AP42 Section:	11.19.2
Title:	*Comments, correspondence and emission test summaries*

MRI

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Review and Update Remaining Sections of Chapter 8 (Mineral Products Industry) of AP-42
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I. INTRODUCTION

This memorandum presents the background information that was used to develop the revised AP-42 Section 8.19.2 on crushed stone processing. Emission data from eight emission tests conducted at stone (granite and limestone) processing plants were used to develop emission factors for various crushing, screening, and conveying operations. Descriptions of these test reports are provided in Section II of this memorandum. Tables 1 and 2 present PM-10 emission data and the new PM-10 emission factors developed for inclusion in the revised AP-42 section. Tables 3 and 4 present filterable PM emission data and the new filterable PM emission factors developed for inclusion in the revised AP-42 section. The AP-42 section narrative also was revised to include current terminology and industry practices; a complete revision of the AP-42 section will not be performed until the ongoing test program for the stone crushing source category is completed. The draft AP-42 section is provided as the attachment.

II. DESCRIPTION OF REFERENCES

A. Reference 1

This test report documents an emission test conducted at a Martin Marietta stone crushing plant in Raleigh, North Carolina. The test was conducted for the Emission Inventory Branch (EIB) of the U. S. Environmental Protection Agency (EPA) as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled particulate matter less than 10 micrometers (μm) in diameter (PM-10) emissions from a Deister vibrating screen were measured using EPA Method 201A in conjunction with a track-mounted hood system that was used to capture fugitive emissions from the screen. The Deister screen consists of three vertically stacked decks. The upper deck has a mesh opening of 2.86 centimeters (cm)

TABLE 1. SUMMARY OF EMISSION DATA FOR PM-10 EMISSIONS FROM CRUSHED STONE PROCESSING TEST REPORTS[a]

Data Rating: A

Source (material)	Average material moisture content[b]	No. of test runs	Emission factor range, kg/Mg (lb/ton)	Average emission factor, kg/Mg (lb/ton)	Ref No.
Screening (granite)	0.48%	3	0.0010-0.0075 (0.0020-0.015)	0.0035 (0.0070)	1
Screening (granite)	1.57%	3	0.00028-0.00037 (0.00056-0.00073)	0.00031 (0.00061)	1
Tertiary crushing (granite)	0.44%	3	0.00075-0.0010 (0.0015-0.0020)	0.00090 (0.0018)	2
Tertiary crushing (granite)	1.77%	3	0.00017-0.00055 (0.00034-0.0011)	0.00042 (0.00083)	2
Tertiary crushing (granite)	0.70%	3	0.0011-0.0031 (0.0021-0.0062)	0.0020 (0.0040)	3
Tertiary crushing (granite)	1.78%	3	0.000075-0.00019 (0.00015-0.00037)	0.00013 (0.00026)	3
Screening (granite)	0.70%	3	0.012-0.015 (0.024-0.030)	0.014 (0.027)	3
Screening (granite)	1.78%	3	0.00049-0.00055 (0.00097-0.0011)	0.00050 (0.0010)	3
Fines crushing (granite)	0.97%	3	0.0017-0.013 (0.0034-0.026)	0.0075 (0.015)	4
Fines crushing (granite)	1.92%	3	0.00055-0.0013 (0.0011-0.0026)	0.0010 (0.0020)	4
Fines screening (granite)	< 1.5%	3	0.021-0.050 (0.042-0.10)	0.036 (0.071)	4
Fines screening (granite)	1.68%	3	0.00060-0.0015 (0.0012-0.0030)	0.0011 (0.0021)	4
Conveyor transfer point (granite)	0.27%	3	0.00010-0.00021 (0.00020-0.00042)	0.00014 (0.00028)	5
Conveyor transfer point (granite)	0.66%	3	3.1×10^{-5}-5.9×10^{-5} (6.1×10^{-5}-1.2×10^{-4})	4.6×10^{-5} (9.2×10^{-5})	5
Conveyor transfer point (granite)	0.33%	3	0.00037-0.00081 (0.00074-0.0016)	0.00053 (0.0011)	5

Table 1. (continued)

Source (material)	Average material moisture content[b]	No. of test runs	Emission factor range, kg/Mg (lb/ton)	Average emission factor, kg/Mg (lb/ton)	Ref No.
Conveyor transfer point (granite)	1.11%	3	$9.0x10^{-6}$-$2.6x10^{-5}$ ($1.8x10^{-5}$-$5.1x10^{-5}$)	$1.5x10^{-5}$ ($3.0x10^{-5}$)	5
Conveyor transfer point (granite)	0.29%	3	0.0013-0.0016 (0.0025-0.0033)	0.0015 (0.0029)	6
Conveyor transfer point (granite)	2.62%	3	$9.4x10^{-6}$-$1.3x10^{-5}$ ($1.9x10^{-5}$-$2.5x10^{-5}$)	$1.1x10^{-5}$ ($2.2x10^{-5}$)	6
Tertiary crushing (limestone)	0.88%	3	0.00092-0.0020 (0.0018-0.0041)	0.0015 (0.0029)	7
Tertiary crushing (limestone)	2.07%	3	0.00033-0.00083 (0.00066-0.0017)	0.00053 (0.0011)	7
Screening (limestone)	0.88%	3	0.0033-0.017 (0.0067-0.033)	0.0092 (0.018)	7
Screening (limestone)	2.07%	3	0.00032-0.0011 (0.00064-0.0023)	0.00061 (0.0012)	7
Tertiary crushing (limestone)	0.67%	3	0.00039-0.0065 (0.00079-0.0013)	0.0052 (0.0010)	8
Tertiary crushing (limestone)	1.44%	3	0.000053-0.000095 (0.00011-0.00019)	0.000074 (0.00015)	8
Screening (limestone)	0.67%	3	0.0033-0.0036 (0.0067-0.0073)	0.0035 (0.0069)	8
Screening (limestone)	1.44%	3	0.00024-0.00030 (0.00049-0.00059)	0.00027 (0.00055)	8

[a]Emission factors in units of material throughput (process) unless noted.
[b]Moisture content <1.5 percent indicates uncontrolled and ≥ 1.5 percent indicates controlled emissions.

TABLE 2. SUMMARY OF PM-10 EMISSION FACTORS[a]

(Factors represent uncontrolled emissions unless noted)

Process (SCC)	No. of tests	Average emission factor, kg/Mg (lb/ton)	Emission factor rating	Ref. Nos.
Screening (3-05-020-02,-03)	4	0.0076 (0.015)	D	1, 3, 7, 8
Screening with wet suppression (3-05-020-02,-03)	4	0.00042 (0.00084)	D	1, 3, 7, 8
Tertiary crushing (3-05-020-03)	4	0.0012 (0.0024)	D	2, 3, 7, 8
Tertiary crushing with wet suppression (3-05-020-03)	4	0.00029 (0.00059)	D	2, 3, 7, 8
Fines crushing (3-05-020-05)	1	0.0075 (0.015)	D	4
Fines crushing with wet suppression (3-05-020-05)	1	0.0010 (0.0020)	D	4
Fines screening (3-05-020-)	1	0.036 (0.071)	D	4
Fines screening with wet suppression (3-05-020-)	1	0.0011 (0.0021)	D	4
Conveyor transfer point (3-05-020-06)	2	0.00072 (0.0014)	D	5, 6
Conveyor transfer point with wet suppression (3-05-020-06)	2	2.4×10^{-5} (4.8×10^{-5})	D	5, 6

[a]Emission factors in units of material throughput (process) unless noted.

TABLE 3. SUMMARY OF EMISSION DATA FOR FILTERABLE PM EMISSIONS FROM CRUSHED STONE PROCESSING TEST REPORTS[a]

Data Rating: B (unless otherwise noted)

Source (material)	Average material moisture content[b]	No. of test runs	Emission factor range, kg/Mg (lb/ton)	Average emission factor, kg/Mg (lb/ton)	Ref No.
Tertiary crushing (granite)	0.70%	3	0.021-0.045 (0.043-0.091)	0.037 (0.074)	3
Tertiary crushing (granite)	1.78%	3	0.00016-0.00071 (0.00032-0.0014)	0.00044 (0.00087)	3
Screening (granite)	0.70%	3	0.062-0.16 (0.12-0.31)	0.097 (0.19)	3
Screening (granite)	1.78%	3	0.00096-0.0018 (0.0019-0.0035)	0.0015 (0.0029)	3
Fines crushing (granite)	0.97%	3	0.13-0.58 (0.26-1.2)	0.36 (0.72)	4
Fines crushing (granite)	1.92%	3	0.065-0.11 (0.13-0.23)	0.067 (0.13)	4
Fines screening (granite)	< 1.5%	3	0.11-0.18 (0.22-0.37)	0.15 (0.30)	4
Fines screening (granite)	1.68%	3	0.00096-0.0027 (0.0019-0.0054)	0.0018 (0.0036)	4
Conveyor transfer point (granite)	0.27%	3	0.0012-0.0023 (0.0023-0.0046)	0.0015 (0.0031)	5
Conveyor transfer point (granite)	0.66%	3	9.3×10^{-5}-0.00019 (0.00019-0.00037)	0.00014 (0.00028)	5
Conveyor transfer point (granite)	0.33%	3	0.0054-0.0087 (0.011-0.017)	0.0078 (0.014)	5
Conveyor transfer point (granite)	1.11%	3	2.3×10^{-5}-6.5×10^{-5} (4.6×10^{-5}-1.3×10^{-4})	3.8×10^{-5} (7.6×10^{-5})	5
Conveyor transfer point (granite)	0.29%	3	0.033-0.036 (0.066-0.071)	0.034 (0.069)	6
Conveyor transfer point (granite)	2.62%	3	1.3×10^{-5}-2.5×10^{-5} (2.6×10^{-5}-5.0×10^{-5})	1.9×10^{-5} (3.8×10^{-5})	6
Conveyor transfer point[c] (granite)	0.29%	3	0.014-0.035 (0.029-0.069)	0.028 (0.055)	6

Table 3. (continued)

Source (material)	Average material moisture content[b]	No. of test runs	Emission factor range, kg/Mg (lb/ton)	Average emission factor, kg/Mg (lb/ton)	Ref No.
Conveyor transfer point[c] (granite)	2.62%	3	1.1×10^{-5}-8.1×10^{-5} (2.3×10^{-5}-1.6×10^{-4})	4.0×10^{-5} (8.0×10^{-5})	6
Tertiary crushing (limestone)	0.88%	3	0.0032-0.012 (0.0064-0.023)	0.0073 (0.015)	7
Tertiary crushing (limestone)	2.07%	3	0.00067-0.0022 (0.0013-0.0043)	0.0013 (0.0025)	7
Screening (limestone)	0.88%	3	0.016-0.10 (0.032-0.21)	0.073 (0.15)	7
Screening (limestone)	2.07%	3	0.0020-0.014 (0.0040-0.029)	0.0062 (0.012)	7
Tertiary crushing (limestone)	0.67%	3	0.00064-0.014 (0.0013-0.027)	0.0096 (0.019)	8
Tertiary crushing (limestone)	1.44%	3	0.00042-0.00074 (0.00083-0.0015)	0.00064 (0.0013)	8
Screening (limestone)	0.67%	3	0.012-0.052 (0.025-0.10)	0.037 (0.074)	8
Screening (limestone)	1.44%	3	0.0016-0.0021 (0.0031-0.0043)	0.0019 (0.0037)	8

[a]Emission factors in units of material throughput (process) unless noted.
[b]Moisture content <1.5 percent indicates uncontrolled and ≥ 1.5 percent indicates controlled emissions.
[c]Data are A-rated.

TABLE 4. SUMMARY OF FILTERABLE PM EMISSION FACTORS[a]

(Factors represent uncontrolled emissions unless noted)

Process (SCC)	No. of tests	Average emission factor, kg/Mg (lb/ton)	Emission factor rating	Ref. Nos.
Screening (3-05-020-02,-03)	3	0.069 (0.14)	D	3, 7, 8
Screening with wet suppression (3-05-020-02,-03)	3	0.0031 (0.0062)	D	3, 7, 8
Tertiary crushing (3-05-020-03)	3	0.018 (0.036)	D	3, 7, 8
Tertiary crushing with wet suppression (3-05-020-03)	3	0.00079 (0.0016)	D	3, 7, 8
Fines crushing (3-05-020-05)	1	0.36 (0.72)	D	4
Fines crushing with wet suppression (3-05-020-05)	1	0.067 (0.13)	D	4
Fines screening (3-05-020-)	1	0.15 (0.30)	D	4
Fines screening with wet suppression (3-05-020-)	1	0.0018 (0.0036)	D	4
Conveyor transfer point (3-05-020-06)	2	0.018 (0.035)	D	5, 6
Conveyor transfer point with wet suppression (3-05-020-06)	2	0.000059 (0.00012)	D	5, 6

[a]Emission factors in units of material throughput (process) unless noted.

square (1.125 inches [in.] square) for the first 3.66 meters (m) (12 feet [ft]) and 2.54 cm square (1 in. square) for the last 2.44 m (8 ft.). The middle deck has a mesh opening of 1.47 cm square (0.58 in. square), and the lower deck has slot openings of 0.30 cm (0.118 in.) by 2.54 cm (1 in.). Ambient levels of PM-10 were quantified using HiVol samplers, and the ambient concentrations were subtracted from the Method 201A concentrations to determine the actual emissions from the screen. Wet suppression was used to control emissions from the screen. Water spray nozzles are located on the conveyor underneath the tertiary crusher, at one conveyor transfer point, at the top of the stream conveyor above the Deister screen, and on the inlet chute to the Deister screen. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and ≥ 1.5 percent, respectively. Average material moisture contents are shown in Table 1. In addition, sieve analyses were performed on stone samples taken from the conveyor that feeds the screen. Silt content of the stone as sampled (wet) was negligible, and the average silt content of the sample after drying was 3.35 percent. The relatively small amount of silt particles (<75 μm) present in the raw material suggests that the potential for PM-10 emissions from the material processing operations is low.

Uncontrolled and controlled PM-10 emission factors were developed from the emission data and the material processing rates that were measured during the testing. These emission factors are shown in Table 1. The emission factors presented differ slightly from the emission factors reported in the test report because average production rates were used in the test report, whereas actual run-by-run production rates were used in the data analyses presented in this memorandum. The data are assigned an A rating. The report provided adequate detail, the test methodology was sound, and no problems were reported.

B. Reference 2

This test report documents an emission test conducted at a Martin Marietta stone crushing plant in Garner, North Carolina. The test was conducted for EIB as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM-10 emissions from a Model 1560 Omnicone conical-type tertiary crusher were measured using EPA Method 201A in conjunction with a quasi-stack system, which was used to capture fugitive emissions from the crusher. The crusher reduces 8.9- to 10.2-cm (3.5- to 4-in.) stone to 2.5 cm (1 in.) and smaller. The crusher inlet and outlet each were enclosed and tested separately. Wet suppression was used to control emissions from the crusher. Water spray nozzles are located on the conveyor underneath the tertiary crusher, at one conveyor transfer point, and at the entrance to the surge bin and vibrating feeder. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and ≥ 1.5 percent, respectively. Average material moisture contents are presented in Table 1. In addition, sieve analyses were performed on stone samples taken from the conveyor that feeds the surge bin prior to the crusher. The results of the sieve analyses are not documented in the test report.

Uncontrolled and controlled PM-10 emission factors were developed from the emission data and the material processing rates that were measured during the test. These emission factors are shown in Table 1. The data are assigned an A rating. The report provided adequate detail, the test methodology was sound, and no problems were reported.

C. Reference 3

This test report documents an emission test conducted at Vulcan Materials Company stone crushing plant in Skippers, Virginia. The test was conducted for the National Stone Association to determine emission factors for various stone crushing process operations. Uncontrolled and controlled PM-10 and filterable PM emissions from a cone crusher (tertiary crusher) and a Deister vibrating screen were measured using EPA Method 201A in conjunction with a quasi-stack and a track-mounted hood system, which were used to capture fugitive emissions from the crusher and screen, respectively. The crusher produces stone that is 7.6 cm (3 in.) and smaller in size. The Deister screen consists of three vertically stacked decks. The upper deck has a mesh opening of 2.86 cm square (1.125 in. square) for the first 3.66 meters (m) (12 feet [ft]) and 2.54 cm square (1.0 in.) for the last 2.44 m (8 ft). The middle deck has a mesh opening of 1.47 cm square (0.58 in. square), and the lower deck has slot openings of 0.30 cm (0.118 in.) by 2.54 cm (1.0 in.). Wet suppression was used to control emissions from both processes. Water spray nozzles are located on the vibrating feeder to the crusher, on the conveyor below the crusher, and on the inlet chute to the Deister screens. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and ≥ 1.5 percent, respectively. Average material moisture contents are shown in Table 1. In addition, sieve analyses were performed on stone samples taken from a process conveyor. The average silt content of the stone as sampled (wet) was 3.3 percent, and the average silt content of the sample after drying was 4.0 percent. The relatively small amount of silt particles (<75 μm) present in the raw material suggests that the potential for PM-10 emissions from the material processing operations is low.

Uncontrolled and controlled PM-10 and filterable PM emission factors were developed from the emission data gathered and the material processing rates that were measured during the test. These emission factors are shown in Table 1. The PM-10 data are assigned an A rating. The filterable PM data are assigned a B rating. Although Method 201A is not the reference test method for quantifying filterable PM emissions, the preseparator and filter catch for the method should provide representative results for filterable PM. The report provided adequate detail, the test methodology was sound, and no problems were reported.

D. Reference 4

This test report documents an emission test at Nello L. Teer stone crushing plant in Raleigh, North Carolina. The test was conducted for EIB as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM-10 and filterable PM emissions from a Model 1560 Omnicone conical-type crusher (fines crusher) and a TD Seco vibrating screen (fines screen) were measured using EPA Method 201A in conjunction with a quasi-stack and a track-mounted hood system, which were used to capture fugitive emissions from the crusher and screen, respectively. The crusher reduces 2.5- to 1.9-cm (1-to 0.75-in.) stone to 0.476 cm (0.188 in.) and smaller. The screen consisted of three decks. The top and middle decks were 2.22 and 1.43 cm square (0.875 and 0.563 in. square), respectively. The bottom deck had slots 0.476 by 2.54 cm (0.188 by 1 in.). The crusher inlet and outlet were each enclosed and tested separately. Wet suppression was used to control emissions from both processes. Water spray nozzles are located at the crusher inlet, midway through the crusher body, at the crusher outlet, and at the conveyor transfer point to the screen. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and ≥ 1.5 percent, respectively. Average material moisture contents are presented in Table 1. In addition, sieve analyses were performed on stone samples taken from the conveyor that feeds the screen and the conveyor that carries the crusher product. The results of the sieve analyses are not documented in the test report.

Uncontrolled and controlled PM-10 and filterable PM emission factors were developed from the emission data and the material processing rates that were measured during the test. These emission factors are shown in Table 1. The PM-10 data are assigned an A rating. The filterable PM data are assigned a B rating. Although Method 201A is not the reference test method for quantifying filterable PM emissions, the preseparator and filter catch for the method should provide representative results for filterable PM. The report provided adequate detail, the test methodology was sound, and no problems were reported during the valid test runs.

E. Reference 5

This test report documents an emission test at Wake Stone Corporation stone crushing plant in Knightdale, North Carolina. The test was conducted for EIB as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM-10 and filterable PM emissions from two separate conveyor transfer points were measured using EPA Method 201A in conjunction with quasi-stack systems, which were used to capture fugitive emissions from the two transfer points. Wet suppression was used to control transfer point emissions. Water spray nozzles are located on the exit conveyor underneath each transfer point, and at numerous other locations throughout the process. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and ≥ 1.5 percent, respectively. Average material moisture contents are presented in Table 1. In addition, sieve analyses were performed on stone samples taken from each of the conveyor lines. The average silt content of the samples after drying was 1.4 percent for the first transfer point and 2.4 percent for the second transfer point. The relatively small amount of silt particles (<75 μm) present in the raw material suggests that the potential for PM-10 emissions from the material processing operations is low.

Uncontrolled and controlled PM-10 and filterable PM emission factors were developed from the emission data and the material processing rates that were measured during the test. These emission factors are shown in Table 1. The PM-10 data are assigned an A rating. The filterable PM data are assigned a B rating. Although Method 201A is not the reference test method for quantifying filterable PM emissions, the preseparator and filter catch for the method should provide representative results for filterable PM. The report provided adequate detail, the test methodology was sound, and no problems were reported during the valid test runs.

F. Reference 6

This test report documents an emission test at a Martin Marietta stone crushing plant in Raleigh, North Carolina. The test was conducted for the National Stone Association as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM-10 and filterable PM emissions from a conveyor transfer point were measured using EPA Method 201A and EPA Method 5, respectively, in conjunction with a quasi-stack system, which was used to capture fugitive emissions from the transfer point. Wet suppression was used to control transfer point emissions. Water spray nozzles are located on the exit conveyor underneath the transfer point, and at numerous other locations throughout the process. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and ≥ 1.5 percent, respectively. Average material moisture contents are presented in Table 1. In addition, sieve analyses were performed on stone samples taken from the conveyor. The average silt content of the dried stone was 2.2 percent. The relatively small amount of silt particles (<75 μm) present in the raw material suggests that the potential for PM-10 emissions from the material processing operations is low.

Uncontrolled and controlled PM-10 and filterable PM emission factors were developed from the emission data and the material processing rates that were measured during the test. These emission factors are shown in Table 1. The PM-10 data and the filterable PM (Method 5) data are assigned an A rating. The filterable PM data from the Method 201A tests are assigned a B rating. Although Method 201A is not the reference test method for quantifying filterable PM emissions, the preseparator and filter catches for the method should provide results that are representative for filterable PM. In addition, the emission factors developed from the Method 201A data are similar to the emission factors developed using the Method 5 data. The report provided adequate detail, the test methodology was sound, and no problems were reported during the valid test runs.

G. Reference 7

This test report documents an emission test conducted at Vulcan Materials Company stone crushing plant in Bristol, Tennessee. The test was conducted for EIB as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM-10 and filterable PM emissions from a cone crusher (tertiary crusher) and a triple-deck vibrating screen were measured using EPA Method 201A in conjunction with a quasi-stack and a track-mounted hood system, which were used to capture fugitive emissions from the crusher and screen, respectively. The crusher produces stone 7.6 cm (3 in.) and smaller in size. The screen consists of three vertically stacked decks. The upper deck has a mesh opening of 3.175 cm square (1.25 in. square). The middle deck has a mesh opening of 1.59 cm square (0.625 in. square), and the lower deck has a mesh opening of 0.635 cm square (0.25 in. square). Wet suppression was used to control emissions from both processes. Water spray nozzles are located in the feed hopper to the crusher and on the conveyor below the crusher. The targeted moisture contents of the raw material (limestone) during the uncontrolled and controlled runs were <1.0 percent and $\geq$1.0 percent, respectively. Average material moisture contents are shown in Table 1. In addition, sieve analyses were performed on stone samples taken from a process conveyor. The average silt content of the stone was 1.8 percent. The relatively small amount of silt particles (<75 μm) present in the raw material suggests that the potential for PM-10 emissions from the material processing operations is low.

Uncontrolled and controlled PM-10 and filterable PM emission factors were developed from the emission data gathered and the material processing rates that were measured during the test. These emission factors are shown in Table 1. The PM-10 data are assigned an A rating. The filterable PM data are assigned a B rating. Although Method 201A is not the reference test method for quantifying filterable PM emissions, the preseparator and filter catch for the method should provide representative results for filterable PM. The report provided adequate detail, the test methodology was sound, and no problems were reported.

H. Reference 8

This test report documents an emission test conducted at Vulcan Materials Company stone crushing plant in Marysville, Tennessee. The test was conducted for EIB as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM-10 and filterable PM emissions from a cone crusher (tertiary crusher) and a triple-deck vibrating screen were measured using EPA Method 201A in conjunction with a quasi-stack and a track-mounted hood system, which were used to capture fugitive emissions from the crusher and screen, respectively. The crusher produces stone 7.6 cm (3 in.) and smaller in size. The screen consists of three vertically stacked decks. The upper deck has a mesh opening of 3.175 cm square (1.25 in. square). The middle deck has a mesh opening of 1.59 cm square (0.625 in. square), and the lower deck has a mesh opening of 0.635 cm square (0.25 in. square). Wet suppression was used to control emissions from both processes. Water spray nozzles are located on the vibrating feeder to the crusher. The targeted moisture contents of the raw material (limestone) during the uncontrolled and controlled runs were $<$ 1.0 percent and $\geq$1.0 percent, respectively. Average material moisture contents are shown in Table 1. In addition, sieve analyses were performed on stone samples taken from a process conveyor. The average silt content of the stone was 3.25 percent. The relatively small amount of silt particles ($<$75 μm) present in the raw material suggests that the potential for PM-10 emissions from the material processing operations is low.

Uncontrolled and controlled PM-10 and filterable PM emission factors were developed from the emission data gathered and the material processing rates that were measured during the test. These emission factors are shown in Table 1. The PM-10 data are assigned an A rating. The filterable PM data are assigned a B rating. Although Method 201A is not the reference test method for quantifying filterable PM emissions, the preseparator and filter catch for the method should provide representative results for filterable PM. The report provided adequate detail, the test methodology was sound, and no problems were reported.

III. RESULTS OF DATA ANALYSIS

Emission factors were developed for conveyor transfer points, screening, tertiary crushing, fines crushing, and fines screening operations. The only data available on primary and secondary crushing were of questionable quality and were not consistent with the emission tests included in this review. Therefore, the revised AP-42 section does not include emission factors for primary and secondary crushing of stone. However, the emission factors for tertiary stone crushing can be used as an upper limit to primary and secondary crushing.

Emissions generally were considered uncontrolled if the raw material moisture content was less than 1.5 percent and controlled if the raw material moisture content was greater than or equal to 1.5 percent. The material moisture contents in the Reference 5 and Reference 8 emission tests did not reach the targeted 1.5 percent for the controlled runs. However, data from these tests are consistent with data from other controlled tests and are treated as controlled. Table 2 presents the PM-10 emission factors and Table 4 presents the filterable PM emission factors developed using the data from References 1 through 8. All of the emission factors were assigned a D rating because data from relatively few plants (compared with the total number of domestic stone crushing facilities) were used to develop the emission factors.

In addition to the emission factors described above, the revised AP-42 section includes emission factors for wet drilling, and truck unloading and loading that were retained from the previous version of AP-42 Section 8.19.2. Although the quality of the data upon which these emission factors was based is questionable, no other data on those sources were located during this review.

IV. REFERENCES

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8. T. Brozell and J. Richards, *PM-10 Emission Factors for a Limestone Crushing Plant Vibrating Screen and Crusher for Marysville, Tennessee*, EPA Contract No. 68-D2-0163, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1993.

Attachment

ATTACHMENT

DRAFT AP-42 SECTION 8.19.2

8.19.2 CRUSHED STONE PROCESSING

8.19.2.1 Process Description[1,2]

Major rock types processed by the rock and crushed stone industry include limestone, granite, dolomite, traprock, sandstone, quartz, and quartzite. Minor types include calcareous marl, marble, shell, and slate. Industry classifications vary considerably and, in many cases, do not reflect actual geological definitions.

Rock and crushed stone products generally are loosened by drilling and blasting, then are loaded by power shovel or front-end loader into large haul trucks that transport the material to the processing operations. Techniques used for extraction vary with the nature and location of the deposit. Processing operations may include crushing, screening, size classification, material handling, and storage operations. All of these processes can be significant sources of PM and PM-10 emissions if uncontrolled.

Quarried stone normally is delivered to the processing plant by truck and is dumped into a hoppered feeder, usually a vibrating grizzly type, or onto screens, as illustrated in Figure 8.19.2-1. The feeder or screens separate large boulders from finer rocks that do not require primary crushing, thus reducing the load to the primary crusher. Jaw, or gyratory, crushers are usually used for initial reduction. The crusher product, normally 7.5 to 30 centimeters (3 to 12 inches) in diameter, and the grizzly throughs (undersize material) are discharged onto a belt conveyor and usually are conveyed to a surge pile for temporary storage.

The stone from the surge pile is conveyed to a vibrating inclined screen called the scalping screen. This unit separates oversized rock from the smaller stone. The undersize material from the scalping screen is considered to be a product stream and is transported to a storage pile and sold as base material. The stone that is too large to pass through the top deck of the scalping screen is processed in the secondary crusher. Cone crushers are commonly used for secondary crushing, although impact crushers are sometimes used. The material (throughs) from the second level of the screen bypasses the secondary crusher because it is sufficiently small for the last crushing step. The output from the secondary crusher and the throughs from the secondary screen are transported by conveyor to the tertiary circuit, which includes a sizing screen and a tertiary crusher.

Tertiary crushing is usually performed using cone crushers or hammermills. Oversize material from the top deck of the sizing screen is fed to the tertiary crusher. The tertiary crusher output is returned to the sizing screen. Various product streams with different size gradations are separated in the screening operation. The products are conveyed or trucked directly to finished product bins or to open area stockpiles.

Some stone crushing plants produce manufactured sand. This is a small-sized rock product with a maximum size of 0.50 centimeters (3/16th inch). Crushed stone from the tertiary sizing screen is sized in a vibrating inclined screen (fines screen) with relatively small mesh sizes. Oversized material is processed in a cone crusher or a hammermill (fines crusher) adjusted to produce small diameter material. The output is then returned to the fines screen for resizing.

Figure 8.19.2-1. Typical stone processing plant.[2]

In certain cases, stone washing is required to meet particular end product specifications or demands, as with concrete aggregate processing. Crushed and broken stone normally is not milled but is screened and shipped to the consumer after secondary or tertiary crushing.

8.19.2.2 Emissions And Controls[1-4,7,8]

Emissions of PM and PM-10 occur from a number of operations in stone quarrying and processing. A substantial portion of these emissions consists of heavy particles that may settle out within the plant. As in other operations, crushed stone emission sources may be categorized as either process sources or fugitive dust sources. Process sources include those for which emissions are amenable to capture and subsequent control. Fugitive dust sources generally involve the reentrainment of settled dust by wind or machine movement. Factors affecting emissions from either source category include the stone size distribution and surface moisture content of the stone processed; the process throughput rate; the type of equipment and operating practices used; and topographical and climatic factors.

Of geographic and seasonal factors, the primary variables affecting uncontrolled PM emissions are wind and material moisture content. Wind parameters vary with geographical location, season, and weather. It can be expected that the level of emissions from unenclosed sources (principally fugitive dust sources) will be greater during periods of high winds. The material moisture content also varies with geographic location, season, and weather. Therefore, the levels of uncontrolled emissions from both process emission sources and fugitive dust sources generally will be greater in arid regions of the country than in temperate ones, and greater during the summer months because of a higher evaporation rate.

The moisture content of the material processed can have a substantial effect on emissions. This effect is evident throughout the processing operations. Surface wetness causes fine particles to agglomerate on, or to adhere to, the faces of larger stones, with a resulting dust suppression effect. However, as new fine particles are created by crushing and attrition, and as the moisture content is reduced by evaporation, this suppressive effect diminishes and may disappear. Plants that use wet suppression systems (spray nozzles) to maintain relatively high material moisture contents can effectively control PM emissions throughout the process. Depending on the geographic and climatic conditions, the moisture content of mined rock may range from nearly zero to several percent. Because moisture content is usually expressed on a basis of overall weight percent, the actual moisture amount per unit area will vary with the size of the rock being handled. On a constant mass-fraction basis, the per-unit area moisture content varies inversely with the diameter of the rock. Therefore, the suppressive effect of the moisture depends on both the absolute mass water content and the size of the rock product. Typically, wet material contains 1.5 to 4 percent water or more.

A variety of material, equipment, and operating factors can influence emissions from crushing. These factors include (1) stone type, (2) feed size and distribution, (3) moisture content, (4) throughput rate, (5) crusher type, (6) size reduction ratio, and (7) fines content. Insufficient data are available to present a matrix of rock crushing emission factors detailing the above classifications and variables. Available data indicate that PM-10 emissions from limestone and granite processing operations are similar. Therefore, the emission factors developed from the emission data gathered at limestone and granite processing facilities are considered to be representative of typical crushed stone processing operations. Emission factors for filterable PM and PM-10 emissions from crushed stone processing operations are presented in Table 8.19-1.

Table 8.19.2-1.(METRIC UNITS)
EMISSION FACTORS FOR CRUSHED STONE PROCESSING OPERATIONS[a]

Emission Factors in kg/Mg of Material Throughput
Ratings (A-E) Follow Each Emission Factor

Source[b] (SCC)	Filterable PM		PM-10	
Screening (3-05-020-02,-03)	0.069[c]	D	0.0076[d]	D
Screening with wet suppression (3-05-020-02,-03)	0.0031[c]	D	0.00042[d]	D
Primary crushing (3-05-020-01)	e	E	e	E
Secondary crushing (3-05-020-02)	e	E	e	E
Tertiary crushing (3-05-020-03)	0.018[c]	D	0.0012[f]	D
Primary crushing with wet suppression (3-05-020-01)	e	E	e	E
Secondary crushing with wet suppression (3-05-020-02)	e	E	e	E
Tertiary crushing with wet suppression (3-05-020-03)	0.00079[c]	D	0.00029[f]	D
Fines crushing[g] (3-05-020-05)	0.36	D	0.0075	D
Fines crushing with wet suppression[g] (3-05-020-05)	0.067	D	0.0010	D
Fines screening[g] (3-05-020-)	0.15	D	0.036	D
Fines screening with wet suppression[g] (3-05-020-)	0.0018	D	0.0011	D
Conveyor transfer point[h] (3-05-020-06)	0.018	D	0.00072	D
Conveyor transfer point with wet suppression[h] (3-05-020-06)	5.9×10^{-5}	D	2.4×10^{-5}	D
Wet drilling: unfragmented stone[i] (3-05-020-10)	ND		4.0×10^{-5}	E
Truck loading: fragmented stone[i] (3-05-020-31)	ND		8.0×10^{-6}	E
Truck loading--conveyor: crushed stone[j] (3-05-020-32)	ND		5.0×10^{-5}	E

ND = No data available
[a]Emission factors represent uncontrolled emissions unless noted.
[b]Sources controlled with wet suppression maintain a material moisture content ≥ 1.5 percent. Sources that process material with a moisture content of <1.5 percent are considered to be uncontrolled.
[c]References 11, 15, and 16.
[d]References 9, 11, 15 and 16.
[e]No data available, but emission factors for tertiary crushing can be used as an upper limit for primary and secondary crushing.
[f]References 10, 11, 15 and 16.
[g]Reference 12.
[h]References 13 and 14.
[i]Reference 3.
[j]Reference 4.

Table 8.19.2-1.(ENGLISH UNITS)
EMISSION FACTORS FOR CRUSHED STONE PROCESSING OPERATIONS[a]

Emission Factors in lb/ton of Material Throughput
Ratings (A-E) Follow Each Emission Factor

Source[b] (SCC)	Filterable PM		PM-10	
Screening (3-05-020-02,-03)	0.14[c]	D	0.015[d]	D
Screening with wet suppression (3-05-020-02,-03)	0.0062[c]	D	0.00084[d]	D
Primary crushing (3-05-020-01)	e	E	e	E
Secondary crushing (3-05-020-02)	e	E	e	E
Tertiary crushing (3-05-020-03)	0.036[c]	D	0.0024[f]	D
Primary crushing with wet suppression (3-05-020-01)	e	E	e	E
Secondary crushing with wet suppression (3-05-020-02)	e	E	e	E
Tertiary crushing with wet suppression (3-05-020-03)	0.0016[c]	D	0.00059[f]	D
Fines crushing[g] (3-05-020-05)	0.72	D	0.015	D
Fines crushing with wet suppression[g] (3-05-020-05)	0.13	D	0.0020	D
Fines screening[g] (3-05-020-)	0.30	D	0.071	D
Fines screening with wet suppression[g] (3-05-020-)	0.0036	D	0.0021	D
Conveyor transfer point[h] (3-05-020-06)	0.035	D	0.0014	D
Conveyor transfer point with wet suppression[h] (3-05-020-06)	0.00012	D	4.8×10^{-5}	D
Wet drilling: unfragmented stone[i] (3-05-020-10)	ND		8.0×10^{-5}	E
Truck unloading: fragmented stone[j] (3-05-020-31)	ND		1.6×10^{-5}	E
Truck loading--conveyor: crushed stone[j] (3-05-020-32)	ND		0.0010	E

ND = No data available
[a]Emission factors represent uncontrolled emissions unless noted.
[b]Sources controlled with wet suppression maintain a material moisture content $\geq$ 1.5 percent. Sources that process material with a moisture content of $<$1.5 percent are considered to be uncontrolled.
[c]References 11, 15 and 16.
[d]References 9, 11, 15 and 16.
[e]No data available, but emission factors for tertiary crushing can be used as an upper limit for primary and secondary crushing.
[f]References 10, 11, 15 and 16.
[g]Reference 12.
[h]References 13 and 14.
[i]Reference 3.
[j]Reference 4.

