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

MARYVILLE, TENNESSEE

EPA CONTRACT NO. 68-D2-0163
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Prepared for:

Emission Measurement Branch
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Research Triangle Park, North Carolina 27711

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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 5.5 foot shorthead cone crusher (5.5' crusher) and an 6 by 16 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 Maryville, 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 5.5' 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 12 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 5.5' crusher and the vibrating screen were low. These wet stone emission factor results are entirely consistent with the zero visible emissions operating conditions observed during all of these 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%)	0.001041	
	(> 1%)	0.000147	85.9 %
Vibrating Screen	(< 1%)	0.006920	
	(> 1%)	0.000549	92.1 %

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 5.5′ Shorthead, conical type tertiary crusher was tested at the Maryville, Tennessee plant. This receives the oversize stone from a pair of 6′ x 16′ triple deck vibrating screens downstream from the secondary surge pile. The stone is feed to the tertiary crusher by means of a conveyor (stream number 17 in Figure 1). The stone is discharged into a feed hopper which serves a vibrating feeder above the 5.5′ shorthead crusher (equipment number 15 in Figure 1). There were very limited free fall distances from the feed conveyor to the feed hopper to the vibrating feeder and from the vibrating feeder to the inlet of the shorthead crusher. The crusher discharges the crushed stone onto a conveyor (stream number 16 in Figure 1) leading to the 6′ X 16′ vibrating screens.

The inlet to the shorthead crusher was defined as the discharge of the vibrating feeder to the shorthead crusher vessel. This area, having a height of approximately 6 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 leading from the secondary surge pile that feeds the 6′ X 16′ vibrating screens (stream number 16 on Figure 1). The discharge point is enclosed approximately 5 feet upstream and downstream of the shorthead discharge point. The discharge of the shorthead crusher was defined as the total enclosure presently surrounding conveyor number 16 underneath the crusher.

The vibrating screens at the Maryville, Tennessee plant of Vulcan Materials Company consists of two parallel 6 x 16 triple deck screens (equipment numbers 13 and 14 in Figure 1). These screens receive stone from the conveyor numbered 16 in Figure 1. A spliter is used to proportion the stone between the two screens. The vibrating screen source was defined as the 6 foot wide, 16 foot long open, sloped surface above the upper screen deck. There is approximately a 10 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 5.5′ crusher is termed "closed circuit" since oversized material containing some fines adhering to the surface can recirculate through the vibrating screens and 5.5′ 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 5.5′ crusher. The total quantity of oversized material entering the 5.5′ crusher was approximately 260 tons per hour. The stone feed rates to the two vibrating screens were approximately 350 tons per hour or 175 tons per hour per screen.

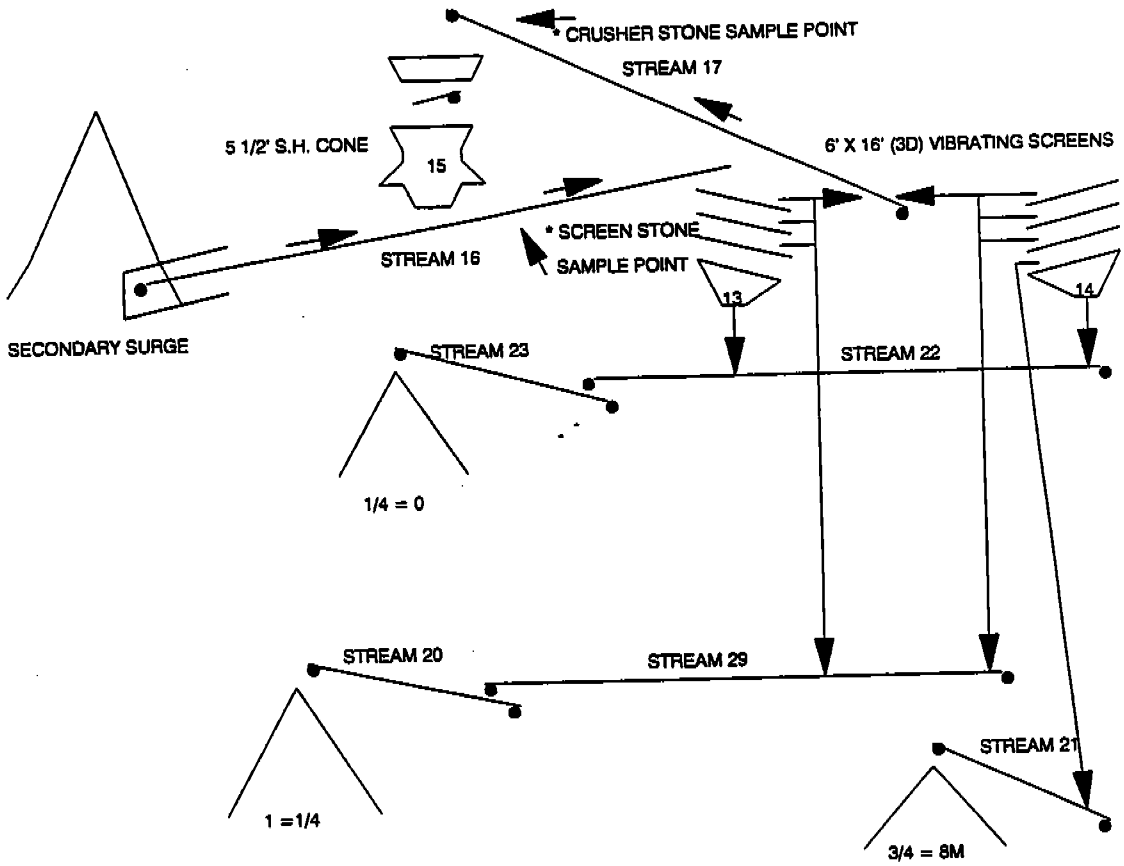

Figure 1. Simplified Process Flowchart

2.2 FUGITIVE DUST CONTROL

Wet suppression is used for fugitive dust control of the 5.5′ shorthead crusher, and the vibrating screens. There are water spray nozzles located on the vibrating feeder to the 5.5′ crusher. Over-wetting 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 screens or the 5.5′ 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 Maryville 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 screens at the Maryville, Tennessee plant because of the height and inaccessibility around the vibrating screens. Also, there were a number of possible sources immediately upwind and downwind of the 5.5′ crusher. These sources included crushers, conveyors and conveyor transfer points, and commercial product haul roads. It would be impossible to isolate the 5.5′ crusher 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

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.

system for gas handling. Entropy rejected this approach primarily because of 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 60 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.

5.5′ 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 5.5′ crusher. This approach allowed isolation of the 5.5′ 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 5.5′ 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 12 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 3 by 5 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.

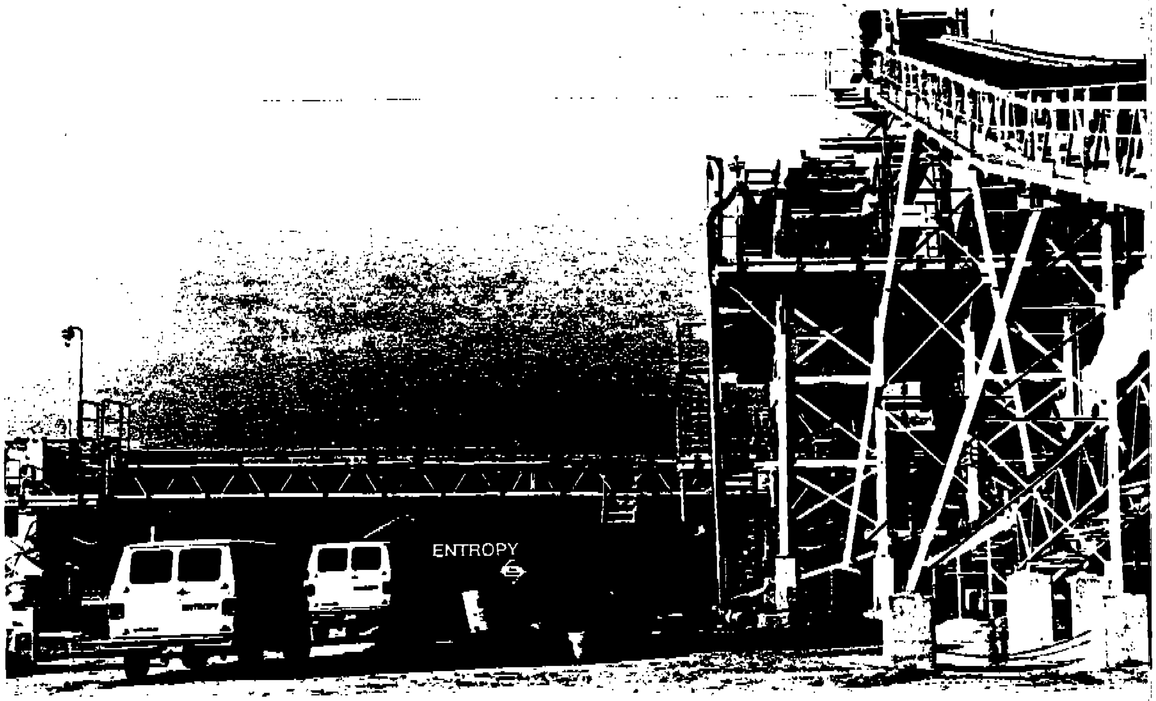

Figure 2. View of Traversing Hood in Vibrating Screen

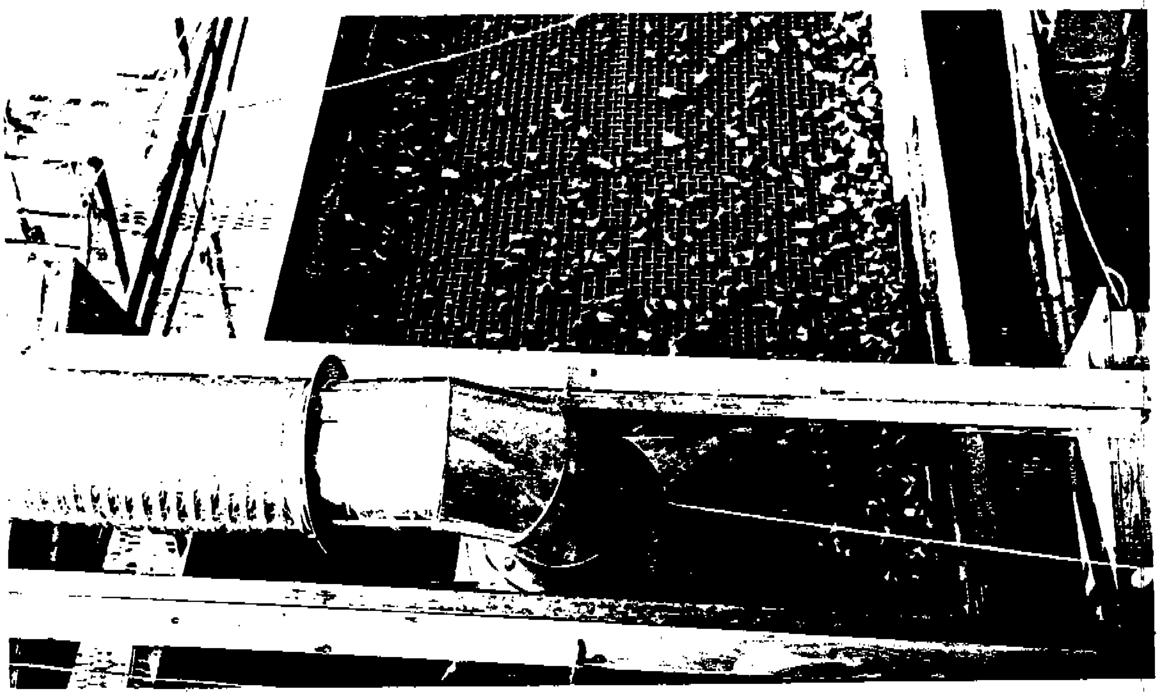

Figure 3. Top View of Traversing Hood in Vibrating Screen

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.

<u>5.5′ Crusher Testing Equipment</u>

The inlet to the 5.5′ crusher was defined as the discharge of the vibrating feeder into the crusher vessel. This area, having a height of approximately 6 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 5.5′ crusher is a conveyor leading to the triple deck vibrating screens. The discharge point was enclosed approximately 4 feet upstream and downstream of the 5.5′ crusher discharge point. There are water spray nozzles on the downstream side of this conveyor. Figure 4 shows a side view of the 5.5′ crusher.

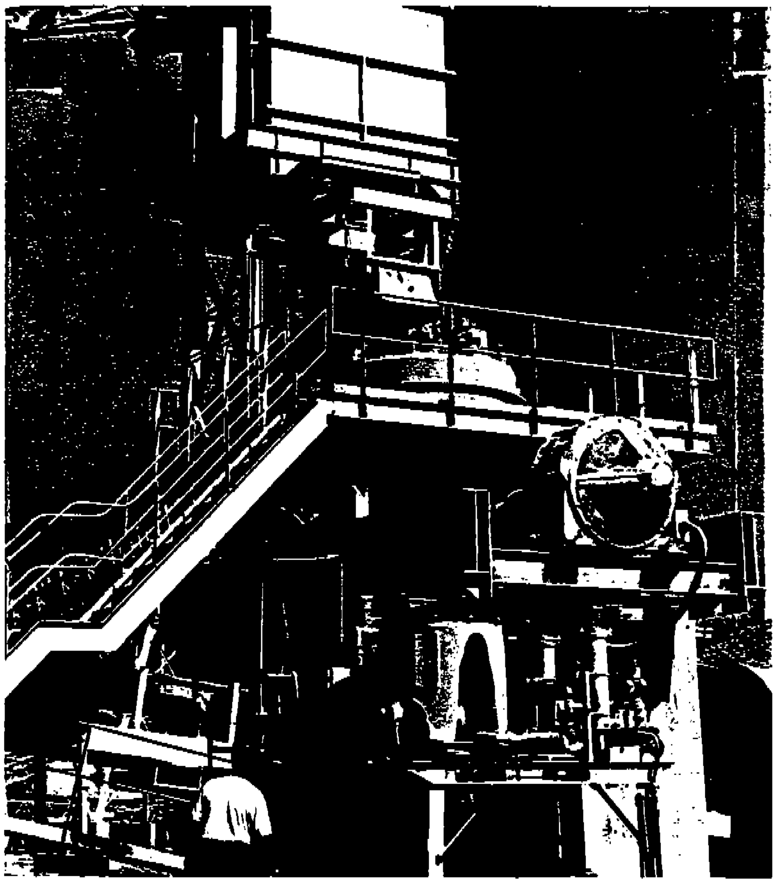

Figure 4. Side View of 5.5′ Crusher

Enclosures were built around the inlet and outlet of the crusher. The inlet enclosure measured approximately 28" high with a 60" diameter, the outlet measured approximately 12'H X 12'D X 9'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 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

