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

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

AP42 Section:	11.19.2
Reference:	2
Title:	Written communication from J. Richards, Air Control Techniques, P.C., to B. Shrager, MRI. March 18, 1994.

AIR CONTROL TECHNIQUES, P.C.

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March 18, 1994

Mr. Brian L. Shrager
Midwest Research Institute
Suite 350
401 Harrison Oaks Boulevard
Cary, North Carolina 27513-212

Dear Mr. Shrager:

Enclosed is material concerning the stone emission factors which I prepared on behalf of the National Stone Association. We hope that this material is of use to you in preparing the revised Section B.19.2 concerning stone crushing plants. Thanks for your assistance with the updating of these emission factors.

Sincerely,

John Richards
Air Control Techniques, P.C.

Enclosure

8.19.2 CRUSHED STONE PROCESSING

8.19.2.1 Process Description

Crushed stone processing involves the quarrying, crushing, and sizing of stone. Various gradations of stone products are used for road and building construction.

An example of a crushed stone production facility is shown in the flowcharts in Figures 8.19.2-1, 8.19.2-2, and 8.19.2-3. These flowcharts illustrate the emission sources which are evaluated by means of emission factors.

The quarry and primary crusher are shown in Figure 8.19.2-1. In the quarry, stone is prepared for blasting by wet drilling 7.5 to 18 centimeter (three to seven inch) holes into the top of the area to be removed.

Blasting involves the controlled use of explosives and blasting agents loaded into the drilled holes. Blasting may be conducted up to two or three times per week depending on the capacity of the processing plant and the amount of stone dislodged per blast. This operation is monitored carefully to minimize noise, vibration, and dust emissions.

After the blast, front end loaders and/or shovels pick-up the fragmented rock and load it into large haul trucks. The capacity of the haul trucks usually varies between 35 to 85 tons per load. The trucks use unpaved haul roads within the quarry which lead over to dump hopper which supplies the vibrating grizzly feeder and the primary crusher. The purpose of the primary crusher is to reduce the fragmented rock to a size range which can be handled on conveyors leading from the quarry area to the main processing area of the plant.

The grizzly feeder transports the fragmented stone to the primary crusher. Stone that is already sufficiently small is separated from the main stone stream in the grizzly feeder. This small material (grizzly throughs) bypasses the primary crusher and goes to the surge pile. This reduces the material throughput of the primary crusher and reduces dust emissions. Jaw or gyratory crushers are usually used for initial reduction in the primary crusher. The primary crusher output is normally 7.5 to 30 centimeters (3 to 12 inches) in diameter. The primary crusher output and the grizzly throughs (undersize material) are discharged onto the initial conveyor and usually are discharged onto a surge pile for temporary storage.

