PM10 EMISSION FACTORS FOR A STONE CRUSHING PLANT TERTIARY CRUSHER

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1.0 INTRODUCTION

1.1 SUMMARY OF TEST PROGRAM

The U. S. Environmental Protection Agency (EPA), Office of Air Quality Planning and Standards (OAQPS), Emission Inventory Branch (EIB) is responsible for developing and maintaining air pollution emission factors for industrial processes. EIB is presently studying the stone crushing industry. As part of this work, EIB sponsored PM10 particulate emissions tests at Martin Marietta Corporation's facilities in Raleigh-Durham and Garner, North Carolina. The specific sources tested were the tertiary crusher at the Garner plant and a Deister vibrating screen at the Raleigh-Durham plant. This report concerns only the tertiary crusher tests. A separate report presents the test results at the Deister vibrating screen.

The PM10 emission factor test procedures were developed and conducted by Entropy Environmentalists, Inc. (Entropy). The Emission Measurement Branch (EMB) of EPA supervised the test program.

A Quasi-stack system was used to conduct emission tests on the inlet and outlet of the tertiary crusher. For the Quasi-stack system enclosures were built. The inlet enclosure measured approximately 8'H X 8'D X 5'W and the outlet measured 7'H X 24'D X 8'W. The systems are shown in Figure 1-1. and Figure 1-2. The mounting positions of the HEPA filtered air supplies and Quasi-stack tube-axial fans ensured that the normal PM10 emissions were not significantly influenced but were directed to the outlet ducts. The capture velocity in the outlet ducts were set by adjusting the variable speed DC motors of the tube axial fans. The velocities of the fans were set so that there was a slight negative pressure within the enclosures. A constant gas flow was used throughout the test program.

The PM10 emissions were tested using EPA Method 201A. The tests were divided into two sets: stone moisture levels greater than 1.5%, and stone moisture levels less than 1.5%. These criteria were used based on limited data concerning moisture requirements of wet suppression systems for fugitive dust[1,2]. It was necessary to operate a continuously recording meteorological station next to the crusher to characterize the wind speed and direction during the tests. The observed PM10 emission levels are summarized in Table 1-1.

TABLE 1-1. TERTIARY CRUSHER PM10 EMISSIONS

	PM10 Emissions, Pounds/Ton[1]
Inlet Dry Stone (< 1.5%)	0.000041 (Without Control)
Outlet Dry Stone (< 1.5%)	0.001717 (Without Control)
Inlet Wet Stone (> 1.5%)	0.000019 (With Controls)
Outlet Wet Stone (> 1.5%)	0.000813 (With Controls)

[1] Based on total stone feedrate from vibrating feeder.

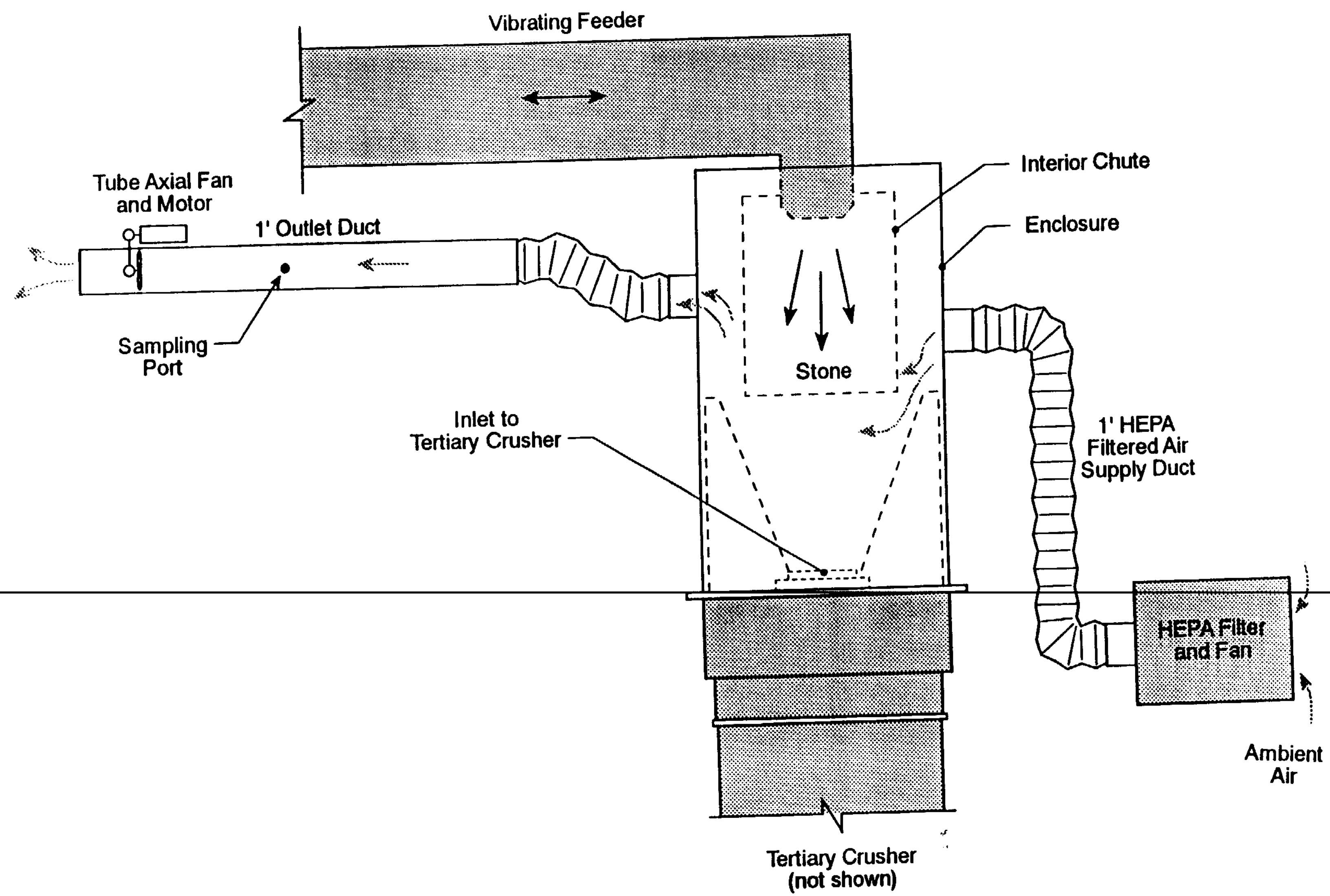


Figure 1-1. Tertiary crusher inlet enclosure.

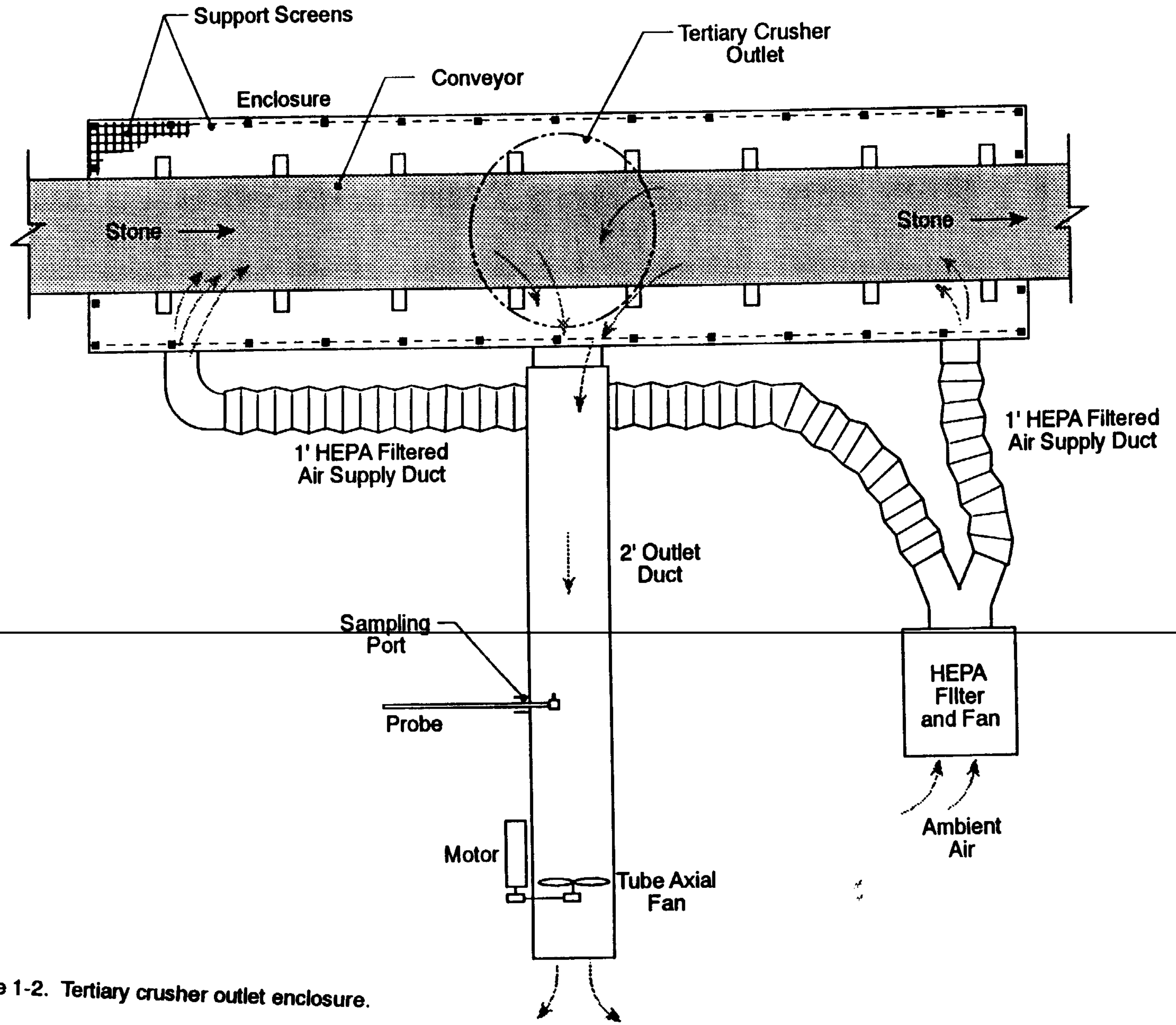


Figure 1-2. Tertiary crusher outlet enclosure.

2.0 PLANT AND SAMPLING LOCATION DESCRIPTION

2.1 PROCESS DESCRIPTION AND OPERATION

The Garner plant produces crushed granite used for construction and road paving. Figure 2-1 is a flowchart of the portion of the Garner plant relevant in this project. The figure was prepared based on a drawing labelled Flow Diagram Plant No. 632 provided by Martin Marietta.

Rock blasted from various locations in the quarry is trucked (stream 1) to a primary crusher. A large surge pile is used to provide a steady flow of stone to the plant processing equipment located adjacent to the quarry. An 8 foot by 540 foot conveyor (stream 3) is used to deliver the stone to the vibrating deck above the secondary crusher. Normal production rates ranged from 250 to 500 tons per hour as calculated by the transport time and volumetric feed of the vibrating feeder, points A and B of Figure 2-1 (see Appendix A for production data).

The scalping screen serving the secondary crushers removes oversized material too large for the secondary crusher, this material is conveyed to a separate storage pile and sold as product. The material passing through the scalping screen is conveyed (stream 4) to the secondary crusher separate storage pile and are sold as product.

The cone-type secondary crusher reduces the size distribution of the material received from the surge pile. Stone leaving the secondary crusher ranges in size from 6 inches to relatively small particles. The material from the secondary crusher discharges onto a conveyor (stream 6) leading to the tertiary crusher inlet. The tertiary crusher discharge stream (stream 10) also discharges onto this conveyor. Following the tertiary crusher discharge, the main feed conveyor (stream 6) contains all of the plant production with the exception of oversized product discussed earlier. The main feed conveyor stream passes through a transfer station and delivers the stone to the top of the structure housing the Deister vibration screens. The stone flow to the Deister screens and tertiary crusher is termed "closed circuit" since oversized material containing some fines adhering to the surface can recirculate through the Deister and tertiary crusher[3] until the stone is crushed small enough to fall through the Deister screen (streams 8,9).

The tertiary crusher is a Model 1560 Omnicone, conical type crusher. Figure 2-2 shows a side view of the vibrating feeder and tertiary crusher before the inlet and outlet enclosures were built. This receives the oversize stone from the 8 x 20 - 3D Diester screens downstream from the secondary crusher. The stone is fed to the tertiary crusher by means of a 36" wide, 260 foot long conveyor (stream 7). The stone is discharged onto a rectangular surge feeder which serves a 36" wide 72" long vibrating feeder (Figure 2-1.). The feeder discharges onto a 4 foot by 4 foot chute directly above the Omnicone inlet. This chute is not indicated on Figure 2-1. There are very limited free fall distances from the feeder to the charging chute and from the charging chute to the inlet of the Omnicone. The Omnicone discharges the crushed stone to a 36 inch wide, 336 foot long conveyor (stream 10) leading to the enclosed Diester screens.

The inlet to the Omnicone was defined as the discharge of the vibrating feeder to the charging chute and the discharge of the charging chute into the crusher vessel. This area, having a height of approximately 7 feet, was enclosed with a tarp 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 5 to 10 mph.

The discharge point of the Omnicone tertiary crusher is a conveyor leading from the secondary crusher to the Diester screens (stream 10). The discharge point is enclosed approximately 5 feet upstream and downstream of the Omnicone discharge point. There are several water spray nozzles on the downstream side of this conveyor.

The discharge of the Omnicone crusher was defined as the total enclosure surrounding stream 10 underneath the Omnicone. Emissions from the Omnicone were clearly visible leaving both the upstream and downstream portions of the enclosure.

The plant operates approximately 200 days per year. The typical operating times are 7 a.m. to 5:00 p.m. each day. Total production quantities per year are approximately 750,000 to 1,000,000 tons.

2.2 FUGITIVE DUST CONTROL

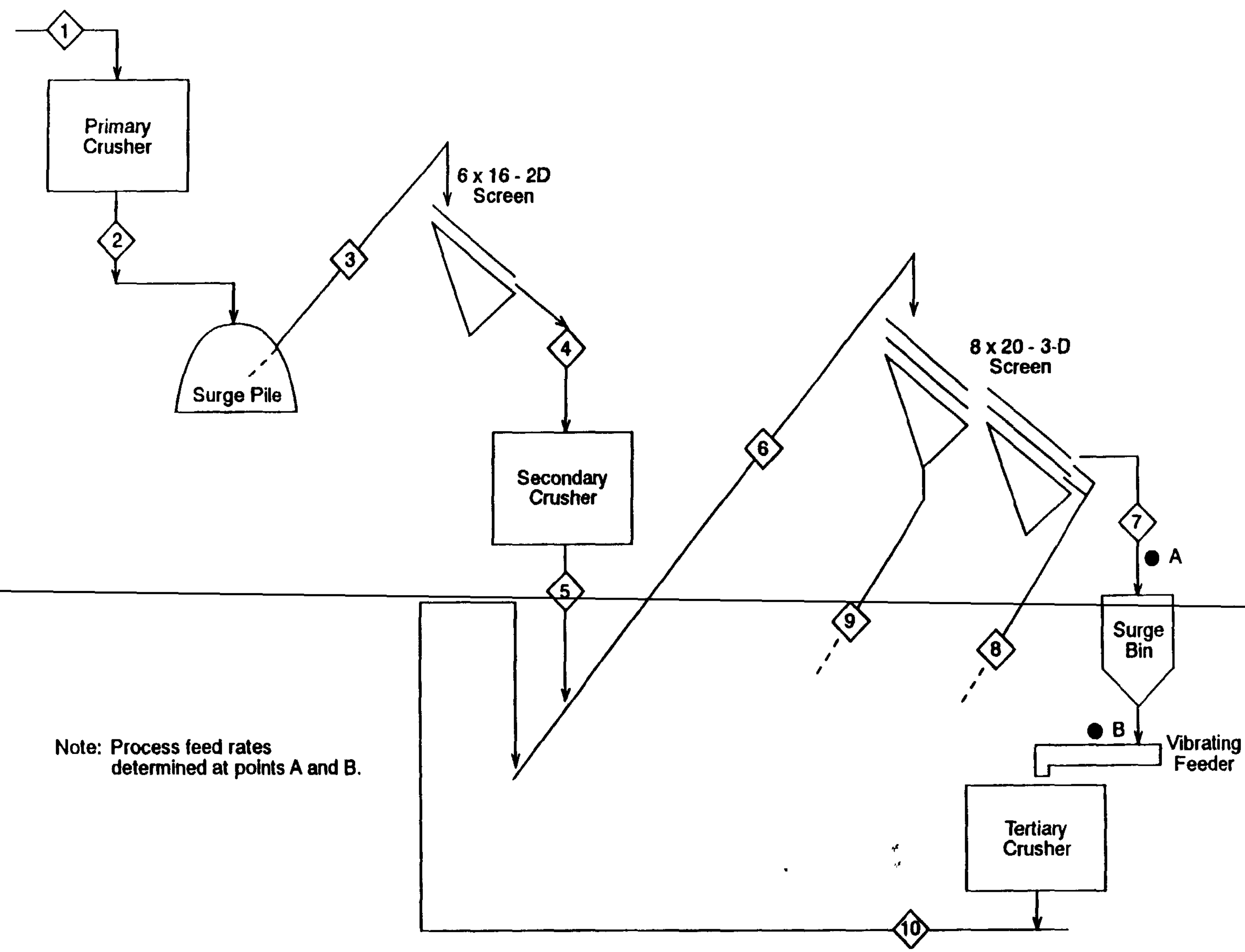
Wet suppression is used for fugitive dust control of the tertiary crusher. There are water spray nozzles located on the conveyor underneath the tertiary crusher (beginning of stream 10), at the transfer point of the conveyor (stream 7) and also the entrance to the surge bin and vibrating feeder (points A and B Figure 2-1). Not all of these spray nozzles are necessary to maintain wet conditions. Over-wetting of the rock can cause blinding of the lower screen or blockage of the fines discharge chute underneath the Deister[4,5].

2.3 SAMPLING AND EMISSION TESTING PROCEDURES

2.3.1 Fugitive Emission Capture Systems

Since there is not an air pollution control device on the inlet and outlet of the tertiary crusher, a fugitive emission capture system is needed to capture the particulate matter. Entropy considered the criteria listed in Table 2-1 in designing the fugitive emission capture system. Entropy evaluated alternative capture systems during several site visits by Entropy and U. S. EPA personnel. The alternative capture techniques which are generally applied to fugitive dust emission sources include[6,7]:

- Roof monitor
- Upwind-downwind profiling
- Quasi-stack



Note: Process feed rates determined at points A and B.

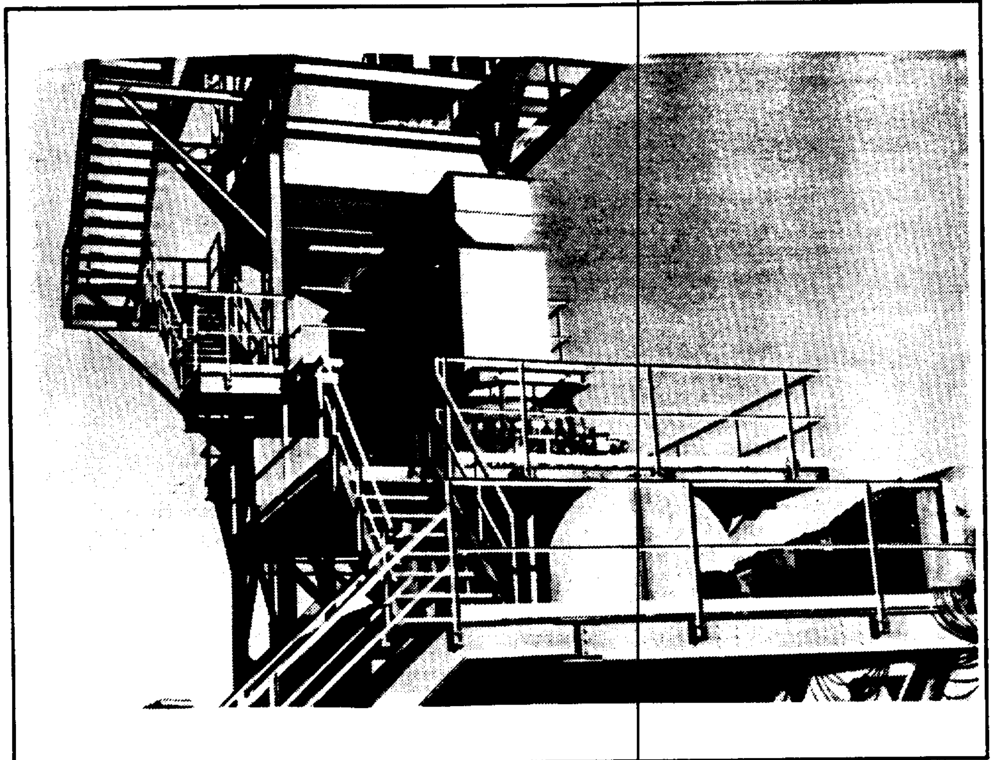


Figure 2-2. Vibrating Feeder and Tertiary Crusher

Emission 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 tertiary crusher at the Garner plant due to the number of sources immediately upwind and downwind of the tertiary crusher. It would be impossible to isolate the tertiary crusher from these nearby sources. These included:

- Generator exhaust
- Secondary crushers
- Various conveyors and stone transfer points
- Interstate 40 traffic.

The emission profiling approach was not practical due to the number of potential PM10 sources and their locations near the tertiary crusher.

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 and outlet. Also, there were no partial enclosures to direct the PM10 emissions to a sampling grid.

Table 2-1. 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 upper Deister screen, near the stone inlet chute, or near the upper screen discharge chute.
- The capture system should not create a sink for PM10 emissions due to particulate losses.
- The capture system should isolate the tertiary crusher being tested (west unit) from the adjacent unit (east unit).
- 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 system 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.

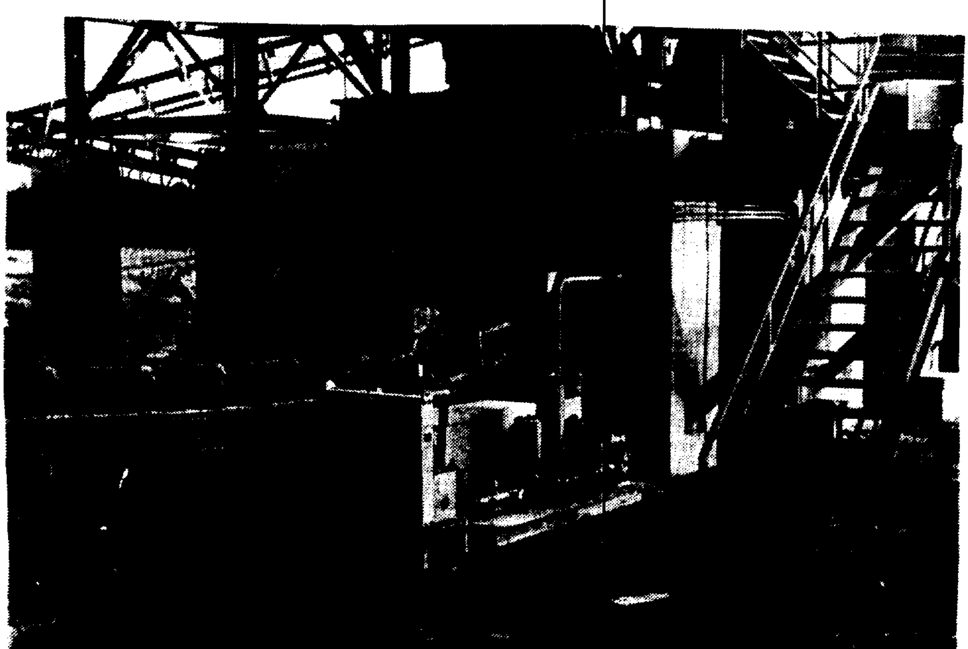


Figure 2-3. Crusher Inlet Enclosure

The quasi-stack method appeared to be the most effective and practical approach for capturing the fugitive emissions. This approach allowed isolation of the crusher inlet and outlet emission points 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 tertiary crusher and the installation of a duct and fan system for gas handling. Since the tertiary crusher outlet was already partially enclosed, the induced gas flow streams would not influence the rate of PM10 emissions. Low make-up air flow rates were used at the relatively exposed inlet emission point in order to minimize higher-than-actual PM10 emissions.

The make-up air to the inlet and outlet enclosures was supplied by a set of two-speed fans equipped with HEPA filters and prefilters. The HEPA filters are rated as greater than 99.97% efficient for submicron particles, therefore, adjacent dust sources could not significantly influence the measured emission rates. Prefilters were replaced when they became overloaded or blinded by large diameter particles, moist particles, or water.

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

The enclosures were constructed of tight fitting tarps stretched over a large mesh metallic screen. The screen was electrically bonded and grounded to ensure that high static voltages would not accumulate on the tarps thereby reducing the actual PM10 emissions. Figure 2-1 and 2-3 show the inlet to the crusher location, Figure 2-1 and 2-4 show the outlet to the crusher location.

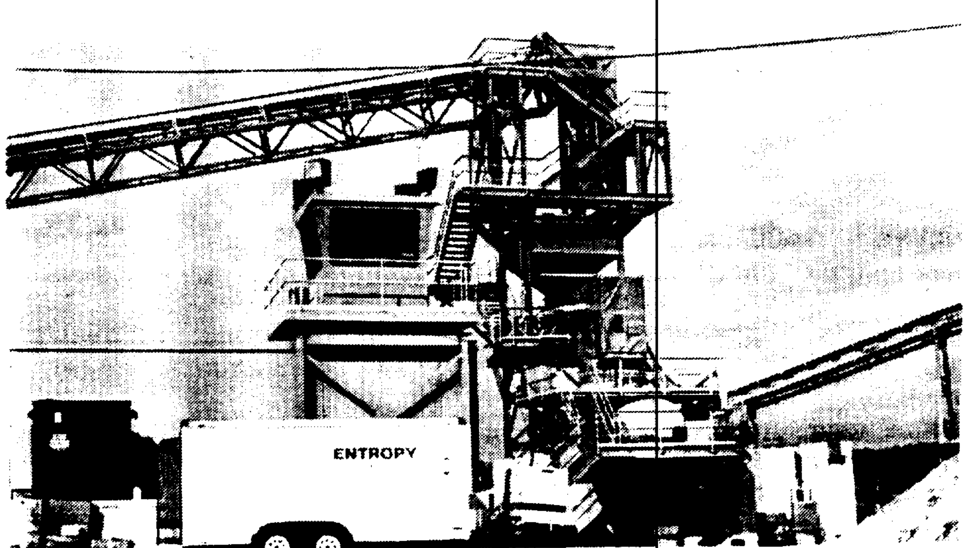


Figure 2-4. Outlet Enclosure

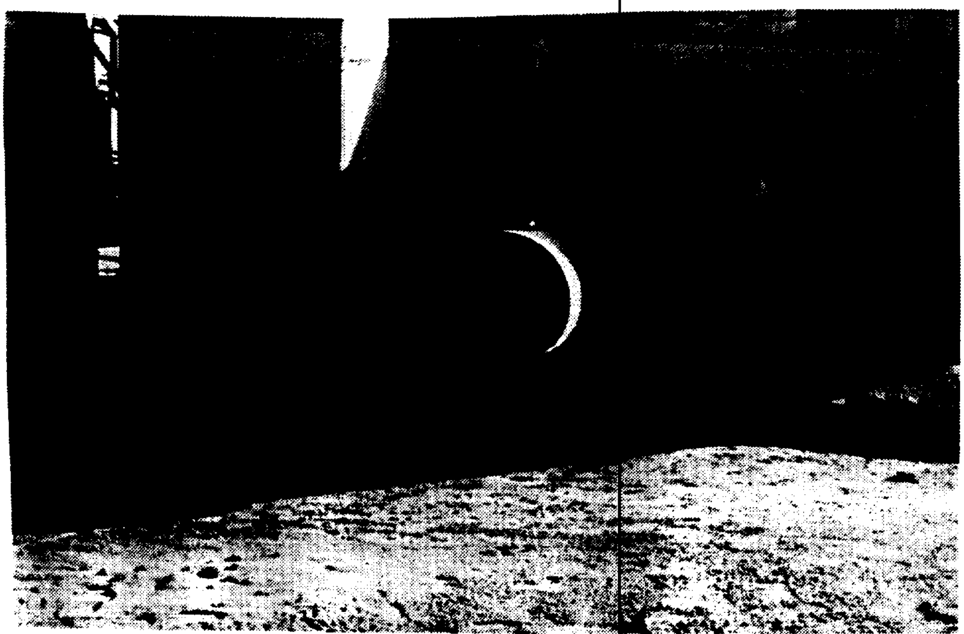


Figure 2-5. Outlet Enclosure Window

One clear lucite window was also included in each enclosure so that plant personnel and the Entropy test team could observe process operating conditions. Figure 2-5 shows the outlet window location and outlet duct system.

2.3.2 PM10 Emission Testing Procedure

EPA Reference Method 201A was used to monitor the PM10 emissions from the tertiary crusher. The complete sampling train is shown in Figure 2-6. This 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. A disassembled PM10 sampling head is shown in Figure 2-7.

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.

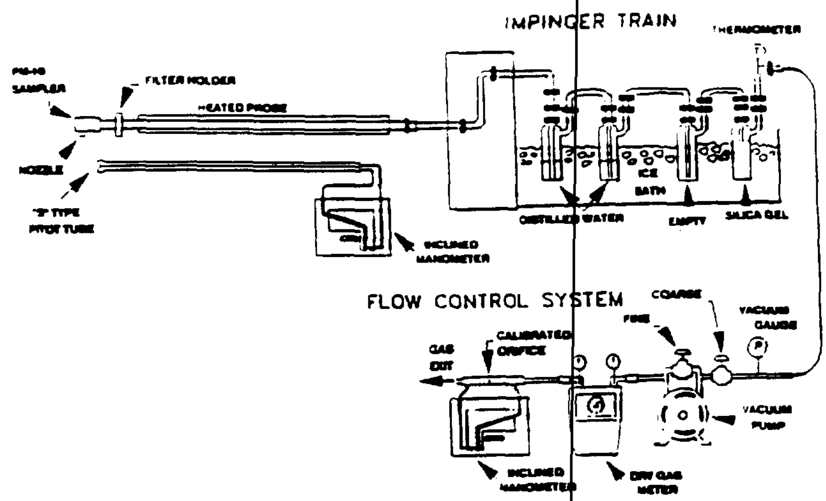


Figure 2-6. PM10 Sampling Train

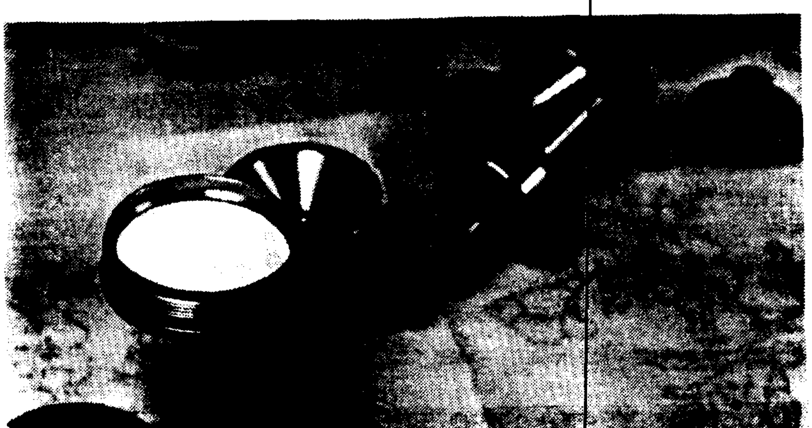


Figure 2-7. Disassembled PM10 Head

PM10 sampling was performed in a 1-foot (inlet location) and 2-foot (outlet location) diameter smooth wall duct mounted directly off the enclosures of the crusher. The ducts were connected to flexible duct leading from the enclosures. The 4-inch diameter sampling port was located 8 duct diameters downstream of the flexible duct connection and 2 duct diameters upstream of the fan. Four traverse points in the horizontal direction were sampled. Sampling in the vertical direction across the ducts was not possible since dust collected in the cyclone could be resuspended and pass through to the filter. The sampling nozzles were selected to provide 80 to 120% isokinetic conditions. The cyclone and nozzle assembly were mounted within the duct during sampling. A heating mantle was used around the filter to keep temperatures approximately 50 degrees Fahrenheit above the stack temperature. This was necessary to avoid filter blinding due to moisture condensation in the sampling train.

The particulate samples were recovered using the procedures specified in Method 201A. The sample recovery scheme is illustrated in Figure 2-8. 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 Deister screen[3,†]:

- Stone moisture level
- Ambient wind speed
- Wind direction
- Stone size distribution
- Stone silt content
- Deister stone feed rates
- Stone type (breaking characteristics)
- 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 granite is the only type of stone processed at this plant. Samples of the stone were archived to permit future analyses if necessary.

2.4.1 <u>Stone Moisture Level</u>

A stone sample was removed during each of the emission tests. In most cases, this sample consisted of a 2 linear foot sample of stone from the main conveyor feeding the surge bin. The conveyor was stopped by plant personnel for approximately 5 minutes to permit the Entropy test crew to remove the stone sample. The sample was placed in a sealed plastic bucket. Each sample weighed more than 120 pounds.

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 250 degrees Fahrenheit. The weight loss during heating was calculated and reported as the stone moisture level.

2.4.2 Wind Speed and Direction

An Entropy-supplied weather station was mounted on the platform directly outside of the control room. A dedicated microcomputer recorded data on a minute-by-minute basis.