Emission factor estimates for stone quarry blasting operations are not presented here because of the sparsity and unreliability of available test data. While a procedure for estimating blasting emissions is presented in Section 8.24, Western Surface Coal Mines, that procedure should not be applied to stone quarries because of dissimilarities in blasting techniques, material blasted, and size of blast areas. Milling of fines is not included in this section as this operation is normally associated with nonconstruction aggregate end uses and will be covered elsewhere when information is adequate. Emission factors for fugitive dust sources, including paved and unpaved roads, materials handling and transfer, and wind erosion of storage piles, can be determined using the predictive emission factor equations presented in AP-42 Section 11.2.

References for Section 8.19.2

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2. Written communication from J. Richards, Air Control Techniques, P.C., to B. Shrager, MRI. March 18, 1994.

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10. J. Richards, T. Brozell, and W. Kirk, *PM-10 Emission Factors for a Stone Crushing Plant Tertiary Crusher*, EPA Contract No. 68-D1-0055, Task 2.84, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1992.

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15. T. Brozell and J. Richards, *PM-10 Emission Factors for a Limestone Crushing Plant Vibrating Screen and Crusher for Bristol, Tennessee*, EPA Contract No. 68-D2-0163, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1993.

16. T. Brozell and J. Richards, *PM-10 Emission Factors for a Limestone Crushing Plant Vibrating Screen and Crusher for Marysville, Tennessee*, EPA Contract No. 68-D2-0163, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1993.

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Copy FOR REVISIONS
April 13, 1994 Meeting w/Stone Association and Martin Marietta

Date: ~~April 7~~ May 4, 1994

Subject: Background Information for Revised AP-42 Section 8.19.2, Crushed Stone Processing
Review and Update Remaining Sections of Chapter 8 (Mineral Products Industry) of AP-42
EPA Contract 68-D2-0159, Work Assignment I-01
MRI Project 4601-01

From: Brian Shrager

To: Ron Myers
EPA/EIB/EFMS (MD-14)
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I. INTRODUCTION

This memorandum presents the background information that was used to develop the revised AP-42 Section 8.19.2 on crushed stone processing. Emission data from eight emission tests conducted at stone (granite and limestone) processing plants were used to develop emission factors for various crushing, screening, and conveying operations. Descriptions of these test reports are provided in Section II of this memorandum. In addition, the references from the previous version of AP-42 Section 8.19.2 were reviewed. Tables 1 and 2 present PM-10 emission data and the new PM-10 emission factors developed for inclusion in the revised AP-42 section. Tables 3 and 4 present filterable PM emission data and the new filterable PM emission factors developed for inclusion in the revised AP-42 section. The AP-42 section narrative also was revised to include current terminology and industry practices; a complete revision of the AP-42 section will not be performed until the ongoing test program for the stone crushing source category is completed. The ~~draft~~ final AP-42 section is provided as the attachment.

II. DESCRIPTION OF REFERENCES

A. Reference 1

This test report documents an emission test conducted at a Martin Marietta stone crushing plant in Raleigh, North Carolina. The test was conducted for the Emission Inventory Branch (EIB) of the U. S. Environmental Protection Agency (EPA) as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled particulate matter less than 10 micrometers (μm) in diameter (PM-10) emissions from a Deister vibrating screen were measured using EPA Method 201A in conjunction with a track-mounted hood system that was used to capture fugitive emissions from the screen. The Deister screen consists

TABLE 1. SUMMARY OF EMISSION DATA FOR PM-10 EMISSIONS FROM CRUSHED STONE PROCESSING TEST REPORTS[a]

Data Rating: A

Source (material)	Average material moisture content[b]	No. of test runs	Emission factor range, kg/Mg (lb/ton)	Average emission factor, kg/Mg (lb/ton)	Ref No.
Screening (granite)	0.48%	3	0.0010-0.0075 (0.0020-0.015)	0.0035 (0.0070)	1
Screening (granite)	1.57%	3	0.00028-0.00037 (0.00056-0.00073)	0.00031 (0.00061)	1
Tertiary crushing (granite)	0.44%	3	0.00075-0.0010 (0.0015-0.0020)	0.00090 (0.0018)	2
Tertiary crushing (granite)	1.77%	3	0.00017-0.00055 (0.00034-0.0011)	0.00042 (0.00083)	2
Tertiary crushing (granite)	0.70%	3	0.0011-0.0031 (0.0021-0.0062)	0.0020 (0.0040)	3
Tertiary crushing (granite)	1.78%	3	0.000075-0.00019 (0.00015-0.00037)	0.00013 (0.00026)	3
Screening (granite)	0.70%	3	0.012-0.015 (0.024-0.030)	0.014 (0.027)	3
Screening (granite)	1.78%	3	0.00049-0.00055 (0.00097-0.0011)	0.00050 (0.0010)	3
Fines crushing (granite)	0.97%	3	0.0017-0.013 (0.0034-0.026)	0.0075 (0.015)	4
Fines crushing (granite)	1.92%	3	0.00055-0.0013 (0.0011-0.0026)	0.0010 (0.0020)	4
Fines screening (granite)	< 1.5%	3	0.021-0.050 (0.042-0.10)	0.036 (0.071)	4
Fines screening (granite)	1.68%	3	0.00060-0.0015 (0.0012-0.0030)	0.0011 (0.0021)	4
Conveyor transfer point (granite)	0.27%	3	0.00010-0.00021 (0.00020-0.00042)	0.00014 (0.00028)	5
Conveyor transfer point (granite)	0.66%	3	3.1×10^{-5}-5.9×10^{-5} (6.1×10^{-5}-1.2×10^{-4})	4.6×10^{-5} (9.2×10^{-5})	5
Conveyor transfer point (granite)	0.33%	3	0.00037-0.00081 (0.00074-0.0016)	0.00053 (0.0011)	5

Table 1. (continued)

Source (material)	Average material moisture content[b]	No. of test runs	Emission factor range, kg/Mg (lb/ton)	Average emission factor, kg/Mg (lb/ton)	Ref No.
Conveyor transfer point (granite)	1.11%	3	$9.0x10^{-6}$-$2.6x10^{-5}$ ($1.8x10^{-5}$-$5.1x10^{-5}$)	$1.5x10^{-5}$ ($3.0x10^{-5}$)	5
Conveyor transfer point (granite)	0.29%	3	0.0013-0.0016 (0.0025-0.0033)	0.0015 (0.0029)	6
Conveyor transfer point (granite)	2.62%	3	$9.4x10^{-6}$-$1.3x10^{-5}$ ($1.9x10^{-5}$-$2.5x10^{-5}$)	$1.1x10^{-5}$ ($2.2x10^{-5}$)	6
Tertiary crushing (limestone)	0.88%	3	0.00092-0.0020 (0.0018-0.0041)	0.0015 (0.0029)	7
Tertiary crushing (limestone)	2.07%	3	0.00033-0.00083 (0.00066-0.0017)	0.00053 (0.0011)	7
Screening (limestone)	0.88%	3	0.0033-0.017 (0.0067-0.033)	0.0092 (0.018)	7
Screening (limestone)	2.07%	3	0.00032-0.0011 (0.00064-0.0023)	0.00061 (0.0012)	7
Tertiary crushing (limestone)	0.67%	3	0.00039-0.0065 (0.00079-0.0013)	0.0052 (0.0010)	8
Tertiary crushing (limestone)	1.44%	3	0.000053-0.000095 (0.00011-0.00019)	0.000074 (0.00015)	8
Screening (limestone)	0.67%	3	0.0033-0.0036 (0.0067-0.0073)	0.0035 (0.0069)	8
Screening (limestone)	1.44%	3	0.00024-0.00030 (0.00049-0.00059)	0.00027 (0.00055)	8

[a]Emission factors in units of material throughput (process) unless noted.
[b]Moisture content <1.5% indicates uncontrolled and ≥1.5% indicates controlled emissions.

TABLE 2. SUMMARY OF PM-10 EMISSION FACTORS[a]

(Factors represent uncontrolled emissions unless noted)

Process (SCC)	No. of tests	Average emission factor, kg/Mg (lb/ton)	Emission factor rating	Ref. Nos.
Screening (3-05-020-02,-03)	4	0.0076 (0.015)	C ~~D~~	1, 3, 7, 8
Screening with wet suppression (3-05-020-02,-03)	4	0.00042 (0.00084)	C ~~D~~	1, 3, 7, 8
Tertiary crushing (3-05-020-03)	4	0.0012 (0.0024)	C ~~D~~	2, 3, 7, 8
Tertiary crushing with wet suppression (3-05-020-03)	4	0.00029 (0.00059)	C ~~D~~	2, 3, 7, 8
Fines crushing (3-05-020-05)	1	0.0075 (0.015)	E ~~D~~	4
Fines crushing with wet suppression (3-05-020-05)	1	0.0010 (0.0020)	E ~~D~~	4
Fines screening (3-05-020-)	1	0.036 (0.071)	E ~~D~~	4
Fines screening with wet suppression (3-05-020-)	1	0.0011 (0.0021)	E ~~D~~	4
Conveyor transfer point (3-05-020-06)	2	0.00072 (0.0014)	D	5, 6
Conveyor transfer point with wet suppression (3-05-020-06)	2	2.4×10^{-5} (4.8×10^{-5})	D	5, 6

[a]Emission factors in units of material throughput (process) unless noted.

3 tests?

TABLE 3. SUMMARY OF EMISSION DATA FOR FILTERABLE PM EMISSIONS FROM CRUSHED STONE PROCESSING TEST REPORTS[a]

Data Rating: B (unless otherwise noted)

Source (material)	Average material moisture content[b]	No. of test runs	Emission factor range, kg/Mg (lb/ton)	Average emission factor, kg/Mg (lb/ton)	Ref No.
Tertiary crushing (granite)	0.70%	3	0.021-0.045 (0.043-0.091)	0.037 (0.074)	3
Tertiary crushing (granite)	1.78%	3	0.00016-0.00071 (0.00032-0.0014)	0.00044 (0.00087)	3
Screening (granite)	0.70%	3	0.062-0.16 (0.12-0.31)	0.097 (0.19)	3
Screening (granite)	1.78%	3	0.00096-0.0018 (0.0019-0.0035)	0.0015 (0.0029)	3
Fines crushing (granite)	0.97%	3	0.13-0.58 (0.26-1.2)	0.36 (0.72)	4
Fines crushing (granite)	1.92%	3	0.065-0.11 (0.13-0.23)	0.067 (0.13)	4
Fines screening (granite)	< 1.5%	3	0.11-0.18 (0.22-0.37)	0.15 (0.30)	4
Fines screening (granite)	1.68%	3	0.00096-0.0027 (0.0019-0.0054)	0.0018 (0.0036)	4
Conveyor transfer point (granite)	0.27%	3	0.0012-0.0023 (0.0023-0.0046)	0.0015 (0.0031)	5
Conveyor transfer point (granite)	0.66%	3	9.3×10^{-5}-0.00019 (0.00019-0.00037)	0.00014 (0.00028)	5
Conveyor transfer point (granite)	0.33%	3	0.0054-0.0087 (0.011-0.017)	0.0078 (0.014)	5
Conveyor transfer point (granite)	1.11%	3	2.3×10^{-5}-6.5×10^{-5} (4.6×10^{-5}-1.3×10^{-4})	3.8×10^{-5} (7.6×10^{-5})	5
Conveyor transfer point (granite)	0.29%	3	0.033-0.036 (0.066-0.071)	0.034 (0.069)	6
Conveyor transfer point (granite)	2.62%	3	1.3×10^{-5}-2.5×10^{-5} (2.6×10^{-5}-5.0×10^{-5})	1.9×10^{-5} (3.8×10^{-5})	6
Conveyor transfer point[c] (granite)	0.29%	3	0.014-0.035 (0.029-0.069)	0.028 (0.055)	6
Conveyor transfer point[c] (granite)	2.62%	3	1.1×10^{-5}-8.1×10^{-5} (2.3×10^{-5}-1.6×10^{-4})	4.0×10^{-5} (8.0×10^{-5})	6

Check Teer Test

Table 3. (continued)

Source (material)	Average material moisture content[b]	No. of test runs	Emission factor range, kg/Mg (lb/ton)	Average emission factor, kg/Mg (lb/ton)	Ref No.
Tertiary crushing (limestone)	0.88%	3	0.0032-0.012 (0.0064-0.023)	0.0073 (0.015)	7
Tertiary crushing (limestone)	2.07%	3	0.00067-0.0022 (0.0013-0.0043)	0.0013 (0.0025)	7
Screening (limestone)	0.88%	3	0.016-0.10 (0.032-0.21)	0.073 (0.15)	7
Screening (limestone)	2.07%	3	0.0020-0.014 (0.0040-0.029)	0.0062 (0.012)	7
Tertiary crushing (limestone)	0.67%	3	0.00064-0.014 (0.0013-0.027)	0.0096 (0.019)	8
Tertiary crushing (limestone)	1.44%	3	0.00042-0.00074 (0.00083-0.0015)	0.00064 (0.0013)	8
Screening (limestone)	0.67%	3	0.012-0.052 (0.025-0.10)	0.037 (0.074)	8
Screening (limestone)	1.44%	3	0.0016-0.0021 (0.0031-0.0043)	0.0019 (0.0037)	8
Conveyor transfer point[d] (limestone)	[e]	3	1.0×10^{-5}-2.0×10^{-5} (2.0×10^{-5}-4.0×10^{-5})	1.5×10^{-5} (3.0×10^{-5})	9
Primary crushing[d] (limestone)	[e]	3	0.00010-0.00065 (0.00020-0.0013)	0.00035 (0.00070)	9
Screening[d] (limestone)	[e]	3	1.0×10^{-5}-0.001 (2.0×10^{-5}-0.002)	0.00037 (0.00074)	9
Screening[f]	[e]	9	0.013-0.16 (0.025-0.33)	0.083 (0.17)	10
Screening[f]	1.5%	9	0.0011-0.011 (0.0021-0.023)	0.0038 (0.0076)	10
Screening[f]	1.5%	9	0.00070-0.021 (0.0014-0.042)	0.0082 (0.016)	10

[a]Emission factors in units of material throughput (process) unless noted.
[b]Moisture content <1.5% indicates uncontrolled and $\geq$1.5% indicates controlled emissions.
[c]Data are A-rated.
[d]Data are C-rated.
[e]Material moisture content is assumed to be low because wet suppression was not used.
[f]Data include emissions from three different types of screens.

TABLE 4. SUMMARY OF FILTERABLE PM EMISSION FACTORS[a]

(Factors represent uncontrolled emissions unless noted)

Process (SCC)	No. of tests	Average emission factor, kg/Mg (lb/ton)	Emission factor rating	Ref. Nos.
Screening (3-05-020-02,-03)	4	0.073 (0.15)	E ~~D~~	3, 7, 8, 10
Screening with wet suppression (3-05-020-02,-03)	5	0.0042 (0.0084)	E ~~D~~	3, 7, 8, 10
Tertiary crushing (3-05-020-03)	3	0.018 (0.036)	E ~~D~~	3, 7, 8
Tertiary crushing with wet suppression (3-05-020-03)	3	0.00079 (0.0016)	E ~~D~~	3, 7, 8
Fines crushing (3-05-020-05)	1	0.36 (0.72)	E ~~D~~	4
Fines crushing with wet suppression (3-05-020-05)	1	0.067 (0.13)	E ~~D~~	4
Fines screening (3-05-020-)	1	0.15 (0.30)	E ~~D~~	4
Fines screening with wet suppression (3-05-020-)	1	0.0018 (0.0036)	E ~~D~~	4
Conveyor transfer point (3-05-020-06)	2	0.018 (0.035)	E ~~D~~	5, 6
Conveyor transfer point with wet suppression (3-05-020-06)	2	0.000059 (0.00012)	E ~~D~~	5, 6
Primary crushing (3-05-020-01)	1	0.00035 (0.00070)	E	9

[a]Emission factors in units of material throughput (process) unless noted.

of three vertically stacked decks. The upper deck has a mesh opening of 2.86 centimeters (cm) square (1.125 inches [in.] square) for the first 3.66 meters (m) (12 feet [ft]) and 2.54 cm square (1 in. square) for the last 2.44 m (8 ft.). The middle deck has a mesh opening of 1.47 cm square (0.58 in. square), and the lower deck has slot openings of 0.30 cm (0.118 in.) by 2.54 cm (1 in.). Ambient levels of PM-10 were quantified using HiVol samplers, and the ambient concentrations were subtracted from the Method 201A concentrations to determine the actual emissions from the screen. Wet suppression was used to control emissions from the screen. Water spray nozzles are located on the conveyor underneath the tertiary crusher, at one conveyor transfer point, at the top of the stream conveyor above the Deister screen, and on the inlet chute to the Deister screen. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and ≥ 1.5 percent, respectively. Average material moisture contents are shown in Table 1. In addition, sieve analyses were performed on stone samples taken from the conveyor that feeds the screen. Silt content of the stone as sampled (wet) was negligible, and the average silt content of the sample after drying was 3.35 percent. The relatively small amount of silt particles (<75 μm) present in the raw material suggests that the potential for PM-10 emissions from the material processing operations is low.

Uncontrolled and controlled PM-10 emission factors were developed from the emission data and the material processing rates that were measured during the testing. These emission factors are shown in Table 1. The emission factors presented differ slightly from the emission factors reported in the test report because average production rates were used in the test report, whereas actual run-by-run production rates were used in the data analyses presented in this memorandum. The data are assigned an A rating. The report provided adequate detail, the test methodology was sound, and no problems were reported.

B. Reference 2

This test report documents an emission test conducted at a Martin Marietta stone crushing plant in Garner, North Carolina. The test was conducted for EIB as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM-10 emissions from a Model 1560 Omnicone conical-type tertiary crusher were measured using EPA Method 201A in conjunction with a quasi-stack system, which was used to capture fugitive emissions from the crusher. The crusher reduces 8.9- to 10.2-cm (3.5- to 4-in.) stone to 2.5 cm (1 in.) and smaller. The crusher inlet and outlet each were enclosed and tested separately. Wet suppression was used to control emissions from the crusher. Water spray nozzles are located on the conveyor underneath the tertiary crusher, at one conveyor transfer point, and at the entrance to the surge bin and vibrating feeder. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and ≥ 1.5 percent, respectively. Average material moisture contents are presented in Table 1. In addition, sieve analyses were performed on stone samples taken from the conveyor that feeds the surge bin prior to the crusher. The results of the sieve analyses are not documented in the test report.

Uncontrolled and controlled PM-10 emission factors were developed from the emission data and the material processing rates that were measured during the test. These emission factors are shown in Table 1. The data are assigned an A rating. The report provided adequate detail, the test methodology was sound, and no problems were reported.

C. Reference 3

This test report documents an emission test conducted at Vulcan Materials Company stone crushing plant in Skippers, Virginia. The test was conducted for the National Stone Association to determine emission factors for various stone crushing process operations. Uncontrolled and controlled PM-10 and filterable PM emissions from a cone crusher (tertiary crusher) and a Deister vibrating screen were measured using EPA Method 201A in conjunction with a quasi-stack and a track-mounted hood system, which were used to capture fugitive emissions from the crusher and screen, respectively. The crusher produces stone that is 7.6 cm (3 in.) and smaller in size. The Deister screen consists of three vertically stacked decks. The upper deck has a mesh opening of 2.86 cm square (1.125 in. square) for the first 3.66 meters (m) (12 feet [ft]) and 2.54 cm square (1.0 in.) for the last 2.44 m (8 ft). The middle deck has a mesh opening of 1.47 cm square (0.58 in. square), and the lower deck has slot openings of 0.30 cm (0.118 in.) by 2.54 cm (1.0 in.). Wet suppression was used to control emissions from both processes. Water spray nozzles are located on the vibrating feeder to the crusher, on the conveyor below the crusher, and on the inlet chute to the Deister screens. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and ≥ 1.5 percent, respectively. Average material moisture contents are shown in Table 1. In addition, sieve analyses were performed on stone samples taken from a process conveyor. The average silt content of the stone as sampled (wet) was 3.3 percent, and the average silt content of the sample after drying was 4.0 percent. The relatively small amount of silt particles (<75 μm) present in the raw material suggests that the potential for PM-10 emissions from the material processing operations is low.

Uncontrolled and controlled PM-10 and filterable PM emission factors were developed from the emission data gathered and the material processing rates that were measured during the test. These emission factors are shown in Table 1. The PM-10 data are assigned an A rating. The filterable PM data are assigned a B rating. Although Method 201A is not the reference test method for quantifying filterable PM emissions, the preseparator and filter catch for the method should provide representative results for filterable PM. The report provided adequate detail, the test methodology was sound, and no problems were reported.

D. Reference 4

This test report documents an emission test at Nello L. Teer stone crushing plant in Raleigh, North Carolina. The test was conducted for EIB as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM-10 and filterable PM emissions from a Model 1560 Omnicone conical-type crusher (fines crusher) and a TD Seco vibrating screen (fines screen) were measured using EPA Method 201A in conjunction with a quasi-stack and a track-mounted hood system, which were used to capture fugitive emissions from the crusher and screen, respectively. The crusher reduces 2.5- to 1.9-cm (1-to 0.75-in.) stone to 0.476 cm (0.188 in.) and smaller. The screen consisted of three decks. The top and middle decks were 2.22 and 1.43 cm square (0.875 and 0.563 in. square), respectively. The bottom deck had slots 0.476 by 2.54 cm (0.188 by 1 in.). The crusher inlet and outlet were each enclosed and tested separately. Wet suppression was used to control emissions from both processes. Water spray nozzles are located at the crusher inlet, midway through the crusher body, at the crusher outlet, and at the conveyor transfer point to the screen. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and ≥ 1.5 percent, respectively. Average material moisture contents are presented in Table 1. In addition, sieve analyses were performed on stone samples taken from the conveyor that feeds the screen and the conveyor that carries the crusher product. The results of the sieve analyses are not documented in the test report.

Uncontrolled and controlled PM-10 and filterable PM emission factors were developed from the emission data and the material processing rates that were measured during the test. These emission factors are shown in Table 1. The PM-10 data are assigned an A rating. The filterable PM data are assigned a B rating. Although Method 201A is not the reference test method for quantifying filterable PM emissions, the preseparator and filter catch for the method should provide representative results for filterable PM. The report provided adequate detail, the test methodology was sound, and no problems were reported during the valid test runs.

E. Reference 5

This test report documents an emission test at Wake Stone Corporation stone crushing plant in Knightdale, North Carolina. The test was conducted for EIB as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM-10 and filterable PM emissions from two separate conveyor transfer points were measured using EPA Method 201A in conjunction with quasi-stack systems, which were used to capture fugitive emissions from the two transfer points. Wet suppression was used to control transfer point emissions. Water spray nozzles are located on the exit conveyor underneath each transfer point, and at numerous other locations throughout the process. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and ≥ 1.5 percent, respectively. Average material moisture contents are presented in Table 1. In addition, sieve analyses were performed on stone samples taken from each of the conveyor lines. The average silt content of the samples after drying was 1.4 percent for the first transfer point and 2.4 percent for the second transfer point. The relatively small amount of silt particles (<75 μm) present in the raw material suggests that the potential for PM-10 emissions from the material processing operations is low.

Uncontrolled and controlled PM-10 and filterable PM emission factors were developed from the emission data and the material processing rates that were measured during the test. These emission factors are shown in Table 1. The PM-10 data are assigned an A rating. The filterable PM data are assigned a B rating. Although Method 201A is not the reference test method for quantifying filterable PM emissions, the preseparator and filter catch for the method should provide representative results for filterable PM. The report provided adequate detail, the test methodology was sound, and no problems were reported during the valid test runs.

F. Reference 6

This test report documents an emission test at a Martin Marietta stone crushing plant in Raleigh, North Carolina. The test was conducted for the National Stone Association as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM-10 and filterable PM emissions from a conveyor transfer point were measured using EPA Method 201A and EPA Method 5, respectively, in conjunction with a quasi-stack system, which was used to capture fugitive emissions from the transfer point. Wet suppression was used to control transfer point emissions. Water spray nozzles are located on the exit conveyor underneath the transfer point, and at numerous other locations throughout the process. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and ≥ 1.5 percent, respectively. Average material moisture contents are presented in Table 1. In addition, sieve analyses were performed on stone samples taken from the conveyor. The average silt content of the dried stone was 2.2 percent. The relatively small amount of silt particles (<75 μm) present in the raw material suggests that the potential for PM-10 emissions from the material processing operations is low.

Uncontrolled and controlled PM-10 and filterable PM emission factors were developed from the emission data and the material processing rates that were measured during the test. These emission factors are shown in Table 1. The PM-10 data and the filterable PM (Method 5) data are assigned an A rating. The filterable PM data from the Method 201A tests are assigned a B rating. Although Method 201A is not the reference test method for quantifying filterable PM emissions, the preseparator and filter catches for the method should provide results that are representative for filterable PM. In addition, the emission factors developed from the Method 201A data are similar to the emission factors developed using the Method 5 data. The report provided adequate detail, the test methodology was sound, and no problems were reported during the valid test runs.

G. Reference 7

This test report documents an emission test conducted at Vulcan Materials Company stone crushing plant in Bristol, Tennessee. The test was conducted for EIB as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM-10 and filterable PM emissions from a cone crusher (tertiary crusher) and a triple-deck vibrating screen were measured using EPA Method 201A in conjunction with a quasi-stack and a track-mounted hood system, which were used to capture fugitive emissions from the crusher and screen, respectively. The crusher produces stone 7.6 cm (3 in.) and smaller in size. The screen consists of three vertically stacked decks. The upper deck has a mesh opening of 3.175 cm square (1.25 in. square). The middle deck has a mesh opening of 1.59 cm square (0.625 in. square), and the lower deck has a mesh opening of 0.635 cm square (0.25 in. square). Wet suppression was used to control emissions from both processes. Water spray nozzles are located in the feed hopper to the crusher and on the conveyor below the crusher. The targeted moisture contents of the raw material (limestone) during the uncontrolled and controlled runs were <1.0 percent and ≥1.0 percent, respectively. Average material moisture contents are shown in Table 1. In addition, sieve analyses were performed on stone samples taken from a process conveyor. The average silt content of the stone was 1.8 percent. The relatively small amount of silt particles (<75 μm) present in the raw material suggests that the potential for PM-10 emissions from the material processing operations is low.

Uncontrolled and controlled PM-10 and filterable PM emission factors were developed from the emission data gathered and the material processing rates that were measured during the test. These emission factors are shown in Table 1. The PM-10 data are assigned an A rating. The filterable PM data are assigned a B rating. Although Method 201A is not the reference test method for quantifying filterable PM emissions, the preseparator and filter catch for the method should provide representative results for filterable PM. The report provided adequate detail, the test methodology was sound, and no problems were reported.

H. Reference 8

This test report documents an emission test conducted at Vulcan Materials Company stone crushing plant in Marysville, Tennessee. The test was conducted for EIB as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM-10 and filterable PM emissions from a cone crusher (tertiary crusher) and a triple-deck vibrating screen were measured using EPA Method 201A in conjunction with a quasi-stack and a track-mounted hood system, which were used to capture fugitive emissions from the crusher and screen, respectively. The crusher produces stone 7.6 cm (3 in.) and smaller in size. The screen consists of three vertically stacked decks. The upper deck has a mesh opening of 3.175 cm square (1.25 in. square). The middle deck has a mesh opening of 1.59 cm square (0.625 in. square), and the lower deck has a mesh opening of 0.635 cm square (0.25 in. square). Wet suppression was used to control emissions from both processes. Water spray nozzles are located on the vibrating feeder to the crusher. The targeted moisture contents of the raw material (limestone) during the uncontrolled and controlled runs were $<$ 1.0 percent and $\geq$ 1.0 percent, respectively. Average material moisture contents are shown in Table 1. In addition, sieve analyses were performed on stone samples taken from a process conveyor. The average silt content of the stone was 3.25 percent. The relatively small amount of silt particles ($<75\ \mu m$) present in the raw material suggests that the potential for PM-10 emissions from the material processing operations is low.

Uncontrolled and controlled PM-10 and filterable PM emission factors were developed from the emission data gathered and the material processing rates that were measured during the test. These emission factors are shown in Table 1. The PM-10 data are assigned an A rating. The filterable PM data are assigned a B rating. Although Method 201A is not the reference test method for quantifying filterable PM emissions, the preseparator and filter catch for the method should provide representative results for filterable PM. The report provided adequate detail, the test methodology was sound, and no problems were reported.

I. Reference 9

This document, which was Reference 1 in the previous AP-42 Section 8.19.2, contains summary data from several emission tests performed at stone crushing plants. Particulate matter emissions were measured at baghouse inlets using EPA Method 5 sampling trains, and each test consisted of three runs. Emission sources, controls, material types, and emission factors for 12 tests at 5 plants were summarized in the document. Data from several of the tests were not analyzed because process rates were not documented. Data from nine of the tests were not analyzed because they represent emissions from combined sources. Data from three of the tests were used to quantify filterable PM emissions from a conveyor transfer point, a primary crusher, and a screen (referred to as a secondary screen in the document).

The data that were analyzed from the three tests described above are assigned a C rating. The test methodologies were sound, and no problems were reported during the valid test runs. However, the document did not provide original data sheets, and little detail about the raw materials was documented. The raw material is assumed to be dry because fabric filtration systems were used for emission control. The data from the other tests do not meet the minimum criteria for developing emission factors for inclusion in the revised AP-42 section.

J. Reference 10

This report, which was Reference 5 in the previous AP-42 Section 8.19.2, contains a review of emission factors developed in several of the references described above. In addition, data and emission factors from two emission tests performed by Engineering-Science are provided in Appendix C. The emission tests were conducted at two sand and gravel processing facilities, and the screens that were tested were horizontal screens. Data from these two emission tests for primary, secondary, and tertiary screening operations are combined to represent all screening operations, because no consistent correlation between the level of screening and the magnitude of PM emissions was established by the data. The quasi-stack method was used to capture fugitive emissions from the screens tested at both plants. Both tests were performed using wet impingement sampling trains (South Coast AQMD Method) for total PM, and cascade impactors for size-specific PM.

The PM data are assigned a B rating. The test methodology appeared to be sound and no problems were reported during the valid test runs. However, the report is a secondary reference, and does not provide sufficient detail to warrant an A rating. The PM-10 data are not rated because only single-run particle-size data are provided in the report.

K. Reference 11

This document, which was Reference 2 in the previous AP-42 Section 8.19.2, examines the granite crushing industry and the potential environmental impacts of industry emissions. Topics addressed include a source description, emissions, control technology, and growth and nature of the industry.

Emission factors for several granite crushing processes were developed using data from two granite processing facilities. Only summary information is provided in the document, although details on the processes and test methodology are provided. A GCA respirable dust monitor was used to sample PM-10 emissions, and emission rates were calculated using dispersion models. Emissions were sampled from several processes, including dumping to the primary crusher, and secondary crushing and screening. The monitor was placed about 100 feet from the source being sampled. No emission controls (for the plants tested) were specified, and the silt and moisture contents of the raw materials were not recorded.

The data do not meet the minimum criteria for developing emission factors for inclusion in the AP-42 section. The test methodology was not acceptable because only one monitor was used, and the monitor was too far from the source during testing. In addition, no detail about the moisture and silt contents of the raw material was provided.

L. Reference 12

This document, which was Reference 3 in the previous AP-42 Section 8.19.2, examines the stone crushing industry and the potential environmental impacts of industry emissions. Topics addressed include a source description, emissions, control technology, and growth and nature of the industry.

Emission factors for several stone crushing processes were developed using data from two traprock processing facilities. Only summary information is provided in the document, although details on the processes and test methodology are provided. A GCA Model RDM 101-4 respirable dust monitor was used to sample PM-10 emissions, and emission rates were calculated using dispersion models. Emissions were sampled from several processes, including primary crushing and unloading, secondary crushing and screening, tertiary crushing and screening, fines crushing and screening, and conveying. The monitor was placed about 100 feet from the source being sampled. No emission controls were specified, and the silt and moisture contents of the raw materials were not recorded.

The data do not meet the minimum criteria for developing emission factors for inclusion in the AP-42 section. The test methodology not acceptable because only one monitor was used, and the monitor was too far from the source during testing. In addition, no detail about the moisture and silt contents of the raw material was provided.

M. Reference 13

This document is divided into four sections, which are addressed separately in the following discussion.

Section I discusses the emission study (sponsored by the construction aggregate industry) that was performed by Monsanto Research Corporation (MRC) and The Research Corporation of New England (TRC). In addition, several conclusions about the control of fugitive dust emissions from construction aggregate processing facilities were drawn from a comparison of AP-42, MRC's source assessment studies, and the MRC-TRC study. These conclusions are: (1) AP-42 emission factors are from 10 to 10,000 times higher than the latest (1979) measurements of uncontrolled emissions; (2) baghouse emissions from aggregate crushing operations are often higher than uncontrolled emissions (apparently due to the suspension of fine particles, which are normally associated with larger particles and are not normally released to the atmosphere); (3) the emission factors developed by MRC in the source assessment program sponsored by EPA are within one order of magnitude of the emission factors developed in the MRC-TRC study, indicating that both data sets are highly reliable; (4) wet suppression can achieve between 80 and 90 percent control of the emissions from crushers; and (5) wet suppression is more efficient than fabric filters for controlling PM-10 emissions from crushers. To conclude Section I, an ambient air quality study performed at a sand and gravel production facility in Colorado is summarized. The study concluded that the sand and gravel processing operations did not have a detectable impact on air quality.

Section II documents the MRC study that included a compilation of emission data from tests at seven stone crushing plants that processed a variety of aggregates. Tests were conducted on four primary crushers, seven secondary crushers, three tertiary crushers, and two fines crushers. Aggregate types included granite (one plant), sand and gravel (two plants), traprock (one plant), and limestone (three plants). One of the limestone processing plants used wet suppression to control PM emissions. Emission factors for PM-10 and PM$<$50 μm were developed for all of the processes tested and were presented by process, aggregate type, and control methods.

A GCA Model RDM 101-4 dust monitor was used to detect fugitive PM emissions downwind of the process operations. The monitor was placed approximately 30 feet from the source during each tests. The "tracer gas method" was used to determine the percentage of PM-10 measured with the GCA instrument that was emitted from the source being tested. The silt and moisture contents of the raw materials were not specified.

The data from this testing program do not meet the minimum criteria for developing emission factors for the revised AP-42 section because an adequate number of downwind monitors were not used during testing. The upwind-downwind test method, specifies a minimum of five downwind samplers for a valid test.

Section III documents the TRC study that included a compilation of emission data from tests at six stone crushing plants that processed a variety of aggregates. Tests were conducted on four primary crushers, six secondary crushers, three tertiary crushers, and one fines crusher. Aggregate types included granite (one plant), sand and gravel (two plants), traprock (one plant), and limestone (two plants). The granite processing plant and both limestone processing plants used wet suppression to control PM emissions. Emission factors for PM-10 and PM$<$50 μm were developed for all of the processes tested, and were presented by process, aggregate type, and control methods.

A GCA Model RDM 101-4 dust monitor was used to detect fugitive PM emissions downwind of the process operations. The monitor was placed approximately 30 feet from the source during each test. The tracer gas method was used to determine the percentage of PM-10 measured with the GCA instrument that was emitted from the source being tested. The silt and moisture contents of the raw materials were not specified.

The data from this testing program do not meet the minimum criteria for developing emission factors for the revised AP-42 section because an adequate number of downwind monitors were not used during testing. The upwind-downwind test method, specifies a minimum of five downwind samplers for a valid test.

Section IV, entitled "Semi-annual Report: Ambient Air Monitoring Program, Cannon-ERTL Site," contains no data that can be used for emission factor development.

