VOLUME II: CHAPTER13

TECHNICAL ASSESSMENT PAPER: AVAILABLE INFORMATION FOR ESTIMATING AIR EMISSIONS FROM STONE MINING AND QUARRYING OPERATIONS

May 1998

Prepared by:
Eastern Research Group, Inc.

Prepared for:
Point Sources Committee
Emission Inventory Improvement Program

DISCLAIMER

As the Environmental Protection Agency has indicated in Emission Inventory Improvement Program (EIIP) documents, the choice of methods to be used to estimate emissions depends on how the estimates will be used and the degree of accuracy required. Methods using site-specific data are preferred over other methods. These documents are non-binding guidance and not rules. EPA, the States, and others retain the discretion to employ or to require other approaches that meet the requirements of the applicable statutory or regulatory requirements in individual circumstances.

ACKNOWLEDGEMENT

This document was prepared by Eastern Research Group, Inc., for the Point Sources Committee of the Emission Inventory Improvement Program and for the Emission Factor and Inventory Group, U.S. Environmental Protection Agency. Members of the Point Sources Committee contributing to the preparation of this document are:

Dennis Beauregard, Co-Chair, Emission Factor and Inventory Group, U.S. Environmental Protection Agency
Bill Gill, Co-Chair, Texas Natural Resource Conservation Commission
Denise Alston-Guiden, Galson Consulting
Bob Betterton, South Carolina Department of Health and Environmental Control
Paul Brochi, Texas Natural Resource Conservation Commission
Alice Fredlund, Louisiana Department of Environmental Quality
Martin Hochhauser, Allegheny County Health Department
Gary Helm, Air Quality Management, Inc.
Toch Mangat, Bay Area Air Quality Management District
Ralph Patterson, Wisconsin Department of Natural Resources
Jim Southerland, North Carolina Department of Environment and Natural Resources
Eitan Tsabari, Omaha Air Quality Control Division
Bob Wooten, North Carolina Department of Environment and Natural Resources

CONTENTS

CONTENTS (CONTINUED)

TABLES

Tables **Page**

This page is intentionally left blank.

1

INTRODUCTION

The purpose of this paper is to summarize the activities performed by the Point Sources Committee (PSC) of the Emission Inventory Improvement Program (EIIP) to identify available emission estimation guidance information for the stone mining and quarrying source category. Stone mining and quarrying falls under the Non-metallic Mineral Mining Industry Group (U.S. Census Bureau, 1997). The Non-metallic Mineral Mining Industry Group is defined by Standard Industrial Classification (SIC) as Division B: Mining, Major Group 14: Mining and Quarrying of Non-metallic Minerals, except fuels (Occupational Safety and Health Administration [OSHA], 1997). The stone mining and quarrying source category consists of the following SIC industry groups:

- 1411 - Dimension Stone;
- 1422 - Crushed and Broken Limestone;
- 1423 - Crushed and Broken Granite;
- 1429 - Crushed and Broken Stone, including Riprap; and
- 1499 - Miscellaneous Non-metallic Minerals, except fuels.

It should be noted that SIC Major Group 14 includes other industry groups (four-digit SICs) that are not considered to be part of the stone mining and quarrying source category. Descriptions for these categories may be found at the SIC web address (OSHA, 1997).

In 1995, there were nearly 1,600 companies in operation with more than 3,200 active surface quarries and underground mines. These quarries produced 1.26 billion tons of crushed stone valued at $6.92 billion dollars (National Stone Association, 1997).

Section 2 of this paper presents a description of the source category, and Section 3 briefly describes the information collection activities. Section 4 provides a description of each guidance document acquired. Examples for estimating emissions from stone mining and quarrying using the acquired methodology are included in Section 5. NOTE: the methods used for these examples do not constitute endorsement as either a preferred or alternative method for estimating emissions by the Point Sources Committee. The purpose is to simply present available information. A comparison of estimates based upon the use of the different available methods is also included in Section 5. References are listed in Section 6.