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. One of the initial sample quadrants not used for moisture analysis was further subdivided for analysis by ASTM sizing screens. A sample of approximately 2 pounds was loaded into the top pan. The screens used included:

- 1.5 inch screen
- 0.75 inch screen
- No. 4 screen (mesh opening 0.187 inches)
- No. 20 screen (mesh opening 0.033 inches)
- No. 100 screen (mesh opening 0.0059 inches)
- No. 200 screen (mesh opening 0.0029 inches)
- 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.

The data provided by the ASTM sizing screens provided information on the "as-sampled" stone size distribution. Following this analysis of the ASTM screens, the sample was placed into an oven and heated to 250°F until dry. Then the ASTM screens were restacked and shaken for 10 minutes. The dry weights per screen were then used as an indication of the total silt content of the stone which could conceivably be released while the stone is being processed on the Deister screens.

2.4.4 Stone Processing and Production Rates

The stone processing rate of the tertiary crusher has been defined by Entropy as the total volume of stone transferred by the vibrating feeder to the tertiary crusher. The volume of stone in tons for a particular test was calculated by dividing the actual volume of the vibrating feeder (ft^3) by the rate of transfer of the feeder (minutes). This number was multiplied by the specific gravity of the stone (2.65) which was in turn multiplied by 62.4 pounds of water/ft^3. Then to obtain the total amount of stone per test this number was multiplied by the length of the test (minutes). This calculation is shown below:

(Volume of Feeder FT^3) / (Feeder Transfer Time Minutes)
= FT^3/Minutes

(FT^3/Minutes) X (2.65 Pounds Stone / Pound Water) X (62.4 pounds of water/ft^3)
= Pounds Stone / Minute

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

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 tertiary crusher at a 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 tertiary crusher 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, stone silt content, wind speed, wind direction.

Table 3-1 presents and sampling and analytical matrix and sampling log for the testing at the Martin Marietta Corporation Garner plant.

3.2 FIELD TEST CHANGES AND PROBLEMS

During two of the tests, the Garner facility experienced a short term production interruption. The Method 201A sampling trains were shut down during these outages. Sampling resumed approximately 2 to 5 minutes after production rates, and stone characteristics returned to normal conditions.

During the initial tests on December 9, 1991 the orifice head pressures for the Method 201A sampling trains were set too low. Accordingly, the results were not consistent with Method 201a. Entropy, with the authorization of the EPA Project Manager elected to void these runs. The data collected from these runs however, are listed in the appendices of this report.

TABLE 3-1. SAMPLING MATRIX

Run No.	Test Type	Date	Time	Test Method	Sampling Location
P1, P2	Dry	12-09-91	11:00	Method 2	In/Out Ducts
			14:00-15:00	Method 201A	In/Out Ducts
			16:10-17:10	Method 201A	In/Out Ducts
			11:10	Stone Sample	Conveyor 5
			15:00-17:00	Wind Conditions	Platform
W1	Wet	12-10-91	11:00	Method 2	In/Out Ducts
			12:25-15:25	Method 201A	Inlet Duct
			13:41-16:13	Method 201A	Outlet Duct
			N.D.	Stone Sample	Conveyor 5
			13:25-16:20	Wind Conditions	Platform
W2, W3	Wet	12-11-91	08:20-12:04	Method 201A	In/Out Ducts
			13:00-16:09	Method 201A	In/Out Ducts
			12:15	Stone Sample	Conveyor 5
			09:20-16:14	Wind Conditions	Platform
D1A, D2A, and D3A		12-12-91	09:10-15:00	Method 201A	Inlet Duct
			07:45-13:54	Method 201A	Outlet Duct
			09:41	Stone Sample	Conveyor 5
			10:05-15:05	Wind Conditions	Platform

3.3 TEST RESULTS

3.3.1 Stone Moisture Content

The stone moisture levels for the tertiary crusher PM10 emission factor tests are presented in Table 3-2. The moisture criteria proposed in the Test Plan were: dry condition - less than 1.5%, and wet conditions - equal to or greater than 1.5%. These values are basically consistent with these criteria. Only the first wet test had a value outside of this range. The low moisture level of 0.49% in this run was due to the sample drying out prior to analysis, although this did not have a significant impact on the PM10 emission test results.

During the emission tests, the stone color was used to qualitatively evaluate moisture levels. Short term changes in stone moisture were indicated by a shift from grey to 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.

TABLE 3-2. STONE MOISTURE LEVELS

Date	Conditions	Test	Moisture Content (% weight)
12-09-91	Dry[1]	P1	0.18
	Dry[1]	P2	0.04
12-12-91	Dry	D1,2,3,A	0.44

			Average 0.44
12-10-91	Wet[2]	W1	0.49
12-11-91	Wet	W2,3	1.77

			Average 1.77

Note: [1] - These runs were voided due to improper method 201A gas flow rates.
Note: [2] - Container seal broken, sample may have dried prior to analysis, omitted from average.

Stone moisture levels were controlled by the plant personnel operating certain water spray headers in the process. Moisture content is a strong function of the stone size distribution. Essentially all of the moisture present in a given stone sample is present in the small size ranges having high surface areas.

3.3.2 Stone Production Rates

The tertiary crusher stone processing rates were calculated following the formula given in Section 2.4.4 of this report. The vibrating feeder volumes, transport times data and the calculated stone production rates are presented in Table 3-3.

3.3.3 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.

Table 3-3. Stone Production Rates,
For the Tertiary Crusher Enclosure Tests

Date	Time	Volume of Flow (FT^3)	Transport Times (Seconds)		Mass Flow Rates (T/Hr.)
12-09-91	14:42	319	268		354
	16:20	319	226		420
	16:53	319	216		440

				Average =	405
		Test Time = 60 Minutes Production Total = 405 Tons (Two Dry Runs)			
12-10-91	13:00	336	217		460
	14:29	336	226		441

				Average =	450
		Test Time = 180 Minutes Production Total = 1350 Tons (One Wet Run)			
12-11-91	09:58	319	223		425
	10:40	319	198		480
	14:05	319	228		416
	15:17	319	213		446
	15:47	319	205		463

				Average =	446
		Test Time = 180 Minutes Production Total = 1338 Tons (Two Wet Runs)			
12-12-91	08:50	336	221		453
	10:02	336	203		493
	12:19	319	217		437
	14:37	319	221		430

				Average =	453
		Test Time = 60 Minutes Production Total = 453 Tons (Three Dry Runs)			

The data are expressed in pounds of PM10 per ton of stone processed through the tertiary crusher. The production rate was calculated as per Section 2.4.4 of this report.

The measured PM10 emission factors are presented in Table 3-4. The average values for the wet tests are approximately a factor of 2 below the average value for the dry tests. This is consistent with general observations during the emission tests. During the dry tests, there were slight visible emissions from the outlet ducts. No visible emissions were apparent during the wet tests. The extremely low emissions occurring during the wet tests are indicated the photograph shown in Figure 3-1.

The emission factors measured during the emission test program are well below previously reported emission factors for total particulate matter[9]. This difference is reasonable since stone crushing processes can generate high concentrations of large diameter particulate when the stone is very dry or the ambient wind speed is very high. The earlier tests were mainly conducted on sources with baghouses for control. Therefore, wet suppression was not used to minimize emissions and the stone was probably very dry (data not provided). The Entropy test crew observed that the visible emissions dropped to negligible levels when the wet suppression equipment was turned on at the Garner plant.

The emission factors applicable to total emissions cannot be compared with the 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.

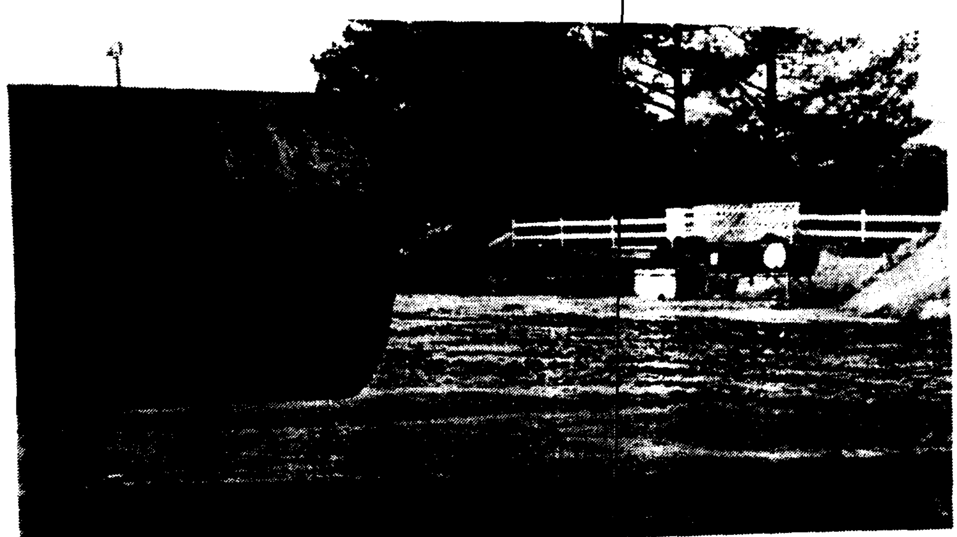


Figure 3-1. Visible Emissions During Wet Test

TABLE 3-4. TERTIARY CRUSHER PM10 EMISSIONS

	PM10 Emissions; Pounds/Ton
Inlet Dry Stone (< 1.5%)	
Run 1A	0.000081
Run 2A	0.000032
Run 3A	0.0000098
Average	0.000041
Inlet Wet Stone (> 1.5%)	
Run 1	0.000014
Run 2	0.000026
Run 3	0.000018
Average	0.000019
Outlet Dry Stone (< 1.5%)	
Run 1A	0.00192
Run 2A	0.00173
Run 3A	0.00150
Average	0.001717
Outlet Wet Stone (> 1.5%)	
Run 1	0.00106
Run 2	0.00031
Run 3	0.00107
Average	0.000813

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 4-1.

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).
- The probe and filter temperatures are maintained at >50°F ambient.
- 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 4-1.

TABLE 4-1.

GARNER AVERAGE DELTA H AND ISOKINETIC RESULTS

Run #	Percent Iso (%)	Delta H (Avg)
IN/DRY/1A/12-12	89.6	.621
IN/DRY/2A/12-12	80.6	.573
IN/DRY/3A/12-12	90.1	.573
IN/WET/1/12-10	89.7	.622
IN/WET/2/12-11	90.1	.567
IN/WET/3/12-11	88.3	.567

Run #	Percent Is (%)	Delta H (Avg)
OUT/DRY/1A/12-12	89.3	.564
OUT/DRY/2A/12-12	88.0	.565
OUT/DRY/3A/12-12	88.2	.565
OUT/WET/1/12-10	101.6	.592
OUT/WET/2/12-11	87.8	.587
OUT/WET/3/12-11	86.1	.542

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 4-2.

Table 4-2. Meter Box Calibration Audit

Meter Box Number	Pre-Audit Value	Allowable Error	Calculated Gamma	Acceptable
N-6	0.9871	0.9476<Y<1.0265	1.0128	Yes
N-14	0.9948	0.9550<Y<1.0346	0.9707	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.

APPENDIX A.

Results in Table Form

Table A-1. Stone Production Rates,
For the Tertiary Crusher Enclosure Tests

Date	Time	Volume of Flow (FT^3)	Transport Times (Seconds)	Mass Flow Rates (T/Hr.)
12-09-91	14:42	319	268	354
	16:20	319	226	420
	16:53	319	216	440

			Average =	405
			Test Time = 60 Minutes Production Total = 405 Tons (Two Dry Runs)	
12-10-91	13:00	336	217	460
	14:29	336	226	441

			Average =	450
			Test Time = 180 Minutes Production Total = 1350 Tons (One Wet Run)	
12-11-91	09:58	319	223	425
	10:40	319	198	480
	14:05	319	228	416
	15:17	319	213	446
	15:47	319	205	463

			Average =	446
			Test Time = 180 Minutes Production Total = 1338 Tons (Two Wet Runs)	
12-12-91	08:50	336	221	453
	10:02	336	203	493
	12:19	319	217	437
	14:37	319	221	430

			Average =	453
			Test Time = 60 Minutes Production Total = 453 Tons (Three Dry Runs)	

GARNER RUN DATA

DATE	TEST NO.	TEST CONDITION	W_F (MG)	C_{PM10} (MG/SCF_{DRY})	$Q_{F\text{-}STD}$ (SCF)	E_{PM10} (POUNDS)	E_f (LBS/TON)
12-10-91	1	OUTWET	37.8	0.590	932,837	1.21	0.00106
12-11-91	2	OUTWET	12.9	0.163	1,141,478	0.409	0.00031
12-11-91	3	OUTWET	46.0	0.591	1,102,764	1.44	0.00107
12-12-91	1A	OUTDRY	27.9	1.026	384,533	0.869	0.00192
12-12-92	2A	OUTDRY	25.5	0.954	372,778	0.783	0.00173
12-12-92	3A	OUTDRY	22.2	0.827	373,771	0.681	0.00150
12-12-92	1A	INDRY	11.3	0.423	39,285	0.037	0.000081
12-12-92	2A	INDRY	4.1	0.168	39,296	0.0146	0.000032
12-12-92	3A	INDRY	1.4	0.051	40,027	0.0044	0.0000098
12-10-92	1	INWET	5.5	0.073	107,936	0.0172	0.000014
12-11-92	2	INWET	10.7	0.127	122,747	0.0343	0.000026
12-11-92	3	INWET	7.4	0.091	118,023	0.0237	0.000018

GARNER RUN DATA

DATE	TEST NO.	TEST CONDITION	$Q_{S\text{-}STD}$ SCF_{Dry}	T_M (^oR)	T_{STK} (^oR)	P_{BS} (INCHES Hg)	P_B (INCHES Hg)	X (%)	T_{TEST} (Min)
12-10-91	1	OUTWET	64.190	551	517	29.92	30.1	1.0	152
12-11-91	2	OUTWET	79.233	536	508	29.92	30.3	0.9	180
12-11-91	3	OUTWET	77.799	557	520	29.92	30.0	0.8	180
12-12-91	1A	OUTDRY	27.187	526	505	29.92	30.3	1.2	60
12-12-92	2A	OUTDRY	26.724	537	516	29.92	30.3	0.6	60
12-12-92	3A	OUTDRY	26.845	546	515	29.92	30.3	0.6	60
12-12-92	1A	INDRY	26.685	555	518	29.92	30.3	1.8	60
12-12-92	2A	INDRY	24.278	552	513	29.92	30.3	2.4	60
12-12-92	3A	INDRY	27.687	555	512	29.92	30.3	0.8	60
12-10-92	1	INWET	75.854	545	522	29.92	30.1	0.9	167
12-11-92	2	INWET	83.687	542	503	29.92	30.3	0.9	180
12-11-92	3	INWET	81.159	550	516	29.92	30.3	0.8	180

APPENDIX B.

Example Calculations

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 fan ACF/Min
Q_{F-STD}	=	Gas flow rate through fan SCF_{Dry}
T_s	=	Standard temperature, 528 Degrees R
T_M	=	Meter box gas temperature, (460R + xF)
T_{STK}	=	Stack Temperature, (460R + xF)
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
X	=	Moisture in flue gas, %(volume)
T_{TEST}	=	Duration of test in minutes

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

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

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

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

3. Calculation of total gas flow rate through fans;

   $Q_{F-STD} = (Q_{F-A})(T_S/T_{STK})(P_B/P_{BS})((1-X)/1)(T_{TEST})$

4. Calculation of total PM10 emissions

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

5. Calculation of PM10 Emission factors

   $E_f = (E_{PM10})(\text{Tons/Hr})(\text{Hr}/60\ \text{min})(T_{TEST}\ \text{min})$

Example Calculation

Run # OUT/WET/1/12-10

December 10, 1991

1.) $Q_{S\text{-}STD} = (67.256\,ACF)(528°R/551°R)(30.1''Hg/29.92''Hg)(.99) = 64.19\ SCF_{DRY}$

2.) $C_{pm10} = (37.8\,mg/64.19\,SCF_{DRY}) = 0.59\,mg/SCF_{DRY}$

3.) $Q_{F\text{-}STD} = (6033.63\,ACF/min)(528°R/517°R)(30.1''Hg/29.92''Hg)(.99)(152\,min)$
$= 932{,}836.96\ SCF_{DRY}$

4.) $E_{pm10} = (0.59\,mg/SCF_{DRY})(932{,}836.96\ SCF_{DRY})\left(\frac{Grams}{1000\,MG}\right)\left(\frac{lbs}{454\,grams}\right) =$

$= 1.21$ pounds

5.) $E_F = (1.21\ Pounds)/(450\ Tons/Hr)(Hr/60\,min)(152\,min)$
$= 0.00106$ Pounds/Ton

Job Number

Job Name

Subject

Version Sheet of

Prepared By Date

Checked By Date

ENTROPY

ENVIRONMENTALISTS INC.

Research Triangle Park, NC 27709-2291

1-800-486-3550

CALCULATION SHEET

APPENDIX C.

Raw Field Data and Calibration Data Sheets

Sampling and Velocity Traverse Point Determination
EPA Method 1

PLANT NAME Martin Marietta
CITY, STATE Garner, NC
SAMPLING LOCATION Inlet

NO. OF PORTS AVAILABLE 2
NO. OF PORTS USED 1
PORT INSIDE DIAMETER 6"

DISTANCE FROM FAR WALL TO OUTSIDE OF PORT 12"
NIPPLE LENGTH AND/OR WALL THICKNESS 0"
DEPTH OF STACK OR DUCT 12"
STACK OR DUCT WIDTH (IF RECTANGULAR) —

EQUIVALENT DIAMETER:

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

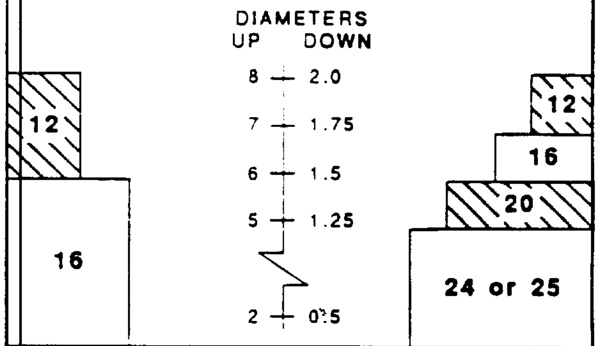
DISTANCE FROM PORTS TO FLOW DISTURBANCES	UPSTREAM	DOWNSTREAM
	8'	2'
DIAMETERS	8	2

STACK/DUCT AREA = ______ = 113 IN²

DRAW HORIZONTAL LINE THROUGH DIAMETERS

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

VELOCITY PARTICULATE



LOCATION OF POINTS IN CIRCULAR STACKS OR DUCTS

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

LOCATION OF POINTS IN RECTANGULAR STACKS OR DUCTS

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

POINT	% OF DUCT DEPTH	DISTANCE FROM INSIDE WALL	DISTANCE FROM OUTSIDE OF PORT
1	6.7	.8"	7/8"
2	25.0	3"	3"
3	75.0	9"	9"
4	93.3	11.2	11¼
5			
6			
7			
8			
9			
10			
11			
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16			
17			
18			
19			
20			
21			
22			
23			
24			

SEE REVERSE FOR FIELD USE CHECKLIST

F-0016
10-90

Sampling and Velocity Traverse Point Determination
EPA Method 1

PLANT NAME Martin Marietta

CITY, STATE Garner, NC

SAMPLING LOCATION Outlet

NO. OF PORTS AVAILABLE 2

NO. OF PORTS USED 1

PORT INSIDE DIAMETER 6"

DISTANCE FROM FAR WALL TO OUTSIDE OF PORT 24"

NIPPLE LENGTH AND/OR WALL THICKNESS 0

DEPTH OF STACK OR DUCT 24"

STACK OR DUCT WIDTH (IF RECTANGULAR) –

EQUIVALENT DIAMETER:

$D_E = \frac{2 \times \text{DEPTH} \times \text{WIDTH}}{\text{DEPTH} + \text{WIDTH}} = \frac{2(\quad)(\quad)}{(\quad + \quad)} =$ NA

DISTANCE FROM PORTS TO FLOW DISTURBANCES	UPSTREAM	DOWNSTREAM
DIAMETERS		

STACK/DUCT AREA = ______ = 452.38 IN²

LOCATION OF POINTS IN CIRCULAR STACKS OR DUCTS

	4	6	8	10	12	14	16	18	20	22	24
1	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3	75.0	29.6	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4	93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5		85.4	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6		95.6	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7			89.5	77.4	64.4	36.6	28.3	23.8	20.4	18.0	16.1
8			96.8	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9				91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10				97.4	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11					93.3	85.4	78.0	70.4	61.2	39.3	32.3
12					97.9	90.1	83.1	76.4	69.4	60.7	39.8
13						94.3	87.5	81.2	75.0	68.5	60.2
14						98.2	91.5	85.4	79.6	73.8	67.7
15							95.1	89.1	83.5	78.2	72.8
16							98.4	92.5	87.1	82.0	77.0
17								95.6	90.3	85.4	80.6
18								98.6	93.3	88.4	83.9
19									96.1	91.3	86.8
20									98.7	94.0	89.5
21										96.5	92.1
22										98.9	94.5
23											96.8
24											98.9

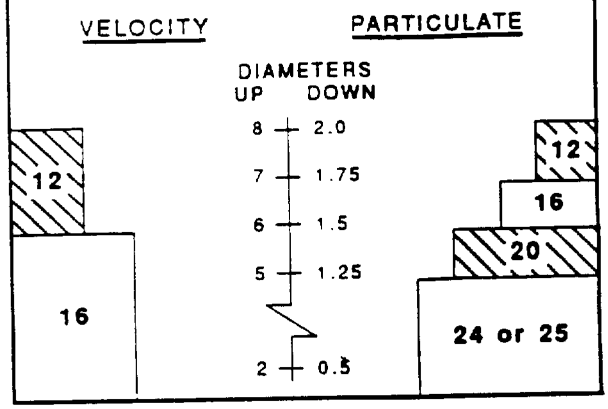
LOCATION OF POINTS IN RECTANGULAR STACKS OR DUCTS

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

F-0016
10-90

DRAW HORIZONTAL LINE THROUGH DIAMETERS

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



POINT	% OF DUCT DEPTH	DISTANCE FROM INSIDE WALL	DISTANCE FROM OUTSIDE OF PORT
1	6.7	16.48"	~~1.62~~ 1 5/8
2	25.0	6"	6"
3	75.0	18"	18"
4	93.3	22.39"	22 3/8
5			
6			
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SEE REVERSE FOR FIELD USE CHECKLIST

ENTROPY

PRELIMINARY VELOCITY AND CYCLONIC FLOW DETERMINATIONS

Plant Name Martin Marietta   Job No. 3864

City/State Garner / NC   Date 12/9/91

Test Location ~~Outlet~~ INLET / Green   Personnel TTB/HWL

Barometric Pres. (Pbar) 30.0 In. Hg   Static Pres. (Pg) -.2865 In. H_2O

Pitot ID HH-72-2   Pitot Coeff. (Cp) .84   Pressure Gauge Set ID M91219

Thermocouple ID M91219   Duct Length/Diameter 21'/2'   Width

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

TRAVERSES Start-Finish Times: ______ - ______			
Pt. No.	Yaw ∡°	ΔP "H_2O	Temp °F
T1			59°
2			
3			
4			
5			
6			
S1		.0548	
2		.0868	
3		.1057	
4		.0891	
5		.1024	
6		.0967	
Avg*		.0909	

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

Bag No. ______   Pump ______

FYRITE DATA, % CO_2				

MOISTURE DATA (WET BULB/DRY BULB)					
Port	Time	Dry Bulb °F	Wet Bulb °F	Diff.	% H_2O

MOISTURE DATA (STOICHIOMETRIC)		
Free Water in Fuel, %		
Water from Fuel Combustion, %		
Ambient Water, %		
Relative Humidity, %		
Ambient Temperature, °F		
Total %		

VOLUMETRIC AIR FLOW RATES		
Dry at Standard Conditions, Qsd =		SCFM
Wet at Stack Conditions, Qaw =		ACFM

HORIZONTAL DUCT FLYASH/DUST BUILDUP >1" DEPTH?
Yes__ No__ If yes, see page 2 for instructions

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

F-1107 rev. 9-91

See page 2 for cyclonic flow check criteria.

ENTROPY

PRELIMINARY VELOCITY AND CYCLONIC FLOW DETERMINATIONS

Plant Name Martin Marietta Job No. 3864

City/State Garner / N C Date 12/9/91

Test Location ~~Inlet~~ Outlet Blue Personnel TTB/HWL

Barometric Pres. (Pbar) 30.0 In. Hg Static Pres. (Pg) -.6959 In. H_2O

Pitot ID HH-72-2 Pitot Coeff. (Cp) .84 Pressure Gauge Set ID M91219

Thermocouple ID M91219 Duct Length/Diameter 10'/12" Width ____
--Specify inches (") or feet (')--

TRAVERSES
Start-Finish Times: ______ - ______

Pt. No.	Yaw ∡°	ΔP "H_2O	Temp °F
T1		.3830	58°F
2		.3488	
3		.4076	
4		.3901	
5		.4380	
6		.3488	
S1		.320	[illegible]
2		.4205	
3		.4070	
4		.4278	
5		.4083	
6		.3178	
Avg*		.3837	

ORSAT DATA

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

Bag No. ______ Pump ______

FYRITE DATA, % CO_2				

MOISTURE DATA (WET BULB/DRY BULB)

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

MOISTURE DATA (STOICHIOMETRIC)

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

VOLUMETRIC AIR FLOW RATES

Dry at Standard Conditions, Qsd = SCFM

Wet at Stack Conditions, Qaw = ACFM

HORIZONTAL DUCT FLYASH/DUST BUILDUP >1" DEPTH?

Yes__ No__ If yes, see page 2 for instructions

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

F-1107 rev. 9-91

See page 2 for cyclonic flow check criteria.

ENTROPY

PRELIMINARY VELOCITY AND CYCLONIC FLOW DETERMINATIONS

Plant Name Martin Marietta Job No. 3684

City/State Garner / NC Date 12-10-91

Test Location Inlet Personnel TTB / HWL

Barometric Pres. (Pbar) 30.1 In. Hg Static Pres. (Pg) -.2865 In. H_2O

Pitot ID HH-72-2 Pitot Coeff. (Cp) .84 Pressure Gauge Set ID N91219

Thermocouple ID N91219 Duct Length/Diameter 10'/1" Width

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

TRAVERSES
Start-Finish Times: ________ - ________

Pt. No.	Yaw ∡°	ΔP "H_2O	Temp °F
S1		.1516	53°F
2		.0657	↓
3		.0596	
4		.055	
Avg*		.0587	

ORSAT DATA

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

Bag No. ________ Pump ________

FYRITE DATA, % CO_2				

MOISTURE DATA (WET BULB/DRY BULB)

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

MOISTURE DATA (STOICHIOMETRIC)

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

VOLUMETRIC AIR FLOW RATES

Dry at Standard Conditions, Qsd = SCFM

Wet at Stack Conditions, Qaw = ACFM

HORIZONTAL DUCT FLYASH/DUST BUILDUP >1" DEPTH?

Yes__ No__ If yes, see page 2 for instructions

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

F-1107 rev. 9-91

See page 2 for cyclonic flow check criteria.

ENTROPY

PRELIMINARY VELOCITY AND CYCLONIC FLOW DETERMINATIONS

Plant Name Martin Marietta   Job No. 3684

City/State Garner/NC   Date 12-10-91

Test Location Outlet   Personnel TTB/HWL

Barometric Pres. (Pbar) 30.1 In. Hg   Static Pres. (Pg) -.6959 In. H_2O

Pitot ID AH-72-2   Pitot Coeff. (Cp) .84   Pressure Gauge Set ID M91219

Thermocouple ID M91219   Duct Length/Diameter 20'/2'   Width ____

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

TRAVERSES
Start-Finish Times: ____ - ____

Pt. No.	Yaw ∡°	ΔP "H_2O	Temp °F
S1		.2037	57F
2		.3093	↓
3		.4324	↓
4		.3625	↓
Avg*		.3213	

ORSAT DATA

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

Bag No. ________   Pump ________

FYRITE DATA, % CO_2				

MOISTURE DATA (WET BULB/DRY BULB)

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

MOISTURE DATA (STOICHIOMETRIC)

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

VOLUMETRIC AIR FLOW RATES

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

HORIZONTAL DUCT FLYASH/DUST BUILDUP >1" DEPTH?

Yes__ No__   If yes, see page 2 for instructions

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

F-1107 rev. 9-91

See page 2 for cyclonic flow check criteria.

ENTROPY

FIELD DATA - METHOD(S) 201A

PLANT Martin Marietta RUN NO. IN/DRY/1/12-9
CITY/STATE Garner/NC JOB NO. 3E64 DATE 12-9-91
SAMPLING LOC. INLET TIME START 1400
BAROMETRIC PRESSURE, IN. HG 30.0 STATIC PRESSURE, IN. H_2O -.2865 TIME FINISH 1500
LEAK CHECK, VACUUM IN. HG 15.0 OPERATOR TTB
LEAK RATE, CUBIC FEET/MIN. .005 ASST(S) HWL

EQUIPMENT CHECKS*	
✓	PITOT, PRETEST
✓	PITOT, POSTTEST
	NOZZLE, PRE/POST
E39	TC 68 °F PRE
	TC °F POST
	ORSAT SYSTEM

FILTER/XAD	TARE WT.
PM 75	0.2537

EQUIPMENT I.D. NUMBERS

REAGENT BOX 0573 METER BOX N14 Y .9948
PITOT 4-19 C_p .84 NOZ'L .375 DIA. .375
TC READOUT F-39 TC PROBE R/303/30F UMBILICAL —
SAMPL'G BOX 78 ORSAT PUMP ✓ TEDLAR BAG ✓

NOMOGRAPH DATA

DELTA H@	1.779
METER TEMP	77
EST. %H2O	1%
C FACTOR	1.082
STACK TEMP	77
REF DELTA P	.0909
K FACTOR	21.936

LEAK CHECKS

B B
E E

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	ORIFICE SETTING IN. H2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	✓
1	A-1	1400	402.171	~~.07~~ .046	74	78	1.0	1.0	1	100			
2		1405	405.008	.08	76	73	1.75	1.76	1½	104			
3		1410	408.610	.07	78	74	1.55	1.54	1½	128			
4		1415	412.15	.076	84	73	1.7	1.69	1½	130			
5		1420	415.76	.078	86	73	1.75	1.746	1½	136			
6		1425	419.52	.078	90	73	1.75	1.759	1½	139			
7		1430	423.36	.072	92	72	1.6	1.632	1½	138			
8		1435	426.96	.077	96	73	1.75	1.756	1½	138			
9		1440	430.70	.075	98	74	1.7	1.712	1½	140			
10		1445	434.43	.088	100	73	2.0	2.02	1½	138			
11		1450	438.37	.08	101	73	1.85	1.84	1½	140			
12		1455	442.31	.077	102	73	1.75	1.77	1½	144			
13		1500/OFF	446.069										
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

* FILTER EXIT for NJ Method 1. FILTER BOX for all others.
** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

Min. (Θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH
60	43.898	.0744		73.5	

ENTROPY

FIELD DATA - METHOD(S) ______

PLANT: Martin Marietta
RUN NO. IN/DRY/2/12-9

CITY/STATE: Garner, N.C.
JOB NO. 3684
DATE 12-9-91

SAMPLING LOC. INLET
TIME START 1610

BAROMETRIC PRESSURE, IN. HG ~~30.0~~ 29.5
STATIC PRESSURE, IN. H2O -.2865
TIME FINISH 1710

LEAK CHECK, VACUUM IN. HG 15
OPERATOR JTB

LEAK RATE, CUBIC FEET/MIN. .004
ASST(S) HWL

EQUIPMENT CHECKS*
- ✓ PITOT, PRETEST
- ✓ PITOT, POSTTEST
- ✓ NOZZLE, PRE/POST
- E39 TC 58 °F PRE
- ___ TC ___ °F POST
- ___ ORSAT SYSTEM

EQUIPMENT I.D. NUMBERS

REAGENT BOX 0573 METER BOX N14 Y 0.9948
PITOT 4-19 C_p .84 NOZ'L 0.375 DIA. 0.375
TC READOUT E-39 TC PROBE P/303/304 UMBILICAL ___
SAMPL'G BOX 78 ORSAT PUMP — TEDLAR BAG —

FILTER/XAD	TARE WT.
NoNane	~~.2026~~ .2184

NOMOGRAPH DATA

DELTA H@	1.779
METER TEMP	77
EST. %H2O	1%
C FACTOR	1.082
STACK TEMP	77
REF DELTA P	0.909
K FACTOR	21.931

LEAK CHECKS

B ___ B ___
E ___ E ___

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	ORIFICE SETTING IN. H2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	✓
1	A1	1610	446.224	.06	106	68	1.4	1.403	1	112			
2		1615	449.50	.072	106	67	1.7	1.69	1	125			
3		1620	453.36	.067	108	68	1.6	1.575	1	133			
4		1625	456.94	.072	108	69	1.7	1.69	1	134			
5		1630	460.62	.091	110	69	2.1	2.14	1	134			
6		1635	464.65	.09	110	70	2.1	2.11	1½	138			
7		1640	468.73	.077	110	68	1.81	1.81	1½	138			
8		1645	472.65	.073	110	68	1.7	1.72	1½	137			
9		1650	476.46	.081	110	69	1.9	1.91	1½	137			
10		1655	480.40	.078	110	68	1.8	1.84	1½	138			
11		1700	484.28	.086	110	67	2.0	2.03	1½	137			
12		1705	488.37	.079	110	67	2.1	2.1	1½	137			
13		1710	492.425										
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

* FILTER EXIT for NJ Method 1. FILTER BOX for all other.

** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

Min. (θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH
60	46.201	.0769	110	68.2	

ENTROPY

FIELD DATA - METHOD(S)

PLANT Martin-Marietta
CITY/STATE Garner
SAMPLING LOC. Crusher Outlet
BAROMETRIC PRESSURE, IN. HG 30.0 STATIC PRESSURE, IN. H2O -.6959
LEAK CHECK, VACUUM IN. HG 11
LEAK RATE, CUBIC FEET/MIN. .01

RUN NO. OUT/Dry/1/91
JOB NO. 3684 DATE 9 DEC 91
TIME START 1400
TIME FINISH 1500
OPERATOR GCB/WKK
ASST(S)

EQUIPMENT CHECKS*
- ✓ PITOT, PRETEST
- — PITOT, POSTTEST
- ✓ NOZZLE, PRE/POST
- ✓ TC ✓ °F PRE
- — TC ___ °F POST
- — ORSAT SYSTEM

FILTER/XAD	TARE WT.
	~~.2166~~
~~#12~~	~~.2195~~
	.2166

EQUIPMENT I.D. NUMBERS

REAGENT BOX 0573 METER BOX N6 .9871
PITOT ___ Cp .84 NOZ'L CAE-20013 DIA. .25
TC READOUT F-32 TC PROBE Ambient R-299 wrap R-302 UMBILICAL U-74
SAMPL'G BOX Probe-4-7 ORSAT PUMP ___ TEDLAR BAG ___

NOMOGRAPH DATA

DELTA H@	1.779
METER TEMP	82
EST. %H2O	1.0
C FACTOR	.993
STACK TEMP	68
REF DELTA P	.447
K FACTOR	4.115

LEAK CHECKS

B ___ B ___
E ___ E ___

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	ORIFICE SETTING IN. H2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	✓
1	A 1	0	764.223	.42	83	70	1.757	1.757	0	78	40	—	
2	2	5	767.985	.48	86	70	2.015	2.015	0	76	41	—	
3	3	10	771.997	.51	90	70	2.00	2.156	.4	95.4	50	—	
4	4	15	776.293	.50	94	69.4	2.4	2.132	2.5	98.4	54	—	
5	5	20	780.548	.52	97	70.6	2.2	2.221	2.5	109	46	—	
6	6	25	784.843	.52	100	70.0	2.3	2.237	3.0	106.2	43	—	
7	7	30	789.114	.53	102	70.0	2.2	2.288	3.2	112.2	42	—	
8	8	35	793.493	.57	104	69.8	2.3	2.469	3.8	114.4	41	—	
9	9	40	798.078	.53	107	70.0	2.5	2.307	4.3	117.2	44	—	
10	10	45	802.526	.55	109	70.2	2.4	2.403	4.2	120.2	43	—	
11	11	50	806.988	.55	110	70.2	2.4	2.407	4.6	121.4	43	—	
12	12	55	811.513	.58	111	70.0	2.4	2.543	5.5	123.0	46	—	
13	OFF	60	816.100									—	
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

* FILTER EXIT for NJ Method 1. FILTER BOX for all others.
** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

60	51.877	.5208		70.	
Min. (θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH

ENTROPY

FIELD DATA - METHOD(S) ____

PLANT MARTIN - MARIETTA RUN NO. OUT/DRY/2/91

CITY/STATE GARNER NC JOB NO. 3684 DATE 9 DEC 91

SAMPLING LOC. Crusher OUTLET TIME START 1610

BAROMETRIC PRESSURE, IN. HG 30.0 STATIC PRESSURE, IN. H_2O -.6955 TIME FINISH 1710

LEAK CHECK, VACUUM IN. HG 10 OPERATOR GCB/WA

LEAK RATE, CUBIC FEET/MIN. .014 ASST(S)

EQUIPMENT CHECKS*	EQUIPMENT I.D. NUMBERS			LEAK CHECKS
✓ PITOT, PRETEST	REAGENT BOX 0223	METER BOX N6	Y .9871	B / B
PITOT, POSTTEST	PITOT 4-7	C_p .84	NOZ'L CAE-20013 DIA. .25	E / E
✓ NOZZLE, PRE/POST	TC READOUT F32	TC PROBE R259	UMBILICAL U24	
✓ TC ___ °F PRE	SAMPL'G BOX	ORSAT PUMP —	TEDLAR BAG —	B / B
TC ___ °F POST				E / E
N/A ORSAT SYSTEM				

NOMOGRAPH DATA

FILTER/XAD	TARE WT.		
#12	.2195	DELTA H@	1.779
		METER TEMP	82
		EST. %H_2O	0
		C FACTOR	1.009
		STACK TEMP	70
		REF DELTA P	.440
		K FACTOR	4.183

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H_2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	ORIFICE SETTING IN. H2O IDEAL	GAUGE VACUUM IN. HG	FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	√
1	A 1	0	816.213	.49	80	70	2.072	2.072	2	132	42	—	
2	2	5	820.38	.49	84	70	2.082	2.082	2	111	42	—	
3	3	10	824.5	.50	88	69	2.144	2.144	3	122	42	—	
4	4	15	828.65	.54	92	69	2.332	2.332	3	127	43	—	
5	5	20	832.99	.54	94	69	2.339	2.339	3	127	44	—	
6	6	25	837.42	.55	96	69	2.391	2.391	4	128	44	—	
7	7	30	841.84	.55	98	69	2.395	2.395	4	128	44	—	
8	8	35	846.26	.54	99	69	2.36	2.36	4	128	44	—	
9	9	40	850.75	.54	100	68	2.369	2.369	4	128	44	—	
10	10	45	855.14	.53	100	68	2.325	2.325	4	128	44	—	
11	11	50	859.5	.53	100	67	2.329	2.329	4	127	44	—	
12	12	55	863.91	.54	102	68	2.377	2.377	5	129	45	—	
13		60/off	868.288										
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

* FILTER EXIT for NJ Method 1. FILTER BOX for all othe

** PROBE EXIT & √ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

Min. (Θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH
60	52.075	.5281		68.75	

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ENTROPY

FIELD DATA - METHOD(S) ______

PLANT Martin Marietta   RUN NO. IN/DRY/1A /12-12

CITY/STATE Garner / NC   JOB NO. 3684   DATE 12-12-91

SAMPLING LOC. INLET   TIME START 0910

BAROMETRIC PRESSURE, IN. HG 30.3   STATIC PRESSURE, IN. H2O -2.865   TIME FINISH 1048

LEAK CHECK, VACUUM IN. HG 15   OPERATOR HWL

LEAK RATE, CUBIC FEET/MIN. .003   ASST(S) TTB

EQUIPMENT CHECKS*

- ✓ PITOT, PRETEST
- ✓ PITOT, POSTTEST
- ✓ NOZZLE, PRE/POST
- ✓ TC 40 °F PRE
- ___ TC ___ °F POST
- ___ ORSAT SYSTEM

FILTER/XAD	TARE WT.
PM160	.2467

EQUIPMENT I.D. NUMBERS

REAGENT BOX 605   METER BOX N-11   Y .9904

PITOT Hp-72-2 C_p .84   NOZ'L ~~.214~~ .3125   DIA. .319

TC READOUT R-39   TC PROBE R303/301   UMBILICAL NA

SAMPL'G BOX N   ORSAT PUMP NA   TEDLAR BAG NA

NOMOGRAPH DATA

DELTA H@	1.882
METER TEMP	70
EST. %H2O	1
C FACTOR	1.068
STACK TEMP	50
REF DELTA P	.173
K FACTOR	10.994

LEAK CHECKS

B ___ B ___
E ___ E ___

B ___ B ___
E ___ E ___

B ___ B ___
E ___ E ___

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

STOP 9.31.30
START 1min 9.32.30
9:35.35 STOP
9.49:35 START

.60
3.05
05

10:06:30 STOP
10:12.30 START
10:19:18 STOP
10:36:18 START

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	ORIFICE SETTING IN. H2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	✓
1	1	0910	962.900	.1516	86	52	.621	.621	>1	188			
2	1	0915	965.160	.1516	89	54	.621	.621	1	145			
3	1	0920	967.445	.1516	90	52	.621	.621	1	135			
4	2	0925	969.735	.0657	92	53	.621	.621	1	142			
5	2	0930	972.045	.0657	94	53	.621	.621	1	134			
6	2	0950	974.630	.0657	97	59	.621	.621	1	103			
7	3	0955	976.950	.0596	98	58	.621	.621	1	106			
8	3	1000	979.275	.0596	99	58	.621	.621	1	107			
9	3	1005	981.605	.0596	100	58	.621	.621	1	111			
10	4	1016	983.945	.055	99	67	.621	.621	1	105			
11	4	1038	986.475	.055	97	63	.621	.621	1	70			
12	4	1043	988.785	.055	98	67	.621	.621	1	92			
13	END	1048	991.105				.621	.621	1	108			
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

* FILTER EXIT for NJ Method 1. FILTER BOX for all others.

** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

Min. (θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH
60	28.205	.0587		57.8	

ENTROPY

FIELD DATA - METHOD(S) ____

PLANT Martin Marietta | RUN NO. IN/DRH/2A/1212
CITY/STATE Garner/NC | JOB NO. 7684 | DATE 12-12-91
SAMPLING LOC. INLET | TIME START 1132
BAROMETRIC PRESSURE, IN. HG 30.3 | STATIC PRESSURE, IN. H2O -.2865 | TIME FINISH 1238
LEAK CHECK, VACUUM IN. HG 15 | OPERATOR HWL
LEAK RATE, CUBIC FEET/MIN. .002 | ASST(S) MB

STOP 11:51:00
START 11:57:00

EQUIPMENT CHECKS*
- ✓ PITOT, PRETEST
- ✓ PITOT, POSTTEST
- ✓ NOZZLE, PRE/POST
- ✓ TC 40 °F PRE
- TC ____ °F POST
- ORSAT SYSTEM

FILTER/XAD	TARE WT.
PM 153	.2661

EQUIPMENT I.D. NUMBERS

REAGENT BOX 605 | METER BOX N-11 | Y .9904
PITOT HH-72-2 | C_p .84 | NOZ'L — | DIA. .219
TC READOUT R-39 | TC PROBE E 303/301 | UMBILICAL NA
SAMPL'G BOX ____ | ORSAT PUMP NA | TEDLAR BAG NA

NOMOGRAPH DATA

DELTA H@	1.882
METER TEMP	70
EST. %H2O	1
C FACTOR	1.068
STACK TEMP	50
REF DELTA P	.173
K FACTOR	10.944

LEAK CHECKS

B ____ B ____
E ____ E ____

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	ORIFICE SETTING IN. H2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	✓
1	1	1132	994.000	.1516	98	59	.621	.621	>1	158			
2	1	1137	996.335	.1516	98	61	.621	.621	>1	130			
3	1	1142	998.670	.1516	98	60	.621	.621	>1	136			
4	2	1147	1001.035	.0657	99	61	.621	.621	>1	139			
5	2	1158	1003.355	.0657	99	62	.621	.621	>1	162			
6	2	1203	1005.685	.0657	99	61	.621	.621	>1	163			
7	3	1208	1008.055	.0596	100	62	.621	.621	>1	135			
8	3	1213	1010.335	.0596	101	61	.621	.621	>1	131			
9	3	1218	1012.665	.0596	101	61	.621	.621	>1	118			
10	4	1223	1015.000	.055	102	62	.621	.621	>1	117			
11	4	1228	1017.335	.055	102	62	.621	.621	>1	118			
12	4	1233	1019.680	.055	102	63	.621	.621	>1	121			
13	STOP	1238	1022.035										
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

* FILTER EXIT for NJ Method 1. FILTER BOX for all ot...

** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser

Min. (θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH
60	28.025	.0587		61.25	

ENTROPY

FIELD DATA - METHOD(S)

PLANT MARTIN MARIETTA RUN NO. IN/DRY/3A/12-12
CITY/STATE GARNER, NC JOB NO. 3684 DATE 12-12-91
SAMPLING LOC. INLET TIME START 1400
BAROMETRIC PRESSURE, IN. HG 30.3 STATIC PRESSURE, IN. H2O -.2865 TIME FINISH 1500
LEAK CHECK, VACUUM IN. HG 15 OPERATOR HWL
LEAK RATE, CUBIC FEET/MIN. .001 ASST(S) TTB

EQUIPMENT CHECKS*
✓ PITOT, PRETEST
✓ PITOT, POSTTEST
✓ NOZZLE, PRE/POST
✓ TC 58 °F PRE
TC ____ °F POST
ORSAT SYSTEM

FILTER/XAD	TARE WT.
PM154	.2721

EQUIPMENT I.D. NUMBERS
REAGENT BOX 603 METER BOX N-11 Y .9904
PITOT HH-32-2 Cp .84 NOZ'L — DIA. .219
TC READOUT R-39 TC PROBE R303/301 UMBILICAL —
SAMPL'G BOX N/A ORSAT PUMP N/A TEDLAR BAG —

NOMOGRAPH DATA
DELTA H@ 1.882
METER TEMP 70
EST. %H2O 1
C FACTOR 1.068
STACK TEMP 50
REF DELTA P .173
K FACTOR 10.994

LEAK CHECKS
B E B E
B E B E
B E B E

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	ORIFICE SETTING IN. H2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	✓
1	1	1400	22.400	.1516	102	60	.621	.621	>1	163			
2	1	1405	24.770	.1516	102	61	.621	.621	>1	148			
3	1	1410	27.115	.1516	102	61	.621	.621	>1	127			
4	2	1415	29.435	.0657	103	61	.621	.621	>1	105			
5	2	1420	31.755	.0657	102	62	.621	.621	>1	116			
6	2	1425	34.190	.0657	102	61	.621	.621	>1	125			
7	3	1430	36.635	.0596	102	61	.621	.621	>1	137			
8	3	1435	39.075	.0596	102	61	.621	.621	>1	141			
9	3	1440	41.520	.0596	103	61	.621	.621	>1	137			
10	4	1445	43.960	.055	104	61	.621	.621	>1	123			
11	4	1450	46.425	.055	104	61	.621	.621	>1	121			
12	4	1455	48.895	.055	104	61	.621	.621	>1	119			
13	stop	off-1500	51.370										
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

* FILTER EXIT for NJ Method 1. FILTER BOX for all others.
** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

Min. (θ) Vm $(\sqrt{\Delta p})^2$ tm ts ΔH

ENTROPY

FIELD DATA - METHOD(S) PM10

PLANT Martin-Marietta RUN NO. OUT-dry-1a-12-12

CITY/STATE Garner, N.C. JOB NO. 3684 DATE 12-12-91

SAMPLING LOC. Crusher Outlet TIME START ~~0845~~ 0745

BAROMETRIC PRESSURE, IN. HG 30.3 STATIC PRESSURE, IN. H_2O -.6959 TIME FINISH ~~0945~~ 0845

OPERATOR WKK

LEAK CHECK, VACUUM IN. HG 15.0 ASST(S)

LEAK RATE, CUBIC FEET/MIN. 0.001

EQUIPMENT CHECKS*	
✓	PITOT, PRETEST
✓	PITOT, POSTTEST
✓	NOZZLE, PRE/POST
✓	TC ✓ °F PRE
✓	TC ✓ °F POST
—	ORSAT SYSTEM

FILTER/XAD	TARE WT.
PM-149	0.2710

EQUIPMENT I.D. NUMBERS

REAGENT BOX 605 METER BOX N-6 Y 0.9871

PITOT — C_p .84 NOZ'L 7/16 DIA. 0.2185

TC READOUT F-32 TC PROBE UMBILICAL U7

SAMPL'G BOX — ORSAT PUMP — TEDLAR BAG —

NOMOGRAPH DATA

DELTA H@ 1.779

METER TEMP

EST. %H2O 3%

C FACTOR

STACK TEMP

REF DELTA P

K FACTOR

LEAK CHECKS

B / E

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

	LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	ORIFICE SETTING IN. H2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	✓
*	1	A-1	0845	125.100	.2037	64	40	.611	.611	0	146	38		
	2	1	0850	127.315	↓	66	46	.61	.61	0	157	38		
	3	1	0855	129.562	↓	68	46	.61	.61	0	172	38		
Port X	4	A-2	0900	131.818	.3093	70	46	.61	.61	0	148	38		
	5	2	0905	134.078	↓	71	45	.61	.61	0	146	39		
	6	2	0910	136.348	↓	72	46	.61	.61	0	144	38		
Port X	7	A-3	0915	138.608	.4324	74	47	.61	.61	0	146	38		
	8	3	0920	140.862	↓	74	44	.61	.61	0	139	38		
	9	3	0925	143.124	↓	74	43	.61	.61	0	134	38		
Port X	10	A-4	0930	145.382	.3625	75	45	.61	.61	0	127	38		
	11	4	0935	147.648	↓	76	45	.61	.61	0	126	38		
	12	4	0940	149.908	↓	76	45	.61	.61	0	141	38		
	13	Stop	0945	152.170										
	14													
	15			* ALL times are off by 1 hour test was										
	16			run 0745 — 0845										
	17													
	18													
	19													
	20													
	21													
	22													
	23													
	24													
	25													

* FILTER EXIT for NJ Method 1. FILTER BOX for all o...

** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser

Min. (θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH
60	27.070	.3212		44.8	

F-1112 (Page 1) 9-9

ENTROPY

FIELD DATA - METHOD(S) PM10

PLANT Martin-Marietta
RUN NO. OUT/Dry/2a/12
CITY/STATE Garner, N.C.
JOB NO. 3684
DATE 12-12-91
SAMPLING LOC. Crusher OUTLET
TIME START 0945
BAROMETRIC PRESSURE, IN. HG 30.3
STATIC PRESSURE, IN. H2O -.6959
TIME FINISH 1105
LEAK CHECK, VACUUM IN. HG 15.0
OPERATOR WKK
LEAK RATE, CUBIC FEET/MIN. 0.005
ASST(S)

EQUIPMENT CHECKS*	
—	PITOT, PRETEST
—	PITOT, POSTTEST
✓	NOZZLE, PRE/POST
✓	TC ✓ °F PRE
✓	TC ✓ °F POST
—	ORSAT SYSTEM

EQUIPMENT I.D. NUMBERS

REAGENT BOX 0208 METER BOX N-6 Y 0.9871
PITOT ______ Cp ______ NOZ'L 0.2185 DIA. 7/16
TC READOUT F-32 TC PROBE ______ UMBILICAL U-7
SAMPL'G BOX 78 ORSAT PUMP — TEDLAR BAG —

NOMOGRAPH DATA

DELTA H@	1.779
METER TEMP	
EST. %H2O	3%
C FACTOR	
STACK TEMP	
REF DELTA P	
K FACTOR	

FILTER/XAD	TARE WT.
PM-157	0.2752

LEAK CHECKS

B ______ B ______
E ______ E ______

B ______ B ______
E ______ E ______

B ______ B ______
E ______ E ______

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	ORIFICE SETTING IN. H2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	√
1	A-1	0945	152.652	.2037	79	66	.61	.61	0	209	41		1
2	1	0950	154.895	↓	79	67	.61	.61	0	216	41		11
3	1	0955	157.128	↓	80	65	.61	.61	0	193	41		1
4	A-2	1000	159.382	.3093	82	66	.61	.61	0	178	42		9
5	2	1005	161.636	↓	82	62	.61	.61	0	175	43		9
6	2	1010	163.888	↓	83	62	.61	.61	0	167	43		9
7	A-3	1015	166.148	.4324	84	60	.61	.61	0	166	44		7
8	3	1040	168.367	↓	83	57	.61	.61	0	132	44		7
9	3	1045	170.652	↓	85	56	.62	.61	0	130	42		7
10	A-4	1050	172.901	.3625	86	57	.61	.61	0	126	43		8
11	4	1055	175.155	↓	86	55	.61	.61	0	132	44		8
12	4	1100	177.401	↓	87	56	.61	.61	0	131	44		8
13	Stop	1105	179.653										
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

Port x (line 4)
1005 Brief belt inter. (line 5)
Port x (line 7)
Belt stopped 1018 2 min. 40 s. Remaining (line 8–9)
Port x (line 10)
1032 - restart belts

* FILTER EXIT for NJ Method 1. FILTER BOX for all others.
** PROBE EXIT & √ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

Min. (θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH
60	27.001	.3212		60.75	

ENTROPY

FIELD DATA - METHOD(S) PM10

PLANT Martin-Marietta RUN NO. OUT/DRY/3A/12-12
CITY/STATE Garner, N.C. JOB NO. 3684 DATE 12-12-91
SAMPLING LOC. Crusher Outlet TIME START 1140
BAROMETRIC PRESSURE, IN. HG 30.3 STATIC PRESSURE, IN. H_2O -.6959 TIME FINISH 1354
LEAK CHECK, VACUUM IN. HG 0.014@15 IN. OPERATOR WKK
LEAK RATE, CUBIC FEET/MIN. ASST(S)

EQUIPMENT CHECKS*	
✓	PITOT, PRETEST
✓	PITOT, POSTTEST
✓	NOZZLE, PRE/POST
✓	TC ✓ °F PRE
✓	TC ✓ °F POST
✓	ORSAT SYSTEM

FILTER/XAD	TARE WT.
PM-167	0.2756

EQUIPMENT I.D. NUMBERS

REAGENT BOX 0208 METER BOX Y 0.9871
PITOT C_p .84 NOZ'L 0.2185 DIA. 7/16
TC READOUT TC PROBE — UMBILICAL U-7
SAMPL'G BOX 77 ORSAT PUMP — TEDLAR BAG —

NOMOGRAPH DATA

DELTA H@ 1.779
METER TEMP
EST. %H_2O 3%
C FACTOR
STACK TEMP
REF DELTA P
K FACTOR

LEAK CHECKS

B / E (blank)

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

Note	LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H_2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	ORIFICE SETTING IN. H2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMP. FILTER *	GAS TEMP. IMPING. EXIT	PROBE OR COND EXIT**	✓
	1	A-1	1140	180.055	.2037	88	58	.61	.61	0	108	40		
	2	1	1145	182.339	↓	88	62	.61	.61	0	116	40		
1148 Belt stopped 2.0 MIN remain	3	1	1155	184.630	↓	89	61	.61	.61	0	128	42		
1151 Belt restart	4	A-2	1200	186.911	.3093	91	61	.61	.61	0	133	41		
Port X	5	2	1205	189.189	↓	92	59	.61	.61	0	144	40		
	6	2	1210	191.485	↓	93	60	.61	.61	0	148	42		
Port X	7	A-3	1215	193.780	.4324	94	55	.61	.61	0	150	42		
	8	3	1220	196.068	↓	95	60	.61	.61	0	122	44		
	9	3	1225	198.367	↓	96	60	.61	.61	0	112	44		
Port X	10	A-4	1230	200.673	.3625	97	60	.61	.61	0	110	44		
	11	4	1235	202.984	↓	98	61	.61	.61	0	106	45		
	12	4	1240	205.298	↓	98	60	.61	.61	0	106	45		
1243 belt stop 2.0 MIN remain	13	Stop	~~1245~~	207.632										
1351 restart belt	14		1354											
	15													
	16													
	17													
	18													
	19													
	20													
	21													
	22													
	23													
	24													
	25													

* FILTER EXIT for NJ Method 1. FILTER BOX for all others.
** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

Min. (θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH
60	27.577	.3212		59.75~60	

ENTROPY

FIELD DATA - METHOD(S)

PLANT Martin Marietta
RUN NO. IN/~~DEV~~ WET/1/1210
CITY/STATE Garner NC
JOB NO. 3684
DATE 12/10/91
SAMPLING LOC. INLET
TIME START 1225
TIME FINISH 1525
BAROMETRIC PRESSURE, IN. HG 30.1
STATIC PRESSURE, IN. H2O -.3565
LEAK CHECK, VACUUM IN. HG 15
OPERATOR TTB
LEAK RATE, CUBIC FEET/MIN. .002
ASST(S) WKK

EQUIPMENT CHECKS*

- N/A PITOT, PRETEST
- ✓ PITOT, POSTTEST
- ✓ NOZZLE, PRE/POST
- ✓ TC 68 °F PRE
- TC ___ °F POST
- N/A ORSAT SYSTEM

FILTER/XAD	TARE WT.
#5	.2176

EQUIPMENT I.D. NUMBERS

REAGENT BOX 0573 METER BOX ~~N6~~ N-TTB Y ~~.9945~~ .9904
PITOT — C_p .84 NOZ'L 3/4DES 1.6 DIA. .3125
TC READOUT R-39 TC PROBE — UMBILICAL —
SAMPL'G BOX ___ ORSAT PUMP — TEDLAR BAG —

NOMOGRAPH DATA

DELTA H@	1.882
METER TEMP	~~77~~ 110
EST. %H2O	3
C FACTOR	1.111
STACK TEMP	70
REF DELTA P	.0587
K FACTOR	11.006

LEAK CHECKS

B ___ B ___
E ___ E ___

FYRITES

N/A

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	ORIFICE SETTING IN. H2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	✓
1	1	1225	691.218	.1516	64	67	.622	.622	>1	161			
2	1	1240	697.800	.1516	72	61	.622	.622	>1	169			
3	1	1255	704.481	.1516	80	63	.622	.622	>1	149			
4	2	1320	711.456	.0657	86	63	.622	.622	>1	150			
5	2	1325	718.587	.0657	88	60	.622	.622	>1	115			
6	2	1340	725.645	.0657	89	61.2	.622	.622	>1	121.8			
7	3	1355	732.613	.0596	89	61	.622	.622	>1	118			
8	3	1410	740.085	.0596	90	60	.622	.622	>1	119			
9	3	1425	747.291	.0596	92	62	.622	.622	>1	116			
10	4	1440	754.582	.055	91	62	.622	.622	>1	110			
11	4	1455	761.869	.055	91	60	.622	.622	>1	115			
12	4	1510	769.160	.055	92	60	.622	.622	>1	119			
13	off	1525 off	770.278										
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

.65 .70 .622 .69 .72

.512 off Plant Down

* FILTER EXIT for NJ Method 1. FILTER BOX for all others.
** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

167	79.060	.0587		61.7	
Min. (θ)	Vm	$(\sqrt{\Delta P})^2$	tm	ts	ΔH

2.783 Hrs

ENTROPY

F-1112 (Page 1) 9-91

FIELD DATA - METHOD(S) [illegible]

PLANT Martin Marietta RUN NO. IN/WET/2/12-11

CITY/STATE Garner / NC JOB NO. 3684 DATE 12-11-91

SAMPLING LOC. Inlet TIME START 0825

BAROMETRIC PRESSURE, IN. HG 30.3 STATIC PRESSURE, IN. H2O -2865 TIME FINISH 1204

LEAK CHECK, VACUUM IN. HG 15.0 OPERATOR HWL

LEAK RATE, CUBIC FEET/MIN. .007 ASST(S)

EQUIPMENT CHECKS*

- ✓ PITOT, PRETEST
- ✓ PITOT, POSTTEST
- ✓ NOZZLE, PRE/POST
- ✓ TC 40 °F PRE
- TC °F POST
- NA ORSAT SYSTEM

FILTER/XAD	TARE WT.
SF563	.2786

EQUIPMENT I.D. NUMBERS

REAGENT BOX 608 METER BOX N-11 Y .9904

PITOT — C_p .84 NOZ'L — DIA. .125

TC READOUT E-39 TC PROBE E303/301 UMBILICAL —

SAMPL'G BOX — ORSAT PUMP — TEDLAR BAG NA

NOMOGRAPH DATA

- DELTA H@ 1.882
- METER TEMP 70
- EST. %H2O 3
- C FACTOR 1.033
- STACK TEMP 50
- REF DELTA P .173
- K FACTOR 10.635

LEAK CHECKS

B
E

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	ORIFICE SETTING IN. H2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	✓
1	1	0825	770.601	.1516	76	43	.614	.614	1	85			
2	1	0840	777.395	.1516	81	41.6	.614	.614	1	150			
3	1	0855	784.195	.1516	86	42.6	.614	.614	1	154			
4	2	0910	791.065	.0657	90	43.8	.614	.614	1	138			
5	2	0925	798.035	.0657	91	47.0	.614	.614	1	121			
6	2	0940	805.210	.0657	92	51	.614	.614	1	125			
7	3	0955	812.465	.0546	94	48	.614	.614	1	119			
8	3	~~1010~~ 1014	819.595	.0546	82	56	.614	.614	1	135			
9	3	~~1025~~ 1029	826.725	.0546	88	55	.614	.614	1	129			
10	4	~~1040~~ 1044	833.940	.055	94	58	.614	.614	1	109			
11	4	~~1055~~ 1059	841.340	.055	97	60	.614	.614	1	117			
12	4	~~1110~~ 1114	848.765	.055	98	61	.614	.614	1	121			
13	OFF	~~1125~~ 1129	856.200	.055	100	61	.614	.614	1	117			
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

8 → 10:44
9 → 11:04
10 → 11:19
11 → 11:34
12 → 11:49
13 → 12:04

9:55:35 STOP
9:59:35 START
9:05:30 STOP
10:40:30 START

4.0 min
+ 35 min
39 min Total stop

* FILTER EXIT for NJ Method 1. FILTER BOX for all other.

** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

180	85.599	.0587		55.6	
Min. (θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH

3 Hrs.

ENTROPY

F-1112 (Page 1) 9-91

FIELD DATA - METHOD(S) ______

PLANT Martin Marietta RUN NO. IN/wet/3/12-11

CITY/STATE Garner/NC JOB NO. 3684 DATE 12-11-91

SAMPLING LOC. INLET TIME START 1300

BAROMETRIC PRESSURE, IN. HG 30.3 STATIC PRESSURE, IN. H2O -2.865 TIME FINISH 1603

LEAK CHECK, VACUUM IN. HG 15.0 OPERATOR HWL

LEAK RATE, CUBIC FEET/MIN. .007 ASST(S)

EQUIPMENT CHECKS*

- ✓ PITOT, PRETEST
- ✓ PITOT, POSTTEST
- ✓ NOZZLE, PRE/POST
- ✓ TC 40 °F PRE
- TC ___ °F POST
- NA ORSAT SYSTEM

FILTER/XAD	TARE WT.
SF634	.2760

EQUIPMENT I.D. NUMBERS

REAGENT BOX 608 METER BOX N-11 1904
PITOT ____ Cp .84 NOZ'L — DIA. .125
TC READOUT N-39 TC PROBE X303/301 UMBILICAL —
SAMPL'G BOX — ORSAT PUMP — TEDLAR BAG NA

NOMOGRAPH DATA

DELTA Hə	1.882
METER TEMP	70
EST. %H2O	3
C FACTOR	1.053
STACK TEMP	52
REF DELTA P	.173
K FACTOR	10.635

LEAK CHECKS

B ___ B ___
E ___ E ___

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

1313:30 STOP +3 min
1316:30 START

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	✓
1	1	1300	856.701	.1516	97	62	.614	.614	1	115			
2	1	1318	863.570	.1516	96	73	.614	.614	1	153			
3	1	1333	870.605	.1516	96	71	.614	.614	1	146			
4	2	~~1348~~	877.850	.0657	97	70	.614	.614	1	108			
5	2	1403	885.155	.0657	97	71	.614	.614	1	114			
6	2	1418	892.395	.0657	97	65	.614	.614	1	108			
7	3	1433	899.335	.0596	96	66	.614	.614	1	118			
8	3	1448	906.210	.0596	98	65	.614	.614	1	119			
9	3	1503	913.090	.0596	98	66	.614	.614	1	124			
10	4	1518	920.000	.055	99	63	.614	.614	1	125			
11	4	1533	926.955	.055	99	61	.614	.614	1	124			
12	4	1548	933.905	.055	100	60	.614	.614	1	124			
13	OFF	1603	940.855	.055	98	60	.614	.614	1	124			
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

* FILTER EXIT for NJ Method 1. FILTER BOX for all others.

** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

Min. (θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH
180	84.154	.0587		71.08	

3 hr

ENTROPY

F-1112 (Page 1) 9-91

FIELD DATA - METHOD(S) ______

PLANT	Martin-Marietta	RUN NO.	DUT / wet / 1 / 12-1
CITY/STATE	Garner	JOB NO.	3684
SAMPLING LOC.	Crusher Outlet	DATE	12/10/91
BAROMETRIC PRESSURE, IN. HG	30.1	STATIC PRESSURE, IN. H_2O	-.70
TIME START	1341	TIME FINISH	1613
LEAK CHECK, VACUUM IN. HG	10 / 10	OPERATOR	SCB/WKK
LEAK RATE, CUBIC FEET/MIN.	.015 / .002	ASST(S)	

EQUIPMENT CHECKS*
___ PITOT, PRETEST
___ PITOT, POSTTEST
___ NOZZLE, PRE/POST
___ TC ___ °F PRE
___ TC ___ °F POST
___ ORSAT SYSTEM

FILTER/XAD	TARE WT.
#6	0.2182

EQUIPMENT I.D. NUMBERS

REAGENT BOX	0223	METER BOX	N6	Y	.9871
PITOT		C_p	.84	NOZ'L	Desired .205; DIA. .205
TC READOUT	F32	TC PROBE	-	UMBILICAL	U74
SAMPL'G BOX		ORSAT PUMP	N/A	TEDLAR BAG	N/A

NOMOGRAPH DATA

DELTA H@	1.779		
METER TEMP	80		
EST. $\%H_2O$	1		
C FACTOR			
STACK TEMP	60		
REF DELTA P			
K FACTOR			

LEAK CHECKS

B ___ B ___
E ___ E ___

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H_2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	√
1	01	0	878.855	.2037	78	56	.6	.6	0	102	44		
2	01	15	885.588	.2037	82	55.4			0	166	40		
3	01	30	892.22	.2037	90	57	.5	.5	0	157	44		
4	02	45	898.62	.3093	91	56	.6	.6	0	150	44		
5	02	60	905.45	.3093	92	57			0	127	44		
6	02	15	912.28	.3093	92	57	.57	.57	0	141	44		
7	03	30	918.99	.4324	94	56	.57	.5	0	144	45		
8	03	45	925.58	.4324	94	57			0	153	45		
9	03	60	932.11	.4324	95	58			0	153	46		
10	04	15	938.64	.3625	95	58			0	154	46		
11	04	30	945.23	.3625	95	58			0	172	46		
12	04	45		.3625									
13		60/stop	946.111										
14													
15													
16													
17													
18			946.111										
19			2hrs 32 mins										
20													
21													
22													
23													
24													
25													

* FILTER EXIT for NJ Method 1. FILTER BOX for all ot

** PROBE EXIT & √ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a cond

Min. (θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH
152	67.256	.3212		57	

2.533

ENTROPY

FIELD DATA - METHOD(S) PM10 -

PLANT Martin - Marietta
CITY/STATE Garner, N.C.
SAMPLING LOC. Crusher Outlet
BAROMETRIC PRESSURE, IN. HG 30.3 STATIC PRESSURE, IN. H2O -.6959
LEAK CHECK, VACUUM IN. HG 0.012@15
LEAK RATE, CUBIC FEET/MIN.

