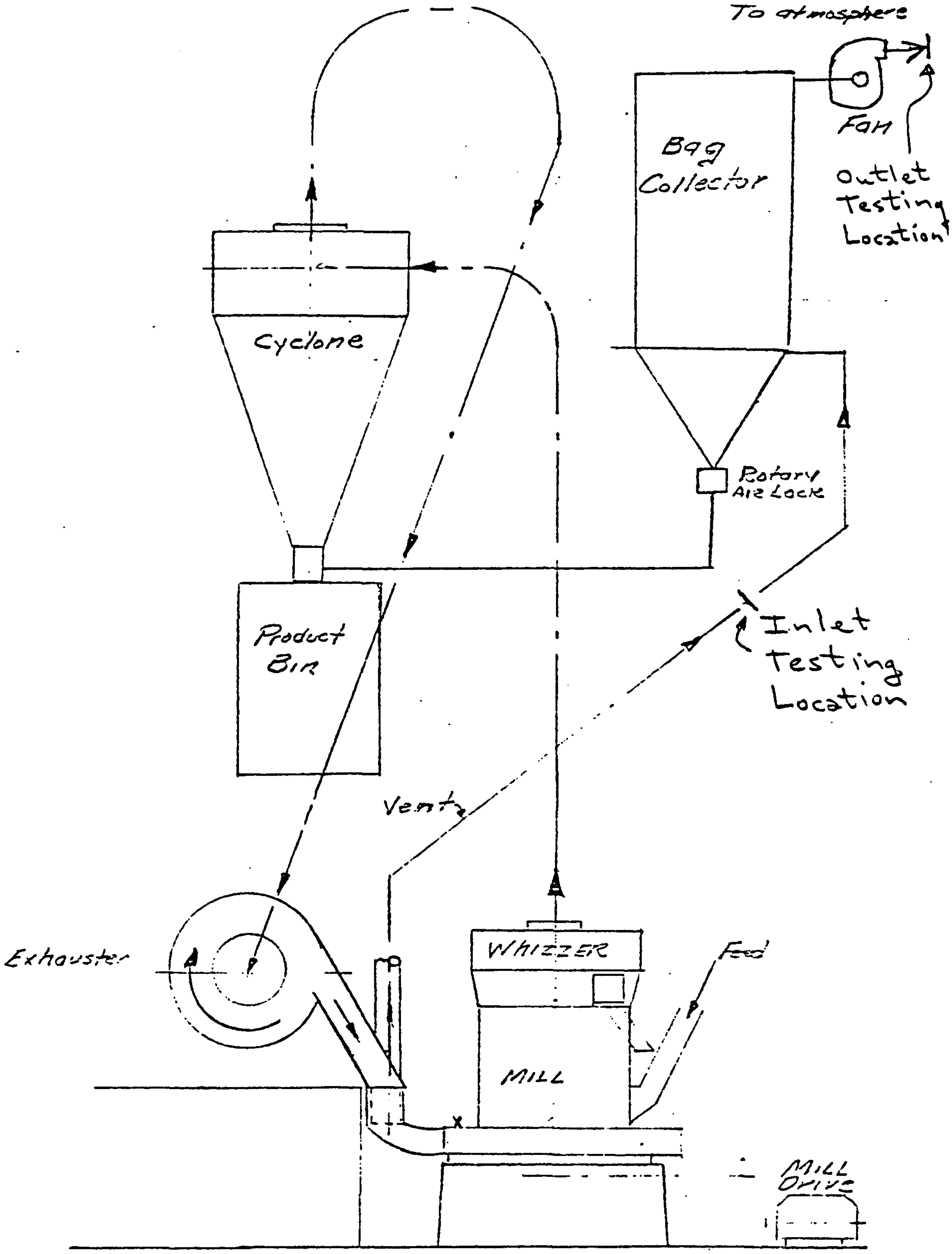
The raw materials feed rate to the mill was approximately 3 tons/hour during each testing period. Raw materials feed rates and product production rates were monitored by Engelhard personnel during each test but that information was not supplied to Weston for inclusion in this report.

No. 2 Fluid Energy Mill

The process schematic of No. 2 Fluid Energy Mill is presented in Figure 2. Also included in the diagram are the baghouse inlet and outlet test locations. Note that product recovery is effected primarily by two cyclones in series prior to final stage capture by the bag collector.

The mill feed rate was approximately 840 pounds/hour during the testing periods. The exact raw material feed rates and product production rates were monitored by Engelhard personnel but was not supplied to Weston for inclusion in this report.

FIGURE 1



ENGELHARD MINERALS AND CHEMICALS CORP.

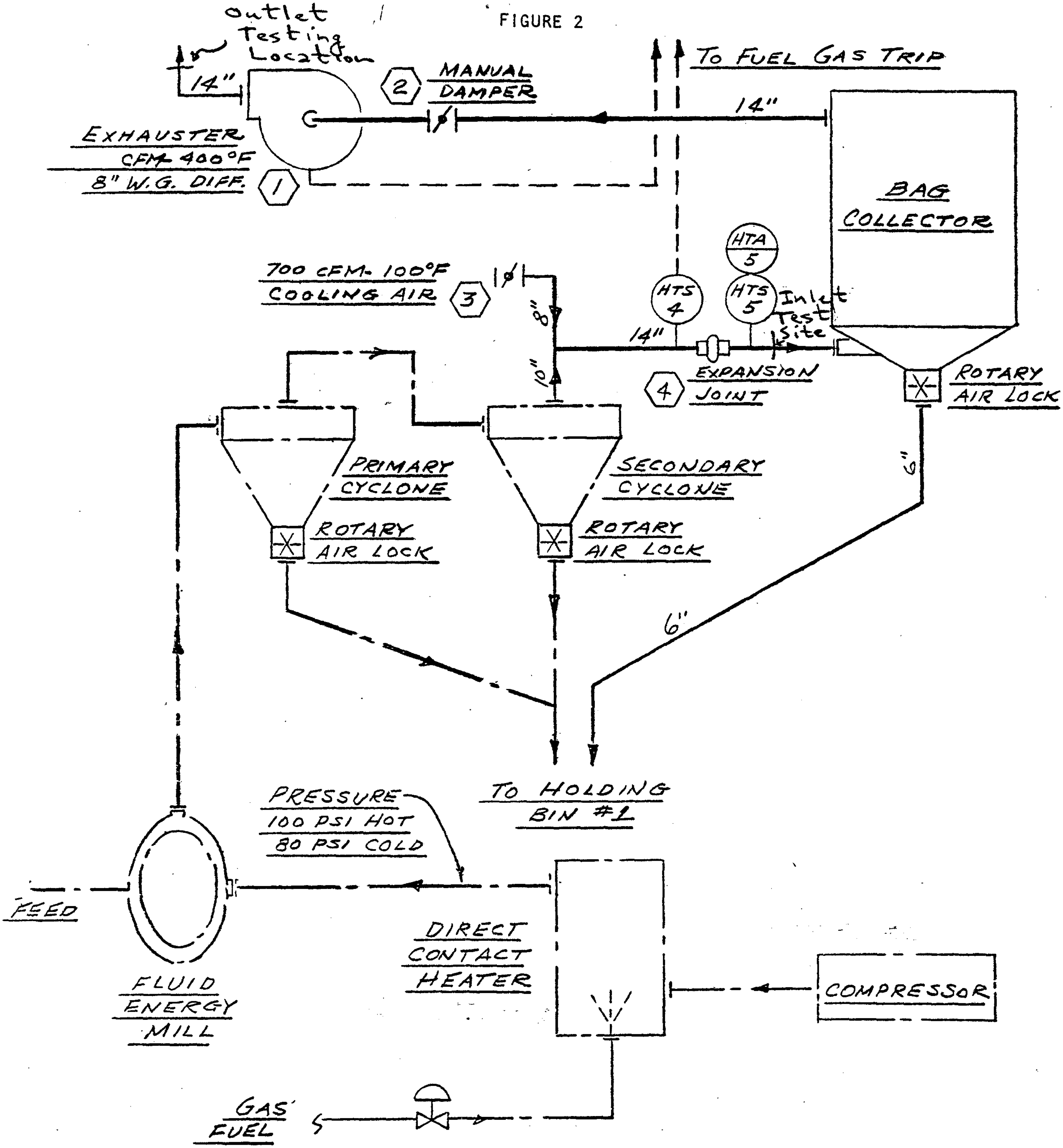
RAYMOND HIGH SIDE ROLLER MILL, CYCLONE & BAG COLLECTOR

TYPICAL FOR MILLS NO'S 1, 2, 4 & 5

NO. COLLECTOR ON NO. 3 MILL (OUT OF SERVICE)

2-24-72 CLH

FIGURE 2



ENGELHARD MINERALS & CHEMICALS CORPORATION
FLUID ENERGY MILL # 2
SCHEMATIC DIAGRAM

JOB 72-01 | 7-24-72 | CA-1-72

No. 2 Raymond Mill Baghouse Exhaust Stack

Two 4" I.D. test ports, 90° apart, were installed on a straight section of the 10 1/4" I.D. metal stack at a location which was 9.4 stack diameters (96") downstream and 1.7 diameters (17") upstream from the nearest gas stream flow disturbances. EPA Method 1[6] criteria for this test location required a minimum of 16 traverse points to aid in the representative measurement of pollutant emissions and total volumetric flow. A total of 20 traverse points were chosen for sampling since this number conveniently related to the desired test period length. See Figure 3 for port and sampling point locations.