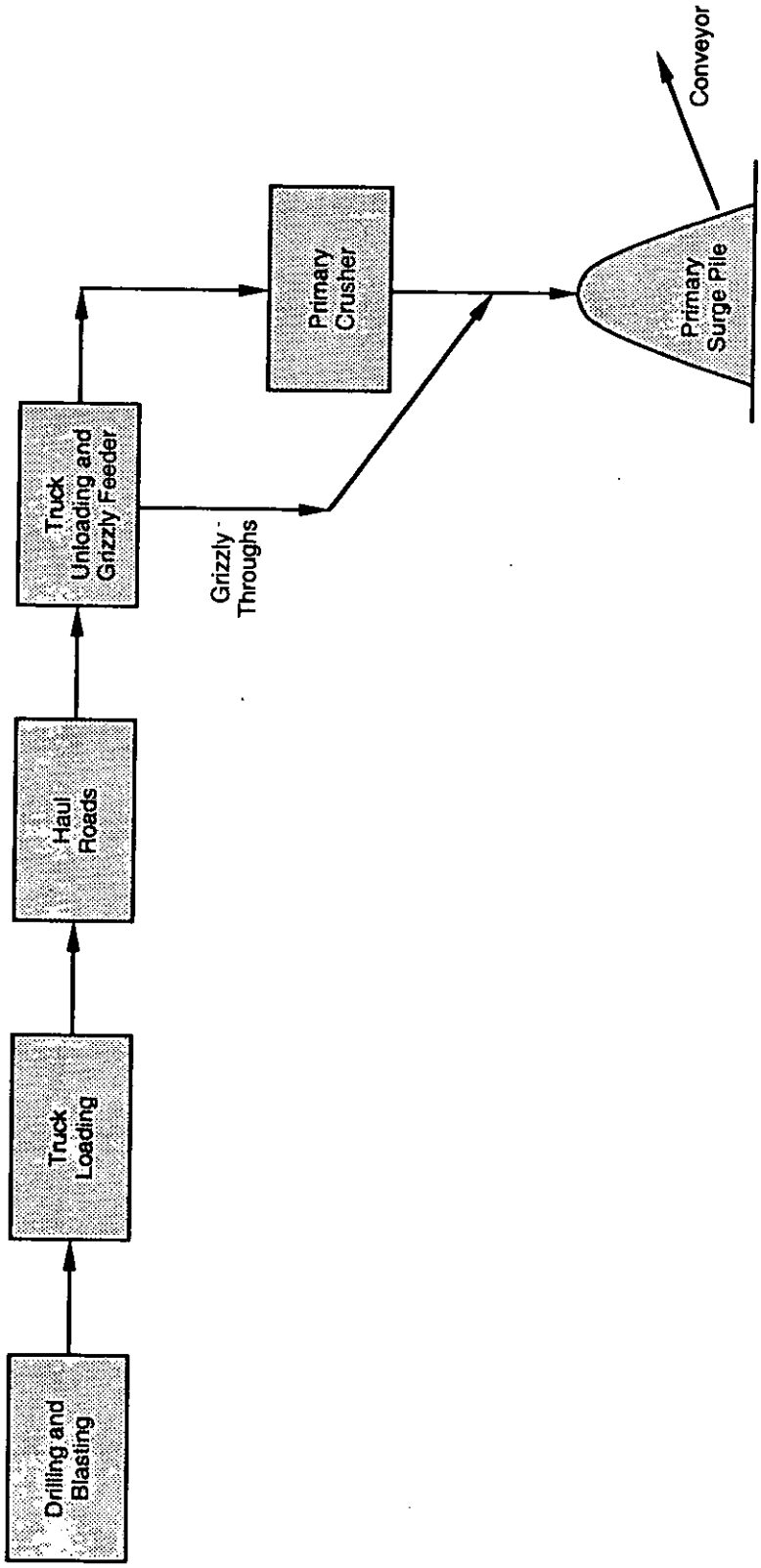

Figure 8-19.2-1 Quarry and Primary Circuit

The secondary and tertiary circuits shown in Figure 8.19.2-2 produce the various gradations of rock products. 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 underflow from the scalping screen is a product stream which is transported to a storage pile and sold as base material.

The stone which 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 bypass the secondary crusher since they are 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.

Tertiary crushing is usually performed using cone crushers or hammermills. Oversized material from the top deck of the vibrating inclined screen is fed to the tertiary crusher. The tertiary crusher output is returned to the vibrating inclined screening for re-sizing. 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.

Wet suppression systems are used at many stone crushing plants. These consists of spraying units on a number of the conveyors and feeders located in the secondary and tertiary processing circuits. These are designed to maintain adequate surface moisture levels.

Some stone crushing sand plants produce manufactured sand. This is a small sized rock product with a maximum size of 0.50 centimeters (3/16th inch). The additional processing involved in the preparation of manufactured sand is illustrated in Figure 8.19.2-3.

Crushed stone is sized in a vibrating inclined screen with relatively small mesh sizes. Oversized material is processed in a cone crusher or a hammermill adjusted to produce small diameter material. The output is then returned to the vibrating inclined screen for resizing. The product stream separated in the screening operation has a top size of less than 0.50 centimeters (3/16th of an inch).

