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

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February 1984

Air

EPA

Emission Test Report (Perlite)

W. R. Grace and Company Irondale, Alabama

NSPS DEVELOPMENT
PARTICULATE AND PARTICLE SIZING EMISSIONS TESTING
PERLITE EXPANSION FURNACE

W. R. GRACE AND COMPANY
IRONDALE, ALABAMA
FEBRUARY 1, 1984

Compiled by:

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

REPORT CERTIFICATION

The sampling and analysis performed for this report was carried out under my direction and supervision.

Date April 25, 1984

Signature

Frank J. Phoenix, P.E.

I have reviewed all testing details and results in this test report and hereby certify that the test report is authentic and accurate.

Date April 25, 1984

Signature

D. James Grove, P.E.

DISCLAIMER

Although the research described in this report has been funded wholly or in part by the United States Environmental Protection Agency through Contract 68-02-3852 to Entropy, it has not been subject to the Agency's peer and administrative review and therefore does not necessarily reflect the views of the Agency, and no official endorsement should be inferred.

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1. INTRODUCTION

1.1 Background. The Emission Measurement Branch of the U.S. EPA (EPA EMB) 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 will be developed based upon process-related emission factors determined from the testing of controlled sources.

1.2 Scope of the Project. The U.S. EPA 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 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 W. R. Grace Source Testing Program. The present report covers stationary source sampling performed at the W.R. Grace & Company manufacturing plant in Irondale, Alabama on February 1, 1984 to characterize emissions from the perlite expansion pollution control equipment. Clarence Duckworth of W. R. Grace and Company and Frank Clay of EPA EMB were present to coordinate the testing. Amy J. Kowalski and Butch Smith of MRI monitored the plant process and recorded operational data during the testing.

1.3.1 Source Applicability. W. R. Grace and Company operates a high temperature perlite expansion furnace. This furnace has the capability of processing NA-79 crushed perlite which has a density of about sixty pounds per cubic foot (60 lbs/ft^3). Emissions from the perlite expansion system are controlled by a baghouse, which represents the best available control technology (BACT).

1.3.2 Outline of Testing Program. Three sets of EPA Method 5 runs were performed concurrently at the baghouse east and west stacks to determine the particulate emissions from the perlite expansion process. The impinger reagents from one Method 5 run at each location were analyzed for trace metals. Concurrent with two sets of the Method 5 runs, Method 9 opacity readings were taken at the baghouse east and west stacks, and Method 22 readings for fugitive emissions were taken at the ore feed belt. One particle sizing run was done at the baghouse west stack, while a simultaneous reactivity run* was performed as a control measure at the baghouse east stack. 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.

TABLE 1-1

TESTING LOG OF 2/1/84

Sampling Location	Sampling Objective	Method	Run Numbers
Baghouse West Stack	particulate	5	1,2,3
	trace metals	5	2
	particle size	impactor	S1
	opacity	9	1 & 2
Ore Feed Belt	fugitive emissions	22	1 & 2
Furnace Inlet Feed	sieving & moisture	grab sample	1,2,3
Cyclones Product Outlet	sieving & moisture	grab sample	1,2,3
Baghouse East Stack	particulate	5	4,5,6
	trace metals	5	5
	reactivity	impactor	R1
	opacity	9	4 & 5

* A reactivity run is a simultaneous duplicate run using a filter prior to the impactor stages to collect all the particulate in the gas stream. The purpose of the run is to determine if gases in the stack effluent are reacting with the impactor stages and creating a high bias on the weights of the normal particle size run. No weight gain on the impactor stages of the reactivity run indicates no reactivity bias on the normal particle size run.

1.4 Report Organization. Immediately following is the "Summary of Results" section. Appendix 7.1 presents the complete results of each run; field data can be found in Appendix 7.2. The source and the process are described in the "Process Description and Operation" section. The next section, "Sampling Locations" provides a comprehensive description and illustration for each location; "Sampling and Analytical Procedures" follows, describing the sampling strategy used. Descriptions of the equipment and procedures can be found in Appendix 7.3, while Appendix 7.4 presents analytical documentation. The final section, "Quality Assurance," notes the procedures used to ensure the integrity of the sampling program; Appendix 7.6 provides pertinent calibration data. Appendix 7.5 contains a listing of the Entropy test participants and their roles in the testing program.

