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PM10 EMISSION FACTORS FOR A LIMESTONE CRUSHING PLANT VIBRATING SCREEN AND CRUSHER FOR

BRISTOL, TENNESSEE

EPA CONTRACT NO. 68-D2-0163
WORK ASSIGNMENT NO. 19

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Prepared for:

Emission Measurement Branch
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

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Entropy Project Number 50119

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1.0 SUMMARY

1.1 TEST PROCEDURES AND RESULTS

The U.S. Environmental Protection Agency (EPA), Emission Measurement Branch (EMB) issued a work assignment to Entropy Environmentalists, Inc. (Entropy) to develop and conduct a set of emission tests at two limestone crushing plants to determine the PM10 emission factors. The specific sources tested were a 4.5 foot shorthead cone crusher (4.5′ crusher) and an 8 by 20 foot vibrating screen. The plants selected by the EPA Task Manager were the Vulcan Materials Company, Maryville and Bristol, Tennessee Plants. This report will reflect the tests conducted at the Bristol, Tennessee Plant.

The primary objective of the tests was to determine the PM10 emissions from the specific processes with the maximum degree of accuracy. The EPA Reference Method used to quantify the PM10 emissions was Method 201A. This procedure utilizes an extractive sampling train consisting of a cyclonic precollector to remove the greater than 10 micron particles, followed by a filter. To use Method 201A, it was necessary to design a fugitive emission capture system to collect the PM10 particle laden gas stream.

A Quasi-stack system was used to conduct emission tests on the inlet and outlet of the 4.5′ crusher. Small enclosures were built at both the inlet and outlet locations. Clean make-up air from HEPA filters was blown into each enclosure at a rate approximately equal to the exhaust gas stream flow rate being drawn to the emission sampling location. Using this testing approach, all of the PM10 emissions from the crusher inlet and outlet were efficiently captured and adjacent sources of PM10 emissions did not affect the results.

The vibrating screen emission tests were conducted using a track-mounted hood system. The hood has dimensions of 2 feet by 2 feet and was mounted approximately 8 inches above the upper screen deck of the vibrating screen. The small scale and the mounting position of the hood ensured that the normal PM10 emissions were not significantly influenced by the presence of the hood. The capture velocity in the hood was set by adjusting the variable speed DC motor of the tubeaxial fan installed on the hood outlet duct. The hood capture velocity was selected based on observations of the fugitive dust capture characteristics of the hood. This testing approach is an adaptation of the conventional "roof monitoring" technique for fugitive emission testing.

The PM10 emissions were tested using EPA Method 201A. The tests were divided into two sets: stone moisture levels greater than 1%, and stone moisture levels less than 1%. The results of the PM10 emission tests are presented in Table 1. The emission rates determined during both series of tests on the 4.5′ cone crusher and the vibrating screen were low. The wet stone emission factor results are entirely consistent with the zero visible emissions operating conditions observed during all of the wet tests. Stone samples obtained during each of the tests were also analyzed and found to have very low levels of material below approximately less than 10 microns.

TABLE 1. CRUSHER PM10 EMISSIONS

PM10 Source	Stone Moisture (% Weight)	PM10 Emissions (Pounds/Ton)	Control Efficiency
Crusher	(< 1%)	0.002917	
	(> 1%)	0.001055	63.8 %
Vibrating Screen	(< 1%)	0.018393	
	(> 1%)	0.001222	93.4 %

1.2 KEY PERSONNEL

The U.S. EPA EIB Project Manager for this project was Mr. Dennis Shipman. Mr. Solomon Ricks served as the U.S. EPA EMB Project Manager. The Entropy Project Director was Dr. John Richards, P.E. The Entropy project manager was Mr. Todd Brozell. The tests were coordinated through the assistance of Mr. Allen Blake P.E. of Vulcan Materials, Inc. The tests were observed by Mr. Steve Whitt of Martin Marietta. A summary of the key personnel and their phone number are provided in Table 2.

TABLE 2. KEY PERSONNEL

	Telephone Numbers
U.S. EPA, Emission Inventory Branch	
Mr. Dennis Shipman	(919) 541-5477
U.S. EPA, Emission Measurement Branch	
Mr. Solomon Ricks	(919) 541-5242
Vulcan Materials, Inc.	
Mr. Allen Blake P.E.	(615) 579-2938
National Stone Association	
Mr. Bill Ford P.E.	(202) 342-1100
Martin Marietta	
Mr. Horace Wilson	(919) 781-4550
Mr. Steve Whitt	(919) 781-4550
Entropy Environmentalists, Inc.	
Mr. Todd Brozell	(919) 781-3550
Dr. John Richards P.E.	(919) 781-3550

2.0 PLANT AND SAMPLING LOCATION DESCRIPTION

2.1 PROCESS DESCRIPTION AND OPERATION

A 4.5 shorthead cone type tertiary crusher was tested at the Bristol, Tennessee plant. This receives the oversize stone from a 8′ x 20′ triple deck vibrating screen downstream from the secondary surge pile and 4.25′ standard crusher. The stone is feed to the tertiary crusher by means of a conveyor. The stone is discharged into a feed hopper which serves the 4.5′ shorthead cone crusher (equipment number 5 in Figure 1). There were very limited free fall distances from the feed conveyor to the feed hopper to the shorthead crusher. The crusher discharges the crushed stone onto a conveyor leading to the 8′ X 20′ vibrating screen.

The inlet to the shorthead crusher was defined as the discharge of the feed hopper to the shorthead crusher vessel. This area, having a height of approximately 4 feet above the platform, was enclosed with galvanized steel flashing to allow capture of the PM10 emissions caused by the stone-to-stone attrition during movement of the stone. The gas velocities around the layers of stone were maintained at gas flow rates equivalent to 1 to 5 mph.

The discharge point of the shorthead tertiary crusher is the same conveyor that feeds the 8′ X 20′ vibrating screen. The discharge point is enclosed approximately 4 feet upstream and downstream of the shorthead discharge point. The discharge of the shorthead crusher was defined as the total enclosure surrounding the conveyor underneath the crusher.

The vibrating screen at the Bristol, Tennessee plant of Vulcan Materials Company consists of one 8′ x 20′- triple deck screen (equipment number 4 in Figure 1). This screen receives stone from the conveyor underneath the 4.5′ shorthead crusher and the 4.25′ standard crusher as seen in Figure 1. The vibrating screen source was defined as the 8 foot wide, 20 foot long open, sloped surface above the upper screen deck. There is approximately a 12 inch freeboard above the upper screen to reduce wind entrainment of dust. The area traversed as part of this test program was the sloped surface parallel to the top of the freeboard.

The stone flow to the vibrating screens and the 4.5′ crusher is termed "closed circuit" since oversized material containing some fines adhering to the surface can recirculate through the vibrating screen and 4.5′ crusher until the stone is crushed small enough to fall through the vibrating screen. The oversized material remaining on the top screen goes to the inlet of the 4.5′ crusher. The total quantity of oversized material entering the 4.5′ crusher was approximately 280 tons per hour. The stone feed rates to the vibrating screen was approximately 425 tons per hour.

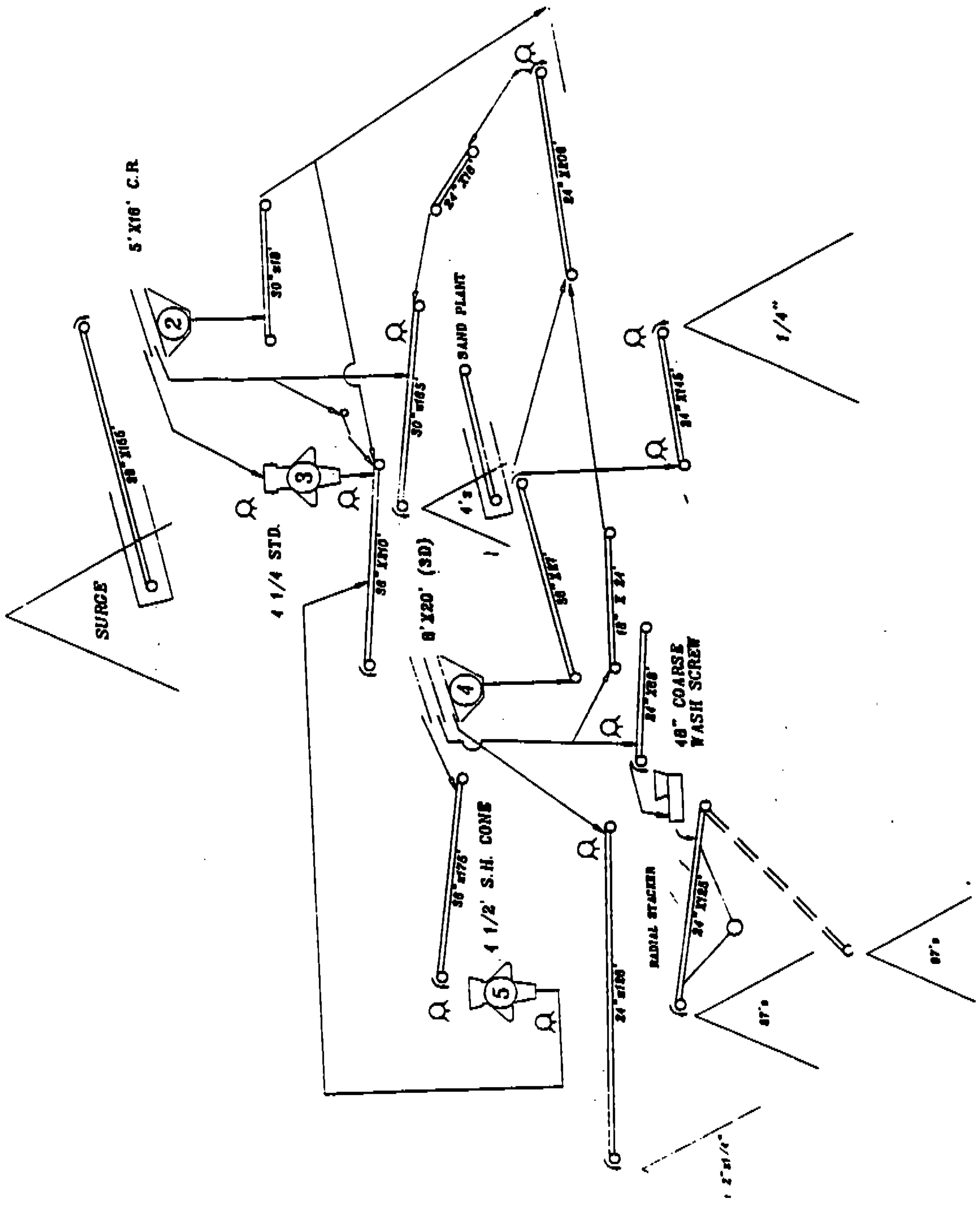

Figure 1. Simplified Process Flowchart

2.2 FUGITIVE DUST CONTROL

Wet suppression is used for fugitive dust control of the 4.5′ shorthead crusher, and the vibrating screen. There are water spray nozzles located in the feed hopper to the 4.5′ crusher and on the exit of the crusher. Overwetting of the rock can cause blinding of the lower screen or blockage of the fines discharge chute underneath the triple deck vibrating screen. During these emission tests, the plant experienced no screen blinding conditions.

2.3 SAMPLING AND EMISSION TESTING PROCEDURES

2.3.1 Fugitive Emission Test Approach

Since there are no air pollution control devices on the vibrating screen or the 4.5′ crusher, fugitive emission testing procedures were needed to capture and measure the PM10 emissions. Entropy considered the criteria listed in Table 3 in designing the test program. Entropy evaluated alternative testing procedures during site visits by Entropy personnel. The emission testing techniques which are generally applied to fugitive dust emission sources include,

- Upwind-downwind profiling,
- Roof monitor sampling, and
- Enclosures and Quasi-stack sampling.

Vibrating Screen Testing Alternatives

The roof monitoring approach of fugitive emission testing appeared to be the most applicable technique for the vibrating screen at the Bristol plant. This involved the sampling at a horizontal array of sampling points above the surface of the emission source. However, an adaption of the general procedure was necessary due to the lack of a partial enclosure to serve as the roof monitor and due to the swirling gas flows created by wind leakage around the screen enclosure. Accordingly, Entropy designed and installed a track-mounted hood system for fugitive emission capture. By using this track-mounted hood version of roof monitor sampling, it was possible to accurately capture and measure the PM10 emissions without influencing the PM10 emission rates from the screen surface.

Upwind-downwind profiling techniques involve measurement of the increase in PM10 concentrations as a gas stream passes over or around the source being evaluated. This is usually performed using ambient PM10 monitors in upwind and downwind locations. Entropy concluded that this approach was not applicable to the vibrating screen at the Bristol, Tennessee plant because of the height and inaccessibility around the vibrating screen. Also, there were a number of possible sources immediately upwind and downwind of the vibrating screen. These sources included crushers, conveyors and conveyor transfer points, and commercial product haul roads. It would be impossible to isolate the vibrating screen from these nearby sources using an upwind-downwind testing procedure.

The quasi-stack method would involve the construction of a temporary enclosure around the vibrating screen and the installation of a duct and fan system for gas handling. Entropy rejected this approach primarily because of

Table 3. FUGITIVE EMISSION CAPTURE SYSTEM DESIGN CRITERIA

- The capture system should not create higher-than-actual PM10 emission rates due to high gas velocity conditions near the point of PM10 particle entrainment.
- The capture system should not create a sink for PM10 emissions.
- The capture system should isolate the process unit being tested from other adjacent sources of PM10 emissions.
- The capture system should not create safety hazards for the emission test crew or for plant personnel. It should not create risks to the plant process equipment.
- The capture systems should not obstruct routine access to the process equipment by plant personnel.
- The capture system and overall test procedures must be economical, practical, and readily adaptable to other plants so that these tests can be repeated by organizations wishing to confirm or challenge the emission factor data developed in this project.

the extremely high gas flow rates necessary. To simulate the identical emission conditions for typical wind speeds at the plant would require gas flow rates between 13,200 and 52,800 actual cubic feet per minute (ACFM). Ductwork with a diameter between 4 and 6 feet would be necessary to carry this large gas flow at velocities where PM10 losses would be minimized. Since the vibrating screen is on a relatively small platform 30 feet above the ground, this ductwork would have to be quite long and carefully supported. This approach would be prohibitively expensive. Other disadvantages include:

- It would be extremely difficult to simulate actual wind speeds and wind approach angles using make-up air.
- An enclosure restricts plant operations personnel's access to the vibrating screen
- Construction safety risks are possible due to the lack of access and due to the rotating equipment in restricted areas.

4.5′ Crusher Inlet and Outlet Testing Alternatives

The quasi-stack method appeared to be the most accurate and practical approach for capturing the fugitive emissions from the inlet and outlet areas of the 4.5′ crusher. This approach allowed isolation of the 4.5′ crusher from the other fugitive dust sources in the immediate vicinity.

The quasi-stack method required the construction of temporary enclosures around the inlet and outlet of the 4.5′ crusher and the installation of a duct and fan system for gas handling. Since the PM10 emissions are generated primarily by stone-to-stone attrition in the crusher and during falling, the use of an enclosure does not influence the rate of PM10 emissions.

The roof monitoring approach of fugitive emission capture involves the sampling at a horizontal array of sampling points above the surface of the emission source. This approach was rejected because there was no logical means to sample in the area immediately above the crusher inlet or outlet. The emission profiling technique was also rejected for the crusher emission points since there were a number of other possible PM10 sources in the immediate vicinity of the crusher.

2.3.2 PM10 Emission Testing Procedure

Screen Testing Equipment

The track-mounted hood system used for sampling the vibrating screen consisted of a 2 foot by 2 foot aluminum hood suspended 8 inches above the upper deck of the vibrating screen. The position of the hood above the stone is shown in Figures 2 and 3. This hood position was close enough to the upper screen deck to ensure good emission capture but not so close that the entering air stream caused greater-than-actual PM10 emissions. A variable speed DC-driven tubeaxial fan controlled the capture velocity of the air entering the hood. This velocity was set at 150 feet per minute based on the hood capture characteristics observed using smoke and lightweight strips of fabric. This velocity is higher than the 50 feet per minute minimum capture velocity specified in reference 9 for vibrating screens.

The top area of the vibrating screen was divided into a 4 by 7 array of sampling locations, each of which was 2 feet by 2 feet in size. The only area not sampled was the 6-foot strip across the upper inlet side of the vibrating screen where the stone feed dumps onto the top of the screen. Positioning the hood in this location would have artificially increased PM10 emissions and caused rapid abrasion of the hood. PM10 from the inlet chute area of the screen are captured as the hood traverses the uppermost portions of the screen.

Entropy sized the ductwork from the hood to the sampling location for an average gas flow velocity less than 1000 feet per minute. This transport velocity is well below the 3500 to 4500 feet per minute velocity used to size commercial ductwork in stone crushing plants and other facilities handling large diameter dusts[2,8]. The purpose of the high velocities in commercial ducts is to ensure that large diameter dust particles do not settle and accumulate in the ductwork over long time periods. PM10 sized dust particles have negligible gravity settling rates in the gas stream residence times in the ducts.