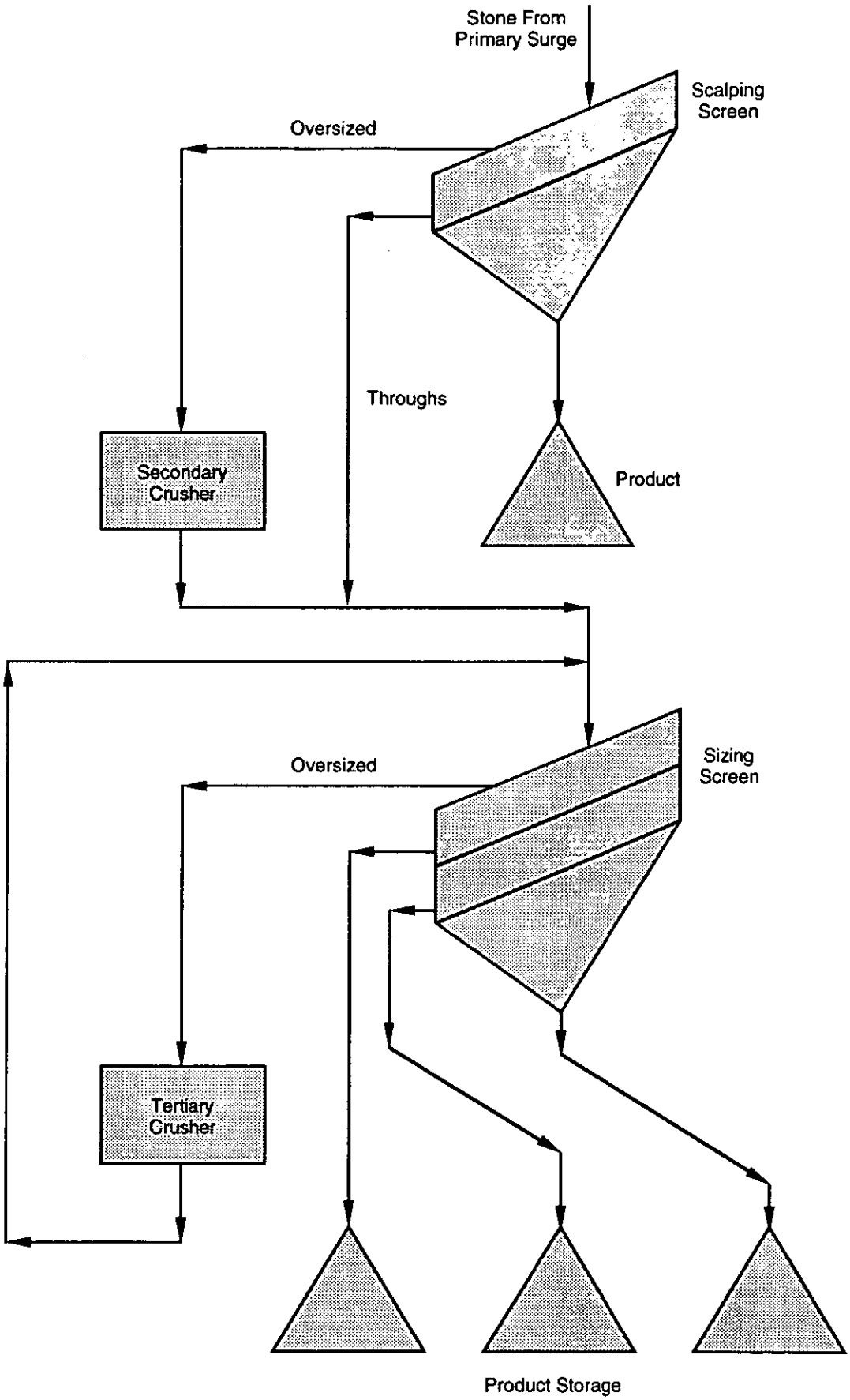

Figure 8.19.2-2. Secondary and tertiary circuits.