2

SOURCE CATEGORY DESCRIPTION

This section describes the various stone mining and quarrying processes and identifies emission points, control devices, and the variables that can influence emissions.

2.1 PROCESS DESCRIPTION

Operations within the stone mining and quarrying industry are facility specific and may vary according to environmental conditions, rock type, and work practices. However, some major processes are common to most facilities and may be described in general terms. These descriptions are provided in *AP-42* and are presented in the following sections (U.S. Environmental Protection Agency [EPA], 1995).

2.1.1 PRE-PROCESSING (BLASTING, TRANSPORTING, AND DUMPING)

Rock and crushed stone products generally are loosened by drilling and blasting, and then are loaded by a power shovel or front-end loader into large haul trucks that transport the material to the processing operations. 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. The feeder or screens separate large boulders from finer rocks that do not require primary crushing, thus reducing the load to the primary crusher.

2.1.2 CRUSHING

Primary Crushing

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 conveyer and usually are conveyed to a surge pile for temporary storage, or are sold as coarse aggregates.

Secondary Crushing

Cone crushers are commonly used for secondary crushing (although impact crushers are sometimes used), which typically reduces material to about 2.5 to 10 centimeters (1 to 4 inches) in diameter. 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

Tertiary crushing is usually performed using cone crushers or other types of impactor crushers. Oversize material from the top deck of the sizing screen is fed to the tertiary crusher. The tertiary crusher output, which is typically 0.50 to 2.5 centimeters (3/16 to 1 inch) in diameter, is returned to the sizing screen. Some stone crushing plants produce manufactured sand, with a maximum diameter of 0.50 centimeters (3/16 inch).

Fines Crushing

Oversized material is processed in a cone crusher or a hammerhill (fines crusher) adjusted to produce small diameter material. The output is then returned to the fines screen for resizing.

2.1.3 SCREENING

Screening (Primary, Secondary, or Tertiary)

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 stone that is too large to pass through the top deck of the scalping screen is processed in a subsequent crusher.

Fines Screening

Crushed stone from the tertiary sizing screen is sized in a vibrating inclined screen (fines screen) with relatively small meshes.

2.1.4 MATERIAL HANDLING AND STORAGE OPERATIONS

In certain cases, as with concrete aggregate processing, stone washing is required to meet particular end product specifications. Conveyor belts move rocks between the crushing and screening stages.

The following table describes typical stone size classifications that occur as a result of crushing and screening processes:

TABLE 13.2-1

TYPICAL SIZE CLASSIFICATIONS

Primary crushing	7.5 to 30 centimeters
Secondary crushing	2.5 to 10 centimeters
Tertiary crushing	0.50 to 2.5 centimeters
Fines screening	<0.50 centimeters
Fines crushing	<0.50 centimeters

2.2 EMISSION POINTS

Each of the operations at stone mining and quarrying plants described in Section 2.1 is a potential emission source. Whether or not an operation is an actual emission source depends on plant-specific operating conditions, work practices, and emissions controls based at the plant.

2.3 VARIABLES THAT INFLUENCE EMISSIONS

Several environmental conditions (variables) may affect uncontrolled emission levels and their effects should be taken into consideration when estimating emissions. This is usually accomplished by including in the emission estimation calculation a term (factor or adjustment) for each variable that affects emission levels. Environmental conditions that may significantly affect uncontrolled emission levels are:

- Wind - Fugitive emission levels typically will increase with high wind. Some facilities will build an enclosure or barrier to reduce the effects of wind.

- Material moisture content - Process and fugitive emissions are greater in arid regions of the country than in temperate ones, and greater during the summer months because of a higher evaporation rate. Surface wetness causes fine particles to agglomerate on, or adhere to, the faces of larger stones, with a resulting dust suppression effect. Moisture content of a mined rock may range from nearly zero to several percent.

- Season - Evaporative emission levels are usually higher during the summer.
- Rock type - Emissions can vary according to rock type, such as volcanic, limestone, sandstone, and granite.
- Local weather conditions - Emissions can vary according to changes in humidity and air and ground temperature.
- Traffic - Vehicle's weight (both empty and loaded), number of tires, speed of vehicles, silt and moisture content of roadway.