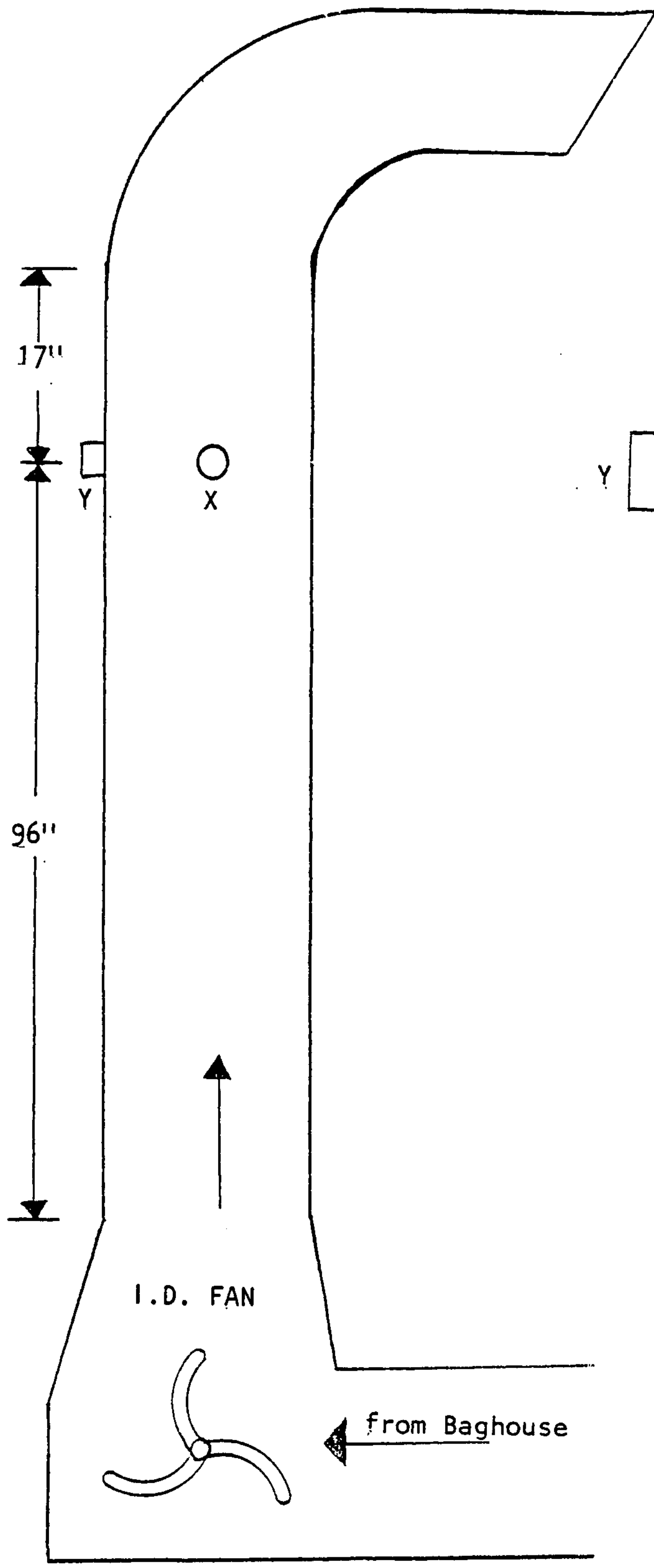
No. 2 Raymond Mill Baghouse Inlet Duct

Two 4" I.D. test ports were placed at right angles on a straight section of the 12" I.D. duct work leading to the inlet of the baghouse at a position greater than eight stack diameters downstream, and greater than two diameters upstream from the nearest gas stream flow disturbances. Since the eight and two diameter criterion were met, a minimum of eight traverse points were required by EPA Method 1 regulations. Figure 4 illustrates duct geometry plus port and sampling point locations.

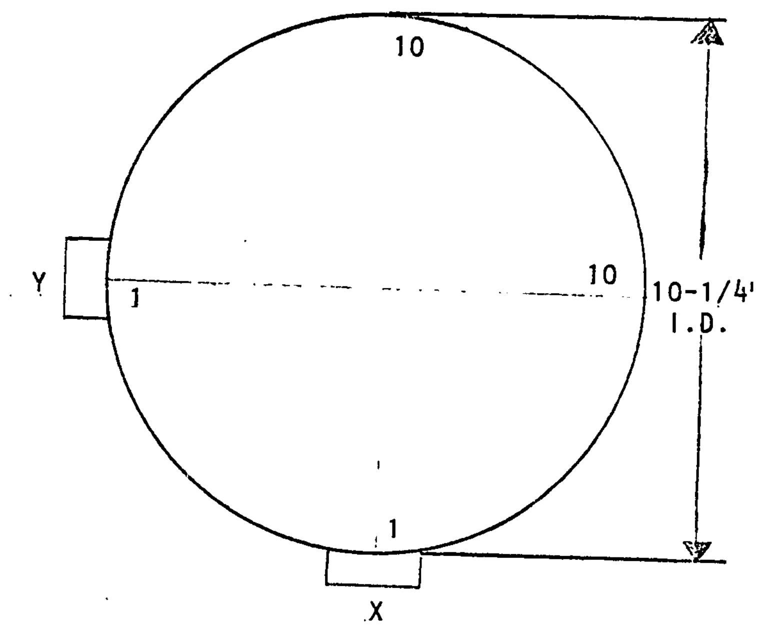
[6] Code of Federal Regulations, Title 40, Part 60, Appendix A, "Standards of Performance for New Stationary Sources," August 18, 1977.

ENGELHARD MINERALS & CHEMICALS CORPORATION
Attapulgus, Georgia
FIGURE 3
#2 RAYMOND MILL BAGHOUSE EXHAUST STACK
PORT AND SAMPLING POINT LOCATIONS

DISCHARGE TO ATMOSPHERE



Metal Stack



DUCT CROSS-SECTIONAL VIEW

Traverse Point Number	Distance From Inside Near Wall, Inches
1	1/2 Adj.
2	7/8
3	1-1/2
4	2-1/4
5	3-1/2
6	6-3/4
7	7-7/8
8	8-3/4
9	9-3/8
10	9-3/4 Adj.

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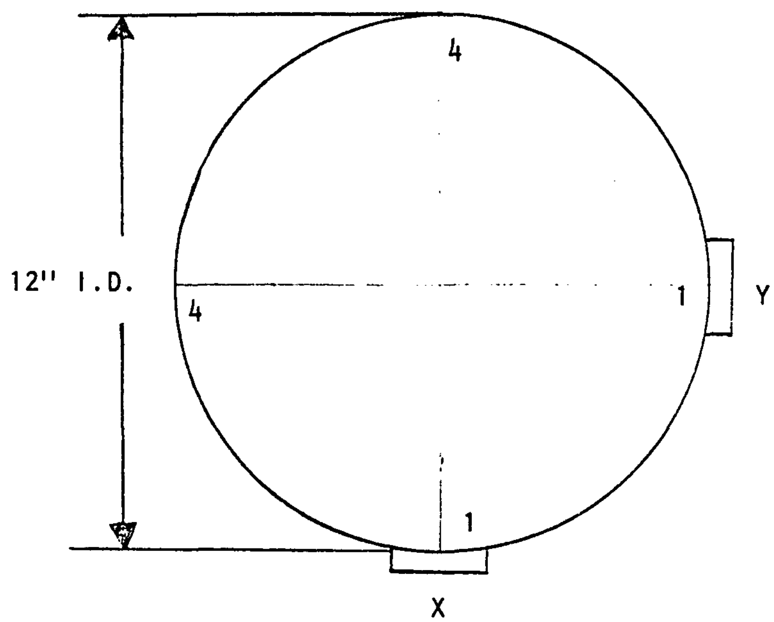
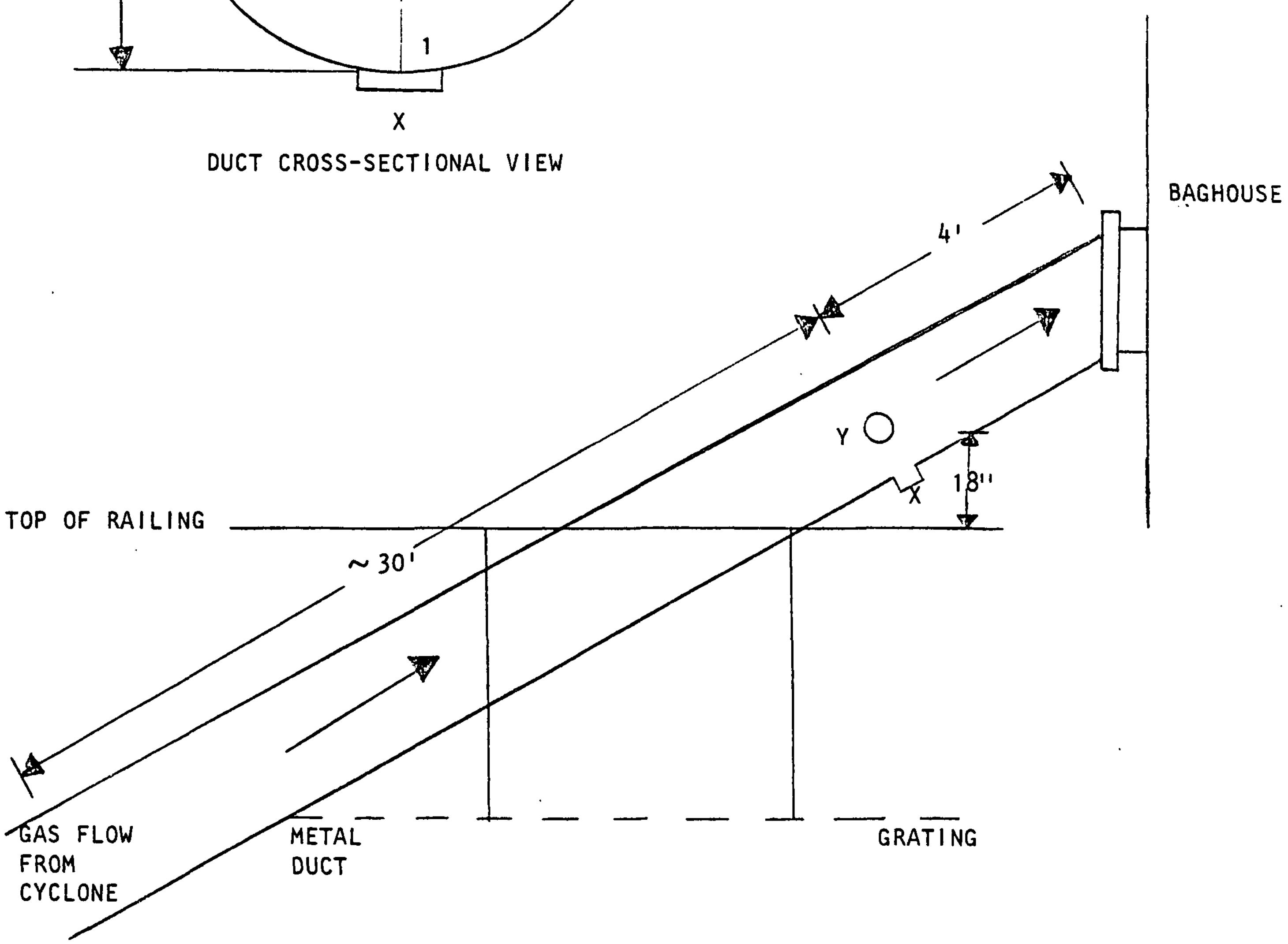
Figure 4
#2 RAYMOND MILL BAGHOUSE INLET DUCT
PORT AND SAMPLING POINT LOCATIONS