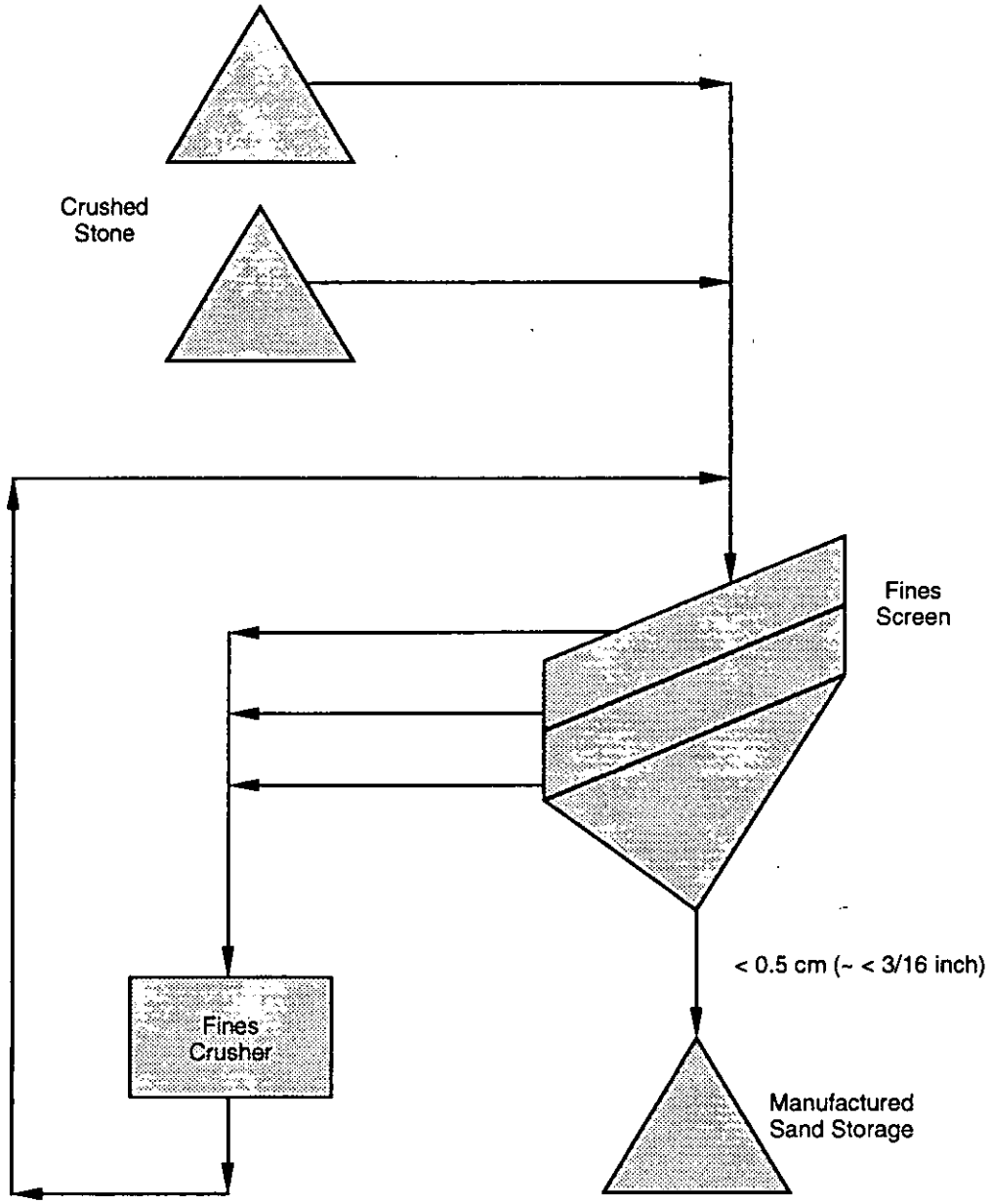

Figure 8.19.2-3. Fines (≤3/16th inch) Circuit

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

Dust emissions occur from a number of operations in stone quarrying and processing. A substantial portion of these emissions consist of heavy particles that settle out in the plant.

As in other operations, crushed stone emission sources may be categorized as either enclosed process sources or fugitive dust sources. Enclosed 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 (1) the surface moisture content, (2) stone size distribution, (3) stone throughput rate, (4) the type of equipment and operating practices used, (5) topography and climatic factors, and (6) the emission testing methods.

These do not affect the emissions.

Stone Surface Moisture Content

The stone surface moisture content is dependent primarily on the operating characteristics of the wet suppression system used throughout the plant. Weather conditions also affect the stone surface moisture content. The wet suppression system is adjusted to take the weather conditions into account.

The stone surface moisture content of the material processed can have a substantial effect on emissions. Surface wetness causes fine particles to agglomerate on or to adhere to the faces of larger stones. This results in a substantial reduction in the dust emission rate. Typically, stone that has been wetted by the plant's wet suppression equipment has moisture levels of 1 to 4 percent depending on the stone size distribution. Large stone generally has slightly less moisture on a per ton basis since the large diameter material has less surface area than small diameter stone.

Stone Size Distribution

The stone size distribution decreases as it passes through the primary, secondary, and tertiary circuits. The smaller diameter stone produced in the tertiary area is more easily entrained by wind and by air currents in the processing equipment. Accordingly, dust emissions from the tertiary circuit equipment are higher than emissions from the secondary and primary circuit equipment. Emissions from the tertiary circuit and even the secondary circuit are further increased by the friction-related drying effect of the size reduction operations.

The type of stone being processed is important to the extent that this may affect the stone size distribution. Data available, however, from granite and limestone facilities indicated very similar PM_{10} emissions.

Stone Throughput

The particulate emissions increase slightly as the production rates increase. Therefore, the emission factors are expressed on a pounds per ton of stone basis.

Type of Equipment and Operating Conditions

The design types of crushers, screens, and other equipment may be important with respect to the stone size distributions which are generated in this equipment. Operating conditions that affect the stone size distribution may also be important. At the present time, insufficient information is available to fully characterize any differences between the commercial types of equipment and the various operating conditions.

Climatic Conditions

The wind speed is important since wind entrainment of particulate is the main fugitive emission mechanism. Emissions are higher when the wind speed is high. The ambient relative humidity levels and rainfall levels are also important climatic conditions since they affect the stone moisture levels.

Emission Testing Methods

The test procedures used to determine emissions factors introduce some variability into the available data base. There are two main techniques: (1) extractive testing, and (2) plume profiling. Emission factors based on extractive tests (conventional emission testing procedures) using U.S. EPA Reference Methods are generally higher than those based on plume profiling tests (upwind and downwind ambient sampling). The extractive tests have a greater degree of reliability.

8.19.2.3 Emission Factors

The emission factors for stone crushing plants are presented in Tables 8.19.2-1 and 8.19.2-2. The tables are presented in pairs, one in metric units of kilograms PM_{10} per megagram and the other in English units of pounds PM_{10} per ton.

The data for the secondary and tertiary screening and crushing operations shown on Figure 8.19.2-2 are shown in Table 8.19.2-1. The emission factors data has been divided into two sets. Uncontrolled emissions (no wet suppression system in operation) are shown in the right column. Controlled emissions are shown in the center.

The data base for the crushing and screening emission factors in Table 8.19.2-1 consists of four separate test programs. Two of these were conducted at granite processing plants and two were conducted at limestone processing plants. Each of the tests consisted of three separate runs using U.S. EPA Reference Method 201A, an extractive-type test procedure. All of the emission

tests were conducted on tertiary screens and crushers. The emissions from the tertiary processes are expected to be higher than from the primary and secondary crushers and screens. However, the tertiary circuit data has been applied to these other units due to the lack of specific information on primary and secondary processes. Such an approach conservatively overestimates the emissions from the primary and secondary units.

The emission factors for conveyor transfer points were measured during tests at three separate conveying units at two different plants. All of the measurement sites were on the main conveyor leading to the tertiary crusher. Accordingly, the size distribution of the stone being handled was relatively small. Emissions from the tested units should be higher than conveyors handling larger sized stone material. All of the conveyor transfer point data was obtained using U.S. EPA Reference Methods.