RUN NO. OUTWET21211
JOB NO. 3684 DATE 12/11/91
TIME START 0820
TIME FINISH 1200
OPERATOR WKK
ASST(S)

EQUIPMENT CHECKS*	
—	PITOT, PRETEST
—	PITOT, POSTTEST
✓	NOZZLE, PRE/POST
✓	TC ___ °F PRE
✓	TC ___ °F POST
—	ORSAT SYSTEM

FILTER/XAD	TARE WT.
PM10109	0.2643

EQUIPMENT I.D. NUMBERS

REAGENT BOX 608 METER BOX N-6 Y .9871
PITOT — C_p 0.84 NOZ'L DIA. 0.219
TC READOUT F-32 TC PROBE — UMBILICAL U74
SAMPL'G BOX ORSAT PUMP — TEDLAR BAG —

NOMOGRAPH DATA

DELTA H@	1.779			
METER TEMP				
EST. %H2O	3%			
C FACTOR				
STACK TEMP				
REF DELTA P				
K FACTOR				

LEAK CHECKS

B		B	
E		E	
B		B	
E		E	
B		B	
E		E	

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H2O ACTUAL	ORIFICE SETTING IN. H2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	~~PROBE OR COND EXIT**~~	✓	%I
1	A-1	0820	951.048	.2037	60	40.0	0.587	0.587	0	120	36			116.
2	A-1	0835	957.780	.2037	69	42	0.587	0.587	0	159	36			111.
3	A-1	0850	964.346	.2037	74	43	0.587	0.58	0	164	36			111.
4	A-1	0905	970.965	~~.2037~~ .3093	78	43	0.6	0.58	0	167	36			89.
5	A-2	0920	977.548	.3093	80	45	0.59	0.59	0	167	36			89.
6	A-2	0935	984.152	.3093	81	47	0.59	0.59	0	159	38			89.
7	A-2	0950	990.758	~~.3093~~ .3324	82	48	0.59	0.59	0	155	38			77.
8	A-3	~~1005~~	997.498	.4324	66	50	0.59	0.59	0	166	39	CLOCK TIME ↓		84.
9	A-3	~~1020~~	1004.602	.4324	73	53	0.63	0.59	0	163	~~53~~ 40	1100		79.
10	A-3	~~1035~~	1011.395	~~.4324~~ .3625	80	55	0.63	0.59	0	188	40	1115		86.
11	A-4	~~1050~~	1018.242	.3625	85	55	0.65	0.59	0	157	43	1130		87.
12	A-4	~~1105~~	1025.218	.3625	87	55	0.64	0.59	0	139	44	1145		87.
13	A-4	~~1120~~	1032.213	~~.3625~~	90	55	0.65	0.59	0	133	44	1200		
14														92.
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														

@9:55 Belt stopped 992.994
@1000 belt began, stopped again
@10:35 good startup
Belt overload caused problem

* FILTER EXIT for NJ Method 1. FILTER BOX for all others.
** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

180	81.165	.3212		52.58	
Min. (θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH

ENTROPY

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(7)

FIELD DATA - METHOD(S) PM10

PLANT	Martin-Marietta/Garner	RUN NO.	OUT/WET/3/12-11
CITY/STATE	Garner, N.C.	JOB NO. 3684	DATE 12-11-91
SAMPLING LOC.	OUTLET-CRUSHER	TIME START	1305
BAROMETRIC PRESSURE, IN. HG	30.0	STATIC PRESSURE, IN. H_2O -.6959	TIME FINISH ~~1409~~ 1609
LEAK CHECK, VACUUM IN. HG	15 in Hg	OPERATOR	WKK
LEAK RATE, CUBIC FEET/MIN.	.001	ASST(S)	

EQUIPMENT CHECKS*	
—	PITOT, PRETEST
—	PITOT, POSTTEST
✓	NOZZLE, PRE/POST
✓	TC ___ °F PRE
✓	TC ___ °F POST
—	ORSAT SYSTEM

FILTER/XAD	TARE WT.
SF-600	0.2775

EQUIPMENT I.D. NUMBERS

REAGENT BOX	605	METER BOX	N-6	Y	0.9871
PITOT		C_p	0.84	NOZ'L DIA.	0.219
TC READOUT	F-32	TC PROBE	-	UMBILICAL	U74
SAMPL'G BOX		ORSAT PUMP	—	TEDLAR BAG	—

NOMOGRAPH DATA

DELTA H@	1.779
METER TEMP	
EST. %H_2O	3%
C FACTOR	
STACK TEMP	
REF DELTA P	
K FACTOR	

LEAK CHECKS

B	B
E	E
B	B
E	E
B	B
E	E

FYRITES

* PITOT: VISUAL INSPECTION/LEAK CHECK; NOZZLE: VISUAL INSPECTION; TC: AMBIENT TEMPS.; ORSAT SYSTEM: LEAK CHECK

	LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READING CUBIC FEET	PITOT READING IN. H_2O	GAS METER TEMP. °F	STACK TEMP. °F	ORIFICE SETTING IN. H_2O ACTUAL	ORIFICE SETTING IN. H_2O IDEAL	GAUGE VACUUM IN. HG	GAS TEMPERATURES °F FILTER *	IMPING. EXIT	PROBE OR COND EXIT**	✓	φ 15
	1	A-1	1305 / 0	32.892	0.2037	92	59	0.59	0.59	0	100	48			115
1312 - belt stopped	2	1	1320 / 15	39.857	0.2037	84	61	0.61	0.59	0	126	44			123
1316 - restart	3	1	1339 / 30	47.185	0.2037	90	61	0.62	0.59	0	132	45			105
	4	A 2	1354 / 45	53.484	0.3093	94	58	0.62	0.59	0	134	45			90
	5	2	1409 / 60	60.253	0.3093	96	60	0.58	0.59	0	139	46			)
	6	2	1424 / 75	66.975	0.3093	98	60	0.59	0.59	0	142	46			89.
	7	A 3	1439 / 90	73.686	0.4324	99	60	0.59	0.59	0	129	47			75.
	8	3	1454 / 105	80.420	0.4324	100	60	0.59	0.59	0	120	46			75.
	9	3	1509 / 120	87.162	0.4324	101	60	0.59	0.59	0	116	46			76.
	10	A 4	1524 / 135	93.938	0.3625	102	60	0.59	0.59	0	131	47			84
	11	4	1539 / 150	100.798	0.3625	101	59	0.62	0.59	0	142	48			84.
	12	4	1554 / 165	107.700	0.3625	100	59	0.62	0.59	0	137	47			84.
	13	off	1609 / 180	114.588	0.3625	98	59	0.62	0.59	0	136	48			91.
	14														
	15														
	16														
	17														
	18														
	19														
	20														
	21														
	22														
	23														
	24														
	25														

* FILTER EXIT for NJ Method 1. FILTER BOX for all othe

** PROBE EXIT & ✓ (probe & filter heat off) apply to NJ Method 1. COND EXIT applies if sampling train has a condenser.

Min. (θ)	Vm	$(\sqrt{\Delta p})^2$	tm	ts	ΔH
180	81.696	.3212		59.75 ±60	

ENTROPY

ON SITE MOISTURE SAMPLING

LABORATORY RESULTS

.nt Name: Martin Marietta

EEI Ref# 3684

Sampling Location: Garner

Date Analyzed:

Reagent Box(es): 0573

Run Number	IN/DRY/1/12-9	OUT/DRY/1/12-9	IN/DRY/2/12-
Run Date	12/9/91	12/9/91	12/9/91

ANALYSIS OF MOISTURE CATCH

Reagent 1 (H_2O)			
Final Weight, g.	586.0	581.9	582.8
Tared Weight, g.	581.0	579.5	580.0
Water Catch, g	5.0	2.4	2.8
Reagent 2 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
Reagent 3 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
CONDENSED WATER, G.			
Silica Gel:			
Final Weight, g.	223.7	211.8	211.2
Tared Weight, g.	216.5	200.0	203.5 ~~201.0~~
ADSORBED WATER, g.	7.2	11.8	7.7
TOTAL WATER COLLECTED, g.	12.2 g	14.2 g	10.5 g

Balance # 12

.itials ---> HWL HWL HWL

Sample Custodian (init.) DRR

Received into custody 12-18-91

ON SITE MOISTURE SAMPLING

LABORATORY RESULTS

Plant Name: Martin Marietta

EEI Ref# 3684

Sampling Location: ~~Outlet~~ Garner, NC

Reagent Box(es): 0223

Date Analyzed:

Run Number	OUT/DRY/2/12-9 ~~Out #2~~	Out/wet/1/12-10	IN/wet/1/12-10
Run Date	12 / 9 / 91	12 / 10 /91	12 / 10 /91

ANALYSIS OF MOISTURE CATCH

Reagent 1 (H_2O)			
Final Weight, g.	590.5	586.5	584.3
Tared Weight, g.	585.0	584.5	581.5
Water Catch, g	5.5	2.0	2.8
Reagent 2 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
Reagent 3 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
CONDENSED WATER, G.			
Silica Gel:			
Final Weight, g.	210.2	212.5	213.5
Tared Weight, g.	200.5	200.5	201.0
ADSORBED WATER, g.	9.7	12.0	12.5
TOTAL WATER COLLECTED, g.	15.2	14.0	15.3

Balance # 12

Initials --->	HWL	HWL	HWL

Sample Custodian (init.) DRA

Received into custody 12-15-91

ON SITE MOISTURE SAMPLING

LABORATORY RESULTS

Plant Name: Martin Marietta

Sampling Location: farmer, NC

Date Analyzed:

EEI Ref# 3684

Reagent Box(es): 608

Run Number	OUT/WET/2/12-11	IN/WET/2/12-11	IN/WET/3/12-11
Run Date	12 / 11 / 91	12/ 11 /91	12/ 11 /91

ANALYSIS OF MOISTURE CATCH

Reagent 1 (200ml H2O)			
Final Weight, g.	573.2	586.0	580.8
Tared Weight, g.	570.5	582.5	580.5
Water Catch, g	2.7	3.5	.3
Reagent 2 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
Reagent 3 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
CONDENSED WATER, G.			
Silica Gel:			
Final Weight, g.	226.8	219.4	239.9
Tared Weight, g.	214.0	207	225.5
ADSORBED WATER, g.	12.8	12.4	14.4
TOTAL WATER COLLECTED, g.			

Balance # 12

Initials ---> 15.5   15.9   14.7

Sample Custodian (init.) DRA   Received into custody 12-18-91

ON SITE MOISTURE SAMPLING

LABORATORY RESULTS

nt Name: Martin Marietta

EEI Ref# 3684

Sampling Location: Garner NC

Reagent Box(es): 625

Date Analyzed:

Run Number	OUT/WET/3/12-11	IN/DRY/1A/12-12	OUT/DRY/1A/12
Run Date	12/11/91	12/12/91	12/12/91
ANALYSIS OF MOISTURE CATCH			
Reagent 1 (200g H_2O)			
Final Weight, g.	582.9	~~697.2~~ 680.2	601.3
Tared Weight, g.	580.0	675.5	600.5
Water Catch, g	2.9	~~21.7~~ 4.7	.8
Reagent 2 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
Reagent 3 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
CONDENSED WATER, G.			
Silica Gel:			
Final Weight, g.	211.2	~~211.2~~ 206.3	215.8
Tared Weight, g.	200.0	200.5	209.5
ADSORBED WATER, g.	11.2	~~10.7~~ 5.8	6.3
TOTAL WATER COLLECTED, g.	14.1	~~[illegible]~~ 10.5	7.1

Balance # 12

itials --->

Sample Custodian (init.) DR Pat

Received into custody 12-18-91

ON SITE MOISTURE SAMPLING

LABORATORY RESULTS

nt Name: MARTIN MARIETTA

EEI Ref# 3684

Sampling Location: GARNER, NC

Date Analyzed:

Reagent Box(es): 0208

Run Number	OUT/Dry/2a/12-12	OUT/DRY/3A/12-12		IN/DRY/2A/12-1
Run Date	12/12/91 12/12/91	12/12/91		12/12/91
ANALYSIS OF MOISTURE CATCH				
Reagent 1 ( )	OUT/Dry/2a/12-12			
Final Weight, g.	582.5	577.8	? 550.5	550.5
Tared Weight, g.	583.0	579.	? 542.0	554.5
Water Catch, g	-.5	-1.2	8.5	-4
Reagent 2 ( )				
Final Weight, g.				
Tared Weight, g.				
Water Catch, g.				
Reagent 3 ( )				
Final Weight, g.				
Tared Weight, g.				
Water Catch, g.				
CONDENSED WATER, G.				
Silica Gel:				
Final Weight, g.	203.6	208.4		207.4
Tared Weight, g.	200.0 g	204.0		203
ADSORBED WATER, g.	3.6	4.4		4.4
TOTAL WATER COLLECTED, g.			Tare wrong used	
Balance # 12				? H_2O TARE
itials --->	3.1	3.2	12.9	.4

Sample Custodian (init.) [signature]

Received into custody 12-19-91

ON SITE MOISTURE SAMPLING

LABORATORY RESULTS

Plant Name: MARTIN MARIETTA

EEI Ref# 3684

Sampling Location: Garner, NC

Reagent Box(es): 603

Date Analyzed:

Run Number	IN/DRY/3A/12-12		
Run Date	12 / 12 / 91	/ /91	/ /91

ANALYSIS OF MOISTURE CATCH

Reagent 1 (200g H_2O)			
Final Weight, g.	581.5		
Tared Weight, g.	581.5		
Water Catch, g	0		
Reagent 2 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
Reagent 3 ( )			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
CONDENSED WATER, G.			
Silica Gel:			
Final Weight, g.	206.8		
Tared Weight, g.	202.0		
ADSORBED WATER, g.	4.8		
TOTAL WATER COLLECTED, g.	4.8		

Balance # ______

Initials --->

Sample Custodian (init.) DR [signature] Received into custody 12-19-91

ISOKINETIC METERBOX FULLTEST CALIBRATION

Meterbox No. N6 Calibrated By MBC

Date 8-20-91 Barometric Pressure (P_b) 29.35 (In. Hg)

Date ______* Barometric Pressure (P_b) ______ (In. Hg)*

Standard Meter No. 3586003 Standard Meter Coefficient .9908

STANDARD METER			METERBOX METERING SYSTEM				
Gas Volume (V_{ds}) cf	Temp. (t_{ds}) °F	Time (θ) Min.	Orifice Setting (ΔH) In. H2O	Gas Volume (V_d) cf	Temp. (t_d) °F	Coeff. (Y_d)	$\Delta H@$ In. H_2O
4.114	77	10	0.5	4.218	85	.9795	1.720
4.092	77		0.5	4.195	86	.9822	1.733
7.934	78		2.0	8.134	91	.9849	1.836
7.832			2.0	8.081	95	.9857	1.831
12.350			4.8	12.743	105	.9965	1.774
12.327			4.8	12.756	105	.9936	1.780
					Average	.9871	1.779

1. Coefficient range: 0.97-1.03.
2. Coefficient tolerance: for individual runs, ± 0.02 from average.
3. $\Delta H@$ range: 1.6-2.0.
4. $\Delta H@$ tolerance: ≤ 0.15 In. H_2O over ΔH range of 0.4 In.-4.0 In.

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + (\Delta H / 13.6))}$$

$$\Delta H@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

R-0030 rev. 2-90

ENTROPY

ISOKINETIC METERBOX FULLTEST CALIBRATION

Meterbox No. N14

Date 8-5-91

Date ______________*

Standard Meter No. 1017057

Calibrated By MBC

Barometric Pressure (P_b) 29.57 (In. Hg)

Barometric Pressure (P_b) ________ (In. Hg)

Standard Meter Coefficient 1.0083

STANDARD METER			METERBOX METERING SYSTEM				
Gas Volume (V_{ds}) cf	Temp. (t_{ds}) °F	Time (θ) Min.	Orifice Setting (ΔH) In. H2O	Gas Volume (V_d) cf	Temp. (t_d) °F	Coeff. (Y_d)	$\Delta H@$ In. H_2O
4.275	75	11	0.5	4.440	86	.9896	1.830
3.873		10	0.5	4.040	89	.9907	1.832
7.720			2.0	8.001	92	.9988	1.835
7.691			2.0	8.006	93	.9963	1.845
11.461			4.8	11.935	98	.9980	1.977
11.475	76		4.8	12.001	100	.9954	1.972
					Average	.9948	1.882

1. Coefficient range: 0.97-1.03.
2. Coefficient tolerance: for individual runs, ± 0.02 from average.
3. $\Delta H@$ range: 1.6-2.0.
4. $\Delta H@$ tolerance: ≤ 0.15 In. H_2O over ΔH range of 0.4 In.-4.0 In.

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + (\Delta H / 13.6))}$$

$$\Delta H@ = \frac{0.0317 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \theta}{Y_{ds} * V_{ds}}\right]^2$$

R-0030 rev. 2-90

ENTROPY

ISOKINETIC METERBOX FULLTEST CALIBRATION

Meterbox No. N11 Calibrated By MBC/SWS

Date 10-24-91 Barometric Pressure (P_b) 29.85 (In. Hg)

Standard Meter No. 3586003 Standard Meter Coefficient .9908

STANDARD METER			METERBOX METERING SYSTEM				
Gas Volume (V_{ds}) cf	Temp. (t_{ds}) °F	Time (Θ) Min.	Orifice Setting (ΔH) In. H2O	Gas Volume (V_d) cf	Temp. (t_d) °F	Coeff. (Y_d)	ΔH@ In. H_2O
3.997	75	10	0.5	4.066	85	.9873	1.795
4.374	75	11	0.5	4.459	85	.9889	1.807
7.687	75	10	2.0	7.829	86	.9880	1.919
7.680	74		2.0	7.841	88	.9910	1.909
11.821	74		4.8	12.010	90	.9920	1.927
11.771	74		4.8	11.996	93	.9950	1.932
					Average	.9904	1.882

1. Coefficient range: 0.97-1.03.
2. Coefficient tolerance: for individual runs, ± 0.02 from average.
3. ΔH@ range: 1.6-2.0.
4. ΔH@ tolerance: ≤ 0.15 In. H_2O over ΔH range of 0.4 In.-4.0 In.

$$Y_d = \frac{Y_{ds} * V_{ds} * (t_d + 460) * P_b}{V_d * (t_{ds} + 460) * (P_b + \{\Delta H / 13.6\})}$$

$$\Delta H@ = \frac{0.0319 * \Delta H}{P_b * (t_d + 460)} * \left[\frac{(t_{ds} + 460) * \Theta}{Y_{ds} * V_{ds}}\right]^2$$

R-0030 rev. 10-91

ENTROPY

Dry Gas Meter Identification: 3586003 Calibration by: WLS

PAGE 1 OF 2

Date: 8-14-91 Barometric Pressure (P_b): 29.82 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

*Date: ______ *Barometric Pressure (P_b): ______ in. Hg

	Spirometer		Dry Gas Meter						
	Gas Volume (V_s) ft^3	Temp. (t_s) °F	Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F	Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q)	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	2.76	75	2.795	76	-.43	10	.23	.9904	NA
	2.75		2.765	76	-.43		.23	.9975	
	2.76		2.762	76	-.43		.23	1.0022	
	4.098		4.151	74	-.47		.55	.9865	
	4.089		4.136	74	-.47		.55	.9879	
	4.089		4.130	74	-.47		.55	.9894	
	4.927		4.985	76	-.95		.80	.9925	
	5.009		5.059	76	-.95		.80	.9943	
	4.964		5.042	76	-.95		.80	.9887	
	8.097		8.253	78	-2.2		2.10	.9920	
	8.078		8.237	78	-2.2		2.10	.9916	
	7.987		8.159	78	-2.2		2.10	.9898	
	10.383		10.636	78	-3.4		3.45	.9900	
	10.300		10.537	78	-3.4		3.45	.9913	
	10.300		10.552	78	-3.4		3.45	.9899	
	12.523		12.873	78	-4.95		4.70	.9904	

$$Y_{ds} = \frac{(V_s)\,(t_{ds} + 460)\,(P_b)}{(V_{ds})\,(t_s + 460)\,(P_b + (\ p\ /\ 13.6.}$$

Dry Gas Meter Identification: 3586003 Calibration by: WLS

Date: 8-14-91 Barometric Pressure (P_b): 29.82 in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

*Date: ______ *Barometric Pressure (P_b): ______ in. Hg

	Spirometer		Dry Gas Meter						
	Gas Volume (V_s) ft^3	Temp. (t_s) °F	Gas Volume (V_{ds}) ft^3	Temp. (t_{ds}) °F	Pressure (Δp) in. H_2O	Time (O) min.	Flow Rate (Q)	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	12.259	75	12.626	78	-4.95	10	4.70	.9884	NA
	12.077		12.441	78	-4.95		4.70	.9882	
	13.661		14.108	79	-5.70		5.80	.9895	
	13.652		14.107	79	-5.70		5.80	.9889	
	13.452		13.925	79	-5.70		5.80	.9871	

Y_{ds} = ~~.9908~~

$$Y_{ds} = \frac{(V_s)(t_{ds} + 460)(P_b)}{(V_{ds})(t_s + 460)(P_b + (p / 13.6))}$$

Dry Gas Meter Identification: 1017057 Calibration by: WLS

Date: 1-15-91 Barometric Pressure (P_b): 29.58 in. Hg

*Date: ______ *Barometric Pressure (P_b): ______ in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

Approx. Flow Rate (Q) cfm	Spirometer Gas Volume (V_s) ft³	Spirometer Temp. (t_s) °F	Dry Gas Meter Gas Volume (V_{ds}) ft³	Dry Gas Meter Temp. (t_{ds}) °F	Pressure (Δp) in. H_2O	Time (θ) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	2.5956	77.0	2.549	70.5	-0.40	10	0.2522	1.0070 ~~1.0066~~	
	2.6047	77.0	2.526	72.0	-0.40	10	0.2531	1.0226	
	2.5592	77.0	2.462	73.0	-0.40	10	0.2487	1.0328	
	4.4080	77.0	4.339	74.0	-0.62	11	0.3894	1.0118	
	4.0619	77.0	3.973	74.0	-0.62	10	0.3947	1.0182	
	3.9799	77.0	3.953	75.0	-0.62	10	0.3867	1.0046	
	4.8178	77.0	4.800	75.0	-0.80	10	0.4681	1.0020	
	4.8634	77.0	4.770	75.0	-0.80	10	0.4726	1.0178	
	4.8634	77.0	4.794	76.0	-0.80	10	0.4726	1.0146	
	7.8142	77.0	7.711	76.0	-1.70	10	0.7593	1.0158	
	7.7596	77.0	7.693	76.0	-1.70	10	0.7540	1.0111	
	7.7140	77.0	7.684	76.0	-1.70	10	0.7496	1.0063	
	10.0000	77.0	9.979	76.0	-2.10	10	0.9717	1.0055	
	9.8725	77.0	9.850	76.0	-2.10	10	0.9593	1.0057	
	9.8178	77.0	9.845	76.0	-2.10	10	0.9540	1.0006	
	11.5392	77.0	11.591	76.0	-3.40	10	1.1212	1.0021	

$Y_{ds} = \frac{(V_s)(t_{ds} + 460)(P_b)}{\ldots}$

$Q = (17.64)\frac{(P_b)(V_s)}{(t_s + 460)(\theta)}$

Dry Gas Meter Identification: 1017057 Calibration by: WLS

Date: 1-15-91 Barometric Pressure (P_b): 29.58 in. Hg

*Date: ______ *Barometric Pressure (P_b): ______ in. Hg

ENTROPY ENVIRONMENTALISTS, INC.

Approx. Flow Rate (Q) cfm	Spirometer Gas Volume (V_s) ft^3	Spirometer Temp. (t_s) °F	Dry Gas Meter Gas Volume (V_{ds}) ft^3	Dry Gas Meter Temp. (t_{ds}) °F	Pressure (Δp) in. H_2O	Time (θ) min.	Flow Rate (Q) cfm	Meter Meter Coeff. (Y_{ds})	Avg. Meter Coeff. ($\bar{Y}_{ds}$)
	11.5118	77.0	11.592	76.0	-3.40	10	1.1186	0.9997	
	11.5027	77.0	11.606	76.0	-3.40	10	1.1177	0.9977	
	12.7413	77.0	12.871	76.0	-4.40	10	1.2380	0.9990	
	12.6867	77.0	12.805	76.0	-4.40	10	1.2327	0.9999	
	12.6685	77.0	12.784	76.0	-4.40	10	1.2310	1.0001	

Yds =
1.0083

$$Y_{ds} = \frac{(V_s)\,(t_{ds} + 460)\,(P_b)}{(V_{ds})\,(t_s + 460)\,(P_b + (\Delta p / 13.6))}$$

$$Q = (17.64)\,\frac{(P_b)\,(V_s)}{(t_s + 460)\,(\theta)}$$

APPENDIX D.

Sampling Log and Chain-of-Custody Records

RECORD OF CUSTODY, CONTAINER NO. 0573

Container Type (check) X Reagent Box 0573 Cooler ___ Other ________

Plant Name/Address Martin Marietta / Garner

Job No. 3684 Sampling Method 2014 (EPA, NIOSH, etc.)

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
1650	11-26	3:15	S	Eddie Smith	
	12-9	7:55	B	Todd Brozell	Charge Trains.
446	12-13	1451	S	Todd Brozell	
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

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

Received by Sample Custodian **Seal Intact?

Donald R Pot[illegible] 12-19-91 11:00 X Yes ___ No

Signature Date Time

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

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

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

REMARKS ________

L-0023 rev. 10-91

ENTROPY

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. 0573 Assembly Date 11-26-91 Assembled By ES

Plant Name/address Martin Marietta Job No. 3684

Sampling Loc. Garner Inlet/outlet Crusher Method 201A

Individual Tare Of Reagent 200 (Ml)(gm) Of DI H_2O

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

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

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

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
In/Dry/1/12-9	12-9	PM75	.2537	✓	TTB	12-9	5	✓	TTB
Cyclone Rinse Nozzle Filter Rinse			.2166	Filter Appearance* Heavy loading		Reagents Appearance* clear			
OUT/Dry/1/12-9	12-9	~~+2~~ NO NAME	~~.2195~~	✓	TTB	12-9	5	✓	TTB
" "				Filter Appearance* Heavy Loading		Reagents Appearance* clear			
IN/DRY/2/12-9	12-9	?	.2184	✓	TTB	12-9	5	✓	TTB
				Filter Appearance* SAA		Reagents Appearance*			
				Filter Appearance*		Reagents Appearance*			

* Use "REMARKS" section if needed.

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

REMARKS ______

Custodian [signature] Date 12-15-91 Time 1100

Q-1002 rev. 10-91

ENTROPY

RECORD OF CUSTODY, CONTAINER NO. 0223

Container Type (check) X Reagent Box ___Cooler ___Other ____________

Plant Name/Address ____________

Job No. ____________ Sampling Method ____________ (EPA, NIOSH, etc.)

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
1999	11-26	4:00	S	Eddie Smith	
	12-9	15:50	B	[illegible]	CHARGE TRAINS
1175	12-13	1452	S	Todd Bozell	
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

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

Received by Sample Custodian **Seal Intact?

[illegible] 12-19-91 11:00 / Yes ___ No

Signature Date Time

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

As Applicable:
TUBE SAMPLES put in freezer by ____________ Date ________ Time ________

CONDENSATE SAMPLES put in refrige. by ____________ Date ________ Time ________

REMARKS ____________

L-0023 rev. 10-91

ENTROPY

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. 0223 Assembly Date 11-26-91 Assembled By ES

Plant Name/address Martin Marietta Job No. 3684

Sampling Loc. Garner NC Method 201A

Individual Tare Of Reagent 200 (Ml)(gm) of DI H2O

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

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

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

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
IN/WET/1/12/10	12-10	5	.2176	✓	TTB	12-10	5	✓	TTB
Cyclone & Filter Rinse				Filter Appearance* Light					
Filter Rinse				Reagents Appearance* Clear					
OUT/WET/1/12/10	12-10	6	.2182	✓	TTB	12-10	5	✓	TTB
"				Filter Appearance* SAA					
"				Reagents Appearance* SAA					
OUT/DRY/2/12/9	12-9	12	.2195	✓	TTB	12-9	5	✓	TTB
				Filter Appearance* Heavy Loading					
				Reagents Appearance* Clear					
				Filter Appearance*					
				Reagents Appearance*					

* Use "REMARKS" section if needed.

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

REMARKS ~~SAA~~ ~~SAA~~

Custodian DRB Date 12-15-91 Time 11:00

Q-1002 rev. 10-91

ENTROPY

RECORD OF CUSTODY, CONTAINER NO. 608

Container Type (check) X Reagent Box ___ Cooler ___ Other ______________

Plant Name/Address ______________________________

Job No. ______________ Sampling Method ______________ (EPA, NIOSH, etc.)

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
1975	11-26	4:00	S	Eddie Smith	
			B		
	12-10	4:24	S	John R [illegible]	[illegible] CHANGE TRAINS.
			B		
1174	12-13	1454	S	Todd Brozell	
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

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

Received by Sample Custodian

[signature] 12-19-91 11:10
Signature Date Time

**Seal Intact? / Yes ___ No

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

As Applicable:
TUBE SAMPLES put in freezer by ______________ Date ________ Time ________

CONDENSATE SAMPLES put in refrige. by ______________ Date ________ Time ________

REMARKS ______________________________

L-0023 rev. 10-91

ENTROPY

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. 608 Assembly Date 11-26-91 Assembled By ES

Plant Name/address MARTIN Marietta Job No. 3684

Sampling Loc. Garner NC Method 201A

Individual Tare Of Reagent 200 (Ml)(gm) of DI - H2O

Individual Tare Of Reagent ________ (Ml)(gm) of ________

Individual Tare Of Reagent ________ (Ml)(gm) of ________

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

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
OUT/WET/2/12-11	12-11	PM10 105	.2643	✓	TTB	12-11	5	✓	TTB
Cyclone & Nozzle Rinse				Filter Appearance* Ripped & light					
Filter Rinse				Reagents Appearance* clear					
IN/WET/2/12-11	12-11	SF563	.2786	✓	TTB	12-11	5	✓	TTB
"				Filter Appearance* Light					
"				Reagents Appearance* clear					
IN/WET/3/12-11	12-11	SF634	? .2760						
"				Filter Appearance* SAA					
"				Reagents Appearance* SAA					
				Filter Appearance*					
				Reagents Appearance*					

* Use "REMARKS" section if needed.

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

REMARKS ________________________________

Custodian DRPratt Date 12-19-91 Time 11:10

Q-1002 rev. 10-91

ENTROPY

RECORD OF CUSTODY, CONTAINER NO. 605

Container Type (check) X Reagent Box \ Cooler ___Other ____________

Plant Name/Address Martin Marietta

Job No. 3684 Sampling Method M201A (EPA, NIOSH, etc.)

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
1594	11/26	3:15	S	Eddie Smith	
	12/11	9:22	B	Todd T. Bizzell	Change Trains
1173	12-13	1453	S	Todd T Bizzell	
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

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

Received by Sample Custodian **Seal Intact?

DeRit 12-19-91 11:00 ✓Yes ___No

Signature Date Time

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

As Applicable:
TUBE SAMPLES put in freezer by ____________ Date ________ Time ________

CONDENSATE SAMPLES put in refrige. by ____________ Date ________ Time ________

REMARKS ____________

L-0023 rev. 10-91

ENTROPY

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. 605 Assembly Date 11/26/91 Assembled By ES

Plant Name/address Martin Marietta Job No. 3684

Sampling Loc. Garner, NC Method 201A

Individual Tare Of Reagent 200 (Ml)(gm) of DI-H2O

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

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

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

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
OUT/WET/3/12/11	12-11	SF600	.2775?	✓	TTB	12-11	5	✓	TTB
Cyclone & Nozzle Rinse Filter Rinse				Filter Appearance* Light Grey Reagents Appearance* clear					
OUT/DRY/1A/12/12	12-12	PM149	.2710	✓	TTB	12-12	5	✓	TTB
" "				Filter Appearance* Light Grey Reagents Appearance* clear					
IN/DRY/1A/12/12	12-12	PM160	.2667	✓	TTB	12-12	5	✓	TTB
" "				Filter Appearance* ______ Reagents Appearance* ______					
				Filter Appearance* ______ Reagents Appearance* ______					

* Use "REMARKS" section if needed.

