

Note: This is a reference cited in AP 42, *Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources*. AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

**DRAFT
REVISION 0**

6

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

BRISTOL, TENNESSEE

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

JULY 19, 1993

Prepared for:

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

Prepared by:

**Todd T. Brozell and Dr. John Richards, P.E.
Control Equipment Testing And Optimization Division
Entropy Environmentalists, Inc.
P.O. Box 12291
Research Triangle Park, North Carolina 27709-2291**

Entropy Project Number 50119

TABLE OF CONTENTS

| | | |
|-----|---|----|
| 1.0 | Summary | 1 |
| 1.1 | Test Procedures and Results..... | 1 |
| 1.2 | Key Personnel..... | 2 |
| 2.0 | Plant and Sampling Location Description..... | 3 |
| 2.1 | Process Description and Operation..... | 3 |
| 2.2 | Fugitive Dust Control..... | 5 |
| 2.3 | Sampling and Emission Testing Procedures..... | 5 |
| 2.4 | Monitoring of Process Operating Conditions..... | 14 |
| 3.0 | Test Results..... | 16 |
| 3.1 | Objectives and Test Matrix..... | 16 |
| 3.2 | Stone Moisture Levels | 16 |
| 3.3 | Ambient PM10 Concentrations | 16 |
| 3.4 | Stone Production Rates | 17 |
| 3.5 | PM10 Emission Factors | 18 |
| 4.0 | QA/QC Activities..... | 20 |
| 4.1 | QC Procedures..... | 20 |
| 4.2 | Velocity/Volumetric Flow Rate Determination..... | 20 |
| 4.3 | QA Audits..... | 21 |
| 4.4 | Particulate/Condensibles Sampling QC Procedures..... | 21 |
| 4.5 | Sample Volume and Percent Isokinetics..... | 22 |
| 4.6 | Manual Sampling Equipment Calibration Procedures..... | 22 |
| 4.7 | Data Validation..... | 24 |
| 5.0 | References..... | 25 |
| 6.0 | Glossary..... | 26 |
| | Appendix A. Field Data and Results Tabulation | |
| | Appendix B. Example Emission Factor Calculations | |
| | Appendix C. Audit Calibration Data Sheets | |
| | Appendix D. Sampling Log and Chain-of-Custody Records | |
| | Appendix E. Moisture Analytical Data | |

1.0 SUMMARY

1.1 TEST PROCEDURES AND RESULTS

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

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

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

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

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

TABLE 1. CRUSHER PM10 EMISSIONS

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

1.2 KEY PERSONNEL

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

TABLE 2. KEY PERSONNEL

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

2.0 PLANT AND SAMPLING LOCATION DESCRIPTION

2.1 PROCESS DESCRIPTION AND OPERATION

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

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

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

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

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

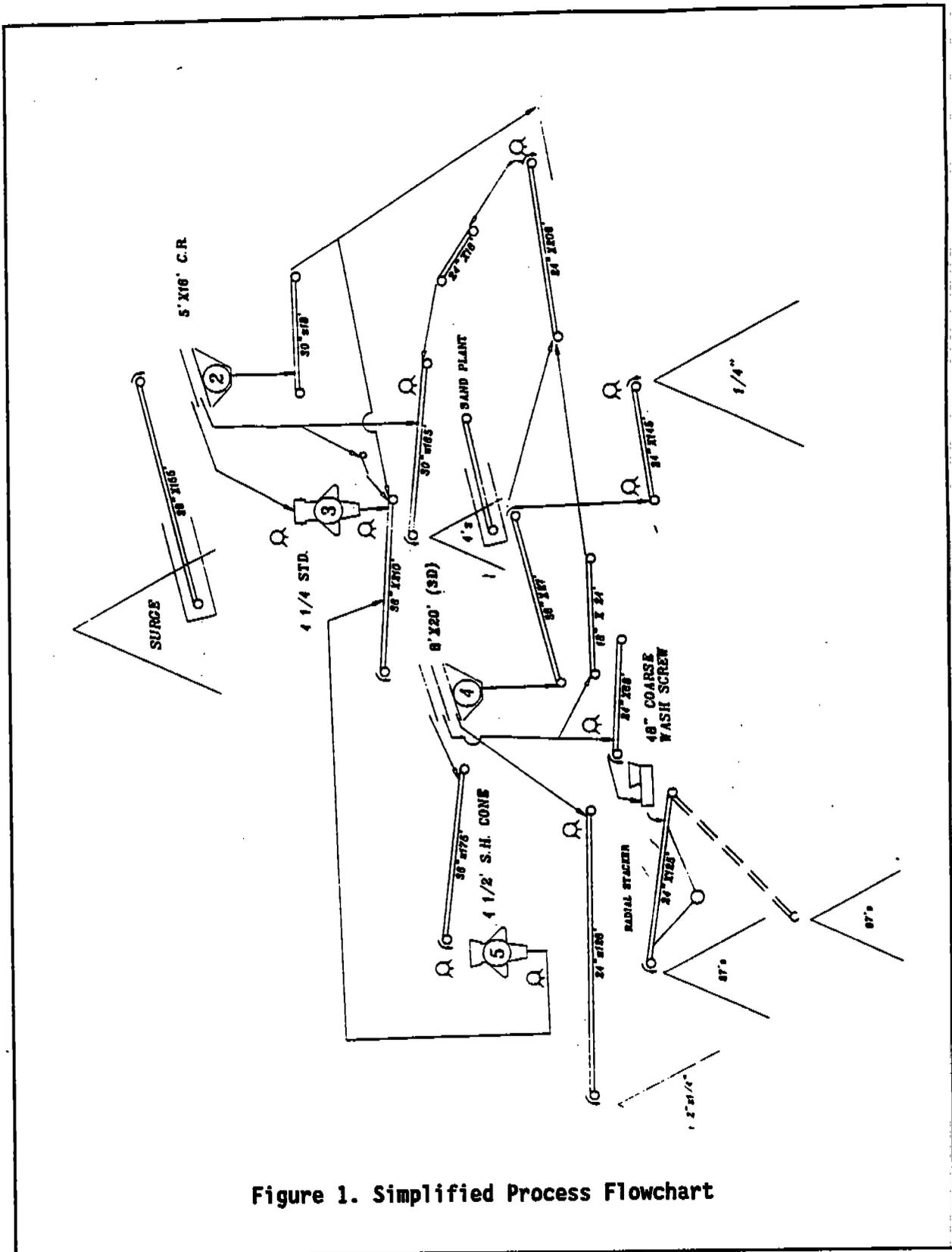


Figure 1. Simplified Process Flowchart

2.2 FUGITIVE DUST CONTROL

Wet suppression is used for fugitive dust control of the 4.5' shorthead crusher, and the vibrating screen. There are water spray nozzles located in the feed hopper to the 4.5' crusher and on the exit of the crusher. 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 screen or the 4.5' crusher, fugitive emission testing procedures were needed to capture and measure the PM10 emissions. Entropy considered the criteria listed in Table 3 in designing the test program. Entropy evaluated alternative testing procedures during site visits by Entropy personnel. The emission testing techniques which are generally applied to fugitive dust emission sources include,