Available emission factors for other operations at a stone crushing plant are summarized in Table 8.19.2-2. These factors have been determined through tests at various quarries and processing plants. The singe-valued open dust emission factors given in Table 8.19.2-2 may be used when no other information is available. 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 of the emission factors in Table 8.19.2-2 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.

Emission factor estimates for stone quarry blasting operations are not presented here because of the sparsity and unreliability of the 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, moisture content, and size of the blast areas. Furthermore, blasting occurs only two to three times per week and the emissions persist for a very short time period. These emissions are considerably smaller than for processes that operate on a continuous basis.

Table 8.19.2-1 (METRIC UNITS)
EMISSION FACTORS FOR STONE CRUSHING PLANTS
Emission Factors in kG/Mg of Material Throughput
Ratings (A-E) Follow Each Emission Factor

PM_{10} Emissions, Kg/Mg	Wet Suppression		Uncontrolled	
	Kg/Mg	Rating	Kg/Mg	Rating
Primary, Secondary, and Tertiary Crushers[8,11,12,13]	0.00029	B	0.0012	B
Fines Crushing[10]	0.00102	D	0.0073	D
Screening[9,11,12,13]	0.00042	B	0.0073	B
Fines Screening[10]	0.00092	D	0.0352	D
Conveyor Transfer Points[14,15]	0.000023	B	0.00070	B

Table 8.19.2-1 (ENGLISH UNITS)
EMISSION FACTORS FOR STONE CRUSHING PLANTS
Emission Factors in lb/ton of Material Throughput
Ratings (A-E) Follow Each Emission Factor

PM_{10} Emissions, Pounds/Ton of Stone	Wet Suppression		Uncontrolled	
	Lbs/Ton	Rating	Lbs/Ton	Rating
Primary, Secondary, and Tertiary Crushers[8,11,12,13]	0.00057	B	0.0024	B
Fines Crushing[10]	0.00203	D	0.0145	D
Screening[9,10,12,13]	0.00083	B	0.0146	B
Fines Screening[10]	0.00184	D	0.0704	D
Conveyor Transfer Points[14,15]	0.000046	B	0.00141	B

Emission factors represent uncontrolled emissions unless noted. Sources controlled with wet suppression process material with a moisture content ≥ 1.5 percent by weight. Uncontrolled sources process material with a moisture content < 1.5 percent by weight.

Reference numbers for the emission factor data are shown as superscripts in the above tables.

Table 8.19.2-2 (METRIC UNITS)
EMISSION FACTORS FOR STONE CRUSHING PLANTS
Emission Factors in kG/Mg of Material Throughput
Ratings (A-E) Follow Each Emission Factor

PM_{10} Emissions, kilograms per Megagram of Stone	Uncontrolled	
	kg/Mg	Rating
Wet Drilling and Blasting, Unfragmented Stone	0.00004	E
Unpaved Haul Roads	b	-
Truck Unloading: Fragmented Stone (Quarry Area)	0.000008	D
Truck Loading from Conveyor: Crushed Stone (Product)	0.00005	E
Truck Load from Front End Loader: Crushed Stone (Product)	a	-

Table 8.19.2-2 (ENGLISH UNITS)
EMISSION FACTORS FOR STONE CRUSHING PLANTS
Emission Factors in lb/ton of Material Throughput
Ratings (A-E) Follow Each Emission Factor

PM_{10} Emissions, Pounds/Ton of Stone	Uncontrolled	
	Lbs/Ton	Rating
Wet Drilling and Blasting: Unfragmented Stone	0.00010	E
Unpaved Haul Roads	b	-
Truck Unloading: Fragmented Stone (Quarry Area)	0.00002	D
Truck Loading - Conveyor: Crushed Stone	0.00010	E
Truck Loading - Front-End Loader: Crushed Stone	a	-

Notes:
a. No data available
b. See Section 11.2 for empirical equation

Emission factors represent uncontrolled emissions unless noted. Sources controlled with wet suppression process material with a moisture content ≥ 1.5 percent by weight. Uncontrolled sources process material with a moisture content < 1.5 percent by weight.

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.

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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, Arcadia, Calif., 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, N.C., June 1974.

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8. J. Richards, T. Brozell, and W. Kirk, PM-10 Emissions from a Tertiary Crusher, U.S. EPA Contract 68-D1-0055, January 1992.

9. J. Richards, T. Brozell, and W. Kirk, PM-10 Emissions from a Tertiary Screen, U.S. EPA Contract 68-D1-0055, January 1992.

10. W. Kirk, T. Brozell, and J. Richards, PM-10 Emissions from a Tertiary Crusher and a Tertiary Screen, U.S. EPA Contract 68-D1-0055, October 1992.

11. T. Brozell, J. Richards, and W. Kirk, PM-10 Emissions from a Tertiary Crusher and a Tertiary Screen , National Stone Association Contract. December 1992.