2. SUMMARY AND DISCUSSION OF RESULTS

2.1 Summary. Table 2-1 presents the total baghouse emission rates and concentrations and visible emissions summary for the particulate testing performed at the baghouse west and east stacks. A run-by-run summary of the particulate results for the west and east baghouse stacks is presented in Tables 2-2 and 2-3, respectively. Detailed results for the testing program appear in Appendix 7.1.

2.2 Discussion of Results. Particle sizing Run S1 data indicate a mass median diameter of approximately 4 microns; however, due to the low concentrations, the catches on some stages are extremely low so, caution should be used in interpreting the particle sizing data. The results appear in Appendix 7.1.3. Due to process upsets, the particle sizing testing scheduled for February 2 was not completed; limited data from the aborted runs show the mass median diameter to be consistant with Run S1.

Only the first set of two-hour visible and fugitive emissions runs was completed. The second set of readings was interrupted after one hour due to the onset of darkness; the scheduled third set was not performed.

Visible emissions plume opacity was negligible except during the cleaning cycles. Fugitive emissions were observed only when the conveyer belt was operating.

TABLE 2-1

BAGHOUSE TOTAL EMISSION RATES & CONCENTRATIONS

	Run Numbers 1 & 4	2 & 5	3 & 6	Average
Emission Rates, lb/hr:				
Baghouse West Stack	0.256	0.298	0.239	0.264
Baghouse East Stack	0.321	0.338	0.338	0.332
Sum Total	0.577	0.636	0.577	0.596
Emission Rates, kg/hr:				
Baghouse West Stack	0.116	0.135	0.108	0.120
Baghouse East Stack	0.146	0.153	0.153	0.151
Sum Total	0.262	0.288	0.261	0.271
Air Flow Rates, SCFM:				
Baghouse West Stack	2,702	2,601	2,607	2,637
Baghouse East Stack	1,986	1,986	1,997	1,990
Sum Total	4,688	4,587	4,604	4,627
Concentration, Gn/DSCF:				
Baghouse West Stack	0.0110	0.0134	0.0105	0.0116
Baghouse East Stack	0.0189	0.0198	0.0198	0.0195
Weighted Average*	0.0144	0.0162	0.0146	0.0150
Concentration, mg/DSCM:				
Baghouse West Stack	25.280	30.598	23.944	26.607
Baghouse East Stack	43.142	45.409	45.225	44.592
Weighted Average**	32.948	37.067	33.406	34.550
Average Opacity, Percent:				
Baghouse West Stack	0.16	0.04	-	-
Baghouse East Stack	0.14	0.35	-	-
Fugitive Emissions:				
Observation Time, min.	95.00	45.00	-	-
Duration of Emissions, min.	10.60	35.63	-	

$$* \text{ Weighted Gn/DSCF} = \frac{\text{lb/hr } (7000)}{\text{SCFM } (60)}$$

$$** \text{ Weighted mg/DSCM} = \frac{453{,}592}{7000\ (0.02832)} * \text{ Weighted Gn/DSCF}$$

TABLE 2-2

PARTICULATE TESTS SUMMARY OF RESULTS

Expansion Furnace Baghouse West Stack

	1	2	3
Run Date	02/01/84	02/01/84	02/01/84
Test Train Parameters:			
Volume of Dry Gas Sampled, SCF*	90.792	89.090	90.990
Percent Isokinetic	99.1	101.0	100.5
Stack Parameters:			
Temperature, Deg. F	370	383	378
Air Flow Rates SCFM*, Dry	2,702	2,601	2,670
ACFM, Wet	4,525	4,463	4,568
Method 5 Test Results:			
Catch, Milligrams	65.0	77.2	61.7
Concentration, Grains Per DSCF*	0.0110	0.0134	0.0105
Milligrams Per DSCM	25.280	30.598	23.944
Emission Rate, Pounds Per Hour	0.256	0.298	0.239
Kilograms Per Hour	0.116	0.135	0.108