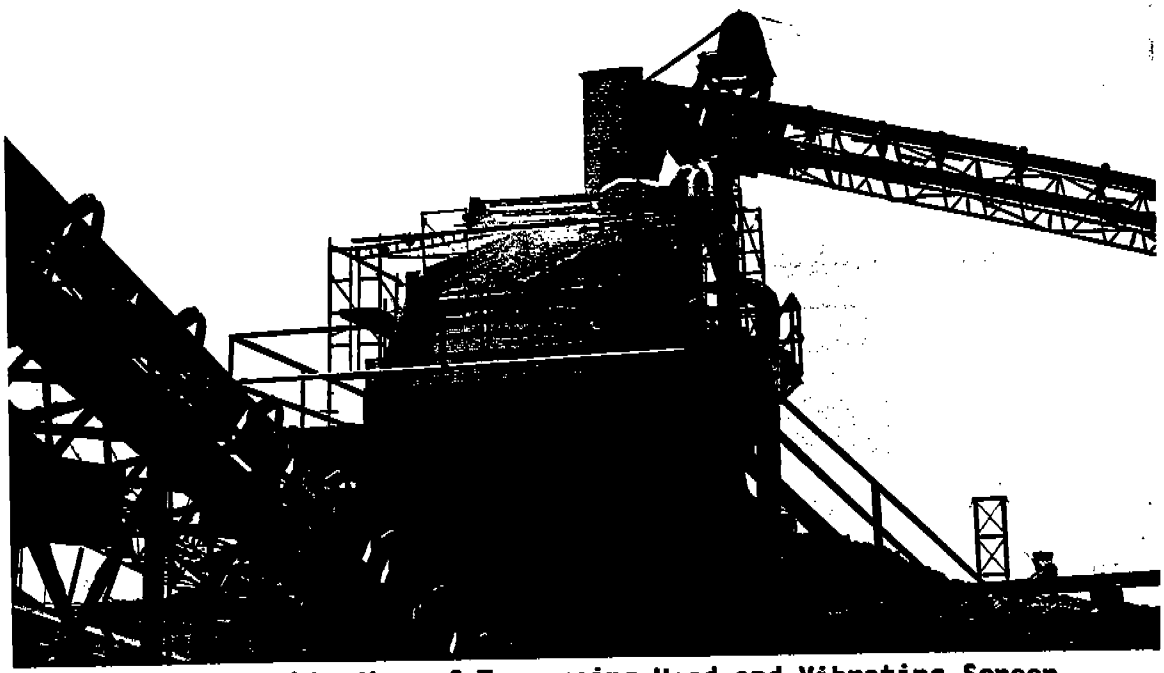

Figure 2. Side View of Traversing Hood and Vibrating Screen

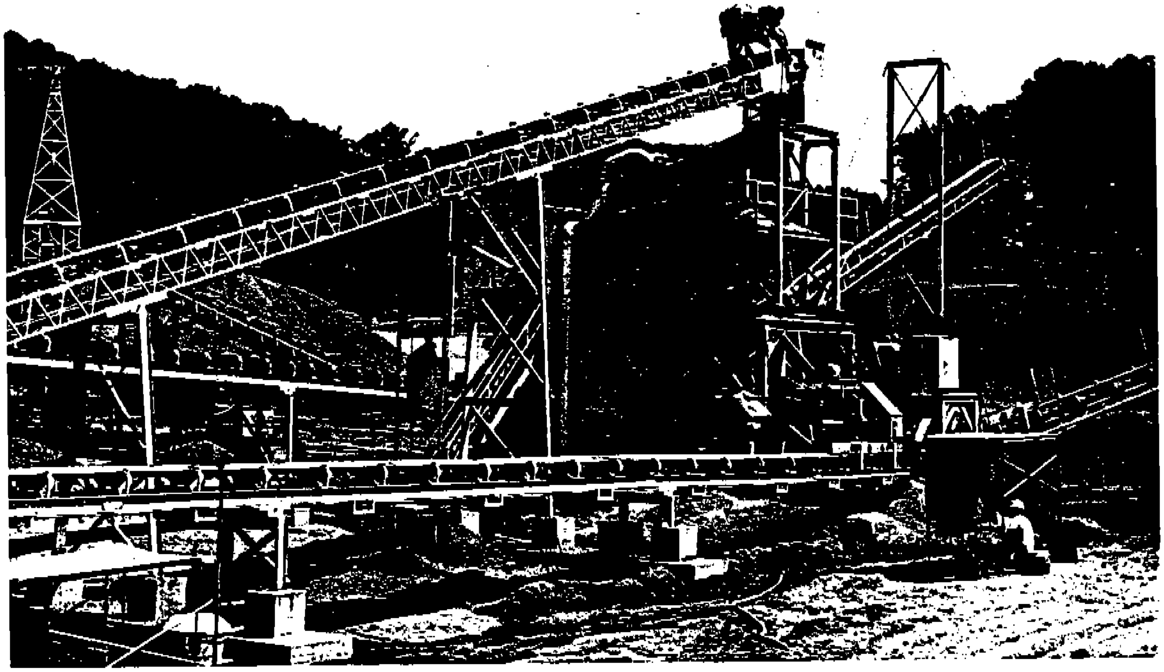

Figure 3. Front View of Traversing Hood and Vibrating Screen

Dust accumulation in the ductwork was not a problem during this study since the hood operating times were relatively short and the flexible duct was cleaned regularly. The 1000 feet per minute duct velocity limit is advantageous since this limits the impaction of particles less than 10 microns on the side walls of the hood elbow and the side walls of the flexible duct. Also, the low gas transport velocity limits any formation of PM10 emissions due to the movement of the gas stream over the surfaces of large diameter particles entrained in the gas stream or settling on the bottom of the duct.

4.5′ Crusher Testing Equipment

The inlet to the 4.5′ crusher was defined as the discharge of the feed hopper into the crusher vessel. This area, having a height of approximately 2 feet, was enclosed with galvanized steel flashing to allow capture of the PM10 emissions caused by the stone-to-stone attrition during movement of the stone. The discharge point of the 4.5′ crusher is a conveyor leading to the triple deck vibrating screen. The discharge point was enclosed approximately 4 feet upstream and downstream of the 4.5′ crusher discharge point. There are water spray nozzles on the feed hopper and the downstream side of this conveyor. Figure 4 shows a side view of the 4.5′ crusher.

Enclosures were built around the inlet and outlet of the crusher. The inlet enclosure measured approximately 14" high with a 54" diameter, the outlet measured approximately 9′H X 12′D X 8′W. The enclosure outlet ducts were combined into a single 1 foot diameter outlet duct. The single one foot diameter duct was used as a combined sample point for both the inlet and outlet of the crusher. The one foot diameter duct was then increased to a two foot

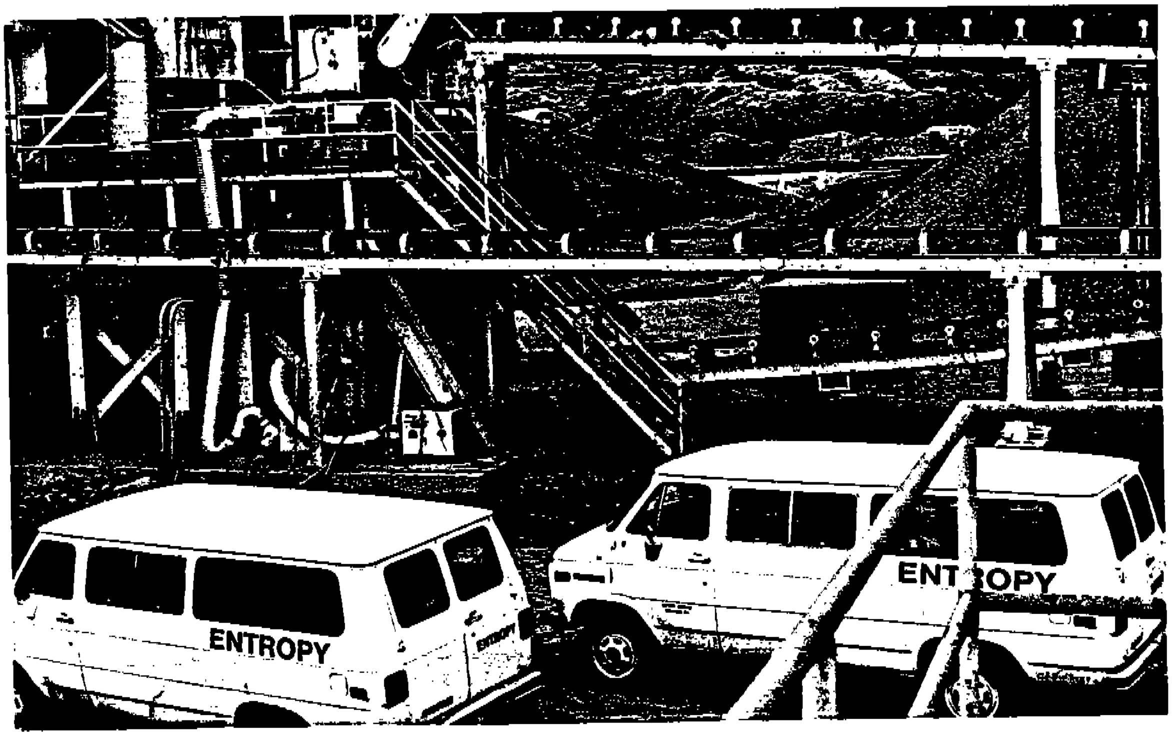

Figure 4. Side View of 4.5′ Crusher

diameter duct, to allow use of a two foot diameter SCR driven tubeaxial fan. Filtered air was supplied to each of the enclosures by means of HEPA (high efficiency particulate absolute) filters and centrifugal fans, see Figure 5. Use of HEPA make-up air ensured that PM10 emissions measured in the outlet duct were generated by the unit being tested rather than from adjacent sources. The air flows from each enclosure were set by adjusting the variable speed DC motor of the tubeaxial fan installed on the combined outlet duct. The mounting positions of the inlet and outlet ducts on the enclosures ensured that the normal PM10 emissions were not significantly influenced by air flow patterns.

Views of the crusher inlet after installation of the enclosure are provided in Figures 6 and 7. In Figure 6, the flexible duct delivers the HEPA filtered make-up air to the enclosure and the duct in Figure 7 takes PM10-laden air to the emission testing location. The crusher outlet ducts are shown in Figures 8 and 9. In Figure 9, the horizontal duct in the photographs contains the PM10 emissions from the inlet and outlet enclosures and the vertical duct contains the PM10 emissions descending from the inlet enclosures. The gas streams are joined at the duct TEE shown on the bottom of Figure 9.

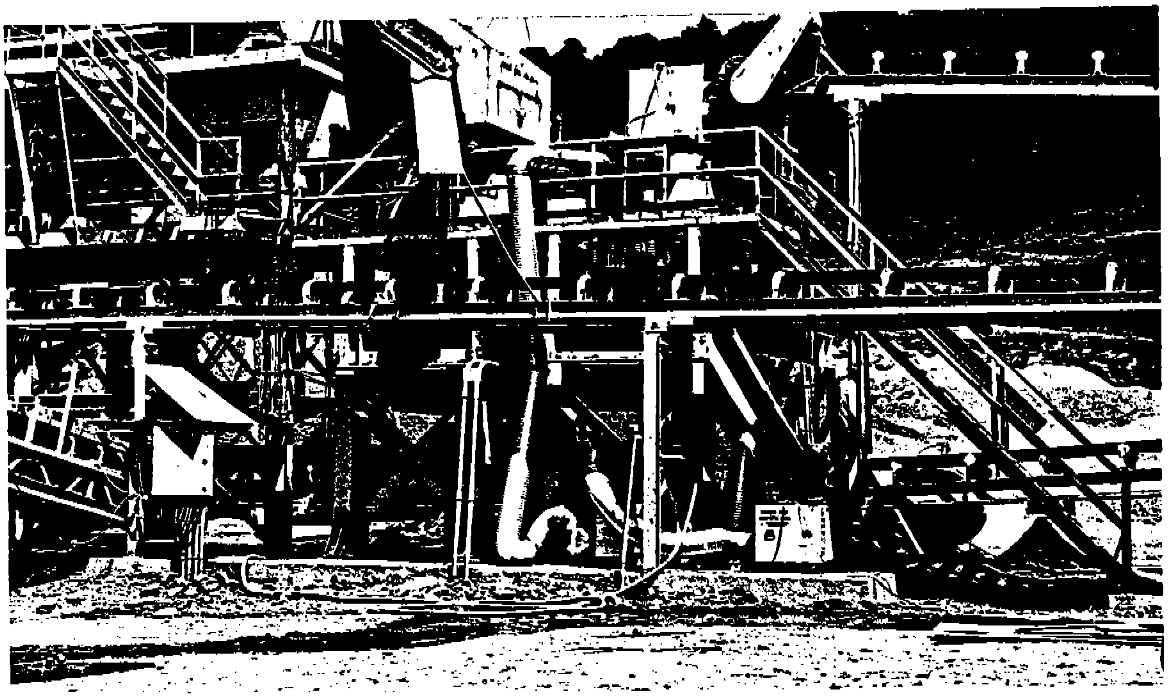

Figure 5. 4.5' Crusher Hepa Filtered Air Makeup

The combined gas flow from the inlet and outlet enclosures was controlled by a Dayton Model 3C411 24 inch, 2 HP direct current (DC) driven tubeaxial fan. This variable speed fan was set at the gas flow rate necessary to maintain a slightly negative static pressure within the enclosure. Negative pressures were required to ensure that there was no loss of PM10 emissions from the enclosure. Highly negative static pressures were undesirable since there could be high velocity ambient air streams entering the enclosure which could

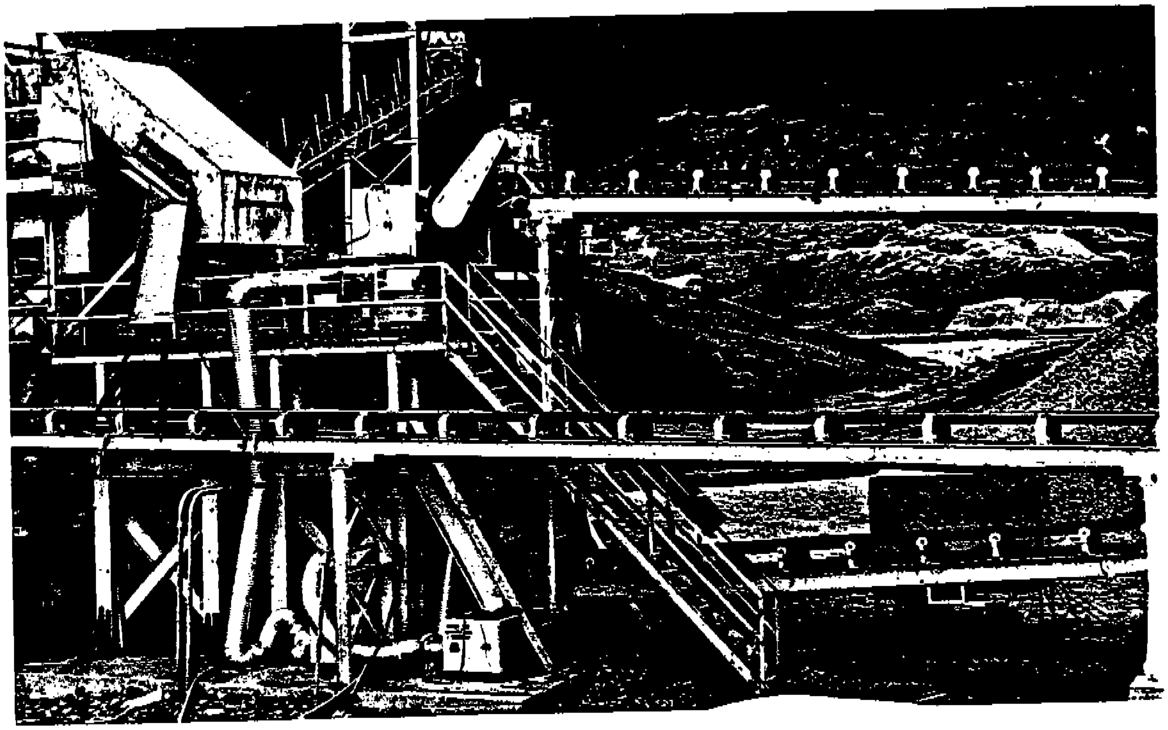

Figure 6. Side View of Crusher Inlet and Outlet Enclosure

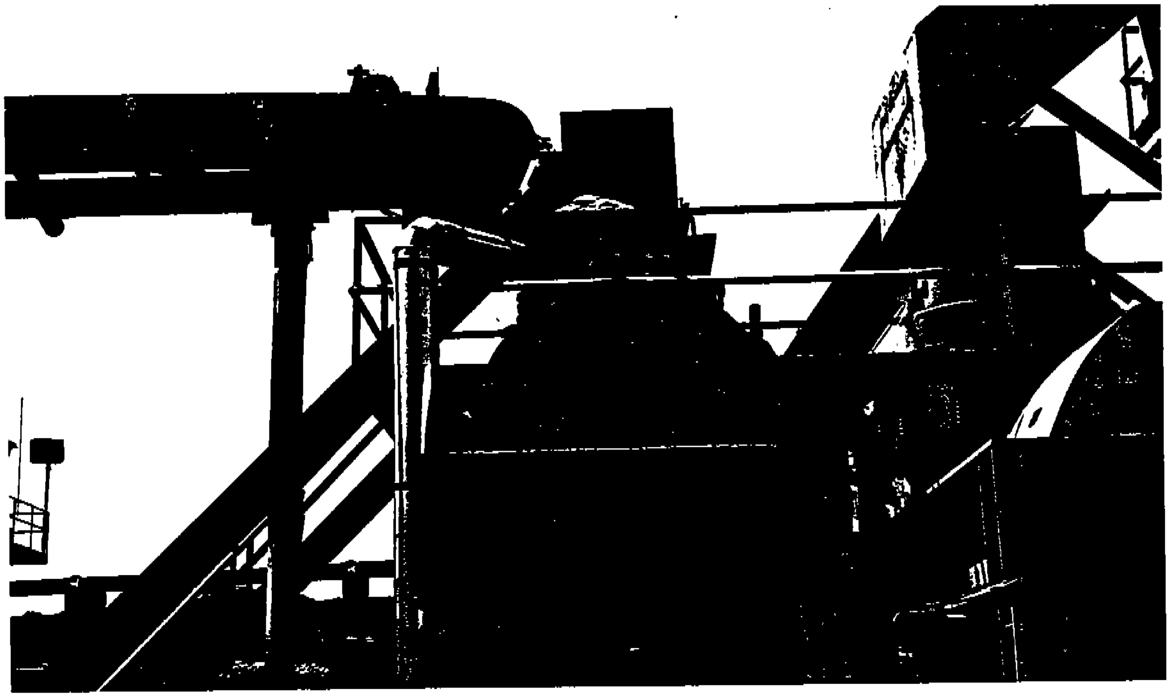

Figure 7. Crusher Inlet Enclosure, Outlet Duct

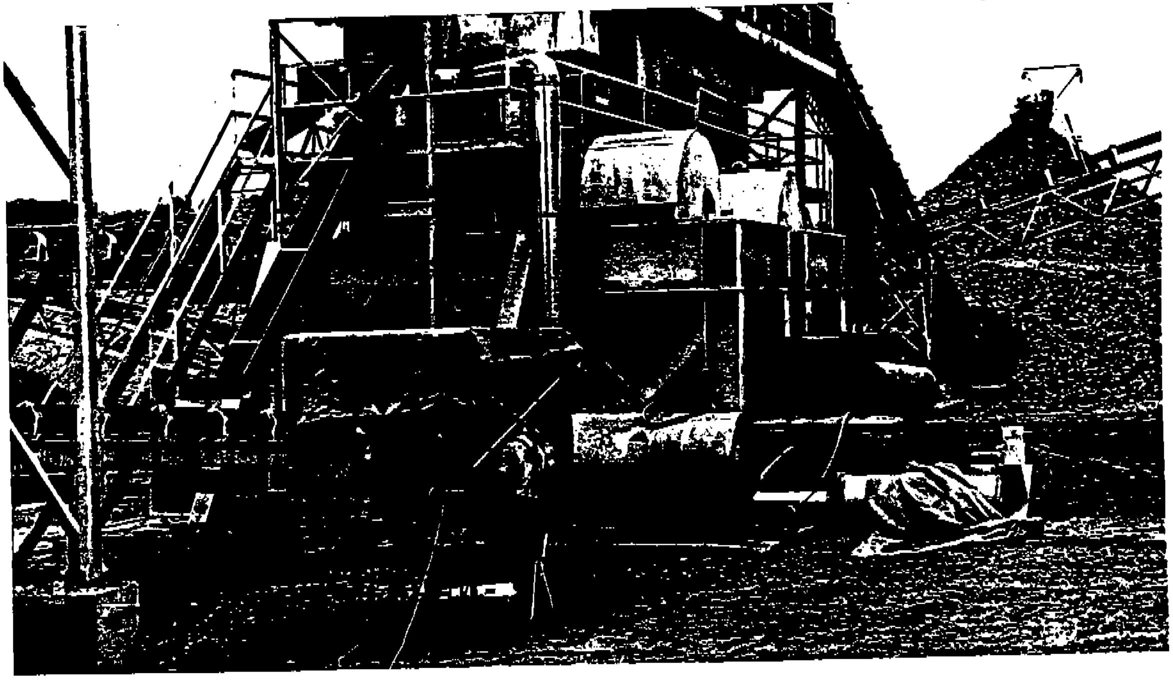

Figure 8. Crusher Outlet Ducts and Fan

increase the PM10 emissions.