12. T. Brozell and J. Richards, PM-10 Emissions from a Tertiary Crusher and a Tertiary Screen , U.S. Environmental Protection Agency, May 1993.

13. T. Brozell and J. Richards, PM-10 Emissions from a Tertiary Crusher and a Tertiary Screen , U.S. Environmental Protection Agency, May 1993.

14. T. Brozell, J. Richards, and W. Kirk, PM-10 Emissions from a Conveyor Transfer Point, U.S. EPA Contract 68-D1-0055, February 1993.

15. T. Brozell, PM-10 Emissions from Two Transfer Points at a Granite Stone Crushing Plant, U.S. EPA Contract 68-D1-0055, January 1994.

BACKGROUND INFORMATION

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. PM_{10} emission data from eight test programs 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, 2, and 3 present the new emission data and the emission factors developed for inclusion in the revised AP-42 section. The new emission factors for crushing, screening, and conveying have replaced the previous factors which are considerably less accurate. The narrative section also has been revised. The draft AP-42 section is provided as an attachment.

II. DESCRIPTION OF REFERENCES

A. Reference 1

This test report documents an emission test conducted at 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 inclined screen were measured using EPA Method 210A. A track-mounted hood system was used to capture fugitive emissions from an area immediately above the screen.

The Deister screen consists 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 (0.2118 in.) by 2.54 cm (1 in.). Ambient levels of PM_{10} were measured using M_{10} HIVol samplers immediately upwind of the screen, and the ambient concentrations were subtracted from the Method 201A concentrations to determine the actual PM_{10} emissions contributed by 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.

Table 1. Vibrating Screen and Tertiary Crusher Data

Emission Source	Ave. Moisture % wt.	No. Runs	Emission Factor Range kg/Mg (lb/ton)	Ave. Factor	Ref.
Tertiary Screens	0.48	3	0.0010-0.0075 (0.0020-0.0150)	0.0035 (0.0070)	1
	1.57	3	0.00028-0.00037 (0.00056-0.00074)	0.00031 (0.00061)	1
	0.70	3	0.012-0.015 (0.024-0.030)	0.014 (0.027)	3
	1.78	3	0.00049-0.00055 (0.00097-0.0011)	0.00050 (0.0010)	3
	0.67	3	0.00334-0.00366 (0.00668-0.00731)	0.00035 (0.00069)	5
	1.44	3	0.000285-0.00030) (0.000570-0.00059)	0.00275 (0.00549)	5
	0.88	3	0.00334-0.00165 (0.00668-0.0330)	0.0092 (0.0184)	6
	2.07	3	0.00032-0.00113 (0.00064-0.00225)	0.0061 (0.00122)	6
Tertiary Crushers	0.44	3	0.00075-0.0010 (0.0015-0.0020)	0.00090 (0.0018)	2
	1.77	3	0.00017-0.00055 (0.00034-0.0011)	0.0042 (0.0083)	2
	0.70	3	0.0011-0.0031 (0.0021-0.0062)	0.0020 {0.0040)	3
	1.78	3	0.000075-0.00019 (0.00015-0.00037)	0.00013 {0.00026)	3
	0.67	3	0.0039-0.00066 (0.0078-0.00131)	0.00052 (0.00104)	5
	1.44	3	0.000053-0.00010 (0.000105-0.00019)	0.000074 (0.000147)	5
	0.88	3	0.00093-0.00203 (0.00185-0.00405)	(0.00146) (0.00292)	6
	2.07	3	0.00328-0.00083 (0.00655-0.00166)	0.00053 (0.00106)	6

The intended 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 feeding the screen. Slit 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 PM10 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 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 U.S. EPA Reference Method 201A. A quasi-stack system was used to capture fugitive emissions from the crusher.

The crusher reduces 8.9 to 10.2 cm (3.4 to 4 in.) stone to 2.5 cm (1 in.) and smaller. The crusher inlet and outlet were each enclosed and tested separately. Wet suppression is 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 intended 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.

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 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.

C. Reference 3

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 (tertiary crusher) and a Deister vibrating sloped screen (tertiary screen) were measured using U.S. EPA Reference Method 201A. The Deister vibrating sloped screen was located in an enclosure.

A quasi-stack enclosure and a track-mounted hood system 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 Deister vibrating sloped 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 first 2.44 m (8 ft.). The middle 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 is 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 intended 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.

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.

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 emissions data on stone crushing for AP-42 emission factor development. Uncontrolled and controlled PM_{10} emissions from a Model 1560 Omnicone conical-type crusher (fines crusher) and a TD Seco vibrating sloped screen (fines screen) were measured using U.S. EPA Reference Method 201A. Ambient levels of PM_{10} were quantified using PM_{10} HIVol samplers immediately upwind of the screen, and the ambient concentrations were subtracted from the Method 201A concentrations to determine the actual PM_{10} emissions contributed by the screen.

A quasi-stack enclosure and a track-mounted hood system 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 (0.876 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 intended 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 2.

Sieve analyses were performed on stone samples taken from the conveyor that feeds that 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} 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.