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

REMARKS ______

Custodian [signature] Date 12-19-91 Time 11:00

Q-1002 rev. 10-91

ENTROPY

RECORD OF CUSTODY, CONTAINER NO. 0208

Container Type (check) X Reagent Box ___ Cooler ___ Other ___

Plant Name/Address MARTIN MARIETTA GARNER NC

Job No. 3684 Sampling Method 201A (EPA, NIOSH, etc.)

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
1600	11-26	3:15	S	Eddie Smith	
	12-12	0911	B	William K Kirk Jr	to charge the train
1171	~~1340~~ 12-13	1340	S	Todd T Buzzell	
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

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

Received by Sample Custodian **Seal Intact? ✓ Yes ___ No

DRPW (Signature) 12-19-91 (Date) 11:00 (Time)

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

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

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

REMARKS ___

L-0023 rev. 10-91

ENTROPY

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. 0208 Assembly Date 11-26-91 Assembled By ES

Plant Name/address Martin Marietta Garner, NC Job No. 3684

Sampling Loc. Garner, NC Method 201A

Individual Tare Of Reagent 200 (Ml)(gm) of DI H2O

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

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

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

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
OUT/DRY/2A/12/12	12/12/91	PM157	.2752	✓	TTB	12/12	5	✓	TTB
Cyclone & Nozzle Rinse Filter Rinse									
IN/DRY/2A/12-12	12/12/91	PM153	.2664	✓	TTB	12/12	5	✓	TTB
"									
"									
OUT/DRY/3A/12/12	12/12/91	PM167	.2756	✓	TTB	12/12	5	✓	TTB
"									
"									

Run OUT/DRY/2A/12/12:
Filter Appearance* Light Grey.
Reagents Appearance* clear

Run IN/DRY/2A/12-12:
Filter Appearance* White Light Loading
Reagents Appearance* ______

Run OUT/DRY/3A/12/12:
Filter Appearance* Light Grey
Reagents Appearance* clear

Blank row:
Filter Appearance* ______
Reagents Appearance* ______

* Use "REMARKS" section if needed.

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

REMARKS ______

Custodian [signature] Date 12-18-91 Time 11:00

Q-1002 rev. 10-91

ENTROPY

RECORD OF CUSTODY, CONTAINER NO. 603

Container Type (check) X Reagent Box ___Cooler ___Other ___________

Plant Name/Address MARTIN MARIETTA

Job No. 3684 Sampling Method M201A (EPA, NIOSH, etc.)

Seal ID	Date	Time	*	Full Signature	Reason for Breaking Seal**
1529	11-26	4:00	S	Eddie Smith	
	12-12	12:06	B	Todd Bizzell	Charge Trains
1025	12-13	1455	S	Todd Bizzell	
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		
			S		
			B		

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

Received by Sample Custodian **Seal Intact?

[signature] Signature 12-19-91 Date 1100 Time ___Yes ___No

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

As Applicable:
TUBE SAMPLES put in freezer by ______________ Date ________ Time ________

CONDENSATE SAMPLES put in refrige. by ______________ Date ________ Time ________

REMARKS ________________________________

L-0023 rev. 10-91

ENTROPY

FIELD SAMPLE RECOVERY QUALITY CONTROL

Box No. 603 Assembly Date 11-26-91 Assembled By ES

Plant Name/address MARTIN MARIETTA Job No. 3684

Sampling Loc. Garner, NC Method M201A

Individual Tare Of Reagent 200 (Ml)(gm) of DI-H2O

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

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

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

Run Number	Run Date	Filter or XAD Number	Filter or XAD Tare, grams	Liquid Tare at Mark? @	Init.	Sample Recov. Date	%Sil. Gel Spent	Liquid Level Marked?	Init.
IN/DRY/3A 12/12	12-12	PM154	.2721	✓	TTB	12-12	5	✓	TTB

Filter Rinse
Cyclone + Nozzle Rinse

Filter Appearance* White

Reagents Appearance* clear

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

Filter Appearance*

Reagents Appearance*

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

Filter Appearance*

Reagents Appearance*

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

Filter Appearance*

Reagents Appearance*

* Use "REMARKS" section if needed.

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

REMARKS ______

Custodian DPR Date 12-19-91 Time 11:00

Q-1002 rev. 10-91

ENTROPY

APPENDIX E.

Analytical Data

PARTICULATE SAMPLING LABORATORY RESULTS

Plant Name:	MARTIN MARIETTA	EEI Ref#	3684
Sampling Location:	Inlet/Outlet Crusher		
Date Received:	12/20/91	Date Analyzed:	01/03/92

Run Number	IN/DRY/1/12-9	OUT/DRY/1/12-~~12~~ 9	IN/DRY/1A/12-12

Sample ID/Container #	init.	date		F / 279	date		F / 281	date		F / 283
	DK	01/03		4.3116	01/03		4.7487	01/03		4.1839
	DK	12/31	@	4.3114	12/31	@	4.7483	12/31	@	4.1837
Baggie Tare Wt., g.				3.9523			3.8102			3.9093
Filter Tare Wt., g.				0.2537			0.2195			0.2667
DRY PARTICULATE WT., g.				0.1054			0.7186			0.0077

Sample ID/Container #	init.	date		R / 280	date		R / 282	date		R / 284
	DK	01/03		6.6740	01/03	@	3.9035	01/03		3.6732
	DK	12/31	@	6.6734	12/31	@	3.9035	12/31	@	3.6728
Tare Wt., g.				3.8514			3.8755			3.6690
SAMPLE WT., g.				2.8220			0.028			0.0038

Total Particulate., mg.		2927.4		746.6		11.5
Blank Residuè, mg.	(80 ml)	0.2	(70 ml)	0.1	(85 ml)	0.2
TOTAL PARTICULATE CATCH, mg.		2927.2		746.5		11.3

Blank Beaker #	2003
Final wt., mg.	99546.3
Tare wt., mg.	99545.9
Residue, mg.	0.4
Volume, ml.	200
Conc., mg/ml	0.002

—Legend—
@ = Final Weight
F = Filter R = Rinse

1 = Light 2 = Medium
3 = Heavy or Dark

Sample Description

Run #	Color	Loading
1	1 2 3	1 2 3
2	1 2 3	1 2 3
3	1 2 3	1 2 3

Notes and comments:
Predominate color of samples is: Very light grey
Date of full balance span 12/30/91

PARTICULATE SAMPLING LABORATORY RESULTS

Plant Name: MARTIN MARIETTA — EEI Ref# 3684

Sampling Location: Inlet/Outlet Crusher

Date Received: 12/20/91 — Date Analyzed: 01/03/92

Run Number	init.	date		OUT/DRY/1A/12-12	date		IN/DRY/2/12-9	date		OUT/DRY/2/12-9
Sample ID/Container #				F / 285			F / 287			F / 289
	DK	01/03		4.1434	01/03		4.1244	01/03		4.8110
	DK	12/31	@	4.1432	12/31	@	4.1239	12/31	@	4.8106
Baggie Tare Wt., g.				3.8498			3.8081			3.8532
Filter Tare Wt., g.				0.2710			0.2184			0.2195
DRY PARTICULATE WT., g.				0.0224			0.0974			0.7379
Sample ID/Container #				R / 286			R / 288			R / 290
	DK	01/03		3.6343	01/03		3.8912	01/03		4.0001
	DK	12/31	@	3.6340	12/31	@	3.8910	12/31	@	3.9998
Tare Wt., g.				3.6283			3.8724			3.9306
SAMPLE WT., g.				0.0057			0.0186			0.0692
Total Particulate., mg.				28.1			116.0			807.1
Blank Residue, mg.	(	75	ml)	0.2	(60	ml)	0.1	(85	ml)	0.2
TOTAL PARTICULATE CATCH, mg.				27.9			115.9			806.9

Blank Beaker #	2003
Final wt., mg.	99546.3
Tare wt., mg.	99545.9
Residue, mg.	0.4
Volume, ml.	200
Conc., mg/ml -	0.002

—Legend—
@ = Final Weight
F = Filter R = Rinse

1 = Light 2 = Medium
3 = Heavy or Dark

Sample Description

Run #	Color	Loading
-	1 2 3	1 2 3
-	1 2 3	1 2 3
-	1 2 3	1 2 3

Notes and comments:
Predominate color of samples is: Light Grey
Date of full balance span 12/30/91

PARTICULATE SAMPLING LABORATORY RESULTS

Plant Name: MARTIN MARIETTA   EEI Ref# 3684

Sampling Location: Inlet/Outlet Crusher

Date Received: 12/20/91   Date Analyzed: 01/03/92

Run Number			OUT/DRY/3A/12-12		IN/WET/1/12-10		OUT/WET/1/12-10
Sample ID/Container #	init.	date	F / 297	date	F / 299	date	F / 301
	DK	01/03	4.3502	01/03	4.0808	01/03	4.0772
	DK	12/31	@ 4.3499	12/31	@ 4.0805	12/31	@ 4.0770
Baggie Tare Wt., g.			4.0559		3.8600		3.8310
Filter Tare Wt., g.			0.2756		0.2176		0.2182
DRY PARTICULATE WT., g.			0.0184		0.0029		0.0278
Sample ID/Container #	init.	date	R / 298	date	R / 300	date	R / 302
	DK	01/03	@ 3.9252	01/03	3.7188	01/03	3.8199
	DK	12/31	@ 3.9252	12/31	@ 3.7186	12/31	@ 3.8198
Tare Wt., g.			3.9213		3.7158		3.8096
SAMPLE WT., g.			0.0039		0.0028		0.0102
Total Particulate., mg.			22.3		5.7		38.0
Blank Residue, mg.		(50 ml)	0.1	(115 ml)	0.2	(75 ml)	0.2
TOTAL PARTICULATE CATCH, mg.			22.2		5.5		37.8

Blank Beaker #	2003
Final wt., mg.	99546.3
Tare wt., mg.	99545.9
Residue, mg.	0.4
Volume, ml.	200
Conc., mg/ml	0.002

—Legend—
@ = Final Weight
F = Filter   R = Rinse

1 = Light   2 = Medium
3 = Heavy or Dark

Sample Description

Run #	Color	Loading
-	1 2 3	1 2 3
-	1 2 3	1 2 3
-	1 2 3	1 2 3

Notes and comments:
Predominate color of samples is: Very light Tan-Grey
Date of full balance span 12/30/91

PARTICULATE SAMPLING LABORATORY RESULTS

Plant Name: MARTIN MARIETTA — EEI Ref# 3684

Sampling Location: Inlet/Outlet Crusher

Date Received: 12/20/91 — Date Analyzed: 01/03/92

Run Number				IN/WET/2/12-11			OUT/WET/2/12-11			IN/WET/3/12-11
Sample ID/Container #				F / 303			F / 305			F / 307
	init.	date			date			date		
	DK	01/03		4.0655	01/03		4.2830	01/03		3.8353
	DK	12/31	@	4.0652	12/31	@	4.2825	12/31	@	3.8349
Baggie Tare Wt., g.				3.7791			4.0135			3.5537
Filter Tare Wt., g.				0.2786			0.2643			0.2760
DRY PARTICULATE WT., g.				0.0075			0.0047			0.0052
Sample ID/Container #				R / 304			R / 306			R / 308
	init.	date			date			date		
	DK	01/03		3.9008	01/03		3.7671	01/03		3.8517
	DK	12/31	@	3.9007	12/31	@	3.7668	12/31	@	3.8516
Tare Wt., g.				3.8974			3.7584			3.8493
SAMPLE WT., g.				0.0033			0.0084			0.0023
Total Particulate., mg.				10.8			13.1			7.5
Blank Residue, mg.	(	50	ml)	0.1	(	80 ml)	0.2	(	40 ml)	0.1
TOTAL PARTICULATE CATCH, mg.				10.7			12.9			7.4

Blank Beaker #	2003
Final wt., mg.	99546.3
Tare wt., mg.	99545.9
Residue, mg.	0.4
Volume, ml.	200
Conc., mg/mL	0.002

—Legend—

@ = Final Weight

F = Filter R = Rinse

1 = Light 2 = Medium

3 = Heavy or Dark

Sample Description

Run #	Color	Loading
-	1 2 3	1 2 3
-	1 2 3	1 2 3
-	1 2 3	1 2 3

Notes and comments:

Predominate color of samples is: Off White

Date of full balance span 12/30/91

PARTICULATE SAMPLING LABORATORY RESULTS

Plant Name: MARTIN MARIETTA — EEI Ref# 3684

Sampling Location: Inlet/Outlet Crusher

Date Received: 12/20/91 — Date Analyzed: 01/03/92

Run Number	init.	date	IN/DRY/2A/12-12	date	OUT/DRY/2A/12-12	date	IN/DRY/3A/12-12
Sample ID/Container #			F / 291		F / 293		F / 295
	DK	01/03	4.0292	01/03	4.1519	01/03	3.9555
	DK	12/31	@ 4.0288	12/31	@ 4.1518	12/31	@ 3.9554
Baggie Tare Wt., g.			3.7598		3.8575		3.6824
Filter Tare Wt., g.			0.2664		0.2752		0.2721
DRY PARTICULATE WT., g.			0.0026		0.0191		0.0009
Sample ID/Container #			R / 292		R / 294		R / 296
	DK	01/03	3.7834	01/03	@ 3.9436	01/03	3.9475
	DK	12/31	@ 3.7830	12/31	@ 3.9436	12/31	@ 3.9472
Tare Wt., g.			3.7813		3.9371		3.9466
SAMPLE WT., g.			0.0017		0.0065		0.0006
Total Particulate., mg.			4.3		25.6		1.5
Blank Residue, mg.		(75 ml)	0.2	(70 ml)	0.1	(55 ml)	0.1
TOTAL PARTICULATE CATCH, mg.			4.1		25.5		1.4

Blank Beaker #	2003
Final wt., mg.	99546.3
Tare wt., mg.	99545.9
Residue, mg.	0.4
Volume, ml.	200
Conc., mg/ml	0.002

---Legend---

@ = Final Weight

F = Filter R = Rinse

1 = Light 2 = Medium

3 = Heavy or Dark

Sample Description

Run #	Color	Loading
-	1 2 3	1 2 3
-	1 2 3	1 2 3
-	1 2 3	1 2 3

Notes and comments:

Predominate color of samples is: Very light Grey

Date of full balance span 12/30/91

PARTICULATE SAMPLING LABORATORY RESULTS

Plant Name: MARTIN MARIETTA — EEI Ref# 3684

Sampling Location: Inlet/Outlet Crusher

Date Received: 12/20/91 — Date Analyzed: 01/03/92

Run Number: OUT/WET/3/12-11

Sample ID/Container #	init.	date		F / 309		
	DK	01/03		4.1571		
	DK	12/31	@	4.1568		
Baggie Tare Wt., g.				3.8378		
Filter Tare Wt., g.				0.2775		
DRY PARTICULATE WT., g.				0.0415		

Sample ID/Container #	init.	date		R / 310		
	DK	01/03		3.7577		
	DK	12/31	@	3.7576		
Tare Wt., g.				3.7530		
SAMPLE WT., g.				0.0046		

Total Particulate., mg.		46.1
Blank Residue, mg.	(50 ml)	0.1
TOTAL PARTICULATE CATCH, mg.		46.0

Blank Beaker #	2003
Final wt., mg.	99546.3
Tare wt., mg.	99545.9
Residue, mg.	0.4
Volume, ml.	200
Conc., mg/ml	0.002

—Legend—

@ = Final Weight

F = Filter R = Rinse

1 = Light 2 = Medium

3 = Heavy or Dark

Sample Description

Run #	Color	Loading
-	1 2 3	1 2 3
-	1 2 3	1 2 3
-	1 2 3	1 2 3

Notes and comments:

Predominate color of samples is: Light Grey

Date of full balance span 12/30/91

Oxford Laboratories, Inc.

Analytical and Consulting Chemists
1316 South Fifth Street
Wilmington, N.C. 28401
(919) 763-9793

DATE RECEIVED 01-20-92
DATE REPORTED 01-30-92
92W5251

ENTROPY ENVIRONMENTALIST INC. P.O. # 1983-3684
P. O. BOX 12291
RESEARCH TRIANGLE PARK, NC 27709-2291

ATTENTION: RICHARD TEBEAU

SAMPLE DESCRIPTION: CRUSHED GRANITE

1. GAR/WET/1/12-10
2. GAR/DRY/2/12-9
3. SR/WET/3/1-6
4. SR/DRY/2/12-19
5. METHOD CODE SW846-

RESULTS

	1	2	3	4	5
Cadmium, as Cd, ug/g	<3.80	<3.67	<2.25	<3.85	7131
Nickel, as Ni, ug/g	315	628	35.1	19.2	7521
Lead, as Pb, ug/g	75.4	81.8	27.8	30.6	7421

Roger Oxford

ROGER C. OXFORD, CHEMIST

INTERLABORATORY SAMPLE TRANSFER

RECORD OF CUSTODY

Please include this form with the final (typed) results, and whenever the final results are faxed.

The samples referenced in Entropy Environmentalists Inc. purchase order No. 1983-3684 were shipped via Pony on 1-17-92 to OLI by John V. Staub.

The samples were received at OLI on 1-20-92 by MSC.

Note any broken seals, leakage, spillage, or damage to samples (*if discrepancy, indicate seal No., jar No., sample No., etc.*).

L-0012 rev. 8-91

ENTROPY

APPENDIX F.

Audit Data Sheets

SAMPLING EQUIPMENT AUDIT

Plant Name Martin Marietta Job No. 3684

City/State Garner, NC Auditor(s) GCP

Test Loc. Lower Outlet of Crusher Date 9 Dec 91

BAROMETER
Entropy In-House Ref. Barometer ______ "Hg vs Field Barometer ______ "Hg

Date Compared ______ Dev. ______ "Hg (Max. Allowable Dev.: ± 0.1 "Hg)

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

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

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

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

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

ISOKINETIC METERBOX I.D. U6 Gamma (Y) .9871 ΔH@ 1.779

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

Barometric Pressure (P_{bar}) 30.0 Auditor GCP Date 9 Dec 91

Dry Gas Meter Reading (Cubic Ft.)	Meter Temperature (°F)	Lower and Upper Limits for Audit Gamma
Final 761.130	Final 92	0.96 * Y = .94761
Initial 753.600	Initial 82	1.04 * Y = 1.02658

Dry Gas Volume Metered (Cubic Ft.)	Average Meter Temp. (°F)	Run Time (Base = 10) (Minutes)	(Seconds)
Vm = 7.53	Tm = 87	10	0

$$Y_c = \frac{[\text{Min.} + (\text{Sec.} / 60)]}{V_m} * \left[\frac{0.0319\,(T_m + 460)}{P_{bar}}\right]^{1/2}$$

$$Y_c = \frac{[\,10 + (\,0\, / 60)]}{7.53} * \left[\frac{0.0319\,(\,87 + 460)}{30.0}\right]^{1/2} = 1.0282$$

Audit Gamma

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

F-1113 9-91

ENTROPY

SAMPLING EQUIPMENT AUDIT

Plant Name Martin Marietta Job No. 3684

City/State Garner, NC Auditor(s) GCB

Test Loc. Upper Inlet to Crusher Date 9 Dec 91

BAROMETER
Entropy In-House Ref. Barometer ______ "Hg vs Field Barometer ______ "Hg

Date Compared ______ Dev. ______ "Hg (Max. Allowable Dev.: ± 0.1 "Hg)

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

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

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

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

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

ISOKINETIC METERBOX I.D. N14 Gamma (Y) .9948 ΔH@ 1.882

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

Barometric Pressure (P_{bar}) 30.0 Auditor GCB Date 9 DEC 91

Dry Gas Meter Reading (Cubic Ft.)	Meter Temperature (°F)	Lower and Upper Limits for Audit Gamma
Final 401.935	Final 94	0.96 * Y = .955008
Initial 394.05	Initial 88	1.04 * Y = 1.034592

Dry Gas Volume Metered (Cubic Ft.)	Average Meter Temp. (°F)	Run Time (Base = 10) (Minutes)	(Seconds)
Vm = 7.885	Tm = 91	10	0

$$Y_c = \frac{[\text{Min.} + (\text{Sec.} / 60)]}{V_m} * \left[\frac{0.0319\,(T_m + 460)}{P_{bar}}\right]^{1/2}$$

$$Y_c = \frac{[\,10 + (\,0\,/ 60)]}{7.885} * \left[\frac{0.0319\,(\,91 + 460)}{30.0}\right]^{1/2} = \frac{.970753}{\text{Audit Gamma}}$$

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

F-1113 9-91

ENTROPY

APPENDIX G.

List of Participants

KEY PERSONNEL

The key personnel who coordinated the test program and their telephone numbers are:

• Mr. Solomon Ricks Field Test Coordinator, EMB	919/541-5242
• Mr. Dennis Holzschuh Field Test Coordinator, EMB	919/541-5239
• Mr. Horace Wilson Martin Marietta Corporate Contact	919/781-4550
• Mr. Steve Witt Martin Marietta Corporate Contact	919/781-4550
• Mr. John Richards, Phd, P.E. Project Manager, Entropy	919/781-3551
• Mr. Todd Brozell Field Test Director, Entropy	919/781-3551
• Mr. William Kirk Meteorological and Process Data Coordinator, Entropy	919/781-3551
• Mr. Harold Lee Field Engineer and Teamleader, Entropy	919/781-3551

APPENDIX H.

Method 201A (PM10)
Standard Operating Procedures Manual

METHOD 201A (PM-10)
Standard Operating Procedures Manual

September 5, 1991
Jeff Kunstling
Rev'n # 1.0

Method 201A (Determination of PM_{10} emissions)

TABLE OF CONTENTS

METHOD 201A

DETERMINATION OF PM_{10} EMISSIONS (Constant Sampling Rate Procedures)

1. APPLICABILITY AND PRINCIPLE.

1.1 Applicability.

This method applies to the in-stack measurement of particulate matter (PM) emissions equal to or less than an aerodynamic diameter of nominally 10 μm (PM_{10}) from stationary sources.

1.2 Principle.

A gas sample is extracted at a constant flow rate through an in-stack sizing device which separates the PM_{10} particulate from the rest of the particulate matter. Variations from isokinetic sampling conditions are maintained within well defined limits. The particulate mass is determined gravimetrically after removal of uncombined water.

2. APPARATUS.

2.1 Sampling train. This method can be performed using an apparatus similar to Method 5 or similar to Method 17.

2.1.1 Probe nozzle. Use stainless steel nozzles provided with the cyclone.

2.1.2 PM_{10} sizer. Use stainless steel cyclone particle sizer.

2.1.3 In stack filter holder. Use 63 mm stainless steel filter holder that matches with the in-stack cyclone.

2.1.4 For saturated sources, heat wrap is needed for the nozzle, cyclone and filter holder.

2.1.5 Pitot tube. Use the modified S-type Pitot tubes that are extended and widened to accommodate the cyclone/filter holder assembly.

2.1.6 Probe liner. Use stainless steel or glass liner. If possible, use the stainless steel liner because the glass liners tend to break easily with the particle sizer attached. Probe should be heated to avoid condensation.

2.1.7 Depending on what sampling train is used, either a filter by-pass and heated filter compartment will be used for the Method 5 type train or metal L's, metal U's, and a vacuum jumper will be used for the Method 17 type train.

2.1.8 Differential pressure gauge, condenser, metering system, barometer, gas density determination equipment. Same as for Method 5.

2.2 Sample recovery.

2.2.1 Use nylon bristle brushes with stainless steel wire shafts and handles, properly sized and shaped for cleaning the nozzle, sizing device, probe liner, and filter holder.

2.3 Analysis. Same as in Method 5.

3. REAGENTS. (Same as for Method 5)

3.1 Sampling.

3.1.1 Filters. Use glass fiber filters exhibiting at least 99.95% efficiency (<.05% penetration) on 0.3 micron dioctyl phthalate smoke particles.

3.1.2 Silica gel. Use indicating type 6 to 16 mesh.

3.1.3 Water. Use distilled water.

3.2 Sample recovery.

3.2.1 Acetone - reagent grade (<.001% residue)

3.3 Analysis.

3.3.1 Desiccant. Use indicating type such as anhydrous calcium sulfate.

4. PROCEDURE.

4.1 Pretest preparation. (Same as for Method 5)

4.2 Cyclone/Filter Holder Assembly.

4.2.1 The two filter holders we use require two different sizes of filters. Some filters fit both filter holder assemblies, and some only fit one or the other. This information can be found on the petri dishes that the filters come in. Special attention must be given to the filter size when assembling the filters.

4.2.2 Open the filter holder and place the filter on the filter support screen. (Note: One of the filter holders has a removable filter support screen that is rough on one side and smooth on the other. This screen needs to be placed so that the filter rests on the smooth side.)

4.2.3 Assemble the filter holder and cyclone, making sure that the Viton O-rings are in good condition, and tighten all the connections securely. Teflon tape may be needed to insure a good seal; however, this needs to be done very carefully. If any of the tape is exposed to the inside of the cyclone or filter holder, it will tear off and catch on the filter, possibly voiding the run. Therefore, extreme care must be taken to insure that only the outer threads are wrapped with the Teflon tape.

4.2.4 Remove the sticker containing the filter number and tare weight from the petri dish and place it on the filter holder.

4.2.5 Once the nozzle has been selected and attached to the cyclone, leak check the entire train from the nozzle back. The cyclone/filter holder assembly is going to leak quite a bit, so the rest of the train needs to be in very good shape. The cyclone/filter holder assembly will be removed prior to the post-test leak check, so if the pre-test leak rate is at or below 0.02 cfm with the majority of the leak being attributed to the cyclone/filter holder assembly, there should be no problem in obtaining a good run.

4.3 Site Requirements.

4.3.1 Use a sampling port diameter of 6 inches. This is required for nozzle diameters greater than 0.16 inches and preferred in all cases.

4.3.2 Cross sectional area of the sampling assembly must not be greater than 3% of the duct. The cross sectional area of our sampling assembly is 18.75 square inches. This translates into a minimum duct sizes of 28.25" diameter for a circular duct or 625 square inches for a rectangular stack (about 25" by 25"). For smaller ducts, sampling is still possible using a Method 2A type setup with a standard Pitot.

4.3.3 For saturated sources, use heat wrap to heat the cyclone/filter assembly to 50°F above the stack temperature.

4.4 Preliminary determinations. Same as Method 5 except use the directions in this method for nozzle size selection and sampling time.

4.4.1 The maximum number of traverse points for any location shall be 12. Use the standard Method 1 procedure for a 12 point traverse to determine the location of these 12 points. (See Section 10.1)

4.4.2 Preform a preliminary traverse, recording the velocity head (ΔP) and the stack temperature (t_s) at each point on a Air Flow Rate Determinations (Method 2) data sheet. (See Section 10.2)

4.4.3 Using the laptop computer with the "PM10CALC" file loaded, enter the average ΔP and average t_s from the preliminary traverse along with the other required data such as moisture, pressure, etc. A listing of all the equations that are used is presented in the calculations section.

4.4.4 The computer will give information such as ΔH, $\Delta H_{t+50°}$, $\Delta H_{t-50°}$, and the desired nozzle diameter which are to be recorded on the Method 201A field data sheet. (See Section 10.6)

4.4.5 Choose the two nozzles from the nozzle box closest in diameter to the desired nozzle diameter (one higher and one lower) and enter them into the computer one at a time where the nozzle selected is asked for. Record onto the data sheet the ΔP_{min} and the ΔP_{max} that the computer calculates for each nozzle.

4.4.6 Examine the range of ΔPs from the preliminary traverse and select the nozzle which best incorporates the range of ΔPs. Ideally, all 12 points should fall between the ΔP_{min} and the ΔP_{max} of one of the nozzles; however, it is permissible to have one point fall outside the range if the isokinetics for the run are between 80% and 120%. If neither nozzle meets these conditions, a nozzle change during the run will be required.

NOTE: See section 4.6.1 on nozzle changes.

4.4.7 Calculate the dwell time for the first point using the equation presented in section 7.1.15. Calculate the dwell time for all subsequent points using the equation presented in section 7.1.16.

NOTE: The method calls for the calculation of the dwell times as you proceed through the test. When the probe is moved to the next point, the ΔP is read and then used to calculate the dwell time for the point. However, in order to simplify matters and to make the run more predictable, we have elected to use the ΔPs from the preliminary traverse to calculate the dwell times and assume that they remain essentially constant during the run. The benefits of this are that it allows us to calculate and check the dwell times for each point prior to testing, and it also eliminates the possibility of points unexpectedly dropping out of the nozzle's range.

4.5 Sampling.

4.5.1 Preform a pre-test leak check through the entire sampling train.

4.5.2 Allow the sizing device to reach stack temperature by placing it in the stack for 20 to 30 minutes prior to the run.

4.5.3 Position the probe at the first sampling point and begin sampling at the ΔH determined by the computer.

4.5.4 Record the appropriate data onto the field data sheet.

NOTE: Record the ΔP and t_s from the preliminary traverse onto the field data sheet for the corresponding points. The ΔP and t_s actually encountered during the run need not be recorded.

4.5.5 After the dwell time for the first point has elapsed, move on to the next point using the same ΔH.

NOTE: See section 4.6.2 on changing the ΔH.

4.5.6 Continue until all points have been sampled.

4.5.7 At the conclusion of the run, remove the cyclone/filter holder assembly **BEFORE** performing the post-test leak check.

4.5.8 After removing the cyclone/filter holder assembly, keep it in an upright position (cyclone up, filter down) and cover the openings with tape until it has cooled enough to clean. See section 4.7 on sample recovery.

4.5.9 Leak check the train from the front of the probe liner back at the highest vacuum observed during the run.

4.5.10 If a Method 17 type train is being used, drain the umbilical.

4.6 Special Cases.

4.6.1 Nozzle Change During The Run.

1. If there is more than one point with a ΔP that is out of the range of the selected nozzle, a nozzle change will be required during the run.

2. Sample all the points within the range of the selected nozzle, skipping over the points that fall outside of the range.

3. After all the points that are within the nozzles range have been sampled, stop the run and remove the probe from the stack. As soon as the nozzle has cooled enough to handle, remove the nozzle and replace it with the next nozzle. Do NOT preform a leak check.

4. Tape over the old nozzle and place it aside to be cleaned up with the cyclone catch after the run.

5. Position the probe at the first traverse point that has not yet been sampled and is in the new nozzles ΔP range. Allow the cyclone/filter holder assembly to reach stack temperature and resume sampling AT THE SAME ΔH.

6. The points sampled with the new nozzle must be clearly noted on the data sheet. Changing the nozzle diameter requires the isokinetic sampling rate for the run to be calculated as a time weighted average of the isokinetic sampling rates achieved during each segment of the run involving a different nozzle. To do this the exact points using each nozzle must be known.

7. If three or more nozzles are required, repeat the same procedure for each of the nozzles used.

4.6.2 ΔH Change During The Run.

1. In general, the entire run will be done using the same ΔH, even if the nozzle is changed.

2. The only time the ΔH is changed is if the stack temperature at a sampling point varies by more than 50°F from the average stack temperature that was determined by the preliminary traverse.

3. During the preliminary calculations, values were obtained for $\Delta H_{t+50°}$ and $\Delta H_{t-50°}$ and recorded on

the field data sheet. These are the respective values that are to be used for ΔH if the stack temperature is 50°F higher or lower than the average stack temperature.

4. If a point with a 50° temperature variation is encountered during the run, adjust the meter box to the appropriate temperature adjusted value for ΔH at the beginning of the point.

5. If the next point is back within 50°F of the average stack temperature, go back to the original ΔH.

6. Changing the ΔH will not have an effect on the way that the isokinetics are calculated.

4.7 Sample Recovery.

4.7.1 Assemble the required clean-up containers.

1. Quart jar originally containing the 200 ml H_2O.
2. Plastic bottle originally containing silica gel.
3. Pint jar labelled "nozzle and cyclone rinse."
4. Pint jar labelled "2 in. filter front half rinse."
5. Small jar labelled "2 in. filter."

4.7.2 Pour the H_2O from the impingers back into its original quart jar, weigh, and record.

4.7.3 Pour the silica gel back into its original container, weigh, and record.

4.7.4 Keeping the cyclone/filter holder assembly upright (cyclone up, filter down), remove the top plate with a wrench. The "turn around cup" is the small cup-like piece attached to the top of the cyclone. Rinse the turn around cup's interior surface with acetone into the jar labelled "2 in. filter front-half rinse." Rinse the exterior surface of the turn around cup and the remaining interior surface of the top into the jar labelled "nozzle and cyclone rinse."

4.7.5 Disassemble the cyclone and rinse the inside of the cyclone and the nozzle with acetone into the jar labelled "nozzle and cyclone rinse." Any particulate inside the bowl goes into the nozzle and cyclone rinse jar.

4.7.6 Disassemble the 2 inch filter holder. Clean-up the filter dry into the jar labelled "2 in. filter." If

Teflon tape was used on the threads, be careful not to include any with the catch.

4.7.7 Rinse the front half of the of the 2 inch filter holder and the interior of the cyclone exit tube with acetone into the jar labelled "2 in. filter front half rinse".

5. ANALYSIS.

5.1 Laboratory Analysis Procedure.

5.1.1 Determine the non-PM_{10} catch gravimetrically from the nozzle/cyclone rinse.

5.1.2 Determine the PM_{10} catch from the 2" filter.

5.1.3 Determine the PM_{10} catch from the front half rinse and add it to the filter catch to obtain the total PM_{10} catch.

6. CALIBRATION.

6.1 Pitot Tube, Metering System, Probe Heater, Temperature Gauges, Leak-check of Metering System, and Barometer. Same as in Method 5, Sections 5.1 through 5.7 respectively.