<u>PM10 Sampling Equipment</u>

EPA Reference Method 201A was used to monitor the PM10 emissions from the 4.5′ crusher. This complete sampling system consists of: (1) a sampling nozzle, (2) a PM10 sampler, (3) a probe and umbilical cord, (4) an impinger train, and (5) flow control system. Due to the relatively small ducts and the constant sample gas flow rates set using the DC-driven tubeaxial fans, the "S"-type pitot tube was not mounted on the PM10 sampler probe. Gas velocities were determined prior to the emission tests.

Particulate matter larger than 10 microns in diameter is collected in the cyclone located immediately downstream of the sampling nozzle. Particulate smaller than 10 microns is collected on the outlet tube of the cyclone and on the downstream glass-fiber filter.

The cyclone and filter system used in this study met the design and sizing requirements of Section 5.2 of Method 201A. The gas flow rate through the cyclone was set based on the orifice pressure head equation provided in Figure 4 of Method 201A. The gas flow rate was kept constant throughout the emission test program.

PM10 sampling was performed in a 1-foot (inlet / outlet location) diameter smooth wall duct mounted directly off the enclosures of the crusher. The 4-inch diameter sampling port was located 8 duct diameters downstream of the inlet / outlet tee junction and 2 duct diameters upstream of the 2 foot fan duct. Sampling in the vertical direction across the ducts was not possible

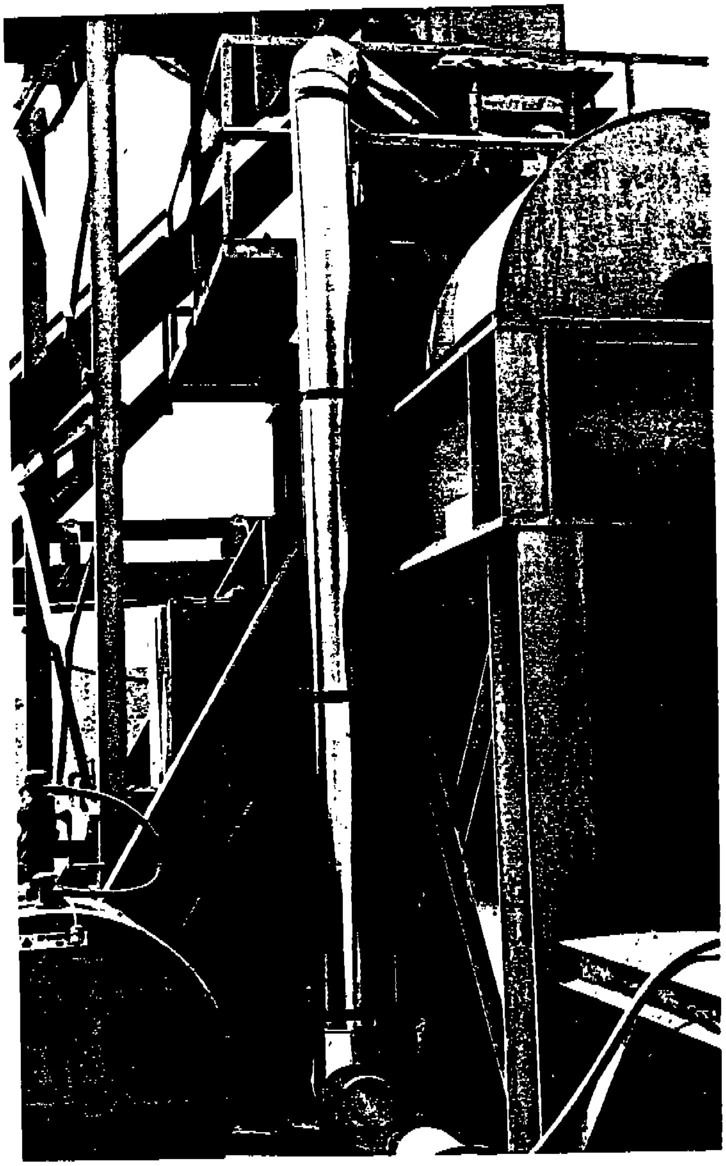

Figure 9. Crusher Inlet and Outlet Exhaust Ducts

since dust collected in the cyclone could be resuspended and pass through to the filter. The sampling nozzles were selected to provide 80 to 120% isokinetic conditions. The cyclone and nozzle assembly were mounted within the duct during sampling.

The particulate samples were recovered using the procedures specified in Method 201A. The material from the filter, cyclone outlet tube, and filter inlet housing were combined to determine the total PM10 catch weight.

2.4 MONITORING OF PROCESS OPERATING CONDITIONS

There are a number of process variables and weather conditions which could conceivably influence PM10 emission rates from the vibrating screen:

- Stone moisture level
- Stone size distribution
- Stone silt content
- screen stone feed rates
- Stone friability
- Stone hardness and density

All of these variables with the exception of stone type were monitored using a combination of plant instruments, special monitoring equipment, and stone sample analyses. Stone type was not monitored since limestone is the only type of stone processed at this plant.

2.4.1 Stone Moisture Level

Two stone samples were removed during each of the emission tests. In all cases, this sample consisted of a 2 linear foot sample of stone from the main conveyor leaving the 4.5′ crusher and a sample from the conveyor leaving the 6′ X 16′ vibrating screens. The conveyors were stopped by plant personnel for approximately 5 minutes to permit the Entropy test crew to remove the stone sample. The sample was placed in a sealed plastic bucket. The samples were weighed and multiplied by the conveyor speed to yield a stone production rate in tons per hour.

A sample was selected for analysis by placing the stone in a pile and dividing it into four quadrants. The quadrant randomly selected for analysis was further subdivided in quadrants until the sample quantity was less than approximately 2 pounds. This sample was then weighed and heated in an oven at a gas temperature of approximately 350 degrees Fahrenheit. The weight loss during heating was calculated and reported as the stone moisture level.

2.4.2 Ambient PM10 Levels

One ambient PM10 monitor was operated in the vibrating screen sample area. It was operated only during the time periods that PM10 emission sampling was in progress. The ambient air flow rates through the samplers were calibrated using an Airdata micromanometer. The filters were weighed and PM10 levels during the test were calculated and subtracted from the vibrating screen emission rates. This data however was not used in the emissions calculations for the 4.5′ crusher due to the enclosures and HEPA filtered make-up air.

2.4.3 Stone Size Distribution and Silt Content

Samples of the stone obtained during the test (see Section 2.4.1) were used to determine the size distribution and silt content. The initial sample quadrants used for moisture analysis were also used for analysis by ASTM sizing screens. The sample of approximately 2 pounds was heated to 350 Fahrenheit for

30 minutes to drive off the moisture, then allowed to cool, then loaded into the top pan. The screen size mesh openings included:

- 37.5 Millimeters
- 19.0 Millimeters
- 4.75 Millimeters
- 2.00 Millimeters
- 150 Microns
- 75 Microns
- 38 Microns
- Bottom Pan

The loaded ASTM screens were placed in a RO-TAP shaker and processed for 10 minutes. The weights of stone remaining on each of the screens were then determined by subtracting the screen tare weights from the loaded weights.

2.4.4 Stone Processing and Production Rates

The stone processing rate of the 4.5' crusher has been defined by Entropy as the total volume of stone entering the 4.5' crusher. The volume of stone in tons for a particular test was calculated by removing and weighing a 2 foot section of the stone from the conveyor entering the 4.5' crusher. This amount in pounds/feet was then multiplied by the speed of the conveyor in feet/minute (380 fpm crusher feed, 430 fpm screen feed) to produce a rate in pounds/minute. Then to obtain the total amount of stone per hour this number was multiplied by 60 minutes per hour. This calculation was also performed for the screen production rates. This calculation is shown below:

4.5 Crusher

(Pounds Stone per 2 FT) X (380 FT per Minute)

= Pounds Stone per Minute

(Pounds Stone/Minute) X (60 Minutes/Hour) X (Ton/2000 Pounds)

= Tons of Stone/Hour

8' X 20' Vibrating Screen

(Pounds Stone per 2 FT) X (430 FT per Minute)

= Pounds Stone per Minute

((Pounds Stone/Minute) X (60 Minutes/Hour) X (Ton/2000 Pounds))
= Tons of Stone/Hour

3.0 TEST RESULTS

3.1 OBJECTIVES AND TEST MATRIX

The objective of this test program was to determine the PM10 emission factors for a shorthead 4.5' crusher and a vibrating screen at a lime stone crushing plant. The test program concerned both wet and dry stone conditions. The specific objectives included the following:

- Capture the PM10 emissions from the inlet and outlet of a 4.5' crusher without significantly affecting the emission rate.
- Capture the PM10 emissions from the vibrating screen without significantly affecting the emission rate.
- Determine the PM10 emission concentrations by means of EPA Reference Method 201A.
- Calculate the total PM10 emission rates using the known outlet duct gas flow rates and the Method 201A emission concentrations.
- Measure the stone moisture content, stone feed rate, stone size distribution, and stone silt content.

3.2 STONE MOISTURE LEVELS

The stone moisture levels for the PM10 emission factor tests are presented in Table 4. The moisture criteria proposed in the Test Plan were: dry condition - less than 1%, and wet conditions - equal to or greater than 1%. The actual values during the tests were consistent with these criteria.

During the emission tests, the stone color was used to qualitatively evaluate moisture levels. Short term changes in stone moisture were indicated by shifts between grey and white. These variations occurred in all of the wet condition tests, but they could not be quantified because of the time needed to obtain a representative stone sample. Stone moisture levels were controlled by the plant personnel operating certain water spray headers in the process.

3.3 AMBIENT PM10 CONCENTRATIONS

The ambient PM10 concentrations were monitored by means of a Anderson PM10 Hi-Vol sampler. This instrument has a cyclonic precollector for particles greater than 10 microns followed by a back-up filter. The analyzer was located on the ground on the near the vibrating screen platform. In this location, it indicated the ambient PM10 levels in the vibrating screen sampling area.

This analyzer was turned on immediately prior to the emission test and turned off at the conclusion of the test. The PM10 concentrations were calculated by dividing the filter catch weights by the total standard cubic feet sampled during the on-line time. The ambient PM10 levels presented in Table 5.

TABLE 4. STONE MOISTURE LEVELS

Date	Conditions	Test	Moisture Content (% weight)
6-16-93	Dry	1	0.88
6-16-93	Dry	2	0.88
6-16-93	Dry	3	0.88
		Average	0.88
6-14-93	Wet	1	1.74
6-15-93	Wet	2	2.24
6-15-93	Wet	3	2.24
		Average	2.073

TABLE 5.
AMBIENT PARTICULATE CONCENTRATION
STANDARD GAS CONDITIONS

	Time		Milligrams	HiVol#1
	Start	Stop	Catch	mg/ft^3 Dry
6-14-93	09:16	15:16	200.4	0.0294
6-15-93	07:40	14:37	135.3	0.0173
6-16-93	08:15	12:10	197.7	0.0472

3.4 STONE PRODUCTION RATES

The 4.5′ crusher and vibrating screen stone processing rates were calculated following the formula given in Section 2.4.4 of this report. The calculated stone production rates for the East vibrating screen during the tests are presented in Table 6.

TABLE 6. STONE PRODUCTION DATA

Date	Test	Condition	Vibrating Screen	Crusher
			Processing Rate, Tons/HR	
6-14-93	1	Wet	435	234
6-15-93	2,3	Wet	415	285
6-10-93	1,2,3	Dry	419	325

3.5 PM10 EMISSION FACTORS

The PM10 emission factors were calculated in accordance with the procedures illustrated in the example calculation of Appendix B. The particulate captured on the filter, in the cyclone outlet tube, and in the filter inlet housing was weighed and added to yield a total capture weight. This value is divided by the standard cubic feet of gas sampled to determine the concentration of PM10 particulate matter in the gas sampled.

The total PM10 emissions from the vibrating screen were determined by multiplying the constant gas flow rate (standard conditions) of the hood-fan system times the 40 separate sampling locations. The total gas flow rate from the vibrating screen was multiplied by the measured PM10 concentration to yield the total PM10 emission rate.

The data are expressed in pounds of PM10 per ton of stone processed through the crusher and vibrating screen. The production rate was calculated as described in section 2.4.4. The measured PM10 emission factors for both the 4.5′ crusher and the vibrating screen are presented in Table 7. The average values for the wet tests are well below the average value for the dry tests. This is consistent with general observations during the emission tests. During the dry tests, there were visible emissions from the vibrating screen. No visible emissions were apparent during the wet tests.

TABLE 7. VIBRATING SCREEN AND 4.5′ CRUSHER PM10 EMISSIONS

		PM10 Emissions; Pounds/Ton	
		5.5′ Crusher	Screen
Dry Stone (< 1)			
	Run 1	0.00185	0.00668
	Run 2	0.00285	0.01550
	Run 3	0.00405	0.03300
	Average	0.00292	0.01839
Wet Stone (> 1)			
	Run 1	0.001660	0.002250
	Run 2	0.000849	0.000776
	Run 3	0.000655	0.000639
	Average	0.001055	0.001222

The emission factors measured during the emission test program are well below previously reported emission factors for total particulate matter[9]. The emission factors applicable to total particulate emissions cannot be compared with PM10 emission factors. The PM10 fraction of the total particulate emissions should be relatively low since very high energy levels are needed to cause stone attrition to the 10 micron range. It is unlikely that the 4.5′ crusher and vibrating screen are creating substantial quantities of PM10 particulate. This is indicated by particle size distribution tests conducted by Entropy using dried stone. The size distribution data is provided in Table 8-1 and Table 8-4. As indicated in the wet stone had near negligible levels of dust in the less than 75 micron size range.

TABLE 8-1. PARTICLE SIZE DISTRIBUTIONS FOR DRY RUNS

Size Range	Fraction of Sample in Specified Range
	Test 1,2,3 Dry
> 37.5 Millimeters	0
> 19.0 Millimeters	0.280
> 4.75 Millimeters	0.358
> 2.00 Millimeters	0.255
> 150 Microns	0.083
> 75 Microns	0.009
> 38 Microns	0.006
Bottom Pan	0.009

TABLE 8-2. PARTICLE SIZE DISTRIBUTIONS FOR WET RUNS

Size Range	Fraction of Sample in Specified Range	
	Test 1, Wet	Test 2,3 Wet
> 37.5 Millimeters	0	0
> 19.0 Millimeters	0.150	0.354
> 4.75 Millimeters	0.313	0.279
> 2.00 Millimeters	0.372	0.205
> 150 Microns	0.145	0.121
> 75 Microns	0.011	0.015
> 38 Microns	0.005	0.016
Bottom Pan	0.006	0.011

4.0 QA/QC ACTIVITIES

4.1 QC PROCEDURES

The specific internal quality assurance and quality control procedures used during this test program are described in this section. Velocity and volumetric flow rate data collection are discussed in Section 4.2. Section 4.3 discusses QA audits. QC procedures for particulate and percent isokinetics are presented in Sections 4.4 and 4.5, respectively. Manual equipment calibration is described in Section 4.6. Data validation is discussed in Section 4.7.

4.2 VELOCITY/VOLUMETRIC FLOW RATE DETERMINATION

The QC procedures for velocity/volumetric flow rate determinations follow guidelines set forth by EPA Method 2.

Flue gas moisture was determined according to EPA Method 4 sampling trains. Flue gas moisture content (B_{ws}) was determined by dividing the volume (mass) of moisture collected by the impingers by the standardized volume of gas sampled. The following QC procedures were followed in determining the volume of moisture collected:

- Preliminary reagent tare weights were measured to the nearest 0.1 g.
- The balance zero was checked and re-zeroed as necessary before each weighing.
- The balance was leveled and placed in a clean, motionless environment for weighing.
- The indicating silica gel was fresh for each run.
- The silica gel impinger gas temperature was maintained below 68°F.

The QC procedures below were followed regarding accurate sample gas volume determination:

- The dry gas meter is fully calibrated every 6 months using an EPA approved intermediate standard.
- The gas meter was read to a thousandth of a cubic foot for the initial and final readings.
- The meter thermocouples were compared with ambient prior to the test run as a check on operation.
- Readings of the dry gas meter, meter orifice pressure (ΔH), and meter temperatures were taken at every sampling point.

- Accurate barometric pressures were recorded at least once per day.
- Post-test dry gas meter checks were completed to verify the accuracy of the meter full calibration constant (Y).
- The S-type pitot tube was visually inspected before sampling.
- Both legs of the pitot tube were leak checked before and after sampling.
- Proper orientation of the S-type pitot tube was maintained while making measurements. The roll and pitch axis of the S-type pitot tube were maintained at 90° to the flow.
- The pitot tube/manometer umbilical lines were inspected before and after sampling for moisture condensate.
- Cyclonic or turbulent flow checks were performed prior to testing the source.
- An average velocity pressure reading were recorded at each point instead of recording extreme high or low values.
- Pitot tube coefficients were determined based on physical measurement techniques as delineated in Method 2.
- The stack gas temperature measuring system was checked by observing ambient temperatures prior to placement in the stack.

4.3 QA AUDITS

Meterbox calibration audits were performed according to Method 5, section 4.4. All of the equipment pre-test and post-test results are presented in Table 9.

4.4 PARTICULATE/CONDENSIBLES SAMPLING QC PROCEDURES

Quality control procedures for particulate sampling ensure high quality flue gas concentrations and emissions data. Flue gas concentrations are determined by dividing the mass of analyte (particulate) collected by the standardized volume of gas sampled. Sampling QC procedures which ensure that a representative amount of the analytes are collected by the sampling system include:

- The sampling rate is within 20 percent of isokinetic (100 percent).
- Only properly prepared glassware is used.
- All sampling nozzles were be manufactured and calibrated according to EPA standards.
- Filters are weighed, handled, and stored in a manner to prevent any contamination.
- Recovery procedures are completed in a clean environment.
- Field reagent blanks are collected.