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

Vibrating Screen Testing Alternatives

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

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

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

**Table 3. FUGITIVE EMISSION CAPTURE
SYSTEM DESIGN CRITERIA**

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

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

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

4.5' Crusher Inlet and Outlet Testing Alternatives

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

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

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

2.3.2 PM10 Emission Testing Procedure

Screen Testing Equipment

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

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

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

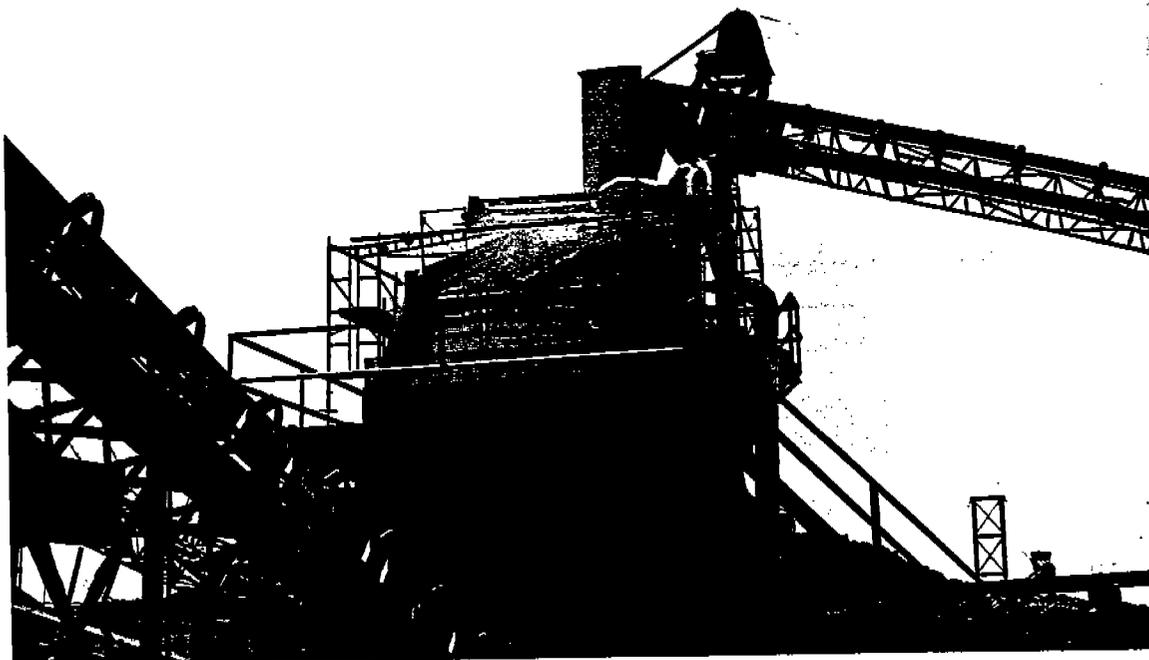


Figure 2. Side View of Traversing Hood and Vibrating Screen

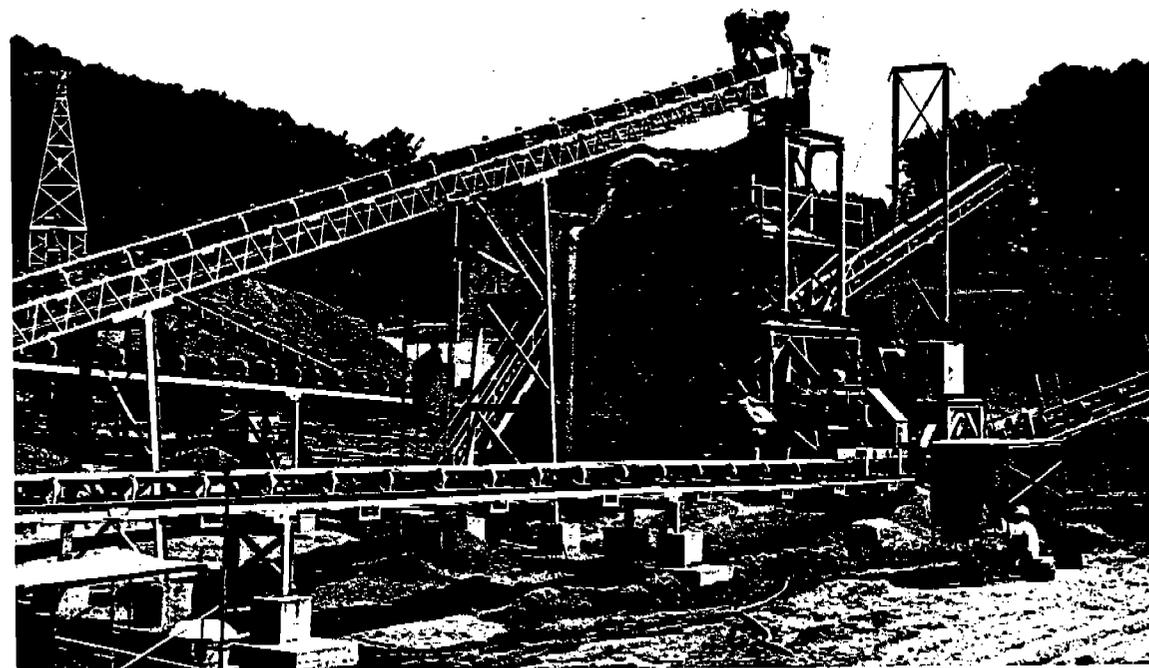


Figure 3. Front View of Traversing Hood and Vibrating Screen

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

4.5' Crusher Testing Equipment

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

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

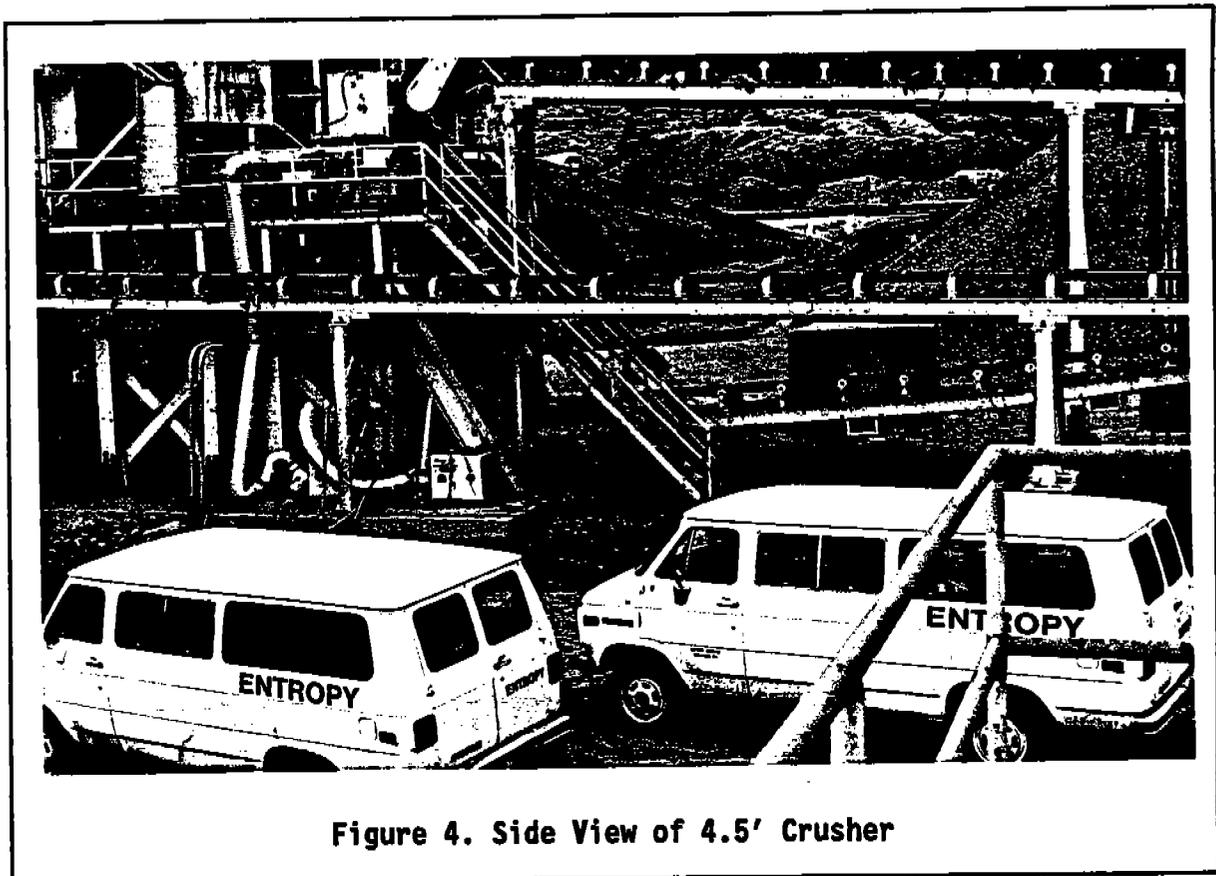


Figure 4. Side View of 4.5' Crusher

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

Views of the crusher inlet after installation of the enclosure are provided in Figures 6 and 7. In Figure 6, the flexible duct delivers the HEPA filtered make-up air to the enclosure and the duct in Figure 7 takes PM10-laden

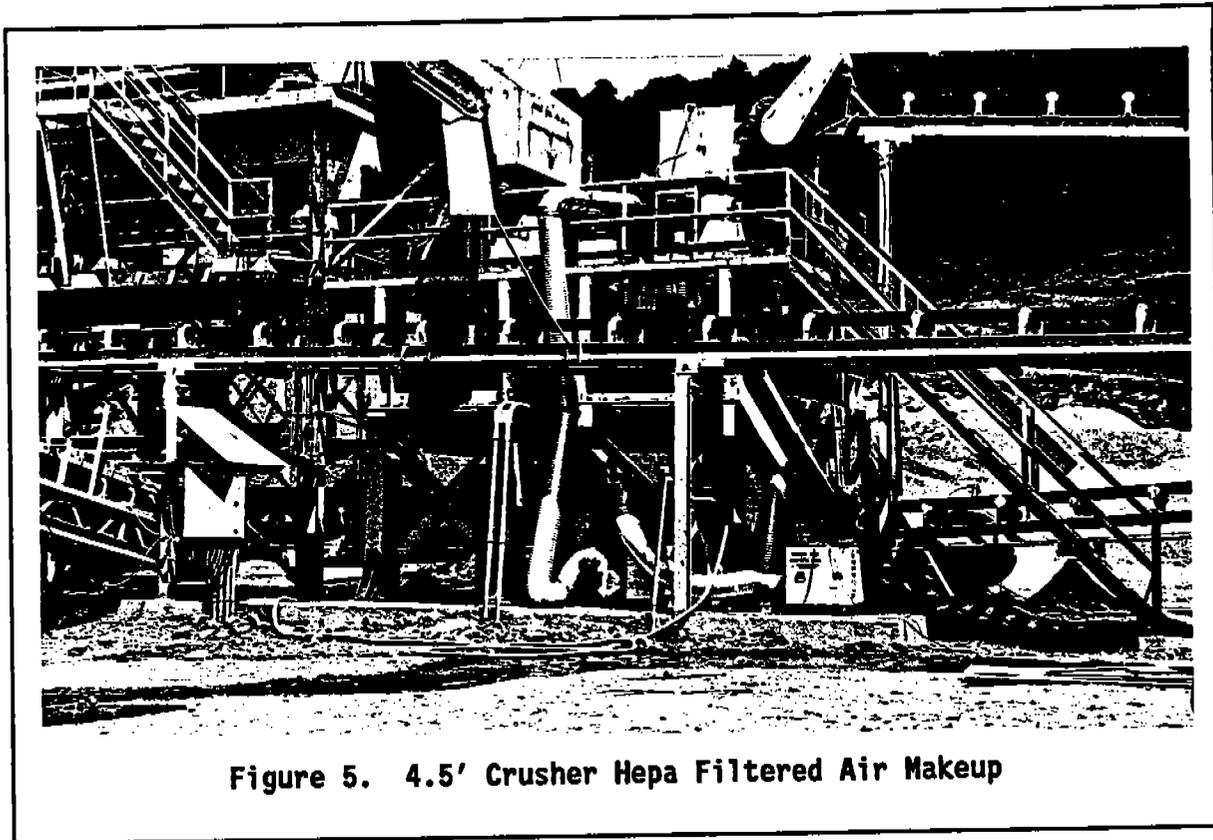


Figure 5. 4.5' Crusher Hepa Filtered Air Makeup

air to the emission testing location. The crusher outlet ducts are shown in Figures 8 and 9. In Figure 9, the horizontal duct in the photographs contains the PM10 emissions from the inlet and outlet enclosures and the vertical duct contains the PM10 emissions descending from the inlet enclosures. The gas streams are joined at the duct TEE shown on the bottom of Figure 9.