3

INFORMATION GATHERING ACTIVITIES

Using the County Business Patterns Database, a query was performed to identify the number of stone mining and quarrying facilities in each state (U.S. Census Bureau, 1993). Air quality agencies in the 16 states with the most facilities (listed in Table 13.3-1) were then contacted to determine if guidance documents were available for estimating emissions from stone mining and quarrying facilities (processes).

In California, three local air quality agencies and the California Air Resources Board (CARB) were contacted. In the other states, state air quality agencies were contacted. A total of 13 agencies were surveyed representing 10 of the initial 16 states. Available emission estimation methodologies and guidance for estimating emissions were requested from each agency. The staff members and associated agencies contacted are listed in Table 13.3-2.

Through the informal survey, one result was that air quality personnel typically estimated emissions using emission factors and equations from *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources (AP-42)*. Eleven of the 13 agencies contacted used emission factors from the 5th edition of the *AP-42*, and one state agency used factors from *AP-42*, 4th edition. The issue of applicability of the *AP-42* 5th edition factors for stone mining and quarrying is a concern for some state and local agencies. Only one of the 13 agencies contacted had developed its own emission factors and equations for estimating emissions. Most agencies contacted maintain a publicly available emissions database for this industry.

Results of the information gathering activities show that 6 of the 13 agencies contacted provide some type of emissions estimation guidance to industries. Copies of the guidance documents were obtained from four of the six agencies: San Diego Air Pollution Control District (APCD), the Texas Natural Resource Conservation Commission (TNRCC), the Wisconsin Department of Natural Resources (DNR), and the Mojave Desert Air Quality Management District (AQMD). The guidance documents are described in Section 4.

TABLE 13.3-1

STATES WITH THE MOST STONE MINING AND QUARRYING FACILITIES[a]

State Contacted	Number of Facilities
Missouri[b]	143
Pennsylvania	133
Iowa[b]	100
Illinois	95
Virginia	78
Ohio[b]	77
Tennessee[b]	76
North Carolina	72
Kentucky[b]	71
California[b,c]	67
New York	67
Georgia[b]	64
Indiana	64
Texas[b]	57
Florida[b]	51
Wisconsin[b]	50

[a] Source: Census Bureau, 1993.
[b] Responded to the informal telephone survey.
[c] Three local air agencies and the Air Resources Board in California were contacted.

TABLE 13.3-2

PERSONNEL AND AGENCIES CONTACTED

Name	Agency
Marcia Banks	San Diego Air Pollution Control District
John Castanis	Kentucky Division of Air Quality
Emily Chen	Iowa Department of Natural Resources
Qui Chiu	Tennessee Air Pollution Control
Rita Felton	Florida Department of Environmental Protection
Dennis Goodenow	California Air Resources Board
Tom Kalman	Ohio Environmental Protection Agency
Richard McDonald	Georgia Environmental Protection Division
Judy Mobrice	Missouri Air Pollution Control Division
Ralph Patterson	Wisconsin Department of Natural Resources
Terry Thomas	Ventura County Air Quality Management District
Richard Wales	Mojave Desert Air Quality Management District
Dois Webb	Texas Natural Resource Conservation Commission

This page is intentionally left blank.

4

AVAILABLE INFORMATION FOR ESTIMATING EMISSIONS

The following sections provide a description of each guidance document that was obtained. Table 13.4-1 summarizes the available guidance for estimating emissions from stone mining and quarrying processes found in the five documents.

4.1 INFORMATION IN AP-42

AP-42 describes some of the major processes used at stone mining and quarrying facilities. These processes include pre-processing, crushing, screening, material handling, and storage operations (EPA, 1995). Particulate Matter (PM) and PM with an aerometric diameter less than or equal to 10 micrometers (PM_{10}) emissions are the primary pollutants emitted from these processes. *AP-42* presents controlled and uncontrolled emission factors for screening operations, crushing operations, conveyor transfer point, drilling, and material unloading (EPA, 1995). These factors were developed from crushing plants in North Carolina, Virginia, and Tennessee (EPA, 1994).