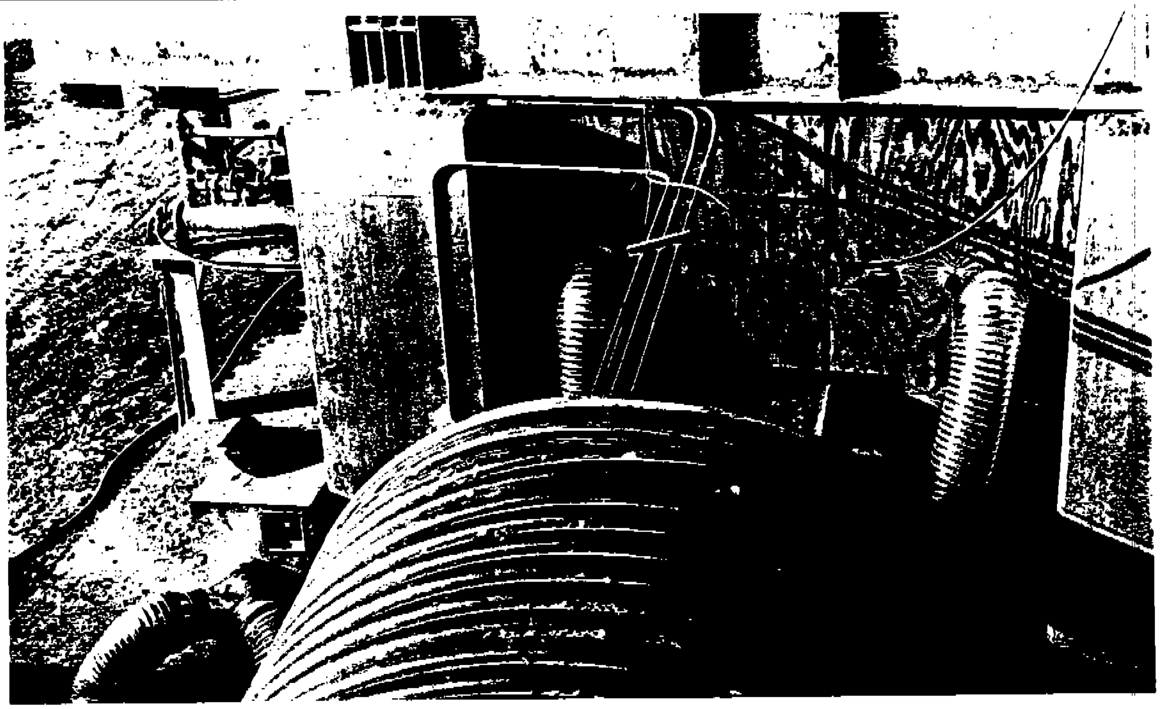

Figure 5. 5.5' Crusher Hepa Filtered Air Makeup

positions of the inlet and outlet ducts on the enclosures ensured that the normal PM10 emissions were not significantly influenced by air flow patterns.

Close-up views of the crusher inlet before and after installation of the enclosure are provided in Figures 6 and 7. In Figure 7, 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 enclosure is shown in Figures 8 and 9. In Figure 8, 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 in the lower left of Figure 8.

Figure 6. Crusher Inlet Before Installation

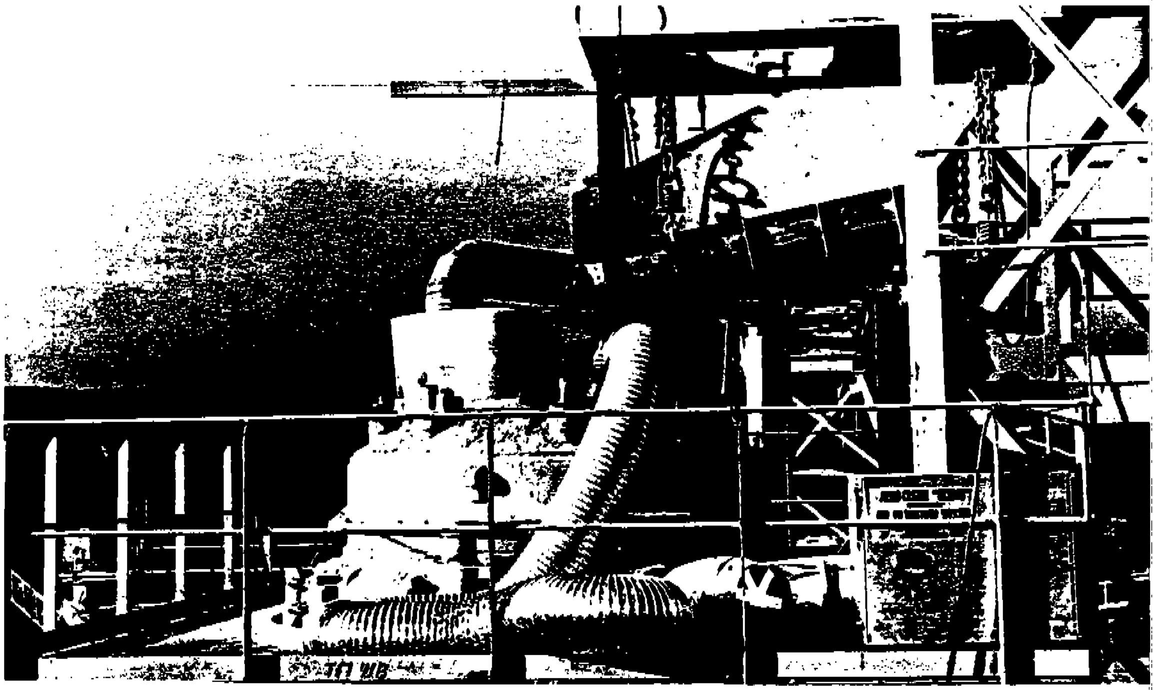

Figure 7. Crusher Inlet with Enclosure

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 increase the PM10 emissions.

PM10 Sampling Equipment

EPA Reference Method 201A was used to monitor the PM10 emissions from the 5.5' 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 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.

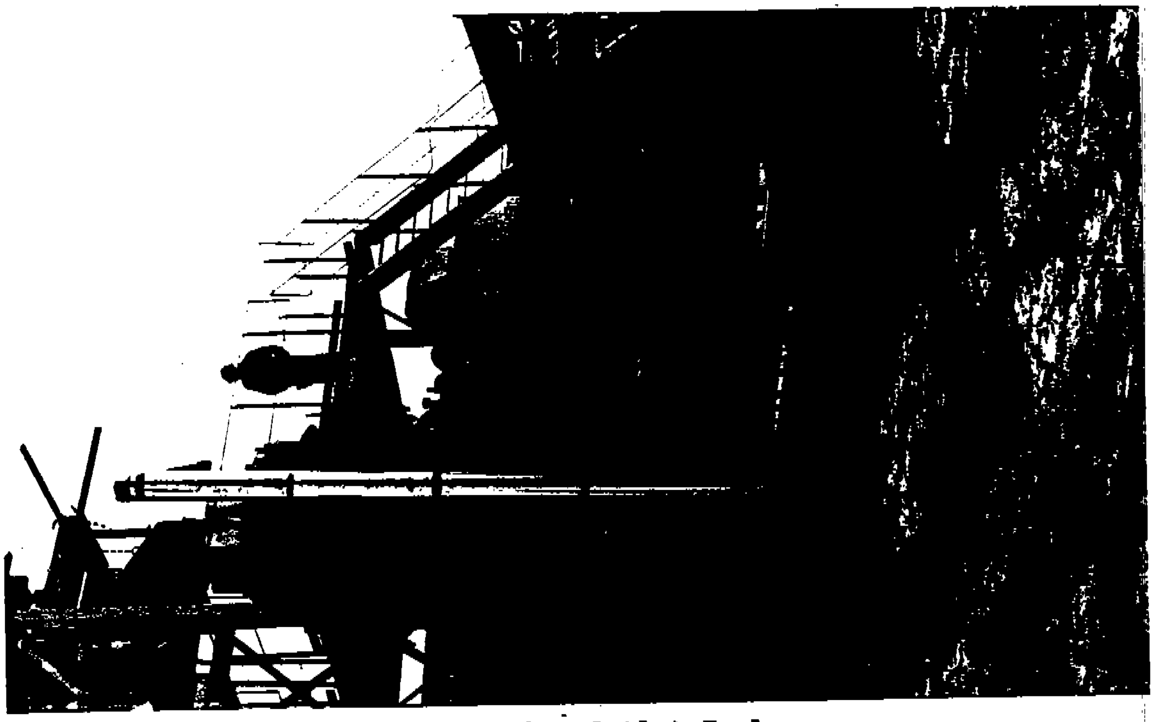

Figure 8. Crusher Outlet Enclosure

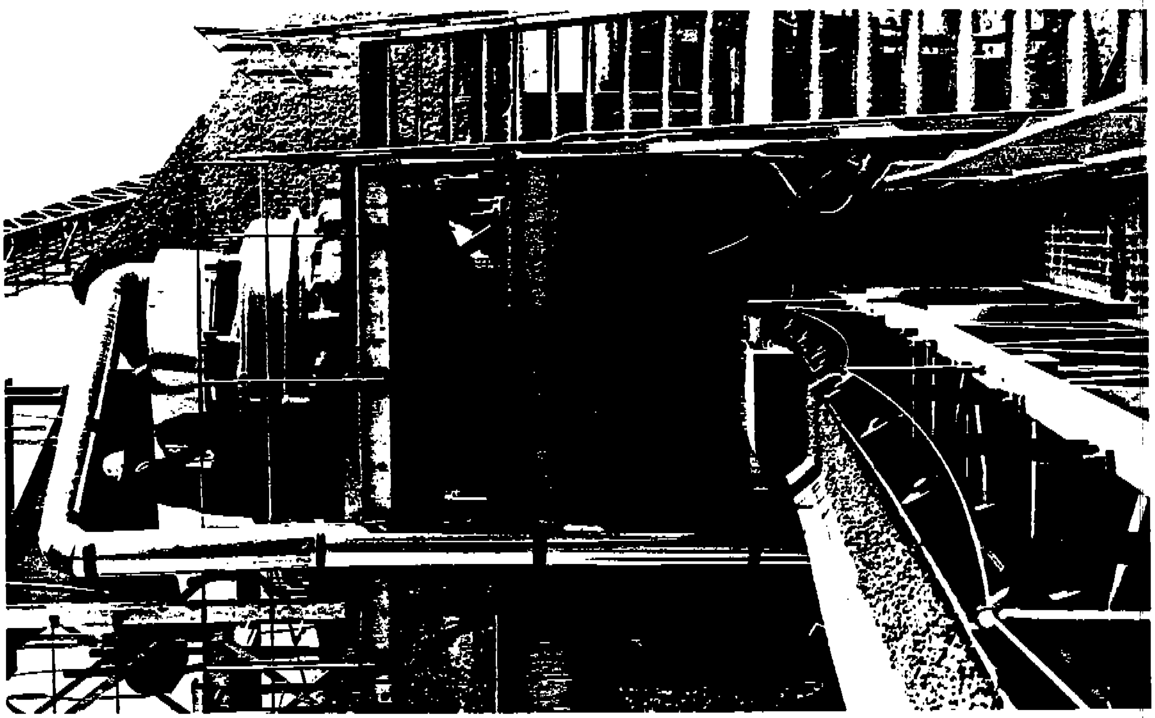

Figure 9. Crusher Enclosures

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 5.5' crusher and a sample from the conveyor leaving the 6' X 16' vibrating screens. The conveyors was 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 5.5' 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 5.5′ crusher has been defined by Entropy as the total volume of stone entering the 5.5′ 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 5.5′ crusher. This amount in pounds/feet was then multiplied by the speed of the conveyor in feet/minute (400 fpm crusher feed, 426 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. However the screen production rates were divided by 2 because there were two screens receiving stone from one conveyor. This calculation is shown below:

5.5 Crusher

(Pounds Stone per 2 FT) X (Belt Speed to Crusher 400 FT per Minute)

= Pounds Stone per Minute

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

= Tons of Stone/Hour

6′ X 16′ Vibrating Screen

(Pounds Stone per 2 FT) X (Belt Speed to Screens 426 FT per Minute)

= Pounds Stone per Minute

((Pounds Stone/Minute) X (60 Minutes/Hour) X (Ton/2000 Pounds)) / 2 Screens

= Tons of Stone/Hour/Screen

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 5.5′ 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 5.5′ 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.

The stone processing rate calculation at the Maryville plant tested during this study were complicated by the presence of two vibrating screens operated in parallel. Because of the configuration of the equipment there is no quantitative means to determine the separate stone flow rates to each. Entropy has based on emission factor calculations of a 50%-50% split based on observations during the emission tests.

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.

TABLE 4. STONE MOISTURE LEVELS

Date	Conditions	Test	Moisture Content (% weight)
6-10-93	Dry	1	0.67
6-10-93	Dry	2	0.89
6-10-93	Dry	3	0.46
		Average	0.673
6-7-93	Wet	1	1.21
6-8-93	Wet	2	1.12
6-9-93	Wet	3	1.98
		Average	1.437

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 pre-collector for particles greater than 10 microns followed by a back-up filter. The analyzer was located on the ground on the East side of 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 5.
AMBIENT PARTICULATE CONCENTRATION
STANDARD GAS CONDITIONS

	Time Start	Time Stop	Milligrams Catch	HiVol#1 mg/ft^3 Dry
6-7-93	09:18	15:29	154.7	0.0218
6-8-93	07:45	13:58	143.7	0.0205
6-9-93	07:53	14:20	166.6	0.0234
6-10-93	07:37	11:40	230.7	0.0504

3.4 STONE PRODUCTION RATES

The 5.5′ crusher and vibrating screen stone processing rates were calculated following the formula given in Section 2.4.4 of this report. The total stone production rate through the vibrating screens was divided in half based on the assumption that both screens received equal stone loadings. 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	East Screen	Crusher
			Processing Rate, Tons/HR	
6-7-93	1	Wet	206	267
6-8-93	2	Wet	168	228
6-9-93	3	Wet	176	291
6-10-93	1	Dry	171	282
6-10-93	2	Dry	166	246
6-10-93	3	Dry	160	267

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 24 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 East vibrating screen. The production rate was calculated as described in section 2.4.4. It was assumed that both of the vibrating screens receive an equal stone loading. The measured PM10 emission factors for both the 5.5′ 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. The extremely low emissions occurring during the wet tests are indicated the photographs shown in Figures 2, 3, 7, 8 and 9.