6.2 Cyclone and Nozzle Combination. Meets design specifications - no calibration necessary.

7. CALCULATIONS.

7.1 Pre-test Calculations.

7.1.1 Absolute Pressure, P_s

$$P_s = P_{bar} + P_g/13.6$$

P_s = Stack Absolute Pressure [in. Hg]
P_g = Stack Static Pressure [in. H_2O]
P_{bar} = Ambient Barometric Pressure [in. H_2O]

7.1.2 Molecular Weight, M_w

$$M_w = M_d(1-B_w) + 18B_w$$

M_w = Molecular Weight of Stack Gas, wet basis [lb/lb-mole]
M_d = Molecular Weight of Stack Gas, dry basis
$= .44(\%CO_2) + .32(\%O_2) + .28(\%N_2 + \%CO)$

[use 29 lb/lb-mole]
B_w = Fraction Moisture Content [fraction H_2O]

7.1.3 Average Velocity Head, ΔP_{avg}

$$\Delta P_{avg} = \sum[(\Delta P_i)^{0.5}]^2/n$$

ΔP_{avg} = Average Velocity Head [in. H_2O]
ΔP_i = Velocity Head at i^{th} Traverse Point [in. H_2O]
n = number of traverse points

7.1.4 Viscosity, μ

$$\mu - 152.4 + 0.255t_s + (0.00569t_s)^2 + 0.5315(\%O_2) - 74.14B_w$$

μ = Viscosity [micropoise]
t_s = Average Stack Temperature [°F]
B_w = Fraction Moisture Content [fraction H_2O]

7.1.5 Cyclone Flow Rate, Q_c

$$Q_c = 0.002837\mu[(t_s + 460)/M_wP_s]^{0.2949}$$

Q_c = Cyclone Flow Rate [ft^3/min (ACFM)]
μ = Viscosity [micropoise]
t_s = Average Stack Temperature [°F]
M_w = Molecular Weight, wet basis [lb/lb-mole]
P_s = Stack Absolute Pressure [in. H_2O]

7.1.6 Desired Nozzle Diameter, D_{nd}

$$D_{nd} = 0.206Q_c^{0.5}[(P_s)(M_w)/(t_s + 460)(\Delta P_{avg})]^{0.25}$$

D_{nd} = Desired Nozzle Diameter [in.]
Q_c = Cyclone Flow Rate [ACFM]
P_s = Stack Absolute Pressure [in. Hg]
M_w = Molecular Weight, wet basis [lb/lb-mole]
t_s = Average Stack Temperature [°F]
ΔP_{avg} = Average Velocity Head [in. H_2O]

7.1.7 Average Stack Gas Velocity, v_s

$$v_s = (85.48)(C_p)[(t_s + 460)(\Delta P_{avg})/(P_s)(M_w)]$$

v_s = Average Stack Gas Velocity, [ft/sec]
C_p = Pitot Coefficient [Use .84 for S-Type Pitot]
t_s = Average Stack Temperature [°F]
ΔP_{avg} = Average Velocity Head [in. H_2O]
P_s = Stack Absolute Pressure [in. Hg]
M_w = Molecular Weight, wet basis [lb/lb-mole]

7.1.8 Orifice Pressure Head Required, ΔH

$$\Delta H = [(Q_c)(1-B_w)(P_s)/(t_s+460)]^2 *[(t_m+460)(M_d)(1.083)(\Delta H_@)/(P_{bar})]$$

ΔH = Orifice Pressure Head [in. H_2O]
Q_c = Cyclone Flow Rate [ACFM]
B_w = Fraction Moisture Content [fraction H_2O]
P_s = Stack Absolute Pressure [in. Hg]
t_s = Average Stack Temperature [°F]
t_m = Meter Box Temperature [°F]
M_d = Molecular Weight, dry basis [29 lb/lb-mole]
$\Delta H_@$ = Orifice Pressure Head @ 0.75 cfm [in. H_2O]
P_{bar} = Ambient Barometric Pressure [in. Hg]

→ Solve for t_s, t_s + 50°F, and t_s - 50°F.

7.1.9 Nozzle Velocity, v_n

$$v_n = (3.056)(Q_c)/(Dia)^2$$

v_n = Nozzle Velocity [ft/s]
Q_c = Cyclone Flow Rate [ACFM]
Dia = Diameter of nozzle [in]

→ Solve for the two nozzles closest to D_{nd}

7.1.10 Percent Isokinetic, I

$$I = (100)(v_n)/v_s$$

I = Percent Isokinetic [%]
v_n = Nozzle Velocity [ft/s]
v_s = Average Stack Gas Velocity [ft/s]

→ Solve for each of the two nozzles

7.1.11 Minimum Velocity, v_{min}

First, calculate R_{min}:

$$R_{min} = 0.2457 + [0.3072 - (0.2603)(Q_c)^{0.5}(\mu)/(v_n)^{1.5}]^{0.5}$$

If R_{min} < 0.5 or is an imaginary number,
→ use Equation 1.
Otherwise use Equation 2.

1. $v_{min} = v_n(0.5)$
2. $v_{min} = v_n(R_{min})$

R_{min} = Interim Value

v_{min} = Minimum Velocity [ft/s]
v_n = Nozzle Velocity [ft/s]
Q_c = Cyclone Flow Rate [ft^3/min (ACFM)]
μ = Viscosity [micropoise]

→ Solve for each of the two nozzles

7.1.12 Minimum Velocity Head, ΔP_{min}

$$\Delta P_{min} = 1.3686/10000[(P_s)(M_w)/(t_s+460)][(v_{min})(C_p)]^2$$

ΔP_{min} = Minimum Velocity Head [in. H_2O]
P_s = Stack Absolute Pressure [in. Hg]
M_w = Molecular Weight of Stack Gas, wet basis [lb/lb-mole]
t_s = Average Stack Temperature [°F]
v_{min} = Minimum Velocity [ft/s]
C_p = Pitot Coefficient [Use .84]

→ Solve for each of the two nozzles

7.1.13 Maximum Velocity, v_{max}

First, calculate R_{max}:

$$R_{max} = 0.4457 + [0.5690 + (0.2603)(Q_c)^{0.5}(\mu)/(v_n)^{1.5}]^{0.5}$$

If R_{max} > 1.5, use Equation 1.
Otherwise, use Equation 2.

1 $v_{max} = v_n(1.5)$
2. $v_{max} = v_n(R_{max})$

R_{max} = Interim Value
v_{max} = Maximum Velocity [ft/s]
v_n = Nozzle Velocity [ft/s]
Q_c = Cyclone Flow Rate [ft^3/min (ACFM)]
μ = Viscosity [micropoise]

→ Solve for each of the two nozzles

7.1.14 Maximum Velocity Head, ΔP_{max}

$$\Delta P_{max} = 1.3686/10000[(P_s)(M_w)/(t_s+460)][(v_{max})(C_p)]^2$$

ΔP_{max} = Maximum Velocity Head [in. H_2O]
P_s = Stack Absolute Pressure [in. Hg]
M_w = Molecular Weight of Stack Gas, wet basis [lb/lb-mole]
t_s = Average Stack Temperature [°F]
v_{max} = Maximum Velocity [ft/s]

C_p = Pitot Coefficient [Use .84]

→ Solve for each of the two nozzles

7.1.15 Dwell Time for First Traverse Point, θ_1

$$\theta_1 = [\Delta P'_1/\Delta P'_{avg}]^{0.5}[\theta_{tot}/n]$$

θ_1 = Dwell Time, First Traverse Point [min]
$\Delta P'_1$ = Velocity Head at First Point [in. H_2O] (from pre-test traverse)
$\Delta P'_{avg}$ = Average Velocity Head [in. H_2O]
θ_{tot} = Total Run Time [min]
n = Number of Traverse Points [should be 12 pts.]

→ Round Dwell Time to the nearest 15 seconds.

7.1.16 Dwell Time for Subsequent Points, θ_n

$$\theta_n = \theta_1[\Delta P'_1/\Delta P'_n]^{0.5} \qquad n = \{2,3,4,...12\}$$

θ_n = Dwell Time on Traverse Point n [minutes]
n = Number of Subsequent Points [points 2 through 12]
θ_1 = Dwell Time, First Traverse Point [minutes]
$\Delta P'_n$ = Velocity Head at Traverse Point n [in. H_2O]
$\Delta P'_{avg}$ = Average Velocity Head [in. H_2O]

→ Round Dwell Times to the nearest 15 seconds.

7.2 Post-test Calculations.

NOTE: Use values from the actual test conditions with the exceptions of the ΔP and the T_s which are to be taken from the preliminary traverse.

7.2.1 Stack Gas Viscosity, μ_s

$$\mu_s = C_1 + C_2T_s + C_3T_s^2 + C_4fO_2 - C_6B_{ws}$$

μ_s = Stack Gas Viscosity [micropoise]
C_1 = 51.05 micropoise
C_2 = 0.207 micropoise/°R
C_3 = $3.24\text{x}10^{-5}$ micropoise/°R^2
C_4 = 53.147 micropoise/fraction O_2
C_6 = 74.143 micropoise/fraction H_2O
T_s = Average Absolute Stack Temperature [°R]
f_{O2} = Stack Gas Fraction O_2 by volume, dry basis
B_{ws} = Moisture Fraction of Stack Gas [fraction O_2]

7.2.2 PM_{10} Flow Rate, Q_s

$$Q_s = [T_s/K_1P_s][Q_{s(std)} + V_{W(std)}/\theta]$$

Q_s = Total Cyclone Flow Rate [ft^3/min] (at wet cyclone conditions)
T_s = Average Absolute Stack Temperature [°R]
K_1 = Constant [17.64 °R / in. Hg]
P_s = Absolute Stack Pressure [in. Hg]
$Q_{s(std)}$ = Total Cyclone Flow Rate [dscf/min] (at standard conditions)
$V_{W(std)}$ = Volume of Water Vapor in Gas Sample [scf] (at standard conditions)
θ = Total Sampling Time [minutes]

7.2.3 Molecular Weight of Stack Gas, M_W

$$M_W = M_d(1-B_{WS}) + 18.0(B_{WS})$$

M_W = Molecular Weight of Stack Gas [lb/lb-mole] (Wet Basis)

M_d = Molecular Weight of Stack Gas [lb/lb-mole] (Dry Basis)
B_{WS} = Moisture Fraction of Stack Gas [fraction O_2]

7.2.4 Aerodynamic Cut Size, D_{50}

$$D_{50} = \beta[(t_s+460)/(M_w)(P_s)]^{0.2091}[(\mu_s)/(Q_s)]^{0.7091}$$

D_{50} = Aerodynamic Cut Size [μm]
β = Constant [0.15625 for English units]
t_s = Average Stack Temperature [°F]
M_w = Molecular Weight of Stack Gas, wet basis [lb/lb-mole]
P_s = Stack Absolute Pressure [in. Hg]

7.2.5 Percent Isokinetic, I,

$$I = 100(t_s+460)V_{m(std)}P_{(std)}/60(T_{(std)})v_s\theta A_n P_s(1-B_w)$$

I = Percent Isokinetic [%]
t_s = Average Stack Temperature [°F]
V_m = Volume of Gas Metered [dscf]
$P_{(std)}$ = Standard Pressure [29.92 in. Hg]
$T_{(std)}$ = Temperature Standard [537 °R]
v_s = Average Stack Velocity [ft/sec]
θ = Total Run Time [minutes]
A_n = Nozzle Area [ft^2] = $(\pi/144)(D_n/2)^2$
D_n = Nozzle Diameter [in.]
P_s = Stack Absolute Pressure [in. Hg]
B_w = Fraction Moisture Content [fraction H_2O]

7.3 Acceptable Results. The results are acceptable it the following two conditions are met:

7.2.1 The aerodynamic cut size, D_{50}, must be between 9.0μm and 11.0μm (9.0μm ≤ D_{50} ≤ 11.0μm).

7.2.2 No sampling points are outside of ΔP_{min} and ΔP_{max} **OR** the isokinetic rate, I, is between 80% and 120% (80% ≤ I ≤ 120%) and no more than one sampling point is outside of ΔP_{min} and ΔP_{max}.

8. QUALITY CONTROL.

8.1 Visual Inspection. Examine the Pitots, nozzle, cyclone, and filter holder prior to testing for any visible signs of damage or wear.

8.2 On-site dry gas meter audit. Prior to testing preform an on-site dry gas meter audit to check the calibration values of the volume metering system. This is the usual 10 minute audit for any meter box (See section 10.4).

9.0 DIAGRAMS.

CYCLONE DIAGRAM

10.0 DATA SHEETS

10.1 Sampling and Velocity Traverse Point Determination
EPA Method 1

10.2 Air Flow Rate Determinations
EPA Method 2

10.3 Field Test Log.

10.4 On-site Dry Gas Meter Audit.

10.5 Sampling Equipment Calibration Checklist.

10.6 Method 201A (PM-10) Field Data Sheet.

Sampling and Velocity Traverse Point Determination
EPA Method 1

PLANT NAME ______________________

CITY, STATE ______________________

SAMPLING LOCATION ______________________

NO. OF PORTS AVAILABLE ______________________

NO. OF PORTS USED ______________________

PORT INSIDE DIAMETER ______________________

DISTANCE FROM FAR WALL TO OUTSIDE OF PORT ________

NIPPLE LENGTH AND/OR WALL THICKNESS ________

DEPTH OF STACK OR DUCT ________

STACK OR DUCT WIDTH (IF RECTANGULAR) ________

EQUIVALENT DIAMETER:

$$D_E = \frac{2 \times \text{DEPTH} \times \text{WIDTH}}{\text{DEPTH} + \text{WIDTH}} = \frac{2(\quad)(\quad)}{(\quad + \quad)} = \_\_\_\_\_\_$$

DISTANCE FROM PORTS TO FLOW DISTURBANCES	UPSTREAM	DOWNSTREAM
	________	________
DIAMETERS	________	________

STACK/DUCT AREA = ________ = ________ IN^2

LOCATION OF POINTS IN CIRCULAR STACKS OR DUCTS

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

LOCATION OF POINTS IN RECTANGULAR STACKS OR DUCTS

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

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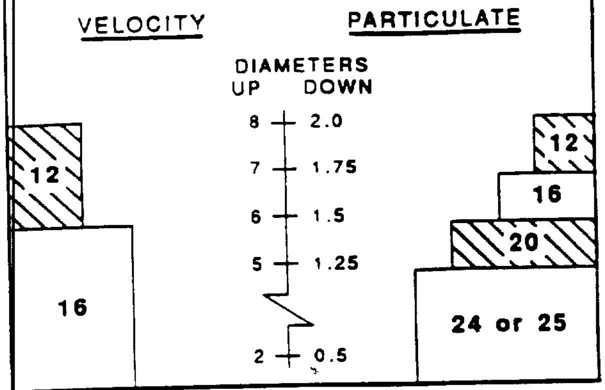
DRAW HORIZONTAL LINE THROUGH DIAMETERS

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



POINT	% OF DUCT DEPTH	DISTANCE FROM INSIDE WALL	DISTANCE FROM OUTSIDE OF PORT
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

SEE REVERSE FOR FIELD USE CHECKLIST

ENTROPY

AIR FLOW RATE DETERMINATIONS

Plant Name ______________________ Run No. __________

City/State ______________________ Date __________

Test Location ______________________ Personnel __________

Barometric Pres. (Pbar) __________ In. Hg Static Pres. (Pg) __________ In. H_2O

Pitot ID __________ Pitot Coeff. (Cp) ______ Pressure Gauge Set ID __________

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

VELOCITY TRAVERSES
Start-Finish Times: ________ - ________

Point No.	ΔP In. H_2O	Temp. °F
Avg.*		

ORSAT DATA

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

Bag No. __________ Pump __________

FYRITE DATA, % CO_2				

MOISTURE DATA (WET BULB/DRY BULB)

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

MOISTURE DATA (STOICHIOMETRIC)

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

VOLUMETRIC AIR FLOW RATES

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

ADDITIONAL DATA

*ΔP average is square of average square root. See page 2 for field flow rate calculations.

FIELD TEST LOG

Plant Name ______________________ Job No. ________

Sampling Location ______________________

Start ____ Stop ____ Comments/Problems* ____ Run No. ______ Date ______

Sampling Team Initials ______(Team Leader) ______________(Others)

Posttest Leak Rate ______ Sample Appearance ______________

Good Run (check)? ___YES ___NO (if NO, explain in "Comments/Problems")

Start ____ Stop ____ Comments/Problems* ____ Run No. ______ Date ______

Sampling Team Initials ______(Team Leader) ______________(Others)

Posttest Leak Rate ______ Sample Appearance ______________

Good Run (check)? ___YES ___NO (if NO, explain in "Comments/Problems")

Start ____ Stop ____ Comments/Problems* ____ Run No. ______ Date ______

Sampling Team Initials ______(Team Leader) ______________(Others)

Posttest Leak Rate ______ Sample Appearance ______________

Good Run (check)? ___YES ___NO (if NO, explain in "Comments/Problems")

* USE REVERSE SIDE IF MORE SPACE REQUIRED.

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ENTROPY

ON-SITE DRY GAS METER AUDIT

Plant Name ______________________ Job Number ____________

Date ____________ Meterbox Identification Number ____________

Time ____________ Fulltest Gamma (Y) ________ $\Delta H_@$ ________

Auditor ____________ Barometric Pressure (P_{bar}) ________ In. Hg

As Applicable:

Zero Magnehelics? (check) ____

Zero/Level Manometer? (check) ____

Dry Gas Meter Reading (ft^3)	Meter Temperature (°F)	Upper and Lower Limits for Audit Gamma
Final ________	Final ________	0.96 * Y = ________
Initial ________	Initial ________	1.04 * Y = ________

Dry Gas Volume Metered (ft^3)	Average Meter Temperature (°F)	Run Time (Base = 10)	
		(Minutes)	(Seconds)
Vm = ________	Tm = ________	________	________

$$Y_c = \frac{[\text{Min.} + (\text{Sec.} / 60)]}{Vm} * \left[\frac{0.0319\ (Tm + 460)}{P_{bar}}\right]^{0.5}$$

$$Y_c = \frac{[\_\_\_\_ + (\_\_\_\_ / 60)]}{\_\_\_\_} * \left[\frac{0.0319\ (\_\_\_\_ + 460)}{\_\_\_\_}\right]^{0.5} = \frac{\_\_\_\_\_\_\_\_}{\text{Calculated Audit Y}}$$

Audit Gamma Within Acceptable Limits? Yes ____ No ____

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ENTROPY

SAMPLING EQUIPMENT CHECKLIST

Plant Name/Address ______________________ Job No. __________

Sampling Location ______________________ Team Leader __________

BAROMETER CHECK

Date	Entropy In-House Reference Barometer	Field Barometer	Check OK?*

* ± 0.1" Mercury

THERMOMETERS AND THERMOCOUPLE CHECK

Date __________ Reference Thermometer Ambient Temperature, °F __________

	Ambient Temperature, °F	Acceptance Range, °F	Check OK?
Thermometers			
Impinger Exit	______	± 2.0	______
Filter Box	______	± 5.4	______
Dry Gas Meter	______	± 5.4	______
______	______	______	______
______	______	______	______

Adjust thermometer until acceptable. If it cannot be adjusted, use as back-up. If no backup, record ambient temp. indicated by unadjusted thermometer.

Thermocouples		Acceptance Range, °F	Check OK?
	______	± 8.0* (± 2.0)**	______
	______		______
	______		______
	______		______
	______		______

* ± 1.5% of Absolute Temperature.
** Acceptance range is ± 2.0°F if used in saturated or water droplet-laden gas stream.

PITOT AND NOZZLE CHECK

Pitot No.	Visual Check	Nozzle No.	Visual Check
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______
______	______	______	______

METHOD 201A (PM-10) FIELD DATA

Plant Name ______ Run Number ______
City/State ______ Time Start ______
Sampling Location ______ Time Stop ______
Date ______ Team Leader ______ Techs ______ Job Number ______
*Train Leak Check Vacuum, In. Hg ____ ____ ____ ____ Barometric Pressure, In. Hg ______
Train Leak Rate, Cubic Ft./Min. ____ ____ ____ ____ Static Pressure, In. H_2O ______

EQUIPMENT CHECKS

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

IDENTIFICATION NUMBERS

Meterbox ______ Meterbox Gamma ______ Reagent Box ______
T/C Readout ______ T/C Probe ______ Umbilical ______
Sampling Box ______ Orsat Pump ______ Tedlar Bag ______
Nozzle(s) Actually Used: Pitot ______
No. ______ Diameter ______ No. ______ Diameter ______

FILTER NO.	TARE

Est % H_2O ______

Delta $H_@$ ______
Delta H_t ______
Delta H_{t+50} ______
Delta H_{t-50} ______
Delta P_{avg} ______
Meter Temp. ______
Stack Temp. ______

NOZZLE SELECTION CRITERIA

Desired Dia. ______

	Nozzle 1	Nozzle 2
Diameter		
Nozzle Number		
Delta P_{min}		
Delta P_{max}		

FYRITE

______
______
______
______

C_p ______

Sample Point	Dwell Time Minutes	Elapsed Time Minutes	Dry Gas Meter Readings Cubic Feet	Pitot Reading In. H_2O	Orifice Setting In. H_2O	Gas Meter Temp °F	Vacuum Gauge In. Hg	Gas Temps Filter Box °F	Gas Temps Impinger Exit °F	Cyclone Temp. °F	Stack Temp. °F
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
		minutes	Vm	$(\sqrt{\Delta P})^2$	ΔH	tm					ts

* ~EMOVE HEAD BEFORE
~OSTTEST LEAK CHECK

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ENTROPY

Emission Gas Recycle. Data Reduction.
Version 3.4 MAY 1986

Test ID. Code: Chapel Hill 2.
Test Location: Baghouse Outlet.
Test Site: Chapel Hill.
Test Date: 10/20/86.
Operators(s): JB RH MH.

Entered Run Data

Temperatures:	
T(STK)	251.0 F
T(RCL)	259.0 F
T(LFE)	81.0 F
T(DGM)	78.0 F
System Pressures:	
DH(ORI)	1.18 INWG
DP(TOT)	1.91 INWG
P(INL)	12.15 INWG
DP(RCL)	2.21 INWG
DP(PTO)	0.08 INWG
Miscellanea:	
P(BAR)	29.99 INWG

Entered Run Data—Continued

DP(STK)	0.10 INWG
V(DGM)	13.744 FT3
TIME	60.00 MIN
% CO2	8.00
% O2	20.00
NOZ (IN)	0.2500
Water Content:	
Estimate	0.0%
or	
Condenser	7.0 ML
Column	0.0 GM
Raw Masses:	
Cyclone 1	21.7 MG
Filter	11.7 MG
Impinger Residue	0.0 MG
Blank Values:	
CYC Rinse	0.0 MG
Filter Holder Rinse	0.0 MG
Filter Blank	0.0 MG
Impinger Rinse	0.0 MG

Calibration Values:	
CP(PITOT)	0.840
DH@(ORI)	10.080
M(TOT LFE)	0.2298
B(TOT LFE)	−.0058
M(RCL LFE)	0.0948
B(RCL LFE)	−.0007
DGM GAMMA	0.9940

Reduced Data

Stack Velocity (FT/SEC)	15.95
Stack Gas Moisture (%)	2.4
Sample Flow Rate (ACFM)	0.3104
Total Flow Rate (ACFM)	0.5819
Recycle Flow Rate (ACFM)	0.2760
Percent Recycle	48.7
Isokinetic Ratio (%)	95.1

	(Particulate)		(MG/DNCM)	(GR/ACF)	(GR/DCF)	(LB/DSCF) (X 1E6)
	(UM)	(% <)				
Cyclone 1	10.15	35.8	56.6	0.01794	0.02470	3.53701
Backup Filter			30.5	0.00968	0.01332	1.907
Particulate Total			87.2	0.02762	0.03802	5.444

Note: Figure 14. Example inputs and outputs of the EGR reduction program.

Method 201A—Determination of PM_{10} Emissions (Constant Sampling Rate Procedure)

1. Applicability and Principle

1.1 Applicability. This method applies to the in-stack measurement of particulate matter (PM) emissions equal to or less than an aerodynamic diameter of nominally 10 (PM_{10}) from stationary sources. The EPA recognizes that condensible emissions not collected by an in-stack method are also PM_{10}, and that emissions that contribute to ambient. PM_{10} levels are the sum of condensible emissions and emissions measured by an in-stack PM_{10} method, such as this method or Method 201. Therefore, for establishing source contributions to ambient levels of PM_{10}, such as for emission inventory purposes, EPA suggests that source PM_{10} measurement include both in-stack PM_{10} and condensible emissions. Condensible emissions may be measured by an impinger analysis in combination with this method.

1.2 Principle. A gas sample is extracted at a constant flow rate through an in-stack sizing device, which separates PM greater than PM_{10}. Variations from isokinetic sampling conditions are maintained within well-defined limits. The particulate mass is determined gravimetrically after removal of uncombined water.

2. Apparatus

Note: Methods cited in this method are part of 40 CFR part 60, appendix A.

2.1 Sampling Train. A schematic of the Method 201A sampling train is shown in Figure 1 of this method. With the exception of the PM_{10} sizing device and in-stack filter, this train is the same as an EPA Method 17 train.

2.1.1 Nozzle. Stainless steel (316 or equivalent) with a sharp tapered leading edge. Eleven nozzles that meet the design specification in Figure 2 of this method are recommended. A larger number of nozzles with small nozzle increments increase the likelihood that a single nozzle can be used for the entire traverse. If the nozzles do not meet the design specifications in Figure 2 of this method, then the nozzles must meet the criteria in Section 5.2 of this method.

2.1.2 PM_{10} Sizer. Stainless steel (316 or equivalent), capable of determining the PM_{10} fraction. The sizing device shall be either a cyclone that meets the specifications in Section 5.2 of this method or a cascade impactor that has been calibrated using the procedure in Section 5.4 of this method.

2.1.3 Filter Holder. 63-mm, stainless steel. An Andersen filter, part number SE274, has been found to be acceptable for the in-stack filter. Note: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

2.1.4 Pitot Tube. Same as in Method 5, Section 2.1.3. The pitot lines shall be made of heat resistant tubing and attached to the probe with stainless steel fittings.

2.1.5 Probe Liner. Optional. Same as in Method 5, Section 2.1.2.

2.1.6 Differential Pressure Gauge, Condenser, Metering System, Barometer, and Gas Density Determination Equipment. Same as in Method 5, Sections 2.1.4, and 2.1.7 through 2.1.10, respectively.

2.2 Sample Recovery.

2.2.1 Nozzle, Sizing Device, Probe, and Filter Holder Brushes. Nylon bristle brushes with stainless steel wire shafts and handles, properly sized and shaped for cleaning the nozzle, sizing dedvice, probe or probe liner, and filter holders.

2.2.2 Wash Bottles, Glass Sample Storage Containers, Petri Dishes, Graduated Cylinder and Balance, Plastic Storage Containers, Funnel and Rubber Policeman, and Funnel. Same as in Method 5, Sections 2.2.2 through 2.2.8, respectively.

2.3 Analysis. Same as in Method 5, Section 2.3.

3. Reagents

The reagents for sampling, sample recovery, and analysis are the same as that specified in Method 5, Sections 3.1, 3.2, and 3.3, respectively.

4. Procedure

4.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers should be trained and experienced with the test procedures.

4.1.1 Pretest Preparation. Same as in Method 5, Section 4.1.1.

4.1.2 Preliminary Determinations. Same as in Method 5, Section 4.1.2, except use the directions on nozzle size selection and sampling time in this method. Use of any nozzle greater than 0.16 in. in diameter require a sampling port diameter of 6 inches. Also, the required maximum number of traverse points at any location shall be 12.

4.1.2.1 The sizing device must be in-stack or maintained at stack temperature during sampling. The blockage effect of the CSR sampling assembly will be minimal if the cross-sectional area of the sampling assembly is 3 percent or less of the cross-sectional area of the duct. If the cross-sectional area of the assembly is greater than 3 percent of the cross-sectional area of the duct, then either determine the pitot coefficient at sampling conditions or use a standard pitot with a known coefficient in a configuration with the CSR sampling assembly such that flow disturbances are minimized.

4.1.2.2 The setup calculations can be performed by using the following procedures.

4.1.2.2.1 In order to maintain a cut size of 10 μm in the sizing device, the flow rate through the sizing device must be maintained at a constant, discrete value during the run. If the sizing device is a cyclone that meets the design specifications in Figure 3 of this method, use the equations in Figure 4 of this method to calculate three orifice heads (ΔH): one at the average stack temperature, and the other two at temperatures ±28 °C (±50 °F) of the average stack temperature. Use ΔH calculated at the average stack temperature as the pressure head for the sample flow rate as long as the stack temperature during the run is within 28 °C (50 °F) of the average stack temperature. If the stack temperature varies by more than 28 °C (50 °F), then use the appropriate ΔH.

4.1.2.2.2 If the sizing device is a cyclone that does not meet the design specifications in Figure 3 of this method, use the equations in Figure 4 of this method, except use the procedures in Section 5.3 of this method to determine Q_s, the correct cyclone flow rate for a 10 μm size.

4.1.2.2.3 To select a nozzle, use the equations in Figure 5 of this method to calculate Δp_{min} and Δp_{max} for each nozzle at all three temperatures. If the sizing device is a cyclone that does not meet the design specifications in Figure 3 of this method, the example worksheets can be used.

4.1.2.2.4 Correct the Method 2 pitot readings to Method 201A pitot readings by multiplying the Method 2 pitot readings by the square of a ratio of the Method 201A pitot coefficient to the Method 2 pitot coefficient. Select the nozzle for which Δp_{min} and Δp_{max} bracket all of the corrected Method 2 pitot readings. If more than one nozzle meets this requirement, select the nozzle giving the greatest symmetry. Note that if the expected pitot reading for one or more points is near a limit for a chosen nozzle, it may be outside the limits at the time of the run.

4.1.2.2.5 Vary the dwell time, or sampling time, at each traverse point proportionately with the point velocity. Use the equations in Figure 6 of this method to calculate the dwell time at the first point and at each subsequent point. It is recommended that the number of minutes sampled at each point be rounded to the nearest 15 seconds.

4.1.3 Preparation of Collection Train. Same as in Method 5, Section 4.1.3, except omit directions about a glass cyclone.

4.1.4 Leak-Check Procedure. The sizing device is removed before the post-test leak-check to prevent any disturbance of the collected sample prior to analysis.

4.1.4.1 Pretest Leak-Check. A pretest leak-check of the entire sampling train, including the sizing device, is required. Use the leak-check procedure in Method 5, Section 4.1.4.1 to conduct a pretest leak-check.

4.1.4.2 Leak-Checks During Sample Run. Same as in Method 5, Section 4.1.4.1.

4.1.4.3 Post-Test Leak-Check. A leak-check is required at the conclusion of each sampling run. Remove the cyclone before the leak-check to prevent the vacuum created by the cooling of the probe from disturbing the collected sample and use the procedure in Method 5, Section 4.1.4.3 to conduct a post-test leak-check.

4.1.5 Method 201A Train Operation. Same as in Method 5, Section 4.1.5, except use the procedures in this section for isokinetic sampling and flow rate adjustment. Maintain the flow rate calculated in Section 4.1.2.2.1 of this method throughout the run provided the stack temperature is within 28 °C (50 °F) of the temperature used to calculate ΔH. If stack temperatures vary by more than 28 °C (50 °F), use the appropriate ΔH value calculated in Section 4.1.2.2.1 of this method. Calculate the dwell time at each traverse point as in Figure 6 of this method.

4.1.6 Calculation of Percent Isokinetic Rate and Aerodynamic Cut Size (D_{50}). Calculate percent isokinetic rate and D_{50} (see Calculations, Section 6 of this method) to determine whether the test was valid or another test run should be made. If there was difficulty in maintaining isokinetic sampling rates within the prescribed range, or if the D_{50} is not in its proper range because of source conditions, the Administrator may be consulted for possible variance.

4.2 Sample Recovery. If a cascade impactor is used, use the manufacturer's recommended procedures for sample recovery. If a cyclone is used, use the same sample recovery as that in Method 5, Section 4.2, except an increased number of sample recovery containers is required.

4.2.1 *Container Number 1* (In-Stack Filter). The recovery shall be the same as that for Container Number 1 in Method 5, Section 4.2.

4.2.3 *Container Number 2* (Cyclone or Large PM Catch). This step is optional. The anisokinetic error for the cyclone PM is theoretically larger than the error for the PM_{10} catch. Therefore, adding all the fractions to get a total PM catch is not as accurate as Method 5 or Method 201. Disassemble the cyclone and remove the nozzle to recover the large PM catch. Quantitatively recover the PM from the interior surfaces of the nozzle and cyclone, excluding the "turn around" cup and the interior surfaces of the exit tube. The recovery shall be the same as that for Container Number 2 in Method 5, Section 4.2.

4.2.4 *Container Number 3* (PM_{10}). Quantitatively recover the PM from all of the surfaces from the cyclone exit to the front half of the in-stack filter holder, including the "turn around" cup inside the cyclone and the interior surfaces of the exit tube. The recovery shall be the same as that for Container Number 2 in Method 5, Section 4.2.

4.2.6 *Container Number 4* (Silica Gel). The recovery shall be the same as that for Container Number 3 in Method 5, Section 4.2.

4.2.7 *Impinger Water*. Same as in Method 5, Section 4.2, under "Impinger Water."

4.3 Analysis. Same as in Method 5, Section 4.3, except handle Method 201A Container Number 1 like Container Number 1, Method 201A Container Numbers 2 and 3 like Container Number 2, and Method 201A Container Number 4 like Container Number 3. Use Figure 7 of this method to record the weights of PM collected. Use Figure 5–3 in Method 5, Section 4.3, to record the volume of water collected.