Emissions generally were considered to be 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. Variables identified that affect emissions include (but are not limited to) wind, material moisture content, stone type, throughput rate, humidity, temperature, and climate (EPA, 1995).

4.2 INFORMATION PROVIDED BY THE SAN DIEGO APCD

The San Diego APCD provides guidance to its engineering staff on the uniform application of *AP-42* emission factors (with some modifications) (Lake, 1996). The guidance addresses emission calculations for conveyer transfer points, crushing operations, screening operations, and paved and unpaved haul roads. Each of these emission points has an associated emission factor.

Industries using these guidance procedures must provide the APCD with information about hourly throughputs for transfer points, crushing systems, and screening systems, as well as process flow diagrams.

TABLE 13.4-1

SUMMARY OF AVAILABLE GUIDANCE[a]

Emission Source	AP-42	San Diego APCD	TNRCC	Wisconsin DNR	Mojave Desert AQMD
Blast Hole Drilling	X				X
Blasting					X
Bulldozing, Scraping, and Grading					X
Conveyor Transfer Point	X	X	X	X	X
Crushing	X	X	X	X	X
Drop Point			X		X[b]
Material Loading (or Handling)			X		X
Material Unloading (or Handling)	X		X		X
Mobile and Vehicular Exhaust					X
Paved Roads		X	X	X	X
Screening	X	X	X	X	X
Stationary Equipment Exhaust					X
Stockpiles			X		X
Unpaved Roads		X	X	X	X
Wind Erosion from Unpaved Operational Areas and Roads					X

[a] The X indicates that emissions estimation guidance materials are available for this emission point from the agency noted.

AP-42 = Compilation of Air Pollutant Emission Factors
APCD = Air Pollution Control District
TNRCC = Texas Natural Resource Conservation Commission
DNR = Department of Natural Resources
AQMD = Air Quality Management District

[b] The Mojave Desert AQMD uses the emission estimation methods described for "Conveyor Transport Point" for "Drop Point," as well.

4.3 INFORMATION PROVIDED BY THE TNRCC

A technical guidance package applicable to any non-metallic mining industry was obtained from the TNRCC (TNRCC, 1994). This package contains guidance on completing permit applications, identifying standard exemptions, and using the TNRCC-approved emission estimation equations. Rules and regulations pertaining to the State of Texas are included in the package for reference and benefit to the facility.

Step-by-step guidance is provided for facilities filling out an initial permit application and for those renewing a permit. A sample permit is included, along with guidance on work practices and operational limitations. Guidance for facilities submitting confidential information is also included.

In the calculation section of the guidance package, appropriate emission estimation equations are listed. Example calculations are provided for emission estimates from crushing, screening, material loading and unloading, material transfer and drop points, stockpiles, and haul roads. A brief description on applying the equations is included as well.

The calculation section also includes tables of TNRCC-approved emission factors and emission control efficiencies. These factors are mostly from *AP-42*, but a few were derived by the TNRCC. Similarly, most of the emission control efficiencies are from *AP-42* except those for road emissions, which were also derived by the TNRCC.

4.4 INFORMATION PROVIDED BY THE WISCONSIN DNR

The Wisconsin DNR, in an effort to standardize criteria for estimating emissions from stone mining and quarrying facilities, established a Non-metallic Mining Air Emissions Work Group. Both the Wisconsin Road Builders Association and the Aggregate Producers of Wisconsin agreed to participate as members of this work group and a "Rock Crushing Agreement" was created in December 1997 (Wisconsin DNR, 1997). This agreement outlines emissions-related issues and describes DNR's training program for a responsible person at the facility to recognize when appropriate dust control measures should be taken.