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

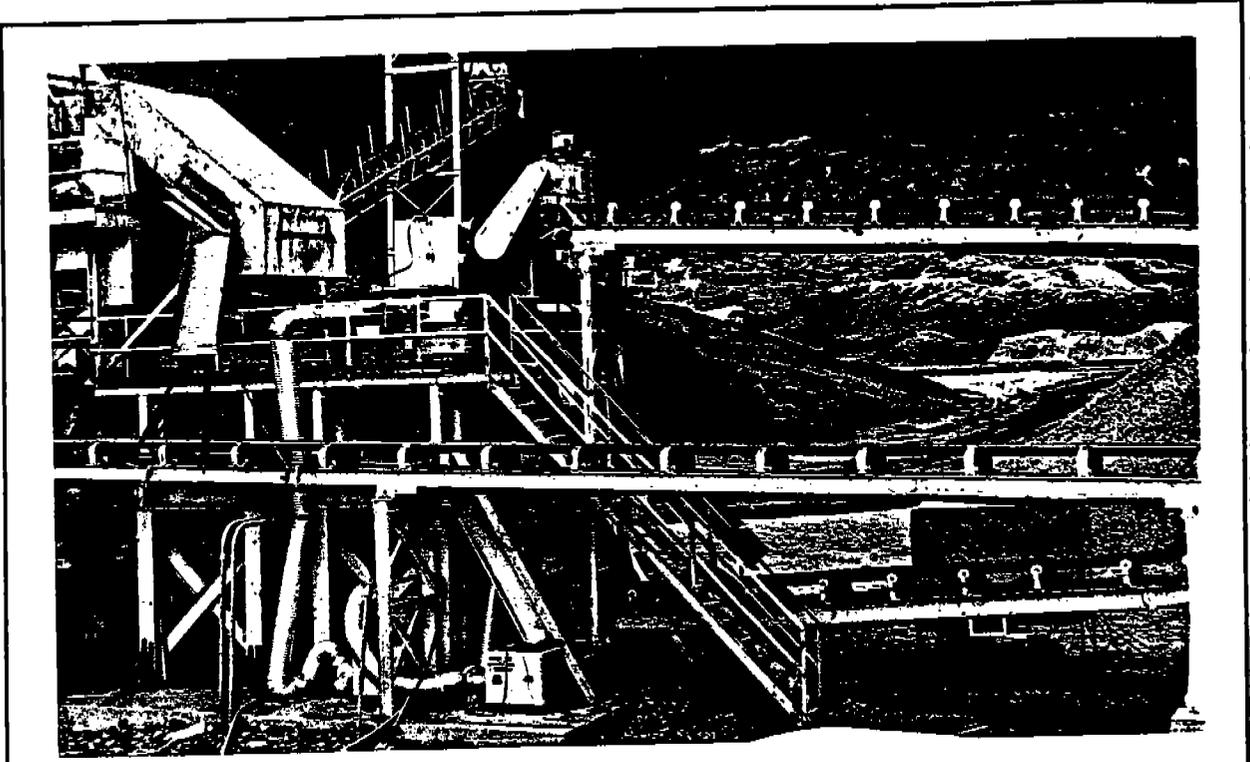


Figure 6. Side View of Crusher Inlet and Outlet Enclosure

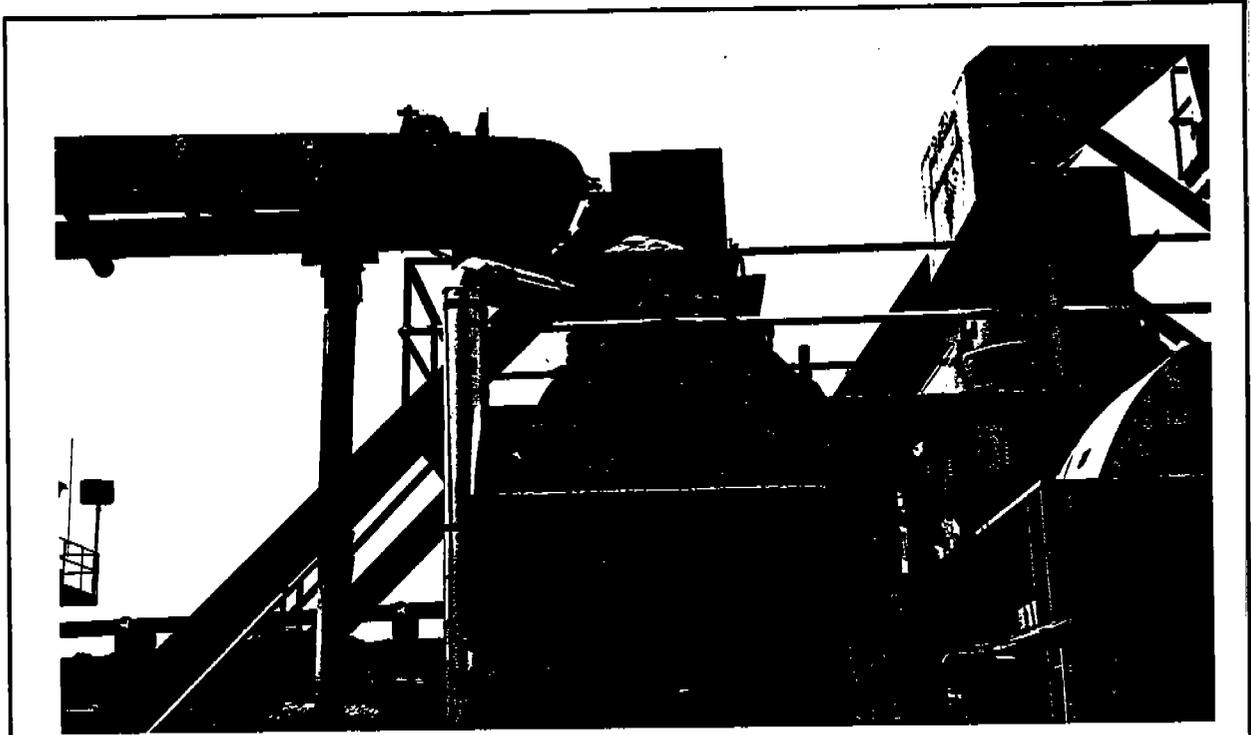


Figure 7. Crusher Inlet Enclosure, Outlet Duct

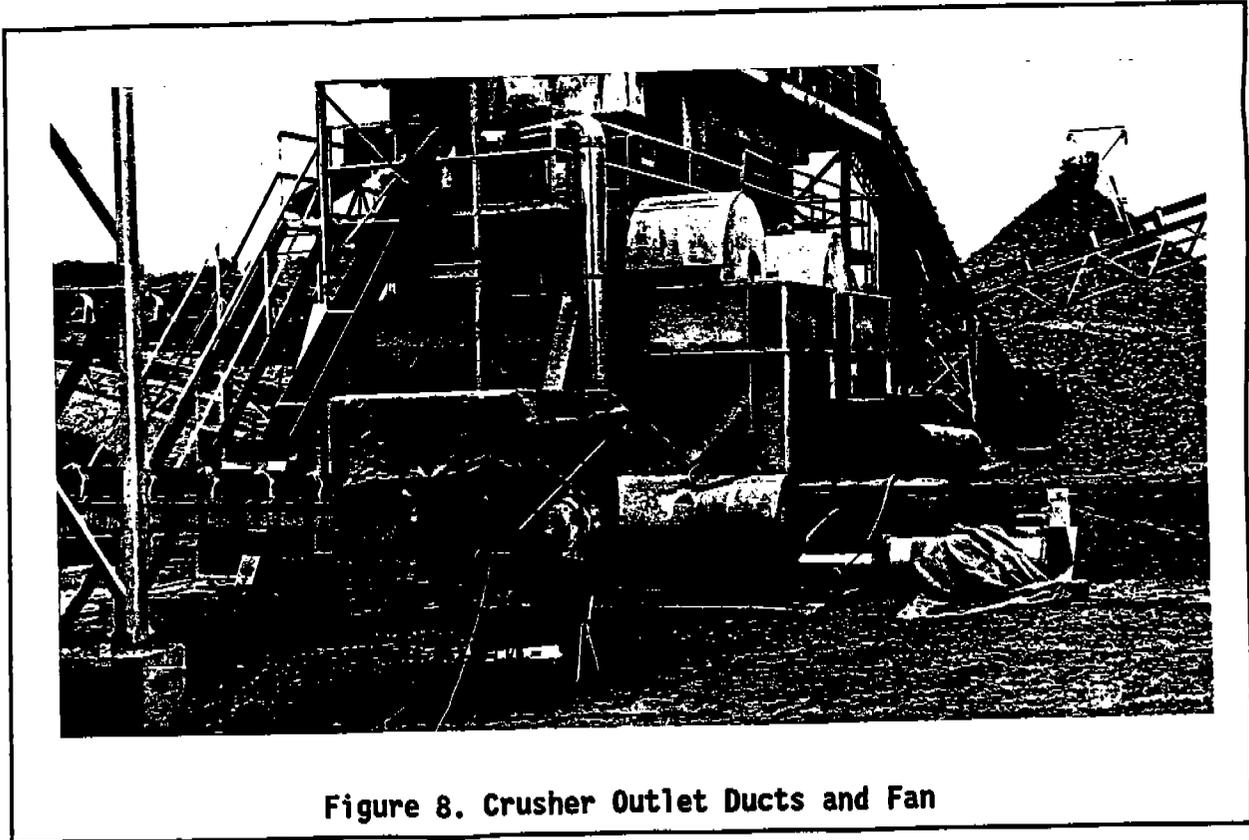


Figure 8. Crusher Outlet Ducts and Fan

increase the PM10 emissions.

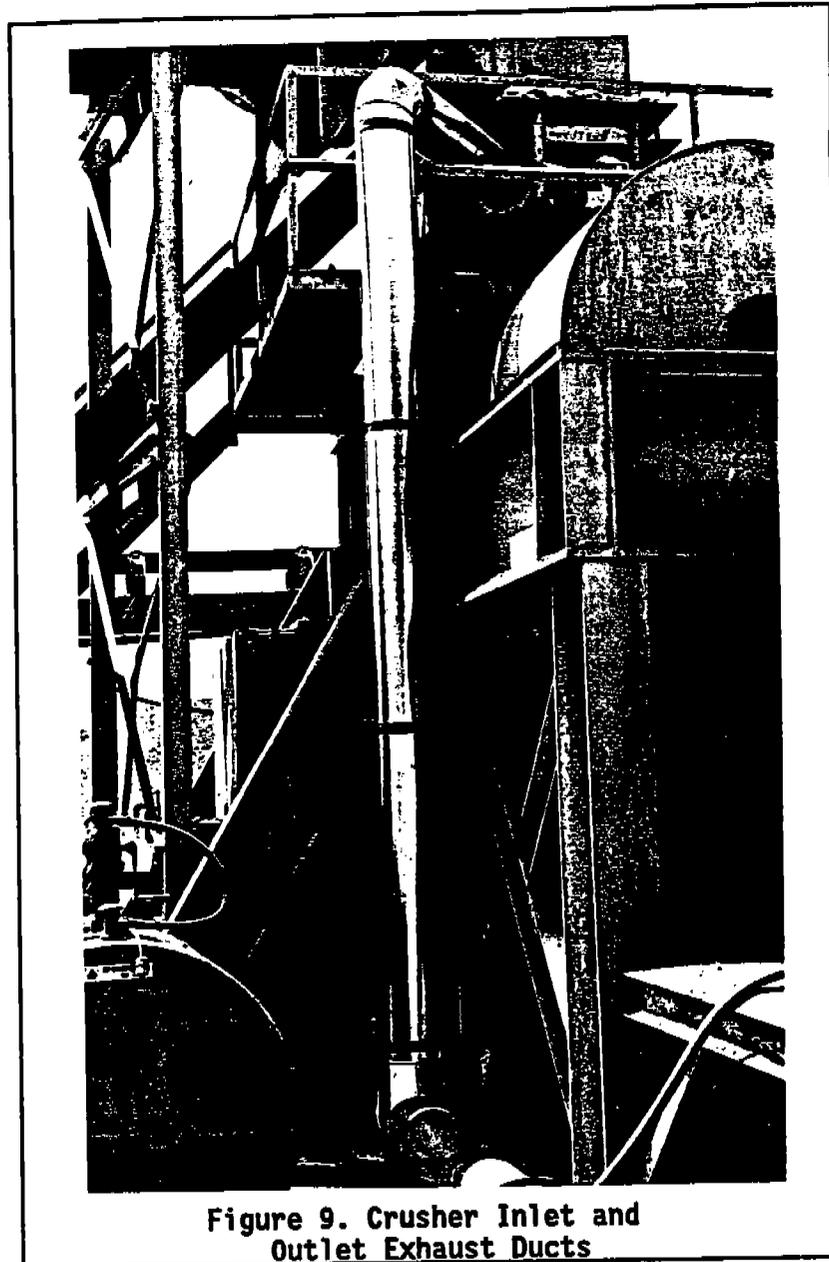
PM10 Sampling Equipment

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

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

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

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



**Figure 9. Crusher Inlet and
Outlet Exhaust Ducts**

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

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

2.4 MONITORING OF PROCESS OPERATING CONDITIONS

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

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

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

2.4.1 Stone Moisture Level

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

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

2.4.2 Ambient PM10 Levels

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

2.4.3 Stone Size Distribution and Silt Content

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

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

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

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

2.4.4 Stone Processing and Production Rates

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

4.5 Crusher

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

= Pounds Stone per Minute

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

= Tons of Stone/Hour

8' X 20' Vibrating Screen

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

= Pounds Stone per Minute

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

= Tons of Stone/Hour

3.0 TEST RESULTS

3.1 OBJECTIVES AND TEST MATRIX

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

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

3.2 STONE MOISTURE LEVELS

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

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

3.3 AMBIENT PM10 CONCENTRATIONS

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

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

TABLE 4. STONE MOISTURE LEVELS

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

**TABLE 5.
AMBIENT PARTICULATE CONCENTRATION
STANDARD GAS CONDITIONS**

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

3.4 STONE PRODUCTION RATES

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

TABLE 6. STONE PRODUCTION DATA

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

3.5 PM10 EMISSION FACTORS

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

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

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

TABLE 7. VIBRATING SCREEN AND 4.5' CRUSHER PM10 EMISSIONS

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

The emission factors measured during the emission test program are well below previously reported emission factors for total particulate matter⁹. The emission factors applicable to total particulate emissions cannot be compared with PM10 emission factors. The PM10 fraction of the total particulate emissions should be relatively low since very high energy levels are needed to cause stone attrition to the 10 micron range. It is unlikely that the 4.5' crusher and vibrating screen are creating substantial quantities of PM10 particulate. This is indicated by particle size distribution tests conducted

by Entropy using dried stone. The size distribution data is provided in Table 8-1 and Table 8-4. As indicated in the wet stone had near negligible levels of dust in the less than 75 micron size range.

TABLE 8-1. PARTICLE SIZE DISTRIBUTIONS FOR DRY RUNS

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

TABLE 8-2. PARTICLE SIZE DISTRIBUTIONS FOR WET RUNS

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

4.0 QA/QC ACTIVITIES

4.1 QC PROCEDURES

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

4.2 VELOCITY/VOLUMETRIC FLOW RATE DETERMINATION

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

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

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

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

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

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

4.3 QA AUDITS

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

4.4 PARTICULATE/CONDENSIBLES SAMPLING QC PROCEDURES

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

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

4.5 SAMPLE VOLUME AND PERCENT ISOKINETICS

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

TABLE 9.
AVERAGE DELTA H AND ISOKINETIC RESULTS

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

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

4.6 MANUAL SAMPLING EQUIPMENT CALIBRATION PROCEDURES

4.6.1 Type-S Pitot Tube Calibration

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

inspected and documented as meeting EPA specifications prior to field sampling.