TRAVERSE POINT NUMBER	DISTANCE FROM INSIDE NEAR WALL, INCHES
1	3/4
2	2
3	9
4	11-1/4



DUCT CROSS-SECTIONAL VIEW



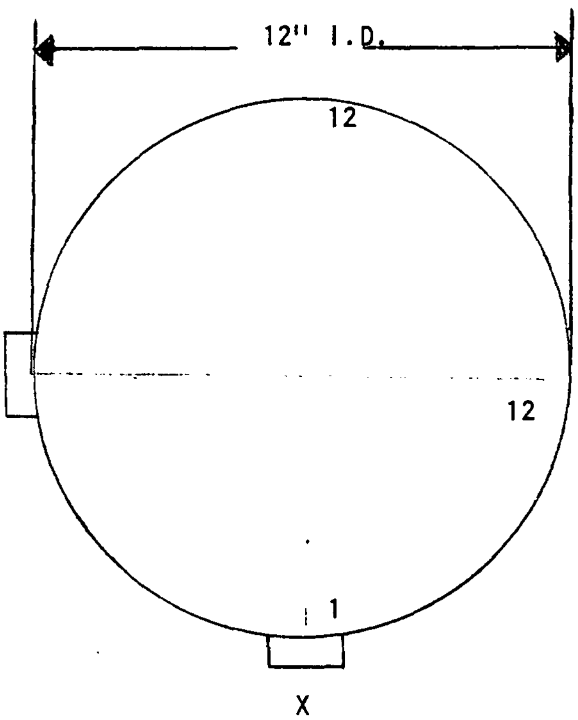
No. 2 Fluid Energy Mill Baghouse Exhaust Stack

Two 4" I.D. test ports at 90°, were placed on the 12" I.D. metal stack 8 diameters downstream and 1.3 diameters upstream from the nearest flow disturbances. EPA Method 1 protocol required the traversing of a minimum of 20 sampling points, 10 per axis, which was the number selected for testing. See Figure 5 for further details.

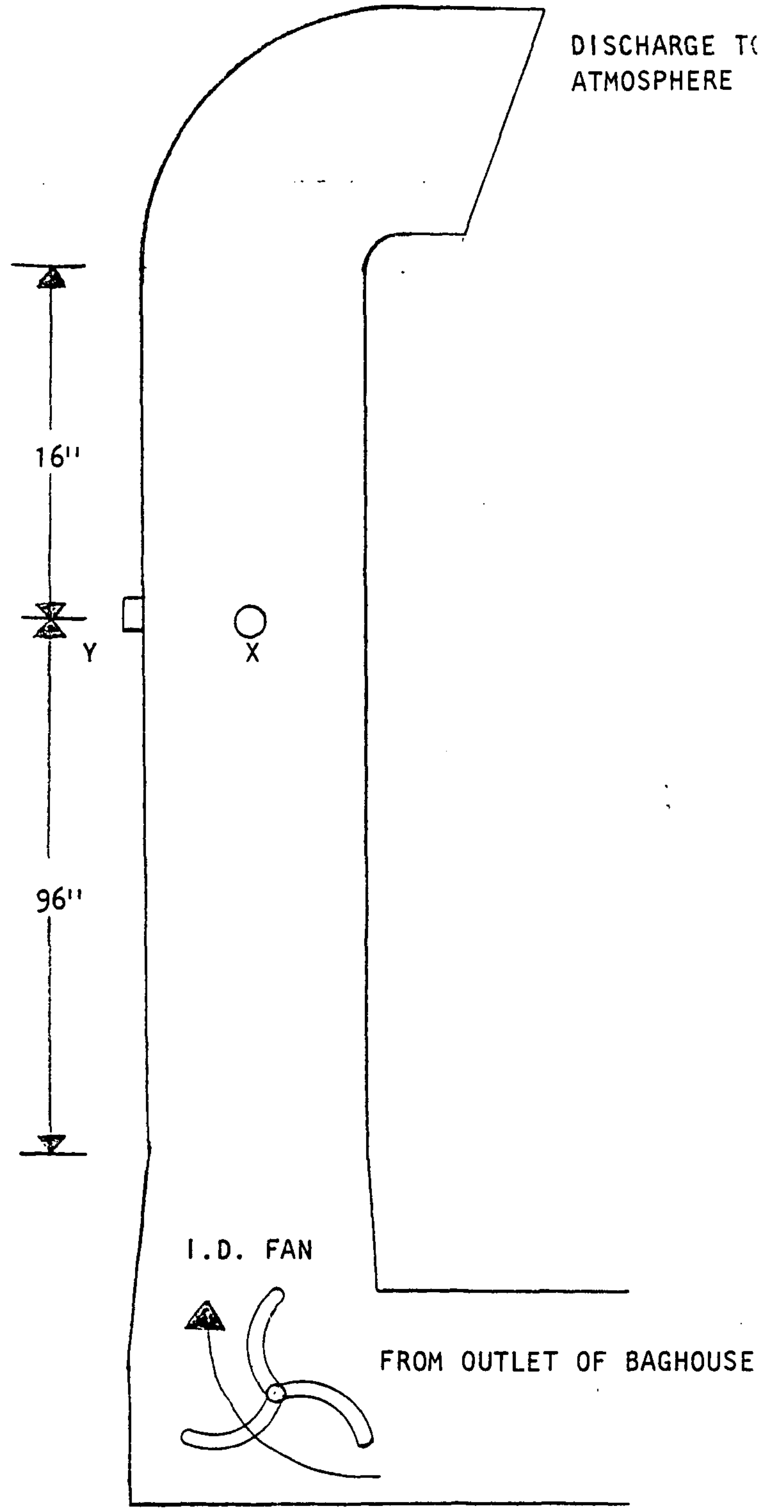
No. 2 Fluid Energy Mill Baghouse Inlet Duct

Two 4" I.D. test ports, 90° apart, were installed in a straight section of the metal stack at a location which was 5.4 duct diameters downstream and 1.4 diameters upstream from the nearest flow disturbances. EPA Method 1 criteria for this test location required a minimum of 20 traverse points for representative sampling. A total of 36 points were selected for test purposes, 18 per port axis. Figure 6 illustrates stack geometry measurements while Figure 7 presents traverse point distances.

ENGELHARD MINERALS & CHEMICALS CORPORATION
Attapulgus, Georgia
FIGURE 5
#2 FLUID ENERGY MILL BAGHOUSE EXHAUST STACK
PORT AND SAMPLING POINT LOCATIONS



DUCT CROSS SECTIONAL VIEW



METAL STACK

TRAVERSE POINT NUMBER	DISTANCE FROM INSIDE NEAR WALL, INCHES
1	1/2 Adj.
2	1
3	1-3/4
4	2-3/4
5	4-1/8
6	7-7/8
7	9-1/4
8	10-1/4
9	11
10	11-1/2 Adj.