N. <u>Reference 14</u>

This report, which was Reference 4 in the previous AP-42 Section 8.19.2, is a compilation of emission factors from 16 test reports. The emission factors from all of the reports were rated and combined by process in order to develop a single emission factor for each process tested. Data quantifying PM-10 emissions from primary and secondary crushing operations (from NSPS test reports) were not used for emission factor development because adequate details about the test methodology are not provided, and problems with cascade impactor tests performed before about 1981 have been reported. The other data presented in this document are presented in several of the other references described in this review.

III. RESULTS OF DATA ANALYSIS

Emission factors were developed for conveyor transfer points, screening, primary crushing, tertiary crushing, fines crushing, and fines screening operations. The only data available for secondary crushing were of questionable quality and were not consistent with the emission tests included in this review. Therefore, the revised AP-42 section does not include emission factors for primary and secondary crushing of stone. However, the emission factors for tertiary stone crushing can be used as an upper limit to primary and secondary crushing.

Emissions generally were considered uncontrolled if the raw material moisture content was less than 1.5 percent and controlled if the raw material moisture content was greater than or equal to 1.5 percent. The material moisture contents in the Reference 5 and Reference 8 emission tests did not reach the targeted 1.5 percent for the controlled runs. However, data from these tests are consistent with data from other controlled tests and are treated as controlled. Table 2 presents the PM-10 emission factors and Table 4 presents the filterable PM emission factors developed using the data from References 1 through 10. Method 201A, which is not the reference test method for filterable PM, was used to quantify emissions. All of the filterable PM emission factors ~~with the exception of the primary crushing emission factor,~~ STET were assigned ~~a D~~ an E rating because ~~data from relatively few plants (compared with the total number of domestic stone crushing facilities) were used to develop the emission factors.~~

STET DON'T DELETE

The PM-10 emission factors for screening and tertiary crushing were assigned a C rating because A-rated data from four tests conducted at "typical" facilities (which is considerd a sufficient number of tests to warrant a C rating) were used. The PM-10 emission factors for fines screening and crushing were assigned an E rating because data from a single A-rated test were used. The PM-10 emission factors for conveyor transfer points were assigned a D rating because data from only three tests (conducted at two ~~plants~~ typical facilities) were used.

The primary crushing emission factor was assigned an E rating because it is based on a single C-rated test.

In addition to the emission factors described above, the revised AP-42 section includes emission factors for wet drilling, and truck unloading and loading that were retained from the previous version of AP-42 Section 8.19.2. Although the quality of the data upon which these emission factors was based is questionable, no other data on those sources were located during this review.

IV. REFERENCES

1. J. Richards, T. Brozell, and W. Kirk, *PM-10 Emission Factors for a Stone Crushing Plant Deister Vibrating Screen*, EPA Contract No. 68-D1-0055, Task 2.84, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1992.

2. J. Richards, T. Brozell, and W. Kirk, *PM-10 Emission Factors for a Stone Crushing Plant Tertiary Crusher*, EPA Contract No. 68-D1-0055, Task 2.84, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1992.

3. W. Kirk, T. Brozell, and J. Richards, *PM-10 Emission Factors for a Stone Crushing Plant Deister Vibrating Screen and Crusher*, National Stone Association, Washington DC, December 1992.

4. T. Brozell, J. Richards, and W. Kirk, *PM-10 Emission Factors for a Stone Crushing Plant Tertiary Crusher and Vibrating Screen*, EPA Contract No. 68-D0-0122, U. S. Environmental Protection Agency, Research Triangle Park, NC, December 1992.

5. T. Brozell, *PM-10 Emission Factors for Two Transfer Points at a Granite Stone Crushing Plant*, EPA Contract No. 68-D0-0122, U. S. Environmental Protection Agency, Research Triangle Park, NC, January 1994.

6. T. Brozell, *PM-10 Emission Factors for a Stone Crushing Plant Transfer Point*, EPA Contract No. 68-D0-0122, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1993.

7. T. Brozell and J. Richards, *PM-10 Emission Factors for a Limestone Crushing Plant Vibrating Screen and Crusher for Bristol, Tennessee*, EPA Contract No. 68-D2-0163, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1993.

8. T. Brozell and J. Richards, *PM-10 Emission Factors for a Limestone Crushing Plant Vibrating Screen and Crusher for Marysville, Tennessee*, EPA Contract No. 68-D2-0163, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1993.

9. *Air Pollution Control Techniques for Nonmetallic Minerals Industry*, EPA-450/3-82-014, U. S. Environmental Protection Agency, Research Triangle Park, NC, August 1982.

10. *Review Emission Data Base and Develop Emission Factors for the Construction Aggregate Industry*, Engineering-Science, Inc., Arcadia, CA, September 1984.

11. P. K. Chalekode *et al.*, *Emissions from the Crushed Granite Industry: State of the Art*, EPA-600/2-78-021, U. S. Environmental Protection Agency, Washington, DC, February 1978.

12. T. R. Blackwood *et al.*, *Source Assessment: Crushed Stone*, EPA-600/2-78-004L, U. S. Environmental Protection Agency, Washington, DC, May 1978.

13. *An Investigation of Particulate Emissions from Construction Aggregate Crushing Operations and Related New Source Performance Standards*, National Crushed Stone Association, Washington, DC, December 1979.

14. F. Record and W. T. Harnett, *Particulate Emission Factors for the Construction Aggregate Industry, Draft Report*, GCA-TR-CH-83-02, EPA Contract No. 68-02-3510, GCA Corporation, Chapel Hill, NC, February 1983.

Attachment

~~DRAFT AP-42 SECTION 8.19.2~~

8.19.2 CRUSHED STONE PROCESSING

8.19.2.1 Process Description[1,2]

Major rock types processed by the rock and crushed stone industry include limestone, granite, dolomite, traprock, sandstone, quartz, and quartzite. Minor types include calcareous marl, marble, shell, and slate. Industry classifications vary considerably and, in many cases, do not reflect actual geological definitions.

Rock and crushed stone products generally are loosened by drilling and blasting, then are loaded by power shovel or front-end loader into large haul trucks that transport the material to the processing operations. Techniques used for extraction vary with the nature and location of the deposit. Processing operations may include crushing, screening, size classification, material handling, and storage operations. All of these processes can be significant sources of PM and PM-10 emissions if uncontrolled.

Quarried stone normally is delivered to the processing plant by truck and is dumped into a hoppered feeder, usually a vibrating grizzly type, or onto screens, as illustrated in Figure 8.19.2-1. The feeder or screens separate large boulders from finer rocks that do not require primary crushing, thus reducing the load to the primary crusher. Jaw, impactor, or gyratory crushers are usually used for initial reduction. The crusher product, normally 7.5 to 30 centimeters (3 to 12 inches) in diameter, and the grizzly throughs (undersize material) are discharged onto a belt conveyor and usually are conveyed to a surge pile for temporary storage, or are sold as coarse aggregates.

The stone from the surge pile is conveyed to a vibrating inclined screen called the scalping screen. This unit separates oversized rock from the smaller stone. The undersize material from the scalping screen is considered to be a product stream and is transported to a storage pile and sold as base material. The stone that is too large to pass through the top deck of the scalping screen is processed in the secondary crusher. Cone crushers are commonly used for secondary crushing, although impact crushers are sometimes used. The material (throughs) from the second level of the screen bypasses the secondary crusher because it is sufficiently small for the last crushing step. The output from the secondary crusher and the throughs from the secondary screen are transported by conveyor to the tertiary circuit, which includes a sizing screen and a tertiary crusher.

Tertiary crushing is usually performed using cone crushers or other types of impactor crushers ~~hammermills~~. Oversize material from the top deck of the sizing screen is fed to the tertiary crusher. The tertiary crusher output is returned to the sizing screen. Various product streams with different size gradations are separated in the screening operation. The products are conveyed or trucked directly to finished product bins, ~~or to~~ open area stockpiles, or to other processing systems, such as washing, air separators, and screens and classifiers (for the production of manufactured sand).

Some stone crushing plants produce manufactured sand. This is a small-sized rock product with a maximum size of 0.50 centimeters (3/16th inch). Crushed stone from the tertiary sizing screen is sized in a vibrating inclined screen (fines screen) with relatively small mesh sizes. Oversized material is processed in a cone crusher or a hammermill (fines crusher) adjusted to produce small diameter material. The output is then returned to the fines screen for resizing.

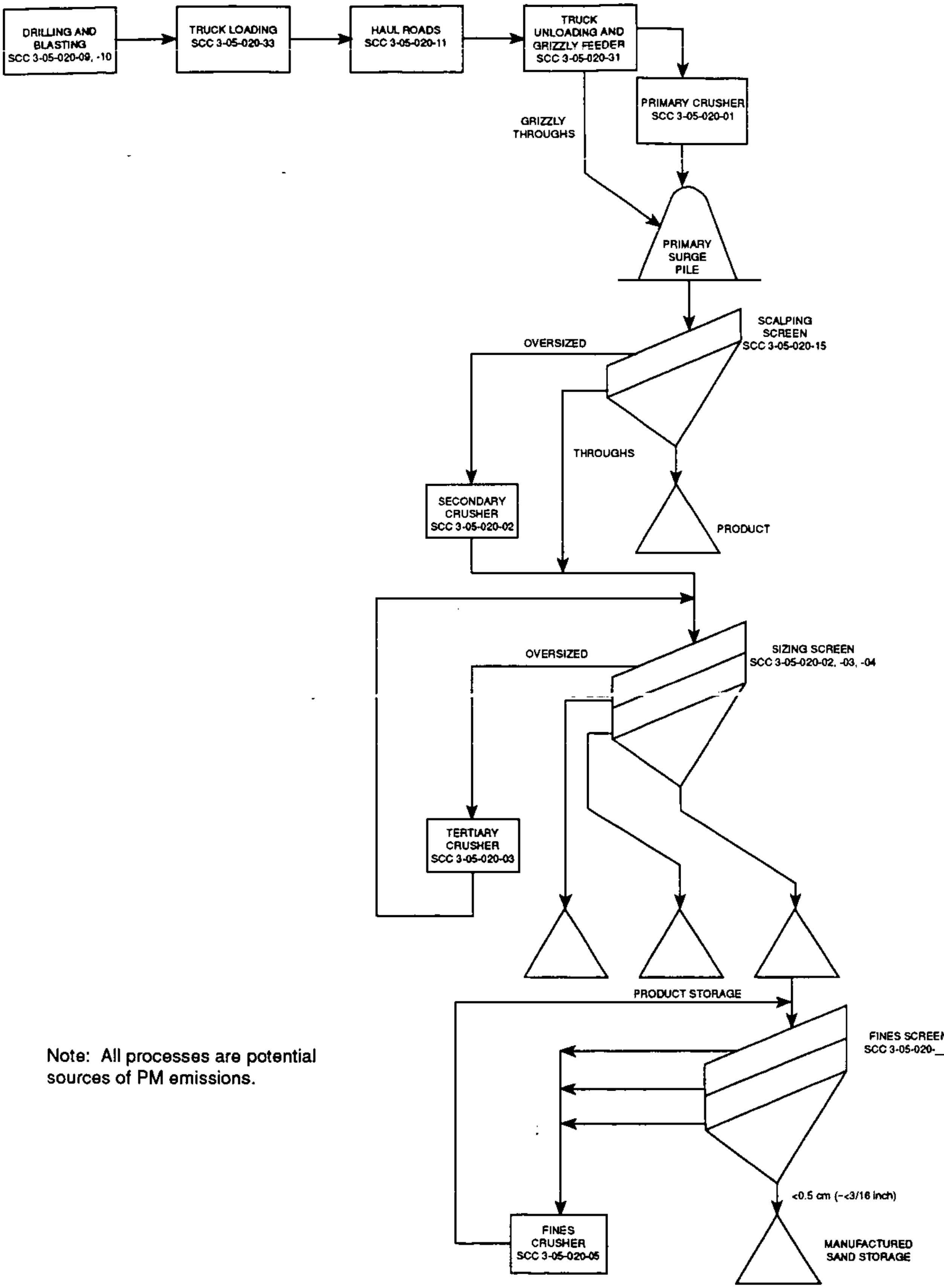

Figure 8.19.2-1. Typical stone processing plant.[2]

In certain cases, stone washing is required to meet particular end product specifications or demands, as with concrete aggregate processing. Crushed and broken stone normally is not milled but is screened and shipped to the consumer after secondary or tertiary crushing.

8.19.2.2 Emissions And Controls[1-4,7,8]

Emissions of PM and PM-10 occur from a number of operations in stone quarrying and processing. A substantial portion of these emissions consists of heavy particles that may settle out within the plant. As in other operations, crushed stone emission sources may be categorized as either process sources or fugitive dust sources. Process sources include those for which emissions are amenable to capture and subsequent control. Fugitive dust sources generally involve the reentrainment of settled dust by wind or machine movement. Factors affecting emissions from either source category include the stone size distribution and surface moisture content of the stone processed; the process throughput rate; the type of equipment and operating practices used; and topographical and climatic factors.

Emissions from process sources should be considered fugitive unless the sources are vented to a baghouse or are contained in an enclosure with a forced-air vent or stack.

Of geographic and seasonal factors, the primary variables affecting uncontrolled PM emissions are wind and material moisture content. Wind parameters vary with geographical location, season, and weather. It can be expected that the level of emissions from unenclosed sources (principally fugitive dust sources) will be greater during periods of high winds. The material moisture content also varies with geographic location, season, and weather. Therefore, the levels of uncontrolled emissions from both process emission sources and fugitive dust sources generally will be greater in arid regions of the country than in temperate ones, and greater during the summer months because of a higher evaporation rate.

The moisture content of the material processed can have a substantial effect on emissions. This effect is evident throughout the processing operations. Surface wetness causes fine particles to agglomerate on, or to adhere to, the faces of larger stones, with a resulting dust suppression effect. However, as new fine particles are created by crushing and attrition, and as the moisture content is reduced by evaporation, this suppressive effect diminishes and may disappear. Plants that use wet suppression systems (spray nozzles) to maintain relatively high material moisture contents can effectively control PM emissions throughout the process. Depending on the geographic and climatic conditions, the moisture content of mined rock may range from nearly zero to several percent. Because moisture content is usually expressed on a basis of overall weight percent, the actual moisture amount per unit area will vary with the size of the rock being handled. On a constant mass-fraction basis, the per-unit area moisture content varies inversely with the diameter of the rock. Therefore, the suppressive effect of the moisture depends on both the absolute mass water content and the size of the rock product. Typically, wet material contains 1.5 to 4 percent water or more.

A variety of material, equipment, and operating factors can influence emissions from crushing. These factors include (1) stone type, (2) feed size and distribution, (3) moisture content, (4) throughput rate, (5) crusher type, (6) size reduction ratio, and (7) fines content. Insufficient data are available to present a matrix of rock crushing emission factors detailing the above classifications and variables. Available data indicate that PM-10 emissions from limestone and granite processing operations are similar. Therefore, the emission factors developed from the emission data gathered at limestone and granite processing facilities are considered to be representative of typical crushed stone processing operations. Emission factors for filterable PM and PM-10 emissions from crushed stone processing operations are presented in Table 8.19-1.

Put the heading "Emission Factor rating" above the ratings!

Table 8.19.2-1. (METRIC UNITS)
EMISSION FACTORS FOR CRUSHED STONE PROCESSING OPERATIONS[a]

Emission Factors in kg/Mg of Material Throughput
~~Ratings (A-E) Follow Each Emission Factor~~

Source[b] ~~(SCC)~~	Filterable PM[c]		PM-10	
Screening (SCC 3-05-020-02,-03)	0.073[c] d	~~D~~ E	0.0076[d] e	~~D~~ C
Screening with wet suppression (SCC 3-05-020-02,-03)	0.0042[c] d	~~D~~ E	0.00042[d] e	~~D~~ C
Primary crushing (SCC 3-05-020-01)	0.00035[e] f	E	[f] g	E
Secondary crushing (SCC 3-05-020-02)	[f] g	E	[f] g	E
Tertiary crushing (SCC 3-05-020-03)	0.0018[g] h	~~D~~ E	0.0012[h] h	~~D~~ C
Primary crushing with wet suppression (SCC 3-05-020-01)	[f] g	E	[f] g	E
Secondary crushing with wet suppression (SCC 3-05-020-02)	[f]	E	[f]	E
Tertiary crushing with wet suppression (SCC 3-05-020-03)	0.00079[g] h	~~D~~ E	0.00029[h] h	~~D~~ C
Fines crushing[i] (SCC 3-05-020-05)	0.36	~~D~~ E	0.0075	~~D~~ E
Fines crushing with wet suppression[i] (SCC 3-05-020-05)	0.067	~~D~~ E	0.0010	~~D~~ E
Fines screening[i] (SCC 3-05-020-)	0.15	~~D~~ E	0.036	~~D~~ E
Fines screening with wet suppression[i] (SCC 3-05-020-)	0.0018	~~D~~ E	0.0011	~~D~~ E
Conveyor transfer point[j] (SCC 3-05-020-06)	0.018	~~D~~ E	0.00072	D
Conveyor transfer point with wet suppression[j] (SCC 3-05-020-06)	5.9×10^{-5}	~~D~~ E	2.4×10^{-5}	D
Wet drilling: unfragmented stone[k] (SCC 3-05-020-10)	ND		4.0×10^{-5}	E
Truck loading: fragmented stone[k] (SCC 3-05-020-31)	ND		8.0×10^{-6}	E
Truck loading--conveyor: crushed stone[l] (SCC 3-05-020-32)	ND		5.0×10^{-5}	E

ND = No data available

[a]Emission factors represent uncontrolled emissions unless noted.

[b]Sources controlled with wet suppression maintain a material moisture content ≥ 1.5 percent. Sources that process material with a moisture content of < 1.5 percent are considered to be uncontrolled.

d ~~c~~References 6, 11, 15, and 16.

e ~~d~~References 9, 11, 15 and 16.

f ~~e~~Reference 1.

g ~~f~~No data available, but emission factors for tertiary crushing can be used as an upper limit for primary and secondary crushing.

h ~~g~~References 11, 15, and 16.

j ~~h~~References 10, 11, 15 and 16.

k ~~i~~Reference 12. Fines crushing and screening operations produce material that is significantly smaller (maximum size of about 0.5 cm [3/16th inch]) than products of other crushed stone processing operations.

m ~~j~~References 13 and 14.

n ~~k~~Reference 3.

p ~~l~~Reference 4.

c To estimate total suspended particulate (TSP) emissions, a multiplier of 0.80 (in conjunction with TSP percentages of total PM [for vehicle traffic on unpaved roads] from AP-42 Section 13.2.1) can be applied to the filterable PM emission factors. However, no data are available to support this ~~approximation~~, and the calculated TSP emission factors are not suitable for rating or inclusion in AP-42.

Add footnote that no condensible ~~PM is expected.~~

Add footnote about crusher definitions

Add footnote " " fines

Change footnotes in Table 1 also. No longer using letters i, l, or o as footnote callouts!

Table 8.19.2-1. (ENGLISH UNITS)
EMISSION FACTORS FOR CRUSHED STONE PROCESSING OPERATIONS[a]

Emission Factors in lb/ton of Material Throughput
Ratings (A-E) Follow Each Emission Factor

Source[b] ~~(SCC)~~	Filterable PM		PM-10	
Screening (SCC 3-05-020-02,-03)	0.15[c]	~~D~~ E	0.015[d]	~~D~~ C
Screening with wet suppression (SCC 3-05-020-02,-03)	0.0084[c]	~~D~~ E	0.00084[d]	~~D~~ C
Primary crushing (SCC 3-05-020-01)	0.00070[e]	E	[f]	E
Secondary crushing (SCC 3-05-020-02)	[f]	E	[f]	E
Tertiary crushing (SCC 3-05-020-03)	0.036[g]	~~D~~ E	0.0024[h]	~~D~~ C
Primary crushing with wet suppression (SCC 3-05-020-01)	[f]	E	[f]	E
Secondary crushing with wet suppression (SCC 3-05-020-02)	[f]	E	[f]	E
Tertiary crushing with wet suppression (SCC 3-05-020-03)	0.0016[g]	~~D~~ E	0.00059[h]	~~D~~ C
Fines crushing[i] (SCC 3-05-020-05)	0.72	~~D~~ E	0.015	~~D~~ E
Fines crushing with wet suppression[i] (SCC 3-05-020-05)	0.13	~~D~~ E	0.0020	~~D~~ E
Fines screening[i] (SCC 3-05-020-)	0.30	~~D~~ E	0.071	~~D~~ E
Fines screening with wet suppression[i] (SCC 3-05-020-)	0.0036	~~D~~ E	0.0021	~~D~~ E
Conveyor transfer point[j] (SCC 3-05-020-06)	0.035	~~D~~ E	0.0014	D
Conveyor transfer point with wet suppression[j] (SCC 3-05-020-06)	0.00012	~~D~~ E	4.8×10^{-5}	D
Wet drilling: unfragmented stone[k] (SCC 3-05-020-10)	ND		8.0×10^{-5}	E
Truck unloading: fragmented stone[k] (SCC 3-05-020-31)	ND		1.6×10^{-5}	E
Truck loading--conveyor: crushed stone[l] (SCC 3-05-020-32)	ND		~~0.0010~~	E

0.000010 ~~0.00010~~

ND = No data available
[a]Emission factors represent uncontrolled emissions unless noted.
[b]Sources controlled with wet suppression maintain a material moisture content ≥ 1.5 percent. Sources that process material with a moisture content of < 1.5 percent are considered to be uncontrolled.
[c]References 6, 11, 15, and 16.
[d]References 9, 11, 15 and 16.
[e]Reference 1.
[f]No data available, but emission factors for tertiary crushing can be used as an upper limit for primary and secondary crushing.
[g]References 11, 15, and 16.
[h]References 10, 11, 15 and 16.
[i]Reference 12.
[j]References 13 and 14.
[k]Reference 3.
[l]Reference 4.

Make the same changes here as in the last table, plus

Please be careful w/footnotes!

Emission factor estimates for stone quarry blasting operations are not presented here because of the sparsity and unreliability of available test data. While a procedure for estimating blasting emissions is presented in Section 8.24, Western Surface Coal Mines, that procedure should not be applied to stone quarries because of dissimilarities in blasting techniques, material blasted, and size of blast areas. Milling of fines is not included in this section as this operation is normally associated with nonconstruction aggregate end uses and will be covered elsewhere when information is adequate. Emission factors for fugitive dust sources, including paved and unpaved roads, materials handling and transfer, and wind erosion of storage piles, can be determined using the predictive emission factor equations presented in AP-42 Section 11.2.

References for Section 8.19.2

1. *Air Pollution Control Techniques for Nonmetallic Minerals Industry*, EPA-450/3-82-014, U. S. Environmental Protection Agency, Research Triangle Park, NC, August 1982.

2. Written communication from J. Richards, Air Control Techniques, P.C., to B. Shrager, MRI. March 18, 1994.

3. P. K. Chalekode *et al.*, *Emissions from the Crushed Granite Industry: State of the Art*, EPA-600/2-78-021, U. S. Environmental Protection Agency, Washington, DC, February 1978.

4. T. R. Blackwood *et al.*, *Source Assessment: Crushed Stone*, EPA-600/2-78-004L, U. S. Environmental Protection Agency, Washington, DC, May 1978.

5. F. Record and W. T. Harnett, *Particulate Emission Factors for the Construction Aggregate Industry, Draft Report*, GCA-TR-CH-83-02, EPA Contract No. 68-02-3510, GCA Corporation, Chapel Hill, NC, February 1983.

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8. R. Bohn *et al.*, *Fugitive Emissions from Integrated Iron and Steel Plants*, EPA-600/2-78-050, U. S. Environmental Protection Agency, Washington, DC, March 1978.

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13. T. Brozell, *PM-10 Emission Factors for Two Transfer Points at a Granite Stone Crushing Plant*, EPA Contract No. 68-D0-0122, U. S. Environmental Protection Agency, Research Triangle Park, NC, January 1994.

14. T. Brozell, *PM-10 Emission Factors for a Stone Crushing Plant Transfer Point*, EPA Contract No. 68-D0-0122, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1993.

15. T. Brozell and J. Richards, *PM-10 Emission Factors for a Limestone Crushing Plant Vibrating Screen and Crusher for Bristol, Tennessee*, EPA Contract No. 68-D2-0163, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1993.

16. T. Brozell and J. Richards, *PM-10 Emission Factors for a Limestone Crushing Plant Vibrating Screen and Crusher for Marysville, Tennessee*, EPA Contract No. 68-D2-0163, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1993.

Definitions of

3-12" Primary
1-4" Secondary
3/16-1" Tert. Crushing
< 3/16" Fines Crushing

sizes + types of crushers

INTEROFFICE COMMUNICATION

MIDWEST RESEARCH INSTITUTE

September 19, 1994

To: Rick Marinshaw

From: Chat Cowherd

Subject: Review of Entropy Test Plan Proposal

I have completed a preliminary review of the Entropy Test Plan proposal entitled ***"Determination of PM-10 Emission Factors for a Quarry Haul Road and Storage Pile for a Stone Crushing Plant" (March 1993).*** Because the limitation of hours specified for my review effort, I will be brief in highlighting my major concerns as detailed below.

I have serious concerns about a number of aspects of the proposed sampling strategies and emission factor calculation schemes, which depart in many respects from the evolution of work in the field of fugitive dust source quantification over the past 20 years. [Russell Frankel on assignment from UNC to EMB has recently summarized this field in ***"A Review of Methods for Measuring Fugitive PM-10 Emission Rates from Stationary Sources" (1994).***]

The authors make no reference to the prior studies (or the associated sampling methods and calculation schemes) which produced the AP-42 generic fugitive dust emission factor equations for unpaved roads and storage piles. Even the units proposed for the haul road emission factor (lb/ton-ft) are at variance with the standard units (lb/VMT) used for this source. AP-42 also contains standard methods to be used for the collection and analysis of samples from unpaved roads and storage piles, which are adapted from appropriate ASTM methods.

Haul Road

The concept of capturing a road dust plume by inducing a stable flow of ambient air of 1-3 mph in velocity over a 3-6 hour period has many potential pitfalls. Ambient winds in the typical daytime range of 5-15 mph in most cases would seriously disrupt the induced flow. In addition the flow instabilities created by vehicle wake turbulence may inject PM-10 particles to heights well above the top of the vehicle, particularly at low ambient wind flows. I base the conclusion on our studies of winds in the vicinity of roadways during numerous exposure profiling tests at industrial and rural sites.

My question would be: why is not conventional exposure profiling being proposed? That proven technique has generated the most reliable and widely applicable of the fugitive dust emission factor equations in AP-42. Emission rates are calculated by superposition of vertical profiles of PM-10 concentration and wind speed. The ambient wind is used as the transport medium, and no elaborate apparatus is needed to direct the plume across the array of samples.

The time required for an exposure profiling test is usually short enough that wind conditions are relatively constant. In testing of emissions from unpaved roads, traffic counts are enhanced with "captive" vehicles so that the required number of vehicle passes will occur in less than one hour for uncontrolled emissions and no more than about two hours for controlled emissions.

Storage Pile

The other segment of the proposed testing relates to the measurement of emissions discharged during the dropping of stone from a conveyor to a storage pile. Of the six samplers to be deployed during the testing, three are located downwind of the pile. However, only one sampler (suspended from a crane on the prevailing downwind side of the drop zone) is positioned to capture emissions directly from the dropping of stone into the pile. The other two samplers are positioned "on the ground, near the base of the pile," completely away from the drop zone; apparently those samplers are intended to capture emissions generated by the impact of the conveyed material as it falls onto the surface of the pile.

It is unclear why the PM-10 catches from all three samplers are combined in determining the PM-10 emission rate from the dropping of material onto the pile. In effect this weights all three samplers equally in the calculation of downwind concentration, and masks information on the actual concentration variation downwind of the pile. Undoubtedly the apparent emission factor for the drop zone would be reduced significantly by giving equal weighting to the ground based samplers.

Moreover, in calculating the air flow through the pile "array" (base diameter x height), a single average wind velocity is used. In contrast, the actual wind field downwind of the pile is very complex. In addition, wind speed and direction over a period of 6 hours may significantly change the portion of the plume impacting each fixed downwind sampler.

From the Entropy test report (August 1994) for the storage pile emission measurements, it is evident that the downwind sampling network was expanded to five PM-10 samplers, with four of the five samplers at 9 ft above ground. The fifth downwind sampler was suspended immediately downwind of the drop zone, which extended from the stacker height of 33 ft down to the top of the pile, which appeared to range from 15 ft to 29 ft above ground.

Because emissions of interest were restricted to the drop operation, there was concern about the impact of the front end loader operating on one side of the pile, and other trucks operating in the pile area. Even though carbon catches on the filters were shown to be small, the dust created by these vehicles still could have contributed substantially to the downwind concentrations measured during the testing.

Once again the proposed sampling and calculation scheme should be related to what was learned in prior testing of this source. For example, much of the data used in developing the AP-42 equation for materials handling operations, was generated using a symmetrical 2-dimensional sampling array placed immediately downwind of the drop zone. None of the samplers were positioned at a downwind location potentially shielded by the pile itself. The measured concentration field was superimposed on the separately measured velocity field in the calculation of the integrated emission flux (mass/area-time). By focusing the sampling array directly on the drop zone, sampling time was reduced to about an hour, over which wind speed and direction remained fairly constant.

This concludes my preliminary evaluation. I will be happy to discuss these concerns further and expand upon this written evaluation as necessary.

MRI

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Suite 350
401 Harrison Oaks Boulevard
Cary, North Carolina 27513-2412
Telephone (919) 677-0249
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Date: April 23, 1993

Subject: Draft AP-42 Section 8.19.2, Crushed Stone Processing
Review and Update Remaining Sections of Chapter 8
(Mineral Products Industry) of AP-42
EPA Contract 68-D2-0159, Work Assignment 12
MRI Project 3612

From: Brian Shrager

To: Ron Myers
EPA/EIB/EFMS (MD-14)
U. S. Environmental Protection Agency
Research Triangle Park, N.C. 27711

Enclosed is a copy of the draft background memorandum and AP-42 section on crushed stone processing. I would like to point out that we did not revise the process flow diagram to show SCC and emission points, but we will do so before the next submittal. Also, the emission factors presented in Table 8.19.2-3 were taken directly from the existing AP-42 section, and the conversion between english and metric units is not consistent in all cases. We will look into which numbers are correct, and will revise the table accordingly.

In sec what is 1st 2nd 3 crushing

Date: April 23, 1993

Subject: Background Information for Revised AP-42 Section 8.19.2, Crushed Stone Processing
Review and Update Remaining Sections of Chapter 8 (Mineral Products Industry) of AP-42
EPA Contract 68-D2-0159, Work Assignment 12
MRI Project 3612

From: Brian Shrager

To: Ron Myers
EPA/EIB/EFMS (MD-14)
U. S. Environmental Protection Agency
Research Triangle Park, NC 27711

I. INTRODUCTION

This memorandum presents the background information that was used to develop the revised AP-42 Section 8.19.2 on crushed stone processing. Emission data from four emission tests conducted at stone (granite) processing plants were used to develop emission factors for various crushing and screening operations. Descriptions of these test reports are provided in Section II of this memorandum. Tables 1 and 2 present the emission data and the new emission factors developed for inclusion in the revised AP-42 section. The narrative section and existing tables were reformatted and edited for technical accuracy but were not revised; a complete revision of the AP-42 section will not be performed until the ongoing test program for the stone crushing source category is completed. The draft AP-42 section is provided as the attachment.

II. DESCRIPTION OF REFERENCES

A. Reference 1

This test report documents an emission test conducted at a Martin Marietta stone crushing plant in Raleigh, North Carolina. The test was conducted for the Emission Inventory Branch (EIB) of the U. S. Environmental Protection Agency (EPA) as part of an emission test program undertaken to

TABLE 1. SUMMARY OF EMISSION DATA FOR PM-10 EMISSIONS FROM CRUSHED STONE PROCESSING TEST REPORTS[a]

Data Rating: A

Source	Average material moisture content	No. of test runs	Emission factor range, kg/Mg (lb/ton)	Average emission factor, kg/Mg (lb/ton)	Ref No.
Secondary screening	0.48%	3	0.0010-0.0075 (0.0020-0.015)	0.0035 (0.0070)	1
Secondary screening	1.57%	3	0.00028-0.00037 (0.00056-0.00073)	0.00031 (0.00061)	1
Tertiary crushing	0.44%	3	0.00075-0.0010 (0.0015-0.0020)	0.00090 (0.0018)	2
Tertiary crushing	1.77%	3	0.00017-0.00055 (0.00034-0.0011)	0.00042 (0.00083)	2
Primary crushing	0.70%	3	0.0011-0.0031 (0.0021-0.0062)	0.0020 (0.0040)	3
Primary crushing	1.78%	3	0.000075-0.00019 (0.00015-0.00037)	0.00013 (0.00026)	3
Secondary screening	0.70%	3	0.012-0.015 (0.024-0.030)	0.014 (0.027)	3
Secondary screening	1.78%	3	0.00049-0.00055 (0.00097-0.0011)	0.00050 (0.0010)	3
Tertiary crushing	0.97%	3	0.0017-0.013 (0.0034-0.026)	0.0075 (0.015)	4
Tertiary crushing	1.92%	3	0.00055-0.0013 (0.0011-0.0026)	0.0010 (0.0020)	4
Tertiary screening	< 1.5%	3	0.021-0.05 (0.042-0.10)	0.036 (0.071)	4
Tertiary screening	1.68%	3	0.0006-0.0015 (0.0012-0.0030)	0.0011 (0.0021)	4

[a]Emission factors in units of material throughput (process) unless noted.

TABLE 2. SUMMARY OF PM-10 EMISSION FACTORS[a]

(Factors represent uncontrolled emissions unless noted)

Process (SCC)	No. of tests	Average emission factor, kg/Mg (lb/ton)	Emission factor rating	Ref. Nos.
Primary crushing (3-05-020-01)	1	0.0020 (0.0040)	D	3
Primary crushing with wet suppression (3-05-020-01)	1	0.00013 (0.00026)	D	3
Secondary screening (3-05-020-02)	2	0.0085 (0.017)	D	1, 3
Secondary screening with wet suppression (3-05-020-02)	2	0.00040 (0.00081)	D	1, 3
Tertiary crushing (3-05-020-03)	2	0.0042 (0.0084)	D	2, 4
Tertiary crushing with wet suppression (3-05-020-03)	2	0.00071 (0.0014)	D	2, 4
Tertiary screening (3-05-020-03)	1	0.036 (0.071)	D	4
Tertiary screening with wet suppression (3-05-020-03)	1	0.0011 (0.0021)	D	4

[a]Emission factors in units of material throughput (process) unless noted.

does the report have the mesh size of the screen? it should be presented here-

provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled particulate matter less than 10 micrometers (μm) in diameter (PM-10) emissions from a deister vibrating screen (secondary screen) were measured using EPA Method 201A in conjunction with a track-mounted hood system that was used to capture fugitive emissions from the screen. Ambient levels of PM-10 were quantified using HiVol samplers, and the ambient concentrations were subtracted from the Method 201A concentrations to determine the actual emissions from the screen. Wet suppression was used to control emissions from the screen. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and >1.5 percent, respectively. Average material moisture contents are shown in Table 1. In addition, sieve analyses were performed on stone samples taken from a process conveyor. Silt content of the stone as sampled (wet) was negligible, and the average silt content of the sample after drying was 3.35 percent. The relatively small amount of silt particles (<75 μm) present in the raw material suggests that the potential for PM-10 emissions from the material processing operations is low.

before or after the screen?

Uncontrolled and controlled PM-10 emission factors were developed from the emission data and the material processing rates that were measured during the testing. These emission factors are shown in Table 1. The emission factors presented differ slightly from the emission factors reported in the test report because average production rates were used in the test report, whereas actual run-by-run production rates were used in the data analyses presented in this memorandum. The data are assigned an A rating. The report provided adequate detail, the test methodology was sound, and no problems were reported during the valid test runs.

If we are going to use run by run data we should present it in the table

do we have the results of test runs that were not valid? can we present the results and also add the reason the value was invalidated?

B. Reference 2

what size of gravel was this crusher designed or adjusted to produce?