Reference 5

This test report documents an emission test conducted at the Vulcan Materials, Inc. plant in Marysville, Tennessee. 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

Table 2. Fines Screening and Crushing

Emission Source	Ave. Moisture % wt.	No. Runs	Emission Factor Range kg/Mg (lb/ton)	Ave. Factor	Ref.
Fines (<3/16th) Screens	0.70	3	0.021-0.05 (0.042-0.10)	0.036 (0.071)	4
	1.68	3	0.0006-0.0015 (0.0012-0.0030)	0.0011 (0.0021)	4
Fines (<3/16th) Crushers	0.97	3	0.00175-0.013 (0.0034-0.026)	0.00075 (0.0015)	4
	1.92	3	0.00055-0.0013 (0.0011-0.0026)	0.0010 (0.0020)	4

AP-42 emission factor development. Uncontrolled and controlled particulate matter less than 10 micrometers (μm) in diameter (PM_{10}) emissions from a Deister vibrating sloped screen were measured using EPA Method 210A. A track-mounted hood system was used to capture fugitive emissions from an area immediately above the screen.

The vibrating inclined screen consists of three vertically stacked decks. The upper deck has a mesh opening of 3.175 centimeters (cm) square (1.25 inches [in.] square). The middle deck has a mesh opening of 1.59 cm square (0.625 in. square), and the lower deck has slot openings of 0.635 cm (0.25 in.) square. ← Not a slot! Ambient levels of PM_{10} were quantified using PM_{10} HIVol samplers immediately upwind of the screen, and the ambient concentrations were subtracted from the Method 201A concentrations to determine the actual PM_{10} emissions contributed by 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 screens. Does not address the crusher!

The intended moisture content 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.

Sieve analyses were performed on stone samples taken from the conveyor that feeds the screen. Slit content of the stone as sampled (wet) was negligible, and the average silt content of the sample after drying was 1.9 percent. ← 1.9? I got 3.25% The relatively small amount of silt particles (<75 μm) present in the raw material suggests that the potential for PM10 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 data are assigned an A rating. The report provided adequate detail, the test methodology was sound, and no problems were reported.

Reference 6

This test report documents an emission test conducted at Vulcan Materials, Inc. plant in Bristol, Tennessee. 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 vibrating sloped screen were measured using EPA Method 210A. A track-mounted hood system was used to capture fugitive emissions from an area immediately above the screen. Crusher?

The vibrating, inclined screen consists of three vertically stacked decks. The upper deck has a mesh opening of 3.175 centimeters (cm) square (1.25 inches [in.] square). The middle deck has a mesh opening of 1.59 cm square (0.625 in. square), and the lower deck has mesh openings of 0.635 cm (0.25 in.) square. Ambient levels of PM_{10} were quantified using PM_{10} HIVol samplers immediately upwind of the screen, and the ambient concentrations were subtracted from the Method 201A concentrations to determine the actual PM_{10} emissions contributed by 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 screens. Not a deister screen

The target moisture content 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.

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 0.9 percent. The relatively small amount of silt particles (<75 μm) present in the raw material suggests that the potential for PM10 emissions from the material processing operations is low. I got 1.8%

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.

Reference 7

This test report documents an emission test conducted at the 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} emissions and total particulate emissions were determined for a conveyor transfer point on the conveyor leading to the vibrating sloped screens and the tertiary crusher. U.S. EPA Reference Methods 201A and 5 were used. A quasi-stack system was used to capture the fugitive emissions. Wet suppression was used to control emissions from the crusher. Water spray nozzles are located on the conveyor underneath the tertiary crusher, at a point two feet downstream from the transfer point enclosure, and at the entrance to the surge bin and vibrating feeder. The intended 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 3.

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.

Slit content of the stone as sampled (wet) was negligible, and the average silt content of the sample after drying was 1.5 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 3. The data are assigned an A rating. The report provided adequate detail, the test methodology was sound, and no problems were reported.

Reference 8

This test report documents an emission test conducted at the Wake Stone Corporation stone crushing plant in Knightdale, 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 PM_{10} emissions were determined for two separate conveyor transfer points on the conveyors leading to the vibrating sloped screens and the tertiary crusher. U.S. EPA Reference Methods 201A was used in conjunction with a quasi-stack system to capture the fugitive emissions. Wet suppression was used to control emissions from the transfer points. Water spray nozzles are located on the conveyor underneath the tertiary crusher, at points immediately downstream from the transfer point enclosures, and at the entrance to the surge bin and vibrating feeder.

The intended 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 3. The moisture levels were consistency below the target levels.