4.5 SAMPLE VOLUME AND PERCENT ISOKINETICS

All sampling runs met the results acceptability criteria as defined by Section 6.3.5 of Method 201-A. The isokinetic rates are within ±20 percent. A summary of the sample volume and percent isokinetics is presented in Table 9.

TABLE 9.
AVERAGE DELTA H AND ISOKINETIC RESULTS

Run #	Percent Iso (%)	Delta H (Avg)
D-2-C-M201A-1	107.5	0.55
D-2-C-M201A-2	104.4	0.53
D-2-C-M201A-3	104.5	0.53
W-2-C-M201A-1	102.3	0.57
W-2-C-M201A-2	111.2	0.58
W-2-C-M201A-3	108.2	0.57

Run #	Percent Is (%)	Delta H (Avg)
D-2-S-M201A-1	98.0	0.67
D-2-S-M201A-2	100.2	0.67
D-2-S-M210A-3	98.4	0.67
W-2-S-M201A-1	91.7	0.65
W-2-S-M210A-2	87.3	0.66
W-2-S-M201A-3	86.3	0.66

4.6 MANUAL SAMPLING EQUIPMENT CALIBRATION PROCEDURES

4.6.1 Type-S Pitot Tube Calibration

The EPA has specified guidelines concerning the construction and geometry of an acceptable Type-S pitot tube. If the specified design and construction guidelines are met, a pitot tube coefficient of 0.84 is used. Information pertaining to the design and construction of the Type-S pitot tube is presented in detail in Section 3.1.1 of EPA Document 600/4-77-027b. Only Type-S pitot tubes meeting the required EPA specifications are used. Pitot tubes are inspected and documented as meeting EPA specifications prior to field sampling.

4.6.2 Sampling Nozzle Calibration

Calculation of the isokinetic sampling rate requires that the cross sectional area of the sampling nozzle be accurately determined. All nozzles are thoroughly cleaned, visually inspected, and calibrated according to the procedure outlined in Section 3.4.2 of EPA Document 600/4-77-027b.

4.6.3 Temperature Measuring Device Calibration

Accurate temperature measurements are required during source sampling. Bimetallic stem thermometers and thermocouple temperature sensors are calibrated using the procedure described in Section 3.4.2 of EPA Document 600/4-77-027b. Each temperature sensor is calibrated at a minimum of three points over the anticipated range of use against a NIST-traceable mercury-in-glass thermometer. All sensors are calibrated prior to field sampling.

4.6.4 Dry Gas Meter Calibration

Dry gas meters (DGM's) are used in the sample trains to monitor the sampling rate and measure the sample volume. All DGM's are fully calibrated to determine the volume correction factor prior to their use in the field. Post-test calibration checks are performed as soon as possible after the equipment has been returned as a QA check on the calibration coefficients. Pre- and post-test calibrations should agree within 5 percent. The calibration procedure is documented in Section 3.3.2 of EPA Document 600/4-77-237b.

Prior to calibration, a positive pressure leak check of the system is performed using the procedure outlined in Section 3.3.2 of EPA Document 600/4-77-237b. The system is placed under approximately 10 inches of water pressure and a gauge oil manometer is used to determine if a pressure decrease can be detected over a one-minute period. If leaks are detected, they are eliminated before actual calibrations are performed.

After the sampling console is assembled and leak checked, the pump is allowed to run for 15 minutes to allow the pump and DGM to warm-up. The valve is then adjusted to obtain the desired flow rate. For the pre-test calibrations, data are collected at orifice manometer settings (ΔH) of 0.5, 1.0, 1.5, 2.0, 3.0 and 4.0 inches H_2O. Gas volumes of 5 ft^3 are used for the two lower orifice settings, and volumes of 10 ft^3 are used for the higher settings. The individual gas meter correction factors (Y_i) are calculated for each orifice setting and averaged. The method requires that each of the individual correction factors fall within ± 2 percent of the average correction factor or the meter is cleaned, adjusted, and recalibrated. For the post-test calibration, the meter is calibrated three times at the average orifice setting and vacuum used during the actual test. The meter box calibration data is presented in Table 10.

Table 10. Meter Box Calibration Audit

Meter Box Number	Pre-Audit Value	Allowable Error	Calculated Gamma	Acceptable
NU-7	0.9850	0.9456<Y<1.0244	1.0088	Yes
EN-2	0.9831	0.9438<Y<1.0224	0.9796	Yes

4.7 DATA VALIDATION

All data and/or calculations for flow rates, moisture content, and isokinetic rates made using a computer software program are validated by an independent check. All calculations are spot checked for accuracy and completeness.

In general, all measurement data are validated based on the following criteria:

- Process conditions during sampling or testing.
- Acceptable sample collection procedures.
- Consistency with expected other results.
- Adherence to prescribed QC procedures.

5.0 REFERENCES

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3. M. White, "Crusher and screen training: a key to better operating costs," Pit & Quarry, September 1991, p. 26-32.

4. L.C. Lucas and L.M. Noland, "Keeping down the dust," Pit & Quarry, November 1988, p. 27-29.

5. B. Weaver, "Stretching water resources," Pit & Quarry, March 1991, p. 22-24.

6. R.E. Kenson and P.T. Bartlett, Technical Manual for the Measurement of Fugitive Emissions: Roof Monitor Sampling Method for Industrial Fugitive Emissions, EPA-600/2-76-089b, U.S. Environmental Protection Agency, Research Triangle Park, 1976.

7. H.J. Kolnsberg, P.W. Kalika et al, Technical Manual for the Measurement of Fugitive Emissions: Quasi-Stack Sampling Method for Industrial Fugitive Emissions, EPA-600/2-76-089c, U.S. Environmental Protection Agency, Research Triangle Park, 1976.

8. Industrial Ventilation, A Manual of Recommended Practice, Edwards Brothers, 1980.

9. JACA Corporation, Control of Air Emissions from Process Operations in the Rock Crushing Industry," EPA Contract No. 68-01-4135, U.S. Environmental Protection Agency, Washington, D.C., February 1978.

10. IT Environmental Programs, Inc., Regulatory and Inspection Manual for Nonmetallic Mineral Processing Plant, EPA-240/1/90-010, U.S. Environmental Protection Agency, Washington, D.C., 1991.

6.0 GLOSSARY

1. ASTM: American Society for Testing & Materials

2. Aggregate: in the case of materials of construction, essentially inert materials which, when bound together into a conglomerated mass by a matrix, form concrete, mastic, mortar or plaster; crushed rock or gravel screened to size for use in road surfaces, concrete or bituminous mixes; any of several hard materials such as sand, gravel, stone, slag, cinders or other inert materials used for mixing with a cementing material to form concrete. Aggregate, in a surface course in the building of roads is often called a "road metal".

3. Conveyor belt: a rubberized belt, usually 18" to 60" wide, used to carry aggregates.

4. Crusher (cone): a crusher that is specially designed to produce fines.

5. Crusher (primary): usually a jaw or gyratory type crusher which reduces very large rocks to a size that can be processed by a secondary crusher.

6. Crusher (secondary): any second or third stage crusher that further reduces the size of stone.

7. Fines: the smaller particles of aggregates; usually less than .25" in size.

8. Head Pulley: the driving pulley, usually at the discharge end of conveyor belt.

9. Ro-Tap screen: trade name for a type of testing screen.

10. Scalping: a screening operation, removing stone too large for the crusher.

11. Scalping Screen: removes oversize material.

12. Screen (or sieve): a metallic plate or sheet, woven wire cloth or similar device, with regularly spaced apertures of uniform size mounted in a suitable frame or holder for use in separating material according to size.

Appendix A.

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Crusher

		D-2-C-M2-1	D-2-C-M2-2	Average
	Test Date	6/16/93	6/16/93	
	Run Start Time	742	1139	
	Run Finish Time	745	1143	
	Net Traversing Points	6	6	
Cp	Pitot Tube Coefficient	0.84	0.84	
Pbar	Barometric Pressure, Inches Hg	28.5	28.5	
Pg	Flue Gas Static Pressure, Inches H2O	-0.55	-0.55	-0.550
Ps	Absolute Flue Gas Pressure, Inches Hg	28.46	28.46	28.46
ts	Flue Gas Temperature, Degrees F	63	80	72
Delta-p	Average Velocity Head, Inches H2O	0.3136	0.3850	0.3484 *

* Represents the square of the average square root of the "Delta-p"

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Crusher

		D-2-C-M201A-1	D-2-C-M201A-2	D-2-C-M201A-3
	Test Date	6/16/93	6/16/93	6/16/93
	Run Start Time	813	923	1033
	Run Finish Time	913	1023	1133
	Net Traversing/Sampling Points	6/1	6/1	6/1
Theta	Net Run Time, Minutes	60	60	60
Dia	Nozzle Diameter, Inches	0.198	0.198	0.198
Cp	Pitot Tube Coefficient	0.84	0.84	0.84
Y	Dry Gas Meter Calibration Factor	0.985	0.985	0.985
Pbar	Barometric Pressure, Inches Hg	28.5	28.5	28.5
Delta H	Avg. Pressure Differential of Orifice Meter, Inches H2O	0.55	0.53	0.53
Vm	Volume of Metered Gas Sample, Dry ACF	26.656	26.361	26.514
tm	Dry Gas Meter Temperature, Degrees F	73	86	90
Vmstd	Volume of Metered Gas Sample, Dry SCF*	24.811	23.951	23.914
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, mL	12.1	12.7	12.3
Vwstd	Volume of Water Vapor, SCF*	0.570	0.598	0.579
%H2O	Moisture Content, Percent by Volume	2.24 **	2.44 **	2.36 **
%H2OSAT	Moisture Sat. @ Flue Gas Conditions, %	2.78	2.78	2.78
Mfd	Dry Mole Fraction	0.978	0.976	0.976
%CO2	Carbon Dioxide, Percent by Volume, Dry	0	0	0
%O2	Oxygen, Percent by Volume, Dry	20.9	20.9	20.9
Md	Gas Molecular Weight, Lb/Lb-Mole, Dry	28.84	28.84	28.84
Ms	Gas Molecular Weight, Lb/Lb-Mole, Wet	28.59	28.57	28.58
Pg	Flue Gas Static Pressure, Inches H2O	-0.55	-0.55	-0.55
Ps	Absolute Flue Gas Pressure, Inches Hg	28.46	28.46	28.46
	Volumetric Air Flow Rate			
ts	Flue Gas Temperature, Degrees F	72	72	72
Delta-p	Average Velocity Head, Inches H2O	0.3484	0.3484	0.3484
vs	Flue Gas Velocity, Feet per Second	34.27	34.28	34.28
A	Stack/Duct Area, Square Inches	113.1	113.1	113.1
Qsd	Volumetric Air Flow Rate, Dry SCFM*	1,490	1,488	1,489
Qmsd	Volumetric Air Flow Rate, Dry SCMM*	42	42	42
Qaw	Volumetric Air Flow Rate, Wet ACFM	1,615	1,616	1,615
ton/hr	Production Rate, tons/hour	324.9	324.9	324.9

* 68 ° F (20 ° C) -- 29.92 Inches of Mercury (Hg).

** Moisture used in calculations.

(Continued Next Page)

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Crusher

		D-2-C-M201A-1	D-2-C-M201A-2	D-2-C-M201A-3
	Percent Isokinetic			
ts	Flue Gas Temperature, Degrees F	67	71	75
Delta-p	Average Velocity Head, Inches H2O	0.31	0.31	0.31
vs	Flue Gas Velocity, Feet per Second	32.18	32.31	32.43
%I	Isokinetic Sampling Rate, Percent	107.5	104.4	104.5
	PM10 Calculations			
ucyc	Stack Gas Viscosity	179.8	179.6	179.7
Qs	PM10 Flow, at Cyclone Conditions, ACFM	0.448	0.433	0.432
D50	Dia. of Particles in Cyclone, Microns	10.03	10.27	10.28
	Particulate Catch,			
mg<D50	≤ 10 Microns, Milligrams	75.5	112.7	159.8
mg>D50	> 10 Microns, Milligrams	184.9	431.2	760.3
mg	Total Milligrams	260.4	543.9	920.1
	Percent of Total Particulate,			
%<D50	≤ 10 Microns	29.0	20.7	17.4
%>D50	> 10 Microns	71.0	79.3	82.6
	Particulate ≤ 10 Microns			
	Concentration, milligrams/DSCF*			
mg/DSCF	Concentration in Gas Sample	3.04	4.71	6.68
mg/DSCF,A	Concentration in Ambient Air	0.00	0.00	0.00
mg/DSCF,adj	Adjusted Concentration in Gas Sample	3.04	4.71	6.68
lb/hr	Emission Rate, lb/hr	0.600	0.926	1.32
lb/ton	Emission Rate, lb/ton	0.00185	0.00285	0.00405

* 68 ° F (20 ° C) -- 29.92 Inches of Mercury (Hg).

AIR FLOW RATE DETERMINATIONS

Plant Name Vulcan Materials

Run No. Dry-2-Crusher-M2

City/State Bristol, Tenn.

Date 6/16/93

Test Location Crusher

Personnel JRW, TTB JB

Barometric Pres. (Pbar) 28.5 In. Hg

Static Pres. (Pg) -0.55 In. H_2O

Pitot/Orifice ID DP48-8

Pitot Coef. (Cp) 0.84

Pres. Gauge Set ID NU-7

Thermocouple ID R 284

Duct Length/Diameter 12"

Width N.A.

--Specify inches (") or feet (')--

VELOCITY TRAVERSES
Start-Finish Times: 0742 - 0745

Point No.	ΔP In. H_2O	Temp. °F
A-1	0.27	63
2	0.27	63
3	0.31	63
4	0.39	63
5	0.35	63
6	0.30	63
Avg	0.3136	63
	1139 —	1143
A-1	0.31	81
2	0.35	81
3	0.36	80
4	0.45	79
5	0.44	79
6	0.41	79
Avg.*	0.385	80

ORSAT DATA

Sampling Time	Analysis Time	CO_2 (A) Reading	O_2 (B) Reading	%O_2 (B-A)	%CO+N_2 (100-B)
	Average				

Bag No. ________ Pump ________

FYRITE DATA, % CO_2				

MOISTURE DATA (WET BULB/DRY BULB)

Port	Time	Dry Bulb °F	Wet Bulb °F	Diff.	% H_2O

MOISTURE DATA (STOICHIOMETRIC)

Free Water in Fuel, %		
Water from Fuel Combustion, %		
Ambient Water, %		
Relative Humidity, %		
Ambient Temperature, °F		
Total %		

VOLUMETRIC AIR FLOW RATES

Dry at Standard Conditions, Qsd =	SCFM
Wet at Stack Conditions, Qaw =	ACFM

ADDITIONAL DATA

* ΔP average is square of average square root.

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ENTROPY

METHOD 201A (PM-10) FIELD DATA

Client EPA
Plant Name Vulcan Materials
City/State Bristol Tenn.
Sampling Location Crusher
Date 6/16/93 Team Leader JRW Techs TTB, JB
*Train Leak Check Vacuum, In. Hg 5 2
Train Leak Rate, Cubic Ft./Min. 0.015 0.001

Run Number Dry-2-Crusher 11229A 1
Time Start 0813
Time Stop 0913
Job Number 50119
Barometric Pressure, In. Hg 28.5
Static Pressure, In. H_2O -0.55

EQUIPMENT CHECKS

✓ Pitot, Pretest
✓ Pitot, Posttest
N.A. M3 Sampling Sys/Ted Bag
✓ Thermocouple @ 61 Pre
✓ Thermocouple @ 70 Post

IDENTIFICATION NUMBERS

Meterbox NU-7 Meterbox Gamma 0.9850 Reagent Box N.A.
T/C Readout F52 T/C Probe R218 Umbilical U108
Sampling Box 8 Orsat Pump N.A. Tedlar Bag N.A.
Nozzle(s) Actually Used: 0.198 TTB Pitot N.A.
No. Diameter ~~0.188~~ No. Diameter

FILTER NO.	TARE

Est % H_2O 1

Delta $H_@$ 1.728
Delta H_t 0.5882
Delta H_{t+50} 0.4903
Delta H_{t-50} 0.7185
Delta P_{avg} 0.3136
Meter Temp. 80
Stack Temp. 65

NOZZLE SELECTION CRITERIA

Desired Dia. 0.20

	Nozzle 1	Nozzle 2
Diameter	0.188	
Nozzle Number	0	
Delta P_{min}	0.2004	
Delta P_{max}	0.7410	

FYRITE

N.A.
↓

C_p 084

	Sample Point	Dwell Time, Minutes	Elapsed Time, Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading, In. H_2O (ΔP)	Gas Meter Temp, °F	Stack Temp, °F	Orifice Setting, In. H_2O (ΔH)	Vacuum Gauge, In. Hg	Gas Temps Filter Box, °F	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-3	10:00	00:00	761.400	0.31	64	66	0.55	1	N.A.	54	N.A.
2	↓	10:00	10:00	765.84	↓	68	66	↓	1	↓	58	↓
3	↓	10:00	20:00	770.25	↓	71	67	↓	1	↓	60	↓
4	↓	10:00	30:00	774.71	↓	75	68	↓	1	↓	61	↓
5	↓	10:00	40:00	779.15	↓	79	68	↓	1	↓	58	↓
6	↓	10:00	50:00	783.60	↓	81	69	↓	1	↓	58	↓
7			60:00	788.056								
8												
9												
10												
11												
12												

60	26.656	0.31	77	67	0.55
minutes	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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METHOD 201A (PM-10) FIELD DATA

Client EPA
Plant Name Vulcan Materials
City/State Bristol, Tenn.
Sampling Location Crusher
Date 6/16/93 Team Leader JRW Techs TTB, JB
*Train Leak Check Vacuum, In. Hg 5 3
Train Leak Rate, Cubic Ft./Min. 0.002 0.001

Run Number Dry-2-Crusher-M201A-2
Time Start 0923
Time Stop 1023
Job Number 50119
Barometric Pressure, In. Hg 28.5
Static Pressure, In. H_2O -0.55

EQUIPMENT CHECKS

/ Pitot, Pretest
/ Pitot, Posttest
N.A. M3 Sampling Sys/Ted Bag
/ Thermocouple @ 70 Pre
/ Thermocouple @ 74 Post

IDENTIFICATION NUMBERS

Meterbox NU-7 Meterbox Gamma 0.9850 Reagent Box N.A.
T/C Readout F52 T/C Probe R302 Umbilical M108
Sampling Box 12 Orsat Pump N.A. Tedlar Bag N.A.
Nozzle(s) Actually Used: Pitot N.A.
No. Diameter ~~0.188~~ 0.198 TTB No. Diameter

FILTER NO. **TARE**

Est % H_2O 3

Delta $H_@$ 1.728
Delta H_t 0.5691
Delta H_{t+50} 0.4755
Delta H_{t-50} 0.6933
Delta P_{avg} 0.3136
Meter Temp. 90
Stack Temp. 72

NOZZLE SELECTION CRITERIA

Desired Dia. 0.206

	Nozzle 1	Nozzle 2
Diameter	0.188	
Nozzle Number		
Delta P_{min}	0.2000	
Delta P_{max}	0.7769	

FYRITE

N.A.