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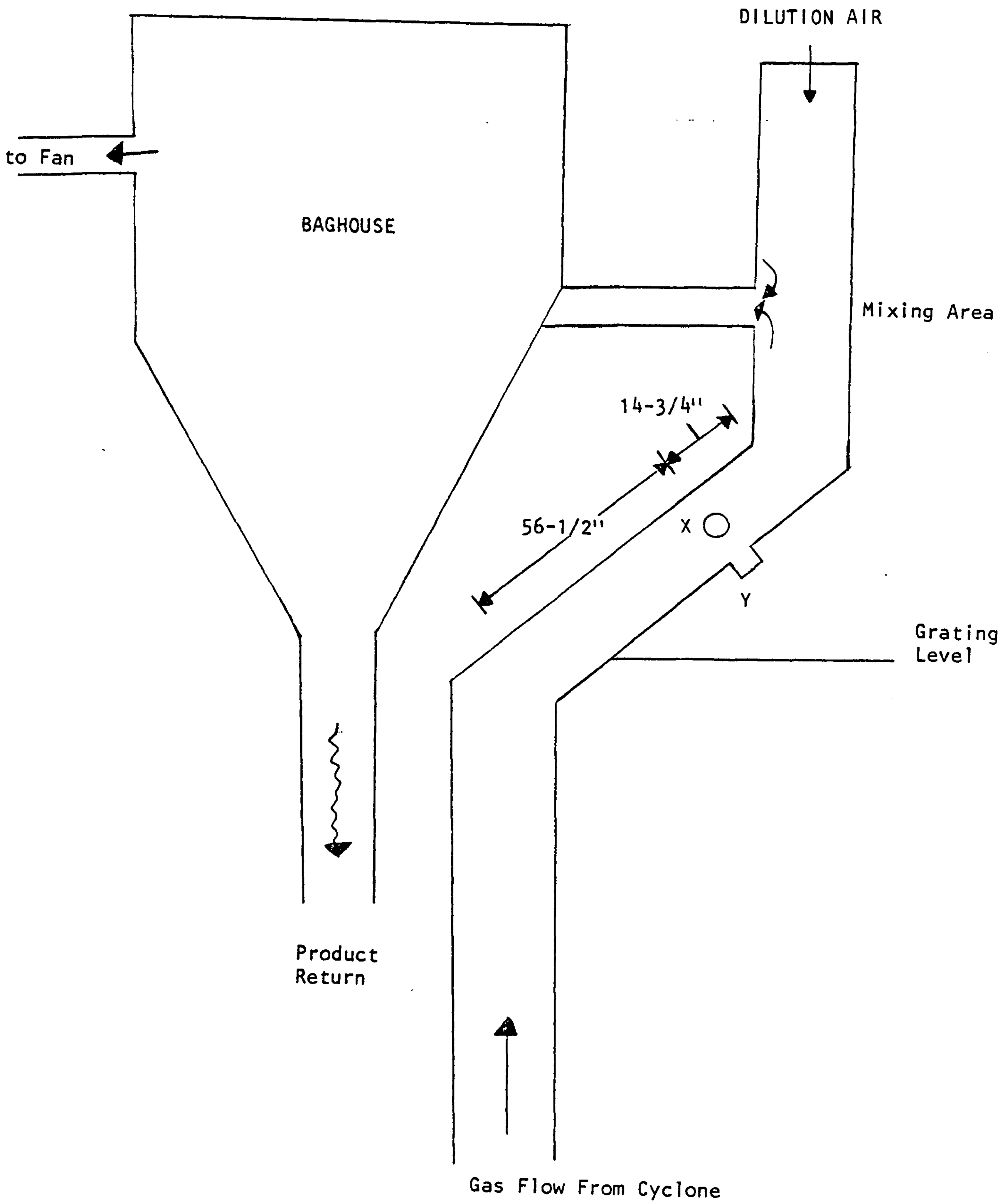
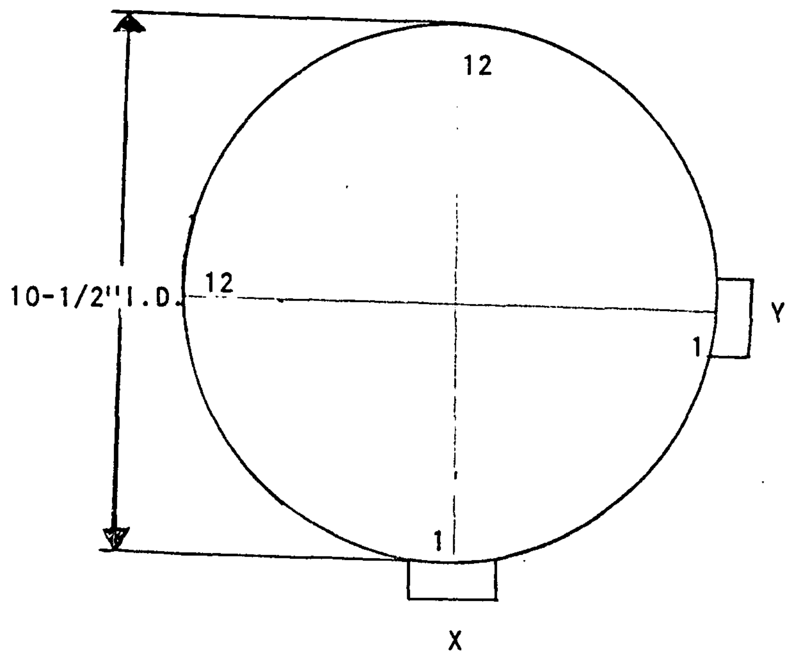
Attapulgus, Georgia
FIGURE 6
#2 FLUID ENERGY MILL BAGHOUSE INLET DUCT
TEST PORT LOCATIONS



METAL STACK

ENGELHARD MINERALS & CHEMICALS CORPORATION
Attapulgus, Georgia
FIGURE 7
#2 FLUID ENERGY MILL BAGHOUSE INLET DUCT
SAMPLING POINT LOCATIONS



DUCT CROSS-SECTIONAL VIEW

TRAVERSE POINT NUMBER	DISTANCE FROM INSIDE NEAR WALL, INCHES
1	1/2 Adj.
2	1/2
3	3/4
4	1-1/8
5	1-1/2
6	1-7/8
7	2-1/2
8	3-1/8
9	4
10	6-1/2
11	7-3/8
12	8
13	8-1/2
14	9
15	9-3/8
16	9-3/4
17	10
18	10 Adj.

Particulate Sampling Trains

The test train utilized for particulate sampling at both baghouse inlet duct locations was the standard EPA Method Five Train (see Figure 8).

A stainless steel nozzle was attached to a heated (~250°F) 3" borosilicate glass probe which was connected directly to a borosilicate filter holder containing a 4" Reeve Angel 900 AF glass fiber filter. The filter holder was maintained at approximately 250° F in a heated chamber, and was connected by Tygon® vacuum tubing to the first of four Greenburg-Smith impingers which were included in the train to condense the moisture in the gas stream. Each of the first two impingers contained 100 ml of distilled water, the third was dry and the final impinger contained 200 grams of dry pre-weighted silica gel. The first, third, and fourth impingers were modified Greenburg-Smith type; the second was a standard Greenburg-Smith impinger. All impingers were maintained in a crushed ice bath. A RAC control console with vacuum pump, dry gas meter, a calibrated orifice, and inclined manometers completed the sampling train.

Flue gas temperature was measured by means of a Type K thermocouple which was connected to a direct readout pyrometer. The thermocouple sensor was positioned adjacent to the sampling nozzle.

Gas velocity was measured using a calibrated "S" type pitot tube provided with extensions and fastened alongside the sampling probe. Gas stream composition (carbon dioxide, oxygen, and carbon monoxide content) was determined utilizing Orsat apparatus to analyze stack gas samples. Gas stream composition proved to be ambient air since no combustion products were found in any of the stack gas effluent samples.

The test train used for particulate sampling at both baghouse exhaust stack locations was the EPA Method 17 Train (In-Stack Filtration Method). See Figure 9 for train schematic.

The configuration and operation of the train is similar to the Method 5 train except that the filter was placed immediately after the nozzle and prior to the probe in the Method 17 train. Also, the glass probe and filter heating systems were eliminated, and the sample was collected at or below stack temperature. It should be noted that elbow nozzles with extra long shafts were utilized with the Method 17 trains to enable sampling the small stacks without exceeding the cross sectional area blockage limit of 3% as specified in the regulations.

<u>Particle Size Distribution Sampling Apparatus</u>

A stainless steel nozzle was connected directly to an 8-stage Anderson^{R} cascade impaction device which separated the particles according to their effective aerodynamic particle diameters. A glass fiber filter was used to capture any particles that passed through the impactor substrates to permit the measurement of total particulate. The filter holder was maintained at stack temperature and was connected by Tygon^{R} vacuum tubing to the first of four Greenburg-Smith impingers which were included in the train to condense the moisture in the gas stream. All impingers were maintained in a crushed ice bath. A RAC control console with vacuum pump, dry gas meter, a calibrated orifice, and inclined manometers completed the sampling train.