This test report documents an emission test conducted at a Martin Marietta stone crushing plant in Garner, North Carolina. The test was conducted for EIB as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM-10 emissions from a Model 1560 Omnicone conical-type tertiary crusher were measured using EPA Method 201A in conjunction with a quasi-stack system, which was used to capture fugitive emissions from the crusher. The crusher inlet and outlet were each enclosed and tested separately. Wet suppression was used to control emissions from the crusher. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and >1.5 percent, respectively. Average material moisture contents are presented in

do we know how the water was applied and where - ie sprays over the inlet raw pile and ? on sprays over the exit. also what were the size of the openings, how much water was applied

Table 1. In addition, sieve analyses were performed on stone samples taken from a process conveyor. The results of the sieve analyses are not documented in the test report.

could you call MH and obtain the info?

Uncontrolled and controlled PM-10 emission factors were developed from the emission data and the material processing rates that were measured during the testing. These emission factors are shown in Table 1. The data are assigned an A rating. The report provided adequate detail, the test methodology was sound, and no problems were reported during the valid test runs.

need some description of the method i.e. x gal/min water covering the exit of the crusher ... x lbs averaged

C. Reference 3

not a primary crusher

what size stone was it designed or adjusted to produce?

what was the mesh size of the screen

This test report documents an emission test conducted at Vulcan Materials, Inc. stone crushing plant in Skippers, Virginia. The test was conducted for the National Stone Association to determine emission factors for various stone crushing process operations. Uncontrolled and controlled PM-10 emissions from a cone crusher (primary crusher) and a deister vibrating screen (secondary screen) were measured using EPA Method 201A in conjunction with a quasi-stack and a track-mounted hood system, which were used to capture fugitive emissions from the crusher and screen, respectively. Wet suppression was used to control emissions from both processes. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were < 1.5 percent and > 1.5 percent, respectively. Average material moisture contents are shown in Table 1. In addition, sieve analyses were performed on stone samples taken from a process conveyor. The average silt content of the stone as sampled (wet) was 3.3 percent, and the average silt content of the sample after drying was 4.0 percent. The relatively small amount of silt particles (< 75 μm) present in the raw material suggests that the potential for PM-10 emissions from the material processing operations is low.

Uncontrolled and controlled PM-10 emission factors were developed from the emission data gathered and the material processing rates that were measured during the testing. These emission factors are shown in Table 1. The data are assigned an A rating. The report provided adequate detail, the test methodology was sound, and no problems were reported during the valid test runs.

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What was the material size of the feed to the crusher and what size material was it designed or adjusted to produce

D. Reference 4

This test report documents an emission test at Nello L. Teer stone crushing plant in Raleigh, North Carolina. The test was conducted for EIB as part of an emission test program undertaken to provide emission data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM-10 emissions from a Model 1560 Omnicone conical-type tertiary crusher and a TD Seco vibrating screen (tertiary screen) were measured using EPA Method 201A in conjunction with a quasi-stack and a track-mounted hood system, which were used to capture fugitive emissions from the crusher and screen, respectively. The crusher inlet and outlet were each enclosed and tested separately. Wet suppression was used to control emissions from both processes. The targeted moisture contents of the raw material (granite) during the uncontrolled and controlled runs were <1.5 percent and >1.5 percent, respectively. Average material moisture contents are presented in Table 1. In addition, sieve analyses were performed on stone samples taken from a process conveyor. The results of the sieve analyses are not documented in the test report. Can we obtain the sieve analysis - test contractor or plant

What was the screen size (mesh).

describe the suppression system - spray location, spray flow, spray size...

Uncontrolled and controlled PM-10 emission factors were developed from the emission data and the material processing rates that were measured during the testing. These emission factors are shown in Table 1. The data are assigned an A rating. The report provided adequate detail, the test methodology was sound, and no problems were reported during the valid test runs.

III. RESULTS OF DATA ANALYSIS

Emission factors were developed for primary crushing, secondary screening, tertiary crushing, and tertiary screening operations. Emissions were considered uncontrolled if the raw material moisture content was less than 1.5 percent and controlled if the raw material moisture content was greater than 1.5 percent. Table 2 presents the emission factors developed using the data from References 1 through 4. All of the emission factors were assigned a D rating because data from only one or two plants were used to develop the emission factors.

The previous version of Section 8.19.2 includes emission factors for the same types of sources for which new emission factors are presented in this memorandum. However, the emission factors in the previous version of the section are based on the testing of various types of stones, and there is inadequate information to classify the tests according to stone type. Because emissions are likely to vary significantly by stone type, the new emission factors for granite stone processing are presented in a separate table in the revised AP-42 Section 8.19.2; they were not averaged with the corresponding emission factors in the previous version of the section.

REFERENCES

1. PM-10 Emission Factors for a Stone Crushing Plant Deister Vibrating Screen, EPA Contract No. 68-D1-0055, Task 2.84, U.S. Environmental Protection Agency, Research Triangle Park, NC, February 1992.

2. PM-10 Emission Factors for a Stone Crushing Plant Tertiary Crusher, EPA Contract No. 68-D1-0055, Task 2.84, U.S. Environmental Protection Agency, Research Triangle Park, NC, February 1992.

3. PM-10 Emission Factors for a Stone Crushing Plant Deister Vibrating Screen and Crusher, National Stone Association, Washington DC, December 1992.

4. PM-10 Emission Factors for a Stone Crushing Plant Tertiary Crusher and Vibrating Screen, EPA Contract No. 68-D0-0122, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1992.

Attachment

DRAFT AP-42 SECTION 8.19.2

8.19.2 CRUSHED STONE PROCESSING

8.19.2.1 Process Description[1]

Major rock types processed by the rock and crushed stone industry include limestone, granite, dolomite, traprock, sandstone, quartz, and quartzite. Minor types include calcareous marl, marble, shell, and slate. Industry classifications vary considerably and, in many cases, do not reflect actual geological definitions.

Rock and crushed stone products generally are loosened by drilling and blasting, then are loaded by power shovel or front-end loader and transported by heavy earth-moving equipment. Techniques used for extraction vary with the nature and location of the deposit. Further processing may include crushing, screening, size classification, material handling, and storage operations. All of these processes can be significant sources of dust emissions if uncontrolled. Some processing operations also include washing, depending on rock type and desired product.

Quarried stone normally is delivered to the processing plant by truck and is dumped into a hoppered feeder, usually a vibrating grizzly type, or onto screens, as illustrated in Figure 8.19.2-1. These screens separate or scalp large boulders from finer rocks that do not require primary crushing, thus reducing the load to the primary crusher. Jaw, or gyratory, crushers are usually used for initial reduction. The crusher product, normally 7.5 to 30 centimeters (3 to 12 inches) in diameter, and the grizzly throughs (undersize material) are discharged onto a belt conveyor and usually are transported either to secondary screens and crushers or to a surge pile for temporary storage.

Further screening generally separates the process flow into two or three fractions (oversize, undersize, and throughs) ahead of the secondary crusher. The oversize is discharged to the secondary crusher for further reduction, and the undersize usually bypasses the secondary crusher. The throughs sometimes are separated, because they contain unwanted fines, and are stockpiled as crusher

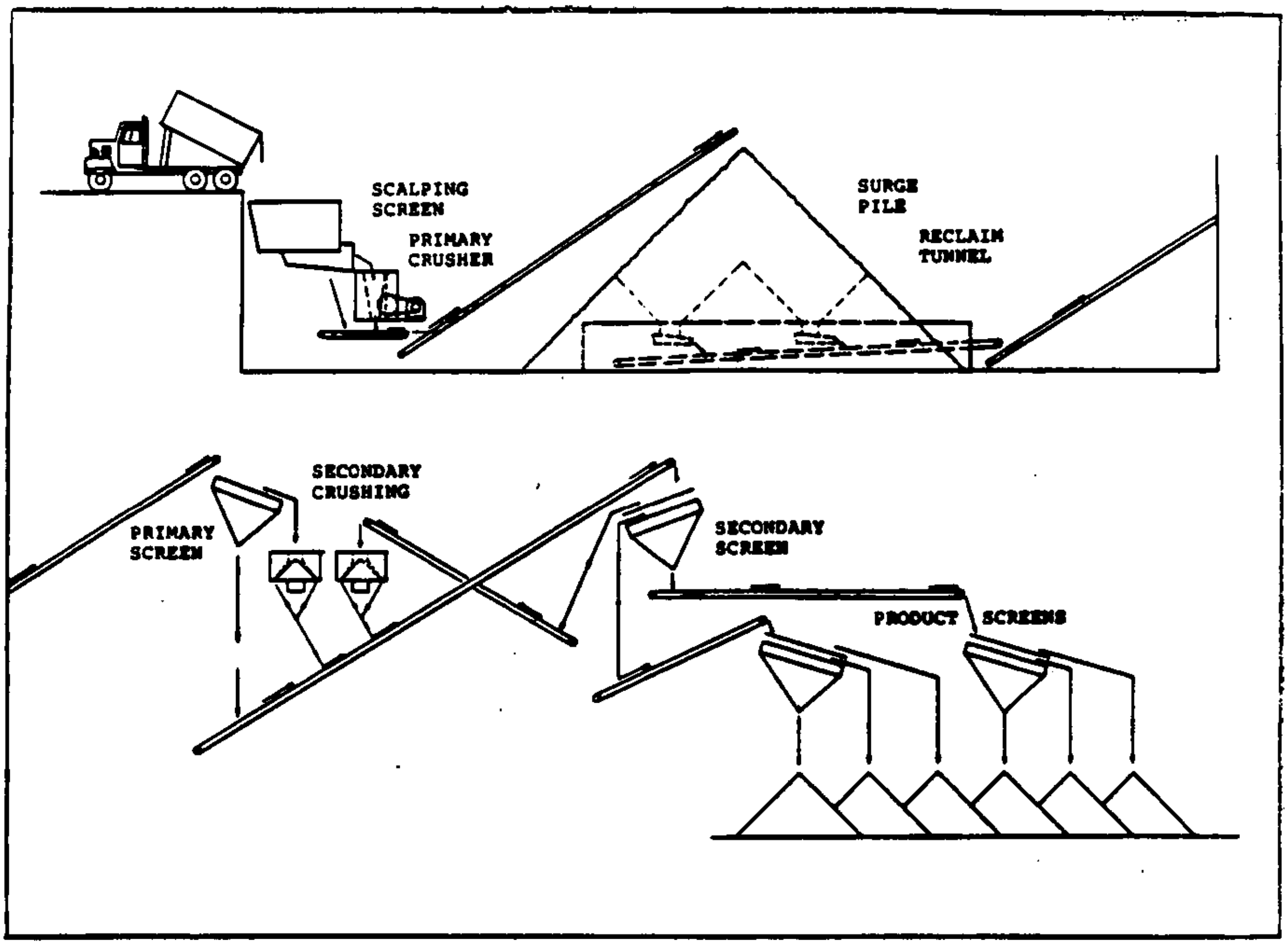

Figure 8.19.2-1. Typical stone processing plant.

run material. Gyratory crushers or cone crushers are commonly used for secondary crushing, although impact crushers are sometimes found.

The product of the secondary crushing stage, usually 2.5 centimeters (1 inch) diameter or less, is transported to secondary screens for further sizing. Oversize material is sent back for recrushing. Depending on rock type and desired product, tertiary crushing or grinding may be necessary, usually using cone crushers or hammermills. The product from tertiary crushing may be conveyed to a classifier, such as a dry vibrating screen system, or to an air separator. Any oversize is returned to the tertiary crusher for further reduction. At this point, end products of the desired grade are conveyed or trucked directly to finished product bins or to open area stockpiles.

In certain cases, stone washing is required to meet particular end product specifications or demands, as with concrete aggregate processing. Crushed and broken stone normally is not milled but is screened and shipped to the consumer after secondary or tertiary crushing.

8.19.2.2 Emissions And Controls[1-3,6,7]

Dust emissions occur from many operations in stone quarrying and processing. A substantial portion of these emissions consists of heavy particles that may settle out within the plant. As in other operations, crushed stone emission sources may be categorized as either process sources or fugitive dust sources. Process sources include those for which emissions are amenable to capture and subsequent control. Fugitive dust sources generally involve the reentrainment of settled dust by wind or machine movement. Factors affecting emissions from either source category include the type, quantity, and surface moisture content of the stone processed; the type of equipment and operating practices used; and topographical and climatic factors.

Of geographic and seasonal factors, the primary variables affecting uncontrolled particulate matter (PM) emissions are wind and material moisture content. Wind parameters vary with geographical location, season, and weather. It can be expected that the level of emissions from unenclosed sources (principally fugitive dust sources) will be greater during periods of high winds. The material moisture content also varies with geographic location, season, and weather. Therefore, the levels of uncontrolled emissions from both process emission sources and fugitive dust sources generally will be greater in arid regions of the country than in temperate ones, and greater during the summer months because of a higher evaporation rate.

The moisture content of the material processed can have a substantial effect on uncontrolled emissions. This effect is especially evident during mining, initial material handling, and initial plant process operations such as primary crushing. Surface wetness causes fine particles to agglomerate on, or to adhere to, the faces of larger stones, with a resulting dust suppression effect. However, as new fine particles are created by crushing and attrition, and as the moisture content is reduced by evaporation, this suppressive effect diminishes and may disappear. Depending on the geographic and climatic conditions, the moisture content of mined rock may range from nearly zero to several percent. Because moisture content is usually expressed on a basis of overall weight percent, the actual moisture amount per unit area will vary with the size of the rock being handled. On a constant mass-fraction basis, the per-unit area moisture content varies inversely with the diameter of the rock. Therefore, the suppressive effect of the moisture depends on both the absolute mass water content and the size of the rock product. Typically, a wet material will contain 1.5 to 4 percent water or more.

A large number of material, equipment, and operating factors can influence emissions from crushing. These factors include (1) rock type, (2) feed size and distribution, (3) moisture content, (4) throughput rate, (5) crusher type, (6) size reduction ratio, and (7) fines content. Insufficient data are available to present a matrix of rock crushing emission factors detailing the above classifications and variables. Data available from which to prepare emission factors also vary considerably, for both extractive testing and plume profiling. Emission factors from extractive testing are generally higher than those based upon plume profiling tests, but they have a greater degree of reliability. Some test data for primary crushing indicate higher emissions than from secondary crushing, although factors affecting emission rates and visual observations suggest that the secondary crushing emission factor, on a throughput basis, should be higher. Table 8.19.2-1 shows single factors for either primary or secondary crushing reflecting a combined data base. An emission factor for tertiary crushing is given, but it is based on extremely limited data. All factors are rated low because of the limited and highly variable data base. Emission factors for PM-10 emissions from granite processing operations are presented in Table 8.19-2.

TABLE 8.19.2-1.(METRIC UNITS)
EMISSION FACTORS FOR STONE CRUSHING OPERATIONS[a]

Emission Factors in kg/Mg of Material Throughput
Ratings (A-E) Follow Each Emission Factor

Source (SCC)	Particulate matter ≤ 30 μm		Particulate matter PM-10	
Primary or secondary crushing[b] (3-05-020-01, -02)	0.14	D	0.0085	D
Primary or secondary crushing with wet suppression[c] (3-05-020-01, -02)	0.009	D	NA	
Tertiary crushing[d] (3-05-020-03)	0.93	E	NA	

TABLE 8.19.2-1.(ENGLISH UNITS)
EMISSION FACTORS FOR STONE CRUSHING OPERATIONS[a]

Emission Factors in lb/ton of Material Throughput
Ratings (A-E) Follow Each Emission Factor

Source (SCC)	Particulate matter ≤ 30 μm		Particulate matter PM-10	
Primary or secondary crushing[b] (3-05-020-01, -02)	0.28	D	0.017	D
Primary or secondary crushing with wet suppression[c] (3-05-020-01, -02)	0.018	D	NA	
Tertiary crushing[d] (3-05-020-03)	1.9	E	NA	

NA = No data available
[a]Based on actual feed rate of raw material entering the particular operation. Emissions will vary by rock type, but available data are insufficient to characterize these phenomena.
[b]References 4 and 5. Typical control efficiencies for cyclone, 70 - 80 percent; fabric filter, 99 percent; wet spray systems, 70 - 90 percent.
[c]References 5 and 6. Refers to crushing of rock either naturally wet or moistened to 1.5 - 4 percent with wet suppression techniques.
[d]Range of values used to calculate emission factor is 0.0008 - 1.38 kg/Mg (0.0016 - 2.76 lb/ton).

TABLE 8.19.2-2.(METRIC UNITS)
EMISSION FACTORS FOR GRANITE PROCESSING OPERATIONS[a]

Emission Factors in kg/Mg of Material Throughput
Ratings (A-E) Follow Each Emission Factor

Source[b] (SCC)	PM-10	
Primary crushing[c] (3-05-020-01)	0.0020	D
Primary crushing with wet suppression[c] (3-05-020-01)	0.00013	D
Secondary screening[d] (3-05-020-02)	0.0085	D
Secondary screening with wet suppression[d] (3-05-020-02)	0.00040	D
Tertiary crushing[e] (3-05-020-03)	0.0042	D
Tertiary crushing with wet suppression[e] (3-05-020-03)	0.00071	D
Tertiary screening[f] (3-05-020-03)	0.036	D
Tertiary screening with wet suppression[f] (3-05-020-03)	0.0011	D

TABLE 8.19.2-2.(ENGLISH UNITS)
EMISSION FACTORS FOR GRANITE PROCESSING OPERATIONS[a]

these can be combined into one table.

Emission Factors in lb/ton of Material Throughput
Ratings (A-E) Follow Each Emission Factor

Source[b] (SCC)	PM-10	
Primary crushing[c] (3-05-020-01)	0.0040	D
Primary crushing with wet suppression[c] (3-05-020-01)	0.00026	D
Secondary screening[d] (3-05-020-02)	0.017	D
Secondary screening with wet suppression[d] (3-05-020-02)	0.00081	D
Tertiary crushing[e] (3-05-020-03)	0.0084	D
Tertiary crushing with wet suppression[e] (3-05-020-03)	0.0014	D
Tertiary screening[f] (3-05-020-03)	0.071	D
Tertiary screening with wet suppression[f] (3-05-020-03)	0.0021	D

[a]Emission factors represent uncontrolled emissions unless noted.
[b]Sources controlled with wet suppression process material with a moisture content $\geq$ 1.5 percent. Uncontrolled sources process material with a moisture content of $<$ 1.5 percent.
[c]Reference 10.
[d]References 8 and 10.
[e]References 9 and 11.
[f]Reference 11.

Emission factor estimates for stone quarry blasting operations are not presented here because of the sparsity and unreliability of available test data. While a procedure for estimating blasting emissions is presented in Section 8.24, Western Surface Coal Mines, that procedure should not be applied to stone quarries because of dissimilarities in blasting techniques, material blasted, and size of blast areas. Milling of fines is not included in this section as this operation is normally associated with nonconstruction aggregate end uses and will be covered elsewhere when information is adequate.

Open dust source (fugitive dust) emission factors for stone quarrying and processing are presented in Table 8.19.2-3. These factors have been determined through tests at various quarries and processing plants. The single-valued open dust emission factors given in Table 8.19.2-2 may be used when no other information exists. Empirically derived emission factor equations presented in Section 11.2 of this document are preferred and should be used when possible. Because these predictive equations allow the adjustment of emission factors for specific source conditions, these equations should be used instead the emission factors in Table 8.19.2-3 whenever emission estimates applicable to specific stone quarrying and processing facility sources are needed. Section 11.2 provides measured properties of crushed limestone, as required for use in the predictive emission factor equations.

TABLE 8.19.2-3.(METRIC UNITS) PARTICULATE MATTER EMISSION FACTORS FOR OPEN DUST SOURCES AT STONE CRUSHING PLANTS[a]

Emission Factors in kg/Mg of Material Through Primary Crusher Except as Noted
Ratings (A-E) Follow Each Emission Factor

Source (SCC)	Particulate matter[b]			
	TSP ≤ 30 μm		PM-10	
Wet quarry drilling: unfractured stone[c] (3-05-020-__)	0.0004	E	4.0×10^{-5}	E
Batch drop truck unloading: fractured stone[c] (3-05-020-__)	0.00017	D	8.0×10^{-6}	D
Truck loading--conveyor: crushed stone[d] (3-05-020-__)	0.00017	E	5.0×10^{-5}	E
Truck loading--front-end loader: crushed stone[e] (3-05-020-__)	0.029	E	NA	E
Conveying--tunnel belt: crushed stone[c] (3-05-020-06)	0.0017	E	0.00011	E
Unpaved haul roads (3-05-020-11)	f		f	
Blasting: quarried stone (3-05-020-09)	g		g	

NA = No data available
[a]Emission factors represent uncontrolled emissions unless noted.
[b]Total suspended particulate (TSP) is that PM measured by a standard high-volume sampler (see Section 11.2). Use of empirical equations in Chapter 11 is preferred to single value factors in this table. Factors in this table are provided for convenience in quick approximations and/or for occasions when equation variables can not be reasonably estimated.
[c]Reference 2.
[d]Reference 3.
[e]Reference 6. Expressed as kg/Mg of material transferred.
[f]See Section 11.2 for empirical equation.
[g]Not presented because of sparsity and unreliability of test data.

TABLE 8.19.2-3.(ENGLISH UNITS) PARTICULATE MATTER EMISSION FACTORS FOR OPEN DUST SOURCES AT STONE CRUSHING PLANTS[a]

Emission Factors in lb/ton of Material Through Primary Crusher Except as Noted
Ratings (A-E) Follow Each Emission Factor

Source (SCC)	Particulate matter[b]			
	TSP $\leq$ 30 μm		PM-10	
Wet quarry drilling: unfractured stone[c] (3-05-020-__)	0.00080	E	0.0001	E
Batch drop truck unloading: fractured stone[c] (3-05-020-__)	0.00030	D	2.0×10^{-5}	D
Truck loading--conveyor: crushed stone[d] (3-05-020-__)	0.00030	E	0.0001	E
Truck loading--front-end loader: crushed stone[e] (3-05-020-__)	0.060	E	NA	E
Conveying--tunnel belt: crushed stone[c] (3-05-020-06)	0.0034	E	0.00020	E
Unpaved haul roads (3-05-020-11)	f		f	
Blasting: quarried stone (3-05-020-09)	g		g	

NA = No data available
[a]Emission factors represent uncontrolled emissions unless noted.
[b]Total suspended particulate (TSP) is that PM measured by a standard high-volume sampler (see Section 11.2). Use of empirical equations in Chapter 11 is preferred to single value factors in this table. Factors in this table are provided for convenience in quick approximations and/or for occasions when equation variables can not be reasonably estimated.
[c]Reference 2.
[d]Reference 3.
[e]Reference 6. Expressed as lb/ton of material transferred.
[f]See Section 11.2 for empirical equation.
[g]Not presented because of sparsity and unreliability of test data.

References for Section 8.19.2

1. Air Pollution Control Techniques for Nonmetallic Minerals Industry, EPA-450/3-82-014, U. S. Environmental Protection Agency, Research Triangle Park, NC, August 1982.

2. P. K. Chalekode et al., Emissions from the Crushed Granite Industry: State of the Art, EPA-600/2-78-021, U. S. Environmental Protection Agency, Washington, DC, February 1978.

3. T. R. Blackwood et al., Source Assessment: Crushed Stone, EPA-600/2-78- 004L, U. S. Environmental Protection Agency, Washington, DC, May 1978.

4. F. Record and W. T. Harnett, Particulate Emission Factors for the Construction Aggregate Industry, Draft Report, GCA-TR-CH-83-02, EPA Contract No. 68-02-3510, GCA Corporation, Chapel Hill, NC, February 1983.

5. Review Emission Data Base and Develop Emission Factors for the Construction Aggregate Industry, Engineering-Science, Inc., Arcadia, CA, September 1984.

6. C. Cowherd, Jr. et al., Development of Emission Factors for Fugitive Dust Sources, EPA-450/3-74-037, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1974.

7. R. Bohn et al., Fugitive Emissions from Integrated Iron and Steel Plants, EPA-600/2-78-050, U. S. Environmental Protection Agency, Washington, DC, March 1978.

8. PM-10 Emission Factors for a Stone Crushing Plant Deister Vibrating Screen, EPA Contract No. 68-D1-0055, Task 2.84, U.S. Environmental Protection Agency, Research Triangle Park, NC, February 1992.

9. PM-10 Emission Factors for a Stone Crushing Plant Tertiary Crusher, EPA Contract No. 68-D1-0055, Task 2.84, U.S. Environmental Protection Agency, Research Triangle Park, NC, February 1992.

10. PM-10 Emission Factors for a Stone Crushing Plant Deister Vibrating Screen and Crusher, National Stone Association, Washington DC, December 1992.

11. PM-10 Emission Factors for a Stone Crushing Plant Tertiary Crusher and Vibrating Screen, EPA Contract No. 68-D0-0122, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1992.

MARTIN MARIETTA

FAX COVER SHEET

MARTIN
MARIETTA
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NAME Brian Shrager

COMPANY Midwest Research

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FROM Horace Willson

DEPARTMENT Environmental Services

DESCRIPTION:

Silica Analysis for Garner and Raleigh Plants.

Horace

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WILL CALL BACK ASAP 8/2/93

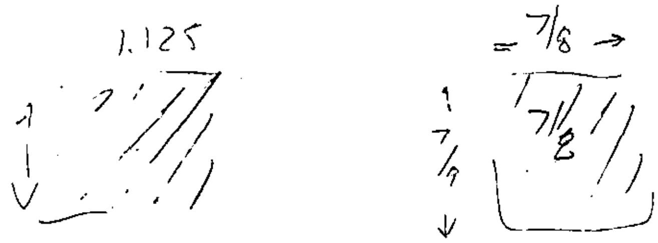
Ref. 2. Martin Marietta, Garner.

Size of stone to crusher? 4 in. 400
Size of stone from crusher?
Can we get a copy of the sieve analysis?

Ref. 3. Skippers, Va. No questions.

Ref. 4. Nello Teer, Raleigh

Mesh size of screen? Fines screen?
Size of stone to crusher? Fines crusher? ½ in. 63 TPH
Size of stone from crusher?
Can we get a copy of the sieve analysis?



Ca. 8/18/93
Garner
1560
to crusher 3½ to 4 in
discharge 1" and smaller

Teer
feed 1" to 3/4"
discharge ≤ 3/16"
top deck 7/8"
middle 9/16"
bottom 3/16" 1-inch slots

MARTIN MARIETTA

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FROM Horace Willson

DEPARTMENT Environmental Services

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Mr. Myers

These are my comments relative to the Section 8.19.2 draft. I will be hand delivering comments from NSA, etc. on Monday 4/25

Horace

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MARTIN MARIETTA AGGREGATES

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April 22, 1994

Mr. Ronald E. Myers
EPA/EIB/EFMS (MD-14)
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Subject: Emission Factors
Section 8.19.2 - Crushed Stone Processing

Dear Mr. Myers:

We appreciate the time you and Mr. James Southerland took to meet with us on April 13, 1994 to review the latest draft of Section 8.19.2.

As you know, we have been working very closely with EPA and Entropy Environmentalist, Inc. since the middle of 1991 to develop numbers that would better reflect the emissions from our industry. This has been accomplished by the Entropy testing program which covered seven different crushed stone operations located in North Carolina, Virginia and Tennessee. Industry members were present during a majority of the testing at all seven locations.

We feel that the PM10 results from these studies are the best numbers by far for the crushed stone industry. We were glad to see that these numbers, with minor changes, have found their way into table 8.19.2-1. We are, however, surprised to see another column of numbers noted as Filterable PM. As you may recall, we had not seen this term or the numbers before our 9:00 a.m. meeting. This last minute addition has created a major concern with our industry.

It appears from your comments that this filterable PM number includes all of the material captured by the testing device, suspended or otherwise, and that this column could be used to represent TSP numbers. If this is the case, we feel that the publishing of this table will create more controversy than has ever been experienced in the past.

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We have major problems with the Filterable PM column as noted in the following comments:

- How can it be explained that the difference between Filterable PM (FPM) and PM10 for dry screens is by a factor of 10, that for crushing is by a factor of 15, and that for conveying is by a factor of 25. This is the same type of dust. How can it be so different between pieces of equipment?

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- AP42, by definition, states that "total suspended particulates (TSP) is that measured by a standard high volume sampler." Entropy was not instructed to determine FPM as an emission factor. According to Dr. John Richards, Entropy would not be able to certify these FPM numbers as representing dependable data. The data was not obtained using EPA reference methods and the procedure used by EPA to calculate the emission from 201A data has not been studied. Dr. Richards will be responding to this issue in more detail later.

- In all of the documents we have seen relative to this testing program, the work assignment issued to Entropy Environmentalist, Inc. was to "conduct a set of emission tests at several stone crushing plants to determine the PM10 emission factor." In addition, during the many meetings with Dennis Shipmen and Solomon Ricks, the only factor refereed to was PM10. FPM has never been mentioned throughout this entire testing program.

  We are requesting that you please reconsider including FPM in the new draft table. We need a single conversion relationship between PM10 and TSP. We feel that this is very necessary since many states are still asking for TSP numbers. It would be very helpful if we could total up the PM10 figures for the plant emissions and then multiply this total by one TSP conversion number.

  Another concern with the new table is the ratings. MRI's report states that the testing methods used during this entire project received an "A" rating for data, but a "D" rating overall due to the testing of only a few plants. Based on our understanding of crushed stone plants, we feel that the results collected thus far could be duplicated at any number of additional plants. This testing series deserves at least a "B" rating. We are concerned that the "D" rating will cause some agencies to insist on using the old numbers since the ratings are the same.

In summary, we are fearful of the FPM numbers showing up in the same table as the PM10 numbers. Please consider deleting this column from the table. We will be glad to meet with you again to discuss this matter in more detail. Please give me a call here in Raleigh at 783-4631 if you have any questions regarding the above comments or to arrange an additional meeting.

Respectfully submitted,

Horace Willson

Horace Willson
Manager
Environmental Services

HSW/bp

cc: James Southerland
Dennis Shipmen
Bill Ford
Fred Allen

U:\evs\hw\myers.epa

Vulcan
Materials Company

April 25, 1994

Mr. Ronald E. Myers
Emission Factors and Methodologies Section
Emission Inventory Branch
Office of Air Quality Planning and Standards (MD-14)
United States Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Post-it™ brand fax transmittal memo 7671	# of pages ▸ 1
To Ronald E Myers	From Allen Blake
Co. EPA	Co. Vulcan Materials
Dept. Emissions Investig	Phone # 615-579-2938
Fax # 919-541-0684	Fax # 615-579-2948

Dear Mr. Myers:

I appreciate this opportunity to communicate with you on this topic of great importance to our industry. We must strive for scientific and accurate information where environmental regulation is concerned. The time for usage of pre or ill-conceived information is past. The present NSA-EPA project for accurately determining emission factors should be replicated for all industry to work cooperatively with EPA, cost effectively maximizing the information base for environmental projects.

As a member of the NSA AP-42 Task group, I am familiar with the correspondence from Mr. William Ford, P.E. who is Vice President Environmental Programs of the NSA. I will state that I am in complete agreement with all the points he discussed in his letter, as I am sure it is truly a representative response for all members of our association. As one who daily interacts with state and local regulators, I am particularly going to expand on the discussion of the inclusion of unnecessary filterable PM emission factors in Table 8.19.2-1. At first, the inclusion of this information confused me and I have been closely observing this project for several years. The opportunities for misuse of this information is enormous, being that I know of no appropriate regulatory use for this information. The use of the filterable PM information is not apparent to me and I am justifiably concerned that its inclusion is detrimental to the useability of the AP-42 document.

The quality of the information generated is obviously greater than the "D" rating as given the collective project. Most probably the improper inclusion of the California dry sand and gravel operation data is responsible for this. I am not in favor of diluting the properly designed testing program of crusher stone plants with this outside information and thereby reducing the effect of the scientific procedures used. Great care was used to properly represent the industry with the input of EPA and NSA. I can not imagine a more thoughtfully designed project with input from a more diverse cross section of regulators and industry than this project. I would therefore recommend a "B" rating for the AP-42 factors as representative of the industry.

Again, I would like to extent my congratulations on an excellent research project and my thanks for the opportunity to have a positive impact on the correct usage of AP-42, a very vital information source.

Sincerely Yours,

Allen Blake, P.E.

cc. Dennis Shipman
Jim Southerland

nsa **National Stone Association**

1415 Elliot Place, N.W., Washington, D.C. 20007-2599 202/342-1100

TO : **Ron Myers**	
FAX # : **919/541-0684**	
COMPANY : **U.S. EPA/OAQPS/EIB/EFMS (MD-14)**	
FROM : **Bill Ford**	
DATE : **April 28, 1994**	
TOTAL PAGES :	**(including cover sheet)**
We transmit from 202-342-0702. If you do not receive the pages clearly, call me at 800-342-1415 or locally at 202-342-1100.	

I will be in Raleigh on Friday. Horace Willson and I would like to drop by and visit with you and Jim Southerland for a few minutes Friday afternoon if your schedules permit. There are a few things we would like to touch base on:

o We now have some cost estimates for the additional parameters we discussed earlier and would like to share that with you.

o Have we furnished everything you need in the way of comments on the draft AP-42 Section?

o Will we be able to hit the May 1 deadline for the October revision of AP-42?

Please call Christine Saunderson at 800/342-1415 and let her know if we can droip by for a few minutes.

Thanks.

The Ohio Aggregates Association

ROBERT A. WILKINSON
Managing Director

20 SOUTH FRONT STREET, SUITE 200
COLUMBUS, OHIO 43215

TELEPHONE
AREA CODE 614
224-2717

April 25, 1994

Mr. Ronald E. Myers
Emission Factors and Methodologies Section
Emission Inventory Branch
Office of Air Quality Planning & Standards (MD-14)
United States Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Fax #: (919) 541-0684

Dear Mr. Myers:

We have had a chance to review the draft AP-42 Section 8.19.2 Crushed Stone Processing report. We would like to complement EPA and NSA on the work that went into producing this document.

The Ohio Aggregates Association only has two suggestions towards making this a more usable reference:

1) We feel the reference to Filterable PM should be removed. It appears to us these factors just add confusion to those using the document.

2) A note or explanation that an estimate of TSP(PM_{30}) can be obtained by multiplying the new PM_{10} value by 2.2. Ohio EPA has a lot of TSP data, but not much PM_{10} data on our type operations. A suggested conversion factor would help both the regulated community and the regulators.

We appreciate the opportunity to review and comment on AP-42 draft.

Sincerely,

Robert A. Wilkinson, P.E.
Managing Director
OHIO AGGREGATES ASSOCIATION

Ohio Aggregates Association

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VAA

VIRGINIA AGGREGATES ASSOCIATION

Ross E. Jeffries
President
B. Scott White
Vice-President

Thomas E. Carroll
Executive Director

BY FACSIMILE

April 25, 1994

Mr. Ronald E. Myers
Emission Factors and Methodologies Section
Emission Inventory Branch
Office of Air Quality Planning and Standards (MD-14)
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

RE: Draft AP-42 Section 8.19.2

Dear Mr. Myers:

I am writing in response to the recently released draft AP-42 SECTION 8.19.2 CRUSHED STONE PROCESSING and the corresponding background report. The Virginia Aggregates Association (VAA) is a state-based trade association whose members account for over 80 percent of the total annual non-fuel mineral production in Virginia. Virginia has consistently been ranked in the top ten nationally in total annual crushed stone production. On behalf of the VAA member companies I appreciate the opportunity to comment on the above referenced draft.

First, let me note that I have reviewed National Stone Association's (NSA) letter to you of April 22, 1994 and fully support the comments contained therein. For brevity, I will not repeat the entire body of Mr. Ford's letter. However, there are a number of critical points in his correspondence which are worthy of specific emphasis. They are:

> 1) **Filterable PM emission factors should not be included in this edition of AP-42.** PM_{10} is the criteria pollutant for particulate matter and AP-42 should not include emission factors for other pollutants. According to the MRI background document "Method 102A is not the reference test method for quantifying filterable PM emissions,...." I fail to see justification in including such questionable data in the results of a three year test program that used standard testing procedures to develop more accurate data on a specific pollutant (i.e. PM_{10}). Including filterable PM factors will only lead to confusion within both the regulatory and regulated community.

1904 Byrd Avenue - Suite 111 - Richmond, Virginia 23230
Phone (804) 282-9401 Facsimile (804) 282-8134

2) **The "D" ratings given to the PM_{10} emission factors are much too low.** In review of Section 5.3 of EPA's October 1993 manual, Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections there does not appear to be a basis for such low emission factor ratings. The individual test are all "A" rated.