C_p 0.84

	Sample Point	Dwell Time, Minutes	Elapsed Time, Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading, In. H_2O (ΔP)	Gas Meter Temp, °F	Stack Temp, °F	Orifice Setting, In. H_2O (ΔH)	Vacuum Gauge, In. Hg	Gas Temps Filter Box, °F	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-3	10:00	00:00	788.25	0.31	82	70	0.53	|	N.A.	55	N.A.
2		10:00	10:00	792.68		84	70		|		55	
3		10:00	20:00	797.06		86	70		|		57	
4		10:00	30:00	801.52		87	71		|		56	
5		10:00	40:00	805.06		88	72		|		58	
6	↓	10:00	50:00	810.24	↓	89	72	↓	|	↓	56	↓
7			60:00/fin	814.611								
8												
9												
10												
11												
12												

* REMOVE HEAD BEFORE
POSTTEST LEAK CHECK

60 minutes 26.361 Vm 0.31 $(\sqrt{\Delta P})^2$ 86 tm 71 ts 0.53 ΔH

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METHOD 201A (PM-10) FIELD DATA

Client EPA
Plant Name Vulcan Materials
City/State Bristol, Tenn.
Sampling Location Crusher
Date 6/16/93 Team Leader JRW Techs JB, TTB
*Train Leak Check Vacuum, In. Hg 5 4
Train Leak Rate, Cubic Ft./Min. 0.002 0.002

Run Number Dry - 2 - Crusher - M201A - 3
Time Start 1033
Time Stop 1133
Job Number 30119
Barometric Pressure, In. Hg 28.5
Static Pressure, In. H_2O -0.55

EQUIPMENT CHECKS

✓ Pitot, Pretest
✓ Pitot, Posttest
N.A. M3 Sampling Sys/Ted Bag
✓ Thermocouple @ 74 Pre
✓ Thermocouple @ 78 Post

IDENTIFICATION NUMBERS

Meterbox NU-7 Meterbox Gamma 0.9850
T/C Readout F52 T/C Probe R218
Sampling Box 4 Orsat Pump N.A.
Nozzle(s) Actually Used:
No. ____ Diameter ~~0.188~~ 0.198TTB No. ____

Reagent Box N.A.
Umbilical U108
Tedlar Bag N.A.
Pitot N.A.
Diameter ____

FILTER NO.	**TARE**

Est % H_2O 3

Delta $H_@$ 1.728
Delta H_t 0.5695
Delta H_{t+50} 0.4763
Delta H_{t-50} 0.6930
Delta P_{avg} 0.3136
Meter Temp. 90
Stack Temp. 75

NOZZLE SELECTION CRITERIA

Desired Dia. 0.206

	Nozzle 1	Nozzle 2
Diameter	0.188	
Nozzle Number		
Delta P_{min}	0.2014	
Delta P_{max}	0.7415	

FYRITE
N.A.

C_p 0.84

	Sample Point	Dwell Time, Minutes	Elapsed Time, Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading, In. H_2O (ΔP)	Gas Meter Temp, °F	Stack Temp, °F	Orifice Setting, In. H_2O (ΔH)	Vacuum Gauge, In. Hg	Gas Temps Filter Box, °F	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-7	10:00	00:00	814.85	0.31	88	74	0.53	1	N.A.	54	N.A.
2		10:00	10:00	819.33		87	74		1		56	
3		10:00	20:00	823.73		89	74		1		58	
4		10:00	30:00	828.13		91	75				57	
5		10:00	40:00	832.94		92	75				57	
6	↓	10:00	50:00	836.94	↓	93	76	↓		↓	57	↓
7			60:00/Fin	841.364								
8												
9												
10												
11												
12												

60 minutes
26.514 Vm
0.31 $(\sqrt{\Delta P})^2$
90 tm
75 ts
0.53 ΔH

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Crusher

		W-2-C-M2-1	W-2-C-M2-2	Average
	Test Date	6/14/93	6/14/93	
	Run Start Time	855	1521	
	Run Finish Time	905	1525	
	Net Traversing Points	6	6	
Cp	Pitot Tube Coefficient	0.84	0.84	
Pbar	Barometric Pressure, Inches Hg	28.5	28.5	
Pg	Flue Gas Static Pressure, Inches H2O	-0.63	-0.63	-0.630
Ps	Absolute Flue Gas Pressure, Inches Hg	28.45	28.45	28.45
ts	Flue Gas Temperature, Degrees F	64	76	70
Delta-p	Average Velocity Head, Inches H2O	0.3475	0.3777	0.3624 *

* Represents the square of the average square root of the "Delta-p"

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Crusher

		W-2-C-M2-3	W-2-C-M2-4	Average
	Test Date	6/15/93	6/15/93	
	Run Start Time	722	1420	
	Run Finish Time	725	4123	
	Net Traversing Points	6	6	
Cp	Pitot Tube Coefficient	0.84	0.84	
Pbar	Barometric Pressure, Inches Hg	28.63	28.6	
Pg	Flue Gas Static Pressure, Inches H2O	-0.55	-0.55	-0.550
Ps	Absolute Flue Gas Pressure, Inches Hg	28.59	28.59	28.59
ts	Flue Gas Temperature, Degrees F	66	75	71
Delta-p	Average Velocity Head, Inches H2O	0.3284	0.2181	0.2704 *

* Represents the square of the average square root of the "Delta-p"

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Crusher

		W-2-C-M201A-1	W-2-C-M201A-2	W-2-C-M201A-3
	Test Date	6/14/93	6/15/93	6/15/93
	Run Start Time	912	736	1100
	Run Finish Time	1512	1036	1416
	Net Traversing/Sampling Points	6/1	6/1	6/1
Theta	Net Run Time, Minutes	360	180	180
Dia	Nozzle Diameter, Inches	0.198	0.198	0.198
Cp	Pitot Tube Coefficient	0.84	0.84	0.84
Y	Dry Gas Meter Calibration Factor	0.985	0.985	0.985
Pbar	Barometric Pressure, Inches Hg	28.50	28.63	28.63
Delta H	Avg. Pressure Differential of Orifice Meter, Inches H2O	0.57	0.58	0.57
Vm	Volume of Metered Gas Sample, Dry ACF	163.967	82.509	81.416
tm	Dry Gas Meter Temperature, Degrees F	88	81	91
Vmstd	Volume of Metered Gas Sample, Dry SCF*	148.446	76.012	73.642
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, mL	56.0	34.7	31.3
Vwstd	Volume of Water Vapor, SCF*	2.636	1.633	1.473
%H2O	Moisture Content, Percent by Volume	1.74 **	2.10 **	1.96 **
%H2OSAT	Moisture Sat. @ Flue Gas Conditions, %	2.60	2.68	2.68
Mfd	Dry Mole Fraction	0.983	0.979	0.980
%CO2	Carbon Dioxide, Percent by Volume, Dry	0	0	0
%O2	Oxygen, Percent by Volume, Dry	20.9	20.9	20.9
Md	Gas Molecular Weight, Lb/Lb-Mole, Dry	28.84	28.84	28.84
Ms	Gas Molecular Weight, Lb/Lb-Mole, Wet	28.65	28.61	28.62
Pg	Flue Gas Static Pressure, Inches H2O	-0.63	-0.55	-0.55
Ps	Absolute Flue Gas Pressure, Inches Hg	28.45	28.59	28.59
	Volumetric Air Flow Rate			
ts	Flue Gas Temperature, Degrees F	70	71	71
Delta-p	Average Velocity Head, Inches H2O	0.3624	0.2704	0.2704
vs	Flue Gas Velocity, Feet per Second	34.86	30.09	30.08
A	Stack/Duct Area, Square Inches	113.1	113.1	113.1
Qsd	Volumetric Air Flow Rate, Dry SCFM*	1,529	1,319	1,320
Qmsd	Volumetric Air Flow Rate, Dry SCMM*	43.3	37.4	37.4
Qaw	Volumetric Air Flow Rate, Wet ACFM	1,643	1,418	1,418
ton/hr	Production Rate, tons/hour	233.70	285.00	285.00

* 68 ° F (20 ° C) -- 29.92 Inches of Mercury (Hg).

** Moisture used in calculations.

(Continued Next Page)

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Crusher

		W-2-C-M201A-1	W-2-C-M201A-2	W-2-C-M201A-3
	Percent Isokinetic			
ts	Flue Gas Temperature, Degrees F	70	67	72
Delta-p	Average Velocity Head, Inches H2O	0.34	0.30	0.30
vs	Flue Gas Velocity, Feet per Second	33.76	31.57	31.71
%I	Isokinetic Sampling Rate, Percent	102.3	111.2	108.2
	PM10 Calculations			
ucyc	Stack Gas Viscosity	179.7	179.7	179.8
Qs	PM10 Flow, at Cyclone Conditions, ACFM	0.443	0.454	0.439
D50	Dia. of Particles in Cyclone, Microns	10.10	9.92	10.16
	Particulate Catch,			
mg<D50	≤ 10 Microns, Milligrams	284.9	105.4	78.7
mg>D50	> 10 Microns, Milligrams	454.2	137.7	81.7
mg	Total Milligrams	739.1	243.1	160.4
	Percent of Total Particulate,			
%<D50	≤ 10 Microns	38.5	43.4	49.1
%>D50	> 10 Microns	61.5	56.6	50.9
	Particulate ≤ 10 Microns			
	Concentration, milligrams/DSCF*			
mg/DSCF	Concentration in Gas Sample	1.919	1.387	1.069
mg/DSCF,A	Concentration in Ambient Air	0.00	0.00	0.00
mg/DSCF,adj	Adjusted Concentration in Gas Sample	1.919	1.387	1.0687
lb/hr	Emission Rate, lb/hr	0.388	0.242	0.187
lb/ton	Emission Rate, lb/ton	0.00166	0.000849	0.000655

* 68 ° F (20 ° C) -- 29.92 Inches of Mercury (Hg).

AIR FLOW RATE DETERMINATIONS

Plant Name Vulcan Materials **Run No.** Wet-2-Crusher-M2-1

City/State Bristol, Tenn. **Date** 6/14/93

Test Location Crusher **Personnel** JRW TTB

Barometric Pres. (Pbar) 28.5 **In. Hg** **Static Pres. (Pg)** -0.63 **In. H_2O**

Pitot/Orifice ID DP48-8 **Pitot Coef. (Cp)** 0.84 **Pres. Gauge Set ID** NU-7

Thermocouple ID R284 **Duct Length/Diameter** 12" **Width** ______

--Specify inches (") or feet (')--

VELOCITY TRAVERSES
Start-Finish Times: 0855 - 0905

	Point No.	ΔP In. H_2O	Temp. °F
	A-1	0.31	64
	2	0.32	64
Pretest	3	0.34	64
	4	0.39	64
	5	0.40	64
	6	0.33	64
	Avg.	0.3475	64
		1521 - 1525	
	A-1	0.36	78
	2	0.35	77
Post	3	0.41	76
test	4	0.42	76
	5	0.39	76
	6	0.34	76
	Avg.*	0.378	77

ORSAT DATA

Sampling Time	Analysis Time	CO_2 (A) Reading	O_2 (B) Reading	%O_2 (B-A)	%CO+N_2 (100-B)
	Average				

Bag No. ______ **Pump** ______

FYRITE DATA, % CO_2				

MOISTURE DATA (WET BULB/DRY BULB)

Port	Time	Dry Bulb °F	Wet Bulb °F	Diff.	% H_2O

MOISTURE DATA (STOICHIOMETRIC)

Free Water in Fuel, %		
Water from Fuel Combustion, %		
Ambient Water, %		
Relative Humidity, %		
Ambient Temperature, °F		
Total %		

VOLUMETRIC AIR FLOW RATES

Dry at Standard Conditions, Qsd = SCFM

Wet at Stack Conditions, Qaw = ACFM

ADDITIONAL DATA

* ΔP average is square of average square root.

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ENTROPY

AIR FLOW RATE DETERMINATIONS

Plant Name Vulcan Materials **Run No.** Wet-2-Crusher M2-2
City/State Bristol, Tenn. **Date** 6/15/93
Test Location Crusher **Personnel** JRW, TTB JB
Barometric Pres. (Pbar) 28.63 **In. Hg** **Static Pres. (Pg)** -0.55 **In. H_2O**
Pitot/Orifice ID DP48-8 **Pitot Coef. (Cp)** 0.84 **Pres. Gauge Set ID** NU-7
Thermocouple ID R284 **Duct Length/Diameter** 12" **Width** N.A.
--Specify inches (") or feet (')--

VELOCITY TRAVERSES
Start-Finish Times: 0722 - 0725

Pretest

Point No.	ΔP In. H_2O	Temp. °F
A-1	0.26	66
2	0.34	66
3	0.30	66
4	0.39	66
5	0.38	66
6	0.31	66
Avg.	0.3284	66
	1420 -	1423
A-1	0.22	75
2	0.21	75
3	0.20	75
4	0.23	75
5	0.24	75
6	0.21	75
Avg.	0.2181	75
Avg.*	~~0.3284~~	

* ΔP average is square of average square root.

ORSAT DATA

Sampling Time	Analysis Time	CO_2 (A) Reading	O_2 (B) Reading	%O_2 (B-A)	%CO+N_2 (100-B)
	Average				

Bag No. ________ Pump ________

FYRITE DATA, % CO_2				

MOISTURE DATA (WET BULB/DRY BULB)

Port	Time	Dry Bulb °F	Wet Bulb °F	Diff.	% H_2O

MOISTURE DATA (STOICHIOMETRIC)

Free Water in Fuel, %		
Water from Fuel Combustion, %		
Ambient Water, %		
Relative Humidity, %		
Ambient Temperature, °F		
Total %		

VOLUMETRIC AIR FLOW RATES

Dry at Standard Conditions, Qsd = SCFM
Wet at Stack Conditions, Qaw = ACFM

ADDITIONAL DATA

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ENTROPY

METHOD 201A (PM-10) FIELD DATA

Client EPA
Plant Name Vulcan Materials
City/State Bristol, Tenn.
Sampling Location Crusher
Date 6/14/93 Team Leader JRW Techs TTB
*Train Leak Check Vacuum, In. Hg 10 6
Train Leak Rate, Cubic Ft./Min. 0.010 0.003

Run Number Wet-2 - Crusher - M201A-1
Time Start 0912
Time Stop 1512
Job Number 50119
Barometric Pressure, In. Hg 28.5
Static Pressure, In. H_2O -0.63

EQUIPMENT CHECKS

✓ Pitot, Pretest
✓ Pitot, Posttest
N.A. M3 Sampling Sys/Ted Bag
✓ Thermocouple @ 64 Pre
✓ Thermocouple @ 75 Post

IDENTIFICATION NUMBERS

Meterbox NU-7 Meterbox Gamma 0.9850 Reagent Box N.A.
T/C Readout F52 T/C Probe R302 Umbilical 4108
Sampling Box 12 Orsat Pump N.A. Tedlar Bag N.A.
Nozzle(s) Actually Used: 0.198 TTB Pitot N.A.
No. Diameter ~~0.188~~ No. Diameter

FILTER NO.	**TARE**
PM348	0.2728

Est % H_2O 2.4

Delta $H_@$ 1.728
Delta H_t 0.5837
Delta H_{t+50} 0.4882
Delta H_{t-50} 0.7103
Delta P_{avg} 0.3475
Meter Temp. 95
Stack Temp. 75

NOZZLE SELECTION CRITERIA

Desired Dia. 0.201

	Nozzle 1	**Nozzle 2**
Diameter	0.188	
Nozzle Number		
Delta P_{min}	0.2026	
Delta P_{max}	0.7492	

FYRITE
N.A.

C_p 0.84

	Sample Point	Dwell Time, Minutes	Elapsed Time, Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading, In. H_2O (ΔP)	Gas Meter Temp, °F	Stack Temp, °F	Orifice Setting, In. H_2O (ΔH)	Vacuum Gauge, In. Hg	Gas Temps Filter Box, °F	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-3	15:00	00:00	431.050	0.34	65	64	0.57		N.A.	43	N.A.
2		15:00	15:00	437.80		70	64	0.57			42	
3		15:00	30:00	444.54		74	66	0.57			42	
4		15:00	45:00	451.31		78	66	0.57			43	
5		15:00	60:00/0	458.09		81	66	0.57			43	
6		15:00	15:00	464.91		84	67	0.57			45	
7		15:00	30:00	471.70		85	68	0.57			42	
8		15:00	45:00	478.53		85	69	0.57			44	
9		15:00	120:00/0	485.38		88	70	0.57			43	
10		15:00	15:00	492.24		90	70	0.57			45	
11		15:00	30:00	499.09		91	70	0.57			48	
12		15:00	45:00	505.91		92	71	0.57			50	

minutes	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH
360	163.967	0.34	88	70	0.57

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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METHOD 201A (PM-10) FIELD DATA (continued)

Client EPA
Plant Name Vulcan Materials
City/State Bristol, Tenn
Sampling Location Crusher

Run Number Wet-2 - Crusher - M201A 1
Job Number 50119

	Sample Point	Dwell Time, Minutes	Elapsed Time, Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading, In. H_2O (P)	Gas Meter Temp, °F	Stack Temp, °F	Orifice Setting, In. H_2O (H)	Vacuum Gauge, In. Hg	Gas Temps Filter Box, °F	Gas Temps Impinq Exit, °F	Cyclone Temp, °F
13	A-7	15:00	180:00/0	512.78	0.34	92	72	0.57	1	N.A.	42	N.A
14		15:00	15:00	519.62		93	72	0.57	1		40	
15		15:00	30:00	526.40		94	72	0.57	1		41	
16		15:00	45:00	533.38		94	72	0.57	1		42	
17		15:00	240:00/0	540.23		93	72	0.57	1		44	
18		15:00	15:00	547.11		93	72	0.57	1		45	
19		15:00	30:00	553.97		93	73	0.57	1		47	
20		15:00	45:00	560.88		94	72	0.57	1		48	
21		15:00	300:00/0	567.78		96	74	0.57	1		49	
22		15:00	15:00	574.45		98	74	0.57	1		48	
23		15:00	30:00	581.33		97	75	0.57	1		45	
24		15:00	45:00	588.24		97	75	0.57	1		44	
25			360/00/Fin.	595.017								
26												
27												
28												
23												
29												
30												
31												
32												
33												
34												
35												
36												
37												
38												
39												
40												

* REMOVE HEAD BEFORE
POSTTEST LEAK CHECK

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METHOD 201A (PM-10) FIELD DATA

Client EPA

Plant Name Vulcan Materials

City/State Bristol, Tenn.