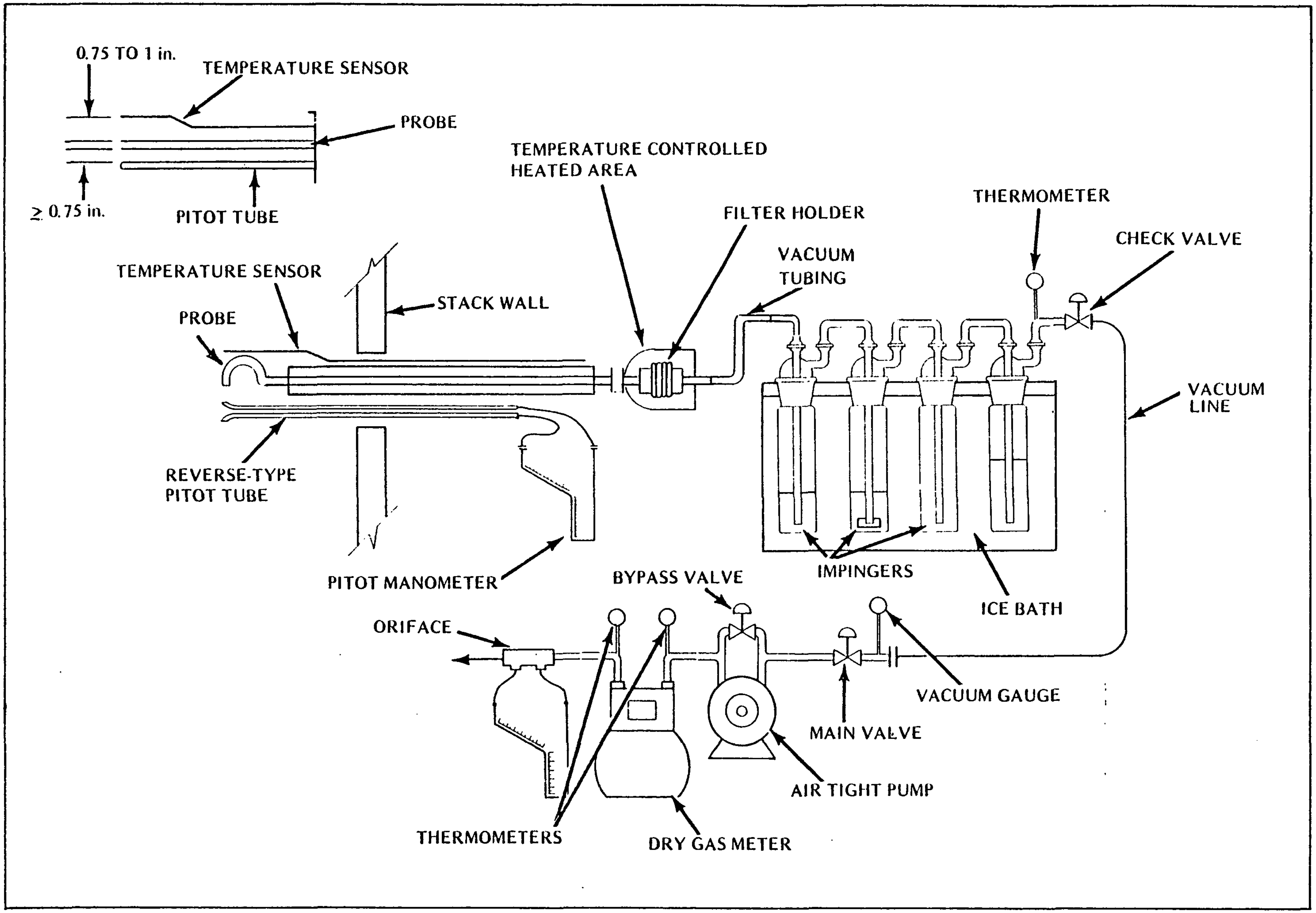


FIGURE 8 PARTICULATE SAMPLING TRAIN
EPA METHOD 5

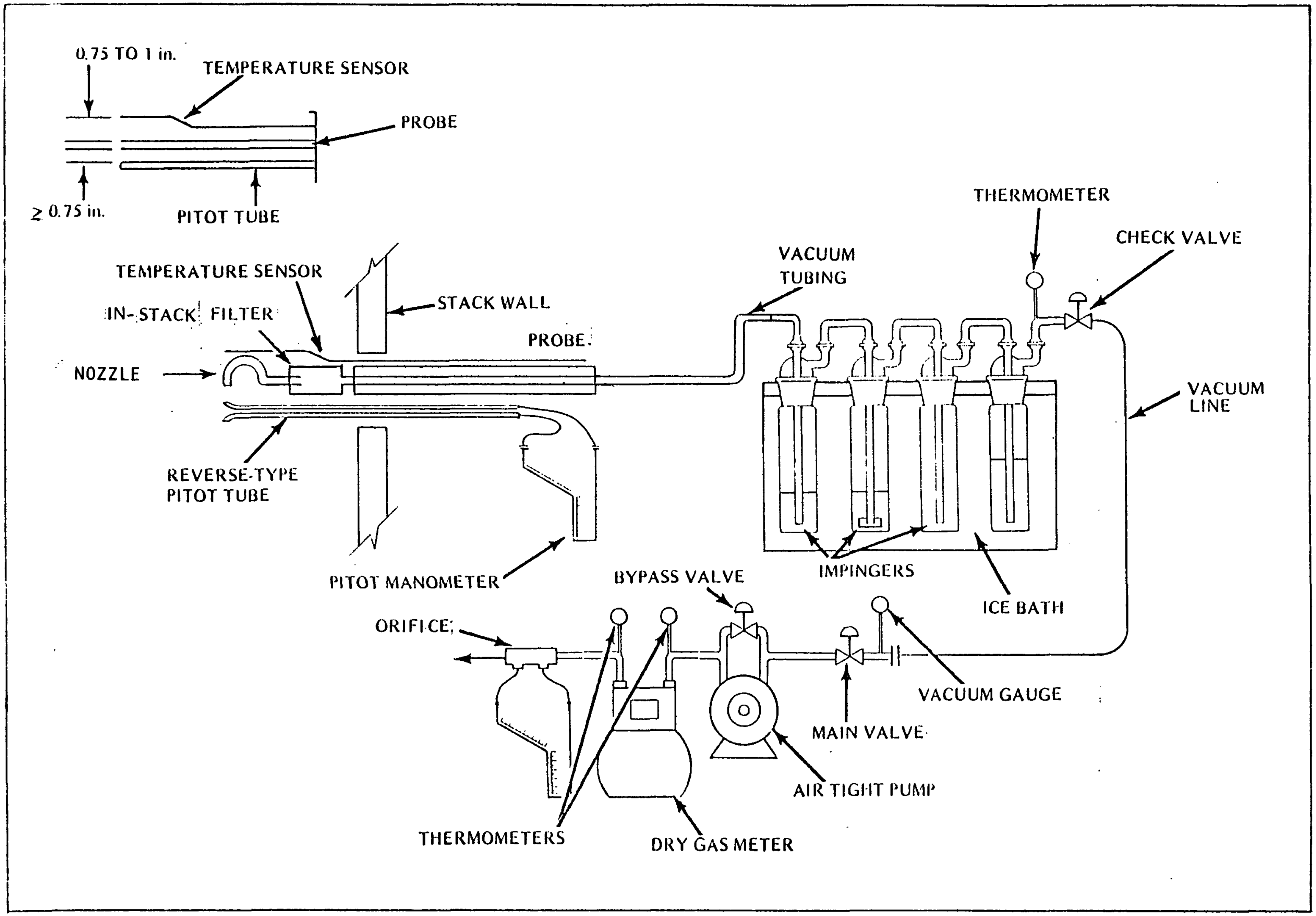


FIGURE 9 PARTICULATE SAMPLING TRAIN
EPA METHOD 17
IN-STACK FILTRATION METHOD

Preliminary Tests

Preliminary test data was obtained at each sampling location. Stack geometry measurements were recorded and sampling point distances calculated. A preliminary velocity traverse was performed at each test location utilizing a calibrated "S" type pitot tube and a Dwyer inclined manometer to determine velocity profiles. A check for the presence or absence of cyclonic flow was conducted at each test location prior to formal testing. The cyclonic flow check proved negative at all locations verifying the suitability of these locations for representative sampling. Stack gas temperatures were observed with a direct read-out pyrometer equipped with a chromel-alumel thermocouple. Gas stream composition and moisture content values were estimated from information supplied by Englehard.

Preliminary test data was used for nozzle sizing and nomagraph set-up for isokinetic sampling procedures.

Calibration of the probe nozzles, pitot tubes, metering systems, probe heaters, temperature gauges and barometer were performed as specified in Section 5 of EPA Method 5 test procedures (see Appendix E for calibration data).

No. 2 Raymond Mill Baghouse Exhaust Stack

A series of three tests were conducted at No. 2 Raymond Mill Baghouse Exhaust Stack to measure the concentration and mass rate of particulate matter emissions. Twenty traverse points, 10 per port axis, were sampled for six minutes each resulting in a total test time of 120 minutes.

During particulate sampling, gas stream velocities were measured by inserting a calibrated "S" type pitot tube into the stream adjacent to the sampling nozzle. The velocity pressure differential was observed immediately after positioning the nozzle at each point, and sampling rates were adjusted to maintain isokinetic sampling. Stack gas temperatures were also monitored at each point with the pyrometer and thermocouple. Additional temperature measurements were made at the final impinger and at the inlet and outlet of the dry gas meter.