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

TABLE 2-3

PARTICULATE TESTS SUMMARY OF RESULTS

Expansion Furnace Baghouse East Stack

	4	5	6
Run Date	02/01/84	02/01/84	02/01/84
Test Train Parameters:			
Volume of Dry Gas Sampled, SCF*	106.647	108.400	107.826
Percent Isokinetic	104.6	106.3	105.2
Stack Parameters:			
Temperature, Deg. F	371	376	372
Air Flow Rates SCFM*, Dry	1,986	1,986	1,997
ACFM, Wet	3,346	3,380	3,389
Method 5 Test Results:			
Catch, Milligrams	130.3	139.4	138.1
Concentration, Grains Per DSCF*	0.0189	0.0198	0.0198
Milligrams Per DSCM	43.142	45.409	45.225
Emission Rate, Pounds Per Hour	0.321	0.338	0.338
Kilograms Per Hour	0.146	0.153	0.153

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

3. PROCESS DESCRIPTION AND OPERATION

3.1 Introduction. Source emission tests were conducted on the perlite expansion furnace at the W. R. Grace & Co. (Grace) plant in Irondale, Alabama from January 30 through February 2, 1984. Mr. Frank Clay of EPA/EMB was present during the testing to observe emission testing procedures. The tests were conducted by an eight-person test crew headed by Mr. Frank Phoenix of Entropy. The process was monitored by Stacy Smith and Amy Kowalski from MRI. Mr. Clarence Duckworth of Grace coordinated the testing with plant personnel and provided process information.

3.2 Pollutants/Sampling Points. The primary objectives of the emission test were to obtain the following data for the outlet of the perlite expansion furnace baghouse: (1) particulate matter (PM) concentrations, (2) PM mass emission rates, and (3) particle size distributions (PS) for the PM. Visible emission (VE) observations were made at the two outlet stacks simultaneously with the emission testing. VE measurements were also made of the process fugitive emissions at the expansion furnace feed inlet. The feed inlet consists of a covered belt conveyer which dumps into a bucket elevator. No VE measurements were taken on the product outlet because the system was totally enclosed with no visible leaks. Grab samples of the feed and product material and of the baghouse fines were taken for particle size sieve and moisture content analyses. Table 1 presents the tests conducted at this facility.

TABLE 3-1. EMISSION TESTS CONDUCTED AT W. R. GRACE & CO.[a]

Sampling point	Test type	Test method(s)	No. of samples/run
Furnace feed inlet	Visible emissions	EPA-9,22	1
	Moisture content	ASTM D2216	1
	Particle size sieve	ASTM D422	1
Furnace product outlet	Moisture content	ASTM D2216	1
	Particle size sieve	ASTM D422	1
Baghouse outlet stacks (2)	Particle concentration	EPA-5	1
	Particle size	EPA draft method	1
	Visible emissions	EPA-9	1

[a]EPA Method 5 tests consisted of three runs, all on February 1, 1984. Particle size testing consisted of one run also on February 1, 1984. Additional particle size runs were not possible because of fan malfunctions. Simultaneous particle size and particulate testing was not feasible because of the small stack diameter.

3.3 Process Description

3.3.1 General. Grace expands one size of perlite ore, for horticultural uses, in its Perlite Corporation Model VS-450 vertical expansion furnace. During emission testing, Grefco NA 79 ore was processed. The pre-sized perlite concentrate is fed into the 0.7-m (28-in.) -diameter stainless steel furnace through a surge preheater at a rate of about 0.91 mg/h (1 ton/h). Four variable speed screw feeders on the side of the furnace inject the perlite 1.5 to 1.8 m (5 to 6ft) above the natural gas-fired combustion burner. The fuel usage rate for this furnace is 198 to 227 m^3/h (7,000 to 8,000 ft^3/h).

The perlite is expanded 4 to 20 times its original volume in the hot zone of the furnace at temperatures of 982 degrees to 1093 degrees Celsius (1800 to 2000 degrees Fahrenheit). The four baghouse exhaust fans convey the expanded perlite particles through 30.5-cm (1-ft) -diameter circular ductwork to a 1.75-m (69-in.) -diameter product collection cyclone. The collected perlite falls through a cooler/classifier unit prior to bagging. The air stream from the product cyclone and cooler/classifier cyclone passes through a four-compartment Perlite Corporation baghouse prior to being emitted to the atmosphere. Figure 1 shows an expansion furnace with the Perlite Corporation cyclone and baghouse that is similiar to the system used at Grace. The controlled expansion temperature of the furnace, as indicated by the control panel monitor, ranges from 799 to 832 degrees Celsius (1470 to 1530 degrees Fahrenheit). The furnace has a retention time of two to three seconds. Table 2 presents the design and operating parameters for the furnace. Table 3 presents the specifications for the feed and product material provided by Mr. Frederick Eaton of Grace.