Sampling Location Crusher

Date 6/15/93 Team Leader JRW Techs TTB, JB

*Train Leak Check Vacuum, In. Hg 10 6

Train Leak Rate, Cubic Ft./Min. 0.002 0.001

Run Number Wet-2-Crusher - M201 2

Time Start 0736

Time Stop 1036

Job Number 50119

Barometric Pressure, In. Hg 28.63

Static Pressure, In. H_2O -0.55

EQUIPMENT CHECKS

- ✓ Pitot, Pretest
- ✓ Pitot, Posttest
- N.A. M3 Sampling Sys/Ted Bag
- ✓ Thermocouple @ 65 Pre
- ✓ Thermocouple @ 71 Post

IDENTIFICATION NUMBERS

Meterbox NU-7 Meterbox Gamma 0.9850 Reagent Box N.A.

T/C Readout F52 T/C Probe R218 Umbilical U108

Sampling Box 4 Orsat Pump N.A. Tedlar Bag N.A.

Nozzle(s) Actually Used: 0.198 TTB Pitot N.A.

No. ____ Diameter ~~0.188~~ No. ____ Diameter ____

FILTER NO.	TARE
PM30	0.2701

Est % H_2O 1.5

Delta $H_@$ 1.728

Delta H_t 0.5874

Delta H_{t+50} 0.4905

Delta H_{t-50} 0.7162

Delta P_{avg} 0.3284

Meter Temp. 85

Stack Temp. 70

NOZZLE SELECTION CRITERIA

Desired Dia. 0.203

	Nozzle 1	Nozzle 2
Diameter	0.188	
Nozzle Number		
Delta P_{min}	0.204	
Delta P_{max}	0.7463	

FYRITE

N.A.

C_p 0.84

	Sample Point	Dwell Time, Minutes	Elapsed Time, Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading, In. H_2O (ΔP)	Gas Meter Temp, °F	Stack Temp, °F	Orifice Setting, In. H_2O (ΔH)	Vacuum Gauge, In. Hg	Gas Temps Filter Box, °F	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-3	15:00	00:00	596.200	0.30	65	66	0.58	1	N.A.	60	N.A.
2		15:00	15:00	603.06		70	66		1		59	
3		15:00	30:00	609.92		75	66		1		58	
4		15:00	45:00	616.78		79	67		1		59	
5		15:00	60:00/0	623.64		81	66		1		57	
6		15:00	15:00	630.50		83	66		1		58	
7		15:00	30:00	637.36		84	66		1		60	
8		15:00	45:00	644.24		85	67		1		60	
9		15:00	120:00/0	651.12		85	68		1		59	
10		15:00	15:00	658.01		85	68		1		58	
11		15:00	30:00	664.92		87	68		1		59	
12		15:00	45:00	671.82		89	69				61	
			180/fin	678.709								

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

180 minutes

82.509 Vm

0.30 $(\sqrt{\Delta P})^2$

81 tm

67 ts

0.58 ΔH

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METHOD 201A (PM-10) FIELD DATA

Client EPA
Plant Name Vulcan Materials
City/State Bristol Tenn.
Sampling Location Crusher
Date 6/15/93 Team Leader JRW Techs TTB, JB
*Train Leak Check Vacuum, In. Hg 6 6
Train Leak Rate, Cubic Ft./Min. 0.003 0.001

Run Number Vet-2-Crusher-M201A-3.
Time Start 1100
Time Stop 1416
Job Number 50119
Barometric Pressure, In. Hg 28.63
Static Pressure, In. H_2O -0.55

Stop 1252
Start 1307

EQUIPMENT CHECKS

✓ Pitot, Pretest
✓ Pitot, Posttest
N.A. M3 Sampling Sys/Ted Bag
✓ Thermocouple @ 71 Pre
✓ Thermocouple @ 78 Post

IDENTIFICATION NUMBERS

Meterbox N4-7 Meterbox Gamma 0.9850 Reagent Box N.A.
T/C Readout F52 T/C Probe R302 Umbilical U,08
Sampling Box 12 Orsat Pump N.A. Tedlar Bag N.A.
Nozzle(s) Actually Used: Pitot N.A.
No. Diameter 0.198 ~~0.188~~ TB No. Diameter

FILTER NO.	TARE
PM293	0.2660

Est % H_2O 3

Delta $H_@$ 1.728
Delta H_t 0.5753
Delta H_{t+50} 0.4809
Delta H_{t-50} 0.7006
Delta P_{avg} 0.3284
Meter Temp. 95
Stack Temp. 73

NOZZLE SELECTION CRITERIA

Desired Dia. 0.203

	Nozzle 1	Nozzle 2
Diameter	0.188	
Nozzle Number		
Delta P_{min}	0.2007	
Delta P_{max}	0.7399	

FYRITE
N.A.

C_p 0.84

	Sample Point	Dwell Time, Minutes	Elapsed Time, Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading, In. H_2O (ΔP)	Gas Meter Temp, °F	Stack Temp, °F	Orifice Setting, In. H_2O (ΔH)	Vacuum Gauge, In. Hg	Gas Temps Filter Box, °F	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-3	15:00	00:00	679.600	0.30	85	71	0.57	1	N.A.	65	N.A.
2		15:00	15:00	686.44		88	70		1		52	
3		15:00	30:00	693.30		89	71		1		50	
4		15:00	45:00	700.17		90	71		1		51	
5		15:00	60:00/0	707.3003		91	72		1		53	
6		15:00	15:00	713.78		92	72		1		54	
7		15:00	30:00	720.54		93	72		1		52	
8		15:00	45:00	727.32		93	73		1		55	
9		15:00	120:00/0	734.07		90	73		1		54	
10		15:00	15:00	740.82		93	74		1		48	
11		15:00	30:00	747.56		95	74		1		48	
12		15:00	45:00	754.29								
			180:00 (Am	761.016								

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

180 minutes
81.416 Vm
0.30 $(\sqrt{\Delta P})^2$
91 tm
72 ts
0.57 ΔH

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FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Screen

		D-2-S-M2-1	D-2-S-M2-2	Average
	Test Date	6/16/93	6/16/93	
	Run Start Time	815	1155	
	Run Finish Time	820	1200	
	Net Traversing Points	6	6	
Cp	Pitot Tube Coefficient	0.84	0.84	
Pbar	Barometric Pressure, Inches Hg	28.5	28.5	
Pg	Flue Gas Static Pressure, Inches H2O	-0.31	-0.31	-0.310
Ps	Absolute Flue Gas Pressure, Inches Hg	28.48	28.48	28.48
ts	Flue Gas Temperature, Degrees F	62	79	71
Delta-p	Average Velocity Head, Inches H2O	0.0432	0.0415	0.0423 *

* Represents the square of the average square root of the "Delta-p"

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Screen

		D-2-S-M201A-1	D-2-S-M201A-2	D-2-S-M201A-3
	Test Date	6/16/93	6/16/93	6/16/93
	Run Start Time	820	940	1052
	Run Finish Time	920	1040	1152
	Net Traversing/Sampling Points	6/1	6/1	6/1
Theta	Net Run Time, Minutes	60	60	60
Dia	Nozzle Diameter, Inches	0.341	0.341	0.341
Cp	Pitot Tube Coefficient	0.84	0.84	0.84
Y	Dry Gas Meter Calibration Factor	0.9831	0.9831	0.9831
Pbar	Barometric Pressure, Inches Hg	28.5	28.5	28.5
Delta H	Avg. Pressure Differential of Orifice Meter, Inches H2O	0.6654	0.6654	0.6654
Vm	Volume of Metered Gas Sample, Dry ACF	27.680	28.261	28.059
tm	Dry Gas Meter Temperature, Degrees F	81	88	95
Vmstd	Volume of Metered Gas Sample, Dry SCF*	25.341	25.543	25.040
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, mL	9.3	15.1	14.0
Vwstd	Volume of Water Vapor, SCF*	0.438	0.711	0.659
%H2O	Moisture Content, Percent by Volume	1.70 **	2.71	2.56 **
%H2OSAT	Moisture Sat. @ Flue Gas Conditions, %	2.69	2.69 **	2.69
Mfd	Dry Mole Fraction	0.983	0.973	0.974
%CO2	Carbon Dioxide, Percent by Volume, Dry	0	0	0
%O2	Oxygen, Percent by Volume, Dry	20.9	20.9	20.9
Md	Gas Molecular Weight, Lb/Lb-Mole, Dry	28.84	28.84	28.84
Ms	Gas Molecular Weight, Lb/Lb-Mole, Wet	28.65	28.54	28.56
Pg	Flue Gas Static Pressure, Inches H2O	-0.31	-0.31	-0.31
Ps	Absolute Flue Gas Pressure, Inches Hg	28.48	28.48	28.48
	<u>Volumetric Air Flow Rate</u>			
ts	Flue Gas Temperature, Degrees F	71	71	71
Delta-p	Average Velocity Head, Inches H2O	0.0423	0.0423	0.0423
vs	Flue Gas Velocity, Feet per Second	11.91	11.94	11.93
A	Stack/Duct Area, Square Inches	113.1	113.1	113.1
Qsd	Volumetric Air Flow Rate, Dry SCFM*	522	518	519
Qmsd	Volumetric Air Flow Rate, Dry SCMM*	15	15	15
Qaw	Volumetric Air Flow Rate, Wet ACFM	561	563	562
ton/hr	Production Rate, tons/hour	419.25	419.25	419.25

* 68 ° F (20 ° C) -- 29.92 Inches of Mercury (Hg).

** Moisture used in calculations.

(Continued Next Page)

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Screen

		D-2-S-M201A-1	D-2-S-M201A-2	D-2-S-M201A-3
	Percent Isokinetic			
ts	Flue Gas Temperature, Degrees F	69	75	78
Delta-p	Average Velocity Head, Inches H2O	0.044	0.044	0.044
vs	Flue Gas Velocity, Feet per Second	12.13	12.22	12.25
%I	Isokinetic Sampling Rate, Percent	98.0	100.2	98.4
	PM10 Calculations			
ucyc	Stack Gas Viscosity	180.0	179.2	179.3
Qs	PM10 Flow, at Cyclone Conditions, ACFM	0.454	0.462	0.453
D50	Dia. of Particles in Cyclone, Microns	9.93	9.79	9.94
	Particulate Catch,			
mg<D50	≤ 10 Microns, Milligrams	26.8	61.6	127.6
mg>D50	> 10 Microns, Milligrams	100.4	728.1	669.4
mg	Total Milligrams	127.2	789.7	797.0
	Percent of Total Particulate,			
%<D50	≤ 10 Microns	21.1	7.8	16.0
%>D50	> 10 Microns	78.9	92.2	84.0
	Particulate ≤ 10 Microns			
	Concentration, milligrams/DSCF*			
mg/DSCF	Concentration in Gas Sample	1.06	2.41	5.10
mg/DSCF,A	Concentration in Ambient Air	0.04399	0.04495	0.05269
mg/DSCF,adj	Adjusted Concentration in Gas Sample	1.01	2.37	5.04
lb/hr	Emission Rate, lb/hr	0.0700	0.162	0.346
lb/ton	Emission Rate, lb/ton	0.000167	0.000387	0.000825
M	Screen Size Correction Factor	40	40	40
lb/ton,Tot	Emission Rate, lb/ton, Total	0.00668	0.0155	0.0330

* 68 ° F (20 ° C) -- 29.92 Inches of Mercury (Hg).

AIR FLOW RATE DETERMINATIONS

Plant Name VULCAN MATL - LIMESTONE Run No. DS2201(1,2,3)

City/State BRISTOL, TENN. Date 6/16/92

Test Location SCREEN Personnel DWS

Barometric Pres. (Pbar) 28.5 In. Hg Static Pres. (Pg) -.31 In. H_2O

Pitot/Orifice ID D48 Pitot Coef. (Cp) .84 Pres. Gauge Set ID ADM-1

Thermocouple ID R254 Duct Length/Diameter 12 DIA. Width ______
--Specify inches (") or feet (')--

VELOCITY TRAVERSES
Start-Finish Times: ______ - ______

	Point No.	ΔP In. H_2O	Temp. °F
	A-1	.039	62
	2	.049	62
	3	.031	62
PRE →	4	.044	62
	5	.055	62
	6	.043	62
	AVG	.0432	62
	A-1	.035	79
	2	.044	79
	3	.035	79
Post →	4	.049	79
	5	.046	79
	6	.041	79
	AVG	00415	79
	Avg.*		

ORSAT DATA

Sampling Time	Analysis Time	CO_2 (A) Reading	O_2 (B) Reading	%O_2 (B-A)	%CO+N_2 (100-B)
	Average				

Bag No. ______ Pump ______

FYRITE DATA, % CO_2				

MOISTURE DATA (WET BULB/DRY BULB)

Port	Time	Dry Bulb °F	Wet Bulb °F	Diff.	% H_2O

MOISTURE DATA (STOICHIOMETRIC)

Free Water in Fuel, %		
Water from Fuel Combustion, %		
Ambient Water, %		
Relative Humidity, %		
Ambient Temperature, °F		
Total %		

VOLUMETRIC AIR FLOW RATES

Dry at Standard Conditions, Qsd = SCFM

Wet at Stack Conditions, Qaw = ACFM

ADDITIONAL DATA

* ΔP average is square of average square root.

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ENTROPY

METHOD 201A (PM-10) FIELD DATA

Client VULCAN MATL - LIMESTONE
Plant Name BRISTOL, TENN
City/State SCREEN
Sampling Location
Date 6/16/93 Team Leader DWS Techs JR
*Train Leak Check Vacuum, In. Hg 10
Train Leak Rate, Cubic Ft./Min. .001

Run Number DS22011
Time Start 0820
Time Stop 0920
Job Number 5019
Barometric Pressure, In. Hg 28.5
Static Pressure, In. H_2O -.31

EQUIPMENT CHECKS

✓ Pitot, Pretest
✓ Pitot, Posttest
NA M3 Sampling Sys/Ted Bag
✓ Thermocouple @ 62 Pre
✓ Thermocouple @ 71 Post

IDENTIFICATION NUMBERS

Meterbox EN-2
T/C Readout F38
Sampling Box NA
Nozzle(s) Actually Used: TTB, .341
No. CAE Diameter ~~.344~~
Meterbox Gamma .9831
T/C Probe R129
Orsat Pump NA
No.
Reagent Box NA
Umbilical U81
Tedlar Bag NA
Pitot 4-42
Diameter

FILTER NO.	TARE

Est % H_2O 2.0

Delta $H_@$ 1.985
Delta H_t .6654
Delta H_{t+50} .5542
Delta H_{t-50} .8178
Delta P_{avg} .0432
Meter Temp. 90
Stack Temp. 62

NOZZLE SELECTION CRITERIA

Desired Dia. .377

	Nozzle 1	Nozzle 2
Diameter	.344	
Nozzle Number	CAE	
Delta P_{min}	.0099	
Delta P_{max}	.0891	

FYRITE

NA

C_p .84

	Sample Point	~~Dwell~~ Time, Minutes	~~Elapsed~~ Time, Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading, In. H_2O (ΔP)	Gas Meter Temp, °F	Stack Temp, °F	Orifice Setting, In. H_2O (ΔH)	Vacuum Gauge, In. Hg	Gas Temps ~~Filter Box~~, $\frac{°F}{\sqrt{}}$ / 112	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-4	0	10	764.726	.044	75	62	.6654	1.0	0	60	62
2	4	10	10	769.28	.044	77	66	.6654	1.0	4/110	60	66
3	4	20	10	773.84	.044	80	70	.6654	1.0	5/110	59	70
4	4	30	10	778.48	.044	84	71	.6654	1.0	5/110	58	71
5	4	40	10	783.13	.044	84	71	.6654	1.0	4/110	58	71
6	4	50	10	787.93	.044	86	71	.6654	1.0	3/110	57	71
7	END	60		792.406								
8												
9												
10												
11												
12												

60	27.680	0.044	81	69	0.6654
minutes	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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METHOD 201A (PM-10) FIELD DATA

Plant Name VULCAN MATL - LIMESTONE
City/State BRISTOL, TENN.
Sampling Location SCREEN
Date 6/16/93 Team Leader DWS Techs JB
*Train Leak Check Vacuum, In. Hg 10
Train Leak Rate, Cubic Ft./Min. .001

Run Number DS22012
Time Start 0940
Time Stop 1040
Job Number 50119
Barometric Pressure, In. Hg 28.5
Static Pressure, In. H_2O -.31

EQUIPMENT CHECKS

✓ Pitot, Pretest
✓ Pitot, Posttest
NA M3 Sampling Sys/Ted Bag
✓ Thermocouple @ 73° Pre
✓ Thermocouple @ 78° Post

IDENTIFICATION NUMBERS

Meterbox EN-2
T/C Readout F38
Sampling Box NA
Nozzle(s) Actually Used: TT3 .341
No. CAG Diameter ~~.344~~
Meterbox Gamma .9831
T/C Probe R129
Orsat Pump NA
No.
Reagent Box NA
Umbilical U81
Tedlar Bag NA
Pitot 4-42
Diameter

FILTER NO. **TARE**

Est % H_2O 2.0

Delta $H_@$ 1.935
Delta H_t .6654
Delta H_{t+50} .5542
Delta H_{t-50} .8138
Delta P_{avg} .0432
Meter Temp. 90
Stack Temp. 62

NOZZLE SELECTION CRITERIA

Desired Dia. .337

	Nozzle 1	Nozzle 2
Diameter	.344	
Nozzle Number	CAG	
Delta P_{min}	.0099	
Delta P_{max}	.0891	

FYRITE
NA

C_p .84

	Sample Point	Dwell Time, Minutes	Elapsed Time, Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading, In. H_2O (ΔP)	Gas Meter Temp, °F	Stack Temp, °F	Orifice Setting, In. H_2O (ΔH)	Vacuum Gauge, In. Hg	WIND Gas Temps ~~Filter Box, °F~~ V / Dir°	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-4	10	0	792.639	.044	85	72	.6654	1.0	2/110°	60	72
2	4	10	10	797.31	.044	86	74	.6654	1.0	4/110°	58	74
3	4	10	20	802.04	.044	87	76	.6654	1.0	4/110°	58	76
4	4	10	30	806.77	.044	90	75	.6654	1.0	5/110°	56	75
5	4	10	40	811.49	.044	90	77	.6654	1.0	4/110°	56	77
6	4	10	50	816.22	.044	92	78	.6654	1.0	4/110°	56	78
7			60	820.900								
8												
9												
10												
11												
12												

minutes	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH
60	28.261	0.044	88	75	0.6654

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

F-1109 rev. 11-92

ENTROPY

METHOD 201A (PM-10) FIELD DATA

Plant Name VULCAN MATL - LIMESTONE
City/State BRISTOL, TENN.
Sampling Location SCREEN
Date 6/16/93 Team Leader JWS Techs JG
*Train Leak Check Vacuum, In. Hg 10
Train Leak Rate, Cubic Ft./Min. .001

Run Number DS22013
Time Start 1052
Time Stop 1152
Job Number 5011S
Barometric Pressure, In. Hg 28.5
Static Pressure, In. H_2O -.31