4.4 Quality Control Procedures. Same as in Method 5, Section 4.4.

5. *Calibration*

Maintain an accurate laboratory log of all calibrations.

5.1 Probe Nozzle, Pitot Tube, Metering System, Probe Heater Calibration, Temperature Gauges, Leak-check of Metering System, and Barometer. Same as in Method 5, Section 5.1 through 5.7, respectively.

5.2 Probe Cyclone and Nozzle Combinations. The probe cyclone and nozzle combinations need not be calibrated if both meet design specifications in Figures 2 and 3 of this method. If the nozzles do not meet design specifications, then test the cyclone and nozzle combinations for conformity with performance specifications (PS's) in Table 1 of this method. If the cyclone does not meet design specifications, then the cyclone and nozzle combination shall conform to the PS's and calibrate the cyclone to determine the relationship between flow rate, gas viscosity, and gas density. Use the procedures in Section 5.2 of this method to conduct PS tests and the procedures in Section 5.3 of this method to calibrate the cyclone. The purpose of the PS tests are to conform that the cyclone and nozzle combination has the desired sharpness of cut. Conduct the PS tests in a wind tunnel described in Section 5.2.1 of this method and particle generation system described in Section 5.2.2 of this method. Use five particle sizes and three wind velocities as listed in Table 2 of this method. A minimum of three replicate measurements of collection efficiency shall be performed for each of the 15 conditions listed, for a minimum of 45 measurements.

5.2.1 Wind Tunnel. Perform the calibration and PS tests in a wind tunnel (or equivalent test apparatus) capable of establishing and maintaining the required gas stream velocities within 10 percent.

5.2.2 Particle Generation System. The particle generation system shall be capable of producing solid monodispersed dye particles with the mass median aerodynamic diameters specified in Table 2 of this method. Perform the particle size distribution verification on an integrated sample obtained during the sampling period of each test. An acceptable alternative is to verify the size distribution of samples obtained before and after each test, with both samples required to meet the diameter and monodispersity requirements for an acceptable test run.

5.2.2.1 Establish the size of the solid dye particles delivered to the test section of the wind tunnel by using the operating parameters of the particle generation system, and verify them during the tests by microscopic examination of samples of the particles collected on a membrane filter. The particle size, as established by the operating parameters of the generation system, shall be within the tolerance specified in Table 2 of this method. The precision of the particle size verification technique shall be at least ±0.5 μm, and particle size determined by the verification technique shall not differ by more than 10 percent from that established by the operating parameters of the particle generation system.

5.2.2.2 Certify the monodispersity of the particles for each test either by microscopic inspection of collected particles on filters or by other suitable monitoring techniques such as an optical particle counter followed by a multichannel pulse height analyzer. If the proportion of multiplets and satellites in an aerosol exceeds 10 percent by mass, the particle generation system is unacceptable for the purpose of this test. Multiplets are particles that are agglomerated, and satellites are particles that are smaller than the specified size range.

5.2.3 Schematic Drawings. Schematic drawings of the wind tunnel and blower system and other information showing complete procedural details of the test atmosphere generation, verification, and delivery techniques shall be furnished with calibration data to the reviewing agency.

5.2.4 Flow Measurements. Measure the cyclone air flow rates with a dry gas meter and a stopwatch, or a calibrated orifice system capable of measuring flow rates to within 2 percent.

5.2.5 Performance Specification Procedure. Establish test particle generator operation and verify particle size microscopically. If monodispersity is to be verified by measurements at the beginning and the end of the run rather than by an integrated sample, these measurements may be made at this time.

5.2.5.1 The cyclone cut size, or D_{50}, of a cyclone is defined here as the particle size having a 50 percent probability of penetration. Determine the cyclone flow rate at which D_{50} is 10 μm. A suggested procedure is to vary the cyclone flow rate while keeping a constant particle size of 10 μm. Measure the PM collected in the cyclone (m_c), the exit tube (m_t), and the filter (m_f). Calculate cyclone efficiency (E_c) for each flow rate as follows:

$$E_c = \frac{m_c}{(m_c + m_t + m_f)} \times 100$$

5.2.5.2. Do three replicates and calculate the average cyclone efficiency ($E_{c(ave)}$) as follows:

$$E_{c(ave)} = (E_1 + E_2 + E_3)/3$$

Where E_1, E_2, and E_3 are replicate measurements of E_c.

5.2.5.3 Calculate the standard deviation (σ) for the replicate measurements of E_c as follows:

$$\sigma = \left[\frac{(E_1{}^2 + E_2{}^2 + E_3{}^2) - \dfrac{(E_1 + E_2 + E_3)^2}{3}}{2} \right]^{1/2}$$

If σ exceeds 0.10, repeat the replicated runs.

5.2.5.4 Measure the overall efficiency of the cyclone and nozzle, E_o, at the particle sizes and nominal gas velocities in Table 2 of this method using the following procedure.

5.2.5.5 Set the air velocity and particle size from one of the conditions in Table 2 of this method. Establish isokinetic sampling conditions and the correct flow rate in the cyclone (obtained by procedures in this section) such that the D_{50} is 10 μm. Sample long enough to obtain ±5 percent precision on total collected mass as determined by the precision and the sensitivity of measuring technique. Determine separately the nozzle catch (m_n), cyclone catch (m_c), cyclone exit tube (M_t), and collection filter catch (m_f) for each particle size and nominal gas velocity in Table 2 of this method. Calculate overall efficiency (E_o) as follows:

$$E_o = \frac{(m_n + m_c)}{(m_n + m_c + m_t + m_f)} \times 100$$

5.2.5.6 Do three replicates for each combination of gas velocity and particle size in Table 2 of this method. Use the equation below to calculate the average overall efficiency ($E_{o(ave)}$) for each combination following the procedures described in this section for determining efficiency.

$$E_{o(ave)} = (E_1 + E_2 + E_3)/3$$

Where E_1, E_2, and E_3 are replicate measurements of E_o.

5.2.5.7 Use the formula in Section 5.2.5.3 to calculate σ for the replicate measurements. If σ exceeds 0.10 or if the particle sizes and nominal gas velocities are not within the limits specified in Table 2 of this method, repeat the replicate runs.

5.2.6 Criteria for Acceptance. For each of the three gas stream velocities, plot the $E_{o(ave)}$ as a function of particle size on Figure 8 of this method. Draw smooth curves through all particle sizes. $E_{o(ave)}$ shall be within the banded region for all sizes, and the $E_{c(ave)}$ shall be 50±0.5 percent at 10 μm.

5.3 Cyclone Calibration Procedure. The purpose of this procedure is to develop the relationship between flow rate, gas viscosity, gas density, and D_{50}.

5.3.1 Calculate Cyclone Flow Rate. Determine flow rates and D_{50}'s for three different particle sizes between 5 μm and 15 μm, one of which shall be 10 μm. All sizes must be determined within 0.5 μm. For each size, use a different temperature within 60 °C (108 °F) of the temperature at which the cyclone is to be used and conduct triplicate runs. A suggested procedure is to keep the particle size constant and vary the flow rate

5.3.1.1. On log-log graph paper, plot the Reynolds number (Re) on the abscissa, and the square root of the Stokes 50 number [$(Stk_{50})^{1/2}$] on the ordinate for each temperature. Use the following equations to compute both values:

$$Re = \frac{4 \rho Q_{cyc}}{d_{cyc} \pi \mu_{cyc}}$$

$$(Stk_{50})^{1/2} = \left[\frac{4 Q_{cyc} (D_{50})^2}{9 \pi \mu_{cyc} (d_{cyc})^3} \right]^{1/2}$$

where:

Q_{cyc} = Cyclone flow rate, cm³/sec.
ρ = Gas density, g/cm³.
d_{cyc} = Diameter of cyclone inlet, cm.
μ_{cyc} = Viscosity of gas through the cyclone, micropoise.
D_{50} = Aerodynamic diameter of a particle having a 50 percent probability of penetration, cm.

5.3.1.2 Use a linear regression analysis to determine the slope (m) and the Y-intercept (b). Use the following formula to determine Q, the cyclone flow rate required for a cut size of 10 μm.

$$Q_s = \frac{\pi \mu_{cyc}}{4} \left[(3000)(K_1) - b \right]^{-(0.5-m)} \left[\frac{T_s}{M_s P_s} \right]^{m/(m-0.5)} d^{(m-1.5)/(m-0.5)}$$

where:

m = Slope of the calibration line.
b = y-intercept of the calibration line.
Q_s = Cyclone flow rate for a cut size of 10 μm, cm³/sec.
d = Diameter of nozzle, cm.
T_s = Stack gas temperature, R.
P_s = Absolute stack pressure, in. Hg.
M_s = Molecular weight of the stack gas, lb/lb-mole.
$K_1 = 4.077 \times 10^{-3}$.

5.3.1.3 Refer to the Method 201A operators manual, entitled *Application Guide for Source PM₁₀ Measurement with Constant*

Sampling Rate, for directions in the use of this equation for Q in the setup calculations.

5.4 Cascade Impactor. The purpose of calibrating a cascade impactor is to determine the empirical constant (STK_{50}), which is specific to the impactor and which permits the accurate determination of the cut size of the impactor stages at field conditions. It is not necessary to calibrate each individual impactor. Once an impactor has been calibrated, the calibration data can be applied to other impactors of identical design.

5.4.1 Wind Tunnel. Same as in Section 5.2.1 of this method.

5.4.2 Particle Generation System. Same as in Section 5.2.2 of this method.

5.4.3 Hardware Configuration for Calibrations. An impaction stage constrains an aerosol to form circular or rectangular jets, which are directed toward a suitable substrate where the larger aerosol particles are collected. For calibration purposes, three stages of the cascade impactor shall be discussed and designated calibration stages 1, 2, and 3. The first calibration stage consists of the collection substrate of an impaction stage and all upstream surfaces up to and including the nozzle. This may include other preceding impactor stages. The second and third calibration stages consist of each respective collection substrate and all upstream surfaces up to but excluding the collection substrate of the preceding calibration stage. This may include intervening impactor stages which are not designated as calibration stages. The cut size, or D_{50}, of the adjacent calibration stages shall differ by a factor of not less than 1.5 and not more than 2.0. For example, if the first calibration stage has a D_{50} of 12 μm, then the D_{50} of the downstream stage shall be between 6 and 8 μm.

5.4.3.1 It is expected, but not necessary, that the complete hardware assembly will be used in each of the sampling runs of the calibration and performance determinations. Only the first calibration stage must be tested under isokinetic sampling conditions. The second and third calibration stages must be calibrated with the collection substrate of the preceding calibration stage in place, so that gas flow patterns existing in field operation will be simulated.

5.4.3.2 Each of the PM_{10} stages should be calibrated with the type of collection substrate, viscid material (such as grease) or glass fiber, used in PM_{10} measurements. Note that most materials used as substrates at elevated temperatures are not viscid at normal laboratory conditions. The substrate material used for calibrations should minimize particle bounce, yet be viscous enough to withstand erosion or deformation by the impactor jets and not interfere with the procedure for measuring the collected PM.

5.4.4 Calibration Procedure. Establish test particle generator operation and verify particle size microscopically. If monodispersity is to be verified by measurements at the beginning and the end of the run rather than by an integrated sample, these measurements shall be made at this time. Measure in triplicate the PM collected by the calibration stage (m) and the PM on all surfaces downstream of the respective calibration stage (m') for all of the flow rates and particle size combinations shown in Table 2 of this method. Techniques of mass measurement may include the use of a dye and spectrophotometer. Particles on the upstream side of a jet plate shall be included with the substrate downstream, except agglomerates of particles, which shall be included with the preceding or upstream substrate. Use the following formula to calculate the collection efficiency (E) for each stage.

5.4.4.1 Use the formula in Section 5.2.5.3 of this method to calculate the standard deviation (σ) for the replicate measurements. If σ exceeds 0.10, repeat the replicate runs.

5.4.4.2 Use the following formula to calculate the average collection efficiency (E_{avg}) for each set of replicate measurements.

$E_{avg}=(E_1+E_2+E_3)/3$

where E_1, E_2, and E_3 are replicate measurements of E.

5.4.4.3 Use the following formula to calculate Stk for each E_{avg}.

$$Stk=\frac{D^2Q}{9\,\mu\,A\,d_j}$$

where:

D = Aerodynamic diameter of the test particle, cm $(g/cm^3)^{1/2}$.

Q = Gas flow rate through the calibration stage at inlet conditions, cm^3/sec.

μ = Gas viscosity, micropoise.

A = Total cross-sectional area of the jets of the calibration stage, cm^2.

d_j = Diameter of one jet of the calibration stage, cm.

5.4.4.4 Determine Stk_{50} for each calibration stage by plotting E_{avg} versus Stk on log-log paper. Stk_{50} is the Stk number at 50 percent efficiency. Note that particle bounce can cause efficiency to decrease at high values of Stk. Thus, 50 percent efficiency can occur at multiple values of Stk. The calibration data should clearly indicate the value of Stk_{50} for minimum particle bounce. Impactor efficiency versus Stk with minimal particle bounce is characterized by a monotonically increasing function with constant or increasing slope with increasing Stk.

5.4.4.5 The Stk_{50} of the first calibration stage can potentially decrease with decreasing nozzle size. Therefore, calibrations should be performed with enough nozzle sizes to provide a measured value within 25 percent of any nozzle size used in PM_{10} measurements.

5.4.5 Criteria For Acceptance. Plot E_{avg} for the first calibration stage versus the square root of the ratio of Stk to Stk_{50} on Figure 9 of this method. Draw a smooth curve through all of the points. The curve shall be within the banded region.

6. Calculations

6.1 Nomenclature.

B_{ws} = Moisture fraction of stack, by volume, dimensionless.

C_1 = Viscosity constant, 51.12 micropoise for °K (51.05 micropoise for °R).

C_2 = Viscosity constant, 0.372 micropoise/°K (0.207 micropoise/°R).

C_3 = Viscosity constant, 1.05×10^{-4} micropoise/$°K^2$ (3.24×10^{-5} micropoise/$°R^2$).

C_4 = Viscosity constant, 53.147 micropoise/fraction O_2.

C_5 = Viscosity constant, 74.143 micropoise/fraction H_2O.

D_{50} = Diameter of particles having a 50 percent probability of penetration, μm.

f_{O_2} = Stack gas fraction O_2, by volume, dry basis.

K_1 = 0.3858 °K/mm Hg (17.64 °R/in. Hg).

M_c = Wet molecular weight of mixed gas through the PM_{10} cyclone, g/g-mole (lb/lb-mole).

M_d = Dry molecular weight of stack gas, g/g-mole (lb/lb-mole).

P_{bar} = Barometric pressure at sampling site, mm Hg (in. Hg).

P_s = Absolute stack pressure, mm Hg (in. Hg).

Q_s = Total cyclone flow rate at wet cyclone conditions, m^3/min (ft^3/min).

$Q_{s(std)}$ = Total cyclone flow rate at standard conditions, dscm/min (dscf/min).

T_m = Average absolute temperature of dry meter, °K (°R).

T_s = Average absolute stack gas temperature, °K (°R).

$V_{w(std)}$ = Volume of water vapor in gas sample (standard conditions), scm (scf).

θ = Total sampling time, min.

μ_{cyc} = Viscosity of mixed cyclone gas, micropoise.

μ_{std} = Viscosity of standard air, 180.1 micropoise.

6.2 Analysis of Cascade Impactor Data. Use the manufacturer's recommended procedures to analyze data from cascade impactors.

6.3 Analysis of Cyclone Data. Use the following procedures to analyze data from a single stage cyclone.

6.3.1 PM_{10} Weight. Determine the PM catch in the PM_{10} range from the sum of the weights obtained from Container Numbers 1 and 3 less the acetone blank.

6.3.2 Total PM Weight (optional). Determine the PM catch for greater than PM_{10} from the weight obtained from Container Number 2 less the acetone blank, and add it to the PM_{10} weight.

6.3.3 PM_{10} Fraction. Determine the PM_{10} fraction of the total particulate weight by dividing the PM_{10} particulate weight by the total particulate weight.

6.3.4 Aerodynamic Cut Size. Calculate the stack gas viscosity as follows:

$\mu_{cyc}=C_1+C_2T_s+C_3T_s^2+C_4f_{O_2}-C_5B_{ws}$

6.3.4.1 The PM_{10} flow rate, at actual cyclone conditions, is calculated as follows:

$$Q_s=\frac{T_s}{K_1\,P_s}\left[Q_{s(std)}+\frac{V_{w(std)}}{\theta}\right]$$

6.3.4.2 Calculate the molecular weight on a wet basis of the stack gas as follows:

$M_c=M_d(1-B_{ws})+18.0(B_{ws})$

6.3.4.3 Calculate the actual D_{50} of the cyclone for the given conditions as follows:

$$D_{50} = \beta_1 \left[\frac{T_s}{M_s P_s} \right]^{0.2091} \left[\frac{\mu_{cyc}}{Q_s} \right]^{0.7091}$$

where $\beta_1 = 0.027754$ for metric units (0.15625 for English units).

6.3.5 Acceptable Results. The results are acceptable if two conditions are met. The first is that 9.0 μm < D_{50} < 11.0 μm. The second is that no sampling points are outside Δp_{min} and Δp_{max}, or that 80 percent < I < 120 percent and no more than one sampling point is outside Δp_{min} and Δp_{max}. If D_{50} is less than 9.0 μm, reject the results and repeat the test.

Bibliography

1. Same as Bibliography in Method 5.

2. McCain, J.D., J.W. Ragland, and A.D. Williamson. Recommended Methodology for the Determination of Particle Size Distributions in Ducted Sources. Final Report. Prepared for the California Air Resources Board by Southern Research Institute. May 1986.

3. Farthing, W.E., S.S. Dawes, A.D. Williamson, J.D. McCain, R.S. Martin, and J.W. Ragland. Development of Sampling Methods for Source PM_{10} Emissions. Southern Research Insitute for the Environmental Protection Agency. April 1989. NTIS PB 89 190375, EPA/600/3–88–056.

4. *Application Guide for Source PM_{10} Measurement with Constant Sampling Rate.* EPA/600/3–88–057.

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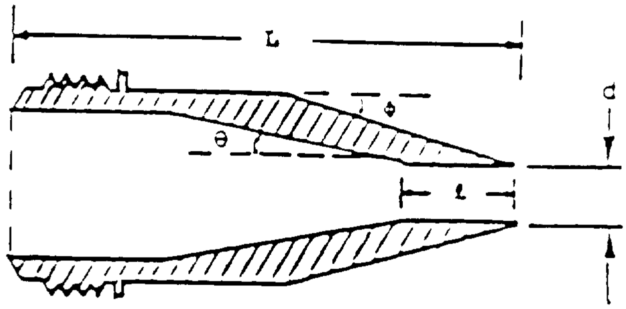
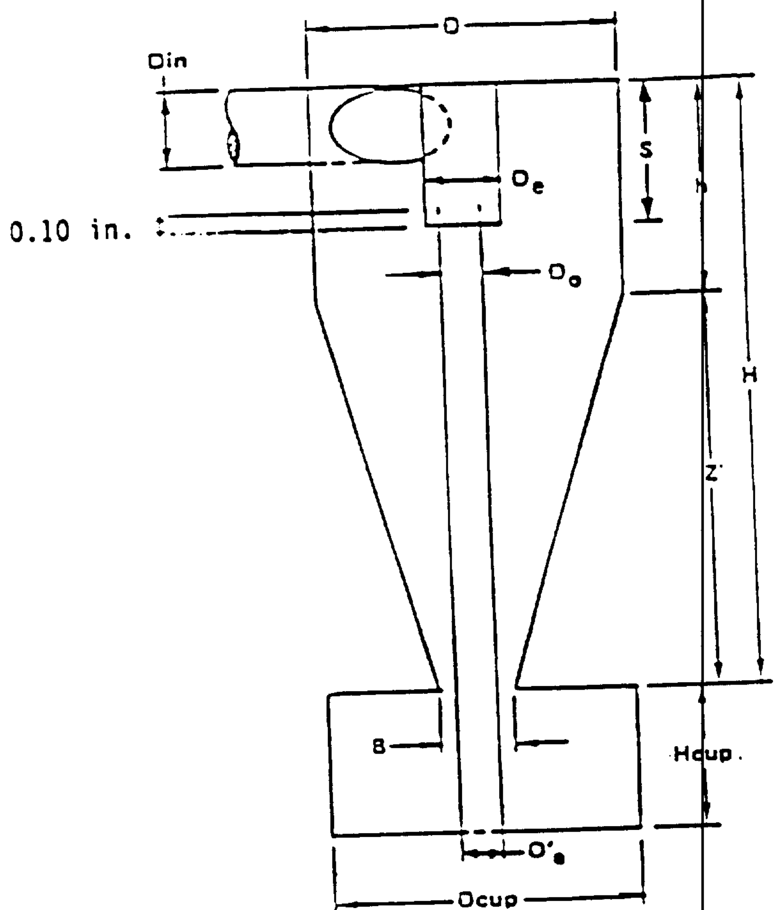


Nozzle Diameter (inches)	Cone Angle, θ (degrees)	Outside taper, ϕ (degrees)	Straight inlet length, ℓ (inches)	Total Length L (inches)
0.136	4	15	<0.05	2.653±0.05
0.150	4	15	<0.05	2.553±0.05
0.164	5	15	<0.05	1.970±0.05
0.180	6	15	<0.05	1.572±0.05
0.197	6	15	<0.05	1.491±0.05
0.215	6	15	<0.05	1.45 ±0.05
0.233	6	15	<0.05	1.45 ±0.05
0.264	5	15	<0.05	1.45 ±0.05
0.300	4	15	<0.05	1.48 ±0.05
0.342	4	15	<0.05	1.45 ±0.05
0.390	3	15	<0.05	1.45 ±0.05

Figure 2. Nozzle design specifications.

Cyclone Interior Dimensions



	Dimensions (±0.02 cm, ±0.01 in.)											
	Din	D	De	B	H	h	Z	S	Hcup	Dcup	D'e	Do
cm	1.27	4.47	1.50	1.88	6.95	2.24	4.71	1.57	2.25	4.45	1.02	1.24
inches	0.50	1.76	0.59	0.74	2.74	0.88	1.85	0.62	0.89	1.75	0.40	0.49

Figure 3. Cyclone design specifications.

Barometric pressure,
P_{bar}, in. Hg = ________
Stack static pressure,
P_g, in. H_2O = ________
Average stack temperature,
t_s, °F = ________
Meter temperature, t_m, °F = ________
Orifice $\Delta H_@$, in. H_2O = ________
Gas analysis:
%CO_2 = ________
%O_2 = ________
%N_2 + %CO = ________
Fraction moisture content,
B_{ws} = ________
Molecular weight of stack gas, dry basis:
$M_d = 0.44\ (\%CO_2) + 0.32\ (\%O_2) + 0.28\ (\%N_2 + \%CO)$ = ________ lb/lb mole
Molecular weight of stack gas, wet basis:
$M_w = M_d\ (1-B_{ws}) + 18\ (B_{ws})$ = ________ lb/lb mole
Absolute stack pressure:

$$P_s = P_{bar} + \frac{P_g}{13.6} = \text{\_\_\_\_\_\_\_\_ in. Hg}$$

Viscosity of stack gas:
$\mu_s = 152.418 + 0.2552\ t_s + 3.2355 \times 10^{-5}\ t_s^2 + 0.53147\ (\%O_2) - 74.143\ B_{ws}$ = ________ micropoise
Cyclone flow rate:

$$Q_s = 0.002837\ \mu_s \left[\frac{(t_s+460)}{M_w P_s}\right]^{0.2949} = \text{\_\_\_\_\_\_\_\_ ft}^3\text{/min}$$

Figure 4. Example worksheet 1, cyclone flow rate and ΔH.

Orifice pressure head (ΔH) needed for cyclone flow rate:

$$\Delta H = \left[\frac{Q_s\ (1-B_{ws})\ P_s}{t_s+460}\right]^2 \frac{t_m\ M_d\ 1.083\ \Delta H_@}{P_{bar}} = \text{\_\_\_\_\_\_\_\_ in. } H_2O$$

Calculate ΔH for three temperatures:

t_m, °F			
ΔH, in. H_2O			

Stack viscosity, μ_s, micropoise = ________
Absolute stack pressure,
P_s, in. Hg = ________
Average stack temperature,
t_s, °F = ________
Meter temperature, t_m, °F = ________
Method 201A pitot coefficient,
C_p = ________
Cyclone flow rate, ft³/min,
Q_s = ________
Method 2 pitot coefficient,
C_p' = ________
Molecular weight of stack gas, wet basis,
M_w = ________
Nozzle diameter, D_n, in. = ________
Nozzle velocity:

$$v_n = \frac{3.056\ Q_s}{D_n^2} = \text{\_\_\_\_\_\_\_\_ ft/sec}$$

Maximum and minimum velocities:

$$v_{min} = v_n \left[0.2457 + \left(0.3072 - \frac{0.2603\ Q_s^{1/2}\ \mu_s}{v_n^{1.5}}\right)^{1/2}\right] = \text{\_\_\_\_\_\_\_\_ ft/sec}$$

$$v_{max} = v_n \left[0.4457 + \left(0.5690 - \frac{0.2603\ Q_s^{1/2}\ \mu_s}{v_n^{1.5}}\right)^{1/2}\right] = \text{\_\_\_\_\_\_\_\_ ft/sec}$$

Figure 5. Example worksheet 2, nozzle selection.

Maximum and minimum velocity head values:

$$\Delta p_{min} = 1.3686 \times 10^{-4}\ \frac{P_s\ M_w\ (v_{min})^2}{(t_s + 460)\ C_p^2} = \text{\_\_\_\_\_\_\_\_ in. } H_2O$$

$$\Delta p_{max} = 1.3686 \times 10^{-4} \frac{P_s M_w (v_{max})^2}{(t_s + 460) C_p^2} = \_\_\_\_\_\_ \text{ in. } H_2O$$

Nozzle No.			
D_n, in.			
v_n, ft/sec			
v_{min}, ft/sec			
v_{max}, ft/sec			
Δp_{min}, in. H_2O			
Δp_{max}, in. H_2O			

Velocity traverse data:

$$\Delta p(\text{Method 201A}) = \Delta p(\text{Method 2}) \left[\frac{C_p}{C_p'}\right]^2$$

Total run time, minutes = ______

Number of traverse points = ______

$$t_1 = \left[\frac{\Delta p'_1}{\Delta p'_{avg}}\right]^{1/2} \frac{(\text{Total run time})}{(\text{Number of points})}$$

where:

t_1 = dwell time at first traverse point, minutes.

$\Delta p'_1$ = the velocity head at the first traverse point (from a previous traverse), in. H_2O.

$\Delta p'_{avg}$ = the square of the average square root of the Δp's (from a previous velocity traverse), in. H_2O.

At subsequent traverse points, measure the velocity Δp and calculate the dwell time by using the following equation:

$$t_n = \frac{t_1}{(\Delta p_1)^{1/2}} (\Delta p_n)^{1/2}, \; n = 2, 3, \cdots \text{ total number of sampling points}$$

where:

t_n = dwell time at traverse point n, minutes.

Δp_n = measured velocity head at point n, in. H_2O.

Δp_1 = dwell time at first traverse point, minutes.

Figure 6. Example worksheet 3, dwell time.

Point No.	Port							
	Δp	t	Δp	t	Δp	t	Δp	t
1								
2								
3								
4								
5								
6								

Plant ______

Date ______

Run no. ______

Filter no. ______

Amount of liquid lost during transport ______

Acetone blank volume, ml ______

Acetone wash volume, ml (4) ______ (5) ______

Acetone blank conc., mg/mg (Equation 5–4, Method 5) ______

Acetone wash blank, mg (Equation 5–5, Method 5) ______

Container No.	Weight of PM_{10} (mg)		
	Final weight	Tare weight	Weight gain
1			
3			
Total			
Less acetone blank			
Weight of PM_{10}			

Figure 7. Method 201A analysis sheet.

TABLE 1.—PERFORMANCE SPECIFICATIONS FOR SOURCE PM_{10} CYCLONES AND NOZZLE COMBINATIONS

Parameter	Units	Specifications
1. Collection efficiency.	Percent	Such that collection efficiency falls within envelope specified by Section 5.2.6 and Figure 8.
2. Cyclone cut size (D_{50}).	μm	10 ± 1 μm aerodynamic diameter.

TABLE 2.—PARTICLE SIZES AND NOMINAL GAS VELOCITIES FOR EFFICIENCY

Particle size (μm)[a]	Target gas velocities (m/sec)		
	7 ± 1.0	15 ± 1.5	25 ± 2.5
5 ± 0.5			
7 ± 0.5			
10 ± 0.5			
14 ± 1.0			
20 ± 1.0			

[a] Mass median aerodynamic diameter.

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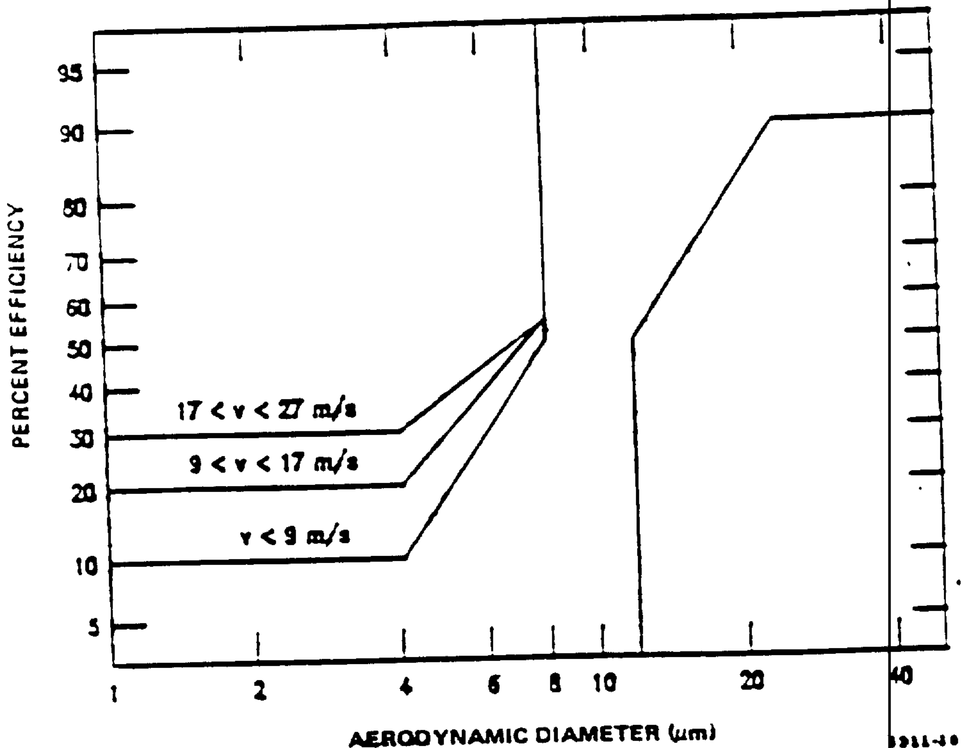

Figure 8. Efficiency envelope for the PM_{10} cyclone.

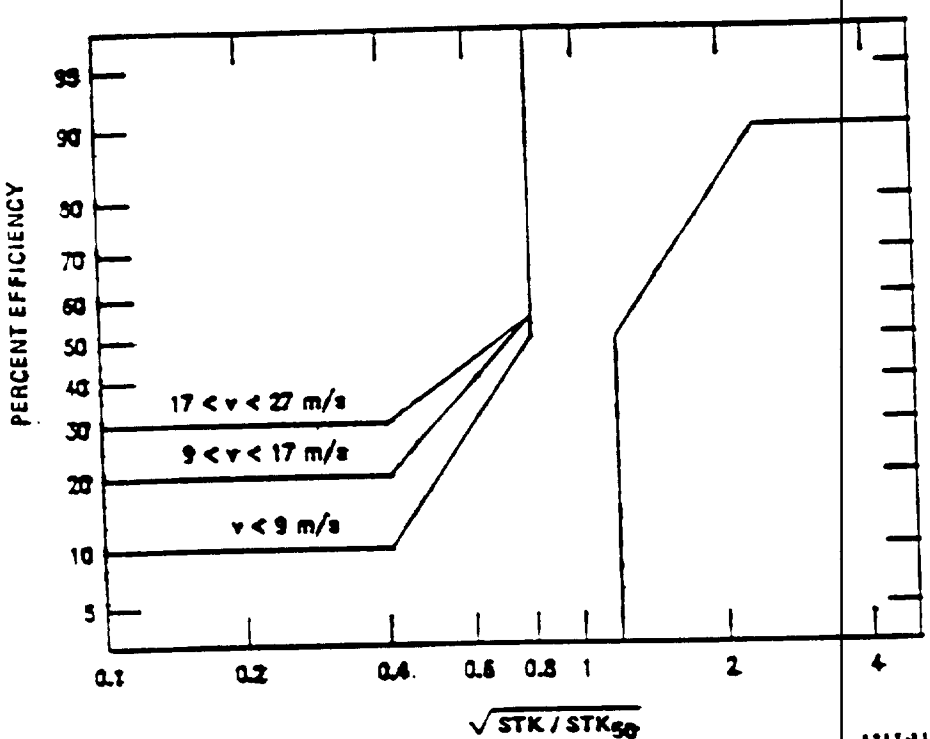

Figure 9. Efficiency envelope for first calibration stage.

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APPENDIX I.

Additional Information

KEY TO AVIATION WEATHER OBSERVATIONS . . . .