4.6.2 Sampling Nozzle Calibration

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

4.6.3 Temperature Measuring Device Calibration

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

4.6.4 Dry Gas Meter Calibration

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

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

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

Table 10. Meter Box Calibration Audit

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

4.7 DATA VALIDATION

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

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

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

5.0 REFERENCES

1. M. Kestner, "Water-spray systems: the dust-control workhorse," Pit & Quarry, March 91, p. 26-31.
2. Determination of Emissions for the Stone Crushing Industry, JACA Corporation, Final Report for the U. S. Environmental Protection Agency, SSCD, July 1978.
3. M. White, "Crusher and screen training: a key to better operating costs," Pit & Quarry, September 1991, p. 26-32.
4. L.C. Lucas and L.M. Noland, "Keeping down the dust," Pit & Quarry, November 1988, p. 27-29.
5. B. Weaver, "Stretching water resources," Pit & Quarry, March 1991, p. 22-24.
6. R.E. Kenson and P.T. Bartlett, Technical Manual for the Measurement of Fugitive Emissions: Roof Monitor Sampling Method for Industrial Fugitive Emissions, EPA-600/2-76-089b, U.S. Environmental Protection Agency, Research Triangle Park, 1976.
7. H.J. Kolnsberg, P.W. Kalika et al, Technical Manual for the Measurement of Fugitive Emissions: Quasi-Stack Sampling Method for Industrial Fugitive Emissions, EPA-600/2-76-089c, U.S. Environmental Protection Agency, Research Triangle Park, 1976.
8. Industrial Ventilation, A Manual of Recommended Practice, Edwards Brothers, 1980.
9. JACA Corporation, Control of Air Emissions from Process Operations in the Rock Crushing Industry, EPA Contract No. 68-01-4135, U.S. Environmental Protection Agency, Washington, D.C., February 1978.
10. IT Environmental Programs, Inc., Regulatory and Inspection Manual for Nonmetallic Mineral Processing Plant, EPA-240/1/90-010, U.S. Environmental Protection Agency, Washington, D.C., 1991.

6.0 GLOSSARY

1. **ASTM:** American Society for Testing & Materials
2. **Aggregate:** in the case of materials of construction, essentially inert materials which, when bound together into a conglomerated mass by a matrix, form concrete, mastic, mortar or plaster; crushed rock or gravel screened to size for use in road surfaces, concrete or bituminous mixes; any of several hard materials such as sand, gravel, stone, slag, cinders or other inert materials used for mixing with a cementing material to form concrete. Aggregate, in a surface course in the building of roads is often called a "road metal".
3. **Conveyor belt:** a rubberized belt, usually 18" to 60" wide, used to carry aggregates.
4. **Crusher (cone):** a crusher that is specially designed to produce fines.
5. **Crusher (primary):** usually a jaw or gyratory type crusher which reduces very large rocks to a size that can be processed by a secondary crusher.
6. **Crusher (secondary):** any second or third stage crusher that further reduces the size of stone.
7. **Fines:** the smaller particles of aggregates; usually less than .25" in size.
8. **Head Pulley:** the driving pulley, usually at the discharge end of conveyor belt.
9. **Ro-Tap screen:** trade name for a type of testing screen.
10. **Scalping:** a screening operation, removing stone too large for the crusher.
11. **Scalping Screen:** removes oversize material.
12. **Screen (or sieve):** a metallic plate or sheet, woven wire cloth or similar device, with regularly spaced apertures of uniform size mounted in a suitable frame or holder for use in separating material according to size.

Appendix A.

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Crusher

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

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

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Crusher

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

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

** Moisture used in calculations.

(Continued Next Page)

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Crusher

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

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

METHOD 201A (PM-10) FIELD DATA

Client EPA Run Number Dry - 2 - Crusher
 Plant Name Vulcan Materials Time Start 0813
 City/State Priston Tenn. Time Stop 0913
 Sampling Location Crusher Job Number 50119
 Date 6/16/93 Team Leader JRW Techs TTB, JB
 *Train Leak Check Vacuum, In. Hg 5 Barometric Pressure, In. Hg 28.5
 Train Leak Rate, Cubic Ft./Min. 0.015 Static Pressure, In. H₂O -0.55

EQUIPMENT CHECKS
 Pitot, Pretest _____
 Pitot, Posttest _____
 M3 Sampling Sys/Ted Bag _____
 Thermocouple @ 61 Pre _____
 Thermocouple @ 10 Post _____

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

NOZZLE SELECTION CRITERIA
 Desired Dia. 0.20 Nozzle 2
 Diameter 0.188 Nozzle 1
 Nozzle Number 8
 Delta P min 0.2004
 Delta P max 0.7410

Delta Hg 1.728
 Delta Ht 0.5882
 Delta Ht+50 0.4903
 Delta Ht-50 0.7185
 Delta Pavg 0.3176
 Meter Temp. 80
 Stack Temp. 65

FILTER NO. _____ TARE _____
 Est % H₂O _____ Cp 0.84

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

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK
 F-1109 rev. 5-93

Vm 26.656 minutes 60
 (ΔP)² 0.31 tm 77 ts 67 ΔH 0.55

METHOD 201A (PM-10) FIELD DATA

Client EPA Run Number Dry-2-Crusher-Mn01A-2
 Plant Name Vulcan Materials Time Start 0923
 City/State Bristol, Tenn. Time Stop 1023
 Sampling Location Crusher Job Number 50119
 Date 6/16/93 Team Leader JRW Techs TJA JB
 *Train Leak Check Vacuum, In. Hg 5 Barometric Pressure, In. Hg 28.5
 Train Leak Rate, Cubic Ft./Min. 0.002 Static Pressure, In. H₂O -0.55

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

IDENTIFICATION NUMBERS
 Meterbox Nu-7 Meterbox Gamma 0.9850 Reagent Box N/A
 T/C Readout F52 T/C Probe R302 Umbilical N108
 Sampling Box 12 Orsat Pump N/A Tedlar Bag N/A
 Nozzle(s) Actually Used: 0.178 TB Diameter 0.178 No. _____ Pitot N/A
 No. _____ Diameter 0.178 No. _____ Pitot N/A

NOZZLE SELECTION CRITERIA
 Desired Dia. 0.206 Nozzle 1
 Diameter 0.178 Nozzle 2
 Nozzle Number 0.2000
 Delta Pmin 0.7769
 Delta Pmax _____

Delta Hg 1.728
 Delta Ht 0.5691
 Delta Ht+50 0.4755
 Delta Ht-50 0.6999
 Delta Pavg 0.3136
 Meter Temp. 90
 Stack Temp. 72

| Sample Point | Dwell Time, Minutes | Elapsed Time, Minutes | Dry Gas Meter Readings Cubic Feet | Pitot Reading, In. H ₂ O (ΔP) | Gas Meter Temp, °F | Stack Temp, °F | Orifice Setting, In. H ₂ O (ΔH) | Vacuum Gauge, In. Hg | Gas Filter Box, °F | Impinging Cyclone Temp, °F |
|--------------|---------------------|-----------------------|-----------------------------------|--|--------------------|----------------|--|----------------------|--------------------|----------------------------|
| 1 | 10:00 | 00:00 | 788.25 | 0.91 | 82 | 70 | 0.53 | 1 | N/A | 55 |
| 2 | 10:00 | 10:00 | 792.68 | | 84 | 70 | | 1 | | 55 |
| 3 | 10:00 | 20:00 | 797.06 | | 86 | 70 | | 1 | | 57 |
| 4 | 10:00 | 30:00 | 801.52 | | 87 | 71 | | 1 | | 56 |
| 5 | 10:00 | 40:00 | 805.06 | | 88 | 72 | | 1 | | 58 |
| 6 | 10:00 | 50:00 | 810.24 | | 89 | 72 | | 1 | | 56 |
| 7 | | 10:00/82 | 814.61 | | | | | | | |
| 8 | | | | | | | | | | |
| 9 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 11 | | | | | | | | | | |
| 12 | | | | | | | | | | |

Est % H₂O 3
 Fyrite 0.84
 Cp 0.84

Remove Head Before Posttest Leak Check
 60 minutes Vm 26.361 (ΔP)² 0.91 tm 86 ts 71 ΔH 0.57

METHOD 201A (PM-10) FIELD DATA

Client EPA Run Number Dry - 2 - Crusher - M201A - 3
 Plant Name Vulcan Materials Time Start 1033
 City/State Bristol, Tenn. Time Stop 1133
 Sampling Location Crusher Job Number 50119
 Date 8/16/93 Team Leader JRW Techs JB, TTB
 *Train Leak Check Vacuum, In. Hg 5 Barometric Pressure, In. Hg 28.5
 Train Leak Rate, Cubic Ft./Min. 0.002 Static Pressure, In. H₂O -0.55

IDENTIFICATION NUMBERS

Meterbox MU-7 Meterbox Gamma 0.95D Reagent Box N.A.
 T/C Readout F52 T/C Probe R21R Umbilical U108
 Sampling Box 4 Orsat Pump N.A. Tedlar Bag N.A.
 Nozzle(s) Actually Used: Diameter 0.188 No. Pitot N.A.
 Diameter No. Pitot Diameter

EQUIPMENT CHECKS

Pitot, Pretest
 Pitot, Posttest
 M3 Sampling Sys/Ted Bag Thermocouple @ 24 Pre
 Thermocouple @ 78 Post

| FILTER NO. | TARE | NOZZLE SELECTION CRITERIA | NOZZLE | FYRITE |
|------------------------|----------|---------------------------|-----------------------|----------------|
| | | Desired Dia. <u>0.206</u> | Nozzle 1 <u>0.188</u> | <u>N.A.</u> |
| | | Diameter <u> </u> | Nozzle 2 <u> </u> | <u> </u> |
| | | Nozzle Number <u> </u> | <u> </u> | <u> </u> |
| | | Delta P min <u> </u> | <u> </u> | <u> </u> |
| | | Delta P max <u> </u> | <u> </u> | <u> </u> |
| Est % H ₂ O | <u>3</u> | | | <u>CP 0.84</u> |

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

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK
 minutes 60 Vm 26.514 (ΔP)² 0.91 tm 90 ts 75 ΔH 0.57

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Crusher

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

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

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Crusher

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

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

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Crusher

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

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

** Moisture used in calculations.

(Continued Next Page)

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Crusher

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

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

METHOD 201A (PM-10) FIELD DATA

Client EPA Run Number Wet-2 - Crusher - M 2014-
 Plant Name Vulcan Materials Time Start 0912
 City/State Prystal, Tenn Time Stop 1512
 Sampling Location Crusher Job Number 50119
 Date 6/14/93 Team Leader JRW Techs TTB
 *Train Leak Check Vacuum, In. Hg 10 Barometric Pressure, In. Hg 28.5
 Train Leak Rate, Cubic Ft./Min. 0.010 Static Pressure, In. H₂O -0.63

EQUIPMENT CHECKS
 Pitot, Pretest _____
 Pitot, Posttest _____
 M3 Sampling Sys/Ted Bag _____
 Thermocouple @ 64 Pre _____
 Thermocouple @ 75 Post _____

IDENTIFICATION NUMBERS
 Meterbox NK-7 Meterbox Gamma 0.9850 Reagent Box N.A.
 T/C Readout F52 T/C Probe R902 Umbilical 4108
 Sampling Box 12 Orsat Pump N.A. Tedlar Bag N.A.
 Nozzle(s) Actually Used: 0198 TB Pitot _____
 No. _____ Diameter 0.188 No. _____ Diameter _____