A table describing the criteria a facility must meet in order to receive the desired credit for emissions reductions for each process is included in the agreement. The processes that the agreement applies to are screening, primary crushing, secondary crushing, tertiary crushing, fines crushing, conveyor transfer points, and haul roads. Definitions of key terms are included for uniformity and clarity among stakeholders.

4.5 INFORMATION FROM MOJAVE DESERT AQMD

The Mojave Desert AQMD published a draft document entitled *Emissions Inventory Guidance on Mineral Handling and Processing* in an attempt to standardize the method for estimating emissions from a large number of operations and processes (Mojave Desert AQMD, 1997). It is Mojave Desert AQMD's plan to make the "Emission Inventory Guidance" a living document that will be expanded and modified as needed. Each method provides several levels of increasing complexity and accuracy. At the lowest level of complexity, an emission factor is simply multiplied by a process activity rate. The greatest level of complexity and accuracy involves the use of data from a source test. If feasible, facilities are encouraged to perform source tests in lieu of the methods presented in the guidance document.

Each method, presented in the same format, begins with a detailed discussion of the applicable processes and operations. The method and equations are then provided, beginning with the most conservative and least complex (requiring minimal inputs and level of effort), and followed by increasingly complex methods and equations (requiring more inputs and level of effort). The Mojave Desert AQMD encourages facilities to strive for more accurate emissions, which would require in-depth documentation and use of more complex methods and equations. The least complex method uses very conservative factors that result in the highest emission rate. When using a more complex method, the emissions typically are lower than when a less complex method is used. However, the more complex the method, the more information the facility must collect. The benefit is that total emissions will be lower using the more complex methods and equations.

The guidance document contains tables that present various common inputs to emissions calculations, such as percentage of silt content and blasting and drilling activity. Each method discussed includes applicable control strategies and appropriate calculations methods. The equations presented for each method are derived principally from *AP-42* or from other South Coast AQMD information sources. Methods are available for the following emission points: blast hole drilling; blasting; bulldozing, scraping, and grading of materials; drop point; material handling operations; material crushing and screening operations; wind erosion from stockpiles; stationary equipment exhaust; mobile equipment and vehicular exhaust; dust entrainment from paved roads; dust entrainment from unpaved roads; and wind erosion from unpaved operational areas and roads.

5

EXAMPLE CALCULATIONS USING THE GUIDANCE PROVIDED

The purpose of this section is to provide the user with example calculations for determining emissions from stone mining and quarrying facilities based on the information described earlier. NOTE: the methods used for these examples do not constitute endorsement as either a preferred or alternative method for estimating emissions by the EIIP Point Sources Committee. The purpose is to simply present available information.

Table 13.5-1 lists the variables and symbols used in the discussions that follow.

TABLE 13.5-1

LIST OF VARIABLES AND SYMBOLS

Variable	Symbol	Units
Hourly emissions of pollutant x	E_x	lb/hr; ton/hr
Emission factor for pollutant x	EF_x	lb/units
Activity factor for process	AF	units/hr
Annual emissions of pollutant x	$E_{x(annual)}$	lb/yr; ton/yr
Operating hours for process	OH	hr/yr
Controlled hourly emissions of pollutant x	$E_{c,x}$	lb/hr; ton/hr
Controlled annual emissions of pollutant x	$E_{c,x(annual)}$	lb/yr; ton/yr
Control efficiency	C	%
Tier i emissions of pollutant x, where i = 1 to 3	$E_{tier\ i,x}$	lb/yr
Control efficiency of Tier i scenario, where i = 1 to 3	$CE_{tier\ i,x}$	%
Sum of Tier i emissions (lb/yr), where i = 1 to 3	$E_{total,x}$	lb/yr
Number of transfer points from initial application for a specific control technique	n	unitless

When using emission factors, the general equation for estimating emissions is:

$$E_x = EF_x * AF \tag{13.5-1}$$

where:

E_x = Hourly emissions of pollutant x (lb/hr)
EF_x = Emission factor for pollutant x (lb/units)
AF = Activity factor for process (units/hr)