Table 3. Conveyor Transfer Points

Emission Source	Ave. Moisture % wt.	No. Runs	Emission Factor Range kg/Mg (lb/ton)	Ave. Factor	Ref.
Conveyor Transfer Point	0.29	3	0.00125-0.00163 (0.00249-0.00325)	0.000704 (0.001407)	7
	2.62	3	0.000006-0.0000095 (0.000012-0.000019)	0.000023 (0.000046)	7
Conveyor Transfer Point C1	0.27	3	0.000102-0.000209) (0.000203-0.000418)	0.00014 (0.00028)	8
	0.66	3	0.000031-0.000059 (0.000061-0.000118)	0.000046 (0.000092)	8
Conveyor Transfer Point J2	0.27	3	0.000370-0.000810 (0.000740-0.001620)	(0.00053 (0.00105)	8
	0.66	3	0.000009-0.000026 (0.000018-0.000051)	0.000015 (0.000030)	8

Sieve analyses were performed on stone samples taken from the conveyor that feeds the surge bin prior to the crusher. Slit content of the stone as sampled (wet) was negligible, and the average silt content of the sample after drying was 1.4 to 2.9. The relatively small amount of silt particles (<75 μm) present in the raw material suggests that the potential for PM10 emissions from the material processing operations is low. 1.4 - 2.4 ?

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 3. The data are assigned an A rating.

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 secondary screening, tertiary crushing, tertiary screening, fines crushing, fines screening operations, and conveyor transfer points. 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 or equal to 1.5 percent. Table 4 presents the emissions factors developed using the data from References 1 through 8.

The previous emission factor for tertiary crushers was 0.93 kg/Mg (1.9 pounds per ton). This factor applied only to dry emissions of total particulate. The PM_{10} emissions data for crushers should be substantially lower than the total particulate emissions. Processes which generate particles by means of physical attrition would need extreme mechanical energy levels to reduce stone to a size range predominately less than 10 microns. Most of the particulate matter generated by physical attrition in crushers is in the greater than 10 micron size range. The 0.93 kg/Mg factor also did not apply to processes which use wet suppression to reduce particulate emissions.

The previous PM_{10} emission factor for uncontrolled primary and secondary crushing processes was 0.0085 kg/Mg (0.017 pounds per ton). There was no factor for primary or secondary crushing with wet suppression. These processes have been grouped with tertiary crushing since the dust emissions should be less than from the tertiary crushing operation. Accordingly, the emission factor for tertiary crushing slightly overestimates emissions from primary and secondary crushing. The various crushing operations have been grouped since the recently developed tertiary crushing emission factors are considerably more accurate that the previously available data.

The previous emission factor for vibrating sloped screens was 0.06 kg/Mg (0.12 pounds per ton). This factor was based on a single test of a flat screen at an aggregate processing facility. The data applied only to dry stone conditions. For these reasons, this old data is not as accurate or as representative as the data described above which was developed recently by the U.S. EPA and the National Stone Association.

The previous emission factors for drilling, truck loading, haul roads, and other operations have not been changed. There is no recently published data concerning these operations.

The emission factors for the tertiary crushers and screening operations were assigned a B rating because there is data from a number of different units processing both limestone and granite.

No significant difference was found in the PM_{10} emissions from processes handling these two different types of stone. The emission factors for the fines crushing and screening operations were assigned a B rating since only one test program has been conducted. The emission factor data for the conveyor transfer points was assigned a B rating since there is data from three points. All of conveyor transfer points tested involved conveyors handling relatively small stone which had a higher potential to emit dust than conveyors handling stone from the primary surge pile and other areas of the plant upstream of the tertiary crushers. Accordingly, the conveyor transfer point tests may slightly overestimate emissions from conveyor transfer points in the plant.

Table 4. (METRIC UNITS)
EMISSION FACTORS FOR STONE CRUSHING PLANTS
Emission Factors in kG/Mg of Material Throughput
Ratings (A-E) Follow Each Emission Factor

PM_{10} Emissions, Kg/Mg Stone	Wet Suppression		Uncontrolled	
	Kg/Mg	Rating	Kg/Mg	Rating
Primary, Secondary, and Tertiary Crushers[2,3,5,6]	0.00029	B	0.0012	B
Fines Crushing[4]	0.00102	D	0.0073	D
Screening[1,3,5,6]	0.00042	B	0.0073	B
Fines Screening[4]	0.00092	D	0.0352	D
Conveyor Transfer Points[7,8]	0.000028	B	0.00037	B

Table 4. (ENGLISH UNITS)
EMISSION FACTORS FOR STONE CRUSHING PLANTS
Emission Factors in lb/ton of Material Throughput
Ratings (A-E) Follow Each Emission Factor

PM_{10} Emissions, Pounds/Ton of Stone	Wet Suppression		Uncontrolled	
	Lbs/Ton	Rating	Lbs/Ton	Rating
Primary, Secondary, and Tertiary Crushers[2,3,5,6]	0.00057	B	0.0024	B
Fines Crushing[4]	0.00203	D	0.0145	D
Screening[1,3,5,6]	0.00083	B	0.0146	B
Fines Screening[4]	0.00184	D	0.0704	D
Conveyor Transfer Points[7,8]	0.000046	B	0.00074	B

Emission factors represent uncontrolled emissions unless noted. Sources controlled with wet suppression process material with a moisture content ≥ 1.5 percent by weight. Uncontrolled sources process material with a moisture content < 1.5 percent by weight.

Reference numbers for the emission factor data are provided in the tables.

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