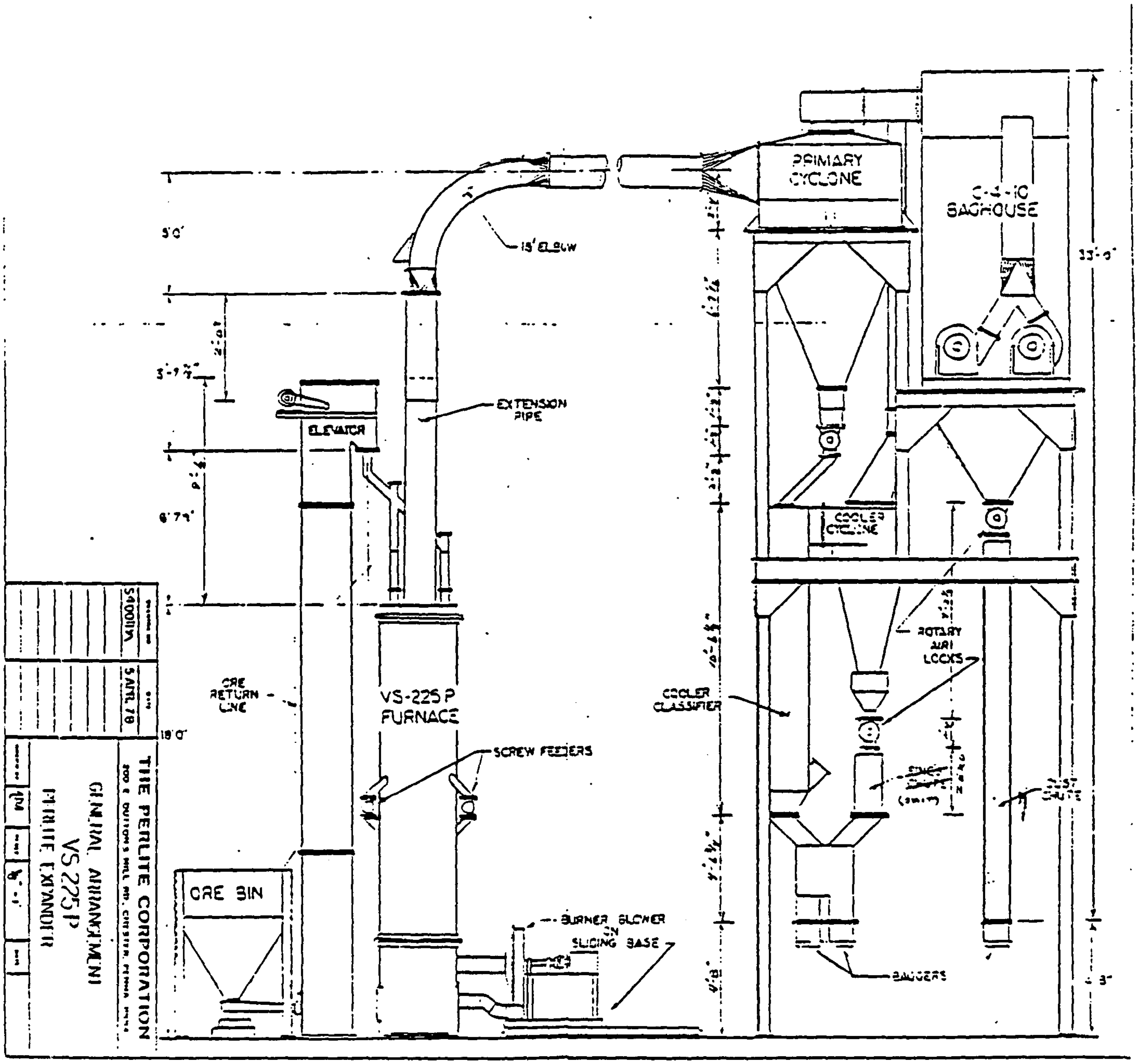

Figure 3-1. Perlite expansion system
W. R. Grace & Co.