TABLE 7. VIBRATING SCREEN AND 5.5' CRUSHER PM10 EMISSIONS

		PM10 Emissions; Pounds/Ton	
Dry Stone (< 1)		5.5' Crusher	Screen
	Run 1	0.00078	0.00677
	Run 2	0.00131	0.00731
	Run 3	0.00103	0.00668
	Average	0.00104	0.00692
Wet Stone (> 1)			
	Run 1	0.000190	0.000591
	Run 2	0.000147	0.000568
	Run 3	0.000105	0.000489
	Average	0.000147	0.000549

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 5.5' crusher and vibrating screens 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 8-2. 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	0.065
> 4.75 Millimeters	0.280
> 2.00 Millimeters	0.464
> 150 Microns	0.141
> 75 Microns	0.019
> 38 Microns	0.014
Bottom Pan	0.017

TABLE 8-2. PARTICLE SIZE DISTRIBUTIONS FOR WET RUNS

	Fraction of Sample in Specified Range		
Size Range	Test 1, Wet	Test 2, Wet	Test 3, Wet
> 37.5 Millimeters	0	0	0
> 19.0 Millimeters	0.125	0.050	0.034
> 4.75 Millimeters	0.267	0.420	0.268
> 2.00 Millimeters	0.447	0.405	0.453
> 150 Microns	0.111	0.079	0.175
> 75 Microns	0.020	0.020	0.029
> 38 Microns	0.015	0.014	0.023
Bottom Pan	0.016	0.012	0.019

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-1-C-M201A-1	104.2	0.57
D-1-C-M201A-2	103.6	0.57
D-1-C-M201A-3	100.3	0.58
W-1-C-M201A-1	103.0	0.58
W-1-C-M201A-2	107.0	0.57
W-1-C-M201A-3	104.2	0.57

Run #	Percent Is (%)	Delta H (Avg)
D-1-S-M201A-1	103.1	0.67
D-1-S-M201A-2	102.8	0.67
D-1-S-M210A-3	103.0	0.67
W-1-S-M201A-1	93.5	0.68
W-1-S-M210A-2	105.1	0.67
W-1-S-M201A-3	90.1	0.68

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	$0.9456<Y<1.0244$	1.0073	Yes
EN-2	0.9831	$0.9438<Y<1.0224$	0.9741	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.

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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.

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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.

Sampling and Velocity Traverse Point Determination
EPA Method 1

PLANT NAME: *Vulcan Materials*

CITY, STATE: *Maryville, Tenn.*

SAMPLING LOCATION: ______

NO. OF PORTS AVAILABLE: *1*

NO. OF PORTS USED: *1*

PORT INSIDE DIAMETER: *4"*

DISTANCE FROM FAR WALL TO OUTSIDE OF PORT: *12"*

NIPPLE LENGTH AND/OR WALL THICKNESS: *0*

DEPTH OF STACK OR DUCT: *12"*

STACK OR DUCT WIDTH (IF RECTANGULAR): *N.A.*

EQUIVALENT DIAMETER:

$D_E = \frac{2 \times \text{DEPTH} \times \text{WIDTH}}{\text{DEPTH} + \text{WIDTH}} = \frac{2(\quad)(\quad)}{(\quad + \quad)}$ = *N.A.*

DISTANCE FROM PORTS TO FLOW DISTURBANCES	UPSTREAM	DOWNSTREAM
	96"+	*24"*
DIAMETERS	*8+*	*2*

STACK/DUCT AREA = *$(12/2)^2\pi$* = *113.10* IN²

LOCATION OF POINTS IN CIRCULAR STACKS OR DUCTS

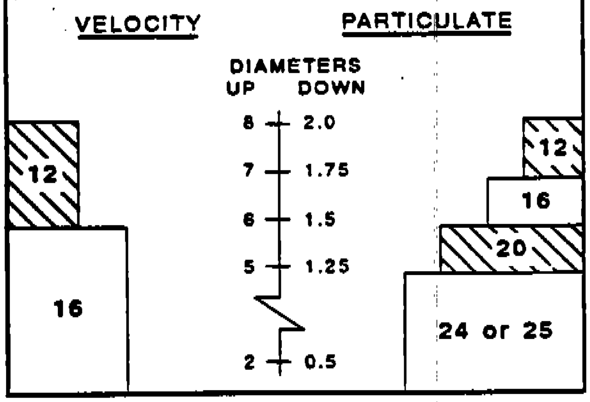
	4	6	8	10	12	14	16	18	20	22	24
1	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3	75.0	29.6	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4	93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5		85.4	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6		95.6	80.6	65.8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

LOCATION OF POINTS IN RECTANGULAR STACKS OR DUCTS

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

DRAW HORIZONTAL LINE THROUGH DIAMETERS

If more than 8 and 2 diameters and if duct dia. is less than 24", use 8 or 9 points.



PITOT USED (✓) TYPE "S" ____ STANDARD ✓

POINT	% OF DUCT DEPTH	DISTANCE FROM INSIDE WALL	DISTANCE FROM OUTSIDE OF PORT
1	*4.4*	*0.53*	*1/2*
2	*14.6*	*1.75*	*1 3/4*
3	*29.6*	*3.55*	*3 1/2*
4	*70.4*	*8.45*	*8 1/2*
5	*85.4*	*10.25*	*10 1/4*
6	*95.6*	*11.47*	*11 1/2*
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Maryville, TN

SAMPLING LOCATION: Crusher

		D-1-C-M2-1	D-1-C-M2-2	Average
	Test Date	6/10/93	6/10/93	
	Run Start Time	721	1103	
	Run Finish Time	725	1106	
	Net Traversing Points	6	6	
Cp	Pitot Tube Coefficient	0.84	0.84	
Pbar	Barometric Pressure, Inches Hg	29.09	29.09	
Pg	Flue Gas Static Pressure, Inches H2O	-0.64	-0.66	-0.65
Ps	Absolute Flue Gas Pressure, Inches Hg	29.04	29.04	29.04
ts	Flue Gas Temperature, Degrees F	70	83	77
Delta-p	Average Velocity Head, Inches H2O	0.3649	0.4020	0.3832 *

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

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Maryville, TN

SAMPLING LOCATION: Crusher

		D-1-C-M201A-1	D-1-C-M201A-2	D-1-C-M201A-3
	Test Date	6/10/93	6/10/93	6/10/93
	Run Start Time	739	847	954
	Run Finish Time	839	947	1054
	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	29.09	29.09	29.09
Delta H	Avg. Pressure Differential of Orifice Meter, Inches H2O	0.57	0.57	0.58
Vm	Volume of Metered Gas Sample, Dry ACF	27.503	27.900	27.964
tm	Dry Gas Meter Temperature, Degrees F	79	93	103
Vmstd	Volume of Metered Gas Sample, Dry SCF*	25.839	25.548	25.152
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, mL	16.2	17.4	4.7
Vwstd	Volume of Water Vapor, SCF*	0.763	0.819	0.221
%H2O	Moisture Content, Percent by Volume	2.87 **	3.11 **	0.87 **
%H2OSAT	Moisture Sat. @ Flue Gas Conditions, %	3.22	3.22	3.22
Mfd	Dry Mole Fraction	0.971	0.969	0.991
%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	28.53	28.50	28.74
Pg	Flue Gas Static Pressure, Inches H2O	-0.65	-0.65	-0.65
Ps	Absolute Flue Gas Pressure, Inches Hg	29.04	29.04	29.04
	Volumetric Air Flow Rate			
ts	Flue Gas Temperature, Degrees F	77	77	77
Delta-p	Average Velocity Head, Inches H2O	0.3832	0.3832	0.3832
vs	Flue Gas Velocity, Feet per Second	35.79	35.81	35.66
A	Stack/Duct Area, Square Inches	113.1	113.1	113.1
Qsd	Volumetric Air Flow Rate, Dry SCFM*	1,564	1,560	1,590
Qmsd	Volumetric Air Flow Rate, Dry SCMM*	44	44	45
Qaw	Volumetric Air Flow Rate, Wet ACFM	1,687	1,687	1,680
ton/hr	Production Rate, tons/hour	282.00	246.00	267.00

* 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, Maryville, TN

SAMPLING LOCATION: Crusher

		D-1-C-M201A-1	D-1-C-M201A-2	D-1-C-M201A-3
	Percent Isokinetic			
ts	Flue Gas Temperature, Degrees F	75	79	81
Delta-p	Average Velocity Head, Inches H2O	0.36	0.36	0.36
vs	Flue Gas Velocity, Feet per Second	34.63	34.77	34.69
%I	Isokinetic Sampling Rate, Percent	104.2	103.6	100.3
	PM10 Calculations			
ucyc	Stack Gas Viscosity	180.5	180.4	182.0
Qs	PM10 Flow, at Cyclone Conditions, ACFM	0.465	0.460	0.443
D50	Dia. of Particles in Cyclone, Microns	9.79	9.84	10.16
	Particulate Catch,			
mg<D50	≤ 10 Microns, Milligrams	27.6	39.9	32.9
mg>D50	> 10 Microns, Milligrams	416.6	798.3	521.6
mg	Total Milligrams	444.2	838.2	554.5
	Percent of Total Particulate,			
%<D50	≤ 10 Microns	6.2	4.8	5.9
%>D50	> 10 Microns	93.8	95.2	94.1
	Particulate ≤ 10 Microns			
	Concentration, milligrams/DSCF*			
mg/DSCF	Concentration in Gas Sample	1.07	1.56	1.31
mg/DSCF,A	Concentration in Ambient Air	0.00	0.00	0.00
mg/DSCF,adj	Adjusted Concentration in Gas Sample	1.07	1.56	1.31
lb/hr	Emission Rate, lb/hr	0.221	0.322	0.275
lb/ton	Emission Rate, lb/ton	7.83E-04	1.31E-03	1.03E-03

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

AIR FLOW RATE DETERMINATIONS

Plant Name: Vulcan Materials | Run No.: Dry-1-Crusher-M

City/State: Maryville, Tenn. | Date: 6/10/93

Test Location: Crusher | Personnel: JRW

Barometric Pres. (Pbar): 29.09 In. Hg | Static Pres. (Pg): -0.64 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: 0721 - 0725

Point No.	ΔP In. H_2O	Temp. °F
A-1	0.36	70
2	0.36	70
3	0.36	70
4	0.38	70
5	0.38	70
6	0.35	70
Avg.*	0.3649	70

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.

DC
06-10-93

F-1023 rev. 7-92

ENTROPY

AIR FLOW RATE DETERMINATIONS

Plant Name: Vulcan Materials — Run No. Dry-A-Crusher-M2-2

City/State: Maryville, Tenn. — Date: 6/10/93

Test Location: Crusher — Personnel: JRW

Barometric Pres. (Pbar): 29.09 In. Hg — Static Pres. (Pg): -0.66 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: 1103 - 1106

Point No.	ΔP In. H_2O	Temp. °F
A-1	0.40	83
2	0.39	83
3	0.40	83
4	0.41	82
5	0.42	83
6	0.39	83
Avg.*	0.402	83

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.

DC 06-10-93

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ENTROPY

METHOD 201A (PM-10) FIELD DATA

Client: EPA
Plant Name: Vulcan Materials
City/State: Maryville, Tenn.
Sampling Location: Crusher
Date: 6/10/93 Team Leader: JRW Techs: TTB, JB
*Train Leak Check Vacuum, In. Hg: 10 6
Train Leak Rate, Cubic Ft./Min.: 0.007 0.004

Run Number: Dry-1-Crusher-M201A-1
Time Start: ~~0738~~ 0739
Time Stop: 0839
Job Number: 50119
Barometric Pressure, In. Hg: 29.09
Static Pressure, In. H_2O: -0.64

EQUIPMENT CHECKS

- ✓ Pitot, Pretest
- ✓ Pitot, Posttest
- N.A. M3 Sampling Sys/Ted Bag
- ✓ Thermocouple @ 70 Pre
- ✓ Thermocouple @ 73 Post

IDENTIFICATION NUMBERS

Meterbox: NU-7 Meterbox Gamma: 0.9850 Reagent Box: N.A.
T/C Readout: F38 T/C Probe: R218 Umbilical: 481
Sampling Box: 9 Orsat Pump: N.A. Tedlar Bag: N.A.
Nozzle(s) Actually Used: Pitot: N.A.
No. ____ Diameter: ~~0.188~~ TJB 0.198 No. ____ Diameter ____

FILTER NO.	TARE
PM334	0.2715

Est % H_2O: 2.4

Delta $H_@$: 1.728
Delta H_t: ~~0.5880~~ 0.577
Delta H_{t+50}: ~~0.4410~~ 0.432
Delta H_{t-50}: ~~0.7169~~ 0.704
Delta P_{avg}: 0.3649
Meter Temp.: 85
Stack Temp.: 70

NOZZLE SELECTION CRITERIA

Desired Dia.: 0.198

	Nozzle 1	Nozzle 2
Diameter	0.188	
Nozzle Number		
Delta P_{min}	0.2013	
Delta P_{max}	0.7450	

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	~~322.702~~ 322.248	0.36	71	73	0.57	1	N.A.	51	N.A.
2	↓	10:00	10:00	326.76	↓	74	74	0.57	2	↓	44	↓
3	↓	10:00	20:00	331.33	↓	78	74	0.57	2	↓	44	↓
4	↓	10:00	30:00	335.91	↓	81	75	0.57	2	↓	43	↓
5	↓	10:00	40:00	340.73	↓	83	76	0.57	2	↓	44	↓
6	↓	10:00	50:00	345.13	↓	86	77	0.57	2	↓	42	↓
7			60:00	349.751								
8												
9												
10												
11												
12												

Totals: 60 minutes; 27.503 Vm; 0.36 $(\sqrt{\Delta P})^2$; 79 tm; 75 ts; 0.57 ΔH

QC 06-10-93

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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METHOD 201A (PM-10) FIELD DATA

Client: EPA
Plant Name: Vulcan Materials
City/State: Maryville, Tenn.
Sampling Location: Crusher
Date: 6/10/93 Team Leader: JRN Techs: TTB, JB
*Train Leak Check Vacuum, In. Hg: 6 6
Train Leak Rate, Cubic Ft./Min.: 0.002 0.003

Run Number: Dry-1-Crusher-M201A-2
Time Start: 0847
Time Stop: 0947
Job Number: 50119
Barometric Pressure, In. Hg: 29.09
Static Pressure, In. H_2O: -0.64

EQUIPMENT CHECKS

- ✓ Pitot, Pretest
- ✓ Pitot, Posttest
- N.A. M3 Sampling Sys/Ted Bag
- ✓ Thermocouple @ 74 Pre
- ✓ Thermocouple @ 81 Post

IDENTIFICATION NUMBERS

Meterbox: NU-7 Meterbox Gamma: 0.9850 Reagent Box: N.A.
T/C Readout: F38 T/C Probe: R302 Umbilical: U81
Sampling Box: 2 Orsat Pump: N.A. Tedlar Bag: N.A.
Nozzle(s) Actually Used: Pitot: N.A.
No. ____ Diameter ~~0.188~~ 0.198 No. ____ Diameter ____

FILTER NO.	TARE
PM333	0.2684

Est % H_2O: 2.4

Delta $H_@$: 1.728
Delta H_t: 0.5827
Delta H_{t+50}: 0.4865
Delta H_{t-50}: 0.7104
Delta P_{avg}: 0.3649
Meter Temp.: 90
Stack Temp.: 79

NOZZLE SELECTION CRITERIA

Desired Dia. 0.198

	Nozzle 1	Nozzle 2
Diameter	0.188	
Nozzle Number		
Delta P_{min}	0.2013	
Delta P_{max}	0.745	