For many months, the VAA has been working with our state air regulatory agency to encourage their early adoption of the new emission factors. A very compelling reason for this action is the quality of the new data compared to the old data. By EPA adopting an unreasonably low rating for the new emission factors what impetus is there for any state agency to use these new factors? Considerable time, money and effort went into the testing program by both EPA and industry. I would hope this collaborative effort was not in vain.

VAA appreciates the opportunity to comment on the proposed draft AP-42 section. Should you have any questions regarding the issues raised please do not hesitate to contact me directly.

Very truly yours,

Thomas E. Carroll
Executive Director

TEC/amd

cc: Jim Southerland (EPA)
Dennis Shipman (EPA)
William Ford (NSA)

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nsa National Stone Association

1415 Elliot Place, N.W. • Washington, D.C. 20007-2599 • 202/342-1100

April 22, 1994

Mr. Ronald E. Myers
Emission Factors and Methodologies Section
Emission Inventory Branch
Office of Air Quality Planning and Standards (MD-14)
United States Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Dear Mr. Myers:

Thank you for your recent letter and the enclosed copy of the draft AP-42 SECTION 8.19.2 *CRUSHED STONE PROCESSING and the corresponding background report for the section.* The National Stone Association (NSA), as the national trade association representing the many interests of the crushed stone industry, and whose over 500 members account for approximately 80 percent of the annual United States production of crushed stone, appreciates the opportunity to review and comment on the draft section.

NSA has also appreciated the opportunity to work with EPA over the last three years in the cooperative project to develop high-quality, accurate measurements of PM_{10} emissions from crushed stone operations. We believe the project has been extremely successful and has made a positive contribution to the nation's scientific database on air emissions.

While the draft AP-42 Section 8.19.2 is generally satisfactory, we have comments on four areas and some minor clean-up suggestions. Our comments and suggestions follow.

Process Description

The following changes should be made to Section 8.19.2.1 **Process Description.** Strikeouts indicate text which should be removed and underlining indicates suggested additional text:

- o Paragraph 3, line 4: Jaw, <u>impactor</u>~~,~~ or gyratory crushers....
- o Paragraph 3, line 7: ...a surge pile for temporary storage~~.~~ <u>or sold as coarse aggregates.</u>
- o Paragraph 5, line 1: Tertiary crushing is usually performed using cone crushers or ~~hammermills~~ <u>other types of impactor crushers</u>.
- o Paragraph 5, line 5: ...product bins or to open area stockpiles~~.~~<u>, or to other processing systems, such as washing, air separators, screens and classifiers for the production of manufactured sand</u>.
- o Paragraph 6: This paragraph should be deleted.

75th ANNIVERSARY nsa 1918-1993

Filterable PM
PM should be defined as particulate matter that includes only those particles with an aerodynamic diameter less than or equal to a nominal ten micrometers.

Filterable PM emission factors should not be included in this edition of AP-42. Including Filterable PM emission factors is misleading and will lead to confusion.

- The National Ambient Air Quality Standard is now PM_{10}. It has been PM_{10} for more than six years. According to 40 CFR 50.6 (c), "For the purpose of determining attainment of the primary and secondary standards, particulate matter shall be measured in the ambient air as PM_{10} (particles with an aerodynamic diameter less than or equal to *a nominal 10 micrometers)* by...".

- Since PM_{10} is now the criteria pollutant, there is no reason to include emission factors for Filterable PM in AP-42. To do so only creates confusion among the users of the document and lessens the credibility of AP-42.

- The only potential argument for considering Filterable PM might fall under NSPS Subpart OOO, which includes a standard of 0.05 g/dscm particulate matter, which ties back to the particulate measured by Method 5 or Method 17. Had EPA revised and updated the NSPS rule in a timely manner as required by law, that standard would not remain as it is. Further, the NSPS rule requires that a measurement be made. Compliance cannot be determined using an emission factor. Finally, information we have received from members around the country calculating emissions using the new data indicates that most, if not all, plants will fall under the 100 ton limit set out in Title V of the Clean Air Act Amendments.

  In short, even the outdated NSPS rule does not support the argument for including Filterable PM in the new AP-42 section. In addition, Subpart OOO should be re-promulgated in terms of PM_{10}.

- The new operating permit fee program under Title V of the Clean Air Act Amendments of 1990 is intended to generate revenue for states to use to operate their air pollution control programs. It provides an incentive for states to use the largest numbers available as the basis for their fee programs. As the draft section is currently written, there will be an inclination for the states to use the numbers for Filterable PM, which are larger than the numbers for PM_{10}.

- Filterable PM represents <u>all</u> particulates caught by the filter, including the big stuff. As noted under 8.19.2.2 Emissions and Controls, "A substantial portion of these emissions consists of heavy particles that may settle out within the plant." TSP, as it has been used by the states up to now, and as shown in Table 8.19.2-1 in the current version of AP-42, is PM_{30}. There is a difference between the two parameters. Unless states using Filterable PM as a substitute for TSP_{30} go through the public rule-making process and promulgate new rules based on Filterable PM, *they will be regulating a different* parameter without the benefit of public input.

- o The background document from MRI notes on pages 9 - 12, in reference citations 3 - 8, that "Method 201A is not the reference test method for quantifying filterable PM emissions,...". The author goes on to say that "the preseperator and filter catch for the method *should* provide *representative* results for filterable PM" (emphasis added). We believe this is a poor approach and does not represent good science. If Filterable PM values are to be included, they should be measured using the reference test method.

  Including the Filterable PM emission factors in Table 8.19.2-1 in a column adjacent to the PM_{10} emission factors based on high quality, "A" rated data creates the impression that the Filterable PM emission factors are of equal quality to the PM_{10} emission factors. They were not measured using the reference test method and they are not of equal quality.

- o We have been working cooperatively with EPA on the test program for three years. Until our meeting with you and Jim Southerland on April 13, 1994, no mention has been made of Filterable PM. If there is evidence that Filterable PM will become a criteria pollutant in the next few years, subsequent testing should be designed to gather high quality data to serve as the basis for eventual Filterable PM emission factors. Adding Filterable PM at this point as an apparent afterthought, without an opportunity to build it into the testing program, is bad science and bad policy.

  We recommend deleting Filterable PM from this edition of AP-42. If the Agency is moving in the direction of rule-making involving Filterable PM, we should incorporate it into our testing program and begin developing sound data for future use.

If there is interest in providing guidance on total particulates, at least as an interim measure, we suggest an approach based on the particle size multipliers in the current edition of AP-42. A note could be added to the new section advising that an estimate of TSP (PM_{30}) can be obtained by multiplying the new PM_{10} values by 2.2 (The average of the particle size multipliers in Section 11.2.1 and Section 11.2.3 of the current AP-42). This would give the states a way to estimate PM_{30} and may help keep them from having to re-promulgate rules because the definition of TSP has changed.

Unrepresentative Data

Data from several tests which are not representative of typical stone crushing plants have been included and should be removed. The data from Reference 10 was part of the data set for screening operations. This data was from Engineering-Science tests of horizontal screens at two dry sand and gravel operations in California, not stone crushing operations, and should be deleted from the stone crushing section of AP-42.

Emission Factor Ratings

NSA disagrees with the "D" ratings given to the PM_{10} emission factors. This is not consistent with the criteria specified on page 28 of *Technical Procedures for Developing AP-42 emission Factors and Preparing AP-42 Sections*. The "D" ratings apply to data sets which have the following characteristics:

- o Based on A and B rated test data
- o "...reason to suspect that these facilities do not represent a random sample of the industry."
- o Evidence of variability within the source population.

With the exception of the Engineering-Science tests of sand and gravel plants (which do not belong in this data set) all of the tests have been "A" rated. There are no "B" rated tests.

While not spelled out in the test reports, Entropy, NSA and EPA made a very determined effort to find plants that were representative. Entropy, NSA and EPA personnel visited a large number of facilities in North Carolina, Virginia, Tennessee and Maryland. A significant pre-survey was also conducted prior to the tests in North Carolina and Virginia. Throughout the three year test program there has not been an attempt to find the best or worst facilities for emission testing.

The emission factor tests at the various plants tested exhibited surprisingly little variability. There is no valid reason to discredit the data with a "D" rating.

The "B" rating appears to be very consistent with the stone crushing emission factor data set (References 3 - 8). All of these tests are "A" rated, the tests were conducted at a number of different facilities representative of the overall industry and the data are sufficiently precise.

By not using EPA's published criteria and by adopting a very low rating for the new emission factors, EPA is discrediting the data developed jointly by its own Emission Inventory Branch and NSA. State regulatory agencies could very easily dismiss the new data (which has been obtained at considerable cost and effort) as no better than the earlier versions of AP-42 emission factors. The "D" rating is inappropriate and serves as a disincentive to future joint efforts involving EPA and private organizations.

The new emission factors for crushing, screening and transfer points should receive at least a "B" rating.

<u>Miscellaneous</u>

PM-10 should be written PM_{10}.

Paragraph 1 of Section 8.19.2.2 Emissions and Controls should be modified as follows (line 6): ...re-entrainment of settled dust by wind or machine movement. <u>All processing emissions except baghouses or enclosed buildings with a forced air vent or stack should be considered fugitive emissions.</u> Factors affecting emissions...

Fines crushing in Table 8.19.2-1 should be defined to prevent confusion.

With regard to the background report, line 10 of I. INTRODUCTION should be revised as follows: ...and industry practices; ~~a complete revision of the AP-42 section will not be performed until the ongoing test program for the stone crushing source category is completed.~~ This appears to be hold-over language from last year's draft. We have now finished the test program for crushers, screens and transfer points.

On page 15 of the background document, in paragraph 1 under III. RESULTS OF DATA ANALYSIS, the statement is made that the emission factors for tertiary crushing can be used as an upper limit for secondary crushing. Since footnote f of Table 8.19.2-1 notes that emission factors for tertiary crushing can be used as an upper limit for both primary and secondary crushing, this paragraph should be corrected to include primary crushing so that it corresponds with the table.

There are several rounding errors:

Fines crushing (3-05-020-05) - 0.01446 rounds to 0.014, not 0.015.

Fines screening (3-05-020) - 0.07041 rounds to 0.070, not 0.071.

Transfer point with wet suppression (3-05-020-06) - rounds to 0.000046, not 0.000048.

And two typos:

Fines screening with wet suppression (3-05-020) - should be 0.00184, not 0.0021.

Truck loading-conveyor: crushed stone (3-05-020-32) - should be 0.00010, not 0.0010. The metric version needs to be checked also.

In summary, NSA requests that the following changes be made to the draft AP-42 SECTION 8.19.2 CRUSHED STONE PROCESSING:

1. The process description should be changed as indicated to make it accurate.

2. The emission factors for Filterable PM should be removed from the document.

3. A note that TSP can be estimated by multiplying the PM_{10} values by 2.2 should be added to give state regulators guidance on TSP values.

4. The emission factor ratings based on the new test data should be changed to "B".

5. The miscellaneous changes as noted should be made.

NSA appreciates the opportunity to comment on the proposed draft AP-42 section. We look forward to continuing to work cooperatively with EPA in developing other high-quality additions to the air emissions database in the future.

Sincerely,

William C. Ford, P.E.
Vice President Environmental Programs

cc: Jim Southerland
Dennis Shipman

MARTIN MARIETTA AGGREGATES

POST OFFICE BOX 30013
RALEIGH, NORTH CAROLINA 27622-0013
TELEPHONE (919) 781-4550

April 22, 1994

Mr. Ronald E. Myers
EPA/EIB/EFMS (MD-14)
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Subject: Emission Factors
Section 8.19.2 - Crushed Stone Processing

Dear Mr. Myers:

We appreciate the time you and Mr. James Southerland took to meet with us on April 13, 1994 to review the latest draft of Section 8.19.2.

As you know, we have been working very closely with EPA and Entropy Environmentalist, Inc. since the middle of 1991 to develop numbers that would better reflect the emissions from our industry. This has been accomplished by the Entropy testing program which covered seven different crushed stone operations located in North Carolina, Virginia and Tennessee. Industry members were present during a majority of the testing at all seven locations.

We feel that the PM10 results from these studies are the best numbers by far for the crushed stone industry. We were glad to see that these numbers, with minor changes, have found their way into table 8.19.2-1. We are, however, surprised to see another column of numbers noted as <u>Filterable PM</u>. As you may recall, we had not seen this term or the numbers before our 9:00 a.m. meeting. This last minute addition has created a major concern with our industry.

It appears from your comments that this filterable PM number includes <u>all</u> of the material captured by the testing device, suspended or otherwise, and that this column could be used to represent TSP numbers. If this is the case, we feel that the publishing of this table will create more controversy than has ever been experienced in the past.

We were hoping that a conversion from PM10 to TSP could be accomplished by using <u>one</u> standard conversion number. Such a number currently exists by using the particle size multiplier found in Section 11.2.1 and Section 11.2.3 of AP-42. If the particle size multipliers of each section are averaged, a ratio of 2.2 TSP to 1 PM10 is found. A standard conversion number such as this would not create the controversy that is expected from the new draft.

We have major problems with the Filterable PM column as noted in the following comments:

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- AP42, by definition, states that "total suspended particulates (TSP) is that measured by a standard high volume sampler." Entropy was not instructed to determine FPM as an emission factor. According to Dr. John Richards, Entropy would not be able to certify these FPM numbers as representing dependable data. The data was not obtained using EPA reference methods and the procedure used by EPA to calculate the emission from 201A data has not been studied. Dr. Richards will be responding to this issue in more detail later.

- In all of the documents we have seen relative to this testing program, the work assignment issued to Entropy Environmentalist, Inc. was to "conduct a set of emission tests at several stone crushing plants to determine the PM10 emission factor." In addition, during the many meetings with Dennis Shipmen and Solomon Ricks, the only factor refereed to was PM10. FPM has never been mentioned throughout this entire testing program.

  We are requesting that you please reconsider including FPM in the new draft table. We need a single conversion relationship between PM10 and TSP. We feel that this is very necessary since many states are still asking for TSP numbers. It would be very helpful if we could total up the PM10 figures for the plant emissions and then multiply this total by one TSP conversion number.

  Another concern with the new table is the ratings. MRI's report states that the testing methods used during this entire project received an "A" rating for data, but a "D" rating overall due to the testing of only a few plants. Based on our understanding of crushed stone plants, we feel that the results collected thus far could be duplicated at any number of additional plants. This testing series deserves at least a "B" rating. We are concerned that the "D" rating will cause some agencies to insist on using the old numbers since the ratings are the same.

In summary, we are fearful of the FPM numbers showing up in the same table as the PM10 numbers. Please consider deleting this column from the table. We will be glad to meet with you again to discuss this matter in more detail. Please give me a call here in Raleigh at 783-4631 if you have any questions regarding the above comments or to arrange an additional meeting.

Respectfully submitted,

Horace Willson

Horace Willson
Manager
Environmental Services

HSW/bp

cc: James Southerland
Dennis Shipmen
Bill Ford
Fred Allen

Myers

nsa National Stone Association

1415 Elliot Place, N.W., Washington, D.C. 20007-2599 202/342-1100

TO : Henry Thomas	
FAX # : 919/541-2357	
COMPANY : U.S. EPA OAQPS	
FROM : Bill Ford	
DATE : May 19, 1995	
TOTAL PAGES :	(including cover sheet)
We transmit from 202-342-0702. If you do not receive the pages clearly, call me at 800-342-1415 or locally at 202-342-1100.	

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL	# of pages ▶ 6
To Brian Schrager	From Ron Myers
Dept./Agency MRI / Cary	Phone # 541-5407
Fax #	Fax #
NSN 7540-01-317-7368 5099-101	GENERAL SERVICES ADMINISTRATION

nsa **National Stone Association**

1415 Elliot Place, N.W. • Washington, D.C. 20007-2599 • 202/342-1100

May 19, 1995

By Fax

Mr. Henry Thomas, Deputy Director
Emissions, Monitoring and Analysis Division
Office of Air Quality Planning and Standards (MD-14)
United States Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Dear Henry:

Ms. Judy Blanchard, Deputy Director of the House Committee on Government Reform and Oversight, participated in NSA's Environmental Committee meeting Tuesday, May 16 which was held in Washington in conjunction with our annual Government Affairs Conference.

The Environmental Committee discussed the problems we have had with both AP-42 and NSPS Subpart OOO at length with Ms. Blanchard. Congressman William F. Clinger, Jr., Chairman of the House Government Reform and Oversight Committee, used input from NSA's Environmental Committee in his speech on H.R. 450, The Regulatory Transition Act of 1995, on the House floor. A copy of Congressman Clinger's speech is enclosed for your information. NSA's Environmental Committee is the "group of small businessmen..." mentioned at the bottom of the second page of the speech.

On another matter, we are still awaiting a response from EPA on the haul road test plan. As you know, we want to be sure we are both in agreement on the project before we proceed and commit the considerable sum of money, time and in-kind contributions from the plants involved in the testing.

Two additional items need to be addressed by EPA before we proceed. Test data for the crushers, screens and transfer points, which were used as the basis for the emission factors in the new fifth edition of AP-42, showed insignificant differences between emissions from plants processing granite and plants processing limestone. Accordingly, EPA made the decision to develop a single emission factor for the process, regardless of the type of stone being processed. This has worked well in practice. However, before proceeding with the haul road tests, we want EPA's assurance that tests made on granite will suffice for developing general haul road emission factors.

Finally, EPA staff has suggested incorporating a tracer gas into the study. While we do not believe this is necessary, this matter needs to be resolved before the study proceeds. EPA staff have indicated that Midwest Research Institute may not accept the results of the haul road test without the tracer gas. We respectfully wish to point out that EPA is responsible for establishing policy, not the Agency's consultants.

Your assistance in resolving these questions so we can get the emissions testing done will be most appreciated.

Sincerely,

Bill

William C. Ford, P.E.
Vice President, Environmental Programs

cc: Judy Blanchard
Mary Nichols
Karen Brown

ONE HUNDRED FOURTH CONGRESS

Congress of the United States

House of Representatives

COMMITTEE ON GOVERNMENT REFORM AND OVERSIGHT

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WASHINGTON, DC 20515-6143

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Statement of the Honorable William F. Clinger, Jr.
May 17, 1995

H.R.450/S.219
"The Regulatory Transition Act of 1995"

Mr. Speaker,

As part of the "Contract with America", the House passed overwhelmingly in a bipartisan fashion H.R. 450, "The Regulatory Transition Act of 1995", which imposes a temporary moratorium on the issuance of regulations. It provides a very necessary time out on the promulgation and implementation of regulations while Congress is in the process of deliberating long overdue regulatory reforms.

I think it would be helpful to review the bidding for a moment. After two full days of debate on the House floor and numerous amendments, the final vote was 276-146. The House passed this bill on February 24, 1995, and sent it to the Senate two days later. One month later the Senate passed their version of the moratorium -- which is frankly hard to characterize as a regulatory moratorium. It sets up a Congressional review process. It is VERY different than the House version.

The House bill is a good piece of legislation that was crafted to ensure that the health and safety of our citizens is protected while at the same time providing a necessary time out from the burdens of regulation – a time for review and reflection while we pass major regulatory reform. Both Congressmen Tom Delay and David McIntosh authored H.R. 450 to provide this short term moratorium to allow Congress and the Administration to review regulations on the books and whether they meet cost benefit criteria – and more importantly, whether they make sense.

During hearings and debate on this bill we've heard story after story about regulatory overkill. Many regulations are unnecessary, duplicative or conflicting. How many small businesses do we want to put OUT OF BUSINESS before we pass reforms?

Just yesterday, we heard from a group of small businessmen that again underscored this point. Regulations promulgated under the Clean Air Act require that this industry obtain a permit from the EPA or State EPA for each piece of new equipment that they buy or install for their plant, rather than being allowed to have a single permit for that plant. This is like inspecting a car and rather than requiring a single inspection you have to get a separate inspection for the doors, the windshield, the brakes, the trunk, and the list goes on and on. These businessmen want to protect the environment, but find themselves using enough paper to plant a new forest – with little or no environmental benefits gained. For each facility, 300-400 pages of paper have to be generated to meet both the EPA and State requirements – which are often duplicative and conflicting. I am told that it took a 150 page manual just to explain the regulation.

Mr. Speaker, H.R. 450 is a good bill. We can not afford as a society to continue down the road we are marching. This bill provides us an opportunity for a time out to review regulations. It is my sincere hope that after all this effort we would be able to craft a reasonable compromise with the Senate. Some assumed that we would pass the Senate version of the bill. That simply is not going to happen.

I urge my colleagues to support this motion and hope that the Senate will see fit to move this bill forward to conference in an expedited fashion. It is a bill that does not belong in Congress - it belongs on the President's desk.

William C. Ford, P.E.
Vice-President Environmental Programs
National Stone Association
1415 Elliot Place, NW
Washington, DC 20007-2599

Dear Mr. Ford:

I have reviewed the May 8, 1995 test plan proposal entitled "Determination of PM-10 Emission Factors for a Quarry Haul Road for a Stone Crushing Plant" prepared by John Richards, PhD., P.E. and Todd Brozell of Air Control Techniques, P.C. for the National Stone Association. Other EPA staff which have assisted in this review include Roy Huntley and Solomon Ricks. In the review of this test plan the primary criteria used is to recommend the use of established testing procedures that will collect particulate emission information to satisfy our immediate mutual needs and also satisfy potential future needs that can be identified. In addition, I have included recommendations that will satisfy the needs of other air pollution users where that can be satisfied for minimal expenditure of resources.

I would first like to apologize for the time that it has taken to provide you with a review of the test plan. I would also like to apologize for what may seem like a change in the direction that it seems that we are recommending be taken in the testing of these fugitive emission sources. However, I would prefer that the information collected be of comparable quality to the information that the Agency has used to establish the existing emission factors for unpaved roads and other fugitive sources. I do not hesitate to use novel sampling methods when there are not established protocols or when the protocols that have been established have serious flaws. However, whenever there are established protocols, those should be preferred and if there is some reason that they are not preferred then additional procedures should be incorporated in the test plan to allow valid comparisons of the collected data with the standard methodologies.

It appears that the air flow of the fans is sufficient to provide a capture hood face velocity of only about 60 ft/minute. This is significantly lower that the desired face velocity for this system of 150 ft/min and the stated capture velocity of 130 ft/min. It is recommended that the fan size be increased to more closely achieve the desired face velocity of the hooding system. As a quality control check of this face velocity, it is recommended that velocity measurements at the face of the hood be made and included in the test report. The air flow provided by the fans used to push the air at the upwind locations are not indicated. The upwind air flow should meet the following criteria:

$$Q_1 = \frac{1}{D \; X \; E} \; X \; Q_2$$

Where Q_1 is the upwind airflow, Q_2 is the airflow of the capture hood system, D is the throw length distance (between the fans and the hood) and E is an entrainment factor which is 0.7 for throw lengths in excess of 24 feet. As a quality control check the air flows from the upwind fans should be verified and included in the test report. As suggested by Dr. John Richards in our meeting of April 27, a flange should be used to extend the effective capture height of the hood system. Although the flange height will be limited by structural considerations, it is believed that a height of more than 14 ft would not be beneficial. This is based upon an estimated velocity toward the hood system at the highest point be at least 10% of the average capture velocity of the hood (reference ACGIH Industrial Ventilation, A Manual of Recommended Practice). I have attached the relevant pages from the ACGIH manual for the above calculations.

As you may be aware, the method that has historically been used to quantify emissions from unpaved and paved roads is a profiling tower to quantify total particulate and to obtain particle size distributions. See the attached pages from the Southern Research Institute "Critical Review of Open Source Particulate Emission Measurements" and the Emission Measurements Laboratory study "Review of Methods for Measuring Fugitive PM-10 Emission Rates". The historical methodology has incorporated preferred sampling heights for total particulate mass at 1.5, 2.5, 4.0, 6.0, 7.5 and 10 meters using isokinetic samplers because significant exposures have been documented up to 9 meters. In addition, concurrent particle sizing devices are included in the profiling tower at 1.5, 4.5, and 7.0 meters. This historical sampling methodology has documented maximum exposure values at between 1.5 and 2 meters. This is the methodology that has been used to quantify emissions for the data base supporting the unpaved roads emission factor. The test procedure recommended by Air Control Techniques, P.C. differs substantially from the established methodology that has received critical review and provides good results. The most significant differences and their estimated effects are 1) that because the highest sampling height of the hood system is only 4.2 meters (14 feet), only approximately 50% of the effective area of emissions are captured, and 2) that because the sampling is not being conducted isokinetically, the area where the maximum exposure values have been historically measured may be over sampled. The comparison of results from different tests using the same measurement method is difficult enough. The introduction of a sampling method that has not undergone critical review or a comparison with the established methodology complicates any comparison further.

However, this method does appear to offer advantages with respect to decreased reliance on ambient wind conditions, relative wind directions to the road segment being tested, avoidance of interfering sources of particulate emissions and physical constraints at typical stone quarries that may be selected for performing the test program. It is believed that the obstacles to using the procedure recommended could be overcome by incorporating the use of gas tracer measurements into the QA/QC procedures of the test program. By using the quantitative release of an inert, non-toxic, stable gas to quantify the over/under sampling of the particulate (primarily that particulate smaller than 10 μ meter), the usefulness of the emissions quantified during this test program would be improved to the level of the measurements that have been made for unpaved road emissions factors using the established methodologies. It is recommended that the tracer gas be released from the lower portion of the haul trucks so as to represent not only the dust entrained within the capture area of the hood system but also to represent the dust entrained and carried into the capture area of the hood system by the truck. A study by Russell G. Frankel on the accuracy of Gas Tracer Measurements of Fugitive Dust Emissions is attached.

In section 2.2, there is a statement that the standard operating procedures for Method 201a will be followed. However, later a statement that single point measurements will be made since the hood sampling systems will serve as a mixing chamber for the swirling emissions from the haul road. The standard operating procedures for Method 201a involve a full traverse even when emissions are fully mixed and sampling location criteria have been met. It is recommended that a full traverse be performed using two ports (one at the top of the duct and one 90° off of vertical. In addition, this section indicates that the standard Method 201a procedures will be modified at the request of the U.S. EPA in order to measure total filterable particulate. No modifications of the sampling train are required in order to measure the filterable particulate collected in the cyclone. The gas flow disturbance from large diameter cyclone are not significant when the duct diameters are as large as are proposed for this test. It is also recommended that the emission testers plan to achieve isokinetics within ±10%.

In section 2.3.2, there is a procedure for sampling and analyzing the road material. The procedure does not follow the methodology that has been established for unpaved road surfaces. In addition, the drying procedure described does not follow the recommended procedure. The established procedure for sampling from unpaved roadways is to mark a 0.3M wide portion of the road surface (full width). Sweep the loose surface material from the hard base (avoiding any mounded material along the road centerline). This procedure for collecting the sample is described in more detail in the attached Appendix C.1 of AP-42 5th Edition. The drying procedure uses an oven of 230° F and a drying time of overnight. The procedure for drying the sample is described in more detail in the attached Appendix C.2 of AP-42 5th Edition.

In section 2.3.3, there is a procedure for analyzing the fines content of the road dust collected. This does not appear to follow the recommended laboratory procedure for surface/bulk materials. The stated procedure lists the use of a 325 mesh sizing pan and has 75 micron in parenthesis following that statement. The recommended laboratory procedure is to use a 200 mesh screen. The stated size is the same and the number in the test plan may be a typographical error. The recommended procedure is contained in Appendix C.2 of AP-42 5th Edition.

I have noted that only Filterable PM-10 and Filterable Particulate are included in the test plan. With the increased emphasis that is being placed on particulate in the smaller size ranges, I would suggest that serious consideration be given to extending the usefulness of this test data by obtaining particle size distribution data through the use of a concurrent analysis using some type of cascade impactor.

I appreciate the National Stone Association allowing me to review the test plan and provide the above recommendations on improving the haul road test. I also appreciate the Associations willingness to expend resources and staff time in the development of information that will lead to an improved knowledge of the emissions that are generated by process operations of member companies. As always, should you wish to discuss my recommendations or how the Agency may be of assistance please call me at (919) 541-5407. I look forward to the two haul road tests that you have planned.

Sincerely,

Ronald E. Myers
Emission Factor and Inventory Group

6 Enclosures

cc: Roy Huntley, EFIG without Enclosures
Bill Lamason, SCG-B without Enclosures
John Richards, Air Control Techniques w/ Enclosures
Solomon Ricks, SCG-B without Enclosures
Jim Southerland, EFIG without Enclosures
Henry Thomas, EMAD withoutEnclosures

OAQPS:EMAD:EFIG:MYERS:ew:4201ALEX:6/8/95:HAUL-RD.EVL:(Mobley's Purple Label created:6/8/95)

nsa **National Stone Association**

1415 Elliot Place, N.W., Washington, D.C. 20007-2599 202/342-1100

TO : Mr. Ronald E. Myers
FAX # : 919/541-0684
COMPANY : U.S. EPA/OAQPS/EIB/EFMS (MD-14)
FROM : Bill Ford
DATE : April 22, 1994
TOTAL PAGES : (including cover sheet)
We transmit from 202-342-0702. If you do not receive the pages clearly, call me at 800-342-1415 or locally at 202-342-1100.

Please see attached.

nsa **National Stone Association**

1415 Elliot Place, N.W. • Washington, D.C. 20007-2599 • 202/342-1100

April 22, 1994

Mr. Ronald E. Myers
Emission Factors and Methodologies Section
Emission Inventory Branch
Office of Air Quality Planning and Standards (MD-14)
United States Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Dear Mr. Myers:

Thank you for your recent letter and the enclosed copy of the draft AP-42 SECTION 8.19.2 CRUSHED STONE PROCESSING and the corresponding background report for the section. The National Stone Association (NSA), as the national trade association representing the many interests of the crushed stone industry, and whose over 500 members account for approximately 80 percent of the annual United States production of crushed stone, appreciates the opportunity to review and comment on the draft section.

NSA has also appreciated the opportunity to work with EPA over the last three years in the cooperative project to develop high-quality, accurate measurements of PM_{10} emissions from crushed stone operations. We believe the project has been extremely successful and has made a positive contribution to the nation's scientific database on air emissions.

While the draft AP-42 Section 8.19.2 is generally satisfactory, we have comments on four areas and some minor clean-up suggestions. Our comments and suggestions follow.

Process Description

The following changes should be made to Section 8.19.2.1 **Process Description.** Strikeouts indicate text which should be removed and underlining indicates suggested additional text:

- o Paragraph 3, line 4: Jaw, impactor~~,~~ or gyratory crushers....
- o Paragraph 3, line 7: ...a surge pile for temporary storage~~.~~ or sold as coarse aggregates.
- o Paragraph 5, line 1: Tertiary crushing is usually performed using cone crushers or ~~hammermills~~ other types of impactor crushers.
- o Paragraph 5, line 5: ...product bins or to open area stockpiles~~.~~, or to other processing systems, such as washing, air separators, screens and classifiers for the production of manufactured sand.
- o Paragraph 6: This paragraph should be deleted.

__Filterable PM__

PM should be defined as particulate matter that includes only those particles with an aerodynamic diameter less than or equal to a nominal ten micrometers.

Filterable PM emission factors should not be included in this edition of AP-42. Including Filterable PM emission factors is misleading and will lead to confusion.

- The National Ambient Air Quality Standard is now PM_{10}. It has been PM_{10} for more than six years. According to 40 CFR 50.6 (c), "For the purpose of determining attainment of the primary and secondary standards, particulate matter shall be measured in the ambient air as PM_{10} (particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers) by...".

- Since PM_{10} is now the criteria pollutant, there is no reason to include emission factors for Filterable PM in AP-42. To do so only creates confusion among the users of the document and lessens the credibility of AP-42.

- The only potential argument for considering Filterable PM might fall under NSPS Subpart OOO, which includes a standard of 0.05 g/dscm particulate matter, which ties back to the particulate measured by Method 5 or Method 17. Had EPA revised and updated the NSPS rule in a timely manner as required by law, that standard would not remain as it is. Further, the NSPS rule requires that a measurement be made. *Compliance cannot be determined using an emission factor.* Finally, information we have received from members around the country calculating emissions using the new data indicates that most, if not all, plants will fall under the 100 ton limit set out in Title V of the Clean Air Act Amendments.

  In short, even the outdated NSPS rule does not support the argument for including Filterable PM in the new AP-42 section. In addition, Subpart OOO should be re-promulgated in terms of PM_{10}.

- The new operating permit fee program under Title V of the Clean Air Act Amendments of 1990 is intended to generate revenue for states to use to operate their air pollution control programs. It provides an incentive for states to use the largest numbers available as the basis for their fee programs. As the draft section is currently written, there will be an inclination for the states to use the numbers for Filterable PM, which are larger than the numbers for PM_{10}.

- Filterable PM represents __all__ particulates caught by the filter, including the big stuff. As noted under 8.19.2.2 Emissions and Controls, "A substantial portion of these emissions consists of heavy particles that may settle out within the plant." TSP, as it has been used by the states up to now, and as shown in Table 8.19.2-1 in the current version of AP-42, is PM_{30}. There is a difference between the two parameters. Unless states using Filterable PM as a substitute for TSP_{30} go through the public rule-making process and promulgate new rules based on Filterable PM, they will be regulating a different parameter without the benefit of public input.

- o The background document from MRI notes on pages 9 - 12, in reference citations 3 - 8, that "Method 201A is not the reference test method for quantifying filterable PM emissions,...". The author goes on to say that "the preseperator and filter catch for the method *should* provide *representative* results for filterable PM" (emphasis added). We believe this is a poor approach and does not represent good science. If Filterable PM values are to be included, they should be measured using the reference test method.

  Including the Filterable PM emission factors in Table 8.19.2-1 in a column adjacent to the PM_{10} emission factors based on high quality, "A" rated data creates the impression that the Filterable PM emission factors are of equal quality to the PM_{10} emission factors. They were not measured using the reference test method and they are not of equal quality.

- o We have been working cooperatively with EPA on the test program for three years. Until our meeting with you and Jim Southerland on April 13, 1994, no mention has been made of Filterable PM. If there is evidence that Filterable PM will become a criteria pollutant in the next few years, subsequent testing should be designed to gather high quality data to serve as the basis for eventual Filterable PM emission factors. Adding Filterable PM at this point as an apparent afterthought, without an opportunity to build it into the testing program, is bad science and bad policy.

  We recommend deleting Filterable PM from this edition of AP-42. If the Agency is moving in the direction of rule-making involving Filterable PM, we should incorporate it into our testing program and begin developing sound data for future use.

If there is interest in providing guidance on total particulates, at least as an interim measure, we suggest an approach based on the particle size multipliers in the current edition of AP-42. A note could be added to the new section advising that an estimate of TSP (PM_{30}) can be obtained by multiplying the new PM_{10} values by 2.2 (The average of the particle size multipliers in Section 11.2.1 and Section 11.2.3 of the current AP-42). This would give the states a way to estimate PM_{30} and may help keep them from having to re-promulgate rules because the definition of TSP has changed.

Unrepresentative Data

Data from several tests which are not representative of typical stone crushing plants have been included and should be removed. The data from Reference 10 was part of the data set for screening operations. This data was from Engineering-Science tests of horizontal screens at two dry sand and gravel operations in California, not stone crushing operations, and should be deleted from the stone crushing section of AP-42.

Emission Factor Ratings

NSA disagrees with the "D" ratings given to the PM_{10} emission factors. This is not consistent with the criteria specified on page 28 of *Technical Procedures for Developing AP-42 emission Factors and Preparing AP-42 Sections*. The "D" ratings apply to data sets which have the following characteristics:

- o Based on A and B rated test data
- o "...reason to suspect that these facilities do not represent a random sample of the industry."
- o Evidence of variability within the source population.

With the exception of the Engineering-Science tests of sand and gravel plants (which do not belong in this data set) all of the tests have been "A" rated. There are no "B" rated tests.

While not spelled out in the test reports, Entropy, NSA and EPA made a very determined effort to find plants that were representative. Entropy, NSA and EPA personnel visited a large number of facilities in North Carolina, Virginia, Tennessee and Maryland. A significant pre-survey was also conducted prior to the tests in North Carolina and Virginia. Throughout the three year test program there has not been an attempt to find the best or worst facilities for emission testing.

The emission factor tests at the various plants tested exhibited surprisingly little variability. There is no valid reason to discredit the data with a "D" rating.

The "B" rating appears to be very consistent with the stone crushing emission factor data set (References 3 - 8). All of these tests are "A" rated, the tests were conducted at a number of different facilities representative of the overall industry and the data are sufficiently precise.