EQUIPMENT CHECKS

✓ Pitot, Pretest
✓ Pitot, Posttest
NA M3 Sampling Sys/Ted Bag
✓ Thermocouple @ 78 Pre
✓ Thermocouple @ 80 Post

IDENTIFICATION NUMBERS

Meterbox EN-2
T/C Readout F3B
Sampling Box NA
Meterbox Gamma .9831
T/C Probe R129
Orsat Pump NA
Nozzle(s) Actually Used: TB .341
No. CA5 Diameter ~~.344~~
No.
Reagent Box NA
Umbilical U81
Tedlar Bag NA
Pitot 4-42
Diameter

FILTER NO.	TARE

Est % H_2O 2.0

Delta $H_@$ 1.935
Delta H_t .6654
Delta H_{t+50} .5542
Delta H_{t-50} .8128
Delta P_{avg} .0432
Meter Temp. 90
Stack Temp. 62

NOZZLE SELECTION CRITERIA

Desired Dia. .337

	Nozzle 1	Nozzle 2
Diameter	.344	
Nozzle Number	CA5	
Delta P_{min}	.0099	
Delta P_{max}	.0891	

FYRITE
NA

C_p .84

	Sample Point	Dwell Time, Minutes	Elapsed Time, Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading, In. H_2O (ΔP)	Gas Meter Temp, °F	Stack Temp, °F	Orifice Setting, In. H_2O (ΔH)	Vacuum Gauge, In. Hg	WIND Gas Temps ~~Filter~~ Box, ~~°F~~ V/DIE°	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-4	10	0	821.212	.044	94	77	.6654	1.0	4/110°	60	77
2	4	10	10	825.92	.044	94	78	.6654	1.0	4/110°	58	78
3	4	10	20	830.61	.044	94	77	.6654	1.0	4/110°	58	77
4	4	10	30	835.31	.044	95	77	.6654	1.0	3/110°	58	77
5	4	10	40	839.97	.044	96	79	.6654	1.0	4/110°	57	79
6	4	10	50	844.63	.044	97	79	.6654	1.0	5/110°	56	79
7			60	849.271								
8												
9												
10												
11												
12												

60	28.059	0.044	95	78	0.6654
minutes	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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ENTROPY

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Screen

		W-2-S-M2-1	W-2-S-M2-2	Average
	Test Date	6/14/93	6/14/93	
	Run Start Time	930	1545	
	Run Finish Time	935	1550	
	Net Traversing Points	6	6	
Cp	Pitot Tube Coefficient	0.84	0.84	
Pbar	Barometric Pressure, Inches Hg	28.5	28.5	
Pg	Flue Gas Static Pressure, Inches H2O	-0.28	-0.28	-0.280
Ps	Absolute Flue Gas Pressure, Inches Hg	28.48	28.48	28.48
ts	Flue Gas Temperature, Degrees F	66	78	72
Delta-p	Average Velocity Head, Inches H2O	0.0476	0.0477	0.0476 *

* Represents the square of the average square root of the "Delta-p"

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Screen

		W-2-S-M2-3	W-2-S-M2-4	
	Test Date	6/15/93	6/15/93	
	Run Start Time	1545	xxxx	
	Run Finish Time	1550	xxxx	
	Net Traversing Points	6	6	
Cp	Pitot Tube Coefficient	0.84	0.84	
Pbar	Barometric Pressure, Inches Hg	28.6	28.6	Average
Pg	Flue Gas Static Pressure, Inches H2O	-0.35	-0.35	-0.350
Ps	Absolute Flue Gas Pressure, Inches Hg	28.57	28.57	28.57
ts	Flue Gas Temperature, Degrees F	XXX	XXX	ERR
Delta-p	Average Velocity Head, Inches H2O	0.0550	0.0520	0.0535 *

* Represents the square of the average square root of the "Delta-p"

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Screen

		W-2-S-M201A-1	W-2-S-M201A-2	W-2-S-M201A-3
	Test Date	6/14/93	6/15/93	6/15/93
	Run Start Time	940	805	1120
	Run Finish Time	1540	1105	1435
	Net Traversing/Sampling Points	6/1	6/1	6/1
Theta	Net Run Time, Minutes	360	180	180
Dia	Nozzle Diameter, Inches	0.341	0.341	0.341
Cp	Pitot Tube Coefficient	0.84	0.84	0.84
Y	Dry Gas Meter Calibration Factor	0.9831	0.9831	0.9831
Pbar	Barometric Pressure, Inches Hg	28.5	28.6	28.6
Delta H	Avg. Pressure Differential of Orifice Meter, Inches H2O	0.6542	0.6548	0.6548
Vm	Volume of Metered Gas Sample, Dry ACF	167.018	82.929	83.263
tm	Dry Gas Meter Temperature, Degrees F	89	83	89
Vmstd	Volume of Metered Gas Sample, Dry SCF*	150.674	75.905	75.378
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, mL	67.6	41.9	40.8
Vwstd	Volume of Water Vapor, SCF*	3.182	1.972	1.920
%H2O	Moisture Content, Percent by Volume	2.07 **	2.53 **	2.48 **
%H2OSAT	Moisture Sat. @ Flue Gas Conditions, %	2.78	3.61	3.17
Mfd	Dry Mole Fraction	0.979	0.975	0.975
%CO2	Carbon Dioxide, Percent by Volume, Dry	0	0	0
%O2	Oxygen, Percent by Volume, Dry	20.9	20.9	20.9
Md	Gas Molecular Weight, Lb/Lb-Mole, Dry	28.84	28.84	28.84
Ms	Gas Molecular Weight, Lb/Lb-Mole, Wet	28.61	28.56	28.57
Pg	Flue Gas Static Pressure, Inches H2O	-0.28	-0.35	-0.34
Ps	Absolute Flue Gas Pressure, Inches Hg	28.48	28.57	28.58
	Volumetric Air Flow Rate			
ts	Flue Gas Temperature, Degrees F	72	80	76
Delta-p	Average Velocity Head, Inches H2O	0.0476	0.0535	0.0535
vs	Flue Gas Velocity, Feet per Second	12.66	13.51	13.46
A	Stack/Duct Area, Square Inches	113.1	113.1	113.1
Qsd	Volumetric Air Flow Rate, Dry SCFM*	552	580	582
Qmsd	Volumetric Air Flow Rate, Dry SCMM*	15.6	16.4	16.5
Qaw	Volumetric Air Flow Rate, Wet ACFM	597	637	634
ton/hr	Production Rate, tons/hour	435.37	415.38	415.38

* 68 ° F (20 ° C) -- 29.92 Inches of Mercury (Hg).

** Moisture used in calculations.

(Continued Next Page)

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Screen

		W-2-S-M201A-1	W-2-S-M201A-2	W-2-S-M201A-3
	Percent Isokinetic			
ts	Flue Gas Temperature, Degrees F	73	80	76
Delta-p	Average Velocity Head, Inches H20	0.05	0.057	0.057
vs	Flue Gas Velocity, Feet per Second	12.99	13.95	13.89
%I	Isokinetic Sampling Rate, Percent	91.7	87.3	86.3
	PM10 Calculations			
ucyc	Stack Gas Viscosity	179.9	181.5	180.6
Qs	PM10 Flow, at Cyclone Conditions, ACFM	0.452	0.463	0.456
D50	Dia. of Particles in Cyclone, Microns	9.96	9.89	9.94
	Particulate Catch,			
mg<D50	≤ 10 Microns, Milligrams	55.0	9.3	7.8
mg>D50	> 10 Microns, Milligrams	642.4	38.1	44.0
mg	Total Milligrams	697.4	47.4	51.8
	Percent of Total Particulate,			
%<D50	≤ 10 Microns	7.9	19.6	15.1
%>D50	> 10 Microns	92.1	80.4	84.9
	Particulate ≤ 10 Microns			
	Concentration, milligrams/DSCF*			
mg/DSCF	Concentration in Gas Sample	0.365	0.123	0.103
mg/DSCF,A	Concentration in Ambient Air	0.02940	0.01740	0.01727
mg/DSCF,adj	Adjusted Concentration in Gas Sample	0.336	0.105	0.0862
lb/hr	Emission Rate, lb/hr	0.0245	0.00806	0.00664
lb/ton	Emission Rate, lb/ton	5.63E-05	1.94E-05	1.60E-05
M	Screen Size Correction Factor	40	40	40
lb/ton,Tot	Emission Rate, lb/ton, Total	0.00225	0.000776	0.000639

* 68 ° F (20 ° C) -- 29.92 Inches of Mercury (Hg).

PRELIMINARY VELOCITY AND CYCLONIC FLOW DETERMINATIONS

Plant Name VULCAN MATL - LIMESTONE Job No. 5019

City/State BRISTOL, TENN. Date 6/14/93

Test Location SCREEN Personnel DWS / JB

Barometric Pres. (Pbar) 28.5 In. Hg Static Pres. (Pg) -0.28 In. H_2O

Pitot ID DP483 Pitot Coeff. (Cp) .84 Pressure Gauge Set ID ADM-1

Thermocouple ID R358 Duct Length/Diameter 12 IN. D./Width --Specify inches (") or feet (')--

TRAVERSES
Start-Finish Times: ____ - ____

Pt. No.	Yaw ∠°	ΔP "H_2O	Temp °F
A-1	0	0.040	66
A-2	0	0.053	
A-3	0	0.034	
A-4	0	0.050	
A-5	0	0.057	
A-6	0	0.054	
	AVG	0.0476	66
A-1	0	.052	78
2	0	.036	
3	0	.034	
4	0	.054	
5	0	-.058	
6	0	.055	
	AVG	0.0477	78
Avg*			

PRE TEST →

POST TEST →

240

ORSAT DATA

Sampling Time	Analysis Time	CO_2 (A) Reading	O_2 (B) Reading	%O_2 (B-A)	%CO+N_2 (100-B)
	Average				

Bag No. ______ Pump ______

FYRITE DATA, % CO_2				

MOISTURE DATA (WET BULB/DRY BULB)

Port	Time	Dry Bulb °F	Wet Bulb °F	Diff.	% H_2O

MOISTURE DATA (STOICHIOMETRIC)

Free Water in Fuel, %		
Water from Fuel Combustion, %		
Ambient Water, %		
Relative Humidity, %		
Ambient Temperature, °F		
Total %		

VOLUMETRIC AIR FLOW RATES

Dry at Standard Conditions, Qsd = SCFM

Wet at Stack Conditions, Qaw = ACFM

HORIZONTAL DUCT FLYASH/DUST BUILDUP >1" DEPTH?

Yes__ No__ If yes, see page 2 for instructions

* 1. ∠ average is summation of absolute values divided by number of measurements and must be ≤ 20°.
2. ΔP average is square of average square root.

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See page 2 for cyclonic flow check criteria.

ENTROPY

AIR FLOW RATE DETERMINATIONS

Plant Name VULCAN MATL. - LIMESTONE
Run No. WS2201 (2,3
City/State BRISTOL, TENN
Date 6/15/93
Test Location SCREEN
Personnel DWS/KB
Barometric Pres. (Pbar) 28.6 In. Hg
Static Pres. (Pg) -.35 In. H_2O
Pitot/Orifice ID D48
Pitot Coef. (Cp) .84
Pres. Gauge Set ID ADM-1
Thermocouple ID R234
Duct Length/Diameter 12" DIA. Width
--Specify inches (") or feet (')--

VELOCITY TRAVERSES
Start-Finish Times: -

Pre → tests

Post → tests

Point No.	ΔP In. H_2O	Temp. °F
A-1	.062	
2	.057	
3	.045	
4	.051	
5	.059	
6	.057	
AVG	0.055	
A-1	.041	
2	.072	
3	.060	
4	.046	
5	.047	
6	.048	
AVG	0.052	
Avg.*		

ORSAT DATA

Sampling Time	Analysis Time	CO_2 (A) Reading	O_2 (B) Reading	%O_2 (B-A)	%$CO+N_2$ (100-B)
	Average				

Bag No.
Pump

FYRITE DATA, % CO_2				

MOISTURE DATA (WET BULB/DRY BULB)

Port	Time	Dry Bulb °F	Wet Bulb °F	Diff.	% H_2O

MOISTURE DATA (STOICHIOMETRIC)

Free Water in Fuel, %		
Water from Fuel Combustion, %		
Ambient Water, %		
Relative Humidity, %		
Ambient Temperature, °F		
Total %		

VOLUMETRIC AIR FLOW RATES

Dry at Standard Conditions, Qsd = SCFM

Wet at Stack Conditions, Qaw = ACFM

ADDITIONAL DATA

* ΔP average is square of average square root.

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ENTROPY

METHOD 201A (PM-10) FIELD DATA

Plant Name VULCAN - LIMESTONE CRUSHING
City/State BRISTOL, TENN
Sampling Location SCREEN
Date 6/14/93 Team Leader DWS Techs
*Train Leak Check Vacuum, In. Hg 10
Train Leak Rate, Cubic Ft./Min. .001

Run Number WS22011
Time Start 0940
Time Stop 1540
Job Number 50119
Barometric Pressure, In. Hg 28.5
Static Pressure, In. H_2O -.28

EQUIPMENT CHECKS

✓ Pitot, Pretest
✓ Pitot, Posttest
NA M3 Sampling Sys/Ted Bag
✓ Thermocouple @ 66 Pre
Thermocouple @ Post

IDENTIFICATION NUMBERS

Meterbox EN-2
T/C Readout F-38
Sampling Box NA
Nozzle(s) Actually Used: T/B ·341
No. CAE Diameter .328
Meterbox Gamma .9831
T/C Probe R129
Orsat Pump NA
No.
Reagent Box NA
Umbilical UB1
Tedlar Bag NA
Pitot 4-42
Diameter

FILTER NO.	TARE

Est % H_2O 2.0

Delta $H_@$ 1.935
Delta H_t .6542
Delta H_{t+50} .5455
Delta H_{t-50} .7988
Delta P_{avg} .0476
Meter Temp. 90
Stack Temp. 66

NOZZLE SELECTION CRITERIA

Desired Dia. .329

	Nozzle 1	Nozzle 2
Diameter	.328	
Nozzle Number	CAE	
Delta P_{min}	.0121	
Delta P_{max}	.1087	

FYRITE

NA

C_p .84

	Sample Point	Dwell Time, Minutes	Elapsed Time, Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading, In. H_2O (ΔP)	Gas Meter Temp, °F	Stack Temp, °F	Orifice Setting, In. H_2O (ΔH)	Vacuum Gauge, In. Hg	WIND Gas Temps ~~Filter~~ Box, ~~°F~~ V / DIR	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-4	15.0	0	390.744	.05	76	66	.6542	1.0	1/100°	30	66
2			15	397.56		78	67			2/100°	32	67
3			30	404.36		82	67			1/100°	32	67
4			45	411.17		84	68			2/100°	33	68
5			60	418.02		88	69			3/100°	33	69
6			75	424.99		90	71			2/110°	34	71
7			90	431.96		92	72			2/110°	35	72
8			105	438.97		88	72			2/110°	35	72
9			120	445.92		88	72			3/120°	36	72
10			135	452.86		89	72			1/114°	36	72
11			150	459.81		92	72			1/100°	38	72
12			165	466.80		95	74			1/100°	38	74

CONTINUED →

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

minutes ____ Vm ____ $(\sqrt{\Delta P})^2$ ____ tm ____ ts ____ ΔH ____

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ENTROPY

METHOD 201A (PM-10) FIELD DATA (continued)

Plant Name VULCAN MATL - LIMESTONE
City/State BRISTOL, TENN
Sampling Location SCREEN

Run Number WS22011
Time Start 0940
Time Stop 1540

	Sample Point	Dwell Time, Minutes	Elapsed Time, Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading, In. H_2O (ΔP)	Gas Meter Temp, °F	Stack Temp, °F	Orifice Setting, In. H_2O (ΔH)	Vacuum Gauge, In. Hg	Gas Temps ~~Filter Box, °F~~ √/DIC	Gas Temps Imping Exit, °F	Cyclone Temp, °F
13	A-4	15.0	180	473.81	.05	96	74	.6542	1.0	3/120°	38	74
14			195	480.82		94	72			3/110°	40	72
15			210	487.82		92	72			2/100°	40	72
16			225	494.84		89	72			3/100°	42	72
17			240	501.78		88	73			2/100°	42	73
18			255	508.72		90	74			2/100°	42	74
19			270	515.67		90	77			4/110°	43	77
20			285	522.61		91	76			2/100°	44	76
21			300	529.68		93	76			3/100°	44	76
22			315	536.80		92	75			3/100°	42	75
23			330	543.83		92	78			4/100°	40	78
24			345	550.81		92	78			3/100°	39	78
25			360	557.762								
26												
27												
28												
23												
29												
30												
31												
32												
33												
34												
35												
36												
37												
38												
39												
40												

360	167.018	0.05	89	73	0.6542
minutes	Vm	$(\sqrt{\Delta P})^2$	tm	ts	Δ H

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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ENTROPY

METHOD 201A (PM-10) FIELD DATA

Plant Name VULCAN MATL - LIMESTONE
City/State BRISTOL, TENN
Sampling Location SCREEN
Date 6/15/93 Team Leader DWS Techs JB
*Train Leak Check Vacuum, In. Hg 10
Train Leak Rate, Cubic Ft./Min. .001

Run Number WS2-2012
Time Start 0805
Time Stop 1105
Job Number 50119
Barometric Pressure, In. Hg 28.6
Static Pressure, In. H_2O -.35

EQUIPMENT CHECKS

✓ Pitot, Pretest
✓ Pitot, Posttest
NA M3 Sampling Sys/Ted Bag
✓ Thermocouple @ 67 Pre
✓ Thermocouple @ 72 Post

IDENTIFICATION NUMBERS

Meterbox EN-2
T/C Readout F38
Sampling Box NA
Nozzle(s) Actually Used: TTB .341
No. CAE Diameter ~~.328~~
Meterbox Gamma .9831
T/C Probe R129
Orsat Pump NA
No.
Reagent Box NA
Umbilical U81
Tedlar Bag NA
Pitot 4-42
Diameter

FILTER NO.	TARE

Est % H_2O 2.0

Delta $H_@$ 1.935
Delta H_t .6548
Delta H_{t+50} .5459
Delta H_{t-50} .7999
Delta P_{avg} .055
Meter Temp. 90
Stack Temp. 65

NOZZLE SELECTION CRITERIA

Desired Dia. .317

	Nozzle 1	Nozzle 2
Diameter	.328	
Nozzle Number	CAE	
Delta P_{min}	.0121	
Delta P_{max}	.1086	