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	349.912	0.36	88	77	0.57	1	N.A.	62	N.A.
2	↓	10:00	10:00	354.58	↓	90	78	0.57	1	↓	60	↓
3		10:00	20:00	359.24		93	79	0.57	1		55	
4		10:00	30:00	363.89		94	80	0.57	1		55	
5		10:00	40:00	368.54		95	80	0.57	1		57	
6		10:00	50:00	373.17		98	80	0.57	1		57	
7			60:00	377.812								
8												
9												
10												
11												
12												

minutes	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH
60	27.900	0.3600	93	79	0.57

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

F-1109 rev. 5-93

DC 01-10-93

METHOD 201A (PM-10) FIELD DATA

Client: EPA
Plant Name: Vulcan Materials
City/State: Maryville, Tenn.
Sampling Location: Crusher
Date: 1/10/93 Team Leader: JRW Techs: TTB, JB
*Train Leak Check Vacuum, In. Hg: 6 | 6
Train Leak Rate, Cubic Ft./Min.: 0.002 | 0.002

Run Number: Dry-1-Crusher-M201A 3
Time Start: 0954
Time Stop: 1054
Job Number: 50119
Barometric Pressure, In. Hg: 29.09
Static Pressure, In. H_2O: -0.64

EQUIPMENT CHECKS

- ✓ Pitot, Pretest
- ✓ Pitot, Posttest
- N.A. M3 Sampling Sys/Ted Bag
- ✓ Thermocouple @ 80 Pre
- ✓ Thermocouple @ 83 Post

IDENTIFICATION NUMBERS

Meterbox: NU-7 Meterbox Gamma: 0.9850 Reagent Box: N.A.
T/C Readout: F38 T/C Probe: R218 Umbilical:
Sampling Box: 4 Orsat Pump: N.A. Tedlar Bag: N.A.
Nozzle(s) Actually Used: Pitot: N.A.
No. ____ Diameter ~~0.188~~ 0.198 No. ____ Diameter ____

FILTER NO.	TARE
PM771	0.2711

Est % H_2O: 2.4

Delta $H_@$: 1.728
Delta H_t: 0.5948
Delta H_{t+50}: 0.4984
Delta H_{t-50}: 0.7221
Delta P_{avg}: 0.3649
Meter Temp.: 100
Stack Temp.: 81

NOZZLE SELECTION CRITERIA

Desired Dia. 0.200

	Nozzle 1	Nozzle 2
Diameter	0.188	
Nozzle Number		
Delta P_{min}	0.2066	
Delta P_{max}	0.7619	

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	377.900	0.36	100	81	0.58	|	N.A.	62	N.A.
2	↓	10:00	10:00	382.58	↓	102	81	↓	|	↓	61	↓
3	↓	10:00	20:00	387.24	↓	104	80	↓	|	↓	53	↓
4	↓	10:00	30:00	391.91	↓	104	81	↓	|	↓	52	↓
5	↓	10:00	40:00	396.51	↓	104	81	↓	|	↓	54	↓
6	↓	10:00	50:00	401.22	↓	105	82	↓	|	↓	55	↓
7			60:00	405.869	↓			↓		↓		↓
8												
9												
10												
11												
12												

60 minutes | 27.969 Vm | 0.36 $(\sqrt{\Delta P})^2$ | 103 tm | 81 ts | 0.58 ΔH

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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DC 06-10-93

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Maryville, TN

SAMPLING LOCATION: Crusher

		W-1-C-M2-1	W-1-C-M2-2	Average
	Test Date	6/8/93	6/8/93	
	Run Start Time	814	1542	
	Run Finish Time	819	1548	
	Net Traversing Points	6	6	
Cp	Pitot Tube Coefficient	0.84	0.84	
Pbar	Barometric Pressure, Inches Hg	29.12	29.1	
Pg	Flue Gas Static Pressure, Inches H2O	-0.57	-0.58	-0.58
Ps	Absolute Flue Gas Pressure, Inches Hg	29.08	29.08	29.08
ts	Flue Gas Temperature, Degrees F	67	85	76
Delta-p	Average Velocity Head, Inches H2O	0.3390	0.3950	0.3665 *

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

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Maryville, TN

SAMPLING LOCATION: Crusher

		W-1-C-M2-3	W-1-C-M2-4	Average
	Test Date	6/8/93	6/8/93	
	Run Start Time	722	1352	
	Run Finish Time	726	1355	
	Net Traversing Points	6	6	
Cp	Pitot Tube Coefficient	0.84	0.84	
Pbar	Barometric Pressure, Inches Hg	29.00	29.00	
Pg	Flue Gas Static Pressure, Inches H2O	-0.48	-0.62	-0.550
Ps	Absolute Flue Gas Pressure, Inches Hg	28.96	28.95	28.96
ts	Flue Gas Temperature, Degrees F	72	83	78
Delta-p	Average Velocity Head, Inches H2O	0.3250	0.4110	0.3667 *

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

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Maryville, TN

SAMPLING LOCATION: Crusher

		W-1-C-M2-5	W-1-C-M2-6	Average
	Test Date	6/9/93	6/9/93	
	Run Start Time	726	1412	
	Run Finish Time	728	1414	
	Net Traversing Points	6	6	
Cp	Pitot Tube Coefficient	0.84	0.84	
Pbar	Barometric Pressure, Inches Hg	29.3	29.3	
Pg	Flue Gas Static Pressure, Inches H2O	-0.52	-0.55	-0.54
Ps	Absolute Flue Gas Pressure, Inches Hg	29.26	29.26	29.26
ts	Flue Gas Temperature, Degrees F	71	86	79
Delta-p	Average Velocity Head, Inches H2O	0.3277	0.3810	0.3538 *

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

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Maryville, TN

SAMPLING LOCATION: Crusher

		W-1-C-M201A-1	W-1-C-M201A-2	W-1-C-M201A-3
	Test Date	6/7/93	6/8/93	6/9/93
	Run Start Time	917	737	758
	Run Finish Time	1527	1343	1406
	Net Traversing/Sampling Points	6/1	6/1	6/1
Theta	Net Run Time, Minutes	360	360	360
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	29.12	29.00	29.30
Delta H	Avg. Pressure Differential of Orifice Meter, Inches H2O	0.58	0.57	0.57
Vm	Volume of Metered Gas Sample, Dry ACF	167.156	167.599	167.086
tm	Dry Gas Meter Temperature, Degrees F	99	97	97
Vmstd	Volume of Metered Gas Sample, Dry SCF*	151.581	151.897	152.997
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, mL	70.9	88.0	83.9
Vwstd	Volume of Water Vapor, SCF*	3.337	4.142	3.949
%H2O	Moisture Content, Percent by Volume	2.15 **	2.65 **	2.52 **
%H2OSAT	Moisture Sat. @ Flue Gas Conditions, %	3.11	3.34	3.41
Mfd	Dry Mole Fraction	0.978	0.973	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	28.60	28.55	28.56
Pg	Flue Gas Static Pressure, Inches H2O	-0.58	-0.55	-0.54
Ps	Absolute Flue Gas Pressure, Inches Hg	29.08	28.96	29.26
	Volumetric Air Flow Rate			
ts	Flue Gas Temperature, Degrees F	76	78	79
Delta-p	Average Velocity Head, Inches H2O	0.3665	0.3667	0.3538
vs	Flue Gas Velocity, Feet per Second	34.90	35.08	34.30
A	Stack/Duct Area, Square Inches	113.1	113.1	113.1
Qsd	Volumetric Air Flow Rate, Dry SCFM*	1,541	1,529	1,510
Qmsd	Volumetric Air Flow Rate, Dry SCMM*	43.6	43.3	42.8
Qaw	Volumetric Air Flow Rate, Wet ACFM	1,645	1,653	1,616
ton/hr	Production Rate, tons/hour	267.00	228.00	291.00

* 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, Maryville, TN

SAMPLING LOCATION: Crusher

		W-1-C-M201A-1	W-1-C-M201A-2	W-1-C-M201A-3
	Percent Isokinetic			
ts	Flue Gas Temperature, Degrees F	79	79	81
Delta-p	Average Velocity Head, Inches H2O	0.35	0.33	0.35
vs	Flue Gas Velocity, Feet per Second	34.20	33.31	34.18
%I	Isokinetic Sampling Rate, Percent	103.0	107.0	104.2
	PM10 Calculations			
ucyc	Stack Gas Viscosity	180.8	180.9	181.3
Qs	PM10 Flow, at Cyclone Conditions, ACFM	0.450	0.456	0.455
D50	Dia. of Particles in Cyclone, Microns	10.02	9.94	9.95
	Particulate Catch,			
mg<D50	≤ 10 Microns, Milligrams	37.4	25.1	23.4
mg>D50	> 10 Microns, Milligrams	267.9	227.2	162.5
mg	Total Milligrams	305.3	252.3	185.9
	Percent of Total Particulate,			
%<D50	≤ 10 Microns	12.3	9.9	12.6
%>D50	> 10 Microns	87.7	90.1	87.4
	Particulate ≤ 10 Microns			
	Concentration, milligrams/DSCF*			
mg/DSCF	Concentration in Gas Sample	0.247	0.165	0.153
mg/DSCF,A	Concentration in Ambient Air	0.00	0.00	0.00
mg/DSCF,adj	Adjusted Concentration in Gas Sample	0.247	0.165	0.153
lb/hr	Emission Rate, lb/hr	0.0503	0.0334	0.0305
lb/ton	Emission Rate, lb/ton	0.00019	0.000147	0.000105

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

AIR FLOW RATE DETERMINATIONS

Plant Name: Vulcan Materials | Run No.: Wet-1-Crusher-M2-
City/State: Maryville, Tenn. | Date: 6/7/93
Test Location: Crusher | Personnel: JRW, JB
Barometric Pres. (Pbar): 29.12 In. Hg | Static Pres. (Pg): -0.57 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: 0814 - 0819

Point No.	ΔP In. H_2O	Temp. °F
A-6	0.31	68
5	0.39	67
4	0.39	67
3	0.35	67
2	0.29	67
1	0.31	67
Avg.*	0.339	67

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. See page 2 for field flow rate calculations.

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ENTROPY

AIR FLOW RATE DETERMINATIONS

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

City/State Maryville, Tenn. Date 6/7/93

Test Location Crusher Personnel JRW, JB

Barometric Pres. (Pbar) 29.12 In. Hg Static Pres. (Pg) -0.58 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: 1542 - 1548

Point No.	ΔP In. H_2O	Temp. °F
A-6	0.40	86
5	0.43	85
4	0.41	85
3	0.39	84
2	0.37	84
1	0.37	84
Avg.*	0.395	85

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. See page 2 for field flow rate calculations.

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ENTROPY

AIR FLOW RATE DETERMINATIONS

Plant Name: Vulcan Materials
Run No.: Wet-1-Crusher-MZ-3
City/State: Maryville, Tenn.
Date: 6/8/93
Test Location: Crusher
Personnel: JRW TTB JB
Barometric Pres. (Pbar): 29.0 In. Hg
Static Pres. (Pg): -0.48 In. H_2O
Pitot/Orifice ID: DP48-8
Pitot Coef. (Cp): 0.84
Pres. Gauge Set ID: NA-7
Thermocouple ID: R284
Duct Length/Diameter: 12"
Width: N.A.
--Specify inches (") or feet (')--

VELOCITY TRAVERSES
Start-Finish Times: 0722 - 0726

Point No.	ΔP In. H_2O	Temp. °F
A-1	0.30	73
2	0.33	72
3	0.30	72
4	0.37	73
5	0.31	72
6	0.34	72
Avg.*	0.325	72

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. See page 2 for field flow rate calculations.

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ENTROPY

AIR FLOW RATE DETERMINATIONS

Plant Name: Vulcan Materials — Run No. Wet-1-Crusher-MZ-4
City/State: Maryville, Tenn. — Date: 6/8/93
Test Location: Crusher — Personnel: JRW
Barometric Pres. (Pbar): 29.0 In. Hg — Static Pres. (Pg): -0.62 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: 1352 - 1355

Point No.	ΔP In. H_2O	Temp. °F
A-1	0.41	83
2	0.40	83
3	0.41	82
4	0.45	83
5	0.42	83
6	0.38	83
Avg.*	0.411	83

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.

See page 2 for field flow rate calculations.

AIR FLOW RATE DETERMINATIONS

Plant Name: Vulcan Materials Run No.: Wet-1-Crusher-M 2 5

City/State: Maryville, Tenn. Date: 6/9/93

Test Location: Crusher Personnel: JRW, TTB, JB

Barometric Pres. (Pbar): 29.3 In. Hg Static Pres. (Pg): -0.52 In. H_2O

Pitot/Orifice ID: DP48-8 Pitot Coef. (Cp): 0.84 Pres. Gauge Set ID: N4-7

Thermocouple ID: R284 Duct Length/Diameter: 12" Width: N/A
--Specify inches (") or feet (')--

VELOCITY TRAVERSES
Start-Finish Times: 0726 - 0728

Point No.	ΔP In. H_2O	Temp. °F
A-1	0.31	71
2	0.29	72
3	0.30	71
4	0.35	71
5	0.36	71
6	0.36	71
Avg.*	0.3277	71

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. See page 2 for field flow rate calculations.