By not using EPA's published criteria and by adopting a very low rating for the new emission factors, EPA is discrediting the data developed jointly by its own Emission Inventory Branch and NSA. State regulatory agencies could very easily dismiss the new data (which has been obtained at considerable cost and effort) as no better than the earlier versions of AP-42 emission factors. The "D" rating is inappropriate and serves as a disincentive to future joint efforts involving EPA and private organizations.

The new emission factors for crushing, screening and transfer points should receive at least a "B" rating.

Miscellaneous

PM-10 should be written PM_{10}.

Paragraph 1 of Section 8.19.2.2 Emissions and Controls should be modified as follows (line 6): ...re-entrainment of settled dust by wind or machine movement. All processing emissions except baghouses or enclosed buildings with a forced air vent or stack should be considered fugitive emissions. Factors affecting emissions...

Fines crushing in Table 8.19.2-1 should be defined to prevent confusion.

With regard to the background report, line 10 of I. INTRODUCTION should be revised as follows: ...and industry practices; ~~a complete revision of the AP-42 section will not be performed until the ongoing test program for the stone crushing source category is completed.~~ This appears to be hold-over language from last year's draft. We have now finished the test program for crushers, screens and transfer points.

On page 15 of the background document, in paragraph 1 under III. RESULTS OF DATA ANALYSIS, the statement is made that the emission factors for tertiary crushing can be used as an upper limit for secondary crushing. Since footnote f of Table 8.19.2-1 notes that emission factors for tertiary crushing can be used as an upper limit for both primary and secondary crushing, this paragraph should be corrected to include primary crushing so that it corresponds with the table.

There are several rounding errors:

Fines crushing (3-05-020-05) - 0.01446 rounds to 0.014, not 0.015.

Fines screening (3-05-020) - 0.07041 rounds to 0.070, not 0.071.

Transfer point with wet suppression (3-05-020-06) - rounds to 0.000046, not 0.000048.

And two typos:

Fines screening with wet suppression (3-05-020) - should be 0.00184, not 0.0021.

Truck loading-conveyor: crushed stone (3-05-020-32) - should be 0.00010, not 0.0010. The metric version needs to be checked also.

In summary, NSA requests that the following changes be made to the draft AP-42 SECTION 8.19.2 CRUSHED STONE PROCESSING:

1. The process description should be changed as indicated to make it accurate.

2. The emission factors for Filterable PM should be removed from the document.

3. A note that TSP can be estimated by multiplying the PM_{10} values by 2.2 should be added to give state regulators guidance on TSP values.

4. The emission factor ratings based on the new test data should be changed to "B".

5. The miscellaneous changes as noted should be made.

NSA appreciates the opportunity to comment on the proposed draft AP-42 section. We look forward to continuing to work cooperatively with EPA in developing other high-quality additions to the air emissions database in the future.

Sincerely,

William C. Ford, P.E.
Vice President Environmental Programs

cc: Jim Southerland
Dennis Shipman

Section 8.19.2

Section 4 Reference 1

AP-42 Ref. 8

Emission Test Report Review Checklist--Short Form

Reviewer: Brian Shrager
Review Date: 1/28/93

A. Background Information

1. Facility name: Martin Marietta Stone Crushing
   Location: Raleigh-Durham plant
2. Source category: ~~Stone crushing~~ Crushed stone processing
3. Test date: 12/17/91 - 1/06/92
4. Test sponsor: EPA/EMB
5. Testing contractor: Entropy
6. Purpose of test: Gather data for emission factor development for the AP-42 section
7. Pollutants measured (include test method and indicate if valid): PM-10 (201A)

8. Process overview: Attach a process description and a block diagram. Identify processes tested with letters from the beginning of the alphabet (A, B, C, etc...) and APC systems with letters from the end of the alphabet (V, W, X, etc...). Also identify test locations with Arabic numerals (1,2,3, ...). Using the ID symbols from the diagram, complete the table below.

Test ID	Process	Process ID	Emissions tested: Uncontrolled	Emissions tested: Controlled	APCD (controlled emissions only)
1	Deister vibrating screen	A	✓		ID: Type: Model #:
2	Deister vibrating screen	A		✓	ID: Type: wet suppression Model #:
					ID: Type: Model #:
					ID: Type: Model #:

B. Process Information

1. Provide a brief narrative description of the process and attach process flow diagram. (Note: If the process description provided in the test report is adequate, attach a copy here.)

2.0 PLANT AND SAMPLING LOCATION DESCRIPTION

2.1 PROCESS DESCRIPTION AND OPERATION

The Raleigh-Durham plant produces crushed granite used for construction and road paving. Figure 2-1 is a flowchart of the portion of the Raleigh-Durham plant relevant in this project. The figure was prepared based on a drawing labelled "Plant 632 Flow Diagram" 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 420 foot conveyor (stream 3) is used to deliver the stone to the vibrating deck above the secondary crushers. Martin Marietta monitors the stone feed rate from the surge pile by means of a load cell type weigh belt scale near the discharge end of this conveyor. This instrument is used as the indicator of plant production rates. Normal production rates range from 500 to 700 tons per hour.

The scalping screen serving the secondary crushers removes less than 1.5 inch material produced during blasting or during primary crushing. This less than 1.5 inch material is conveyed (stream 4) to a separate storage pile and are sold as product. Typical stone flow levels in stream 4 are estimated at 80 tons per hour by Martin Marietta personnel.

Two cone-type secondary crushers reduce the size distribution of the material received from the surge pile. Stone leaving the secondary crushers ranges in size from 6 inches to relatively small particles. The material from both secondary crushers discharges onto a conveyor (stream 9) leading to the tertiary crusher inlet. The tertiary crusher discharge stream (stream 16) also discharges onto this conveyor (now labelled stream 10). Following the tertiary crusher discharge, the main feed conveyor (stream 10) contains all of the plant production with the exception of the fines discharge stream 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 and the Omnicone tertiary crusher. 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].

At the conveyor discharge point, the stone feed splits into two streams which lead to the East and West screens. In order to check the adequacy of the weigh belt scale as a production rate monitor, Entropy measured the stone feed rate to the Deister screen being tested by collecting and weighing a 2 foot sample of stone at a point just upstream of the conveyor discharge. Point B on Figure 1 is the conveyor (stream 10) monitoring location.

The Deister decks are 7 feet wide by 20 feet long and are inclined on a 20 degree slope. There are three vertically stacked decks. The upper deck has a mesh opening of 1.125 square inches, for the first 12 feet of travel and an opening of 1 square inch for the last 8 feet of travel. The middle deck has mesh opening of 0.58 square inches and the lower deck has slot openings of 0.118

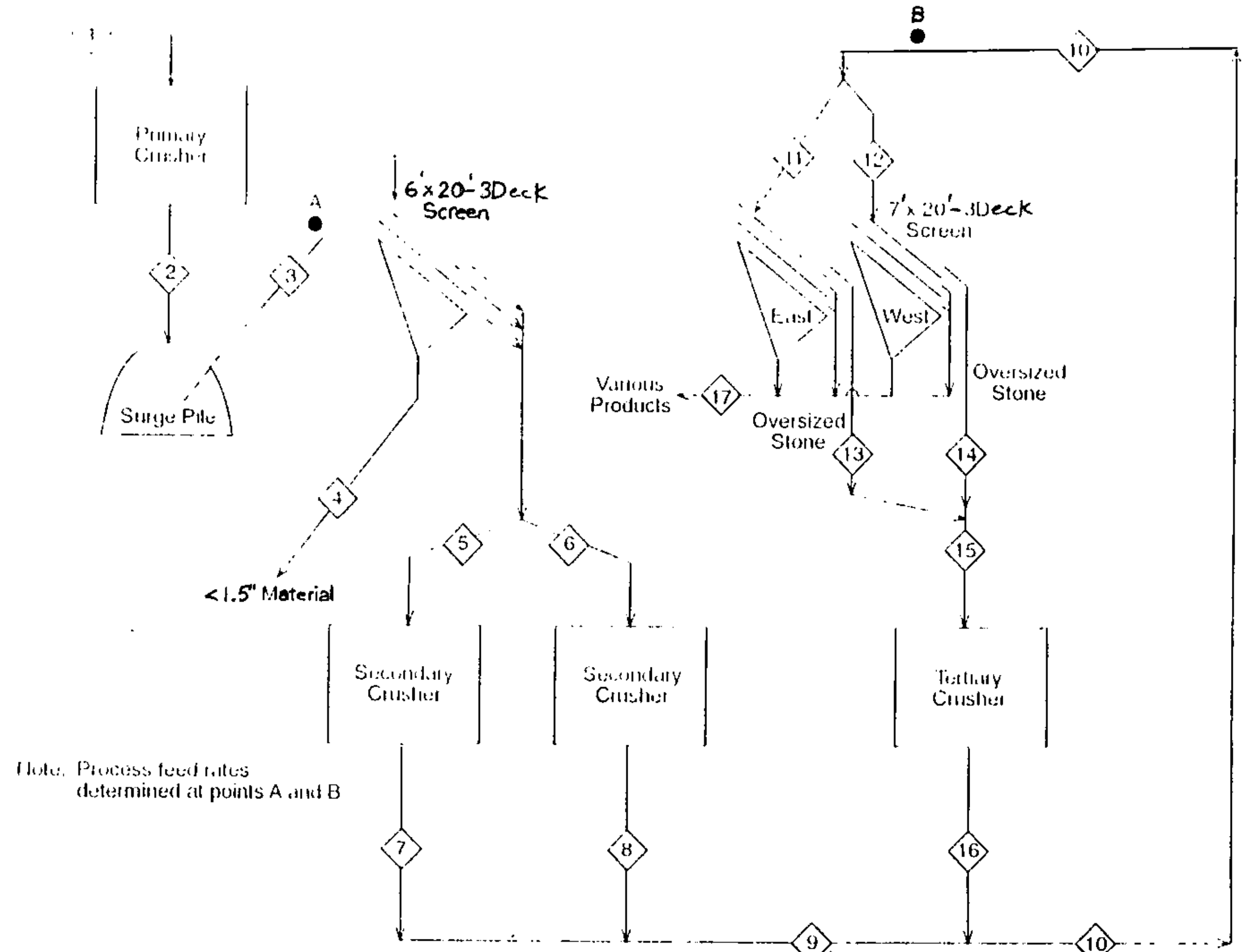


Figure 2-1. Simplified flowchart Raleigh Durham plant.

inches by 1 inch. Stone collecting on the middle and lower decks are combined as one product stream. Fine particles passing through all three decks collect as a separate process stream. Both of these sized product streams are designated together as "stream 17" in Figure 2-1. The oversized material remaining on the top screen goes to the inlet of the tertiary crusher. The total quantity of oversized material entering the Tertiary crusher is estimated to be 300 to 400 tons per hour. The stone feed rates to the two Deister screens were approximately equal during the tests.

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 1,000,000 tons.

2.2 FUGITIVE DUST CONTROL

Wet suppression is used for fugitive dust control of the Deister vibrating screens. There are water spray nozzles located on the conveyor underneath the tertiary crusher (beginning of stream 10), at the stream 10 conveyor transfer point, at the top of the stream conveyor above the Deister screens, and on the discharge chute near the top of the Deister screens. Not all of these spray nozzles are necessary to maintain wet conditions. The nozzles on the inlet chute to the Deister screen were off during the tests.

Over-wetting of the rock can cause blinding of the lower screen or blockage of the fines discharge chute underneath the Deister[4,5]. During these emission tests, the plant experienced no significant screen blinding conditions. However, the wet stone condition test coupled with heavy overnight rains on several test days caused some blockages of the fines discharge chute.

2.3 SAMPLING AND EMISSION TESTING PROCEDURES

2.3.1 <u>Fugitive Emission Capture Systems</u>

Since there is not an air pollution control device on the Deister screens, a fugitive emission capture system is needed to capture the particulate matter leaving the upper screen. 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]:

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

The quasi-stack method involves the construction of a temporary enclosure around the Deister screen and the installation of a duct and fan system for gas handling. Entropy rejected this approach primarily because of the extremely high gas flow rates necessary. Observations of dust emissions made during the pretest visits indicated that wind flowing across the 6- to 24-inch zone above the

C. 1. List any APCD parameters (supplied in the test report) below.

APCD ID	Parameter	Units	Readings			
			Run ~~1~~ 4	Run ~~2~~ 5	Run ~~3~~ 6	~~Run 4~~ AVG
E	% Moisture		1.96	1.52	1.22	1.57
Type of APCD: Wet Supression						
			RUN 1	RUN 2	RUN 3	AVG
Type of APCD: NONE	% Moisture		0.21	0.61	0.61	0.48
Type of APCD:						

2. Include any additional information (such as capture techniques for fugitive systems) and descriptions of the air pollution control systems (use a separate page if necessary).

"Uncontrolled" emissions were measured with a raw material moisture content <1.5%.

"Controlled" emissions were measured with a raw material moisture content >1.5%

RDa

MARTIN MARIETTA/RALEIGH PLANT DEISTER VIBRATING SCREEN

D. Emission Data/Emission Factors

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Average
1	Stack temperature	Deg. R	524	500	501	
	Moisture	%	1.0	1.0	1.3	
	Pressure	in. Hg	29.8	30.3	30.3	
	Volumetric flow, actual	acfm	640.6	640.6	640.6	
	Volumetric flow, standard *	dscfm	17185	18312	18220	
	Percent isokinetic	%	90.7	83.0	83.9	
Circle: Production or feed rate		tons/hr	260	229	234	
	Pollutant concentrations:					
	PM10 (stack)	mg/dscf	0.245	1.4	0.441	
	PM10 (ambient)	mg/dscf	0.0212	0.0126	0.0126	
	PM10 (stack-ambient)	mg/dscf	0.224	1.387	0.428	
	Pollutant mass flux rates:					
	PM10	lb/hr	0.508	3.358	1.032	
	Emission factors:					
	PM10	lb/ton	0.0019549	0.014662	0.004408	0.007008

* Volumetric flow (standard) calculated using 27 times the actual flow rate (27 test pts) with corrections for temperature, pressure, and moisture.

D. Emission Data/Emission Factors

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Average
2	Stack temperature	Deg. R	508	511	513	
	Moisture	%	1.6	0.3	1.4	
	Pressure	in. Hg	30.3	30.2	29.7	
	Volumetric flow, actual	acfm	640.6	640.6	640.6	
	Volumetric flow, standard *	dscfm	17914	17985	17424	
	Percent isokinetic	%	87.6	88.3	92.8	
Circle: Production or feed rate Capacity:		tons/hr	240	239	262	
	Pollutant concentrations:					
	PM10 (stack)	mg/dscf	0.09	0.071	0.1	
	PM10 (ambient)	mg/dscf	0.0163	0.0151	0.0367	
	PM10 (stack-ambient)	mg/dscf	0.0737	0.0559	0.0633	
	Pollutant mass flux rates:					
	PM10	lb/hr	0.174	0.133	0.146	
	Emission factors:					
	PM10	lb/ton	0.000727	0.000556	0.000556	0.000613

* Volumetric flow (standard) calculated using 27 times the actual flow rate (27 test pts) with corrections for temperature, pressure, and moisture.

~~Section~~ 4... Reference 2

AP-42 Ref. 9

Emission Test Report Review Checklist--Short Form

Reviewer: Brian Shrager
Review Date: 2/1/93

A. Background Information

1. Facility name: Martin Marietta (Stone crushing)
   Location: Garner, NC plant
2. Source category: ~~Stone~~ Crushed Stone Processing
3. Test date: 12/09 → 12/12/91
4. Test sponsor: EPA/EMB
5. Testing contractor: Entropy Environmentalists, Inc.
6. Purpose of test: Gather data for emission factor development for AP-42 section 8.19.
7. Pollutants measured (include test method and indicate if valid): PM-10 (201A)
8. Process overview: Attach a process description and a block diagram. Identify processes tested with letters from the beginning of the alphabet (A, B, C, etc...) and APC systems with letters from the end of the alphabet (V, W, X, etc...). Also identify test locations with Arabic numerals (1,2,3, ...). Using the ID symbols from the diagram, complete the table below.

Test ID	Process	Process ID	Emissions tested		APCD (controlled emissions only)
			Uncontrolled	Controlled	
1	Tertiary crushing	A	✓		ID: Type: Model #:
2	Tertiary Crushing	A		✓	ID: Wet suppression Type: Model #:
					ID: Type: Model #:
					ID: Type: Model #:

B. Process Information

1. Provide a brief narrative description of the process and attach process flow diagram. (Note: If the process description provided in the test report is adequate, attach a copy here.)

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

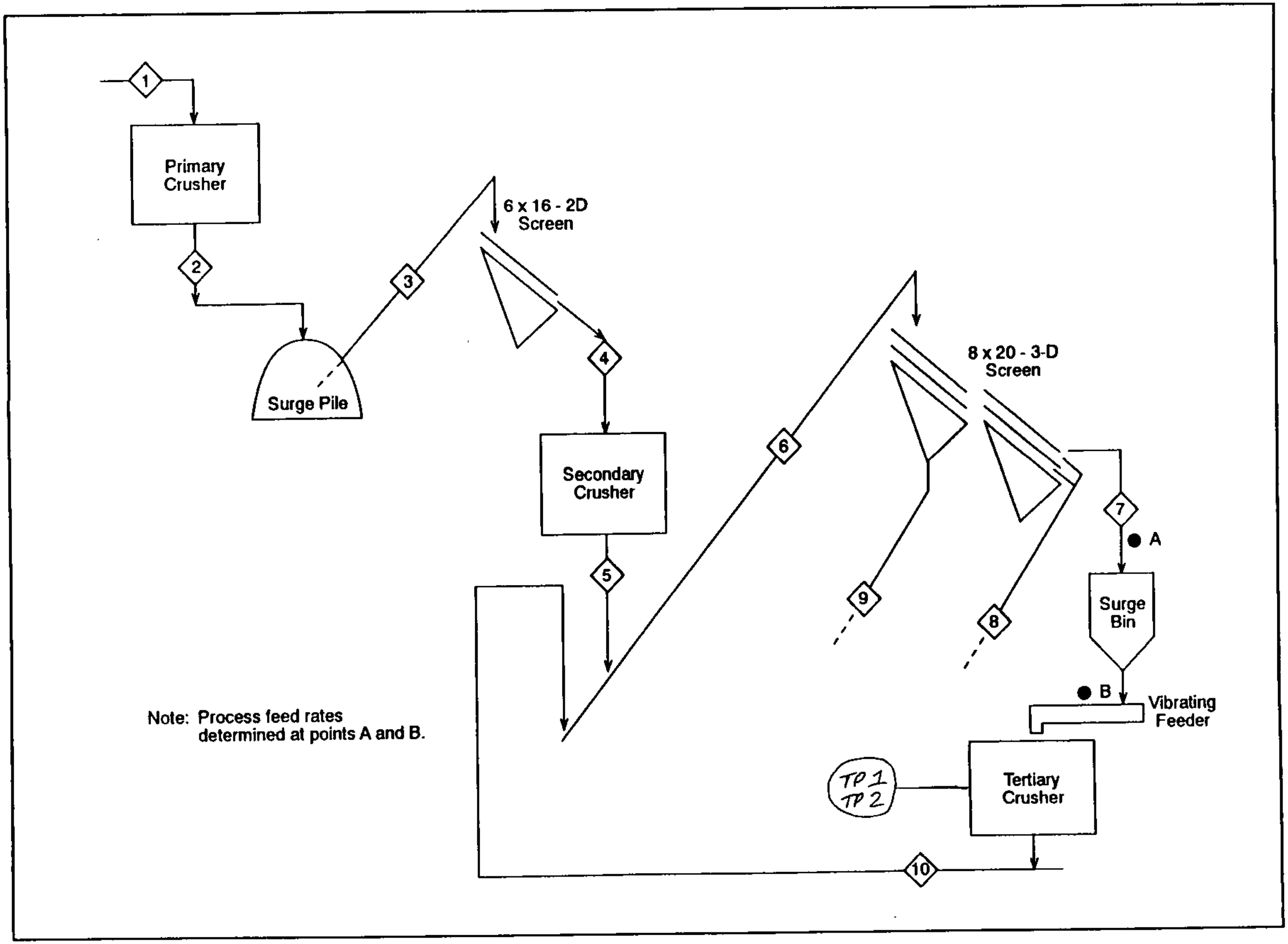
Wet suppression is used for fugitive dust control of the tertiary crusher. There are water spray nozzles located on the conveyor underneath the tertiary crusher (beginning of stream 10), at the transfer point of the conveyor (stream 7) and also the entrance to the surge bin and vibrating feeder (points 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[4,6].

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


1
Primary
Crusher
2
Surge Pile
3
6 x 16 - 2D
Screen
4
Secondary
Crusher
5
6
8 x 20 - 3-D
Screen
9
8
7
A
Surge
Bin
B
Vibrating
Feeder
TP 1
TP 2
Tertiary
Crusher
10
Note: Process feed rates
determined at points A and B.

C. 1. List any APCD parameters (supplied in the test report) below.

APCD ID	Parameter	Units	Readings			
			Run 1	Run 2	Run 3	Run 4
Z	% MOISTURE	DRY RUNS	0.44	0.44	0.44	
Type of APCD: Wet Suppression						
		WET RUNS	*	1.77	1.77	
Type of APCD:						
Type of APCD:						

2. Include any additional information (such as capture techniques for fugitive systems) and descriptions of the air pollution control systems (use a separate page if necessary).

* MATERIAL SAMPLE BOTTLE SEAL BROKEN. VOID MOISTURE CONTENT.

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
	Stack temperature					
	Moisture					
	Oxygen					
	Volumetric flow, actual					
	Volumetric flow, standard					
	Percent isokinetic					
Circle: Production or feed rate Capacity:						
	Pollutant concentrations:					
	Pollutant mass flux rates:					
	Emission factors:					

MARTIN MARIETTA/GARNER PLANT TERTIARY CRUSHER

D. Emission Data/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Average
INLET	Stack temperature	Deg. R	518	513	512	
(DRY)	Moisture	%	1.8	2.4	0.8	
	Pressure	in. Hg	30.3	30.3	30.3	
	Volumetric flow, actual	acfm				
	Total gas volume through stack	dscf	39285	39296	40027	
	Percent isokinetic	%	89.6	80.6	90.1	
Total stone processed during test run:		tons	453	453	453	
	Pollutant concentrations:					
	PM10	mg/dscf	0.423	0.168	0.051	
	Pollutant mass:					
	PM10	lb	0.0366	0.0145	0.0045	
	Emission factors:					
	PM10	lb/ton	8.08E-05	3.2E-05	9.9E-06	4.1E-05

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Average
INLET	Stack temperature	Deg. R	522	503	516	
(WET)	Moisture	%	0.9	0.8	0.8	
	Pressure	in. Hg	30.1	30.3	30.3	
	Volumetric flow, actual	acfm				
	Total gas volume through stack	dscf	107936	122747	118023	
	Percent isokinetic	%	89.7	90.1	88.3	
Total stone processed during test run:		tons	1253	1338	1338	
	Pollutant concentrations:					
	PM10	mg/dscf	0.073	0.127	0.091	
	Pollutant mass:					
	PM10	lb	0.0174	0.0343	0.0237	
	Emission factors:					
	PM10	lb/ton	1.39E-05	2.6E-05	1.8E-05	1.9E-05

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Average
OUTLET	Stack temperature	Deg. R	505	516	515	
(DRY)	Moisture	%	1.2	0.6	0.6	
	Pressure	in. Hg	30.3	30.3	30.3	
	Volumetric flow, actual	acfm				
	Total gas volume through stack	dscf	384533	372778	373771	
	Percent isokinetic	%	89.3	88.0	88.2	
Total stone processed during test run:		tons	453	453	453	
	Pollutant concentrations:					
	PM10	mg/dscf	1.026	0.954	0.827	
	Pollutant mass:					
	PM10	lb	0.869	0.783	0.681	
	Emission factors:					
	PM10	lb/ton	0.001918	0.00173	0.0015	0.00172

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Average
OUTLET	Stack temperature	Deg. R	517	508	520	
(WET)	Moisture	%	1.0	0.9	0.8	
	Pressure	in. Hg	30.1	30.3	30.0	
	Volumetric flow, actual	acfm				
	Total gas volume through stack	dscf	932837	1141478	1102764	
	Percent isokinetic	%	101.6	87.8	86.1	
Total stone processed during test run:		tons	1140	1338	1338	
	Pollutant concentrations:					
	PM10	mg/dscf	0.59	0.163	0.591	
	Pollutant mass:					
	PM10	lb	1.212	0.410	1.436	
	Emission factors:					
	PM10	lb/ton	0.001063	0.00031	0.00107	0.00081

DRY TOTAL EF = 0.00172 + 0.000041 = 0.0018

WET TOTAL EF = 0.00081 + 0.000019 = 0.00083

Emission Test Report Review Checklist--Short Form

Reviewer: Brian Shrager
Review Date: 2/1/93

A. Background Information

1. Facility name: Vulcan Materials, Inc.
   Location: Skippers, Va
2. Source category: Crushed stone processing
3. Test date: Nov. 16-19, 1992
4. Test sponsor: National Stone Association
5. Testing contractor: Entropy
6. Purpose of test: To determine PM10 emission factors applicable to various process units at stone crushing plants.
7. Pollutants measured (include test method and indicate if valid): PM10 (201A)

8. Process overview: Attach a process description and a block diagram. Identify processes tested with letters from the beginning of the alphabet (A, B, C, etc...) and APC systems with letters from the end of the alphabet (V, W, X, etc...). Also identify test locations with Arabic numerals (1,2,3, ...). Using the ID symbols from the diagram, complete the table below.

Test ID	Process	Process ID	Emissions tested: Uncontrolled	Emissions tested: Controlled	APCD (controlled emissions only)
1	Crushing (7' cone crusher)	A	✓		ID: Type: Model #:
2	Crushing (7' cone crusher)	A		✓	ID: Type: Wet Suppression Model #:
3	Delster Vibrating Screen	B	✓		ID: Type: Model #:
4	Delster vibrating screen	B		✓	ID: Type: Wet suppression Model #:

B. Process Information

1. Provide a brief narrative description of the process and attach process flow diagram. (Note: If the process description provided in the test report is adequate, attach a copy here.)

2.0 PLANT AND SAMPLING LOCATION DESCRIPTION

2.1 PROCESS DESCRIPTION AND OPERATION

The Skippers, Virginia plant produces crushed granite used for road paving and construction. Figure 1 provides a simplified flowchart of the portion of the plant relevant to this emission testing program. The primary surge pile shown in the upper right of Figure 1 is rock which has been conveyed from the large surge pile of rock in the quarry. The stone is then conveyed via Stream 1 to the 7' X 20' vibrating screens and the coarse product is conveyed via Stream 2 to the coarse surge pile. The coarse product is transported via Streams 3 and 4 to the 7' heavy duty shorthead Simmons Cone Crusher (hereafter referred to as the 7' crusher). Entropy monitored the stone feed rate leaving the 7' crusher by weighing a two foot section of Stream 5 and multiplying this weight by the speed of the belt.

The 7' crusher reduces the size distribution of the material received from the coarse surge pile. Stone leaving the 7' crusher ranges in size from 3 inches to relatively small particles. The material from the 7' crusher discharges onto a conveyor (Stream 5) leading to the outlets of two Model 1560 omni cone crushers. Following the omni cone crushers discharge, the main feed conveyor (Stream 6) contains all of the plant production with the exception of oversized product. The main feed conveyor (Stream 6) delivers the stone to the top of the structure housing the Deister vibrating screens. The plant operates a scale on this conveyor to calculate total daily tonnage from all three crushers to the 8' X 20' screens. Entropy also used this scale as a basis for calculations of the Deister screen.

The stone flow to the Deister screens and the omni cone crushers is termed "closed circuit" since oversized material containing some fines adhering to the surface can recirculate through the Deister and omni cone crushers until the stone is crushed small enough to fall through the Deister screen. The 7' crusher that Entropy tested however had no recirculated stone flowing through it.

The Deister decks are 8 feet wide by 20 feet long and are inclined on a 20 degree slope. There are three vertically stacked decks. The upper deck has a mesh opening of 1.125 square inches, for the first 12 feet of travel and an opening of 1 square inch for the last 8 feet of travel. The middle deck has mesh opening of 0.58 square inches and the lower deck has slot openings of 0.118 inches by 1 inch. Stone collecting on the middle and lower decks are combined as one product stream. Fine particles passing through all three decks collect as a separate process stream. The oversized material remaining on the top screen goes to the inlet of the Omni Cone crushers. The total quantity of oversized material entering the Omni Cone crushers is estimated to be 500 to 600 tons per hour. The stone feed rates to the two Deister screens were approximately equal during the tests.

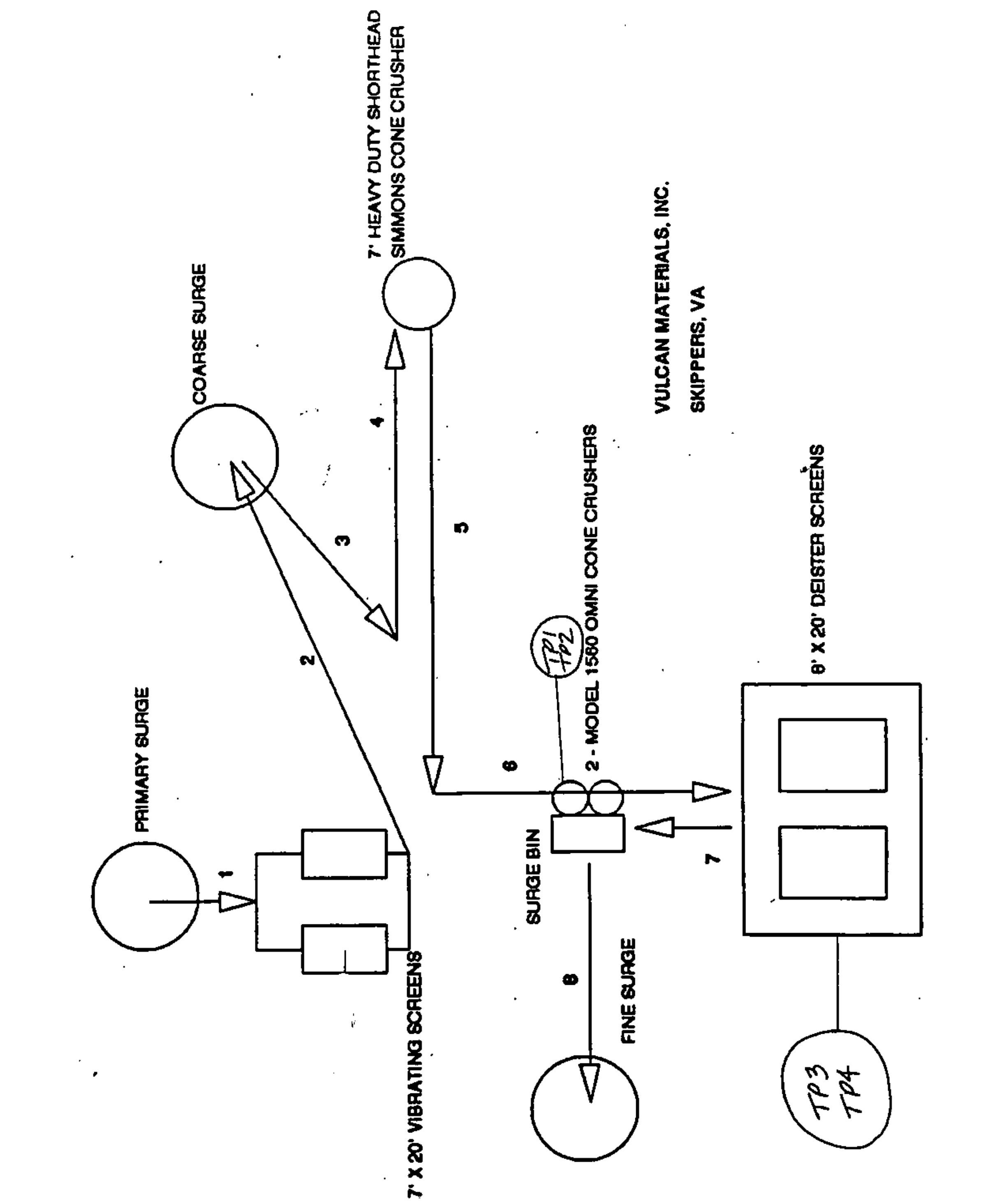


Figure 1. Simplified Process Flowchart

7.

C. 1. List any APCD parameters (supplied in the test report) below.

APCD ID	Parameter	Units	Readings			
			Run 1	Run 2	Run 3	Run 4
2	% moisture	TEST 1	0.69	0.70	—	
Type of APCD: Wet Suppression TESTS 1&2						
	% moisture	TEST 2	2.04	1.13	2.17	
Type of APCD: TESTS 3&4						
Type of APCD:						

2. Include any additional information (such as capture techniques for fugitive systems) and descriptions of the air pollution control systems (use a separate page if necessary).

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
	Stack temperature					
	Moisture					
	Oxygen					
	Volumetric flow, actual					
	Volumetric flow, standard					
	Percent isokinetic					
Circle: Production or feed rate Capacity:						
	Pollutant concentrations:					
	Pollutant mass flux rates:					
	Emission factors:					

VULCAN MATERIALS 7' CONE CRUSHER

D. Emission Data/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Average
1	Stack temperature	Deg. F	45	49	49	
	Moisture	%	0.2	0.3	0.2	
	Pressure	in. Hg	30.6	30.6	30.6	
	Volumetric flow, actual	acfm	2000	2008	2008	
	Volumetric flow, standard	dscfm	2134	2124	2126	
	Percent isokinetic	%	84.9	84.3	84.7	
Circle: Production or feed rate		tons/hr	578	498	484	
	Pollutant concentrations:					
	PM10 (stack)	G/dscf	0.065	0.1	0.164	
	Filterable PM	mg/dscf	87.330	160.903	150.130	
	Pollutant mass flux rates:					
	PM10	lb/hr	1.19	1.82	2.99	
	Filterable PM	lb/hr	24.7	45.2	42.2	
	Emission factors:					
	PM10	lb/ton	0.00206	0.00366	0.00617	0.00396
*	Filterable PM	lb/ton	0.0427	0.0908	0.0872	0.0736

D. Emission Data/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Average
2	Stack temperature	Deg. F	55	61	56	
	Moisture	%	0.8	1.2	1.3	
	Pressure	in. Hg	30.34	30.34	30.54	
	Volumetric flow, actual	acfm	2144	2158	2125	
	Volumetric flow, standard	dscfm	2211	2191	2191	
	Percent isokinetic	%	100.9	104.9	107.7	
Circle: Production or feed rate		tons/hr	388	521	490	
	Pollutant concentrations:					
	PM10 (stack)	G/dscf	0.00542	0.0103	0.00388	
	Filterable PM	mg/dscf	0.638	1.517	2.366	
	Pollutant mass flux rates:					
	PM10	lb/hr	0.103	0.193	0.0729	
	Filterable PM	lb/hr	0.187	0.440	0.686	
	Emission factors:					
	PM10	lb/ton	0.000265	0.000371	0.000149	0.000262
*	Filterable PM	lb/ton	0.000323	0.000883	0.00142	0.00087

* Method 201A

VULCAN MATERIALS DEISTER VIBRATING SCREEN

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Average
3	Stack temperature	Deg. F	47	50	49	
	Moisture	%	0.2	0.2	0.6	
	Pressure	in. Hg	30.68	30.68	30.68	
	Volumetric flow, actual	acfm	827	829	829	
	Volumetric flow, standard *	dscfm	23797	23714	23665	
	Percent isokinetic	%	94.6	94.6	95.4	
Circle: Production or feed rate		tons/hr	552	552	552	
	Pollutant concentrations:					
	PM10 (stack)	G/dscf	0.0640	0.0810	0.0750	
	Filterable PM	mg/dscf	22.505	49.562	22.313	
	Pollutant mass flux rates:					
	PM10	lb/hr	13.054	16.464	15.213	
	Filterable PM	lb/hr	70.840	155.466	69.850	
	Emission factors:					
	PM10	lb/ton	0.02365	0.02983	0.02756	0.02701
*	Filterable PM	lb/ton	0.123	0.312	0.144	0.193

* Volumetric flow (standard) calculated using 27 times the actual flow rate (27 test points) with corrections for temperature, pressure, and moisture.