Test data was recorded every three minutes at each point during all test periods. Leak checks were performed according to EPA Method 17 instructions prior to and after each run and/or component change. Table 1 presents a summary of test data for each of the three runs. Test result summarization appears on Table 5.

Visible emissions observations were recorded concurrently with each particulate test repetition by a certified observer according to EPA Method 9 procedures. See Table 5 for result summary.

<u>No. 2 Raymond Mill Baghouse Inlet Duct</u>

One EPA Method 5 test was performed at the inlet simultaneous with particulate Test Run 3 at the outlet. Eight points were traversed, 4 per port axis, for 15 minutes, each yielding a test period 120 minutes in length.

Procedures for isokinetic sampling were identical for those described for the outlet location except that test data was recorded every 5 minutes and the filter holder temperatures were monitored. Test data and test result summaries are provided in Tables 2 and 6 respectively.

One sampling point located at a site of average velocity was selected from particulate traverse data for particle size distribution testing. The gas stream was sampled isokinetically at that point for 30 seconds which permitted collection of sufficient sample for analysis without overloading the filter substrates. Sample volume, temperature, and pressure data was recorded before and after the test. See Figure 10 for a distribution plot.

<u>No. 2 Fluid Energy Mill Baghouse Exhaust Stack</u>

Three 120 minute Method 17 test runs were performed at the baghouse outlet. A total of 20 points were sampled for 6 minutes each per test.

Procedures for isokinetic sampling were identical to those described in No. 2 Raymond Mill Baghouse Exhaust Stack Section.

See Tables 3 and 7 for test data and test result summaries respectively.

Visual determinations of plume opacity were performed by a certified observer according to Method 9 Procedures. A summary of results is presented in Table 7.

No. 2 Fluid Energy Mill Baghouse Inlet Duct

One Method 5 test was performed at the inlet simultaneous with particulate Test Run 2 at the outlet. Thirty-six points were traversed, 18 per port axis, for 3.5 minutes each yielding a test period of 126 minutes.

Isokinetic sampling procedures were identical to those previously described except that test data was recorded every 3.5 minutes. Table 4 shows test data summarization and Table 8 presents test results.

One particle size distribution sample was collected isokinetically at a point of average velocity over a 1.5 minute period. Sample volume, temperature, and pressure data was recorded before and after the test. See Figure 11 for distribution results.

ANALYTICAL PROCEDURES

Particulate Sample Recovery

At the conclusion of each test, the sampling trains were dismantled, openings sealed, and the components transported to the field laboratory. Sample integrity was assured by maintaining chain of custody records which will be supplied upon request.

A consistent procedure was employed for sample recovery:

- The glass fiber filter(s) was removed from its holder with tweezers and placed in its original container (petri dish), along with any loose particulate and filter fragments (Sample 1).
- The probe (EPA 5) and nozzle were separated and the internal particulate rinsed with acetone into a borosilicate container while brushing a minimum of three times until no visible particles remained. Particulate adhering to the brush was rinsed with acetone into the same container. The front half of the filter holder was rinsed with acetone while brushing a minimum of three times. The rinses were combined (Sample 2) and the container sealed with a Teflon lined closure.
- The total liquid in impingers one, two and three was measured, the value recorded, and the liquid discarded.
- The silica gel was removed from the last impinger and immediately weighed.
- An acetone sample was retained for blank analysis.

Particulate Analyses

The filters (Sample 1) and any loose fragments were desiccated for 24 hours and weighed to the nearest 0.1 milligram to a constant weight.

The acetone wash samples (Sample 2) were evaporated at ambient temperature and pressure in tared beakers, and desiccated to constant weight. All sample residue weights were adjusted by the acetone blank value.

The weight of the material collected on the glass fiber filter(s) plus the weight of the residue of the acetone nozzle/probe/front-half filter holder washes represents the "total" EPA Method 5 catch. Complete laboratory results are presented in Appendix B of this report.

Particle Size Sample Recovery and Analyses

The cascade impactor substrates and any loose fragments were carefully removed from their support plates with tweezers and placed in individual containers (petri dishes) for shipment to Weston Laboratory.

Each cascade impactor filter was fired at 525°C and pre-weighed to the nearest 0.1 milligram to constant weight at Weston's Laboratory prior to on-site application. Subsequent to emissions exposure, the cascade impactor substrates, back-up filters and any loose fragments (Sample 4) were desiccated for 24 hours in the Laboratory, and weighed to the nearest 0.1 milligram to constant weight.

DISCUSSION OF TEST RESULTS

Particulate test data and test result summaries are presented in Tables 1 through 8 of this report. Figures 10 and 11 illustrate the particle size distribution of the particulate matter at the baghouse inlet locations.

No unusual sampling difficulties or process operating problems were encountered during any of the test periods.

The amount of particulate matter discharged to the atmosphere from both baghouse sources was low ($\leq$ 0.007 grains/dscf and $\leq$ 0.08 pounds/hour), which indicates the effectiveness of bag collectors in this application when they are properly maintained. The certified observer further corroborated the particulate test findings since no visible emissions were recorded emanating from either stack during the test program. For the record, almost no visible emissions were detected from similar adjacent sources by the smoke reader.

The particulate removal efficiency of No. 2 Raymond Mill Baghouse was measured at 99.98%; that of No. 2 Fluid Energy Mill was 99.87%. Both efficiencies were calculated based on one simultaneous inlet/outlet test only.

Results of the Anderson R cascade impaction particle size distribution test conducted at No. 2 Raymond Mill Baghouse Inlet showed a preponderance of relatively large particles entering the collector (94% of the particles, by weight, were $\geq$ 4.0 μ in diameter). The large particles were easily captured in the bag collector. At No. 2 Fluid Energy Mill Inlet, the particles were distributed normally across the particle size range. The higher percentage of small particles quantified at this location may explain the slightly lower collection efficiency of No. 2 Fluid Energy Mill Baghouse compared to No. 2 Raymond Mill Baghouse assuming identical bag specifications, collector operating conditions, etc.

ENGELHARD MINERALS & CHEMICALS CORPORATION

Attapulgus, Georgia

TABLE 1

#2 Raymond Mill Baghouse Exhaust

Summary of Test Data

Test Data			
Test Number	1	2	3
Test Date	6/14/78	6/15/78	6/15/78
Test Period	1527-1735	0851-1159	1402-1620
Sampling Data			
Sampling Duration, minutes	120.0	120.0	120.0
Nozzle Diameter, inches	0.218	0.218	0.218
Barometric Pressure, inches mercury	30.12	30.08	30.08
Average Orifice Pressure Differential, inches water	3.2	3.2	3.1
Average Dry Gas Temperature at Meter, °F	130.	111.	121.
Sample Volume at Meter Conditions, cubic feet	116.48	111.61	113.51
Sample Volume at Standard Conditions, [1] cubic feet	105.66	104.45	104.39
Gas Stream Moisture Content			
Total Water Collected by Train, ml	24.6	39.0	35.7
Standard Volume of Water Collected, cubic feet	1.16	1.84	1.68
Moisture in Gas Stream, percent by volume	1.1	1.7	1.6
Mole Fraction of Dry Gas	0.989	0.983	0.984
Gas Stream Composition			
CO_2, percent by volume	0.0	0.0	0.0
O_2, percent by volume	20.9	20.9	20.9
CO, percent by volume	0.0	0.0	0.0
N_2, percent by volume	79.1	79.1	79.1
Molecular Weight of Wet Gas	28.85	28.78	28.80
Molecular Weight of Dry Gas	28.97	28.97	28.97
Gas Stream Velocity			
Static Pressure, inches water	- 0.42	- 0.44	- 0.42
Absolute Pressure, inches mercury	30.09	30.05	30.05
Average Temperature, °F	183.	151.	150.
Pitot Tube Calibration Coefficient	0.855	0.855	0.855
Total Number of Sampling Points	20.0	20.0	20.0
Velocity at Actual Conditions, feet/second	74.9	71.4	71.4
Gas Stream Volumetric Flow			
Stack Cross-Sectional Area, square feet	0.573	0.573	0.573
Volumetric Flow at Actual Conditions, cubic feet/minute	2,580.	2,460.	2,450.
Volumetric Flow at Standard Conditions, cubic feet/minute	2,100.	2,090.	2,100.
Percent Isokinetic	92.6	91.9	91.5
Process Operations Data			
Mill Feed Rate, pounds/hour	MONITORED BY ENGELHARD PERSONNEL		
Baghouse Pressure Drop, inches H_2O	3.7	4.4	4.8

[1] Standard Conditions = 68°F, 29.92 inches mercury, dry basis.