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ENTROPY

AIR FLOW RATE DETERMINATIONS

Plant Name Vulcan Materials Run No. Wet-1-Crusher-M2-6

City/State Maryville, Tenn. Date 6/9/93

Test Location Crusher Personnel JRM, JB

Barometric Pres. (Pbar) 29.3 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: 1412 - 1414

Point No.	ΔP In. H_2O	Temp. °F
A-1	0.40	86
2	0.35	86
3	0.38	86
4	0.41	85
5	0.41	86
6	0.34	86
Avg.*	0.381	86

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: Maryville, Tenn.
Sampling Location: Crusher
Date: 6/7/93 Team Leader: JRK Techs: TTB
*Train Leak Check Vacuum, In. Hg: 10 5
Train Leak Rate, Cubic Ft./Min.: 0.010 0.001

Run Number: Wet-1-Crusher-M201A-1
Time Start: 0917
Time Stop: 1527
Job Number: 50119
Barometric Pressure, In. Hg: 29.12
Static Pressure, In. H_2O: -0.57

EQUIPMENT CHECKS

- ✓ Pitot, Pretest
- ✓ Pitot, Posttest
- N.A. M3 Sampling Sys/Ted Bag
- ✓ Thermocouple @ 78 Pre
- ✓ Thermocouple @ 88 Post

IDENTIFICATION NUMBERS

Meterbox: NU-7 Meterbox Gamma: 0.9850 Reagent Box: N.A.
T/C Readout: F-38 T/C Probe: R218 Umbilical: 481
Sampling Box: 12 Orsat Pump: N.A. Tedlar Bag: N.A.
Nozzle(s) Actually Used: TTB Pitot: N.A.
No. ___ Diameter: ~~0.188~~ 0.198 No. ___ Diameter ___

FILTER NO.	TARE
PM148	0.2710

Est % H_2O: 2

Delta $H_@$: 1.728
Delta H_t: ~~[illegible]~~ 0.598
Delta H_{t+50}: ~~0.512~~ 0.4997
Delta H_{t-50}: ~~0.249~~ 0.744
Delta P_{avg}: ~~0.339~~
Meter Temp.: 90
Stack Temp.: 67

NOZZLE SELECTION CRITERIA

Desired Dia.: 0.202

	Nozzle 1	Nozzle 2
Diameter	0.188	0.182
Nozzle Number		
Delta P_{min}	0.2008	
Delta P_{max}	0.7440	

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	810.700	0.35	76	71	0.58	1	N.A.	48	N.A.
2	↓	15:00	15:00	817.70	↓	82	71	↓	1	↓	50	↓
3		15:00	30:00	824.68		87	72		1		50	
4		15:00	45:00	831.5		92	75		1		52	
5		15:00	60:00/0	838.44		95	74		1		55	
6		15:00	15:00	845.35		96	73		1		55	
7		15:00	30:00	852.28		99	74		1		50	
8		15:00	45:00	859.21		102	76		1		52	
9		15:00	120:00/0	866.16		103	76		1		55	
10		15:00	15:00	873.11		105	77		1		60	
11		15:00	30:00	880.06		106	78		1		54	
12	↓	15:00	45:00	881.01	↓	108	78	↓	1	↓	56	↓
			360 minutes	167.156 Vm	0.35 $(\sqrt{\Delta P})^2$	99 tm	79 ts	0.58 ΔH				

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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Sta[illegible] /24 Sta[illegible] /25[illegible]

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

Client: EPA
Plant Name: Vulcan Materials
City/State: Maryville, Tenn.
Sampling Location: Crusher

Run Number: Wet-1 - Crusher - M201A-
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 Imping Exit, °F	Cyclone Temp, °F
13	A-3	15:00	180:00/0	894.04	0.35	105	80	0.58	1	N.A.	62	N.A
14		15:00	15:00	901.03		104	81		1		54	
15		15:00	30:00	908.07		101	82		1		60	
16		15:00	45:00	914.95		101	82		1		58	
17		15:00	240:00/0	921.95		103	83		1		64	
18		15:00	15:00	928.95		104	84		1		55	
19		15:00	30:00	935.94		102	84		1		60	
20		15:00	45:00	942.91		102	84		1		63	
21		15:00	300:00/0	949.88		99	84		1		55	
22		15:00	15:00	956.90		100	84		1		59	
23		15:00	30:00	963.86		103	85		1		56	
24		15:00	45:00	970.86		105	85		1		63	
25			360:00	977.856								
26												
27												
28												
23												
29												
30												
31												
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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 Maryville, Tenn.

Sampling Location Crusher

Date 6/8/93 Team Leader JRW Techs TTB, JB

*Train Leak Check Vacuum, In. Hg 10 5

Train Leak Rate, Cubic Ft./Min. 0.003 0.001

Run Number Wet-1-Crusher-M201A

Time Start ~~0927~~ 0737

Time Stop 1343

Job Number 50119

Barometric Pressure, In. Hg 29.0

Static Pressure, In. H_2O -0.48

EQUIPMENT CHECKS

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

IDENTIFICATION NUMBERS

Meterbox NU7 Meterbox Gamma 0.9850 Reagent Box N.A.

T/C Readout F38 T/C Probe R302 Umbilical U81

Sampling Box 9 Orsat Pump N.A. Tedlar Bag N.A

Nozzle(s) Actually Used: Pitot N.A

No. ___ Diameter 0.188 No. ___ Diameter ___

FILTER NO.	TARE
PM8	0.2184

Est % H_2O 2

Delta $H_@$ 1.728

Delta H_t 0.5952

Delta H_{t+50} 0.4986

Delta H_{t-50} 0.7229

Delta P_{avg} 0.3245

Meter Temp. 80

Stack Temp. 95

NOZZLE SELECTION CRITERIA

Desired Dia. 0.202

	Nozzle 1	Nozzle 2
Diameter	0.188	
Nozzle Number		
Delta P_{min}	0.2067	
Delta P_{max}	0.7624	

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-2	15:00	00:00	982.801	0.33	84	72	0.57	2	N.A.	44	N.A
2	↓	15:00	15:00	989.75	↓	90	74	0.57	2	↓	42	↓
3		15:00	30:00	996.68		89	74	0.57	2		41	
4		15:00	45:00	1003.60		92	75	0.57	2		41	
5		15:00	60:00/0	1010.59		94	76	0.57	2		43	
6		15:00	15:00	1017.54		96	77	0.57	2		44	
7		15:00	30:00	1024.52		98	77	0.57	2		43	
8		15:00	45:00	1031.49		99	78	0.57	2		42	
9		15:00	120:00/0	1038.46		100	78	0.57	2		46	
10		15:00	15:00	1045.45		100	79	0.57	2		42	
11		15:00	30:00	1052.43		100	79	0.57	2		44	
12		15:00	45:00	1059.44		98	80	0.57	2		48	
			360 minutes	~~167.599~~ 167.599 Vm	0.33 $(\sqrt{\Delta P})^2$	97 tm	79 ts	0.57 ΔH				

* 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: Maryville, Tenn.
Sampling Location: Crusher

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

	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
13	A-2	15:00	180:00/0	1066.33	0.33	97	80	0.57	2	N.A.	49	N.A.
14		15:00	15:00	1073.45		97	80	0.57	2		50	
15		15:00	30:00	1080.45		98	81	0.57	2		42	
16		15:00	45:00	1087.12		99	81	0.57	2		44	
17		15:00	240:00/0	1092.13		100	81	0.57	2		48	
18		15:00	15:00	1099.15		99	80	0.57	2		42	
19		15:00	30:00	1106.07		97	81	0.57	2		46	
20		15:00	45:00	1113.18		98	82	0.57	2		48	
21		15:00	300:00/0	1120.12		101	82	0.57	2		50	
22		15:00	15:00	1127.09		102	83	0.57	2		49	
23		15:00	30:00	1134.08		102	83	0.57	2		41	
24		15:00	45:00	1141.07		103	82	0.57	2		47	
25			360:00/end	1150.400								
26												
27												
28												
23												
29												
30												
31												
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* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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METHOD 201A (PM-10) FIELD DATA

Client: EPA
Plant Name: Vulcan Materials
City/State: Maryville, Tenn.
Sampling Location: Crusher
Date: 6/19/93 Team Leader: JRW Techs: TTB, JB
*Train Leak Check Vacuum, In. Hg: 10 | 6
Train Leak Rate, Cubic Ft./Min.: 0.015 | 0.002

Run Number: Crusher - Wet-1-M201A-3
Time Start: 0758
Time Stop: 1406
Job Number: 50119
Barometric Pressure, In. Hg: 29.3
Static Pressure, In. H_2O: -0.52

Sta 111
Sta 112

EQUIPMENT CHECKS

- ✓ Pitot, Pretest
- ✓ Pitot, Posttest
- N.A. M3 Sampling Sys/Ted Bag
- ✓ Thermocouple @ 71 Pre
- ✓ Thermocouple @ 84 Post

IDENTIFICATION NUMBERS

Meterbox: NU-7 Meterbox Gamma: 0.9850 Reagent Box: N.A.
T/C Readout: F38 T/C Probe: R302 Umbilical: u81
Sampling Box: 12 Orsat Pump: N.A. Tedlar Bag: N.A.
Nozzle(s) Actually Used: ТЗ .18 Pitot: N.A.
No. ___ Diameter: 0.188 No. ___ Diameter ___

FILTER NO.	TARE
PM205	0.2728

Est % H_2O: 2.4

Delta $H_@$: 1.728
Delta H_t: 0.5914
Delta H_{t+50}: 0.4954
Delta H_{t-50}: 0.7182
Delta P_{avg}: 0.3277
Meter Temp.: 95
Stack Temp.: 80

NOZZLE SELECTION CRITERIA

Desired Dia. 0.205

	Nozzle 1	Nozzle 2
Diameter	0.188	
Nozzle Number		
Delta P_{min}	0.2065	
Delta P_{max}	0.7629	

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-4	15:00	00:00	192.001	0.35	72	74	0.57	1	N.A.	55	N.A.
2	↓	15:00	15:00	158.87	↓	75	76	↓	1	↓	52	↓
3		15:00	30:00	165.77		80	77		1		54	
4		15:00	45:00	172.67		85	77		1		51	
5		15:00	60:00/0	179.57		90	78		1		54	
6		15:00	15:00	186.49		93	80		1		50	
7		15:00	30:00	193.43		96	79		1		55	
8		15:00	45:00	200.36		97	80		1		60	
9		15:00	120:00/0	207.27		99	80		1		60	
10		15:00	15:00	214.24		99	81		1		62	
11		15:00	30:00	221.21		100	80		1		57	
12		15:00	45:00	228.16		100	83		1		60	

minutes	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH
360	167.086	0.35	97	81	[illegible]

* 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: Maryville, Tenn.
Sampling Location: Crusher

Run Number: Wet-1-Crusher-M201A 3
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 Imping Exit, °F	Cyclone Temp, °F
13	A-4	15:00	180:00/0	235.12	0.35	101	81	0.57	1	N.A.	62	N.A.
14		15:00	15:00	242.052		101	82		1		63	
15		15:00	30:00	249.08		100	82		1		63	
16		15:00	45:00	256.09		101	82		1		55	
17		15:00	240:00	263.08		102	83		1		60	
18		15:00	15:00	270.06		103	84		1		61	
19		15:00	30:00	277.04		104	84		1		63	
20		15:00	45:00	284.02		105	84		1		63	
21		15:00	300:00/0	291.00		105	84		1		65	
22		15:00	15:00	298.07		106	85		1		55	
23		15:00	30:00	305.08		106	85		1		58	
24		15:00	45:00	312.09		106	86		1		59	
25			360:00 (end)	319.087								
26												
27												
28												
23												
29												
30												
31												
32												
33												
34												
35												
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37												
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39												
40												

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Maryville, TN

SAMPLING LOCATION: Screen

		D-1-S-M2-1	D-1-S-M2-2	Average
	Test Date	6/10/93	6/10/93	
	Run Start Time	xxxx	xxxx	
	Run Finish Time	xxxx	xxxx	
	Net Traversing Points	6	6	
Cp	Pitot Tube Coefficient	0.84	0.84	
Pbar	Barometric Pressure, Inches Hg	29.09	29.09	
Pg	Flue Gas Static Pressure, Inches H2O	-0.31	-0.31	-0.310
Ps	Absolute Flue Gas Pressure, Inches Hg	29.07	29.07	29.07
ts	Flue Gas Temperature, Degrees F	70	86	78
Delta-p	Average Velocity Head, Inches H2O	0.0420	0.0567	0.0491 *

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

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Maryville, TN

SAMPLING LOCATION: Screen

		D-1-S-M201A-1	D-1-S-M201A-2	D-1-S-M201A-3
	Test Date	6/10/93	6/10/93	6/10/93
	Run Start Time	810	925	1035
	Run Finish Time	910	1025	1135
	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	29.09	29.09	29.09
Delta H	Avg. Pressure Differential of Orifice Meter, Inches H2O	0.6722	0.6722	0.6722
Vm	Volume of Metered Gas Sample, Dry ACF	27.761	28.252	28.353
tm	Dry Gas Meter Temperature, Degrees F	89	103	105
Vmstd	Volume of Metered Gas Sample, Dry SCF*	25.563	25.368	25.369
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, mL	14.3	15.2	14.7
Vwstd	Volume of Water Vapor, SCF*	0.673	0.715	0.692
%H2O	Moisture Content, Percent by Volume	2.57 **	2.74 **	2.66 **
%H2OSAT	Moisture Sat. @ Flue Gas Conditions, %	3.33	3.33	3.33
Mfd	Dry Mole Fraction	0.974	0.973	0.973
%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	28.56	28.54	28.55
Pg	Flue Gas Static Pressure, Inches H2O	-0.31	-0.31	-0.31
Ps	Absolute Flue Gas Pressure, Inches Hg	29.07	29.07	29.07
	<u>Volumetric Air Flow Rate</u>			
ts	Flue Gas Temperature, Degrees F	78	78	78
Delta-p	Average Velocity Head, Inches H2O	0.0491	0.0491	0.0491
vs	Flue Gas Velocity, Feet per Second	12.81	12.81	12.81
A	Stack/Duct Area, Square Inches	113.1	113.1	113.1
Qsd	Volumetric Air Flow Rate, Dry SCFM*	561	560	560
Qmsd	Volumetric Air Flow Rate, Dry SCMM*	16	16	16
Qaw	Volumetric Air Flow Rate, Wet ACFM	604	604	604
ton/hr	Production Rate, tons/hour	170.93	166.14	159.75

* 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, Maryville, TN

SAMPLING LOCATION: Screen

		D-1-S-M201A-1	D-1-S-M201A-2	D-1-S-M201A-3
	Percent Isokinetic			
ts	Flue Gas Temperature, Degrees F	79	83	86
Delta-p	Average Velocity Head, Inches H2O	0.041	0.041	0.041
vs	Flue Gas Velocity, Feet per Second	11.72	11.76	11.79
%I	Isokinetic Sampling Rate, Percent	103.1	102.8	103.0
	PM10 Calculations			
ucyc	Stack Gas Viscosity	181.0	180.9	180.9
Qs	PM10 Flow, at Cyclone Conditions, ACFM	0.459	0.456	0.456
D50	Dia. of Particles in Cyclone, Microns	9.90	9.93	9.94
	Particulate Catch,			
mg<D50	≤ 10 Microns, Milligrams	17.9	18.6	16.5
mg>D50	> 10 Microns, Milligrams	47.1	223.9	238.2
mg	Total Milligrams	65.0	242.5	254.7
	Percent of Total Particulate,			
%<D50	≤ 10 Microns	27.5	7.7	6.5
%>D50	> 10 Microns	72.5	92.3	93.5
	Particulate ≤ 10 Microns			
	Concentration, milligrams/DSCF*			
mg/DSCF	Concentration in Gas Sample	0.70	0.73	0.65
mg/DSCF,A	Concentration in Ambient Air	0.05002	0.05044	0.05072
mg/DSCF,adj	Adjusted Concentration in Gas Sample	0.65	0.68	0.60
lb/hr	Emission Rate, lb/hr	0.0482	0.0506	0.0445
lb/ton	Emission Rate, lb/ton	0.000282	0.000304	0.000278
M	Screen Size Correction Factor	24	24	24
lb/ton,Tot	Emission Rate, lb/ton, Total	0.00677	0.00731	0.00668

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

AIR FLOW RATE DETERMINATIONS

Plant Name Vulcan Matl - Limestone Run No. DS1201 1,2,3

City/State Maryville, Tenn Date 6/10/93

Test Location Screen Personnel TIB

Barometric Pres. (Pbar) 29.09 In. Hg Static Pres. (Pg) -.31 In. H_2O

Pitot/Orifice ID 4-42 Pitot Coef. (Cp) .84 Pres. Gauge Set ID ADM-1

Thermocouple ID E234 Duct Length/Diameter ______ Width ______

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

VELOCITY TRAVERSES Start-Finish Times: ______ - ______

Point No.	ΔP In. H_2O	Temp. °F
A-1	.049	70
2	.041	70
3	.037	70
4	.049	70
5	.041	70
6	.038	70
AVG.	.042	70
A-1	.066	86
2	.048	86
3	.055	86
4	.058	86
5	.057	86
6	.057	86
AVG	.0567	86
Avg.*	~~0.042~~	~~70~~

PRE → (points A-1 to 6, first set)

POST → (points A-1 to 6, second set)

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. See page 2 for field flow rate calculations.