Assuming the number of operating hours is known for an entire year, then an annual emission can be estimated:

$$E_{x\ (annual)} = E_x * OH \tag{13.5-2}$$

where:

$E_{x\ (annual)}$ = Annual emissions for pollutant x (lb/yr)
E_x = Hourly emissions for pollutant x (lb/hr)
OH = Operating hours for process (hr/yr)

If control techniques are used and a control efficiency is known, then a controlled emissions can be estimated:

$$E_{c,x} = E_x * (1 - C/100) \tag{13.5-3}$$

where:

$E_{c,x}$ = Controlled hourly emissions for pollutant x (lb/hr)
E_x = Hourly emissions for pollutant x (lb/hr)
C = Control efficiency (%)

As a means of comparison of the guidance material obtained, emissions from screening operations will be estimated using methods listed in Section 4. Section 5.1 will develop estimates for both uncontrolled and controlled emissions. The methods used by the San Diego APCD and the TNRCC are similar and will be considered as one example.

5.1 EXAMPLE CALCULATION USING AP-42 EMISSION FACTORS

AP-42 contains emission factors for nine processes: screening, primary crushing, secondary crushing, tertiary crushing, fines crushing, fines screening, conveyor transfer point, wet drilling, and truck unloading. The following example calculations show how those emission factors (controlled and uncontrolled) can be used to estimate emissions.

Example 13.5-1

This example shows how PM_{10} uncontrolled emissions from screening processes can be estimated by using Equation 5-1.

Given:

EF_{PM10} = 0.015 lb/ton rock crushed (13.5-1)
AF = 100 tons rock crushed/hr

$E_x = EF_x * AF$

E_{PM10} = (0.015 lb/ton rock crushed)(100 tons rock crushed/hr)

E_{PM10} = 1.5 lb/hr

5.2 EXAMPLE CALCULATION USING SAN DIEGO APCD AND TNRCC GUIDANCE

Both the San Diego APCD and TNRCC provide guidance on applying appropriate emission factors and control efficiencies for different processes. When a control efficiency is applied to an emissions estimate or factor, an emissions reduction results.

For example, *AP-42* provides “Dry” and “Wet” emission factors for screening of “Process” and “Fine” materials. The “Wet” factors are lower than the “Dry” factors (0.00084 lb/ton vs 0.015 lb/ton, respectively) for “Process” material (EPA, 1995). In the San Diego APCD guidance for estimating screening operations, “Process” material is defined as an aggregate stream composed of at least 70 percent by weight of aggregate larger in size than a number four MESH (which is the size of the screen). The “Wet” emission factor for “Process” material is used for “Process” material streams having a moisture content of at least 1.5 percent. Otherwise, the “Dry” emission factor must be used. No additional reduction for control technology is applied for “Wet” material streams. The guidance provides appropriate control efficiencies to be used for “Dry” material screening where a control technology is employed.

Similarly, TNRCC lists the acceptable control technologies with respective control efficiencies and emission factors that can be used in determining emissions estimates for nine emission points.

Example 13.5-2

This example shows how PM_{10} hourly emissions can be converted to annual emissions using Equation 13.5-2 when annual operating hours are known.

Given:

E_{PM10} = 1.5 lb/hr emission of PM_{10}
OH = 1,040 operating hr/yr

$$E_{x\ (annual)} = E_x * OH \qquad (13.5\text{-}2)$$

$$E_{PM10\ (annual)} = 1.5\ lb/hr * 1,040\ hr/yr$$

$$E_{PM10\ (annual)} = 1,560\ lb/yr$$

Similarly, the controlled emissions estimate for screening processes can be calculated using the same technique (note that Equations 13.5-1 and 13.5-2 were combined):

Given:

EF_{PM10} = 0.00084 lb/ton rock crushed
AF = 100 tons rock crushed/hr
OH = 1,040 hr/yr

$$E_x = EF_x * AF * OH$$

$$E_{PM10(annual)} = (0.00084\ lb/ton\ rock\ crushed)*(100\ tons\ rock\ crushed/hr)*(1,040\ hr/yr)$$

$$E_{PM10(annual)} = 87.36\ lb/yr$$

Example 13.5-3

This example shows how controlled PM_{10} hourly emissions from screening can be calculated using Equation 13.5-3. The control device is a covered screen with surfactant added.