LOCATION IDENTIFIER TYPE AND TIME OF REPORT*	SKY AND CEILING	VISIBILITY WEATHER AND OBSTRUCTION TO VISION	SEA-LEVEL PRESSURE	TEMPERATURE AND DEW POINT	WIND	ALTIMETER SETTING	REMARKS AND CODED DATA
MKC SA 0758	15 SCT M25 OVC	1R-K	132	/58/56	/1807	/993/	R04LVR20V40

SKY AND CEILING

Sky cover contractions are in ascending order. Figures preceding contractions are heights in hundreds of feet above station. Sky cover contractions are:

- CLR Clear: Less than 0.1 sky cover.
- SCT Scattered: 0.1 to 0.5 sky cover.
- BKN Broken: 0.6 to 0.9 sky cover.
- OVC Overcast: More than 0.9 sky cover
- — Thin (When prefixed to SCT, BKN, OVC)
- —X Partial obscuration: 0.9 or less of sky hidden by precipitation or obstructon to vision (bases at surface.)
- X Obscuration: 1.0 sky hidden by precipitation or obstruction to vision (bases at surface).

Letter preceding height of layer identifies ceiling layer and indicates how ceiling height was obtained. Thus:

- E Estimated height
- M Measured
- W Indefinite

V=Immediately following numerical value, indicates a variable ceiling.

VISIBILITY

Reported in statute miles and fractions. (V=Variable)

WEATHER AND OBSTRUCTION TO VISION SYMBOLS

A	Hail	IC	Ice crystals	S	Snow
BD	Blowing dust	IF	Ice fog	SG	Snow grains
BN	Blowing sand	IP	Ice pellets	SP	Snow pellets
BS	Blowing snow	IPW	Ice pellet showers	SW	Snow showers
D	Dust	K	Smoke	T	Thunderstorms
F	Fog	L	Drizzle	T+	Severe thunderstorm
GF	Ground fog	R	Rain	ZL	Freezing drizzle
H	Haze	RW	Rain showers	ZR	Freezing rain

Precipitation intensities are indicated thus: — Light: (no sign) Moderate: — Heavy

WIND

Direction in tens of degrees from true north, speed in knots. 0000 indicates calm. G indicates gusty. Peak speed of gusts follows G or Q when gusts or squall are reported. The contraction WSHFT followed by GMT time group in remarks indicates windshift and its time of occurrence. (Knots × 1.15=statute mi/hr.)

EXAMPLES: 3627=360 Degrees, 27 knots; 3627G40=360 Degrees, 27 knots, peak speed in gusts 40 knots.

ALTIMETER SETTING

The first figure of the actual altimeter setting is always omitted from the report.

RUNWAY VISUAL RANGE (RVR)

RVR is reported from some stations. Extreme values during 10 minutes prior to observation are given in hundreds of feet Runway identification precedes RVR report.

PILOT REPORTS (PIREPS)

When available, PIREPS, in fixed-formats are appended to weather observations. The PIREP is desgnated by UA

DECODED REPORT

Kansas City: Record observation taken at 0758 GMT 1500 feet scattered clouds, measured ceiling 2500 feet overcast, visibility 1 mile, light rain, smoke, sea-level pressure 1013.2 millibars, temperature 58°F, dewpoint 56°F, wind 180°, 7 knots, altimeter setting 29.93 inches. Runway 04 left, visual range 2000 feet variable to 4000 feet.

*TYPE OF REPORT

- SA—a scheduled record observation
- SP—an unscheduled special observation indicating a significant change in one or more elements
- RS—a scheduled record observation that also qualifies as a special observation.

All three types of observations (SA, SP, RS) are followed by a 24 hour-clock-time-group in GMT.

U.S. DEPARTMENT OF COMMERCE — NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION — NATIONAL WEATHER SERVICE

KEY TO AVIATION WEATHER FORECASTS . . . .

TERMINAL FORECASTS contain information for specific airports on expected ceiling, cloud heights, cloud amounts, visibility, weather, and obstructions to vision and surface wind. They are issued 3 times/day and are valid for 24 hours. The last six hours of each forecast are covered by a categorical statement indicating whether VFR, MVFR, IFR or LIFR conditions are expected (L in LIFR and M in MVFR indicate "low" and "marginal"). Terminal forecasts will be written in the following form:

- **CEILING:** Identified by the letter "C"
- **CLOUD HEIGHTS:** In hundreds of feet above the station (ground)
- **CLOUD LAYERS:** Stated in ascending order of height
- **VISIBILITY:** In statute miles but omitted if over 6 miles
- **WEATHER AND OBSTRUCTION TO VISION:** Standard weather and obstruction to vision symbols are used
- **SURFACE WIND:** In tens of degrees and knots; omitted when less than 10

EXAMPLE OF TERMINAL FORECAST

DCA 221010: DCA Forecast 22nd day of month—valid time 10Z–10Z.
10 SCT C18 BKN 5SW–3415G25 OCNL C8 X 1/2SW: Scattered clouds at 1000 feet, ceiling 1800 feet broken, visibility 5 miles, light snow showers, surface wind 340 degrees 15 knots Gusts to 25 knots, occasional ceiling 8 hundred feet sky obscured, visibility ½ mile in moderate snow showers.
12Z C50 BKN 3312G22: At 12Z becoming ceiling 5000 feet broken, surface wind 330 degrees 12 knots Gusts to 22.
04Z MVFR CIG: Last 6 hours of FT after 04Z marginal VFR due to ceiling.

AREA FORECASTS are 18-hour aviation forecasts plus a 12-hour categorical outlook prepared 2 times/day giving general descriptions of cloud cover, weather and frontal conditions for an area the size of several states. Heights of cloud tops, and icing are referenced ABOVE SEA LEVEL (ASL); ceiling heights, ABOVE GROUND LEVEL (AGL); bases of cloud layers are ASL unless indicated. Each SIGMET or AIRMET affecting an FA area will also serve to amend the Area Forecast.

SIGMET or AIRMET messages broadcast by FAA on NAVAID voice channels warn pilots of potentially hazardous weather. SIGMET concerns severe and extreme conditions of importance to all aircraft, (i.e. icing, turbulence, and duststorms/sandstorms). Convective SIGMETS are issued for thunderstorms by the Severe Storms Forecast Center at Kansas City for the conterminous U.S. AIRMETS concern less severe conditions which may be hazardous to some aircraft or to relatively inexperienced pilots.

WINDS AND TEMPERATURES ALOFT (FD) FORECASTS are 12-hour forecasts of wind direction (nearest 10° true N) and speed (knots) for selected flight levels. Temperatures aloft (°C) are included for all but the 3000-foot level.

EXAMPLES OF WINDS AND TEMPERATURES ALOFT (FD) FORECASTS:

FD WBC 121745
BASED ON 121200Z DATA
VALID 130000Z FOR USE 1800-0300Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
BOS	3127	3425-07	3420-11	3421-16	3516-27	3512-38	311649	292451	283451
JFK	3026	3327-08	3324-12	3322-16	3120-27	2923-38	284248	285150	285749

At 6000 feet ASL over JFK wind from 330° at 27 knots and temperature minus 8°C.

TWEB (CONTINUOUS TRANSCRIBED WEATHER BROADCAST)—Individual route forecasts covering a 25-nautical-mile zone either side of the route. By requesting a specific route number, detailed en route weather for a 12- or 18-hour period (depending on forecast issuance) plus a synopsis can be obtained.

PILOTS . . . report inflight weather to nearest FSS. The latest surface weather reports are available by phone at the nearest pilot weather briefing office by calling at H+10.

U.S. DEPARTMENT OF COMMERCE — NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION — NATIONAL WEATHER SERVICE —REVISED OCTOBER 1978

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GPO : 1978 O - 277-321

SA 0050 150 SCT E250 OVC 12 195/55/42/2207/011/THN SPTS IOVC/ 714 1071 73 (MR 05:54Z)
SY 72306 32969 82207 10128 20056 30036 40195 57014 82071 333 10228 20039 70000 555 90906= (MR05:55Z)

SA 0150 250 -OVC 12 191/55/41/2207/010/FEW AC (MR 06:55Z)
SA 0250 250 -OVC 12 188/55/42/2207/009/FEW AC/ 98448 (MR 07:54Z)
SA 0350 250 -BKN 12 185/53/42/2208/008/ 710 1001 (MR 08:55Z)
SA 0450 E250 BKN 10 183/55/45/2210/008/FEW AC (MR 09:54Z)
SA 0550 250 -BKN 10 190/54/47/2209/007 (MR 10:54Z)
SA 0650 100 SCT 250 -BKN 8 180/52/48/2307/006/ 705 1071 51 (MR 11:54Z)
SY 72306 32962 62307 10111 20089 30020 40180 57005 81071 333 10228 20106 555 90912= (MR11:55Z)

SA 0750 M80 BKN 250 BKN 8 180/55/50/2307/007 (MR 12:54Z)
SA 0851 M70 BKN 250 BKN 7 181/58/50/2409/007/AC MOVG NE (PB 13:56Z)
SA 0950 70 SCT 250 -BKN 7 179/62/51/2208/007/FEW SC E/ 800 1578 (PB 14:55Z)
SA 1050 100 SCT 250 -BKN 7 176/64/51/2307/005 (PB 15:54Z)
SA 1150 80 SCT 250 -BKN 7 165/67/52/2510/002 (PB 16:54Z)
SA 1250 70 SCT 95 SCT 250 -BKN 7 150/71/52/2007/998/ 729 1071 51 (PB 17:54Z)
SY 72306 32861 62007 10217 20111 39992 40150 57029 84071 333 10217 20106 555 90918= (PB17:55Z)

SA 1354 70 SCT 250 -BKN 7 139/73/53/1808/995 (PB 18:58Z)
SA 1450 70 SCT 250 -OVC 7 133/72/55/2009/993/HAZY (PB 19:57Z)
SA 1550 E75 BKN 250 OVC 7 128/70/56/2107/991/FEW SC SC AC INCG FRM SW-W/ 722 1557 (PB 20:55Z)
SA COR 1550 E75 BKN 250 OVC 7 128/70/56/2107/991/FEW SC SC AC INCRG FM SW-W/ 722 1557 (SWS 21:48Z)
SA 1651 40 SCT M100 BKN 250 OVC 12 122/69/57/2006/990/BINOVC (SWS 21:55Z)
SA 1750 M44 BKN 75 BKN 90 OVC 12 118/68/58/1707/989 (SWS 22:54Z)
SA 1850 M40 BKN 65 BKN 75 OVC 12 114/68/58/2110/987/ 714 157/ 73 (SWS 23:55Z)
SY 72306 32669 82110 10200 20144 39956 40114 57014 8657/ 333 10228 20106 555 91000= (SWS23:56Z)

SA 1951 35 SCT M60 BKN 75 OVC 12 110/69/59/2111/986/RB2354E2359 (SWS 00:56Z)
RS 2050 M22 BKN 28 BKN 47 OVC 7R- 114/64/60/2611/987/RB0054 (SWS 01:55Z)
SP 2132 20 SCT M42 BKN 85 OVC 6R-F 2410/987 (SWS 02:36Z)
SA 2150 M42 BKN 90 OVC 6R-F 110/63/61/2409/987/ 80305 157/ (SWS 02:54Z)
SP 2224 M17 BKN 43 OVC 6R-F 2510/987 (SWS 03:28Z)
SP 2245 29 SCT M55 OVC 6R-F 2409/986/FEW LWR SC (SWS 03:49Z)
SA 2251 41 SCT M60 OVC 6R-F 110/63/61/2411/986/FEW LWR SC PCPN VRY LGT (SWS 03:55Z)
SP 2304 9 SCT E22 BKN 33 OVC 6R-F 3218G24/928/WSHFT 02 (SWS 04:11Z)
SP 2321 20 SCT M33 OVC 6R-F 3211/989 (SWS 04:24Z)
SA 2350 M42 OVC 10R- 121/59/56/3312/989/WSHFT 02 FROPA (SWS 04:54Z)

[illegible] Weather Observations [illegible] HDR[illegible]
[illegible] 1 [illegible]

0050	29.6[illegible]	55.0	10	2AC	150	8CI	250	10				6	7	00.00
0150	29.625	55.0	10	0AC	150	10CI	250	10				5		00.00
0250	29.615	55.0	10	0AC	150	10CI	250	10				5		00.00
0350	29.605	53.0	9	9CI	250							4	7	00.00
0450	29.600	55.0	9	0AC	150	9CI	250	9				5		00.00
0550	29.590	54.0	8	8CI	250							4		00.00
0650	29.590	52.0	7	1AC	100	6CI	250	7				3	7	00.00
0750	29.590	55.0	8	6AC	80	2CI	250	8				8		00.00
0851	29.595	58.0	8	6AC	70	2CS	250	8				8		00.00
0950	29.590	62.0	8	0SC	55	5AC	70	5	4CS	250	8	4	0	00.00
1050	29.580	64.0	8	4AC	100	4CS	250	8				4		00.00
1150	29.550	67.0	7	3AC	80	7CI	250	7				3		00.00
1250	29.505	71.0	8	1AC	70	4AC	95	5	3CI	250	8	3	7	00.00
1354	29.475	73.0	9	2AC	70	7CI	250	9				4		00.00
1450	29.455	72.0	10	1AC	70	9CS	250	10				3		00.00
1550	29.440	70.0	10	0SC	55	7AC	75	7	3CS	250	10	7	7	00.00
1651	29.425	69.0	10	2SC	40	6AC	100	8	2CI	250	10	10		00.00
1750	29.410	68.0	10	6SC	44	1AC	75	7	3AC	90	10	10		00.00
1850	29.400	68.0	10	6SC	40	1SC	65	7	3AC	75	10	10	7	T
1951	29.390	69.0	10	4SC	35	2SC	60	6	4AC	75	10	10		T
2050	29.400	64.0	10	6SC	22	2SC	28	8	2SC	47	10	10		00.05
2150	29.390	63.0	10	8SC	42	2AC	90	10				10	8	T
2251	29.390	63.0	10	0SC	29	5SC	41	5	5NS	60	10	10		00.01
2350	29.420	59.0	10	10SC	42							10		00.01

Synoptic Observations

MID1	0.00	.0		57	54		
0050	0.00	.0	0	62	54	29.640	-.005
0650	0.00	.0	0	56	51	29.595	-.005
1250	0.00	.0	0	71	52	29.510	-.005
1350	0.00	.0	0	73	68	29.395	+.005
MID2	0.07	.0	0	69	59		

Summary of Day (midnight to midnight)

Max Temp	Min Temp	Precip (Ins.)	Snow Fall	Snow Depth	[Peak Wind] Speed/Dir Time	Sky Cover s/s	a/a	Water Equiv.	Fastest Wind
73	51	.07	.0	0	24NW 2303	9	9		21 32 2304

Sunrise: 0713 Sunset: 1701 Total Sunshine: 214 % Psbl: 36 Character of Sunrise/Sunset: CLOUDYCLOUDY

Weather & Obstructions to Vision

R- 1354 1359 R- 1954 2001 R- 2008 2325 F 2100 2348 R- 2330 CONT

Remarks, Notes and Miscellaneous Phenomena

TIME CHECK== 0010 // BG CHART CHANGED 1255E //PEAK WIND SPEED WAS LAST OF SEVERAL OCCURRENCES

SA 0053 M55 OVC 7R- 125/58/55/3206/991/ 01507 102/ 73 (JM 05:55Z)
SY 72306 11761 53206 10144 20128 39968 40125 50015 60021 76062 8802/ 333 10228 20106 70018 90926 555 91006= (JM06:01Z)

SA 0153 M70 OVC 7 136/57/55/3108/994/RE40 (JM 06:53Z)
SA 0250 80 SCT 100 SCT 7 145/55/52/3207/997/ 98214 (JM 07:47Z)
SA 0353 85 SCT 12 152/54/50/3208/999/ 12501 1070 (JM 08:54Z)
SA 0451 CLR 12 157/51/49/0004/000 (JM 09:52Z)
SA 0551 M41 BKN 12 169/51/48/3505/003 (JM 10:52Z)
SA 0652 30 SCT 12 185/50/47/3306/008/LN MDT CU N-SE/ 33201 1200 49 20008 (JM 11:53Z)
SY 72306 11569 13306 10100 20083 30025 40185 53032 69931 70161 81200 333 10228 20094 70020 90964 555 91012= (JM11:57Z)

SP 0726 13 SCT M24 BKN 12 3407/010 (JM 12:27Z)
SP 0742 M10 BKN 12 3606/011 (JM 12:42Z)
SA 0751 M10 BKN 12 197/50/47/0106/012 (JM 12:51Z)
SP 0838 9 SCT M20 BKN 12 0305/015 (SGY 13:40Z)
SA 0851 13 SCT M21 BKN 12 209/53/49/0405/015 (SGY 13:52Z)
SP 0939 17 SCT M37 BKN 12 0100/017 (SGY 14:42Z)
SA 0951 17 SCT M37 BKN 20 220/52/46/0409/018/ 234 1000 (SGY 14:53Z)
RS 1053 23 SCT M29 BKN 20 223/53/44/0500/019/BKN V OVC (SGY 15:54Z)
SA 1153 M28 OVC 20 228/56/43/1206/018/BINOVC (SGY 16:54Z)
RS 1251 30 SCT 20 222/56/41/0207/019/ 102 1100 49 (SGY 17:53Z)
SY 72306 32580 40207 10133 20050 30061 40222 51002 84100 333 10150 20094 70020 555 91010= (SGY17:54Z)

SA 1351 31 SCT 20 223/58/40/0305/019 (SGY 18:52Z)
SA 1454 CLR 20 227/58/38/0307/020/FEW SML CU (SGY 19:54Z)
SA 1552 CLR 20 232/57/39/0307/022/ 310 (SGY 20:52Z)
SA 1650 CLR 15 236/54/38/0206/023 (MR 21:52Z)
SA 1750 CLR 15 240/50/39/0404/024 (MR 22:52Z)
SA 1850 CLR 15 249/46/39/0905/027/ 215 60 (MR 23:53Z)
SY 72306 32974 00905 10078 20039 30086 40249 52015 333 10156 20072 70020 555 91100= (MR23:53Z)

SA 1951 CLR 15 258/45/38/0805/029 (MR 00:52Z)
SA 2051 CLR 15 259/43/37/1105/030 (MR 01:53Z)
SA 2151 CLR 15 261/42/36/1105/030/ 212 (MR 02:52Z)
SA 2250 CLR 7 266/42/37/1204/031/K LYR ALQDS (MR 03:52Z)
SA 2350 CLR 10 272/41/37/1305/033/K LYR NW-NE (MR 04:51Z)

[illegible] Observations – [illegible]

0053	29.435	59.0	10	10NS	55				10	0	00.01
0153	29.465	57.0	10	10AS	70				10		T
0252	29.490	55.0	2	1AC	60	1AC	100	2	2		00.00
0353	29.510	54.0	3	3AC	95				3	1	00.00
0451	29.525	51.0	0						0		00.00
0551	29.560	51.0	8	8SC	41				8		00.00
0652	29.605	50.0	1	1CU	30				1	3	00.00
0751	29.640	50.0	9	9SC	10				9		00.00
0851	29.675	53.0	9	1SC	13	8SC	21	9	9		00.00
0951	29.705	52.0	6	1CU	17	5SC	37	6	6	2	00.00
1053	29.715	53.0	9	2SC	23	7SC	29	9	9		00.00
1153	29.705	56.0	10	10SC	28				10		00.00
1251	29.710	56.0	5	5CU	30				5	1	00.00
1351	29.715	58.0	1	1CU	31				1		00.00
1454	29.725	58.0	0	0CU	32				0		00.00
1552	29.740	57.0	0						0	3	00.00
1650	29.750	54.0	0						0		00.00
1750	29.760	50.0	0						0		00.00
1850	29.785	46.0	0						0	2	00.00
1951	29.810	45.0	0						0		00.00
2051	29.815	43.0	0						0		00.00
2151	29.820	42.0	0						0	2	00.00
2250	29.835	42.0	0						0		00.00
2350	29.845	41.0	0						0		00.00

Synoptic Observations

MID1	T	.0		59	58		
0053	0.07	.0	0	69	58	29.435	.000
0652	0.01	.0	0	58	49	29.605	.000
1251	0.00	.0	0	59	49	29.710	.000
1850	0.00	.0	0	60	45	29.785	.000
MID2	0.00	.0	0	47	40		

Summary of Day (midnight to midnight)

Max Temp	Min Temp	Precip (Ins.)	Snow Fall	Snow Depth	[Peak Wind] Speed/Dir Time	Sky Cover s/s	Sky Cover a/a	Water Equiv.	Fastest Wind
60	40	.01	.0	0	14NE 0914	5	3		14 33 2350

Sunrise: 0714 Sunset: 1702 Total Sunshine: 292 % Psbl: 50 Character of Sunrise/Sunset: CLOUDYCLEAR

Weather & Obstructions to Vision

R- CONT 0115 R- 0128 0140

Remarks, Notes and Miscellaneous Phenomena

TIME CHECK== 0527 // NCDC//SA 2250 REMARK SHOULD BE K ALQDS...SA 2350 REMARK SHOULD BE K NW-NE//RG CHART CHANGED 0945E//PEAK WIND SPEED WAS LAST OF SEVERAL OCCURRENCES// FASTEST 1-MINUTE WIND SPEED WAS 2352 OB ON PREVIOUS DAY

Weather Observations

MF1-10A

```
SA 0251 CLR 15 270/41/37/1304/032/K NE/ 108 60 (JM 05:54Z)
SY 72306 31974 01304 10050 20028 30107 40270 51008 70400 333 10156 20044 70003 555 91106= (JM05:55Z)

SA 0152 CLR 15 270/40/37/1304/032 (JM 06:53Z)
SA 0255 CLR 15 273/38/35/0000/033/ 98292 (JM 07:57Z)
SA 0353 CLR 15 277/35/33/0604/034/ 307 (JM 08:54Z)
SA 0451 CLR 15 272/33/31/0903/033 (JM 09:51Z)
SA 0552 CLR 15 273/34/32/0303/034 (JM 10:52Z)
SA 0651 CLR 12 284/32/30/0000/036/F BNK SW/ 305 32 (JM 11:52Z)
SY 72306 31969 00000 10000 21011 30119 40284 53005 74000 333 10156 20000 555 91112= (JM11:55Z)

SA 0750 CLR 12 285/34/32/3203/037/FEW CI F BNK SW-W (JM 12:49Z)
SA 0854 250 -SCT 7 292/40/38/0000/038/F BNK W-NW HAZY (SGY 13:54Z)
SA 0951 250 -SCT 12 296/48/40/3104/040/HAZY/ 214 1001 (SGY 14:51Z)
SA 1052 250 -BKN 12 291/52/41/2505/039 (SGY 15:52Z)
SA 1154 250 -BKN 12 278/55/39/2804/035 (SGY 16:54Z)
SA 1250 250 -BKN 15 266/58/40/1603/031/ 829 1001 31 (SGY 17:52Z)
SY 72306 32974 71603 10144 20044 30103 40266 58029 80001 333 10144 21006 555 91118= (SGY17:53Z)

SA 1352 250 -BKN 15 263/60/39/3503/030/CC W (SGY 18:52Z)
SA 1452 250 -BKN 15 261/59/36/2504/030/FEW AC (SGY 19:54Z)
SA 1554 200 SCT 250 -OVC 15 263/58/37/2304/030/FEW AC/ 603 1079 (SGY 20:54Z)
SA 1650 150 SCT 250 -OVC 12 260/55/38/1603/029 (MR 21:49Z)
SA 1750 E150 BKN 250 BKN 12 269/51/39/0000/032 (MR 22:51Z)
SA 1850 E150 BKN 250 OVC 10 273/48/40/0000/033/BINOVC/ 308 1071 61 (MR 23:51Z)
SY 72306 32966 80000 10089 20044 30108 40273 53008 86071 333 10161 21006 555 91200= (MR23:52Z)

SA 1950 150 SCT E250 BKN 10 279/44/39/0000/034 (MR 00:52Z)
SA 2050 E150 BKN 250 OVC 10 280/43/39/1203/035/BINOVC (MR 01:51Z)
SA 2150 150 SCT E250 BKN 8 272/44/40/1203/033/K LYR NW-NE/ 000 1071 (MR 02:51Z)
SA 2250 E150 BKN 250 OVC 8 277/45/39/0000/035/K LYR N-NE OCNL BINOVC (MR 03:51Z)
SA 2350 150 SCT 250 -BKN 8 275/44/39/3603/034 (MR 04:51Z)
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[illegible] Weather Observations -- HDR7230aRDU 9112
[illegible] MF1-10B

0051	29.845	41.0	0									0	1	00.00
0152	29.845	40.0	0									0		00.00
0255	29.855	38.0	0									0		00.00
0353	29.865	35.0	0									0	3	00.00
0451	29.850	33.0	0									0		00.00
0552	29.865	34.0	0									0		00.00
0651	29.880	32.0	0									0	3	00.00
0750	29.885	34.0	8	8CI	250							0		00.00
0854	29.905	40.0	1	1CI	250							0		00.00
0951	29.920	48.0	3	3CI	250							0	2	00.00
1052	29.905	52.0	6	6CI	250							0		00.00
1154	29.870	55.0	8	8CI	250							0		00.00
1250	29.835	58.0	9	9CI	250							0	8	00.00
1352	29.825	60.0	8	8CI	250							1		00.00
1452	29.820	59.0	9	0AC	100	9CC	250	9				1		00.00
1554	29.825	58.0	10	0AC	150	1CC	200	1	9CS	250	10	2	6	00.00
1650	29.815	55.0	10	4AC	150	6CI	250	10				5		00.00
1750	29.840	51.0	9	6AC	150	3CI	250	9				8		00.00
1850	29.850	48.0	10	8AC	150	2CI	250	10				9	3	00.00
1950	29.865	44.0	7	4AC	150	3CI	250	7				5		00.00
2050	29.870	43.0	10	7AC	150	3CI	250	10				8		00.00
2150	29.850	44.0	9	0K	12	5AC	150	5	4CI	250	9	7	0	00.00
2250	29.865	45.0	10	0K	15	8AC	150	8	2CI	250	10	10		00.00
2350	29.860	44.0	7	3AC	150	4CI	250	7				3		00.00

Synoptic Observations

MID1	0.00	.0		41	40		
0051	0.00	.0	0	47	40	29.850	-.005
0651	0.00	.0	0	41	32	29.880	.000
1250	0.00	.0	0	58	31	29.830	+.005
1850	0.00	.0	0	61	40	29.850	.000
MID2	0.00	.0	0	48	43		

Summary of Day (midnight to midnight)

Max Temp	Min Temp	Precip (Ins.)	Snow Fall	Snow Depth	[Peak Wind] Speed/Dir Time	Sky Cover s/s	Sky Cover m/m	Water Equiv.	Fastest Wind
61	31	00.00	.0	0	8SE 0004	6	5		6 25 1052

Sunrise: 0715 Sunset: 1702 Total Sunshine: 383 % Psbl: 65 Character of Sunrise/Sunset: CLEAR CLOUDY

Weather & Obstructions to Vision

Remarks, Notes and Miscellaneous Phenomena

TIME CHECK== 0555 // FASTEST 1-MINUTE WIND SPEED WAS LAST OF SEVERAL OCCURRENCES

SA 0050 250 -BKN 8 276/41/38/0000/034/ 105 1001 61 (JM 05:51Z)
SY 72306 32962 50000 10050 20033 30113 40276 51005 80001 333 10161 21006 70000 555 91206= (JM05:52Z)

SA 0152 250 -BKN 10 275/39/37/1404/034 (JM 06:55Z)
SA 0254 250 -BKN 10 277/38/36/0000/034/ 98303 (JM 07:56Z)
SA 0353 250 -SCT 10 273/36/34/0000/033/K N/ 603 1001 (JM 08:55Z)
SA 0451 120 SCT 250 -BKN 10 272/37/35/1303/033/K ALQDS (JM 09:52Z)
SA 0552 120 SCT 250 -BKN 10 277/37/35/0000/034 (JM 10:53Z)
SA 0650 120 SCT 250 SCT 7 280/36/34/0000/035/ 305 1071 36 (JM 11:51Z)
SY 72306 32961 30000 10022 20011 30115 40280 53005 82071 333 10161 20022 555 91212= (JM11:53Z)

SA 0751 E100 BKN 7 285/40/37/0000/036 (JM 12:53Z)
SA 0850 E130 BKN 250 BKN 15 288/44/41/0000/037 (SWS 13:51Z)
SA 0950 120 SCT E250 BKN 15 294/51/40/1703/039/ 115 1071 (SWS 14:53Z)
SA 1050 120 SCT E250 BKN 15 290/56/40/2603/039 (SWS 15:52Z)
SA 1150 120 SCT E250 BKN 15 285/59/41/2906/037 (SWS 16:53Z)
SA 1250 130 SCT E250 BKN 15 271/61/38/1507/033/ 822 1071 35 (SWS 17:52Z)
SY 72306 32974 71507 10161 20033 30108 40271 50022 84071 333 10167 20017 555 91218= (SWS17:53Z)

SA 1350 E150 BKN 250 OVC 15 263/60/36/1804/031 (SWS 18:51Z)
SA 1450 E130 BKN 250 OVC 15 261/58/36/1504/030 (SWS 19:51Z)
SA 1551 E120 BKN 250 OVC 15 255/57/37/1507/028/ 717 1071 (SWS 20:52Z)
SA 1650 100 SCT E120 BKN 200 OVC 12 256/56/35/1904/028/VIRGA S-N (MR 21:53Z)
SA 1750 100 SCT E120 BKN 200 OVC 12 262/56/36/2704/030/VIRGA OVHD (MR 22:53Z)
SA 1850 90 SCT 120 SCT E200 OVC 10 265/53/38/1603/031/THN SPTS IOVC/ 210 1078 62 (MR 23:53Z)
SY 72306 32966 81603 10117 20033 30102 40265 52010 84078 333 10167 20017 555 91300= (MR23:54Z)

SA 1950 130 SCT 250 -OVC 10 260/50/39/1203/029 (MR 00:53Z)
SA 2051 E130 BKN 250 OVC 10 258/52/38/1806/029/THN SPTS IOVC (MR 01:54Z)
SA 2150 43 SCT E130 BKN 200 OVC 10 254/51/39/1805/028/ 810 1578 (MR 02:53Z)
SA 2250 M31 BKN 45 OVC 10 249/54/39/1806/027 (MR 03:53Z)
SA 2350 40 SCT 130 SCT E250 OVC 8 242/54/39/1807/025/TNN SPTS IOVC (MR 04:53Z)

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Weather Observations    HOP 91
MF1-10B
-----------------------------------------------------------------------------------------------------------------
0050  29.865  41.0      5  6CI   250                                                         5 1    00.00
0152  29.868  39.0      6  6CI   250                                                         3      00.00
0254  29.865  38.0      6  6CI   250                                                         3      00.00
0353  29.855  36.0      4  4CI   250                                                         1 6    00.00
0451  29.850  37.0      5  2AC   120  4CI   250  5                                           3      00.00
0552  29.865  37.0      6  3AC   120  3CI   250  6                                           3      00.00
0650  29.870  36.0      4  3AC   120  1CI   250  4                                           4 3    00.00
0751  29.885  40.0      9  9AC   100                                                         9      00.00
0850  29.895  44.0      8  8AC   130  0CI   250  8                                           9      00.00
0950  29.915  51.0      7  4AC   120  3CI   250  7                                           6 1    00.00
1050  29.905  56.0      8  3AC   120  5CI   250  8                                           5      00.00
1150  29.890  57.0      7  4AC   120  3CI   250  7                                           6      00.00
1250  29.850  61.0      9  5AC   130  4CI   250  9                                           6 8    00.00
1350  29.825  60.0     10  6AC   150  4CI   250 10                                          10      00.00
1450  29.820  58.0     10  7AC   130  3CI   250 10                                          10      00.00
1551  29.800  57.0     10  7AC   120  3CI   250 10                                          10 7    00.00
1650  29.805  56.0     10  1AS   100  7AC   120  9  2CS   200 10                            10      00.00
1750  29.820  56.0     10  1AS   100  7AC   120  8  2CS   200 10                            10      00.00
1850  29.830  53.0     10  1AS    90  4AC   120  5  5CS   200 10                             9 2    00.00
1950  29.815  50.0     10  4AC   130  6CI   250 10                                           5      00.00
2051  29.810  52.0     10  6AC   130  4CI   250 10                                           8      00.00
2150  29.800  51.0     10  2SC    43  7AC   130  9  1CS   200 10                            10 8    00.00
2250  29.790  54.0     10  9SC    31  1SC    45 10                                          10      00.00
2350  29.770  54.0     10  2SC    40  3AC   130  5  5CI   250 10                             7      00.00
-----------------------------------------------------------------------------------------------------------------
Synoptic Observations
MID1  0.00   .0      44  41
0050  0.00   .0   0  48  41      29.870 -.005
0650  0.00   .0   0  41  36      29.880 -.010
1250  0.00   .0   0  62  35      29.855 -.005
1850  0.00   .0   0  61  53      29.840 -.010
MID2  0.00   .0   0  54  49
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Summary of Day (midnight to midnight)
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Max  Min  Precip  Snow  Snow   [ Peak  Wind ]    Sky Cover  Water    Fastest
Temp Temp (ins.)  Fall  Depth  Speed/Dir Time    s/s  a/a   Equiv.   Wind...
 61   35  00.00    .0     0     13SE 1616         9    8             3 18 2250
Sunrise: 0716  Sunset: 1702  Total Sunshine:   25 % Psbl:    4  Character of Sunrise/Sunset: CLOUDYCLOUDY
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Weather & Obstructions to Vision
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Remarks, Notes and Miscellaneous Phenomena
TIME CHECK== 0139 // NCDC // 0A 2350 OBSERVATION REMARK TNN SPTS 10VC SHOULD BE THN SPTS 10VC //PEAK
WIND SPEED AND FASTEST 1-MINUTE WIND WERE LAST OF SEVERAL OCCURRENCES //
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