ENGELHARD MINERALS & CHEMICALS CORPORATION

Attapulgus, Georgia

TABLE 2

#2 Raymond Mill Baghouse Inlet

Summary of Test Data

Test Data	
Test Number	1
Test Date	6/15/78
Test Period	1400-1612
Sampling Data	
Sampling Duration, minutes	120.0
Nozzle Diameter, inches	0.189
Barometric Pressure, inches mercury	30.08
Average Orifice Pressure Differential, inches water	1.2
Average Dry Gas Temperature at Meter, °F	112.
Sample Volume at Meter Conditions, cubic feet	72.83
Sample Volume at Standard Conditions, [1] cubic feet	67.67
Gas Stream Moisture Content	
Total Water Collected by Train, ml	26.0
Standard Volume of Water Collected, cubic feet	1.22
Moisture in Gas Stream, percent by volume	1.8
Mole Fraction of Dry Gas	0.982
Gas Stream Composition	
CO_2, percent by volume	0.0
O_2, percent by volume	20.9
CO, percent by volume	0.0
N_2, percent by volume	79.1
Molecular Weight of Wet Gas	28.77
Molecular Weight of Dry Gas	28.97
Gas Stream Velocity	
Static Pressure, inches water	- 2.1
Absolute Pressure, inches mercury	29.93
Average Temperature, °F	153.
Pitot Tube Calibration Coefficient	0.835
Total Number of Sampling Points	8.0
Velocity at Actual Conditions, feet/second	54.4
Gas Stream Volumetric Flow	
Stack Cross-Sectional Area, square feet	0.785
Volumetric Flow at Actual Conditions, cubic feet/minute	2,560.
Volumetric Flow at Standard Conditions, cubic feet/minute	2,170.
Percent Isokinetic	104.8
Process Operations Data	
Mill Feed Rate, pounds/hour	MONITORED BY ENGELHARD PERSONNEL
Baghouse Pressure Drop, inches H_2O	4.8

[1] Standard Conditions = 68°F, 29.92 inches mercury, dry basis.

ENGELHARD MINERALS & CHEMICALS CORPORATION

Attapulgus, Georgia

TABLE 3

#2 Fluid Energy Mill Baghouse Exhaust

Summary of Test Data

Test Data			
Test Number	1	2	3
Test Date	6/14/78	6/15/78	6/15/78
Test Period	1543-1801	0914-1151	1333-1636
Sampling Data			
Sampling Duration, minutes	120.0	120.0	120.0
Nozzle Diameter, inches	0.220	0.220	0.220
Barometric Pressure, inches mercury	30.12	30.08	30.08
Average Orifice Pressure Differential, inches water	1.1	0.77	0.75
Average Dry Gas Temperature at Meter, °F	104.	102.	103.
Sample Volume at Meter Conditions, cubic feet	65.76	58.96	56.99
Sample Volume at Standard Conditions, [1] cubic feet	63.31	56.84	54.80
Gas Stream Moisture Content			
Total Water Collected by Train, ml	39.0	52.0	51.0
Standard Volume of Water Collected, cubic feet	1.84	2.45	2.40
Moisture in Gas Stream, percent by volume	2.8	4.1	4.2
Mole Fraction of Dry Gas	0.972	0.959	0.958
Gas Stream Composition			
CO_2, percent by volume	0.0	0.0	0.0
O_2, percent by volume	20.9	20.9	20.9
CO, percent by volume	0.0	0.0	0.0
N_2, percent by volume	79.1	79.1	79.1
Molecular Weight of Wet Gas	28.66	28.52	28.51
Molecular Weight of Dry Gas	28.97	28.97	28.97
Gas Stream Velocity			
Static Pressure, inches water	- 0.10	- 0.25	- 0.21
Absolute Pressure, inches mercury	30.11	30.06	30.06
Average Temperature, °F	124.	121.	124.
Pitot Tube Calibration Coefficient	0.843	0.843	0.843
Total Number of Sampling Points	20.0	20.0	20.0
Velocity at Actual Conditions, feet/second	39.0	31.6	33.2
Gas Stream Volumetric Flow			
Stack Cross-Sectional Area, square feet	0.785	0.785	0.785
Volumetric Flow at Actual Conditions, cubic feet/minute	1,840.	1,490.	1,560.
Volumetric Flow at Standard Conditions, cubic feet/minute	1,620.	1,300.	1,360.
Percent Isokinetic	96.6	108.2	99.9
Process Operations Data			
Mill Feed Rate, pounds/hour	MONITORED BY ENGELHARD PERSONNEL		
Baghouse Pressure Drop, inches H_2O	2.2	2.4	2.0

[1]Standard Conditions = 68°F, 29.92 inches mercury, dry basis.

ENGELHARD MINERALS & CHEMICALS CORPORATION

Attapulgus, Georgia

TABLE 4

#2 Fluid Energy Mill Baghouse Inlet

Summary of Test Data

Test Data	
Test Number	1
Test Date	6/15/78
Test Period	0916-1207
Sampling Data	
Sampling Duration, minutes	126.0
Nozzle Diameter, inches	0.189
Barometric Pressure, inches mercury	30.08
Average Orifice Pressure Differential, inches water	1.2
Average Dry Gas Temperature at Meter, °F	104.
Sample Volume at Meter Conditions, cubic feet	74.38
Sample Volume at Standard Conditions,[1] cubic feet	70.05
Gas Stream Moisture Content	
Total Water Collected by Train, ml	73.0
Standard Volume of Water Collected, cubic feet	3.44
Moisture in Gas Stream, percent by volume	4.7
Mole Fraction of Dry Gas	0.953
Gas Stream Composition	
CO_2, percent by volume	0.0
O_2, percent by volume	20.9
CO, percent by volume	0.0
N_2, percent by volume	79.1
Molecular Weight of Wet Gas	28.46
Molecular Weight of Dry Gas	28.97
Gas Stream Velocity	
Static Pressure, inches water	- 11.0
Absolute Pressure, inches mercury	29.27
Average Temperature, °F	121.
Pitot Tube Calibration Coefficient	0.835
Total Number of Sampling Points	36.0
Velocity at Actual Conditions, feet/second	57.0
Gas Stream Volumetric Flow	
Stack Cross-Sectional Area, square feet	0.601
Volumetric Flow at Actual Conditions, cubic feet/minute	2,060.
Volumetric Flow at Standard Conditions, cubic feet/minute	1,740.
Percent Isokinetic	103.5
Process Operations Data	
Mill Feed Rate, pounds/hour	MONITORED BY ENGELHARD PERSONNEL
Baghouse Pressure Drop, inches H_2O	2.4

[1] Standard Conditions = 68°F, 29.92 inches mercury, dry basis.

ENGELHARD MINERALS & CHEMICALS CORPORATION

Attapulgus, Georgia

TABLE 5

#2 Raymond Mill Baghouse Exhuast

Summary of Test Results

Test Data			
Test Number	1	2	3
Test Date	6/14/78	6/15/78	6/15/78
Test Time	1527-1735	0851-1159	1402-1620
Gas Flow			
Standard Cubic Feet/minute, dry	2,100.	2,090.	2,100.
Actual Cubic Feet/minute, wet	2,580.	2,460.	2,450.
Particulates			
Nozzle and Front Half Filter Holder Catch Fraction, g	0.0089	0.0104	0.0075
Filter Catch Fraction, g	0.0039	0.0053	- 0.0004
Total Particulates, g	0.0128	0.0157	0.0075
Particulate Emissions[1]			
Grains/dry standard cubic foot[2]	0.002	0.002	0.001
Pounds/hour	0.03	0.04	0.02
Baghouse Particulate Removal Efficiency, percent	---	---	99.98
Visible Emissions			
≥ 5 percent opacity, minutes observed	0.	0.	0.
0 percent opacity, minutes observed	0.	0.	0.
No visible emission, minutes observed	120.	120.	120.

[1]Based on Total Particulates captured by train.

[2]Standard Conditions = 68°F and 29.92 inches mercury.

[3]Opacity results listed are in minutes of the observed reading during the 120 minute test period.

ENGELHARD MINERALS & CHEMICALS CORPORATION

Attapulgus, Georgia

TABLE 6

#2 Raymond Mill Baghouse Inlet[3]

Summary of Test Results

Test Data	
Test Number	1
Test Date	6/15/78
Test Time	1400-1610
Gas Flow	
Standard Cubic Feet/minute, dry	2,170.
Actual Cubic Feet/minute, wet	2,560.
Particulates	
Nozzle, Probe and Front Half Filter Holder Catch Fraction, g	0.9102
Filter Catch Fraction, g	22.0470
Total Particulates, g	22.9572
Particulate Emissions[1]	
Grains/dry standard cubic foot[2]	5.24
Pounds/hour	97.4

[1] Based on Total Particulates captured by train.

[2] Standard Conditions = 68°F and 29.92 inches mercury.

[3] Test conducted simultaneously with Run 3, No. 2 Raymond Mill Baghouse Exhaust.

ENGELHARD MINERALS & CHEMICALS CORPORATION

Attapulgus, Georgia

TABLE 7

#2 Fluid Energy Mill Baghouse Exhaust

Summary of Test Results

Test Data			
Test Number	1	2	3
Test Date	6/14/78	6/15/78	6/15/78
Test Time	1543-1801	0914-1151	1333-1636
Gas Flow			
Standard Cubic Feet/minute, dry	1,620.	1,300.	1,360.
Actual Cubic Feet/minute, wet	1,840.	1,490.	1,560.
Particulates			
Nozzle and Front Half Filter Holder Catch Fraction, g	0.0016	0.0051	0.0099
Filter Catch Fraction, g	0.0017	- 0.0004	0.0149
Total Particulates, g	0.0033	0.0051	0.0248
Particulate Emissions[1]			
Grains/dry standard cubic foot[2]	0.001	0.001	0.007
Pounds/hour	0.01	0.02	0.08
Baghouse Particulate Removal Efficiency, percent	---	99.87	---
Visible Emissions			
≥ 5 percent opacity, minutes observed	0.	0.	0.
0 percent opacity, minutes observed	0.	0.	0.
No visible emission, minutes observed	120.	120.	120.