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Average
4	Stack temperature	Deg. F	55	63	55	
	Moisture	%	0.6	1.2	1.2	
	Pressure	in. Hg	30.38	30.38	30.58	
	Volumetric flow, actual	acfm	838	841	840	
	Volumetric flow, standard *	dscfm	23412	22997	23480	
	Percent isokinetic	%	95.9	93.5	94.8	
Circle: Production or feed rate		tons/hr	589	617	531	
	Pollutant concentrations:					
	PM10	G/dscf	0.00305	0.00337	0.00256	
	Filterable PM	mg/dscf	0.612	0.578	0.299	
	Pollutant mass flux rates:					
	PM10	lb/hr	0.612	0.664	0.515	
	Filterable PM	lb/hr	1.895	1.758	0.927	
	Emission factors:					
	PM10	lb/ton	0.00104	0.00108	0.00097	0.00103
*	Filterable PM	lb/ton	0.00328	0.00353	0.00192	0.00291

* Volumetric flow (standard) calculated using 27 times the actual flow rate (27 test points) with corrections for temperature, pressure, and moisture.

* Method 201A

Section 4 Reference 4
~~AP-42~~ Reference 11

Emission Test Report Review Checklist--Short Form

Reviewer: Brian Shrager
Review Date: 2/2/93

A. Background Information

1. Facility name: Nello L. Teer
   Location: Raleigh, NC
2. Source category: Crushed stone processing (Stone crushing)
3. Test date: July 27-30, 1992
4. Test sponsor: EPA/EIB
5. Testing contractor: Entropy
6. Purpose of test: Determine emission factors for PM10 emissions from the stone crushing industry.
7. Pollutants measured (include test method and indicate if valid): PM10 (201A)

8. Process overview: Attach a process description and a block diagram. Identify processes tested with letters from the beginning of the alphabet (A, B, C, etc...) and APC systems with letters from the end of the alphabet (V, W, X, etc...). Also identify test locations with Arabic numerals (1,2,3, ...). Using the ID symbols from the diagram, complete the table below.

Test ID	Process	Process ID	Emissions tested: Uncontrolled	Emissions tested: Controlled	APCD (controlled emissions only)
1	Tertiary Crusher (Inlet + outlet)	A	✓		ID: Type: Model #:
2	Tertiary Crusher (Inlet + outlet)	A		✓	ID: wet Type: suppression Model #:
3	Tertiary Vibrating Screen	B	✓		ID: Type: Model #:
4	Tertiary Vibrating Screen	B		✓	ID: wet Type: suppression Model #:

B. Process Information

1. Provide a brief narrative description of the process and attach process flow diagram. (Note: If the process description provided in the test report is adequate, attach a copy here.)

2.0 PLANT AND SAMPLING LOCATION DESCRIPTION

2.1 PROCESS DESCRIPTION AND OPERATION

The Raleigh plant produces crushed granite used for construction and road paving. Figure 2-1 is a flowchart of the portion of the Raleigh plant relevant in this project. The figure was photocopies from a drawing provided by Nello L. Teer and labelled 6011, Raleigh Quarry Stationary Plant.

Rock blasted from various locations in the quarry is trucked to a primary crusher (No. 25, Fig. 2-1). A large surge pile is used to provide a steady flow of stone to the plant processing equipment. A conveyor delivers stone to the 6′ x 16′ TD Telsmith Vibro-King screen deck above the secondary crusher (No's 5 & 33, Fig.2-1). Stone that passes through the screen is sent to the 6 x 16-foot TD Seco screen via a 30-inch by 159-foot Barber-Greene conveyor (No's 17 & 36, Fig. 2-1). Stone too large to pass through the screen is sent to the tertiary crusher (No. 67, Fig. 2-1). Upon exiting the tertiary crusher the stone is sent back to the TD Seco screen. Production rates ranged from 60 to 100 tons per hour during the test program. Production rates were calculated from 2-foot belt cuts taken during the test. The belt-cut sampling locations for the tertiary crusher and the TD Seco screen are shown in Figure 2-1 as points A and B respectively. The stone flow to the TD Seco screens and tertiary crusher is termed "closed circuit" since oversized material containing some fines adhering to the surface can recirculate through the TD Seco screen and tertiary crusher[3] until the stone is crushed small enough to fall through the TD Seco screen.

The tertiary crusher is a Model 1560 Omnicone, conical type crusher. Figures 1-1 & 2 show views of the tertiary crusher before the inlet and outlet enclosures were built. The crusher receives the oversize stone from the 6 x 16 -TD Seco screen downstream from the secondary crusher. The stone is fed to the tertiary crusher by means of a 24" wide, 25 foot long conveyor (No.18, Fig. 2-1). After passing through the crusher, the stone is discharged onto a 30" wide 159 foot long conveyor (No.21, Fig. 2-1). There are very limited free fall distances from the conveyor to the Omnicone inlet. The Omnicone discharges the crushed stone to a 30 inch wide, 111 foot long conveyor (NO.21, Fig. 2-1).

The inlet to the Omnicone was defined as the area just after the stone was released from the conveyor and included the circular inlet to the Omnicone vessel. This area was enclosed with plywood attached to the safety rails surrounding the Omnicone inlet. The crusher inlet enclosure was approximately 3-feet high with a diameter of 8.5 feet. HEPA filtered air was introduced on one side of the enclosure and the sampling stack was constructed on the opposite side.

The discharge point of the Omnicone tertiary crusher is a conveyor leading from the secondary crusher to the TD Seco screens (No. 21, Fig. 2-1). The discharge point is enclosed approximately 3 feet upstream and downstream of the Omnicone discharge point. A plywood enclosure was constructed around this area also. The outlet enclosure was approximately 8 feet long, 8 feet wide, and 6 feet high. HEPA filtered air was introduced at belt locations upstream and downstream of the discharge chute. The sampling stack was constructed on the opposite side.

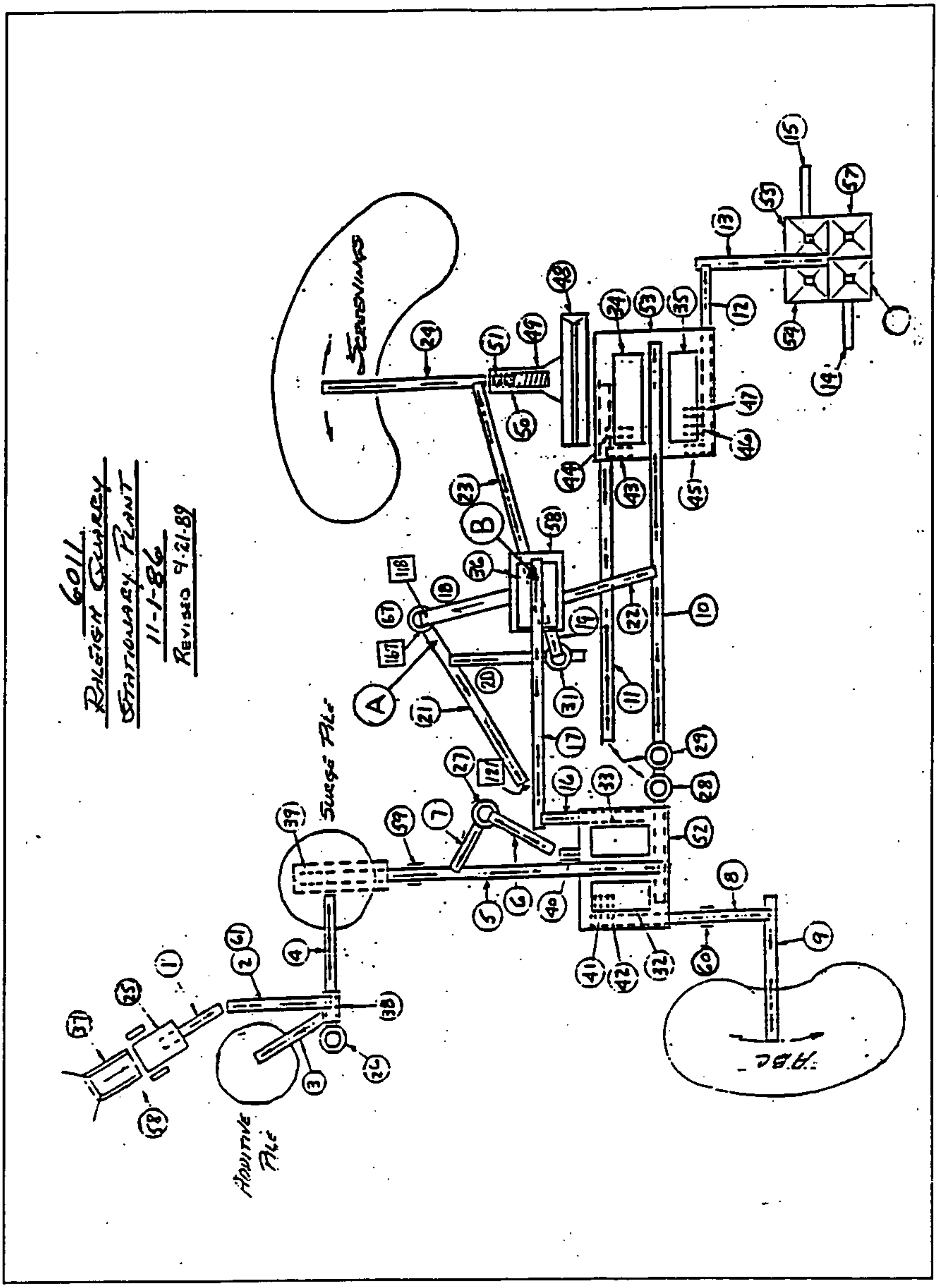


Figure 2-1 Process Flow Diagram

The TD Seco screen decks are 6 feet wide by 16 feet long and are inclined on a 20 degree slope. There are three vertically stacked decks. Fine particles passing through all three decks collect as a separate process stream. The oversized material remaining on the top screen goes to the inlet of the tertiary crusher. The TD Seco screen receives material from a 30-inch wide, 159-foot long overhead conveyor (No. 17, Fig.2-1). All of the crushed stone from the tertiary crusher is deposited on this conveyor and mixed with screened material from the TD Telsmith Vibro-King screen. Process rates were determined by a 2-foot belt cut taken from the overhead conveyor.

The TD Seco vibrating screen emission tests were conducted using a track-mounted hood system. The hood had dimensions of 2 feet by 2 feet and was mounted 12 inches above the upper screen deck of the TD Seco Screen. The small scale and the mounting position of the hood ensured that the normal PM10 emissions were not significantly influenced by the presence of the hood. The capture velocity in the hood was set by adjusting the variable speed DC motor of the tube-axial fan installed on the hood outlet duct. The hood capture velocity was selected based on observations of the fugitive dust capture characteristics of the hood. A constant gas flow was used throughout the test program. This testing approach is an adaptation of the conventional "roof monitoring" technique for fugitive emission testing.

2.2 FUGITIVE DUST CONTROL

Wet suppression is used for fugitive dust control of the tertiary crusher. There are water spray nozzles located at the discharge point of the inlet conveyor, midway in the body of the crusher, and within the discharge chute. Not all of these spray nozzles are necessary to maintain wet conditions. The screen has water spray nozzles located at the conveyor transfer point. These spray nozzles were not used during the test program. Over-wetting of the rock can cause blinding of the lower screen or blockage of the fines discharge chute underneath the screen[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 or the TD Seco screen, 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

C. 1. List any APCD parameters (supplied in the test report) below.

APCD ID	Parameter	Test ~~Units~~	Readings			
			Run 1	Run 2	Run 3	Run 4
	% Moisture	Crusher-Dry	0.63	1.30	—	
Type of APCD:		Crusher-Wet	1.13	1.75	2.88	
		Screen-Dry	—	—	—	
		Screen-Wet	1.61	1.66	1.77	
Type of APCD:						
Type of APCD:						

2. Include any additional information (such as capture techniques for fugitive systems) and descriptions of the air pollution control systems (use a separate page if necessary).

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
	Stack temperature					
	Moisture					
	Oxygen					
	Volumetric flow, actual					
	Volumetric flow, standard					
	Percent isokinetic					
Circle: Production or feed rate Capacity:						
	Pollutant concentrations:					
	Pollutant mass flux rates:					
	Emission factors:					

NELLO L. TEER CRUSHER

D. Emission Data/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Average
1-INLET	Stack temperature	Deg. F	75	84	96	
	Moisture	%	1.8	3.0	2.5	
	Pressure	in. Hg	29.88	29.88	29.88	
	Volumetric flow, actual	acfm	1028	1039	1049	
	Volumetric flow, standard	dscfm	995	977	970	
	Percent isokinetic	%	101.4	102.5	105.9	
Circle: Production or feed rate		tons/hr	63	63	63	
	Pollutant concentrations:					
	PM10	G/dscf	0.00191	0.00373	0.00607	
	% OF FILTERABLE PM	%	14.2%	7.7%	4.3%	
	Pollutant mass flux rates:					
	PM10	lb/hr	0.0163	0.0312	0.0505	
	FILTERABLE PM	lb/hr	0.115	0.406	1.174	
	Emission factors:					
	PM10	lb/ton	0.000259	0.000496	0.000801	0.000518
	FILTERABLE PM	lb/ton	0.00182	0.00644	0.0186	0.00896

D. Emission Data/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Average
1-OUTLET	Stack temperature	Deg. F	73	82	86	
	Moisture	%	2.4	3.0	2.2	
	Pressure	in. Hg	29.88	29.88	29.88	
	Volumetric flow, actual	acfm	4021	4060	4068	
	Volumetric flow, standard	dscfm	3882	3831	3842	
	Percent isokinetic	%	108.8	108.5	109.9	
Circle: Production or feed rate		tons/hr	63	63	63	
	Pollutant concentrations:					
	PM10	G/dscf	0.00594	0.0275	0.0474	
	% OF FILTERABLE PM	%	1.2%	1.9%	2.2%	
	Pollutant mass flux rates:					
	PM10	lb/hr	0.198	0.903	1.56	
	FILTERABLE PM	lb/hr	16.5	47.5	71.0	
	Emission factors:					
	PM10	lb/ton	0.00314	0.0143	0.0248	0.0141
	FILTERABLE PM	lb/ton	0.261	0.754	1.13	0.714

1. Total PM-10 – 0.0146

	1	2	3	Avg
Total filterable –	.263	.760	1.15	0.723

D. Emission Data/Emission Factors

			Values reported			
Test ID	Parameter	Units	Run 1	Run 2	Run 3	Average
2-INLET	Stack temperature	Deg. F	91	81	98	
	Moisture	%	3.9	2.4	2.3	
	Pressure	in. Hg	29.68	29.78	29.98	
	Volumetric flow, actual	acfm	1003	995	1049	
	Volumetric flow, standard	dscfm	916	943	972	
	Percent isokinetic	%	103.7	102.6	102.5	
Circle: Production or feed rate		tons/hr	63	63	63	
	Pollutant concentrations:					
	PM10	G/dscf	0.000927	0.000673	0.000322	
	% OF FILTERABLE PM	%	16.3%	38.3%	39.3%	
	Pollutant mass flux rates:					
	PM10	lb/hr	0.00728	0.00544	0.00268	
	FILTERABLE PM	lb/hr	0.0447	0.0142	0.00682	
	Emission factors:					
	PM10	lb/ton	0.000116	0.000086	0.000043	0.000082
	FILTERABLE PM	lb/ton	0.00071	0.000226	0.000108	0.000348

D. Emission Data/Emission Factors

			Values reported			
Test ID	Parameter	Units	Run 1	Run 2	Run 3	Average
2-OUTLET	Stack temperature	Deg. F	91	80	82	
	Moisture	%	2.9	2.3	2.3	
	Pressure	in. Hg	29.68	29.78	29.98	
	Volumetric flow, actual	acfm	4479	3757	4047	
	Volumetric flow, standard	dscfm	4134	3572	3860	
	Percent isokinetic	%	102.8	111.1	104.6	
Circle: Production or feed rate		tons/hr	63	63	63	
	Pollutant concentrations:					
	PM10	G/dscf	0.00413	0.00515	0.00207	
	% OF FILTERABLE PM	%	1.8%	1.1%	2.6%	
	Pollutant mass flux rates:					
	PM10	lb/hr	0.146	0.158	0.0685	
	FILTERABLE PM	lb/hr	8.13	14.3	2.63	
	Emission factors:					
	PM10	lb/ton	0.00232	0.00250	0.00109	0.00197
	FILTERABLE PM	lb/ton	0.129	0.228	0.0418	0.133

Total	PM10	0.00244			
	Filt PM	0.130	0.220	0.0419	0.133

NELLO L. TEER VIBRATING SCREEN

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Average
3	Stack temperature	Deg. F	82	86	86	
	Moisture	%	1.6	0.5	2.2	
	Pressure	in. Hg	29.88	29.88	29.88	
	Volumetric flow, actual	acfm	1007	1009	1012	
	Volumetric flow, standard *	dscfm	23136	23269	22940	
	Percent isokinetic	%	102.6	98.9	100.3	
Circle: Production or feed rate		tons/hr	102	102	102	
	Pollutant concentrations:					
	PM10	G/dscf	0.0215	0.0347	0.0535	
	% OF FILTERABLE PM	%	19.1%	21.0%	28.0%	
	Pollutant mass flux rates:					
	PM10	lb/hr	4.264	6.921	10.520	
	FILTERABLE PM	lb/hr	22.3	33.0	37.6	
	Emission factors:					
	PM10	lb/ton	0.042	0.068	0.103	0.071
	FILTERABLE PM	lb/ton	0.219	0.323	0.368	0.303

* Volumetric flow (standard) calculated using 24 times the actual flow rate (24 test points) with corrections for temperature, pressure, and moisture.

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Average
4	Stack temperature	Deg. F	85	86	85	
	Moisture	%	2.8	2.1	1.4	
	Pressure	in. Hg	27.71	29.88	29.88	
	Volumetric flow, actual	acfm	1056	1012	1009	
	Volumetric flow, standard *	dscfm	22103	22963	23101	
	Percent isokinetic	%	103.8	89.1	99.4	
Circle: Production or feed rate		tons/hr	102	102	102	
	Pollutant concentrations:					
	PM10	G/dscf	0.00108	0.00154	0.00062	
	% OF FILTERABLE PM	%	36.9%	87.2%	62.9%	
	Pollutant mass flux rates:					
	PM10	lb/hr	0.20461	0.30312	0.12257	
	FILTERABLE PM	lb/hr	0.555	0.348	0.195	
	Emission factors:					
	PM10	lb/ton	0.00201	0.00297	0.00120	0.00206
	FILTERABLE PM	lb/ton	0.00544	0.00341	0.00191	0.00358

* Volumetric flow (standard) calculated using 24 times the actual flow rate (24 test points) with corrections for temperature, pressure, and moisture.

Emission Test Report Review Checklist--Short Form

Reviewer: BRIAN SHRAGER
Review Date: 2/10/94

A. Background Information

1. Facility name: WAKE STONE CORPORATION
   Location: Knightdale, NC
2. Source category: Crushed Stone (granite)
3. Test date: Sept. 13-20, 1993
4. Test sponsor: EPA/EMB
5. Testing contractor: ENTROPY
6. Purpose of test: Determine PM-10 emissions
7. Pollutants measured (include test method and indicate if valid): PM-10 → EPA Method 201A
   (Two transfer points → quasi-stack method of capture)
8. Process overview: Attach a process description and a block diagram. Identify processes tested with letters from the beginning of the alphabet (A, B, C, etc...) and APC systems with letters from the end of the alphabet (V, W, X, etc...). Also identify test locations with Arabic numerals (1,2,3, ...). Using the ID symbols from the diagram, complete the table below.

Test ID	Process	Process ID	Emissions tested: Uncontrolled	Emissions tested: Controlled	APCD (controlled emissions only)
1	Transfer point C1	A	✓ 0.5% moisture		ID: Z Type: ~~Wet suppress~~ Model #:
2	Transfer point C1	A		✓ 0.5% moisture	ID: Z Type: Wet suppression Model #:
3	Transfer point J2	A	✓ 0.5% moisture		ID: Type: Model #:
4	Transfer point J2	A		✓ 0.5% moisture	ID: Z Type: Wet suppression Model #:

B. Process Information

1. **Provide a brief narrative description of the process and attach process flow diagram. (Note: If the process description provided in the test report is adequate, attach a copy here.)**

2.0 PLANT AND SAMPLING LOCATION DESCRIPTION

2.1 PROCESS DESCRIPTION AND OPERATION

The Knightdale North Carolina plant produces crushed granite used for construction and road paving. Figure 2-1 is a flowchart of the portion of the Wake Stone plant which is relevant in this project. This has been copied from a drawing labelled "Knightdale Quarry New Secondary Crushing Plant" provided by Wake Stone Corp. The transfer points tested are circled and join conveyor C and J to conveyor D.

Rock blasted from various locations in the quarry is trucked to a primary jaw type crusher located near the quarry pit. A large surge pile created by the flow of stone from the jaw crusher is used to provide a steady flow of stone to the plant processing equipment located adjacent to the quarry (STATION 4). Conveyor B is used to deliver the stone to the vibrating screen above the 5.5 foot Symons Cone Crusher. The vibrating screen serving the 5.5 foot Symons crusher removes fine material produced during blasting or during primary crushing. These fines are conveyed to a separate storage pile and are sold as product. The rock that remains is crushed and conveyed via conveyor C to conveyor D to the sizing screens (STATION 5). The rock that is still too large to be sold as product is conveyed via conveyor I to a Model 1560 Omnicone crusher (STATION 6), the crushed rock is then conveyed via conveyor J to conveyor D to the sizing screen again. This loop continues until the rock is crushed to the current screen sizes. The transfer points from conveyor C to D and from conveyor J to D are the locations that were tested. They have been denoted as C1 and J2 respectively for the test.

2.2 FUGITIVE DUST CONTROL

Wet suppression is used for fugitive dust control of the transfer point. There are water spray nozzles located on the exit conveyor underneath the transfer point. There are also spray nozzles located at the inlet and outlet of the conetype crushers. Spray nozzles area also located at the top of the conveyor above the vibrating screens, and on the discharge chute near the top of the vibrating screens. 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 vibrating screen[4,5]. During these emission tests, the plant experienced no significant screen blinding conditions.

2.3 SAMPLING AND EMISSION TESTING PROCEDURES

2.3.1 Fugitive Emission Test Approach

Since there is no air pollution control devices on the transfer point, fugitive emission testing procedures were needed to capture and measure the PM10 particulate emissions. The quasi-stack method appeared to be the most accurate and practical approach for capturing the fugitive emissions from the inlet and outlet areas of the transfer point. This approach allowed isolation of the transfer point from the other fugitive dust sources in the immediate

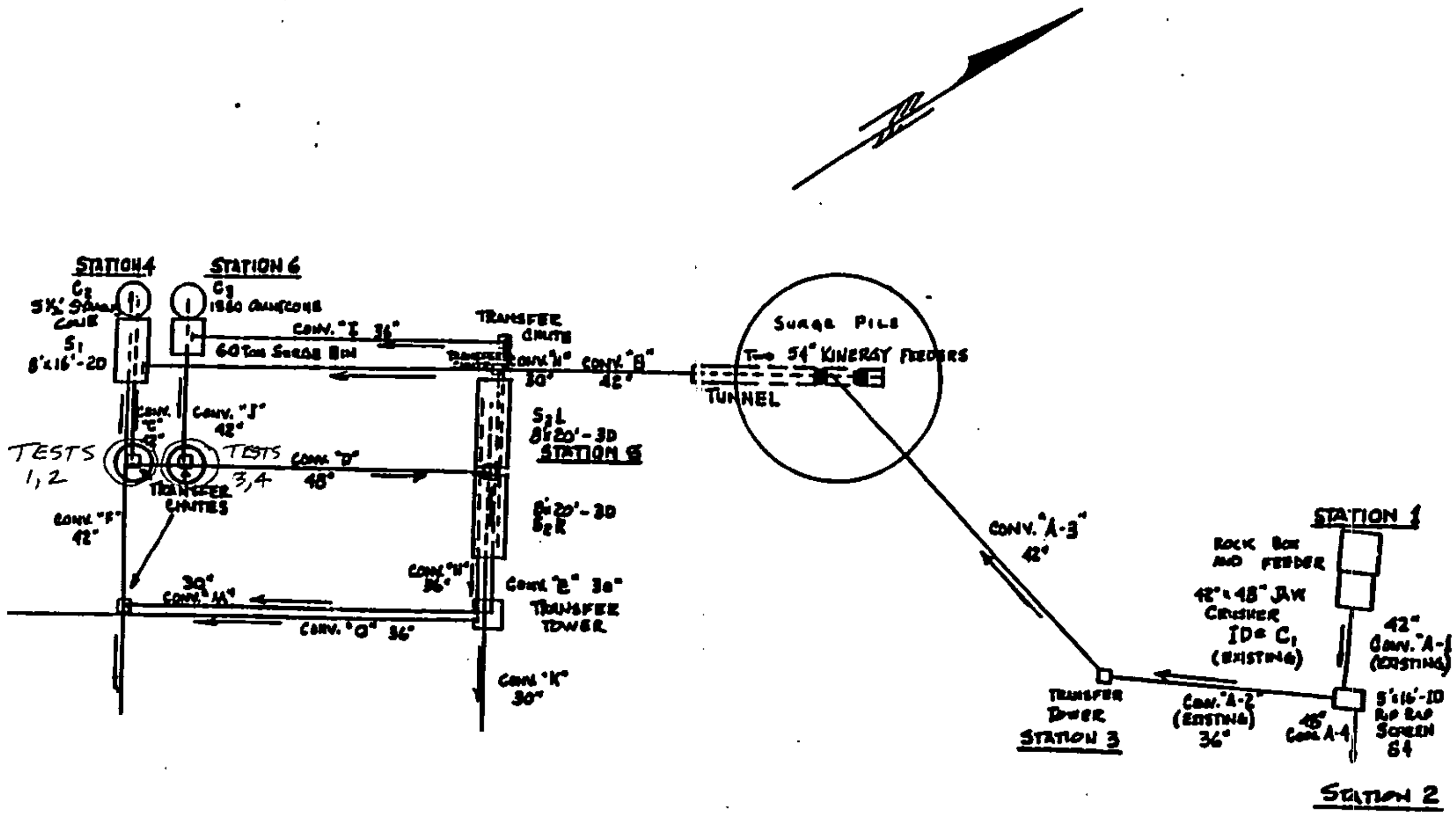


Figure 2-1. Wake Stone Corp. Knightdale Quarry Flow Diagram

The low emission factors are also substantiated by particle size distribution tests conducted by Entropy using dried stone. The size distribution data provided in Table 3-6 explains the higher moisture contents found on the stone material in transfer point J2. From the table one can see J2 had a larger percent of smaller particles than C1 therefore the particles of J2 had a larger surface area exposed to the wet suppression sprays. This explains the lower WET emissions and higher DRY emissions of transfer point J2 compared to transfer point C1.

TABLE 3-6. PARTICLE SIZE DISTRIBUTIONS

	Percent of Total Dry Sample in Specified Range For Transfer Point C1			
Size Range	Test 1, Wet	Test 2, Wet	Test 3 Wet	Test 1 Dry
> 1.5 Inches	28.1	24.3	11.2	31.9
> 0.75 Inches	37.5	41.9	30.3	27.8
> 0.375 Inches	13.8	12.4	19.4	11.0
> 0.0787 Inches	9.1	10.6	18.1	13.3
> 150 Microns	8.5	9.1	16.2	12.8
> 75 Microns	1.5	1.4	2.4	1.7
> 38 Microns	0.7	0.2	1.3	0.8
Bottom Pan	0.8	0.1	1.1	0.7
Moisture Content of Sample (% Wet Weight)	0.55	0.68	0.74	0.27

	Percent of Total Dry Sample in Specified Range For Transfer Point J2			
Size Range	Test 1, Wet	Test 2, Wet	Test 3 Wet	Test 1 Dry
> 1.5 Inches	00.0	00.0	00.0	00.0
> 0.75 Inches	37.7	21.8	35.9	30.2
> 0.375 Inches	25.1	29.0	32.7	18.8
> 0.0787 Inches	18.7	25.1	18.1	26.9
> 150 Microns	14.1	18.1	9.6	19.4
> 75 Microns	2.3	2.9	1.8	2.2
> 38 Microns	1.1	1.6	0.9	1.2
Bottom Pan	1.0	1.5	1.0	1.3
Moisture Content of Sample (% Wet Weight)	0.86	1.48	1.00	0.33

C. 1. List any APCD parameters (supplied in the test report) below.

	APCD ID	Parameter	Units	Readings			
				Run 1	Run 2	Run 3	Run 4
C1	None	Moisture	% wt.	0.27	0.27	0.27	
	Type of APCD:						
J2	None	Moisture	% wt	0.33	0.33	0.33	
C1	Z	Moisture	% wt.	0.55	0.68	0.74	
	Type of APCD: Wet suppression						
J2	Z	Moisture	% wt.	0.86	1.48	1.00	
	Type of APCD:						

2. **Include any additional information (such as capture techniques for fugitive systems) and descriptions of the air pollution control systems (use a separate page if necessary).**

Targeted moisture contents were dry $\leq$ 1.5 %
wet $\geq$ 1.5 %

Actual moisture contents were dry < 0.5 %
wet > 0.5 %

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
	Stack temperature					
	Moisture					
	Oxygen					
	Volumetric flow, actual					
	Volumetric flow, standard					
	Percent isokinetic					
Circle: Production or feed rate Capacity:						
	Pollutant concentrations:					
	Pollutant mass flux rates:					
	Emission factors:					

FILENAME: TRANSPT.WQ1

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
1	Stack temperature	Deg F	59.5	64.8	71	
DRY	Moisture	%	1.28	1.34	1.17	
TRANSFER	Oxygen	%	20.9	20.9	20.9	
POINT,C1	Volumetric flow, actual	acfm	1027	1032	1051	
	Volumetric flow, standard	dscfm	1036	1030	1039	
	Isokinetic variation	%	89.1	89.2	88.3	
Circle: Production or feed rate Capacity:		TPH	467	467	467	
	Pollutant concentrations:	includes adjustment for ambient concentration				
	PM-10	mg/DSCF	0.77	0.70	1.42	
	% OF FILTERABLE PM	%	9.8%	8.7%	9.1%	
	Pollutant mass flux rates:					
	PM-10	lb/hr	0.106	0.0954	0.195	
	FILTERABLE PM	lb/hr	1.08	1.10	2.14	
	Emission factors:					
	PM-10	lb/ton	0.000226	0.000204	0.000418	0.000283
	FILTERABLE PM	lb/ton	0.00231	0.00235	0.00459	0.0030817

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
2	Stack temperature	Deg F	77.1	79.8	78.8	
WET	Moisture	%	1.97	2.56	2.58	
TRANSFER	Oxygen	%	20.9	20.9	20.9	
POINT,C1	Volumetric flow, actual	acfm	1068	1063	1090	
	Volumetric flow, standard	dscfm	1038	1018	1044	
	Isokinetic variation	%	93.7	86.6	85.3	
Circle: Production or feed rate Capacity:		TPH	530	428	530	
	Pollutant concentrations:	includes adjustment for ambient concentration				
	PM-10	mg/DSCF	0.236	0.376	0.37	
	% OF FILTERABLE PM	%	33.1%	31.9%	33.7%	
	Pollutant mass flux rates:					
	PM-10	lb/hr	0.0324	0.0506	0.0511	
	FILTERABLE PM	lb/hr	0.098	0.159	0.152	
	Emission factors:					
	PM-10	lb/ton	6.11E-05	1.18E-04	9.64E-05	9.195E-05
	FILTERABLE PM	lb/ton	0.000185	0.000371	0.000286	0.0002805

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
3	Stack temperature	Deg F	75.9	77.6	79	
DRY	Moisture	%	1.4	1.47	1.24	
TRANSFER	Oxygen	%	20.9	20.9	20.9	
POINT,J2	Volumetric flow, actual	acfm	1075	1085	1082	
	Volumetric flow, standard	dscfm	1050	1055	1052	
	Isokinetic variation	%	86.6	87.3	87.1	
Circle: Production or feed rate Capacity:		TPH	473	473	473	
	Pollutant concentrations:	includes adjustment for ambient concentration				
	PM-10	mg/DSCF	2.68	2.5	5.51	
	% OF FILTERABLE PM	%	7.3%	5.8%	9.3%	
	Pollutant mass flux rates:					
	PM-10	lb/hr	0.372	0.349	0.767	
	FILTERABLE PM	lb/hr	5.10	6.02	8.24	
	Emission factors:					
	PM-10	lb/ton	0.000787	0.000738	0.00162	0.00105
	FILTERABLE PM	lb/ton	0.0108	0.0127	0.0174	0.0136

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
4	Stack temperature	Deg F	78.5	84.1	79.4	
WET	Moisture	%	1.92	1.77	2.64	
TRANSFER	Oxygen	%	20.9	20.9	20.9	
POINT,J2	Volumetric flow, actual	acfm	1071	1076	1074	
	Volumetric flow, standard	dscfm	1039	1031	1027	
	Isokinetic variation	%	85.8	84.8	87.6	
Circle: Production or feed rate Capacity:		TPH	529	470	497	
	Pollutant concentrations:	includes adjustment for ambient concentration				
	PM-10	mg/DSCF	0.0689	0.176	0.0716	
	% OF FILTERABLE PM	%	39.1%	39.2%	38.2%	
	Pollutant mass flux rates:					
	PM-10	lb/hr	0.00946	0.0240	0.00973	
	FILTERABLE PM	lb/hr	0.0242	0.0612	0.0255	
	Emission factors:					
	PM-10	lb/ton	1.79E-05	5.10E-05	1.96E-05	2.95E-05
	FILTERABLE PM	lb/ton	4.58E-05	1.30E-04	5.12E-05	7.57E-05

Section ~~I~~ II Reference 6
AP-42 Reference ___

Emission Test Report Review Checklist--Short Form

Reviewer: BRIAN SHRAGER
Review Date: 3/12/94

A. Background Information

1. Facility name: Martin Marietta Raleigh-Durham
   Location: Raleigh, NC
2. Source category: Crushed Stone Processing
3. Test date: 1/6 → 1/18/94
4. Test sponsor: Martin Marietta
5. Testing contractor: ENTROPY
6. Purpose of test: Determine PM-10 + filt. PM emissions (for emission factors)
7. Pollutants measured (include test method and indicate if valid): PM-10, filterable PM
   M 201-A, Method 5

8. Process overview: Attach a process description and a block diagram. Identify processes tested with letters from the beginning of the alphabet (A, B, C, etc...) and APC systems with letters from the end of the alphabet (V, W, X, etc...). Also identify test locations with Arabic numerals (1,2,3, ...). Using the ID symbols from the diagram, complete the table below.

Test ID	Process	Process ID	Emissions tested: Uncontrolled	Emissions tested: Controlled	APCD (controlled emissions only)
1	Transfer Point	A	✓		ID: Type: Model #:
2	"	A		✓	ID: Wet suppression Type: Model #:
3	"	A	✓		ID: Type: Model #:
4	"	A		✓	ID: Wet Suppression Type: Model #:

B. Process Information

1. Provide a brief narrative description of the process and attach process flow diagram. (Note: If the process description provided in the test report is adequate, attach a copy here.)

See attached.

2.0 PLANT AND SAMPLING LOCATION DESCRIPTION

2.1 PROCESS DESCRIPTION AND OPERATION

The Raleigh-Durham plant produces crushed granite used for construction and road paving. Figure 2-1 is a flowchart of the portion of the Raleigh-Durham plant which is relevant in this project. This has been prepared based on a drawing labelled "Plant 613 Flow Diagram" provided by Martin Marietta. The transfer point tested is circled and joins Streams 10 and 11.

Rock blasted from various locations in the quarry is trucked to a primary crusher located in the quarry pit. A large surge pile in the quarry pit is used to provide a steady flow of stone to the plant processing equipment located adjacent to the quarry. A conveyor is used to deliver the stone to the vibrating screen above the secondary crushers. Martin Marietta monitors the stone feed rate from the quarry by means of a load cell type weigh belt scale near the discharge end of this conveyor. This instrument is used as the indicator of plant production rates. Normal production rates range from 400 to 600 tons per hour.

The vibrating screen serving the secondary crushers removes fine material produced during blasting or during primary crushing. These fines are conveyed to a separate storage pile and are sold as product. Typical fines levels are estimated at 80 tons per hour by Martin Marietta personnel.