NOZZLE SELECTION CRITERIA
 Desired Dia. 0.201 Nozzle 1 _____
 Diameter _____ Nozzle Number _____
 Nozzle Number _____ Delta P min _____
 Delta P min _____ Delta P max _____
 Delta P max _____

Est & H₂O: 2.4 Cp 0.84

| Sample Point | Dwell Time, Minutes | Elapsed Time, Minutes | Dry Gas Meter Readings Cubic Feet | Pitot Reading, In. H ₂ O (ΔP) | Gas Meter Temp, °F | Stack Temp, °F | Orifice Setting, In. H ₂ O (ΔH) | Vacuum Gauge, In. Hg | Gas Temp Imping Cyclone Filter Box, °F | Imping Cyclone Exit, Temp, °F |
|--------------|---------------------|-----------------------|-----------------------------------|--|--------------------|----------------|--|----------------------|--|-------------------------------|
| 1 | 15:00 | 00:00 | 431.050 | 0.34 | 69 | 64 | 0.57 | 1 | N.A. | 73 |
| 2 | 15:00 | 15:00 | 437.80 | | 70 | 64 | 0.57 | 1 | | 72 |
| 3 | 15:00 | 30:00 | 444.54 | | 74 | 66 | 0.57 | 1 | | 72 |
| 4 | 15:00 | 45:00 | 451.31 | | 78 | 66 | 0.57 | 1 | | 73 |
| 5 | 15:00 | 60:00 | 458.07 | | 81 | 66 | 0.57 | 1 | | 73 |
| 6 | 15:00 | 15:00 | 464.91 | | 84 | 67 | 0.57 | 1 | | 73 |
| 7 | 15:00 | 30:00 | 471.70 | | 85 | 68 | 0.57 | 1 | | 72 |
| 8 | 15:00 | 45:00 | 478.53 | | 88 | 69 | 0.57 | 1 | | 74 |
| 9 | 15:00 | 120:00 | 485.38 | | 88 | 70 | 0.57 | 1 | | 73 |
| 10 | 15:00 | 15:00 | 492.24 | | 90 | 70 | 0.57 | 1 | | 75 |
| 11 | 15:00 | 30:00 | 499.09 | | 91 | 70 | 0.57 | 1 | | 78 |
| 12 | 15:00 | 45:00 | 505.91 | | 92 | 71 | 0.57 | 1 | | 50 |

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

minutes 360 Vm 163.967 tm 88 ts 70 ΔH 0.57
 (ΔP)²

F-1109 rev. 5-93

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

Client EPA Run Number Net-2 - Crusher - M201A
 Plant Name Vulcan Materials Job Number 50119
 City/State Prinston, Tenn
 Sampling Location Crusher

| Sample Point | Dwell Time, Minutes | Elapsed Time, Minutes | Dry Gas Meter Readings Cubic Feet | Pitot Reading, In. H ₂ O (P) | Gas Meter Temp, °F | Stack Temp, °F | Orifice Setting, In. H ₂ O (H) | Vacuum Gauge, In. Hg | Gas Temp Filter Box, °F | Gas Temp Imping Exit, °F | Cyclone Temp, °F |
|--------------|---------------------|-----------------------|-----------------------------------|---|--------------------|----------------|---|----------------------|-------------------------|--------------------------|------------------|
| A-7 | 15:00 | 180:00/0 | 512.78 | 0.34 | 92 | 72 | 0.57 | 1 | N.A. | 42 | N.A. |
| 13 | 15:00 | 15:00 | 519.62 | | 93 | 72 | 0.57 | 1 | | 40 | |
| 14 | 15:00 | 30:00 | 526.40 | | 94 | 72 | 0.57 | 1 | | 41 | |
| 15 | 15:00 | 45:00 | 532.98 | | 94 | 72 | 0.57 | 1 | | 42 | |
| 16 | 15:00 | 240:00/0 | 540.23 | | 93 | 72 | 0.57 | 1 | | 44 | |
| 17 | 15:00 | 15:00 | 547.11 | | 93 | 72 | 0.57 | 1 | | 45 | |
| 18 | 15:00 | 30:00 | 553.97 | | 93 | 73 | 0.57 | 1 | | 47 | |
| 19 | 15:00 | 45:00 | 560.88 | | 94 | 72 | 0.57 | 1 | | 48 | |
| 20 | 15:00 | 700:00/0 | 567.78 | | 96 | 74 | 0.57 | 1 | | 49 | |
| 21 | 15:00 | 15:00 | 574.45 | | 96 | 74 | 0.57 | 1 | | 48 | |
| 22 | 15:00 | 30:00 | 581.33 | | 97 | 75 | 0.57 | 1 | | 45 | |
| 23 | 15:00 | 45:00 | 588.24 | | 97 | 75 | 0.57 | 1 | | 44 | |
| 24 | 15:00 | 360:00/0 | 595.017 | | | | | | | | |
| 25 | | | | | | | | | | | |
| 26 | | | | | | | | | | | |
| 27 | | | | | | | | | | | |
| 28 | | | | | | | | | | | |
| 29 | | | | | | | | | | | |
| 30 | | | | | | | | | | | |
| 31 | | | | | | | | | | | |
| 32 | | | | | | | | | | | |
| 33 | | | | | | | | | | | |
| 34 | | | | | | | | | | | |
| 35 | | | | | | | | | | | |
| 36 | | | | | | | | | | | |
| 37 | | | | | | | | | | | |
| 38 | | | | | | | | | | | |
| 39 | | | | | | | | | | | |
| 40 | | | | | | | | | | | |

* REMOVE HEAD BEFORE
 POSTTEST LEAK CHECK
 F-1109 rev. 5-93

METHOD 201A (PM-10) FIELD DATA

M201
2

Client EPA
 Plant Name Nuclear Materials
 City/State Kristol, Tenn.
 Sampling Location Crusher
 Date 6/15/93 Team Leader JRW Techs TTB, VB
 *Train Leak Check Vacuum, In. Hg 10
 Train Leak Rate, Cubic Ft./Min. 0.002 0.001
 Run Number Wet-2-Crusher
 Time Start 0736
 Time Stop 1036
 Job Number 5019
 Barometric Pressure, In. Hg 28.63
 Static Pressure, In. H₂O -0.58

EQUIPMENT CHECKS
 Pitot, Pretest _____
 Pitot, Posttest _____
 M3 Sampling Sys/Ted Bag _____
 Thermocouple @ 65 Pre _____
 Thermocouple @ 71 Post _____

IDENTIFICATION NUMBERS
 Meterbox MU-7 Meterbox Gamma 0.9850 Reagent Box N.A.
 T/C Readout F52 T/C Probe R218 Umbilical U108
 Sampling Box 4 Orsat Pump N.A. Tedlar Bag N.A.
 Nozzle(s) Actually Used: 0.98 TB Pitot N.A.
 No. 0.98 TB Diameter 0.188 No. _____ Diameter _____

FILTER NO. TARE
M20 0.2701

NOZZLE SELECTION CRITERIA
 Desired Dia. 0.203 Nozzle 1
 Diameter _____ Nozzle Number _____
 Nozzle Dia. 0.188
 Nozzle Number _____
 Delta P min 0.204
 Delta P max 0.7463

Est % H₂O 1.5 Cp 0.84

| Sample Point | Dwell Time, Minutes | Elapsed Time, Minutes | Dry Gas Meter Readings Cubic Feet | Pitot Reading, In. H ₂ O (ΔP) | Gas Meter Temp, °F | Stack Temp, °F | Orifice Setting, In. H ₂ O (ΔH) | Vacuum Gauge, In. Hg | Gas Filter Box, °F | Gas Temps Imping Exit, °F | Cyclone Temp, °F |
|--------------|---------------------|-----------------------|-----------------------------------|--|--------------------|----------------|--|----------------------|--------------------|---------------------------|------------------|
| 1 | 15:00 | 00:00 | 596.200 | 0.30 | 65 | 66 | 0.58 | 1 | N.A. | 60 | N.A. |
| 2 | 15:00 | 15:00 | 603.06 | | 70 | 66 | | 1 | | 59 | |
| 3 | 15:00 | 30:00 | 609.92 | | 75 | 66 | | 1 | | 58 | |
| 4 | 15:00 | 45:00 | 616.78 | | 79 | 67 | | 1 | | 59 | |
| 5 | 15:00 | 60:00/0 | 623.64 | | 81 | 66 | | 1 | | 57 | |
| 6 | 15:00 | 15:00 | 630.50 | | 83 | 66 | | 1 | | 58 | |
| 7 | 15:00 | 30:00 | 637.36 | | 84 | 66 | | 1 | | 60 | |
| 8 | 15:00 | 45:00 | 644.24 | | 85 | 67 | | 1 | | 60 | |
| 9 | 15:00 | 120:00/0 | 651.12 | | 85 | 68 | | 1 | | 59 | |
| 10 | 15:00 | 15:00 | 658.01 | | 85 | 68 | | 1 | | 58 | |
| 11 | 15:00 | 30:00 | 664.92 | | 85 | 68 | | 1 | | 59 | |
| 12 | 15:00 | 45:00 | 671.82 | | 87 | 69 | | 1 | | 59 | |
| | | 180/fin | 678.709 | | 89 | 69 | | 1 | | 61 | |
| | | 180 | 685.609 | | 81 | 67 | | | | | |
| | | minutes | 82.509 | 0.30 | tm | ts | 0.58 | | | | ΔH |
| | | | Vm | (ΔP) ² | | | | | | | |

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

F-1109 rev. 5-93

METHOD 201A (PM-10) FIELD DATA

Client EPA Run Number Vel-2-Crusher - M201A-7
 Plant Name Vulcan Materials Time Start 1100
 City/State Bristol Tenn. Time Stop 1416
 Sampling Location Crusher Job Number 50119
 Date 6/15/93 Team Leader JRK Techs TIP, JB
 *Train Leak Check Vacuum, In. Hg 6 Barometric Pressure, In. Hg 28.63
 Train Leak Rate, Cubic Ft./Min. 0.003 Static Pressure, In. H₂O -0.55

Stop 1252
 Stand 1307

EQUIPMENT CHECKS

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

IDENTIFICATION NUMBERS

Meterbox 44-7 Meterbox Gamma 0.9850 Reagent Box N/A
 T/C Readout F52 T/C Probe R302 Umbilical U10R
 Sampling Box 12 Orsat Pump N/A Tedlar Bag N/A
 Nozzle(s) Actually Used: 0.198 Pitot N/A
 No. 0188 Diameter 0.188 No. 773 Diameter N/A

NOZZLE SELECTION CRITERIA

Desired Dia. 0.203 Nozzle 2
 Diameter 0.188
 Nozzle Number 0.2007
 Delta Pmin 0.7399
 Delta Pmax 0.84

Delta Hg 1.728
 Delta Ht 0.5753
 Delta Ht+50 0.4809
 Delta Ht-50 0.7006
 Delta Pavg 0.7287
 Meter Temp. 95
 Stack Temp. 73

| Sample Point | Dwell Time, Minutes | Elapsed Time, Minutes | Dry Gas Meter Readings Cubic Feet | Pitot Reading, In. H ₂ O (ΔP) | Gas Meter Temp, °F | Stack Temp, °F | Orifice Setting, In. H ₂ O (ΔH) | Vacuum Gauge, In. Hg | Gas Filter Box, °F | Impinging Exit, °F | Cyclone Temp, °F |
|--------------|---------------------|-----------------------|-----------------------------------|--|--------------------|----------------|--|----------------------|--------------------|--------------------|------------------|
| 1 | 15:00 | 00:00 | 679.600 | 0.20 | 85 | 71 | 0.57 | 1 | N/A | 65 | N/A |
| 2 | 15:00 | 15:00 | 686.44 | | 88 | 70 | | 1 | | 52 | |
| 3 | 15:00 | 30:00 | 693.30 | | 89 | 71 | | 1 | | 50 | |
| 4 | 15:00 | 45:00 | 700.17 | | 90 | 71 | | 1 | | 51 | |
| 5 | 15:00 | 60:00 | 707.003 | | 91 | 72 | | 1 | | 53 | |
| 6 | 15:00 | 75:00 | 713.78 | | 92 | 72 | | 1 | | 54 | |
| 7 | 15:00 | 90:00 | 720.54 | | 93 | 72 | | 1 | | 52 | |
| 8 | 15:00 | 105:00 | 727.32 | | 93 | 73 | | 1 | | 55 | |
| 9 | 15:00 | 120:00 | 734.07 | | 90 | 73 | | 1 | | 54 | |
| 10 | 15:00 | 135:00 | 740.82 | | 93 | 74 | | 1 | | 58 | |
| 11 | 15:00 | 150:00 | 747.56 | | 95 | 74 | | 1 | | 48 | |
| 12 | 15:00 | 165:00 | 754.29 | | | | | 1 | | | |
| | | 180:00 (end) | 761.016 | | | | | | | | |