[1] Based on Total Particulates captured by train.

[2] Standard Conditions = 68°F and 29.92 inches mercury.

[3] Opacity results listed are in minutes of the observed reading during the 120 minute test period.

ENGELHARD MINERALS & CHEMICAL CORPORATION

Attapulgus, Georgia

TABLE 8

#2 Fluid Energy Mill Baghouse Inlet[3]

Summary of Test Results

Test Data	
Test Number	1
Test Date	6/15/78
Test Time	0916-1207
Gas Flow	
Standard Cubic Feet/minute, dry	1,740.
Actual Cubic Feet/minute, wet	2,060.
Particulates	
Nozzle, Probe and Front Half Filter Holder Fraction, g	0.2755
Filter Catch Fraction, g	4.4616
Total Particulates, g	4.7371
Particulate Emissions[1]	
Grains/dry standard cubic foot[2]	1.04
Pounds/hour	15.6

[1]Based on Total Particulates captured by train.

[2]Standard Conditions = 68°F and 29.92 inches mercury.

[3]Test conducted simultaneously with Run 2, No. 2 Fluid Energy Mill Baghouse Exhaust.

#2 RAYMOND MILL BAGHOUSE INLET

PARTICLE SIZE DISTRIBUTION

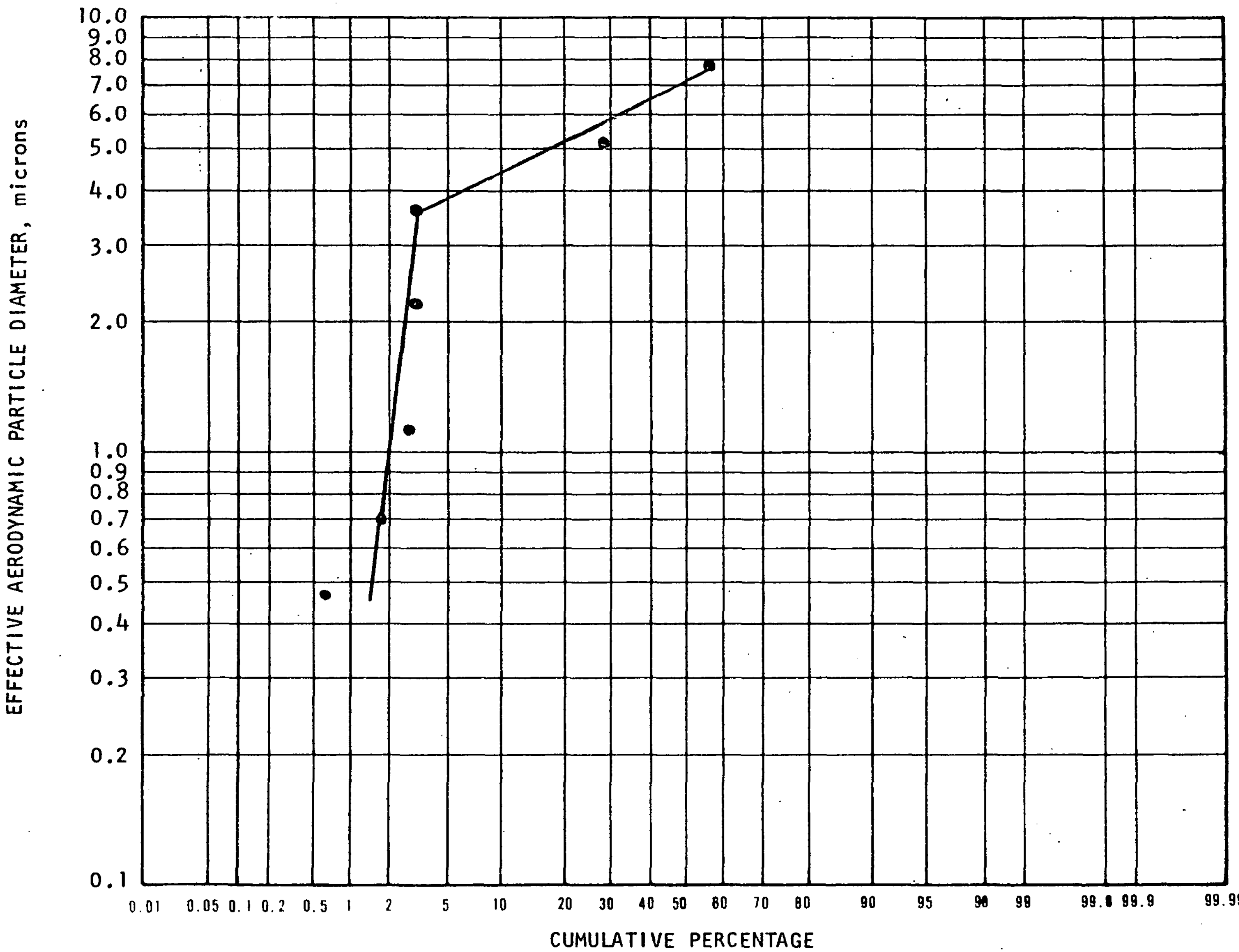


FIGURE 10

#2 FLUID ENERGY MILL BAGHOUSE INLET

PARTICLE SIZE DISTRIBUTION

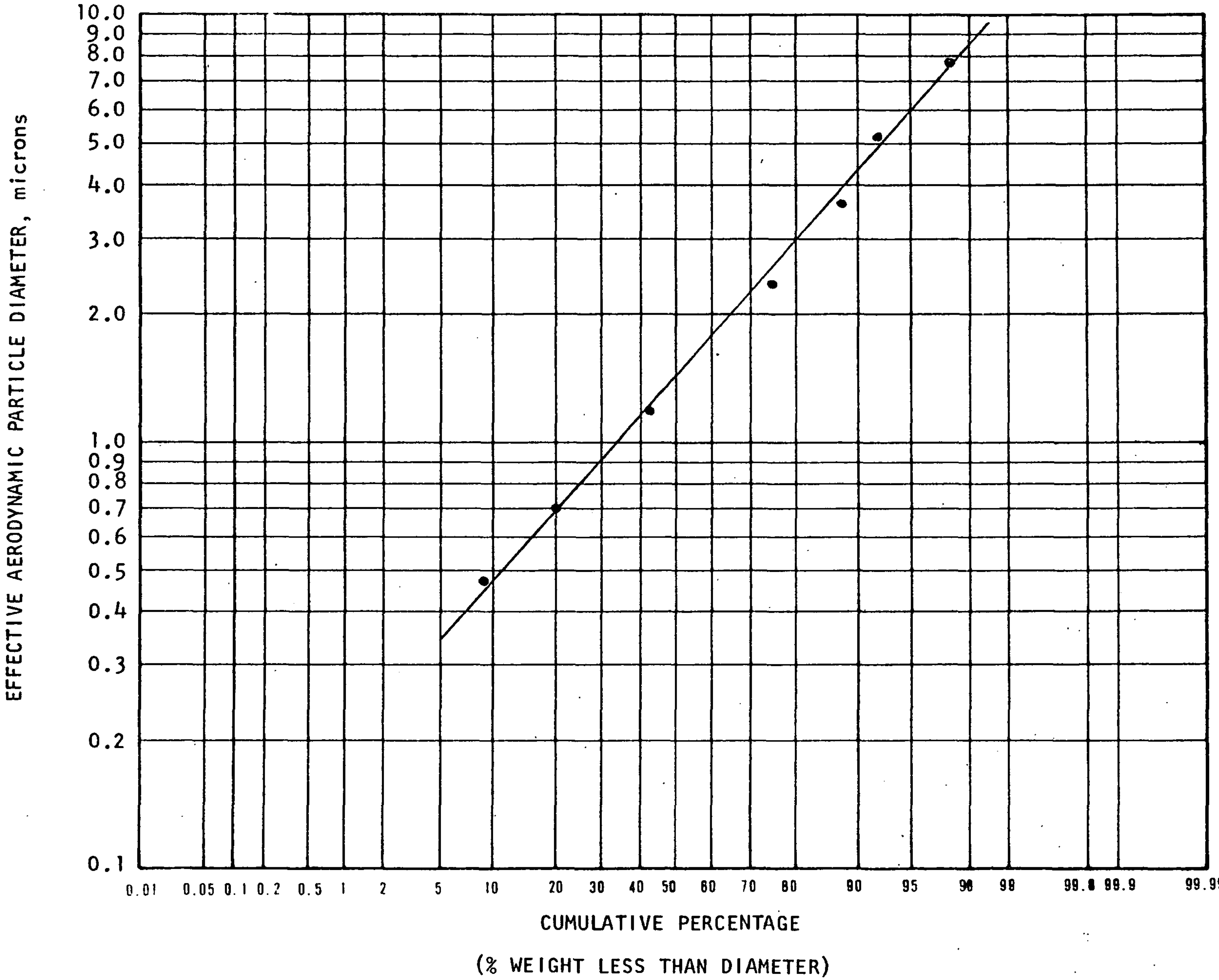


FIGURE 11