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ENTROPY

PC 06-10-93

METHOD 201A (PM-10) FIELD DATA

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

Run Number: DS12011
Time Start: 0810
Time Stop: 0910
Job Number: 5011S
Barometric Pressure, In. Hg: 29.09
Static Pressure, In. H_2O: -.31

EQUIPMENT CHECKS

- ✓ Pitot, Pretest
- ✓ Pitot, Posttest
- NA M3 Sampling Sys/Ted Bag
- ✓ Thermocouple @ 79 Pre
- ✓ Thermocouple @ 82 Post

IDENTIFICATION NUMBERS

Meterbox: EN-2 Meterbox Gamma: .9831 Reagent Box: NA
T/C Readout: F-52 T/C Probe: SAME Umbilical: U10B
Sampling Box: NA Orsat Pump: NA Tedlar Bag: NA
Nozzle(s) Actually Used: Pitot: SAME
No.: CAE Diameter: ~~.344~~ .341 No.: ____ Diameter: ____

FILTER NO.	TARE
PM202	.2704

Est % H_2O: 2.0

Delta $H_@$: 1.935
Delta H_t: .6722
Delta H_{t+50}: .5613
Delta H_{t-50}: .8193
Delta P_{avg}: .0424
Meter Temp.: 100
Stack Temp.: 70

NOZZLE SELECTION CRITERIA

Desired Dia.: .340

	Nozzle 1	Nozzle 2
Diameter	.344	
Nozzle Number	CAE	
Delta P_{min}	.0102	
Delta P_{max}	.0914	

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, °F~~ V/Dir	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-2	10	0	262.036	.041	75	79	.6722	1.0	0/0	60	79
2	2	10	10	266.67	.041	87	77	.6722	1.0	0/0	50	77
3	2	10	20	271.27	.041	90	77	.6722	1.0	0/0	48	77
4	2	10	30	275.91	.041	92	79	.6722	1.0	0/0	45	79
5	2	10	40	280.54	.041	94	79	.6722	1.0	0/0	46	79
6	2	10	50	285.27	.041	95	80	.6722	1.0	0/0	47	80
7			60	289.797								
8												
9												
10												
11												
12												
			60 minutes	27.761 Vm	0.041 $(\sqrt{\Delta P})^2$	89 tm	79 ts	0.6722 ΔH				

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

DC 06-10-93

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ENTROPY

METHOD 201A (PM-10) FIELD DATA

Plant Name: Vulcan - MATL. - Limestone
City/State: Maryville, Tenn
Sampling Location: Screen
Date: 6/10/93 Team Leader: TTB Techs: DWS / JB
*Train Leak Check Vacuum, In. Hg: 10
Train Leak Rate, Cubic Ft./Min.: .002

Run Number: DS12012
Time Start: 0925
Time Stop: 1025
Job Number: 50119
Barometric Pressure, In. Hg: 29.09
Static Pressure, In. H_2O: -.31

EQUIPMENT CHECKS

- ✓ Pitot, Pretest
- ✓ Pitot, Posttest
- NA M3 Sampling Sys/Ted Bag
- ✓ Thermocouple @ 82 Pre
- ✓ Thermocouple @ 85 Post

IDENTIFICATION NUMBERS

Meterbox: EN-2 Meterbox Gamma: .9831 Reagent Box: NA
T/C Readout: FS2 T/C Probe: Same Umbilical: U-08
Sampling Box: NA Orsat Pump: NA Tedlar Bag: NA
Nozzle(s) Actually Used: #3 .341 Pitot: Same
No. CAE Diameter ~~.344~~ No. ____ Diameter ____

FILTER NO.	TARE
PM332	.2655

Est % H_2O: 2.0

Delta $H_@$: 1.935
Delta H_t: .6722
Delta H_{t+50}: .5613
Delta H_{t-50}: .8193
Delta P_{avg}: .0424
Meter Temp.: 100
Stack Temp.: 70

NOZZLE SELECTION CRITERIA

Desired Dia. .340

	Nozzle 1	Nozzle 2
Diameter	.344	
Nozzle Number	CAE	
Delta P_{min}	.0102	
Delta P_{max}	.0914	

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, $\sqrt{}$ / Dir	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-2	10	0	290.249	.041	100	82	.6722	1.0	0/0	65	82
2	2	10	10	294.87	.041	100	83	.6722	1.0	2/270°	64	83
3	2	10	20	299.64	.041	102	84	.6722	1.0	2/270°	60	84
4	2	10	30	304.35	.041	105	83	.6722	1.0	2/270°	58	83
5	2	10	40	309.07	.041	105	82	.6722	1.0	2/260°	54	82
6	2	10	50	313.79	.041			.6722	1.0			
7			60	318.501								
8												
9												
10												
11												
12												
Totals			60 minutes	28.252 Vm	0.041 $(\sqrt{\Delta P})^2$	103 tm	83 ts	0.6722 ΔH				

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

DC 06-10-93

ENTROPY

METHOD 201A (PM-10) FIELD DATA

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

Run Number DS12013
Time Start 1035
Time Stop 1135
Job Number 5015
Barometric Pressure, In. Hg 29.09
Static Pressure, In. H_2O -.31

EQUIPMENT CHECKS

✓ Pitot, Pretest
✓ Pitot, Posttest
NA M3 Sampling Sys/Ted Bag
✓ Thermocouple @ 85 Pre
✓ Thermocouple @ 86 Post

IDENTIFICATION NUMBERS

Meterbox EN-2 Meterbox Gamma .9831 Reagent Box NA
T/C Readout F52 T/C Probe Same Umbilical U108
Sampling Box NA Orsat Pump NA Tedlar Bag NA
Nozzle(s) Actually Used: Pitot Same
No. CAE Diameter .341 ~~.344~~ TB No. Diameter

FILTER NO.	TARE
Pm 329	.2691

Est % H_2O 2.0

Delta $H_@$ 1.935
Delta H_t .6722
Delta H_{t+50} .5613
Delta H_{t-50} .8193
Delta P_{avg} .0424
Meter Temp. 100
Stack Temp. 70

NOZZLE SELECTION CRITERIA

Desired Dia. .340

	Nozzle 1	Nozzle 2
Diameter	.344	
Nozzle Number	CAE	
Delta P_{min}	.0102	
Delta P_{max}	.0914	

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~~, ~~°F~~ V/Dic	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-2	10	0	318.749	.041	104	85	.6722	1.0	0/0	42	85
2	2	10	10	323.47	.041	105	86	.6722	1.0	2/240°	36	86
3	2	10	20	328.18	.041	105	85	.6722	1.0	2/260°	40	85
4	2	10	30	332.88	.041	105	86	.6722	1.0	3/260°	42	86
5	2	10	40	337.57	.041	106	86	.6722	1.0	2/260°	45	86
6	2	10	50	342.33	.041	106	86	.6722	1.0	2/260°	47	86
7			60	347.102								
8												
9												
10												
11												
12												

minutes	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH
60	28.353	0.041	105	86	0.6722

06-10-93

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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ENTROPY

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Maryville, TN

SAMPLING LOCATION: Screen

		W-1-S-M2-1	W-1-S-M2-2	Average
	Test Date	6/7/93	6/7/93	
	Run Start Time	800	xxxx	
	Run Finish Time	810	xxxx	
	Net Traversing Points	6	6	
Cp	Pitot Tube Coefficient	0.84	0.84	
Pbar	Barometric Pressure, Inches Hg	29.12	29.1	
Pg	Flue Gas Static Pressure, Inches H2O	-0.03	-0.03	-0.03
Ps	Absolute Flue Gas Pressure, Inches Hg	29.12	29.12	29.12
ts	Flue Gas Temperature, Degrees F	66	89	78
Delta-p	Average Velocity Head, Inches H2O	0.0455	0.0506	0.0480 *

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

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Maryville, TN

SAMPLING LOCATION: Screen

		W-1-S-M2-3	W-1-S-M2-4	Average
	Test Date	6/8/93	6/8/93	
	Run Start Time	xxxx	xxxx	
	Run Finish Time	xxxx	xxxx	
	Net Traversing Points	6	6	
Cp	Pitot Tube Coefficient	0.84	0.84	
Pbar	Barometric Pressure, Inches Hg	29.00	29.00	
Pg	Flue Gas Static Pressure, Inches H2O	-0.048	-0.048	-0.048
Ps	Absolute Flue Gas Pressure, Inches Hg	29.00	29.00	29.00
ts	Flue Gas Temperature, Degrees F	70	86	78
Delta-p	Average Velocity Head, Inches H2O	0.0430	0.0530	0.0479 *

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

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Maryville, TN

SAMPLING LOCATION: Screen

		W-1-S-M2-5	W-1-S-M2-6	Average
	Test Date	6/9/93	6/9/93	
	Run Start Time	xxxx	xxxx	
	Run Finish Time	xxxx	xxxx	
	Net Traversing Points	6	6	
Cp	Pitot Tube Coefficient	0.84	0.84	
Pbar	Barometric Pressure, Inches Hg	29.3	29.3	
Pg	Flue Gas Static Pressure, Inches H2O	-0.34	-0.34	-0.340
Ps	Absolute Flue Gas Pressure, Inches Hg	29.28	29.28	29.28
ts	Flue Gas Temperature, Degrees F	73	88	81
Delta-p	Average Velocity Head, Inches H2O	0.0510	0.0520	0.0515 *

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

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Maryville, TN

SAMPLING LOCATION: Screen

		W-1-S-M201A-1	W-1-S-M201A-2	W-1-S-M201A-3
	Test Date	6/7/93	6/8/93	6/9/93
	Run Start Time	915	745	815
	Run Finish Time	1525	1352	1420
	Net Traversing/Sampling Points	6/1	6/1	6/1
Theta	Net Run Time, Minutes	360	360	375
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	29.12	29.00	29.30
Delta H	Avg. Pressure Differential of Orifice Meter, Inches H2O	0.6782	0.6720	0.6746
Vm	Volume of Metered Gas Sample, Dry ACF	171.558	168.220	175.918
tm	Dry Gas Meter Temperature, Degrees F	102	91	93
Vmstd	Volume of Metered Gas Sample, Dry SCF*	154.482	153.863	161.979
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, mL	68.6	88.1	79.3
Vwstd	Volume of Water Vapor, SCF*	3.229	4.147	3.733
%H2O	Moisture Content, Percent by Volume	2.05 **	2.62 **	2.25 **
%H2OSAT	Moisture Sat. @ Flue Gas Conditions, %	3.32	3.33	3.64
Mfd	Dry Mole Fraction	0.980	0.974	0.977
%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	28.55	28.59
Pg	Flue Gas Static Pressure, Inches H2O	-0.03	-0.048	-0.34
Ps	Absolute Flue Gas Pressure, Inches Hg	29.12	29.00	29.28
	Volumetric Air Flow Rate			
ts	Flue Gas Temperature, Degrees F	78	78	81
Delta-p	Average Velocity Head, Inches H2O	0.048	0.0479	0.0515
vs	Flue Gas Velocity, Feet per Second	12.64	12.67	13.10
A	Stack/Duct Area, Square Inches	113.1	113.1	113.1
Qsd	Volumetric Air Flow Rate, Dry SCFM*	557	553	576
Qmsd	Volumetric Air Flow Rate, Dry SCMM*	15.8	15.7	16.3
Qaw	Volumetric Air Flow Rate, Wet ACFM	596	597	617
ton/hr	Production Rate, tons/hour	206.00	167.74	175.73

* 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, Maryville, TN

SAMPLING LOCATION: Screen

		W-1-S-M201A-1	W-1-S-M201A-2	W-1-S-M201A-3
	Percent Isokinetic			
ts	Flue Gas Temperature, Degrees F	79	82	84
Delta-p	Average Velocity Head, Inches H2O	0.050	0.040	0.055
vs	Flue Gas Velocity, Feet per Second	12.92	11.62	13.58
%I	Isokinetic Sampling Rate, Percent	93.5	105.1	90.1
	PM10 Calculations			
ucyc	Stack Gas Viscosity	181.4	181.0	182.0
Qs	PM10 Flow, at Cyclone Conditions, ACFM	0.459	0.461	0.463
D50	Dia. of Particles in Cyclone, Microns	9.90	9.86	9.86
	Particulate Catch,			
mg<D50	≤ 10 Microns, Milligrams	14.0	11.5	11.4
mg>D50	> 10 Microns, Milligrams	77.4	51.4	87.4
mg	Total Milligrams	91.4	62.9	98.8
	Percent of Total Particulate,			
%<D50	≤ 10 Microns	15.3	18.3	11.5
%>D50	> 10 Microns	84.7	81.7	88.5
	Particulate ≤ 10 Microns			
	Concentration, milligrams/DSCF*			
mg/DSCF	Concentration in Gas Sample	0.0906	0.0747	0.0704
mg/DSCF,A	Concentration in Ambient Air	0.02181	0.02047	0.02338
mg/DSCF,adj	Adjusted Concentration in Gas Sample	0.0688	0.0543	0.0470
lb/hr	Emission Rate, lb/hr	0.00507	0.00397	0.00358
lb/ton	Emission Rate, lb/ton	2.46E-05	2.37E-05	2.04E-05
M	Screen Size Correction Factor	24	24	24
lb/ton,Tot	Emission Rate, lb/ton, Total	0.000591	0.000568	0.000489

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

Plant Name VULCAN MATL. Job No. 50119

City/State MARYVILLE, TENN Date 6/7/93

Test Location SCREEN Personnel DWIS/JB

Barometric Pres. (Pbar) 29.12 In. Hg Static Pres. (Pg) -.03 In. H_2O

Pitot ID D48-8 Pitot Coeff. (Cp) .84 Pressure Gauge Set ID M19

Thermocouple ID R284 ~~Duct Length~~/Diameter 12 DIA. ~~Width~~ --Specify inches (") or feet (')--

WSI-201-1

TRAVERSES
Start-Finish Times: 0800 - 0810

Pt. No.	Yaw ∡°	ΔP "H_2O	Temp °F
1	0	.03	64
2	0	.045	66
3	0	.05	66
4	0	.055	66
5	0	.05	66
6	0	.045	66
AVG.		.0455	66
TIME →			
1	0	.056	89
2	0	.044	89
3	0	.045	89
4	0	.061	89
5	0	.054	89
6	0	.045	89
AVG.		0.0506	89
Avg*		[illegible]	

PRE RUN → (rows 1–6, first set)

POST RUN → (rows 1–6, second set)

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

Plant Name: VULCAN MATL - LIMESTON   Job No. 50119

City/State: MARYVILLE, TENN.   Date 4/8/93

Test Location: SCREEN   Personnel DWS

Barometric Pres. (Pbar) 29.0 In. Hg   Static Pres. (Pg) -.048 In. H_2O

Pitot ID D48-8   Pitot Coeff. (Cp) .84   Pressure Gauge Set ID ADM

Thermocouple ID R284   Duct Length/Diameter ______ Width ______
--Specify inches (") or feet (')--

	TRAVERSES Start-Finish Times:		
Pt. No.	Yaw ∡°	ΔP "H_2O	Temp °F
A-1 (WS1-M201-3, PRE → TEST)		.051	70
2		.033	70
3		.037	70
4		.052	70
5		.048	70
6		.039	70
AVG →		.043	70
A-1 (POST → TEST)		.052	86
2		.052	86
3		.049	86
4		.065	86
5		.061	86
6		.042	86
AVG →		.053	86
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

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

Plant Name VULCAN MATL - LIMESTONE Run No. WS1201-3

City/State MARYVILLE, TENN Date 6/9/93

Test Location SCREEN Personnel DWS / JB

Barometric Pres. (Pbar) 29.3 In. Hg Static Pres. (Pg) -.34 In. H_2O

Pitot/Orifice ID 4-42 Pitot Coef. (Cp) .84 Pres. Gauge Set ID ADM-1

Thermocouple ID R234 Duct Length/Diameter ______ Width ______

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

PRE-TEST WS1201-3 →

VELOCITY TRAVERSES Start-Finish Times: ____ - ____		
Point No.	ΔP In. H_2O	Temp. °F
A-1	.056	73
2	.045	73
3	.049	73
4	.061	73
5	.055	73
6	.044	73
AVG.	.051	73
A-1	.047	88
2	.064	88
3	.041	88
4	.062	88
5	.060	88
6	.039	88
AVG.	.052	88
Avg.*		

~~POST BREAK~~ POST → ~~BREAK DOWNWIND~~

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. See page 2 for field flow rate calculations.