TABLE 3-2. DATA FOR PERLITE EXPANSION
FURNACE AT W. R. GRACE & CO., IRONDALE, ALABAMA

Manufacturer	Perlite Corporation
Model	VS-450
Date of installation	1977
Design production rate, Mg/h (ton/h)	1.09 (1.20)
Actual production rate, Mg/h (ton/h)	See Confidential Addendum Item No. 2
Hours of operation	
hours/day	8-16
days/week	5
Retention time, s	2-3
Maximum gas temperature, °C (°F)	982-1093 (1800-2000)
Fuel used	Natural gas
Fuel usage rate, m^3/h (ft^3/h)	See Confidential Addendum Item No. 3
Feed moisture content, %	2-5
Feed particle size	90 percent ≥20 mesh
Feed density, kg/m^3 (lb/ft^3)	881+ (55+)
Product moisture content, %	0
Product density, kg/m^3 (lb/ft^3)	64-112 (4-7)

TABLE 3-3. FEED AND PRODUCT SPECIFICATIONS FOR GREFCO NA79 PERLITE[a]

Mesh size	Cumulative percent retained	
	Raw ore	Expanded product[b]
+4	0	--
+8	20	50% minimum
+12	60	--
+16	85	--
+20	90	90% minimum
+50	--	--
+100	--	96% minimum

[a]Telecons. A. J. Kowalski, MRI, with Mr. Frederick Eaton, W. R. Grace & Co. on February 1 and April 4, 1984.

[b]W. R. Grace & Co. quality control purchase specifications.

TABLE 3-4. DATA FOR PERLITE CORPORATION BAGHOUSE
W. R. GRACE & COMPANY, IRONDALE, ALABAMA[a]

Manufacturer	Perlite Corporation
Bag material	Glass graphite
Air-to-cloth ratio	2.6:1
Inlet temp., °C (°F)	232-243 (450-470)
Actual gas flow rate, m^3/s (acfm)	170 @ 177°C (6,000 @ 350°F)[b]
Pressure drop, kPa (in. w.c.)	1.5 (6)
Number of stacks	2
Stack height (from roof), m (ft)	11.3 (27)
Stack diameter, m (ft)	0.4 (1.25)
Number of compartments	4
Design outlet grain loading, g/dsm^3 (gr/dscf)	1.8×10^{-5} (0.01)
Design efficiency	>99%

[a]Telecon, 6/7/83 with Mohammed Huda, Jefferson County Dept. of Health, Birmingham, Ala., and Section 114 response.
[b]Stack temperature.

3.3.2 Control Equipment. Particulate emissions from the perlite expansion furnace are controlled by a baghouse. Data for the baghouse are shown in Table 4. The baghouse was manufactured by the Perlite Corporation. It has four compartments and is equipped with 100 glass graphite bags. The design air-to-cloth ratio is 2.6:1. The temperature of the inlet gas is 232 to 243 degrees Celsius (450 to 470 degrees Fahrenheit). The collected material from the baghouse is bagged separately and landfilled. The baghouse is equipped with four fans, one on each compartment. The baghouse is cleaned by compartment when the respective fan is shut off for a few seconds. The cleaning cycle is set on seven minutes per compartment.

3.4 Process Conditions During Testing. All processes were operating normally during the emission testing. The furnace operation is monitored from a control panel that contains gauges for the furnace outlet temperature, the baghouse internal temperature, and the ore feeder speed. To achieve the required amount of exfoliation for final product quality, the hot section of the furnace must be 982 to 1093 degrees Celsius (1800 to 2000 degrees Fahrenheit). This corresponds to a furnace control temperature of approximately 816 degrees Celsius (1500 degrees Fahrenheit) according to Mr. Duckworth. Throughout the testing the furnace control temperature was 799 to 832 degrees Celsius (1470 to 1530 degrees Fahrenheit) indicating normal furnace operation.