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK
 Est % H₂O 3
 TARE 0.2660
 Vm 81.416
 (ΔP)² 0.20 tm 91 ts 72 ΔH 0.57
 180 minutes

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Screen

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

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

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Screen

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

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

** Moisture used in calculations.

(Continued Next Page)

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Screen

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

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

METHOD 201A (PM-10) FIELD DATA

Client VULCAN MATL - LIMESTONE
 Plant Name BRISOL, TENN
 City/State SCREEN
 Sampling Location _____
 Date 6/16/93 Team Leader DWS Techs JT
 *Train Leak Check Vacuum, In. Hg 10 Barometric Pressure, In. Hg 28.5
 Train Leak Rate, Cubic Ft./Min. .001 Static Pressure, In. H₂O -.31
 Run Number D522011
 Time Start 0820
 Time Stop 0920
 Job Number 50117

EQUIPMENT CHECKS
 Pitot, Pretest
 Pitot, Posttest
 M3 Sampling Sys/Ted Bag
 Thermocouple @ 02 Pre
 Thermocouple @ 71 Post
IDENTIFICATION NUMBERS
 Meterbox EN-2 Meterbox Gamma 9031 Reagent Box NA
 T/C Readout F38 T/C Probe R129 Umbilical 081
 Sampling Box NA Orsat Pump NA Tedlar Bag NA
 Nozzle(s) Actually Used: FRB, 341 Diameter 344 No. _____
 No. CAE Diameter _____ No. _____

NOZZLE SELECTION CRITERIA
 Desired Dia. .344 Nozzle 2
 Diameter .344
 Nozzle Number CAE
 Delta P min .0091
 Delta P max .0871
 FYRITE NA
 Cp .84

| Sample Point | Dwell Time, Minutes | Elapsed Time, Minutes | Dry Gas Meter Readings Cubic Feet | Pitot Reading, In. H ₂ O (ΔP) | Gas Meter Temp, °F | Stack Temp, °F | Orifice Setting, In. H ₂ O (ΔH) | Vacuum Gauge, In. Hg | Gas Temp | | |
|--------------|---------------------|-----------------------|-----------------------------------|--|--------------------|----------------|--|----------------------|----------------|----------------------|------------------|
| | | | | | | | | | Filter Box, °F | Impingement Exit, °F | Cyclone Temp, °F |
| 1 | 0 | 10 | 764.726 | .044 | 75 | 62 | .6654 | 1.0 | 0 | 60 | 62 |
| 2 | 10 | 10 | 769.28 | .044 | 77 | 66 | .6654 | 1.0 | 4/110 | 60 | 66 |
| 3 | 20 | 10 | 778.84 | .044 | 80 | 70 | .6654 | 1.0 | 5/110 | 57 | 70 |
| 4 | 30 | 10 | 778.48 | .044 | 84 | 71 | .6654 | 1.0 | 5/110 | 58 | 71 |
| 5 | 40 | 10 | 783.13 | .044 | 84 | 71 | .6654 | 1.0 | 4/110 | 58 | 71 |
| 6 | 50 | 10 | 787.93 | .044 | 86 | 71 | .6654 | 1.0 | 3/110 | 57 | 71 |
| 7 | 60 | | 792.404 | | | | | | | | |
| 8 | | | | | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | | | | | | | | | | | |
| 11 | | | | | | | | | | | |
| 12 | | | | | | | | | | | |

Est % H₂O 2.0
 * REMOVE HEAD BEFORE POSTTEST LEAK CHECK
 F-1109 rev. 5-93
 60 minutes
 27.680 Vm
 0.044 (VAP)²
 81 tm
 69 ts
 0.6654 ΔH

METHOD 201A (PM-10) FIELD DATA

Plant Name VULCAN MINE - LAMBERTON
 City/State REISTON, TENN.
 Sampling Location SCREEN
 Date 6/16/73 Team Leader DWS Techs TB
 *Train Leak Check Vacuum, In. Hg 10 Barometric Pressure, In. Hg 28.5
 Train Leak Rate, Cubic Ft./Min. .001 Static Pressure, In. H₂O -.31
 Run Number DS22-2012
 Time Start 0940
 Time Stop 1040
 Job Number 50119

EQUIPMENT CHECKS
 Pitot, Pretest
 Pitot, Posttest
 M3 Sampling Sys/Red Bag
 Thermocouple @ 73 Pre
 Thermocouple @ 78 Post

IDENTIFICATION NUMBERS
 Meterbox EA-2 Meterbox Gamma 7031 Reagent Box NA
 T/C Readout F38 T/C Probe R127 Umbilical UB1
 Sampling Box NA Orsat Pump NA Tedlar Bag NA
 Nozzle(s) Actually Used: 73, 74 Pitot 4-42
 No. CAG Diameter 344 No. Diameter

NOZZLE SELECTION CRITERIA
 Desired Dia. .337 Nozzle 1
 Diameter .344
 Nozzle Number CAG
 Delta Pmin .0099
 Delta Pmax .0891

NOZZLE SELECTION CRITERIA
 Delta H₀ 1.735
 Delta H_t .6654
 Delta H_{t+50} .5542
 Delta H_{t-50} .8130
 Delta Pavg .0432
 Meter Temp. 90
 Stack Temp. 62

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

Est & H₂O 2.0
 Cp .84

minutes 60 Vm 28.261 (ΔP)² 0.044 tm 88 ts 75 ΔH 0.6654

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK
 F-1109 rev. 11-92



METHOD 201A (PM-10) FIELD DATA

Plant Name VULCAN MATL - LINDSEYS
 City/State ELIZABETH, TENN.
 Sampling Location SCREEN
 Date 6/16/93 Team Leader JWS Techs JF
 *Train Leak Check Vacuum, In. Hg 10 Barometric Pressure, In. Hg 28.5
 Train Leak Rate, Cubic Ft./Min. .601 Static Pressure, In. H₂O -.31

EQUIPMENT CHECKS
 Pitot, Pretest
 Pitot, Posttest
 M3 Sampling Sys/Ted Bag
 Thermocouple @ 7B Pre
 Thermocouple @ 20 Post

IDENTIFICATION NUMBERS
 Meterbox EM-2 Meterbox Gamma .9831 Reagent Box NA
 T/C Readout F&B T/C Probe R129 Umbilical V81
 Sampling Box NA Orsat Pump NA Tedlar Bag NA
 Nozzle(s) Actually Used: 7B, 34 No. 344 Pitot 4-42
 No. CA5 Diameter .344 No. 344 Diameter 344 Diameter

FILTER NO. TARE
 Delta Hg 1.935
 Delta Ht .6654
 Delta Ht+50 .5542
 Delta Ht-50 .8128
 Delta Pavg .0432
 Meter Temp. 90
 Stack Temp. 62

NOZZLE SELECTION CRITERIA
 Desired Dia. .337 Nozzle 1
 Diameter .344 Nozzle Number CA5
 Nozzle Number CA5 Delta Pmin .0099
 Delta Pmax .0891 Nozzle 2

Est % H₂O 2.0 Cp .84

| Sample Point | Dwell Time, Minutes | Elapsed Time, Minutes | Dry Gas Meter Readings Cubic Feet | Pitot Reading, In. H ₂ O (ΔP) | Gas Meter Temp, °F | Stack Temp, °F | Orifice Setting, In. H ₂ O (ΔH) | Vacuum Gauge, In. Hg | Wind | | Cyclone Temp, °F |
|--------------|---------------------|-----------------------|-----------------------------------|--|--------------------|----------------|--|----------------------|----------------|-----------------|------------------|
| | | | | | | | | | Pitter Box, °F | Imping Exit, °F | |
| A-4 | 10 | 0 | 821.212 | .044 | 94 | 77 | .6654 | 1.0 | 4/110° | 60 | 77 |
| 4 | 10 | 10 | 825.92 | .044 | 94 | 78 | .6654 | 1.0 | 4/110° | 58 | 78 |
| 4 | 10 | 20 | 830.61 | .044 | 94 | 77 | .6654 | 1.0 | 4/110° | 58 | 77 |
| 4 | 10 | 30 | 835.81 | .044 | 95 | 77 | .6654 | 1.0 | 3/110° | 58 | 77 |
| 4 | 10 | 40 | 839.97 | .044 | 96 | 79 | .6654 | 1.0 | 4/110° | 57 | 79 |
| 4 | 10 | 50 | 844.63 | .044 | 97 | 79 | .6654 | 1.0 | 5/110° | 56 | 79 |
| 4 | 10 | 60 | 849.71 | | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | | | | | | | | | | | |
| 11 | | | | | | | | | | | |
| 12 | | | | | | | | | | | |

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK
 F-1109 rev. 11-92

minutes 60 Vm 28.059 tm 95 ts 78 ΔH 0.6654
 (ΔP)²

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Screen

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

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

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Screen

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

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

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Screen

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

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

** Moisture used in calculations.

(Continued Next Page)

FIELD DATA AND RESULTS TABULATION

PLANT: Vulcan Materials, Bristol, TN

SAMPLING LOCATION: Screen

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

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

METHOD 201A (PM-10) FIELD DATA

Plant Name VULCAN - LIMESTONE CRUSHING
 City/State RISEB, TENN
 Sampling Location SCREEN
 Date 6/14/93 Team Leader DWS Techs _____
 Train Leak Check Vacuum, In. Hg 10 Barometric Pressure, In. Hg 28.5
 Train Leak Rate, Cubic Ft./Min. .001 Static Pressure, In. H₂O -.28

EQUIPMENT CHECKS
 Pitot, Pretest
 Pitot, Posttest
 M3 Sampling Sys/Ted Bag
 Thermocouple @ 60 Pre
 Thermocouple @ _____ Post

IDENTIFICATION NUMBERS
 Meterbox EN-2 Meterbox Gamma .9831 Reagent Box NA
 T/C Readout F-38 T/C Probe R127 Umbilical UB1
 Sampling Box NA Orsat Pump NA Tedlar Bag NA
 Nozzle(s) Actually Used: 7/3.341 Pitot 4-42
 No. CAE Diameter .528 No. _____ Diameter _____

NOZZLE SELECTION CRITERIA
 Desired Dia. .329 Nozzle 1
 Diameter .328 Nozzle 2
 Nozzle Number CAE
 Delta Pmin .0121
 Delta Pmax .1087