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ENTROPY

ENTROPY

METHOD 201A (PM-10) FIELD DATA

Plant Name: VULCAN MATL - LIMESTONE
City/State: MARYVILLE, TENN
Sampling Location: SCREEN
Date: 6/1/93 Team Leader: TJB Techs: DWS
*Train Leak Check Vacuum, In. Hg: 10
Train Leak Rate, Cubic Ft./Min.: .001

Run Number: WET-1-SCREEN-201-1
Time Start: 0915
Time Stop: 1525
Job Number: 50119
Barometric Pressure, In. Hg: 29.12
Static Pressure, In. H_2O: -.03

EQUIPMENT CHECKS

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

IDENTIFICATION NUMBERS

Meterbox: EN-2 Meterbox Gamma: .9831 Reagent Box: NA
T/C Readout: F-52 T/C Probe: R129 Umbilical: U108
Sampling Box: NA Orsat Pump: NA Tedlar Bag: NA
Nozzle(s) Actually Used: Pitot: 4-42
No. CAE Diameter: ~~.344~~ TB .341 No. — Diameter: —

FILTER NO.	TARE
PM292	.2663

Est % H_2O: 1.0

Delta $H_@$: 1.935
Delta H_t: .6782
Delta H_{t+50}: .5656
Delta H_{t-50}: .8281
Delta P_{avg}: .0455
Meter Temp.: 90
Stack Temp.: 66

NOZZLE SELECTION CRITERIA

Desired Dia.: .335

	Nozzle 1	Nozzle 2
Diameter	.344	
Nozzle Number	CAE	
Delta P_{min}	.0902	
Delta P_{max}	.0916	

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 ~~Filter Box~~ DIR./V	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-3	15	0	745.300	.05	77	66	.6782	1.0	0/0	58	66
2	↓	↓	15	752.38	↓	84	72	↓	↓	0/0	58	72
3			30	759.16		85	73			0/0	58	73
4			45	766.13		90	73			0/0	58	73
5			60	773.25		93	74			0/0	58	74
6			75	780.37		94	74			1/320°	58	74
7	↓	↓	90	787.58	↓	95	75	↓	↓	0/0	58	75
8			105	794.57		98	76			2/210°	58	76
9			120	801.67		100	77			2/180°	58	77
10			135	808.73		104	78			0/0	58	78
11			150	815.81		105	80			0/0	58	80
12			165	822.94		107	80			0/0	58	80

CONTINUED →

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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

Plant Name: Vulcan Matl - Limestone
City/State: Maryville, Tenn.
Sampling Location: Screen

Run Number: WSL M201A-1
Time Start: 0915
Time Stop: 1525

	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~~ Wind V/Dir	Gas Temps: Imping Exit, °F	Cyclone Temp, °F
13	A-3	15	180	830.12	.05	107	81	.6782	1.0	0/0	59	81
14			195	837.30		108	82			1/240°	60	82
15			210	844.25		109	82			0/0	56	82
16			225	851.62		110	83			4/250°	52	83
17			240	858.85		111	83			1/240°	50	83
18			255	866.14		112	83			5/270°	48	84
19			270	873.41		110	84			4/210°	48	84
20			285	880.72		110	84			4/210°	48	84
21			300	888.02		107	86			0/0	48	86
22			315	895.31		107	86			5/230°	48	86
23			330	902.36		109	83			4/230°	49	83
24			345	909.61		110	85			0/0	49	85
25			360	916.858								
26												
27												
28												
23												
29												
30												
31												
32												
33												
34												
35												
36												
37												
38												
39												
40												

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

minutes	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH
360	171.558	0.05	102	77	0.6452

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ENTROPY

METHOD 201A (PM-10) FIELD DATA

Plant Name: VULCAN MATL. – LIMESTONE
City/State: MARYVILLE, TENN.
Sampling Location: SCREEN
Date: 6/8/93 Team Leader: TIB Techs: DWS
*Train Leak Check Vacuum, In. Hg: 10
Train Leak Rate, Cubic Ft./Min.: .001

Run Number: WS1-201A-2
Time Start: 0745
Time Stop: 1352
Job Number: 50119
Barometric Pressure, In. Hg: 29.0
Static Pressure, In. H_2O: -.048

EQUIPMENT CHECKS

- ✓ Pitot, Pretest
- ✓ Pitot, Posttest
- NA M3 Sampling Sys/Ted Bag
- ✓ Thermocouple @ 70 Pre
- Thermocouple @ ___ Post

IDENTIFICATION NUMBERS

Meterbox: EN-2 Meterbox Gamma: .9831 Reagent Box: NA
T/C Readout: F-52 T/C Probe: # SAME Umbilical: U108
Sampling Box: NA Orsat Pump: NA Tedlar Bag: NA
Nozzle(s) Actually Used: .341 ~~.344~~ TTB Pitot: SAME
No. CAE Diameter: ~~.344~~ No. ___ Diameter ___

FILTER NO.	TARE
PM267	.2720

Est % H_2O: 2.0

Delta $H_@$: 1.935
Delta H_t: .6720
Delta H_{t+50}: .5611
Delta H_{t-50}: .8193
Delta P_{avg}: .043
Meter Temp.: 100
Stack Temp.: 70

NOZZLE SELECTION CRITERIA

Desired Dia. .339

	Nozzle 1	Nozzle 2
Diameter	.344	
Nozzle Number	CAE	
Delta P_{min}	.0101	
Delta P_{max}	.0913	

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 ~~Filter Box, °F~~ V/Dir. (Gas Temps)	Imping Exit, °F (Gas Temps)	Cyclone Temp, °F
1	4-6	15.0	0	917.373	.04	85	73	.6720	1.0	0/0	50	73
2	6	↓	15	924.52	↓	90	75	↓	↓	0/0	50	75
3	6		30	931.26		94	76			2/250°	54	76
4	↓		45	938.23		95	76			2/230°	55	76
5			60	945.18		98	78			2/230	49	78
6			75	952.29		100	79			2/220°	51	79
7			90	959.37		90	80			2/230°	51	80
8			105	966.42		89	81			2/220°	51	81
9			120	973.43		87	82			2/200°	49	82
10			135	980.44		88	83			2/210°	49	83
11			150	987.44		89	83			2/200°	50	83
12			165	994.45		89	83			0/0	51	83
			CONTINUED →									

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

ENTROPY

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

Plant Name: VULCAN MATL. — LIMESTONE
City/State: MARYVILLE, TENN.
Sampling Location: SCREEN

Run Number: WSI-201A-2
Time Start: 0745
Time Stop: 1352

	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: WIND ~~Filter Box~~, $\frac{\Delta P}{V}$/D.C.	Gas Temps: Imping Exit, °F	Cyclone Temp, °F
13	A-6	15.0	180	1001.45	.04	89	84	.672	1.0	2/270°	56	84
14			195	1008.44		89	85			2/270°	56	85
15			210	1015.44		89	85			2/270°	55	85
16			225	1022.45		90	85			2/210°	57	85
17			240	1029.41		90	85			2/270°	56	85
18			255	1036.48		90	85			4/260°	54	85
19			270	1043.53		90	86			2/280°	55	86
20			285	1050.56		90	85			4/280	56	85
21			300	1057.55		92	85			3/270°	56	85
22			315	1064.53		92	85			2/260°	50	85
23			330	1071.59		93	85			5/220°	49	85
24			345	1078.47		93	86			4/220°	49	86
25			360	1085.593								
26												
27												
28												
23												
29												
30												
31												
32												
33												
34												
35												
36												
37												
38												
39												
40												

minutes	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH
360	168.220	0.04	91	82	0.672

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

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ENTROPY

METHOD 201A (PM-10) FIELD DATA

Plant Name: VULCAN MATL - LIMESTONE
City/State: MARYVILLE, TENN
Sampling Location: SCREEN
Date: 6/9/93 Team Leader: TJB Techs: DWS
*Train Leak Check Vacuum, In. Hg: 10
Train Leak Rate, Cubic Ft./Min.: .001

Run Number: WSI-201-3
Time Start: 0815
Time Stop: 1420
Job Number: 5011S
Barometric Pressure, In. Hg: 29.3
Static Pressure, In. H_2O: -.34

EQUIPMENT CHECKS

- ✓ Pitot, Pretest
- ✓ Pitot, Posttest
- NA M3 Sampling Sys/Ted Bag
- ✓ Thermocouple @ 73 Pre
- ✓ Thermocouple @ 86 Post

IDENTIFICATION NUMBERS

Meterbox: EN-2 Meterbox Gamma: .9881 Reagent Box: NA
T/C Readout: F-52 T/C Probe: SAME Umbilical: U108
Sampling Box: NA Orsat Pump: NA Tedlar Bag: NA
Nozzle(s) Actually Used: TJB .341 Pitot: SAME
No. CAE Diameter ~~.328~~ No. ____ Diameter ____

FILTER NO.	TARE
PM9	.2199

Est % H_2O: 2.0

Delta $H_@$: 1.935
Delta H_t: .6746
Delta H_{t+50}: .5638
Delta H_{t-50}: .8215
Delta P_{avg}: .0515
Meter Temp.: 100
Stack Temp.: 73

NOZZLE SELECTION CRITERIA

Desired Dia. .325

	Nozzle 1	Nozzle 2
Diameter	.328	
Nozzle Number	CAE	
Delta P_{min}	.0124	
Delta P_{max}	.1116	

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 WIND ~~Filter Box~~, V/DIR	Gas Temps Imping Exit, °F	Cyclone Temp, °F
1	A-5	15.0	0	85.867	.055	85	80	.6746	1.0	0/0	55	80
2	↓	↓	15	92.72	↓	90	79	↓	↓	3/206°	54	79
3			30	99.53		94	~~78~~ 80			2/200°	50	80
4			45	106.94		96	80			6/200°	48	80
5			60	114.01		100	82			5/200°	48	82
6			75	121.08		100	82			3/240°	46	82
7			90	128.15		102	83			2/230°	44	83
8			105	135.23		105	84			4/220°	42	84
9			120	142.32		92	82			5/220°	40	82
10			135	149.38		90	84			4/210°	40	84
11			150	156.42		89	84			3/220°	40	84
12			165	163.43		89	84			5/216°	42	84

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 NATL. — LIMESTONE
City/State: MARYVILLE, TENN.
Sampling Location: SCREEN

Run Number: WS12013
Time Start: 0815
Time Stop: 1420

	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 V/ΔC	Gas Temps Imping Exit, °F	Cyclone Temp, °F
13	A-5	15.0	180	170.45	[illegible]	89	85	.6746	1.0	4/220°	48	85
14			195	177.51	.055	90	86			8/220°	44	86
15			210	184.55		90	86			4/220°	42	86
16			225	191.58		90	86			2/240	42	86
17			240	198.62		92	86			7/210°	42	86
18			255	205.59		92	86			0/0	43	86
19			270	212.69		94	86			8/220°	44	86
20			285	219.72		94	86			7/210°	44	86
21			300	226.74		94	89			4/220°	43	89
22			315	233.77		94	88			5/280°	44	88
23			330	240.79		94	87			7/260°	44	87
24			345	247.81		94	88			7/220°	46	88
25			360	254.81		94	88			4/190°	48	88
26			375	261.785								
27												
28												
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30												
31												
32												
33												
34												
35												
36												
37												
38												
39												
40												

minutes	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH
375	175.918	0.055	93	84	0.6746

* 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 deister

   $Q_{F\text{-}STD} = (Q_{F\text{-}A})(28 \text{ Sample Points})(T_S/T_{STK})(P_B/P_{BS})(60\text{Min/Hr})(1-X)/1)$

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 Deister processing rate

   P_D = Deister Rate = (P/2)

9. Calculation of PM10 Emission factors

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

Appendix C.