The design capacity of the vertical expansion furnace is 1.09 mg/h (1.2 ton/h). The normal actual production rate is 0.9 mg/h (1 ton/h). Natural gas with a heating value of 1,000 Btu/ft^3 was used to fire the furnace during the testing. The gas firing system was operating normally during the test.

Additional information about the process operation during testing is provided in a Confidential Addendum to this report.

3.5 Discussion. Due to the small diameter of the baghouse outlet stacks [0.4 m (1.25 ft)], simultaneous particle size and Method 5 testing was not possible. In addition, two of the four baghouse fans malfunctioned on three separate occasions. None of the malfunctions affected any of the testing runs. As a result of these breakdowns, however, Method 5 Run No. 3 was performed at night, and VE readings could not be taken. Also, only one 2-hour particle size run was completed due to the fan breakdowns.

Additional particle size testing was scheduled on Thursday, February 2, 1984, to complete the testing requirements. Originally, the three particle size runs were to be performed in only one stack. Due to time constraints, EMB personnel approved simultaneous particle size testing using both stacks. After approximately one hour of testing, the third fan malfunction occurred, and testing was suspended. Because acceptable Method 5 runs had already been obtained and because the outlet particle size data could not be obtained concurrently and were not critical to the calciners and dryers project, it was decided that the testing would be terminated without the final two particle size runs.

Confidential Attachment

4. SAMPLING LOCATIONS

4.1 Suitability of Sampling Sites. The primary goal of the testing program was to characterize emissions from the perlite expansion 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 Perlite Expansion Furnace Inlet (Sampling Location A). Grab samples of the feed to the expansion furnace were collected for sieve analysis and moisture content determination. Samples were taken during each set of simultaneous Method 5 runs.

4.3 Ore Feed Belt (Observation Location E). Fugitive emissions were determined at the ore feed belt according to EPA Reference Method 22.

4.4 Cyclones Product Outlet (Sampling Location B). Grab samples of product from the cyclones product outlet were collected for sieve analysis and moisture content determination. Samples were taken during each set of simultaneous Method 5 runs.

4.5 Baghouse Exhaust Stacks (Sampling Locations C and C'). Measures of particulate emissions were made at the identical baghouse east and west stacks. A determination of particle size distribution was made only at the baghouse west stack, while a reactivity particle size run was conducted for reference at the baghouse east stack. Figure 4-2 illustrates the dimensions and sampling points which are typical for both stacks.

Both stacks are vertical with inside diameters of 15 inches. Each stack has two sampling ports spaced 90^{o} apart and located 12 inches (0.8 stack diameters) upstream from the stack outlet and 60 inches (4 stack diameters) downstream from the nearest flow disturbance. In accordance with EPA Method 1 (promulgated on September 30, 1983), 24 sampling points were used,