Delta H_g 1.935
 Delta H_c .6542
 Delta H_{t-50} .5455
 Delta H_{t-50} .7988
 Delta Pavg .0476
 Meter Temp. 90
 Stack Temp. 66

| Sample Point | Dwell Time, Minutes | Elapsed Time, Minutes | Dry Gas Meter Readings Cubic Feet | Pitot Reading, In. H ₂ O (ΔP) | Gas Meter Temp, °F | Stack Temp, °F | Orifice Setting, In. H ₂ O (ΔH) | Vacuum Gauge, In. Hg | Wet Gas Temps | | Cyclone Temp, °F |
|--------------|---------------------|-----------------------|-----------------------------------|--|--------------------|----------------|--|----------------------|---------------|-----------------|------------------|
| | | | | | | | | | Filter | Imping Exit, °F | |
| 1 | 15.0 | 0 | 390.744 | .05 | 76 | 66 | .6542 | 1.0 | 1/100 | 30 | 66 |
| 2 | | 15 | 397.56 | | 78 | 67 | | | 2/100 | 32 | 67 |
| 3 | | 30 | 404.36 | | 82 | 67 | | | 1/100 | 32 | 67 |
| 4 | | 45 | 411.17 | | 84 | 68 | | | 2/100 | 33 | 68 |
| 5 | | 60 | 418.02 | | 88 | 69 | | | 3/100 | 33 | 69 |
| 6 | | 75 | 424.99 | | 90 | 71 | | | 2/110 | 34 | 71 |
| 7 | | 90 | 431.94 | | 92 | 72 | | | 2/110 | 35 | 72 |
| 8 | | 105 | 438.97 | | 88 | 72 | | | 2/110 | 35 | 72 |
| 9 | | 120 | 445.92 | | 88 | 72 | | | 3/120 | 36 | 72 |
| 10 | | 135 | 452.86 | | 89 | 72 | | | 1/110 | 36 | 72 |
| 11 | | 150 | 459.81 | | 92 | 72 | | | 1/100 | 38 | 72 |
| 12 | | 165 | 466.80 | | 95 | 74 | | | 1/100 | 38 | 74 |

Est % H₂O 2.0
 minutes _____ Vm _____ (ΔP)² _____ tm _____ ΔH _____

CONTINUED →

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK
 P-1109 rev. 11-92

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

Plant Name VULCAN MATL - LIMESTONE Run Number W522011
 City/State BRISTOL, TENN Time Start 0740
 Sampling Location SCREEN Time Stop 1540

| Sample Point | Dwell Time, Minutes | Elapsed Time, Minutes | Dry Gas Meter Readings Cubic Feet | Pitot Reading, In. H ₂ O (ΔP) | Gas Meter Temp, °F | Stack Temp, °F | Orifice Setting, In. H ₂ O (ΔH) | Vacuum Gauge, In. Hg | Gas Temp, Filter Box, °F/Disc | Impingement Exit, °F | Cyclone Temp, °F |
|--------------|---------------------|-----------------------|-----------------------------------|--|--------------------|----------------|--|----------------------|-------------------------------|----------------------|------------------|
| 13 | 15.0 | 180 | 473.81 | .05 | 96 | 74 | .6542 | 1.0 | 3/12.0 | 38 | 74 |
| 14 | | 195 | 480.82 | | 94 | 72 | | | 3/11.0 | 40 | 72 |
| 15 | | 210 | 487.82 | | 92 | 72 | | | 2/10.0 | 40 | 72 |
| 16 | | 225 | 494.84 | | 89 | 72 | | | 3/10.0 | 42 | 72 |
| 17 | | 240 | 501.78 | | 88 | 73 | | | 2/10.0 | 42 | 73 |
| 18 | | 255 | 508.72 | | 90 | 74 | | | 2/10.0 | 42 | 74 |
| 19 | | 270 | 515.67 | | 90 | 77 | | | 4/11.0 | 43 | 77 |
| 20 | | 285 | 522.61 | | 91 | 76 | | | 2/10.0 | 44 | 76 |
| 21 | | 300 | 529.48 | | 93 | 76 | | | 3/10.0 | 44 | 76 |
| 22 | | 315 | 536.80 | | 92 | 75 | | | 3/10.0 | 42 | 75 |
| 23 | | 330 | 543.83 | | 92 | 78 | | | 4/10.0 | 40 | 78 |
| 24 | | 345 | 550.81 | | 92 | 78 | | | 3/10.0 | 59 | 78 |
| 25 | | 360 | 557.762 | | | | | | | | |
| 26 | | | | | | | | | | | |
| 27 | | | | | | | | | | | |
| 28 | | | | | | | | | | | |
| 29 | | | | | | | | | | | |
| 30 | | | | | | | | | | | |
| 31 | | | | | | | | | | | |
| 32 | | | | | | | | | | | |
| 33 | | | | | | | | | | | |
| 34 | | | | | | | | | | | |
| 35 | | | | | | | | | | | |
| 36 | | | | | | | | | | | |
| 37 | | | | | | | | | | | |
| 38 | | | | | | | | | | | |
| 39 | | | | | | | | | | | |
| 40 | | | | | | | | | | | |

360 minutes $\frac{167.018}{(\Delta P)^2}$ 0.05 89 tm 73 ts 0.6542 ΔH

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK
 F-1109 rev. 11-92

METHOD 201A (PM-10) FIELD DATA

Plant Name MULCAN MATL - LIME STONE Run Number MS2-2012
 City/State REXDALE, IOWA Time Start 0805
 Sampling Location SCREEN Time Stop 1105
 Date 6/15/93 Team Leader DWS Techs JB Job Number 50119
 Train Leak Check Vacuum, In. Hg 10 Barometric Pressure, In. Hg 28.6
 Train Leak Rate, Cubic Ft./Min. 0.01 Static Pressure, In. H₂O -.35

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

IDENTIFICATION NUMBERS
 Meterbox EN-2 Meterbox Gamma .9831 Reagent Box NA
 T/C Readout F3B T/C Probe R129 Umbilical UB1
 Sampling Box NA Orsat Pump NA Tedlar Bag NA
 Nozzle(s) Actually Used: 713 .341 No. 1086 Diameter .328 Pitot 4-42
 No. CAE Diameter .328 No. 1086 Diameter 1086

NOZZLE SELECTION CRITERIA
 Desired Dia. .317 Nozzle 1
 Diameter .328 Nozzle 2
 Nozzle Number CAE
 Delta P min .0121
 Delta P max .1086

Est @ H₂O 2.0 Cp .84

| Sample Point | Dwell Time, Minutes | Elapsed Time, Minutes | Dry Gas Meter Readings Cubic Feet | Pitot Reading, In. H ₂ O (ΔP) | Gas Meter Temp, °F | Stack Temp, °F | Orifice Setting, In. H ₂ O (ΔH) | Vacuum Gauge, In. Hg | Filter Box, V/D/C | Imping Exit, °F | Cyclone Temp, °F |
|--------------|---------------------|-----------------------|-----------------------------------|--|--------------------|----------------|--|----------------------|-------------------|-----------------|------------------|
| 1 | 15.0 | 0 | 566.325 | .057 | 74 | 72 | .6548 | 1.0 | 0 | 52 | 72 |
| 2 | | 15 | 573.21 | | 79 | 72 | | | 0 | 50 | 72 |
| 3 | | 30 | 580.11 | | 82 | 79 | | | 4/50 | 50 | 77 |
| 4 | | 45 | 587.02 | | 82 | 79 | | | 3/50 | 50 | 77 |
| 5 | | 60 | 593.91 | | 82 | 77 | | | 4/50 | 50 | 77 |
| 6 | | 75 | 600.87 | | 82 | 81 | | | 4/51 | 52 | 81 |
| 7 | | 90 | 607.81 | | 82 | 85 | | | 8/50 | 52 | 85 |
| 8 | | 105 | 614.56 | | 85 | 85 | | | 5/100 | 53 | 85 |
| 9 | | 120 | 621.48 | | 86 | 86 | | | 5/110 | 54 | 86 |
| 10 | | 135 | 628.34 | | 87 | 89 | | | 4/100 | 55 | 89 |
| 11 | | 150 | 635.33 | | 85 | 81 | | | 7/50 | 54 | 81 |
| 12 | | 165 | 642.31 | | 85 | 75 | | | 5/30 | 52 | 75 |
| | | 180 | 649.254 | | | | | | | | |

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK
 Total Time: 180 minutes
 Total Volume: 82.929 Vm
 Average ΔP: 0.057 (ΔP) 2
 Average Stack Temp: 83 tm
 Average Cyclone Temp: 80 ts
 Average Imping Temp: 0.6548 ΔH

METHOD 201A (PM-10) FIELD DATA

Plant Name VULCAN MATL - LIME STONE Run Number MS22013
 City/State REISTER TOWN Time Start 1120
 Sampling Location SCREEN Time Stop 1435
 Date 6/15/73 Team Leader JMS Techs JB Job Number 50119
 Train Leak Check Vacuum, In. Hg 1.0 Barometric Pressure, In. Hg 28.6
 Train Leak Rate, Cubic Ft./Min. .001 Static Pressure, In. H₂O -.34

EQUIPMENT CHECKS
 Pitot, Pretest
 Pitot, Posttest
 M3 Sampling Sys/Ted Bag
 Thermocouple @ 72 Pre
 Thermocouple @ 78 Post

IDENTIFICATION NUMBERS
 Meterbox EN-2 Meterbox Gamma .9831 Reagent Box NA
 T/C Readout F-36 T/C Probe R125 Umbilical UB1
 Sampling Box NA Orsat Pump NA Tedlar Bag NA
 Nozzle(s) Actually Used: CAE Diameter .341 No. 7B Pitot 4-42
 No. CAE Diameter .328

NOZZLE SELECTION CRITERIA
 Desired Dia. .317 Nozzle 1
 Diameter .328 Nozzle 2
 Nozzle Number CAE
 Delta P_{min} .0121
 Delta P_{max} .108C
 Est % H₂O 2.0 Cp .84

| Sample Point | Dwell Time, Minutes | Elapsed Time, Minutes | Dry Gas Meter Readings Cubic Feet | Pitot Reading, In. H ₂ O (ΔP) | Gas Meter Temp, °F | Stack Temp, °F | Orifice Settling, In. H ₂ O (ΔH) | Vacuum Gauge, In. Hg | Wash Gas Temp | Impinging Exit, °F | Cyclone Temp, °F | Filter | |
|--------------|---------------------|-----------------------|-----------------------------------|--|--------------------|----------------|---|----------------------|---------------|--------------------|------------------|---------|----------|
| | | | | | | | | | | | | Box, °F | Wash, °F |
| 1 | A-2 | 15.0 | 0 | .057 | 85 | 72 | .654B | 1.0 | 0 | 50 | 72 | 5/30 | 50 |
| 2 | | 15 | 649.312 | | 85 | 70 | | | 4/30 | 50 | 78 | 4/30 | 52 |
| 3 | | 30 | 603.11 | | 85 | 77 | | | 4/30 | 50 | 76 | 4/30 | 50 |
| 4 | | 45 | 670.02 | | 89 | 74 | | | 5/30 | 50 | 75 | 5/30 | 50 |
| 5 | | 60 | 677.13 | | 90 | 75 | | | 5/30 | 50 | 74 | 5/30 | 50 |
| 6 | | 75 | 684.18 | | 94 | 74 | | | 7/30 | 48 | 75 | 7/30 | 48 |
| 7 | | 90 | 691.24 | | 93 | 75 | | | 8/30 | 48 | 76 | 8/30 | 48 |
| 8 | | 105 | 698.16 | | 88 | 76 | | | 8/30 | 46 | 76 | 8/30 | 46 |
| 9 | | 120 | 705.19 | | 89 | 76 | | | 7/35 | 44 | 76 | 7/35 | 44 |
| 10 | | 135 | 711.92 | | 90 | 76 | | | 6/30 | 42 | 76 | 6/30 | 42 |
| 11 | | 150 | 718.90 | | 92 | 77 | | | 4/30 | 40 | 76 | 4/30 | 40 |
| 12 | | 165 | 725.74 | | 92 | 78 | | | | | 70 | | |
| | | 180 | 732.575 | | | | | | | | | | |

* REMOVE HEAD BEFORE POSTTEST LEAK CHECK

minutes 180 Vm 83.263 (ΔP)² 0.057 tm 89 ts 76 ΔH 0.6548

F-1109 rev. 11-92

Appendix B

Example Calculation of PM10 Emission Factors

Variables

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

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

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

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

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

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

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

4. Calculation of ambient PM10 concentration

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

5. Calculation of adjusted PM10 concentration in M201A gas sampled

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

6. Calculation of total gas flow rate from screen

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

7. Calculation of total PM10 emissions

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

8. Calculation of Vibrating Screen processing rate

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

9. Calculation of PM10 Emission factors

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

Appendix C.