FYRITE

NA

C_p .84

	Sample Point	Dwell Time, Minutes	Elapsed Time, Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading, In. H_2O (ΔP)	Gas Meter Temp, °F	Stack Temp, °F	Orifice Setting, In. H_2O (ΔH)	Vacuum Gauge, In. Hg	Wind Gas Temps ~~Filter~~ Box, ~~°F~~ $\bar{V}$/Dir°	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-2	15.0	0	566.325	.057	76	72	.6548	1.0	0	52	72
2			15	573.21		79	72			0	50	72
3			30	580.11		82	79			4/50°	50	79
4			45	587.02		82	79			3/50°	50	79
5			60	593.91		82	77			4/50°	50	77
6			75	600.87		82	81			4/51°	52	81
7			90	607.81		82	85			3/50°	52	85
8			105	614.56		85	85			5/110°	53	85
9			120	621.48		86	86			5/110°	54	86
10			135	628.34		87	89			4/100°	55	89
11			150	635.33		85	81			7/50°	54	81
12			165	642.31		85	75			5/30°	52	75
			180	649.254								

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

minutes	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH
180	82.929	0.057	83	80	0.6548

METHOD 201A (PM-10) FIELD DATA

Plant Name VULCAN MATL - LIMESTONE
City/State BRISTOL TENN
Sampling Location SCREEN
Date 6/15/93 Team Leader DWS Techs JR
*Train Leak Check Vacuum, In. Hg .10
Train Leak Rate, Cubic Ft./Min. .001

Run Number WS22013
Time Start 1120
Time Stop 1435
Job Number 50119
Barometric Pressure, In. Hg 28.6
Static Pressure, In. H_2O -.34

EQUIPMENT CHECKS

✓ Pitot, Pretest
✓ Pitot, Posttest
NA M3 Sampling Sys/Ted Bag
✓ Thermocouple @ 72° Pre
✓ Thermocouple @ 78° Post

IDENTIFICATION NUMBERS

Meterbox EN-2
T/C Readout F-38
Sampling Box NA
Nozzle(s) Actually Used:
No. CAE Diameter ~~.308~~ .341 TB No. Diameter
Meterbox Gamma .9831
T/C Probe R129
Orsat Pump NA
Reagent Box NA
Umbilical UB1
Tedlar Bag NA
Pitot 4-42

FILTER NO.	TARE

Est % H_2O 2.0

Delta $H_@$ 1.935
Delta H_t .6548
Delta H_{t+50} .5459
Delta H_{t-50} .7999
Delta P_{avg} .055
Meter Temp. 90
Stack Temp. 65

NOZZLE SELECTION CRITERIA

Desired Dia. .317

	Nozzle 1	Nozzle 2
Diameter	.328	
Nozzle Number	CAE	
Delta P_{min}	.0121	
Delta P_{max}	.1086	

FYRITE
NA

C_p .84

	Sample Point	Dwell Time, Minutes	Elapsed Time, Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading, In. H_2O (ΔP)	Gas Meter Temp, °F	Stack Temp, °F	Orifice Setting, In. H_2O (ΔH)	Vacuum Gauge, In. Hg	WIND Gas Temps ~~Filter Box, °F~~ V/DIR°	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-2	15.0	0	649.312	.057	85	72	.6548	1.0	0	50	72
2			15	656.33		85	78			5/30°	50	78
3			30	663.11		85	~~84~~ 77			4/30°	52	~~78~~ 77
4			45	670.02		89	76			4/30°	50	76
5			60	677.13		90	75			5/30°	50	75
6			75	684.18		94	74			5/30°	50	74
7			90	691.24		93	75			7/30°	48	75
8			105	698.16		88	76			8/30°	48	76
9			120	705.19		89	76			8/30°	46	76
10			135	711.92		90	76			7/35°	46	76
11			150	718.96		92	77			6/30°	42	76
12			165	725.76		92	78			4/30°	40	78
			180	732.575								

minutes	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH
180	83.263	0.057	89	76	0.6548

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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ENTROPY

Appendix B

Example Calculation of PM10 Emission Factors

Variables

Q_{S-A} = Actual gas sampled by M201A train; ACF
Q_{S-STD} = Gas sampled by M210A train; SCF_{Dry}
Q_{F-A} = Gas flow rate through hood and fan; ACF/Min
Q_{F-STD} = Gas flow rate through hood and fan; SCF_{Dry}/Min
Q_{AMB-A} = Gas flow rate through ambient PM10 monitor; ACF/Min
$Q_{AMB-STD}$ = Gas flow rate through ambient PM10 monitor; SCF_{Dry}/Min
T_s = Standard temperature, 528 Degrees °R
T_T = Meter box gas temperature, (460°R + x °F)
T_{STK} = Stack Temperature, (460 °R + x °F)
P_B = Barometric pressure during test, inches Hg.
P_{BS} = Standard Atmospheric Pressure, 29.92 inches Hg.
W_F = Total PM10 catch weight in M201A train, mg
W_{AMB} = Total PM10 catch weight in M201A ambient sampler, mg
X = Moisture in flue gas, %(volume)

1. Calculation of gas volume (standard) sampled in M201A;

   $Q_{S-STD} = (Q_{S-A})(T_s/T_T)(P_B/P_{BS})((1-X)/1)$

2. Concentration of PM10 in gas sampled; C_{PM10}

   $C_{PM10} = (W_F/Q_{S-STD})$

3. Calculation of gas volume(standard) sampled in ambient sampler;

   $Q_{AMB-STD} = (Q_{AMB-A})(0.33FT^2)(T_S/T_{STK})(P_B/P_{BS})(T_{TEST})((1-X)/1)$

4. Calculation of ambient PM10 concentration

   $C_{PM10AMB} = W_{AMB}/Q_{AMB-STD}$

5. Calculation of adjusted PM10 concentration in M201A gas sampled

$C_{PM10AMB}A = (C_{PM10} - {*}C_{PM10AMB})$

6. Calculation of total gas flow rate from screen

$Q_{F\text{-}STD} = (Q_{F\text{-}A})(40\ \text{Sample Points})(T_S/T_{STK})(P_B/P_{BS})(60\text{Min/Hr})(1-X)/1)$

7. Calculation of total PM10 emissions

$E_{PM10} = (C_{PM10AMB}A)(Q_{F\text{-}STD})(\text{Grams}/1000)(\text{Pounds}/454\text{Grams})$

8. Calculation of Vibrating Screen processing rate

$P_D = \text{Screen Rate} = (P/2)$

9. Calculation of PM10 Emission factors

$E_f = (E_{PM10}/P_D)$

Appendix C.

SAMPLING EQUIPMENT AUDIT

Job No. 50119

Plant Name VULCAN - LIMESTONE

Auditor(s) DWS

City/State BRISTOL, TENN

Date 6/14/93

Test Loc. SCREEN

BAROMETER
Entropy In-House Ref. Barometer ______ "Hg vs Field Barometer ______ "Hg
Date Compared ______ Dev. ______ "Hg (Max. Allowable Dev.: ± 0.1 "Hg)
Field Barometric Pressure Corrected for Test Location Elevation? (√) ______
(Note: deduct 0.1" Hg from local NWS *STATION* pressure for each 100' of test location elevation; example: 29.6 - (300'/100 * 0.1) = 29.3" Hg.)

Ref. Therm. Initial Ambient Temp., °F ______

	Allowable Deviation From Ambient	Ambient Temperature, °F				Audit OK (√)
THERMOMETERS *						
Dry Gas Meter	± 5.4 °F	______	(Meterbox No. ______)			______
Impinger Exit	± 2.0 °F	______	______	______	______	______
Filter Box	± 5.4 °F	______	______	______	______	______

* Adjust thermometer until acceptable. If it cannot be adjusted, use as back-up. If no backup, record ambient temperature indicated by unadjusted thermometer and label with correction factor (indicate):

THERMOCOUPLES Allowable Deviation from Ambient: ± 8.0°F* (± 2.0°F)**

TC No. / °F	√ OK	TC No. / °F	√ OK	TC No. / °F	√ OK	TC No. / °F	√ OK	TC No. / °F	√ OK
/		/		/		/		/	

* ± 8.0 °F = ± 1.5% of ambient absolute temperature.
** (± 2.0 °F if used in saturated or water droplet-laden gas stream.)

ISOKINETIC METERBOX I.D. EN-2 Gamma (Y) .9831 ΔH@ 1.975

As Applicable (check): Zero Magnehelics? ______ Zero/Level Manometer? ✓

Barometric Pressure (P_{bar}) 28.5 Auditor DWS Date 6/14/93

Dry Gas Meter Reading (Cubic Ft.)	Meter Temperature (°F)	Lower and Upper Limits for Audit Gamma
Final 390.023	Final 81	0.96 * Y = .9438
Initial 382.083	Initial 80	1.04 * Y = 1.0224

Dry Gas Volume Metered (Cubic Ft.)	Average Meter Temp. (°F)	Run Time (Base = 10)	
		(Minutes)	(Seconds)
Vm = 7.94	Tm = 80.5	10	0

0.75 = Ideal Sampling Rate

$$Y_c = \frac{[\text{Min.} + (\text{Sec.} / 60)]}{Vm} * \left[\frac{\{[(29.92) / (460 + 68) * (0.75)^2] * (Tm + 460)\}}{P_{bar}}\right]^{.5}$$

$$Y_c = \frac{[\ 10\ + (\ 0\ / 60)]}{7.94} * \left[\frac{0.0319\ (\ 80.5\ + 460)}{28.5}\right]^{.5} = .9796$$

Audit Gamma

Audit Gamma Acceptable (between lower & upper limits)? (√) ✓ Yes ______ No

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ENTROPY

SAMPLING EQUIPMENT AUDIT

Plant Name Vulcan Materials
Job No. 50119
City/State Bristol, Tenn.
Team Leader JRW
Test Location Crusher

BAROMETER
Barometer (Van) No. ____ Checked OK? (√) ____ Shop Auditor ____
Entropy In-House Ref. Barometer ____ "Hg vs Van Barometer ____ "Hg
Date Compared ____ Dev. ____ "Hg (Max. Allowable Dev.: ± 0.1 "Hg)
Test Loc. Elevation Above Ground (Van) ____ Ft. Date ____ Field Auditor ____
Field Barometric Pressure Reduced for Test Location Elevation by ____ "Hg

Ref. Therm. Initial Ambient Temp., °F 63

	Allowable Deviation From Ambient	Date 6/14/93 Auditor JRW Ambient Temperature, °F				√ OK
THERMOMETERS Dry Gas Meter	± 5.4 °F	65	(Meterbox I.D. NU-7)			✓
Impinger Exit	± 2.0 °F	62				✓
Filter Box	± 5.4 °F	N.A.				—

THERMOCOUPLES

TC No. / °F	√ OK	TC No. / °F	√ OK	TC No. / °F	√ OK	TC No. / °F	√ OK	TC No. / °F	√ OK
R284/64	✓	R302/64	✓	R210/63	✓	/	—	/	—
(Including Temp. Change and Direction)		(Including Temp. Change and Direction)		(Including Temp. Change and Direction)		(Including Temp. Change and Direction)		(Including Temp. Change and Direction)	
Auditor JRW		Auditor JRW		Auditor JRW		Auditor ____		Auditor ____	

Allowable Deviation from Ambient: ± 8.0°F * (or ± 2.0°F) **
* ± 8.0 °F = ± 1.5% of ambient absolute temperature.
** (± 2.0 °F if used in saturated or water droplet-laden gas stream.)

ISOKINETIC METERBOX I.D. NU-7 Gamma (Y) 0.9850 ΔH@ 1.728
As Applicable (check): Zero Magnehelics? ✓ Zero/Level Manometer? ____
Barometric Pressure (P_{bar}) 28.5 Auditor JRW Date 6/14/93

Dry Gas Meter Reading (Cubic Ft.)	Meter Temperature (°F)	Lower and Upper Limits for Audit Gamma
Final 430.635	Final 72	0.96 * Y = 0.9456
Initial 423.000	Initial 68	1.04 * Y = 1.0244

Dry Gas Volume Metered (Cubic Ft.)	Average Meter Temp. (°F)	Run Time (Base = 10)	
		(Minutes)	(Seconds)
Vm = 7.635	Tm = 70	____	____

$$Y_c = \frac{[10 + (0 / 60)]}{7.635} * \left[\frac{0.0319 (70 + 460)}{28.5}\right]^{.5} = 1.0088$$

Audit Gamma

Audit Gamma Acceptable (between lower & upper limits)? (√) Yes ✓ No ____
Ideal Sampling Rate = 0.75

Positive Pressure Leak Check OK? Yes N/A No N/A

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ENTROPY

Appendix D.

SAMPLE TRACKING LOG

RECORD OF CUSTODY Present / [✓ Absent] / Complete / Incomp.
INVENTORY SHEETS Present / [✓ Absent] / Complete / Incomp.
FIELD SAMPLE RECOV QC Present / [✓ Absent] / Complete / Incomp.
OTHER/REMARKS Samps in cardboard boxes

Job No. 50119 Date 6-22-93
Plant Limestone Crushing
City/State Maryville, TN
Proj Mgr ttb Field Supvr Bristol

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Ice Present? Yes / No / N/A Remarks Samples delivered by hand by ttb

Cont. No.	Run No. or Sample I.D.	Matrix or Component	Type of Container	Received at EEI Date	Init
Card-board	Dry-2-Screen-201A-1	di H_2O	950 glass		
		Nozzle rinse	500		
		F½ rinse	500		
		filter	250		
	-2	same	same		
	-3				
	Dry-2-Crush-201A-1				
	-2				
	-3				
	Wet-2-Screen-201A-1				
	-2				
	-3				
	Wet-2-Crush-201A-1				
	-2				
	-3				

Method 201A Total Conts. ____ No. of Boxes ____ No. of Coolers ____

Cont No. ____
Seal No. ____

Cont No. ____
Seal No. ____

Cont No. ____
Seal No. ____

Cont No. ____
Seal No. ____

Cont No. ____
Seal No. ____

Cont No. ____
Seal No. ____

Cont No. ____
Seal No. ____

Remarks

(cont) / [✓ (comp)]

L-0018 re

E3527

Appendix E.

MOISTURE ANALYTICAL RESULTS

Plant Name Vulcan Materials

Job No. 50119

City/State Bristol, TN

Sampling Loc. Crusher [DRY]

Run Number	Dry-2-Crusher-M4A-1	2	3
Sampling Date	6/16/93	6/16/93	6/16/93
Analysis Date	6/16/97	6/16/93	6/16/93
Analyst	TTB	TTB	TTB
Reagent 1 (200m DI)			
Final Weight, g	574.3	576.8	573.6
Tared Weight, g	~~586.5~~ 566.5 JB	~~580.6~~ 571.9	~~586.8~~ 566.5
Water Catch, g	7.8	4.9	7.1
Reagent 2 (________)			
Final Weight, g			
Tared Weight, g			
Water Catch, g			
Reagent 3 (________)			
Final Weight, g			
Tared Weight, g			
Water Catch, g			
CONDENSED WATER, g	7.8	4.9	7.1
Silica Gel			
Final Weight, g	189.5	213.8	193.8
Tared Weight, g	185.2	206.0	188.6
ADSORBED WATER, g	4.3	7.8	5.2
TOTAL WATER COLLECTED, g	12.1	12.7	12.3

Balance No. #43 Type (✓) Triple Beam ✓ Electronic ____ Reagent Box No. ________

Balance located in stable, draft-free area (✓)? Yes ____ No ____ (If "No", explain below.)

Comments ________________________

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ENTROPY

MOISTURE ANALYTICAL RESULTS

Plant Name Vulcan Materials

Job No. 50119

City/State Bristol, TN

Sampling Loc. Crusher [Wet]

Run Number	Wet-d-Crush-M5014-1	2	3
Sampling Date	6/14/93		6/15/93
Analysis Date	6/14/93		6/15/93
Analyst	JRW, TTB		JRW
Reagent 1 (200 m DI)			
Final Weight, g	612.7	608.4	601.3
Tared Weight, g	582.7	585.2	585.6
Water Catch, g	30.0	23.2	15.7
Reagent 2 (________)			
Final Weight, g			
Tared Weight, g			
Water Catch, g			
Reagent 3 (________)			
Final Weight, g			
Tared Weight, g			
Water Catch, g			
CONDENSED WATER, g	30.0	23.2	15.7
Silica Gel			
Final Weight, g	208.5	195.0	196.2
Tared Weight, g	182.5	183.5	180.6
ADSORBED WATER, g	26.0	11.5	
TOTAL WATER COLLECTED, g	56.0	34.7	31.3

Balance No. #43 Type (✓) Triple Beam ✓ Electronic ___ Reagent Box No. ______

Balance located in stable, draft-free area (✓)? Yes ___ No ___ (If "No", explain below.)

Comments ________________________

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ENTROPY

MOISTURE ANALYTICAL RESULTS

Job No. 50119

Plant Name Vulcan Materials

City/State Bristol, TN

Sampling Loc. Screen [DRY]

Run Number	Dry-2-Scrn-Moist-1	2	3
Sampling Date	6/16/93	6/16/93	6/16/93
Analysis Date	6/16/93	6/16/93	6/16/93
Analyst	TTB	JRW	JRW
Reagent 1 (200 ml DI)			
Final Weight, g	586.0	546.5 ~~646.5~~	570.2
Tared Weight, g	581.6	~~584 4~~ 538.5	~~580.8~~ 561.3
Water Catch, g	4.4	8.0	8.9
Reagent 2 (______)			
Final Weight, g			
Tared Weight, g			
Water Catch, g			
Reagent 3 (______)			
Final Weight, g			
Tared Weight, g			
Water Catch, g			
CONDENSED WATER, g			
Silica Gel			
Final Weight, g	196.4	200.0	196.8
Tared Weight, g	191.5	192.9	191.7
ADSORBED WATER, g	4.9	7.1	5.1
TOTAL WATER COLLECTED, g	9.3	15.1	14.0

Balance No. #43 Type (✓) Triple Beam ✓ Electronic ___ Reagent Box No. ______

Balance located in stable, draft-free area (✓)? Yes ___ No ___ (If "No", explain below.)

Comments ________________

L-0036 rev. 7-92

ENTROPY

MOISTURE ANALYTICAL RESULTS

Plant Name Vulcan Materials Job No. 50119

City/State Bristol, TN Sampling Loc. Screen [WET]

Run Number	WET-2-Screen	2	3
Sampling Date	M201A-1		6/15/93
Analysis Date			6/15/93
Analyst			JRW
Reagent 1 (200M DI)			
Final Weight, g	625.5	613.8	608.5
Tared Weight, g	582.9	584.4	580.7
Water Catch, g	42.6	29.4	27.8
Reagent 2 (________)			
Final Weight, g			
Tared Weight, g			
Water Catch, g			
Reagent 3 (________)			
Final Weight, g			
Tared Weight, g			
Water Catch, g			
CONDENSED WATER, g			27.8
Silica Gel			
Final Weight, g	214.2	193.7	205.4
Tared Weight, g	189.2	181.2	192.4
ADSORBED WATER, g	25.0	12.5	13.0
TOTAL WATER COLLECTED, g	67.6	41.9	40.8

Balance No. #43 Type (✓) Triple Beam ✓ Electronic ___ Reagent Box No. ________

Balance located in stable, draft-free area (✓)? Yes ___ No ___ (If "No", explain below.)

Comments ________________________

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ENTROPY