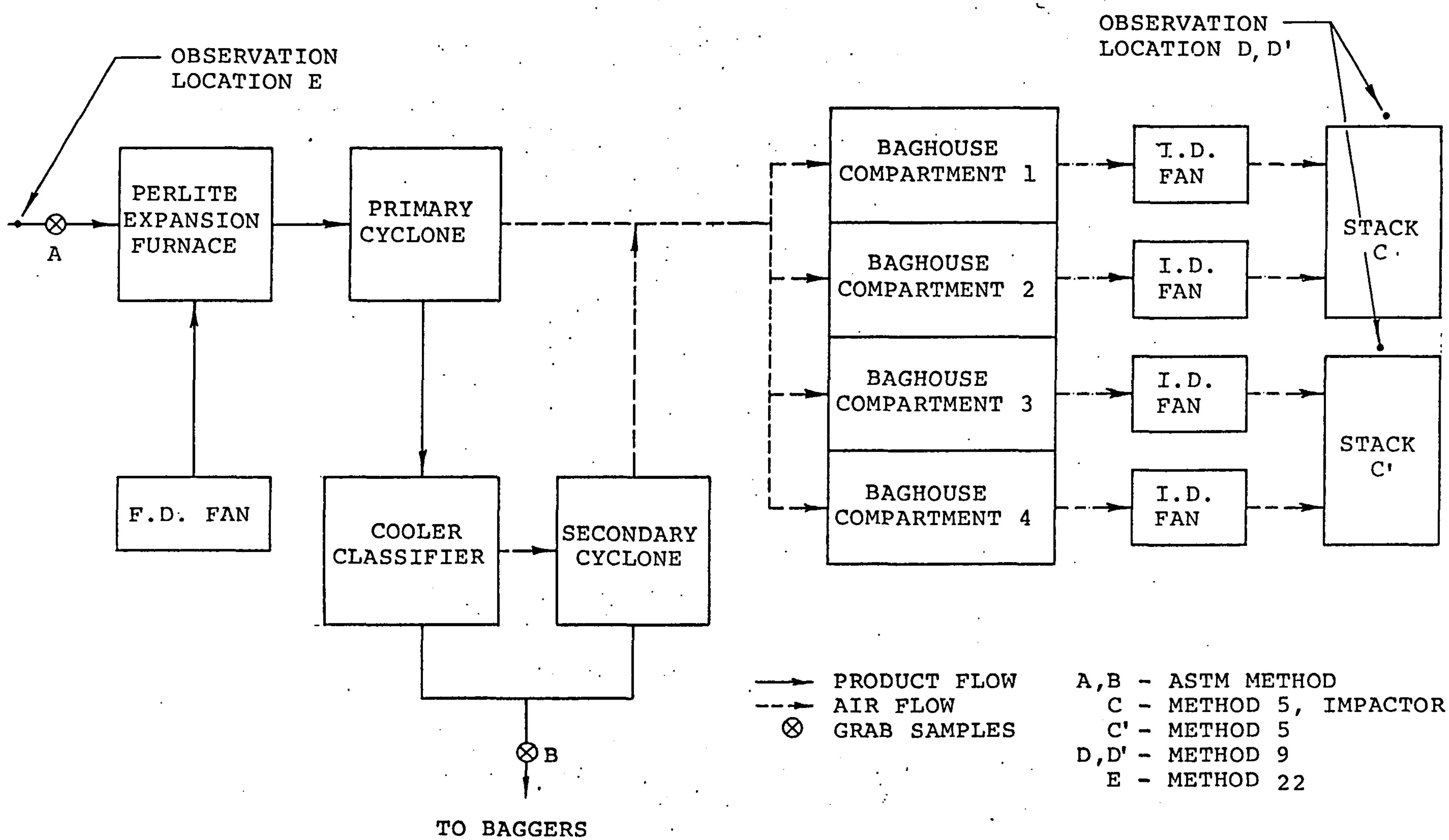

FIGURE 4-1. PERLITE EXPANSION PROCESS SAMPLING LOCATIONS
W. R. GRACE, IRONDALE, ALABAMA

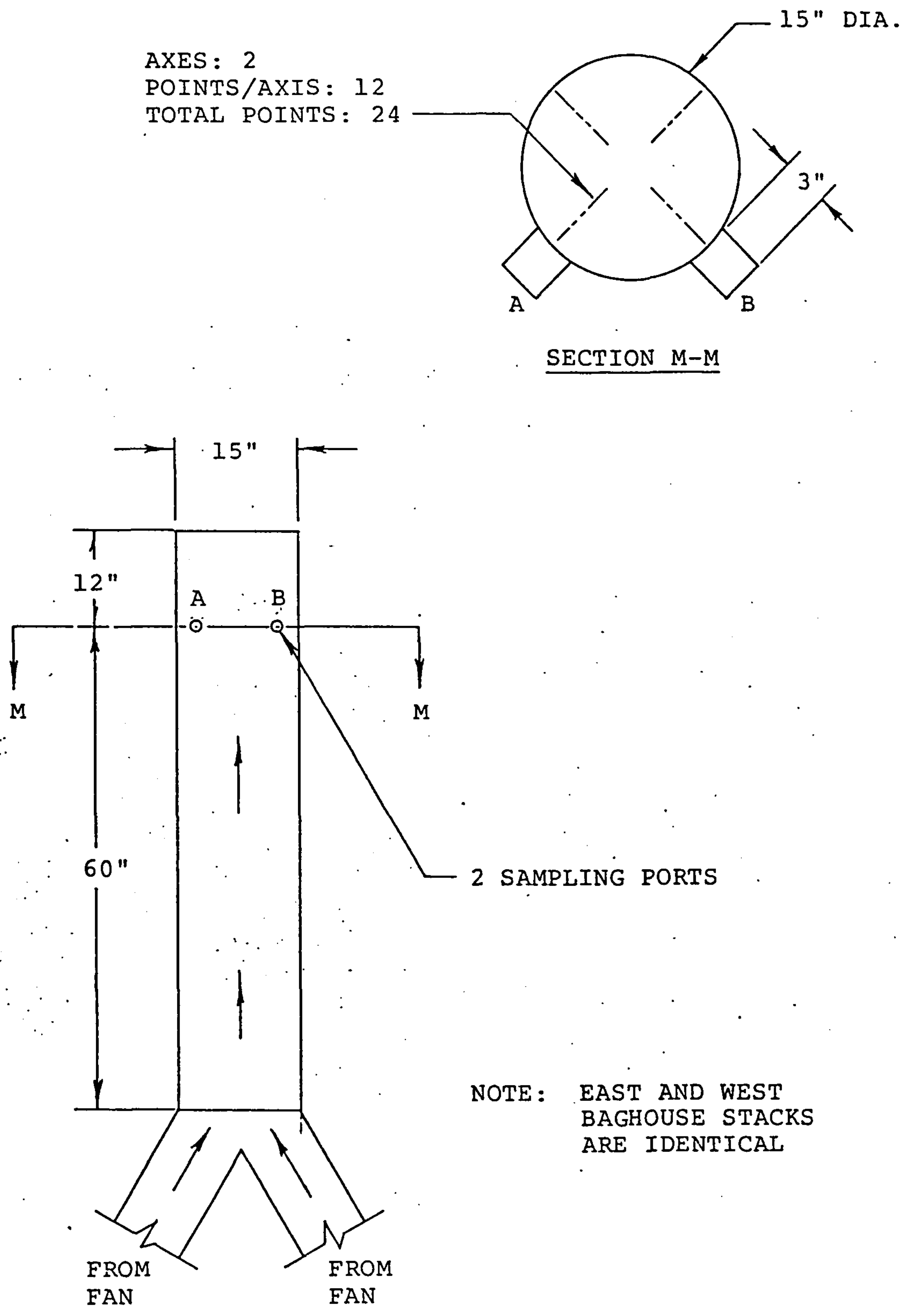

FIGURE 4-2. EAST OR WEST BAGHOUSE OUTLET STACK DIMENSIONS WITH SAMPLING PORT AND POINT LOCATIONS

i.e., 12 sampling points on each of two traverse axes (labeled A and B). Each point was sampled for five minutes resulting in a net test time of 120 minutes.

Particle size determination at the baghouse west stack was performed using the four-point scheme recommended by the Industrial Environmental Research Laboratory (IERL). For the particle size testing the stack cross section was divided into four equal areas, i.e., two traverse axes with two sample points per axis. The centroid of each equal area was sampled for 30 minutes resulting in a net sample time of 120 minutes.

4.6 Baghouse Exhaust Stacks (Observation Locations D and D'). Plume opacity observations for both baghouse exhaust stacks were performed according to procedures outlined in EPA Reference Method 9.

5. SAMPLING AND ANALYTICAL METHODS

5.1 Sampling Objectives. This section describes the sampling and analytical procedures which were employed at the W. R. Grace plant in order to gather data concerning emissions from the perlite expansion pollution control equipment and to investigate physical properties of the process feed stock and the product. The sampling program included outlet tests for particulate emissions, plume opacity, and, at the baghouse west stack only, particle size distribution.

5.2 Particulate Emissions Testing. 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.

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 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. Visible emissions observations were performed in accordance with EPA Reference Method 9 as described in 40 CFR Part 60.

5.6 Fugitive Emissions. Fugitive emissions were determined in accordance with EPA Reference Method 22 as described in 40 CFR Part 60.

5.7 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 perfomed.

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, as shown in Appendix 7.6., was 0.08 milligrams, based upon weight differences ranging from 0.01 to 0.19 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 0.03 milligrams, based upon a difference ranging from 0.0 to 0.03 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.