SAMPLING EQUIPMENT AUDIT

Plant Name: Vulcan Materials   Job No. 50119
City/State: Maryville, 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 70	Allowable Deviation From Ambient	Date 6/7/93 Auditor JRW Ambient Temperature, °F				√ OK
THERMOMETERS						
Dry Gas Meter	± 5.4 °F	71	(Meterbox I.D. NU-7)			✓
Impinger Exit	± 2.0 °F	70				✓
Filter Box	± 5.4 °F	N/A				

THERMOCOUPLES Ref Temp 70 / Ref. Temp 78

TC No./ °F	√ OK	TC No./ °F	√ OK	TC No./ °F	√ OK	TC No./ °F	√ OK	TC No./ °F	√ OK
R284 / 72	✓	R218 / 178	✓	/		/		/	
(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		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}) 29.12 Auditor JRW Date 6/7/93

Dry Gas Meter Reading (Cubic Ft.)	Meter Temperature (°F)	Lower and Upper Limits for Audit Gamma
Final 810.057	Final 87	0.96 * Y = 0.9456
Initial 802.400	Initial 79	1.04 * Y = 1.0244

Dry Gas Volume Metered (Cubic Ft.)	Average Meter Temp. (°F)	Run Time (Base = 10) (Minutes)	(Seconds)
Vm = 7.657	Tm = 83	10	0

$$Y_c = \frac{[10 + (0 / 60)]}{7.657} * \left[\frac{0.0319\,(83 + 460)}{29.12}\right]^{.5} = 1.0073$$

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 NA

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SAMPLING EQUIPMENT AUDIT

Plant Name: Vulcan Matl. Job No.: 50119

City/State: Maryville, Tenn. Auditor(s): DWS

Test Loc.: Screen Date: 6/7/93

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 66	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@ 1.935

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

Barometric Pressure (P_{bar}) 29.12 Auditor DWS Date 6/7/93

Dry Gas Meter Reading (Cubic Ft.)	Meter Temperature (°F)	Lower and Upper Limits for Audit Gamma
Final 745.200	Final 75	0.96 * Y = .9438
Initial 737.374	Initial 66	1.04 * Y = 1.0224

Dry Gas Volume Metered (Cubic Ft.)	Average Meter Temp. (°F)	Run Time (Base = 10) (Minutes)	(Seconds)
Vm = 7.83	Tm = 71	10	0

0.75 = Ideal Sampling Rate

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

$$Y_c = \frac{[10 + (0 / 60)]}{7.83} * \left[\frac{0.0319 (71 + 460)}{29.12}\right]^{.5} = .9741$$

Audit Gamma

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

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ENTROPY

Appendix D.

RECORD OF CUSTODY, CONTAINER NO. ______

Client EPA Job No. 50119

Plant Name Vulcan, Materials

City/State Maryville, TENN

Sampling Method(s) 201A (EPA, NIOSH, etc.)

Container Type (√) Reagent Box ✓ Cooler __ Other (specify)______

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
1694	6/10	12:49	S	Todd T. Brozell	
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

* S = Sealed By; B = Broken By ** Use "REMARKS" Section if more space needed.

Received by Sample Custodian**

[signature] 6-22-93 1215

Signature Date Time

**Seal Intact? Yes ✓ No __

As Applicable:

All liquid levels at mark (check)? YES __ NO __ (Estimate loss if not at mark; describe in "REMARKS")

As Applicable:

TUBE SAMPLES put in freezer by ______ Date ______ Time ______

CONDENSATE SAMPLES put in refrige. by ______ Date ______ Time ______

REMARKS ______

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FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. P309 Assembly Date 6/1/93 Assembled By [illegible]

Client Vulcan Materials Job No. 5019

Plant Vulcan Materials Maryville City/State Maryville, TENN

Sampling Loc. Crusher Method 201A

Individual Tare Of Reagent 200 (Ml)(gm) Of DI

Individual Tare Of Reagent ______ (Ml)(gm) Of ______

Individual Tare Of Reagent ______ (Ml)(gm) Of ______

Individual Tare Of Sil. Gel ~200 Gm ______ other (specify)

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
DRY-1-CRUSHER-M201A-1	6/10	PM334	.2715	✓	TTB	6/10	10	✓	TTB

Filter Appearance* grey

Reagents Appearance* clear

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
2	6/10	PM333	.2684	✓	TTB	6/10	10	✓	TTB

Filter Appearance* "

Reagents Appearance* "

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
3	6/10	PM331	.2711	✓	TTB	6/10	10	✓	TTB

Filter Appearance* "

Reagents Appearance* "

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.

Filter Appearance*

Reagents Appearance*

* Use "REMARKS" section if needed.

@ All liquid levels at mark? (check) YES ___ NO ___ (estimate loss if not at mark; use "REMARKS" section).

REMARKS ______

RECORD OF CUSTODY, CONTAINER NO. ______

Client EPA Job No. 5019

Plant Name Vulcan Materials

City/State Maryville, TENN

Sampling Method(s) M201A (EPA, NIOSH, etc.)

Container Type (√) Reagent Box R✓ Cooler __ Other (specify) ______

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
	N	/ A	S		
			B		
1036	6/10	12:44	S	Todd T. Brozell	
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

* S = Sealed By; B = Broken By ** Use "REMARKS" Section if more space needed.

Received by Sample Custodian** [signature] 6-22-93 1212

Signature Date Time

**Seal Intact? Yes ✓ No __

As Applicable:
All liquid levels at mark (check)? YES __ NO __ (Estimate loss if not at mark; describe in "REMARKS")

As Applicable:
TUBE SAMPLES put in freezer by ______ Date ______ Time ______

CONDENSATE SAMPLES put in refrige. by ______ Date ______ Time ______

REMARKS ______

L-0023 rev. 5-93

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. C207 Assembly Date 6/1/93 Assembled By [illegible]

Client EPA Job No. 5019

Plant Vulcan Materials City/State Maryville, TENN

Sampling Loc. Screen DRY Method M201A

Individual Tare Of Reagent 300 (Ml)(gm) Of DI

Individual Tare Of Reagent ______ (Ml)(gm) Of ______

Individual Tare Of Reagent ______ (Ml)(gm) Of ______

Individual Tare Of Sil. Gel 200 Gm ______ other (specify)

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
DRY-1-SCREEN-M201A-1	6/10	PM202	.2704	✓	TB	6/10	10	✓	TB
2	6/10	PM332	.2655	✓	TB	6/10	10	✓	TB
3	6/10	PM329	.2691	✓	TB	6/10	10	✓	TB

Run 1:
Filter Appearance* Grey
Reagents Appearance* Clear

Run 2:
Filter Appearance* "
Reagents Appearance* "

Run 3:
Filter Appearance* "
Reagents Appearance* "

Run 4:
Filter Appearance* ______
Reagents Appearance* ______

* Use "REMARKS" section if needed.

@ All liquid levels at mark? (check) YES ___ NO ___ (estimate loss if not at mark; use "REMARKS" section).

REMARKS ______

Q-1002 rev. 5-93

RECORD OF CUSTODY, CONTAINER NO. ______

Client Vulcan Materials Job No. 50119

Plant Name Maryville

City/State Maryville, Tenn

Sampling Method(s) M201A (EPA, NIOSH, etc.)

Container Type (√) Reagent Box PL Cooler __ Other (specify)______

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
	6/1/93	10:30	S	Mary Mullins	
[illegible]	6/7/93	06:45	B	Chg Traino	Todd T. Bezell
682	6/9/93	14:32	S	Todd Bezell	
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

* S = Sealed By; B = Broken By ** Use "REMARKS" Section if more space needed.

Received by Sample Custodian**

[signature] Signature 6-22-93 Date 1209 Time

**Seal Intact? Yes ✓ No __

As Applicable:
All liquid levels at mark (check)? YES __ NO __ (Estimate loss if not at mark; describe in "REMARKS")

As Applicable:
TUBE SAMPLES put in freezer by ______ Date ______ Time ______

CONDENSATE SAMPLES put in refrige. by ______ Date ______ Time ______

REMARKS ______

L-0023 rev. 5-93

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. 0567 Assembly Date 6/1/93 Assembled By [illegible]

Client Vulcan Materials Job No. 50119

Plant Maryville City/State Maryville Tenn

Sampling Loc. Crusher (WET) Method 201A

Individual Tare Of Reagent 200 (Ml)(gm) Of [illegible]

Individual Tare Of Reagent ______ (Ml)(gm) Of ______

Individual Tare Of Reagent ______ (Ml)(gm) Of ______

Individual Tare Of Sil. Gel 200 Gm ______ other (specify)

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
WET-1-Crusher-201A-1	6/7	PM148	.2710	✓	TJB	6/7	50	✓	TJB
				Filter Appearance* Lgt Gray					
				Reagents Appearance* Clear					
2	6/8	PM8	.2184	✓	TJB	6/8	60	✓	TJB
				Filter Appearance* "					
				Reagents Appearance* "					
3	6/9	PM205	.2728	✓	TJB	6/9	70	✓	TJB
				Filter Appearance* "					
				Reagents Appearance* "					
				Filter Appearance*					
				Reagents Appearance*					

* Use "REMARKS" section if needed.

@ All liquid levels at mark? (check) YES ___ NO ___ (estimate loss if not at mark; use "REMARKS" section).

REMARKS ______

Q-1002 rev. 5-93

RECORD OF CUSTODY, CONTAINER NO. ____

Client Vulcan Materials Job No. 5019

Plant Name Maryville

City/State Maryville, TENN

Sampling Method(s) 201A (EPA, NIOSH, etc.)

Container Type (√) Reagent Box ✓ Cooler __ Other (specify) ____

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
N/A			S		
	6/7	0900	B	Todd Brozell	Chg Trans
1695	6/9	1456	S	Todd Brozell	
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

* S = Sealed By; B = Broken By ** Use "REMARKS" Section if more space needed.

Received by Sample Custodian** [signature] Signature 6-22-93 Date 1210 Time

**Seal Intact? Yes ✓ No __

As Applicable:

All liquid levels at mark (check)? YES __ NO __ (Estimate loss if not at mark; describe in "REMARKS")

As Applicable:

TUBE SAMPLES put in freezer by ____ Date ____ Time ____

CONDENSATE SAMPLES put in refrige. by ____ Date ____ Time ____

REMARKS ____

L-0023 rev. 5-93

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. C238 Assembly Date 6/1/93 Assembled By [illegible]

Client Vulcan Materials Job No. 5019

Plant Maryville City/State Maryville, TENN

Sampling Loc. Screen (WET) Method 201A

Individual Tare Of Reagent 200 (Ml)(gm) Of DI

Individual Tare Of Reagent ______ (Ml)(gm) Of ______

Individual Tare Of Reagent ______ (Ml)(gm) Of ______

Individual Tare Of Sil. Gel ~200 Gm ______ other (specify)

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
WET-1-SCREEN-M201A	6/7	PM292	.2263	✓	TTB	6/7	65	✓	TTB

Filter Appearance* Light Gray

Reagents Appearance* Clear

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
2	6/8	PM267	.2720	✓	TTB	6/8	50	✓	TTB

Filter Appearance* "

Reagents Appearance* "

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
3		PM9	.2199	✓	TTB	6/9	50	✓	TTB

Filter Appearance* "

Reagents Appearance* "

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.

Filter Appearance*

Reagents Appearance*

* Use "REMARKS" section if needed.

@ All liquid levels at mark? (check) YES ___ NO ___ (estimate loss if not at mark; use "REMARKS" section).

REMARKS ______

Q-1002 rev. 5-93

SAMPL[illegible] ACKING LOG

RECORD OF CUSTODY (Present) / Absent / Complete / Incomp.

INVENTORY SHEETS Present / (Absent) / Complete / Incomp.

FIELD SAMPLE RECOV QC (Present) / Absent / Complete / Incomp.

OTHER/REMARKS

Job No. 50119 Date 6-22-93

Plant Limestone Crushing

City/State Maryville, TN

Proj Mgr Hb Field Supvr

BOOK 5

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Ice Present? Yes / No / (N/A) Remarks

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

Method	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)

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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

Job No. 5019 Date 6-22-93
Plant Limestone Crushing Plant
City/State Maryville, TN
Proj Mgr ftb Field Supvr

BOOK 5
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Ice Present? Yes / No / (N/A) Remarks samps hand delivered by ftb

Cont. No.	Run No. or Sample I.D.	Matrix or Component	Type of Container	Received at EEI Date	Received at EEI Init
	1-AMB-WET-1	hi vol filter	#5955500	6-22	ftb
	-2		499		
	-3		498		
	1-AMB-DRY-1		497		
	2-AMB-DRY-1		494		
	2-AMB-WET-1		496		
	-2		495		

Method hi vol Total Conts. 0 No. of Boxes 0 No. of Coolers 0

Cont No. / Seal No. (×7, blank)

Remarks

(cont) (comp)

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Appendix E.

MOISTURE ANALYTICAL RESULTS

Plant Name Vulcan Materials Job No. 5019

City/State Maryville, TENN Sampling Loc. Crusher, Dry

Run Number	DRY-CRUSHER-M201A-1	2	3
Sampling Date	6/10/93	"	"
Analysis Date	6/10/93	"	"
Analyst	TTB	"	"
Reagent 1 (200mls)			
Final Weight, g	563.7	571.4	~~582.4~~ 582.4 JRK
Tared Weight, g	552.8	559.0	586.6
Water Catch, g	10.9	12.4	-4.2
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	~~187.4~~ 192.7	211.9	222.2
Tared Weight, g	187.4	206.9	217.5
ADSORBED WATER, g	5.3	5.0	4.7
TOTAL WATER COLLECTED, g	16.2	17.4	~~0.5~~ 4.7 DAL

Balance No. 43 Type (✓) Triple Beam X Electronic ___ Reagent Box No. 0209

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 Maryville, Tenn Sampling Loc. Crusher-WET

Run Number	WET-1-CRUSHER-M201A-1	2	3
Sampling Date	6-7-93	6/8/93	6/9/93
Analysis Date	6-7-93	6/8/93	6/9/93
Analyst	JRW	JB	JB

Reagent 1 (200mls)			
Final Weight, g	621.6	649.1	637.2
Tared Weight, g	575.8	586.3	582.0
Water Catch, g	45.6	62.8	55.2
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	199.1	212.2	222.1
Tared Weight, g	173.8	187.0	193.4
ADSORBED WATER, g	25.3	~~212.2~~ JB 25.2	28.7
TOTAL WATER COLLECTED, g	70.9	88.0	83.9

Balance No. 43 Type (✓) Triple Beam X Electronic ___ Reagent Box No. 0567

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 Maryville, Tenn Sampling Loc. SCREEN -DRY

Run Number	DRY-1-SCREEN-M201A-1	2	3
Sampling Date			
Analysis Date			
Analyst			

Reagent 1 (200mLS)			
Final Weight, g	596.0	592.3	584.6
Tared Weight, g	586.8	584.1	574.2
Water Catch, g	9.2	8.2	10.4
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	190.3	205.7	208.7
Tared Weight, g	185.2	198.7	204.4
ADSORBED WATER, g	5.1	7.0	4.3
TOTAL WATER COLLECTED, g	14.3	15.2	14.7

Balance No. 43 Type (✓) Triple Beam X Electronic ___ Reagent Box No. 0209

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 Maryville, Tenn Sampling Loc. SCREEN - WET

Run Number	WET-1-Screen-M2(A1)	2	3
Sampling Date	6-7-93	6/8/93	6/9/93
Analysis Date	6-7-93	6/8/93	6/9/93
Analyst	JB	JRW	TJB
Reagent 1 (200mls)			
Final Weight, g	634.2	644.9	637.4
Tared Weight, g	583.4	580.6	583.4
Water Catch, g	50.8	64.3	54.0
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	226.1	214.1	233.3
Tared Weight, g	208.3	190.3	208.0
ADSORBED WATER, g	17.8	23.8	25.3
TOTAL WATER COLLECTED, g	68.6	88.1	79.3

Balance No. 43 Type (✓) Triple Beam X Electronic ___ Reagent Box No. 0238

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

Comments ____

L-0036 rev. 7-92

ENTROPY