SAMPLING EQUIPMENT AUDIT

Plant Name VULCAN - LIMESTONE Job No. 50119
 City/State BRISTOL, TENN Auditor(s) DWS
 Test Loc. SCREEN Date 6/14/93

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 | 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 backup. 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 |
|-------------|----|-------------|----|-------------|----|-------------|----|-------------|----|
| _____ | ✓ | _____ | ✓ | _____ | ✓ | _____ | ✓ | _____ | ✓ |

* ± 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. EX-2 Gamma (Y) .9831 ΔH@ 1.935
 As Applicable (check): Zero Magnehelics? _____ Zero/Level Manometer?
 Barometric Pressure (P_{bar}) 28.5 Auditor DWS Date 6/14/93

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

| Dry Gas Volume Metered (Cubic Ft.) | Average Meter Temp. (°F) | Run Time (Base = 10) | |
|------------------------------------|------------------------------|----------------------|-----------|
| | | (Minutes) | (Seconds) |
| V _m = <u>7.94</u> | T _m = <u>80.5</u> | <u>10</u> | <u>0</u> |

0.75 = Ideal Sampling Rate

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

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

Audit Gamma

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

SAMPLING EQUIPMENT AUDIT

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

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

Ref. Therm. Initial Ambient Temp., °F 63 Allowable Deviation From Ambient _____ Date 6/14/93 Auditor JRW ✓
 Ambient Temperature, °F _____ OK
THERMOMETERS
 Dry Gas Meter ± 5.4 °F 65 (Meterbox I.D. NH-7) ✓
 Impinger Exit ± 2.0 °F 62 _____ ✓
 Filter Box ± 5.4 °F N.A. _____

THERMOCOUPLES

| TC No. / °F | ✓ OK |
|--|---------|--|---------|--|---------|--|---------|--|---------|
| <u>R284164</u> | ✓ | <u>R302164</u> | ✓ | <u>R218163</u> | ✓ | <u>1</u> | — | <u>1</u> | — |
| (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 <u>JRW</u> | | Auditor <u>JRW</u> | | Auditor <u>JRW</u> | | 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. NH-7 Gamma (Y) 0.9850 ΔH₀ 1.728
 As Applicable (check): Zero Magnehelics? Zero/Level Manometer? _____
 Barometric Pressure (P_{bar}) 28.5 Auditor JRW Date 6/14/93

| Dry Gas Meter Reading (Cubic Ft.) | Meter Temperature (°F) | Lower and Upper Limits for Audit Gamma |
|------------------------------------|----------------------------|--|
| Final <u>430.635</u> | Final <u>72</u> | 0.96 * Y = <u>0.9456</u> |
| Initial <u>423.000</u> | Initial <u>68</u> | 1.04 * Y = <u>1.0244</u> |
| Dry Gas Volume Metered (Cubic Ft.) | Average Meter Temp. (°F) | Run Time (Base = 10) |
| V _m = <u>7.635</u> | T _m = <u>70</u> | (Minutes) _____ (Seconds) _____ |

$$Y_c = \frac{[10 + (0.160)]}{7.635} * \left[\frac{0.0319 (\frac{70}{28.5} + 460)}{28.5} \right]^{.5} = \frac{1.0088}{\text{Audit Gamma}}$$

Audit Gamma Acceptable (between lower & upper limits)? (✓) Yes No _____
 Ideal Sampling Rate = 0.75
 Positive Pressure Leak Check OK? Yes No N/A



Appendix D.

Appendix E.

MOISTURE ANALYTICAL RESULTS

Plant Name Vulcan Materials

Job No. 50119

City/State Bristol, TN

Sampling Loc. Crusher [DRY]

| | | | |
|---------------|--------------------------------|----------------|----------------|
| Run Number | <u>Dry 2 - Crusher - M20A1</u> | <u>2</u> | <u>3</u> |
| Sampling Date | <u>6/16/93</u> | <u>6/16/93</u> | <u>6/16/93</u> |
| Analysis Date | <u>6/16/93</u> | <u>6/16/93</u> | <u>6/16/93</u> |
| Analyst | <u>TTB</u> | <u>TTB</u> | <u>TTB</u> |

| | | | |
|---------------------------------|-------------------------------|-------------------------------|-------------------------------|
| <u>Reagent 1 (200m DF)</u> | | | |
| Final Weight, g | <u>574.3</u> | <u>576.8</u> | <u>573.6</u> |
| Tared Weight, g | <u>580.5 571.9</u> | <u>580.6 571.9</u> | <u>586.8 566.5</u> |
| Water Catch, g | <u>7.8</u> | <u>4.9</u> | <u>7.1</u> |
| <u>Reagent 2 ()</u> | | | |
| Final Weight, g | | | |
| Tared Weight, g | | | |
| Water Catch, g | | | |
| <u>Reagent 3 ()</u> | | | |
| Final Weight, g | | | |
| Tared Weight, g | | | |
| Water Catch, g | | | |
| <u>CONDENSED WATER, g</u> | <u>7.8</u> | <u>4.9</u> | <u>7.1</u> |
| <u>Silica Gel</u> | | | |
| Final Weight, g | <u>189.5</u> | <u>213.8</u> | <u>193.8</u> |
| Tared Weight, g | <u>185.2</u> | <u>206.0</u> | <u>188.6</u> |
| <u>ADSORBED WATER, g</u> | <u>4.3</u> | <u>7.8</u> | <u>5.2</u> |
| <u>TOTAL WATER COLLECTED, g</u> | <u>12.1</u> | <u>12.7</u> | <u>12.3</u> |

Balance No. #43 Type Triple Beam Electronic Reagent Box No. _____

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

Comments _____

MOISTURE ANALYTICAL RESULTS

Plant Name Vulcan Materials Job No. 50119
 City/State Bristol, TN Sampling Loc. Crusher [Wet]

| | | | |
|---------------|-------------------------------|----------|----------------|
| Run Number | <u>Wpt. 2 (Inst. M5011-1)</u> | <u>2</u> | <u>3</u> |
| Sampling Date | <u>6/14/93</u> | | <u>6/15/93</u> |
| Analysis Date | <u>6/14/93</u> | | <u>6/15/93</u> |
| Analyst | <u>JRW, TTB</u> | | <u>JRW</u> |

| | | | |
|---------------------------------|--------------|--------------|--------------|
| <u>Reagent 1 (200 μ DF)</u> | | | |
| Final Weight, g | <u>612.7</u> | <u>608.4</u> | <u>601.3</u> |
| Tared Weight, g | <u>582.7</u> | <u>585.2</u> | <u>585.6</u> |
| Water Catch, g | <u>30.0</u> | <u>23.2</u> | <u>15.7</u> |
| <u>Reagent 2 ()</u> | | | |
| Final Weight, g | | | |
| Tared Weight, g | | | |
| Water Catch, g | | | |
| <u>Reagent 3 ()</u> | | | |
| Final Weight, g | | | |
| Tared Weight, g | | | |
| Water Catch, g | | | |
| CONDENSED WATER, g | <u>30.0</u> | <u>23.2</u> | <u>15.7</u> |
| <u>Silica Gel</u> | | | |
| Final Weight, g | <u>208.5</u> | <u>195.0</u> | <u>196.2</u> |
| Tared Weight, g | <u>182.5</u> | <u>183.5</u> | <u>180.6</u> |
| ADSORBED WATER, g | <u>26.0</u> | <u>11.5</u> | |
| TOTAL WATER COLLECTED, g | <u>56.0</u> | <u>34.7</u> | <u>31.3</u> |

Balance No. #43 Type Triple Beam Electronic Reagent Box No. _____

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

Comments _____

MOISTURE ANALYTICAL RESULTS

Plant Name Vulcan Materials Job No. 50119
 City/State Bristol, TN Sampling Loc. Screen [DRY]

| | | | |
|---------------|---------------------------|----------------|----------------|
| Run Number | <u>Dry-2. Sub-Moist-1</u> | <u>2</u> | <u>3</u> |
| Sampling Date | <u>6/16/93</u> | <u>6/16/93</u> | <u>6/16/93</u> |
| Analysis Date | <u>6/16/93</u> | <u>6/16/93</u> | <u>6/16/93</u> |
| Analyst | <u>TTB</u> | <u>JRW</u> | <u>JRW</u> |

| | | | |
|---------------------------------|--------------|------------------------------|---------------------------|
| <u>Reagent 1 (200A DE)</u> | | | |
| Final Weight, g | <u>586.0</u> | <u>546.5</u> <u>646.5</u> | <u>570.2</u> |
| Tared Weight, g | <u>581.6</u> | <u>584.4</u> <u>538.5</u> | <u>580.8</u> <u>561.3</u> |
| Water Catch, g | <u>4.4</u> | <u>8.0</u> | <u>8.9</u> |
| <u>Reagent 2 (_____)</u> | | | |
| Final Weight, g | _____ | _____ | _____ |
| Tared Weight, g | _____ | _____ | _____ |
| Water Catch, g | _____ | _____ | _____ |
| <u>Reagent 3 (_____)</u> | | | |
| Final Weight, g | _____ | _____ | _____ |
| Tared Weight, g | _____ | _____ | _____ |
| Water Catch, g | _____ | _____ | _____ |
| <u>CONDENSED WATER, g</u> | _____ | _____ | _____ |
| <u>Silica Gel</u> | | | |
| Final Weight, g | <u>196.4</u> | <u>200.0</u> | <u>196.8</u> |
| Tared Weight, g | <u>191.5</u> | <u>192.9</u> | <u>191.7</u> |
| <u>ADSORBED WATER, g</u> | <u>4.9</u> | <u>7.1</u> | <u>5.1</u> |
| <u>TOTAL WATER COLLECTED, g</u> | <u>9.3</u> | <u>15.1</u> | <u>14.0</u> |

Balance No. # 43 Type Triple Beam Electronic _____ Reagent Box No. _____

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

Comments _____

MOISTURE ANALYTICAL RESULTS

Plant Name Vulcon Materials Job No. 50119
 City/State Bristol, TN Sampling Loc. Screen [WET]

Run Number WET-2-SCREEN 2 3
 Sampling Date M201A-1 6/15/93
 Analysis Date 6/15/93
 Analyst JRW

| | | | |
|---------------------------------|--------------|--------------|--------------|
| <u>Reagent 1 (200μ DI)</u> | | | |
| Final Weight, g | <u>625.5</u> | <u>613.8</u> | <u>608.5</u> |
| Tared Weight, g | <u>582.9</u> | <u>584.4</u> | <u>580.7</u> |
| Water Catch, g | <u>42.6</u> | <u>29.4</u> | <u>27.8</u> |
| <u>Reagent 2 ()</u> | | | |
| Final Weight, g | | | |
| Tared Weight, g | | | |
| Water Catch, g | | | |
| <u>Reagent 3 ()</u> | | | |
| Final Weight, g | | | |
| Tared Weight, g | | | " |
| Water Catch, g | | | |
| <u>CONDENSED WATER, g</u> | | | <u>27.8</u> |
| <u>Silica Gel</u> | | | |
| Final Weight, g | <u>214.2</u> | <u>193.7</u> | <u>205.4</u> |
| Tared Weight, g | <u>189.2</u> | <u>181.2</u> | <u>192.4</u> |
| <u>ADSORBED WATER, g</u> | <u>25.0</u> | <u>12.5</u> | <u>13.0</u> |
| <u>TOTAL WATER COLLECTED, g</u> | <u>67.6</u> | <u>41.9</u> | <u>40.8</u> |

Balance No. # 43 Type Triple Beam Electronic Reagent Box No. _____

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

Comments _____