Two cone-type secondary crushers reduce the size distribution of the material received from the surge pile. Stone leaving the secondary crushers ranges in size from 6 inches to relatively small particles. The material from both secondary crushers discharges onto a conveyor leading to the transfer point tested and then to the tertiary crusher inlet. The tertiary crusher discharge stream also discharges onto this conveyor (now labelled stream 10). Following the tertiary crusher discharge, the main feed conveyor (stream 10) contains all of the plant production with the exception of the fines discharge stream discussed earlier. The quantity of this stream exceeds the total plant throughput rates monitored using the weigh belt feeder on the conveyor leading to the secondary crusher due to the recycle of oversized material separated by the Deister screens.

The main feed conveyor stream passes through the tested transfer point and delivers the stone to the top of the structure housing the Deister vibration screens and the Omnicone tertiary crusher. The stone flow to the Deister screens and tertiary crusher is termed "closed circuit" since oversized material and incompletely screened fines can recirculate through the Deister and tertiary crusher[3]. The plant operates approximately 200 days per year. Total production quantities per year are approximately 1,000,000 tons.

2.2 FUGITIVE DUST CONTROL

Wet suppression is used for fugitive dust control of the transfer point. There are water spray nozzles located on the exit conveyor underneath the transfer point. There are also spray nozzles located at the exit of the

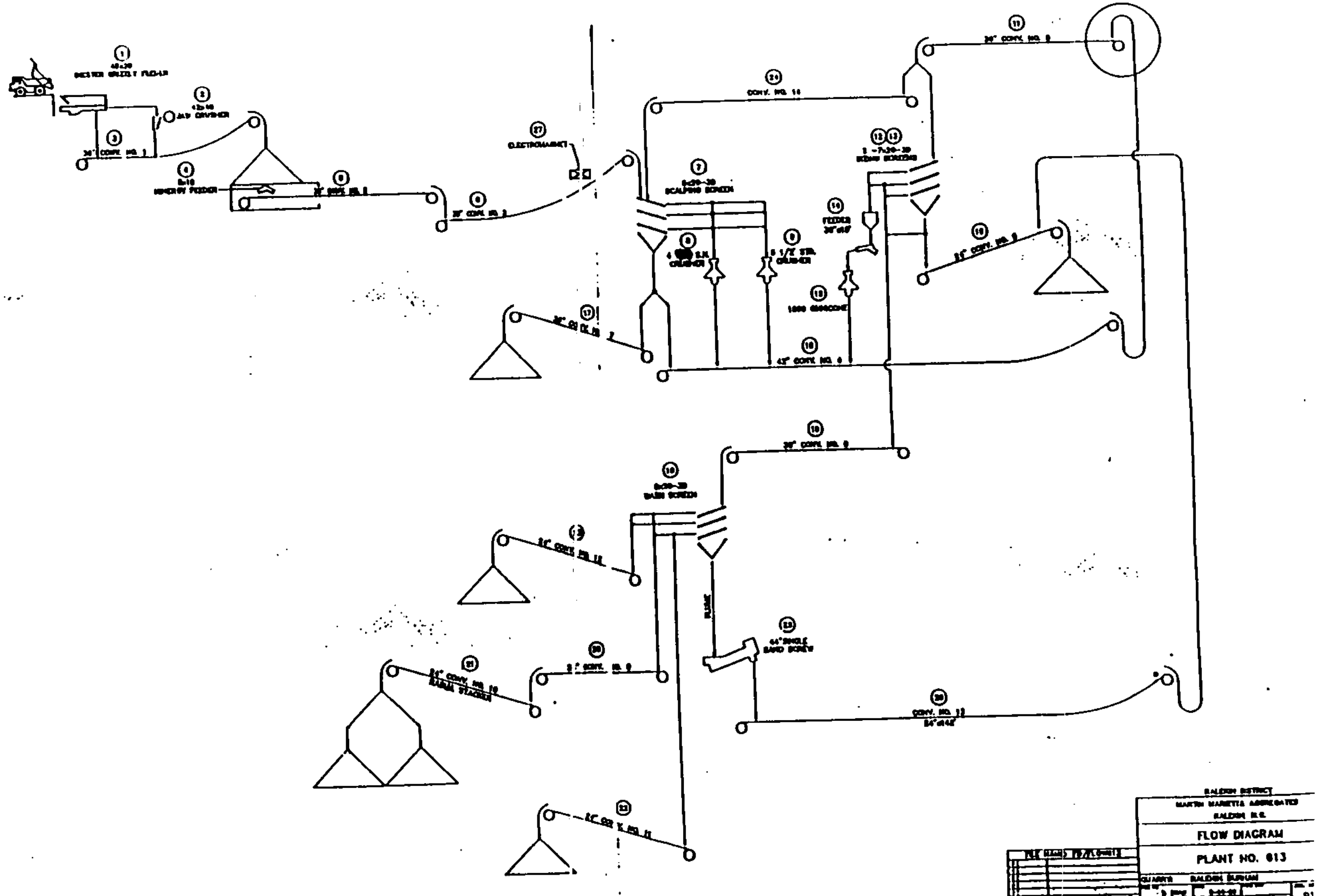


Figure 2-1. Process Flowchart for Raleigh-Durham, North Carolina Plant

tertiary crusher (beginning of stream 10), at the top of the stream conveyor above the Deister screens, and on the discharge chute near the top of the Deister screens. 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]. During these emission tests, the plant experienced no significant screen blinding conditions.

2.3 SAMPLING AND EMISSION TESTING PROCEDURES

2.3.1 Fugitive Emission Test Approach

Since there is no air pollution control devices on the transfer point, fugitive emission testing procedures were needed to capture and measure the PM10 and total particulate emissions. The quasi-stack method appeared to be the most accurate and practical approach for capturing the fugitive emissions from the inlet and outlet areas of the transfer point. This approach allowed isolation of the transfer point 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 transfer point and the installation of a duct and fan system for gas handling. Since the PM10 emissions are generated primarily by stone-to-stone attrition in the transfer point and during falling, the use of an enclosure does not significantly influence the rate of PM10 emissions.

2.3.2 Emission Testing Procedure

The inlet to the transfer point has an area of approximately 1 foot high, by 3.5 feet wide by 8 feet long it was enclosed with foam insulation to allow capture of the emissions caused by the stone-to-stone attrition during movement of the stone. The discharge point of the transfer point is the lower conveyor leading to the Deister screens. The actual transfer point was completely enclosed in a steel chute. The discharge point was enclosed approximately 8 feet downstream of the transfer point. There are several water spray nozzles on the downstream side of the transfer point. Figure 2-2. shows a view of the transfer point.

The enclosure had a one foot diameter outlet duct which ran approximately 35 feet to the ground, it was used as a combined sample point for both the inlet and outlet of the transfer point. The one foot diameter duct upon reaching the ground turned 90^{0} via an elbow and was then increased to a two foot diameter duct, to allow use of a two foot diameter SCR driven tubeaxial fan. The air flows from the combined enclosure were set by adjusting the variable speed DC motor of the tubeaxial fan installed on the outlet duct. Figures 2-2. and 2-3. show views of the inlet and outlet of the transfer point prior to the construction of enclosures. Figure 2-4. shows a view of the transfer point inlet and outlet after the installation of the enclosure. The combined gas flow from the inlet and outlet enclosures was controlled by a Dayton Model 3C411 24 inch, 2 HP direct current (DC) driven tubeaxial fan. This variable speed fan was set at the gas flow rate necessary to maintain a slightly negative static pressure within the enclosure.

C. 1. List any APCD parameters (supplied in the test report) below.

APCD ID	Parameter	Units	Readings			
			Run 1	Run 2	Run 3	Run 4
—	% Moisture	% weight	* 0.29			
Type of APCD: None ~~Wet suppression~~						
Z	% MOISTURE	% weight	*2.62			
Type of APCD: *Wet suppression						
Type of APCD:						

2. Include any additional information (such as capture techniques for fugitive systems) and descriptions of the air pollution control systems (use a separate page if necessary).

* ONLY 1 DRY SAMPLE & 1 wet SAMPLE WERE OBTAINED.

DRY SAMPLE TAKEN 1-18-93

WET SAMPLE TAKEN 1-14-93

C. 1. List any APCD parameters (supplied in the test report) below.

APCD ID	Parameter	Units	Readings			
			Run 1	Run 2	Run 3	Run 4
——	% Moisture	% weight	* 0.29			
Type of APCD: None ~~Wet suppression~~						
Z	% MOISTURE	% weight	*2.62			
Type of APCD: *Wet suppression						
Type of APCD:						

2. **Include any additional information (such as capture techniques for fugitive systems) and descriptions of the air pollution control systems (use a separate page if necessary).**

* ONLY 1 DRY SAMPLE & 1 wet SAMPLE WERE OBTAINED.

DRY SAMPLE TAKEN 1-18-93

WET SAMPLE TAKEN 1-14-93

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
	Stack temperature					
	Moisture					
	Oxygen					
	Volumetric flow, actual					
	Volumetric flow, standard					
	Percent isokinetic					
Circle: Production or feed rate Capacity:						
	Pollutant concentrations:					
	Pollutant mass flux rates:					
	Emission factors:					

FILENAME: TRANSPT2.WQ1

METHOD 201A DATA

D. Emission Data/Mass Flux Rates/Emission Factors

			Values reported			
Test ID	Parameter	Units	Run 1	Run 2	Run 3	Run 4
1	Stack temperature	Deg F	42	45	38	
DRY	Moisture	%	1.5	0??	1.3	
TRANSFE	Oxygen	%	20.9	20.9	20.9	
POINT	Volumetric flow, actual	acfm	896	897	893	
M201A	Volumetric flow, standard	dscfm	933	937	938	
	Isokinetic variation	%	90.2	108.6	107.2	
Circle: Production or feed rate Capacity:		TPH	608	608	608	
	Pollutant concentrations:	includes adjustment for ambient concentration				
	PM-10	mg/DSCF	14.7	12.4	16.0	
	% OF FILTERABLE PM	%	4.52%	3.64%	4.59%	
	Pollutant mass flux rates:					
	PM-10	lb/hr	1.81	1.53	1.99	
	FILTERABLE PM	lb/hr	40.1	42.1	43.3	
	Emission factors:					
	PM-10	lb/ton	0.00298	0.00252	0.00327	0.00292
	FILTERABLE PM	lb/ton	0.0659	0.0692	0.0713	0.0688

			Values reported			
Test ID	Parameter	Units	Run 1	Run 2	Run 3	Run 4
2	Stack temperature	Deg F	42	38	38	
WET	Moisture	%	1.2	0.8	0.9	
TRANSFE	Oxygen	%	20.9	20.9	20.9	
POINT	Volumetric flow, actual	acfm	896	892	892	
M201A	Volumetric flow, standard	dscfm	939	943	943	
	Isokinetic variation	%	111.6	114.2	112.1	
Circle: Production or feed rate Capacity:		TPH	584	604	542	
	Pollutant concentrations:	includes adjustment for ambient concentration				
	PM-10	mg/DSCF	0.0885274	0.1223399	0.0902046	
	% OF FILTERABLE PM	%	71.6%	67.6%	41.5%	
	Pollutant mass flux rates:					
	PM-10	lb/hr	0.0110	0.0153	0.0113	
	FILTERABLE PM	lb/hr	0.0154	0.0226	0.0271	
	Emission factors:					
	PM-10	lb/ton	1.88E-05	2.53E-05	2.08E-05	2.16E-05
	FILTERABLE PM	lb/ton	2.63E-05	3.74E-05	5.00E-05	3.79E-05

METHOD 5 DATA

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
3	Stack temperature	Deg F	38	45	44	
DRY	Moisture	%	0.7	0.8	0.9	
TRANSFE	Oxygen	%				
POINT	Volumetric flow, actual	acfm	891	912	883	
M5	Volumetric flow, standard	dscfm	937	945	916	
	Isokinetic variation	%	100.4	98.8	98.4	
Circle: Production or feed rate Capacity:		TPH	608	608	608	
	Pollutant concentrations:	includes adjustment for ambient concentration				
	FILTERABLE PM	mg/DSCF	140.0	327.2	346.9	
	Pollutant mass flux rates:					
	FILTERABLE PM	lb/hr	17.4	40.9	42.0	
	Emission factors:					
	FILTERABLE PM	lb/ton	2.85E-02	6.73E-02	6.91E-02	0.0550

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
4	Stack temperature	Deg F	42	34	37	
WET	Moisture	%	0.9	0.6	0.7	
TRANSFE	Oxygen	%				
POINT	Volumetric flow, actual	acfm	955	1005	1026	
M5	Volumetric flow, standard	dscfm	1001	1073	1076	
	Isokinetic variation	%	100	100.4	99.1	
Circle: Production or feed rate Capacity:		TPH	596	604	542	
	Pollutant concentrations:	includes adjustment for ambient concentration				
	FILTERABLE PM	mg/DSCF	0.256	0.097	0.614	
	Pollutant mass flux rates:					
	FILTERABLE PM	lb/hr	0.0339	0.0138	0.0874	
	Emission factors:					
	FILTERABLE PM	lb/ton	5.69E-05	2.28E-05	1.61E-04	8.03E-05

Section II Reference 7
AP-42 Reference ___

Emission Test Report Review Checklist--Short Form

Reviewer: BRIAN SHRAGER
Review Date: 2/9/94

A. Background Information

1. Facility name: Vulcan Materials Company
   Location: Bristol, Tennessee
2. Source category: Crushed Stone (limestone)
3. Test date: June 14-16, 1993
4. Test sponsor: EMB/EPA
5. Testing contractor: ENTROPY
6. Purpose of test: Determine PM-10 emissions
7. Pollutants measured (include test method and indicate if valid): PM-10 - Method 201A
   Crusher - quasi-stack system
   Screen - Rack-mounted hood system - adaptation of "roof monitoring"
8. Process overview: Attach a process description and a block diagram. Identify processes tested with letters from the beginning of the alphabet (A, B, C, etc...) and APC systems with letters from the end of the alphabet (V, W, X, etc...). Also identify test locations with Arabic numerals (1,2,3,...). Using the ID symbols from the diagram, complete the table below.

Test ID	Process	Process ID	Emissions tested: Uncontrolled	Emissions tested: Controlled	APCD (controlled emissions only)
1	Shorthead Tertiary Crusher (Cone)	A	✓ <1.0% moisture		ID: Type: Model #:
2	Shorthead Tertiary Crusher (Cone)	A		✓ >1.0% moisture	ID: Type: Model #:
3	Triple Deck Vibrating Screen	B	✓ <1.0% moisture		ID: Type: Model #:
4	Triple Deck Vibrating Screen	B		✓ >1.0% moisture	ID: Type: Model #:

B. Process Information

1. Provide a brief narrative description of the process and attach process flow diagram. (Note: If the process description provided in the test report is adequate, attach a copy here.)

2.0 PLANT AND SAMPLING LOCATION DESCRIPTION

2.1 PROCESS DESCRIPTION AND OPERATION

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

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

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

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

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

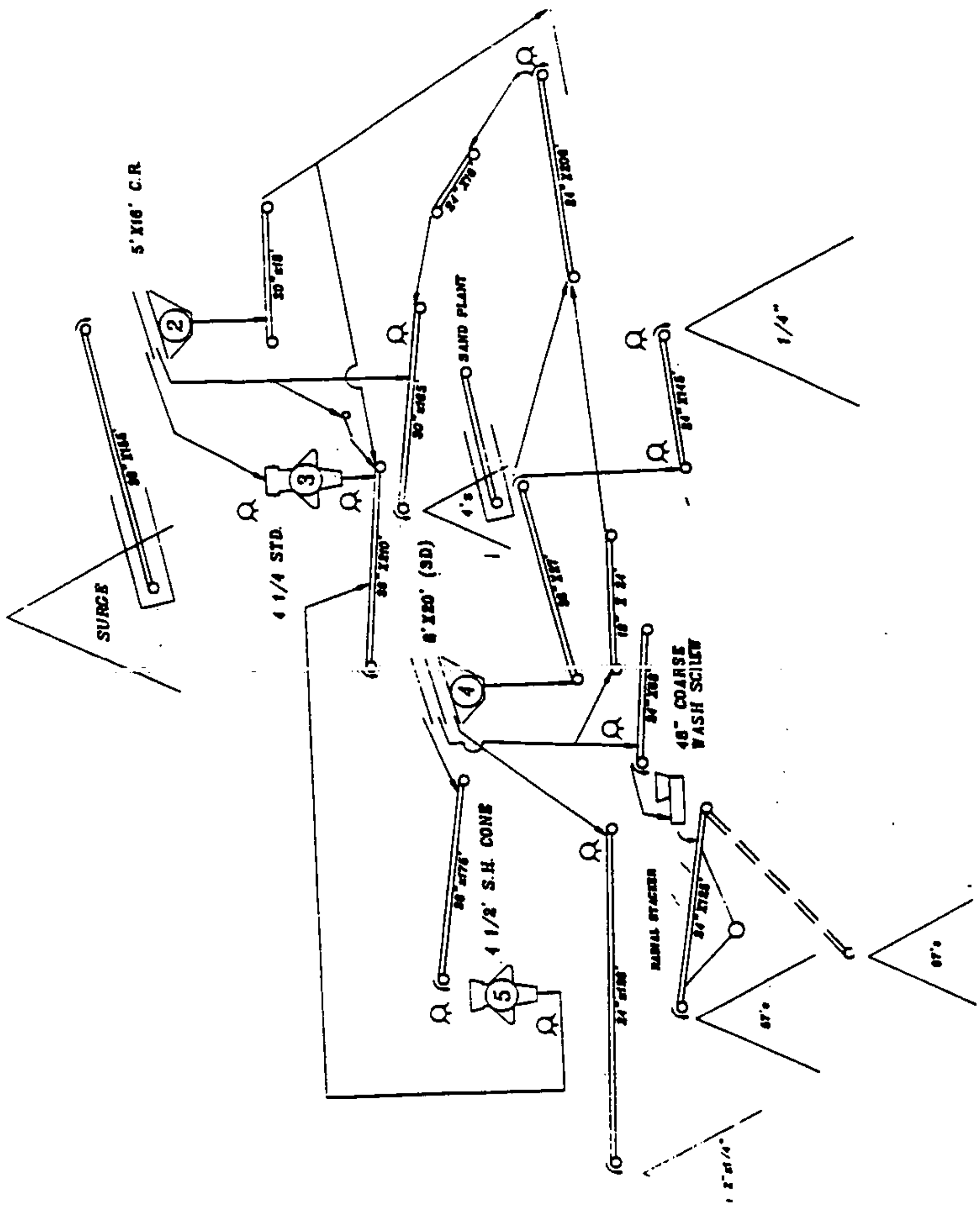


Figure 1. Simplified Process Flowchart

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

TABLE 8-1. PARTICLE SIZE DISTRIBUTIONS FOR DRY RUNS

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

TABLE 8-2. PARTICLE SIZE DISTRIBUTIONS FOR WET RUNS

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

C. 1. List any APCD parameters (supplied in the test report) below.

APCD ID	Parameter	Units	Readings			
			Run 1	Run 2	Run 3	Run 4
NONE	% Moisture	% weight	0.88	0.88	0.88	
Type of APCD:						
Z	% Moisture	% weight	1.74	2.24	2.24	
Type of APCD: Wet suppression						
Type of APCD:						

2. **Include any additional information (such as capture techniques for fugitive systems) and descriptions of the air pollution control systems (use a separate page if necessary).**

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
	Stack temperature					
	Moisture					
	Oxygen					
	Volumetric flow, actual					
	Volumetric flow, standard					
	Percent isokinetic					
Circle: Production or feed rate Capacity:						
	Pollutant concentrations:					
	Pollutant mass flux rates:					
	Emission factors:					

FILENAME: LIMESTN2.WQ1

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
1	Stack temperature	Deg F	72	72	72	
DRY	Moisture	%	2.24	2.44	2.36	
CRUSHER	Oxygen	%	20.9	20.9	20.9	
	Volumetric flow, actual	acfm	1615	1616	1615	
	Volumetric flow, standard	dscfm	1490	1488	1489	
	Isokinetic variation	%	107.5	104.4	104.5	
Circle: Production or feed rate Capacity:		TPH	325	325	325	
	Pollutant concentrations:					
	PM-10	mg/DSCF	3.04	4.71	6.68	
	% OF FILTERABLE PM	%	29.0%	20.7%	17.4%	
	Pollutant mass flux rates:					
	PM-10	lb/hr	0.599	0.927	1.316	
	FILTERABLE PM	%	2.07	4.48	7.56	
	Emission factors:					
	PM-10	lb/ton	0.00184	0.00285	0.00405	0.00291
	FILTERABLE PM	%	0.00636	0.0138	0.0233	0.0145

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
2	Stack temperature	Deg F	70	71	71	
WET	Moisture	%	1.74	2.1	1.96	
CRUSHER	Oxygen	%	20.9	20.9	20.9	
	Volumetric flow, actual	acfm	1643	1418	1418	
	Volumetric flow, standard	dscfm	1529	1319	1320	
	Isokinetic variation	%	102.3	111.2	108.2	
Circle: Production or feed rate Capacity:		TPH	234	285	285	
	Pollutant concentrations:					
	PM-10	mg/DSCF	1.919	1.387	1.069	
	% OF FILTERABLE PM	%	38.5%	43.4%	49.1%	
	Pollutant mass flux rates:					
	PM-10	lb/hr	0.388	0.242	0.187	
	FILTERABLE PM	%	1.01	0.558	0.380	
	Emission factors:					
	PM-10	lb/ton	0.00166	0.000849	0.000655	0.00105
	FILTERABLE PM	%	0.00431	0.00196	0.00133	0.00253

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
3	Stack temperature	Deg F	71	71	71	
DRY	Moisture	%	1.7	2.71	2.56	
SCREEN	Oxygen	%	20.9	20.9	20.9	
	Volumetric flow, actual	acfm	561	563	562	
	Volumetric flow, standard	dscfm	522	518	519	
	Isokinetic variation	%	98	100.2	98.4	
Circle: Production or feed rate Capacity:		TPH	419	419	419	
	Pollutant concentrations:	values reduced by ambient PM-10 concentration				
	PM-10	mg/DSCF	1.01	2.37	5.04	
	% OF FILTERABLE PM	%	21.1%	7.8%	16.0%	
	Pollutant mass flux rates:					
	PM-10	lb/hr	0.0697	0.162	0.346	
	FILTERABLE PM	%	0.331	2.08	2.16	
	Emission factors: screen size factor of 40 applied to factors					
	PM-10	lb/ton	0.00666	0.0155	0.0330	0.0184
	FILTERABLE PM	%	0.0316	0.199	0.206	0.146

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
4	Stack temperature	Deg F	72	80	76	
WET	Moisture	%	2.07	2.53	2.48	
SCREEN	Oxygen	%	20.9	20.9	20.9	
	Volumetric flow, actual	acfm	597	637	634	
	Volumetric flow, standard	dscfm	552	580	582	
	Isokinetic variation	%	91.7	87.3	86.3	
Circle: Production or feed rate Capacity:		TPH	435	415	415	
	Pollutant concentrations:	values reduced by ambient PM-10 concentration				
	PM-10	mg/DSCF	0.336	0.105	0.0862	
	% OF FILTERABLE PM	%	7.9%	19.6%	15.1%	
	Pollutant mass flux rates:					
	PM-10	lb/hr	0.0245	0.00806	0.00664	
	FILTERABLE PM	%	0.311	0.0411	0.0439	
	Emission factors: screen size factor of 24 applied to factors					
	PM-10	lb/ton	0.00226	0.000776	0.000640	0.00122
	FILTERABLE PM	%	0.0286	0.00396	0.00424	0.0123

Section ~~X~~ II Reference 8
AP-42 Reference [illegible]

Emission Test Report Review Checklist--Short Form

Reviewer: BRIAN SHRAGER
Review Date: 2/9/94

A. Background Information

1. Facility name: Vulcan Materials Company
   Location: Maryville, Tennessee
2. Source category: Crushed Stone (limestone)
3. Test date: June 7-10, 1993
4. Test sponsor: USEPA / EMB
5. Testing contractor: ENTROPY
6. Purpose of test: Determine PM-10 emissions
7. Pollutants measured (include test method and indicate if valid): PM-10 - EPA Method 201A
   Quasi-stack on crusher
   Track-mounted hood on screen - adaptation of "roof monitoring"

8. Process overview: Attach a process description and a block diagram. Identify processes tested with letters from the beginning of the alphabet (A, B, C, etc...) and APC systems with letters from the end of the alphabet (V, W, X, etc...). Also identify test locations with Arabic numerals (1,2,3, ...). Using the ID symbols from the diagram, complete the table below.

Test ID	Process	Process ID	Emissions tested: Uncontrolled	Emissions tested: Controlled	APCD (controlled emissions only)
1	Tertiary Crushing	A	✓ (<1.0% moisture)		ID: Type: Model #:
2	Tertiary Crushing	A		✓ (>1.0% Moisture)	ID: Type: Model #:
3	~~Tertiary~~ screening	B	✓ (<1.0% Moisture)		ID: Type: Model #:
4	~~Tertiary~~ screening	B		✓ (>1.0% Moisture)	ID: Type: Model #:

B. Process Information

1. Provide a brief narrative description of the process and attach process flow diagram. (Note: If the process description provided in the test report is adequate, attach a copy here.)

2.0 PLANT AND SAMPLING LOCATION DESCRIPTION

2.1 PROCESS DESCRIPTION AND OPERATION

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

The inlet to the shorthead crusher was defined as the discharge of the vibrating feeder to the shorthead crusher vessel. This area, having a height of approximately 6 feet above the platform, was enclosed with galvanized steel flashing to allow capture of the PM10 emissions caused by the stone-to-stone attrition during movement of the stone. The gas velocities around the layers of stone were maintained at gas flow rates equivalent to 1 to 5 mph.

The discharge point of the shorthead tertiary crusher is the same conveyor leading from the secondary surge pile that feeds the 6′ X 16′ vibrating screens (stream number 16 on Figure 1). The discharge point is enclosed approximately 5 feet upstream and downstream of the shorthead discharge point. The discharge of the shorthead crusher was defined as the total enclosure presently surrounding conveyor number 16 underneath the crusher.

The vibrating screens at the Maryville, Tennessee plant of Vulcan Materials Company consists of two parallel 6 x 16 triple deck screens (equipment numbers 13 and 14 in Figure 1). These screens receive stone from the conveyor numbered 16 in Figure 1. A spliter is used to proportion the stone between the two screens. The vibrating screen source was defined as the 6 foot wide, 16 foot long open, sloped surface above the upper screen deck. There is approximately a 10 inch freeboard above the upper screen to reduce wind entrainment of dust. The area traversed as part of this test program was the sloped surface parallel to the top of the freeboard.

The stone flow to the vibrating screens and the 5.5′ crusher is termed "closed circuit" since oversized material containing some fines adhering to the surface can recirculate through the vibrating screens and 5.5′ crusher until the stone is crushed small enough to fall through the vibrating screen. The oversized material remaining on the top screen goes to the inlet of the 5.5′ crusher. The total quantity of oversized material entering the 5.5′ crusher was approximately 260 tons per hour. The stone feed rates to the two vibrating screens were approximately 350 tons per hour or 175 tons per hour per screen.

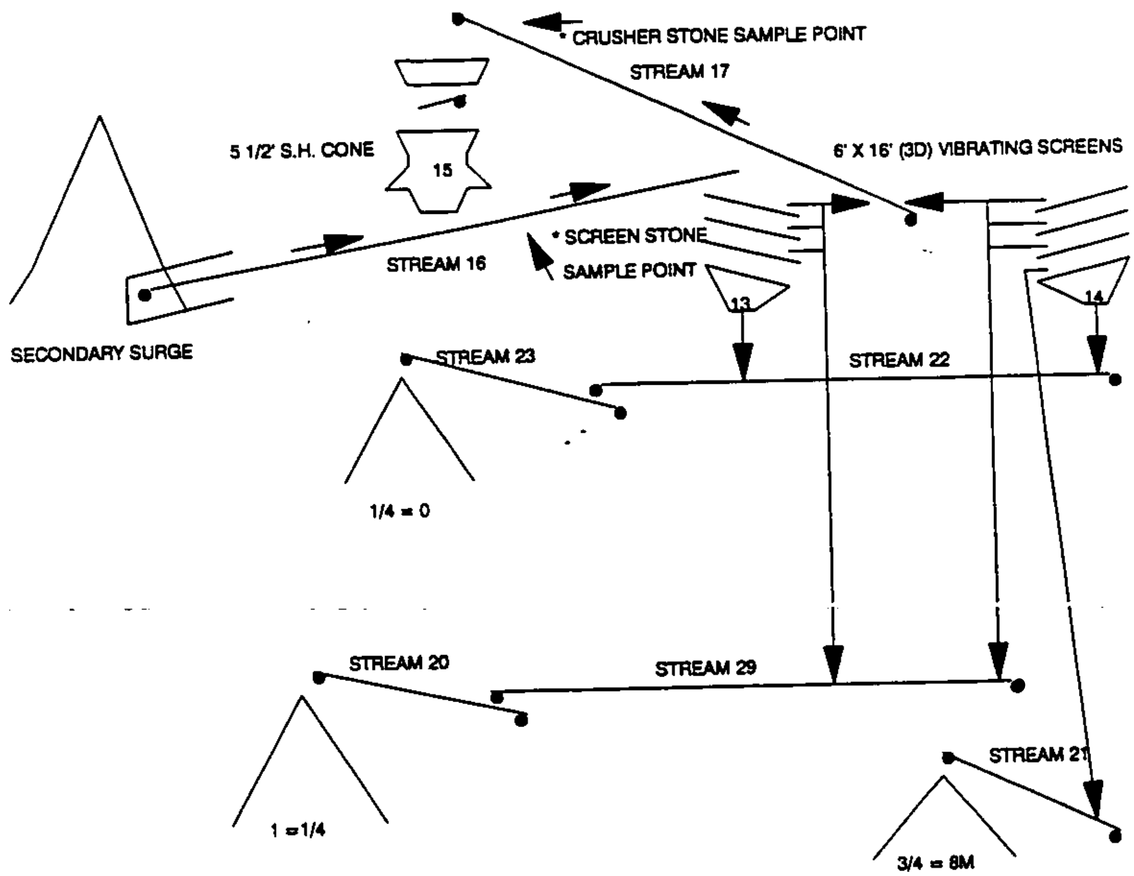


Figure 1. Simplified Process Flowchart

TABLE 8-1. PARTICLE SIZE DISTRIBUTIONS FOR DRY RUNS

Size Range	Fraction of Sample in Specified Range: Test 1,2,3 Dry
> 37.5 Millimeters	0
> 19.0 Millimeters	0.065
> 4.75 Millimeters	0.280
> 2.00 Millimeters	0.464
> 150 Microns	0.141
> 75 Microns	0.019
> 38 Microns	0.014 } 3.1%
Bottom Pan	0.017 }

TABLE 8-2. PARTICLE SIZE DISTRIBUTIONS FOR WET RUNS

	Fraction of Sample in Specified Range		
Size Range	Test 1, Wet	Test 2, Wet	Test 3, Wet
> 37.5 Millimeters	0	0	0
> 19.0 Millimeters	0.125	0.050	0.034
> 4.75 Millimeters	0.267	0.420	0.268
> 2.00 Millimeters	0.447	0.405	0.453
> 150 Microns	0.111	0.079	0.175
> 75 Microns	0.020	0.020	0.029
> 38 Microns	0.015 } 3.1%	0.014 } 2.6%	0.023 } 4.2%
Bottom Pan	0.016 }	0.012 }	0.019 }

C. 1. List any APCD parameters (supplied in the test report) below.

APCD ID	Parameter	Units	Readings			
			Run 1	Run 2	Run 3	Run 4
Z	% moisture	%	1.21	1.12	1.98	
Type of APCD: wet suppression >1.0% moisture						
uncontrolled	% moisture	%	0.67	0.89	0.46	
Type of APCD:						
Type of APCD:						

2. Include any additional information (such as capture techniques for fugitive systems) and descriptions of the air pollution control systems (use a separate page if necessary).

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
	Stack temperature					
	Moisture					
	Oxygen					
	Volumetric flow, actual					
	Volumetric flow, standard					
	Percent isokinetic					
Circle: Production or feed rate Capacity:						
	Pollutant concentrations:					
	Pollutant mass flux rates:					
	Emission factors:					

D. Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
1	Stack temperature	Deg F	77	77	77	
DRY	Moisture	%	2.87	3.11	0.87	
CRUSHER	Oxygen	%	20.9	20.9	20.9	
	Volumetric flow, actual	acfm	1687	1687	1680	
	Volumetric flow, standard	dscfm	1564	1560	1590	
	Isokinetic variation	%	104.2	103.6	100.3	
Circle: Production or feed rate Capacity:		TPH	282	246	267	
	Pollutant concentrations:					
	PM-10	mg/DSCF	1.07	1.56	1.31	
	% OF FILTERABLE PM	%	6.2%	4.8%	5.9%	
	Pollutant mass flux rates:					
	PM-10	lb/hr	0.221	0.322	0.276	
	FILTERABLE PM	lb/hr	3.57	6.71	4.67	
	Emission factors:					
	PM-10	lb/ton	0.000785	0.00131	0.00103	0.00104
	FILTERABLE PM	lb/ton	0.0127	0.0273	0.0175	0.0191

Test ID	Parameter	Units	Values reported Run 1	Run 2	Run 3	Run 4
2	Stack temperature	Deg F	76	78	79	
WET	Moisture	%	2.15	2.65	2.52	
CRUSHER	Oxygen	%	20.9	20.9	20.9	
	Volumetric flow, actual	acfm	1645	1653	1616	
	Volumetric flow, standard	dscfm	1541	1529	1510	
	Isokinetic variation	%	103	107	104.2	
Circle: Production or feed rate Capacity:		TPH	267	228	291	
	Pollutant concentrations:					
	PM-10	mg/DSCF	0.247	0.165	0.153	
	% OF FILTERABLE PM	%	12.3%	9.9%	12.6%	
	Pollutant mass flux rates:					
	PM-10	lb/hr	0.0503	0.0334	0.0306	
	FILTERABLE PM	lb/hr	0.409	0.337	0.243	
	Emission factors:					
	PM-10	lb/ton	0.000189	0.000146	0.000105	0.000147
	FILTERABLE PM	lb/ton	0.00153	0.00148	0.000833	0.00128

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
3	Stack temperature	Deg F	78	78	78	
DRY	Moisture	%	2.57	2.74	2.66	
SCREEN	Oxygen	%	20.9	20.9	20.9	
	Volumetric flow, actual	acfm	604	604	604	
	Volumetric flow, standard	dscfm	561	560	560	
	Isokinetic variation	%	103.1	102.8	103	
Circle: Production or feed rate Capacity:		TPH	171	166	160	
	Pollutant concentrations:	values reduced by ambient PM-10 concentration				
	PM-10	mg/DSCF	0.65	0.68	0.6	
	% OF FILTERABLE PM	%	27.5%	7.7%	6.5%	
	Pollutant mass flux rates:					
	PM-10	lb/hr	0.0482	0.0504	0.0444	
	FILTERABLE PM	lb/hr	0.175	0.654	0.684	
	Emission factors: screen size factor of 24 applied to factors					
	PM-10	lb/ton	0.00677	0.00728	0.00667	0.00691
	FILTERABLE PM	lb/ton	0.0246	0.0946	0.103	0.0739

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	Run 4
4	Stack temperature	Deg F	78	78	81	
WET	Moisture	%	2.05	2.62	2.25	
SCREEN	Oxygen	%	20.9	20.9	20.9	
	Volumetric flow, actual	acfm	596	597	617	
	Volumetric flow, standard	dscfm	557	553	576	
	Isokinetic variation	%	93.5	105.1	90.1	
Circle: Production or feed rate Capacity:		TPH	206	168	176	
	Pollutant concentrations:	values reduced by ambient PM-10 concentration				
	PM-10	mg/DSCF	0.0688	0.0543	0.047	
	% OF FILTERABLE PM	%	15.3%	18.3%	11.5%	
	Pollutant mass flux rates:					
	PM-10	lb/hr	0.00507	0.00397	0.00358	
	FILTERABLE PM	lb/hr	0.0331	0.0217	0.0311	
	Emission factors: screen size factor of 24 applied to factors					
	PM-10	lb/ton	0.000591	0.000567	0.000488	0.000549
	FILTERABLE PM	lb/ton	0.00386	0.00310	0.00425	0.00374