E_{PM10} = 1.5 lb/hr PM_{10} emissions
C = 90 %

$$E_{c,x} = E_x * (1 - C/100) \quad (13.5\text{-}3)$$

$$E_{c,PM10} = 1.5 \text{ lb/hr} * (1 - 90/100)$$

$$E_{c,PM10} = 0.15 \text{ lb/hr}$$

For annual emissions,

$$E_{c,PM10(annual)} = E_{c,PM10} * OH \quad (13.5\text{-}2)$$

where,
OH = 1,040 hr/yr

$E_{c,PM10(annual)}$ = (0.15 lb/hr)*(1,040 hr/yr)
$E_{c,PM10(annual)}$ = 156 lb/yr

5.3 EXAMPLE CALCULATION USING THE WISCONSIN DNR GUIDANCE

The requirements for obtaining credit for control efficiencies to be applied to emissions estimates prepared using the Wisconsin DNR guidance document are more stringent than those in the San Diego and TNRCC guidance documents. The credit for the level of control a facility receives on its emissions is related to the amount of “extra effort” by the facility. Automatically, a facility will receive a 50 percent control efficiency credit in Tier 1 of a three-tiered system, leading to a corresponding 50 percent reduction in emissions. Under Tier 2, a facility may receive a 75 percent control credit, while under Tier 3, a facility may receive a credit for greater than 90 percent control.

To gain Tier 2 credit, the facility must follow specific housekeeping, recordkeeping, and control equipment requirements as determined by DNR. Additionally, the facility must have a “Trained Person” on-site during any stone mining or quarrying operations, otherwise the operation is not eligible for the 75 percent control credit. The “Trained Person” must review a videotape developed by DNR or complete a training program to recognize when fugitive dust control measures need to be taken, and what measures are appropriate.

To gain Tier 3 credit, the facility must again follow specific housekeeping, recordkeeping, and control equipment requirements. However, unlike Tier 2, the facility must have a certified "Visible Emissions Reader" on-site in addition to the "Trained Person." The "Visible Emissions Reader" assigned to the facility must be certified once each calendar year to identify varying levels of visible emissions using U.S. EPA Method 9 criteria.

<u>Example 13.5-4</u>

This example shows the calculation of annual emissions under the Wisconsin DNR three-tiered system.

Company A is a stone mining and quarrying facility that operates at 1,040 hours per year. For 150 hours, there was a "Trained Person" on-site but not adequate recordkeeping, thus the facility can receive only Tier 1 credit for those hours. For 115 hours, there was a "Trained Person" on-site and the recordkeeping requirements satisfied the regulatory agency, thus the facility can receive Tier 2 credit for the 115 hours. For the remaining 775 hours, Company A satisfied the recordkeeping requirements and had both a "Trained Person" a certified "Visible Emissions Reader" on-site during operations, thus the facility can receive Tier 3 credit for 775 hours. Company A crushed stone at a rate of 100 tons/hr during all three time periods.

The PM_{10} emissions from screening processes may be calculated using Equations 13.5-1 to 13.5-3 and the respective control efficiency for each tier.

$$E_x = EF_x * AF \quad (13.5\text{-}1)$$

$$E_{x\ (annual)} = E_x * OH \quad (13.5\text{-}2)$$

$$E_{c,x} = E_x * (1 - C/100) \quad (13.5\text{-}3)$$

Combining terms and substituting $CE_{tier\ i,x}$ for C, a new equation is developed for a facility on a tier basis:

$$E_{tier\ i,\ x} = AF * EF_x * OH * (1 - CE_{tier\ i,x}/100) \quad (13.5\text{-}4)$$

where:

$E_{tier\ i,x}$ = Tier i emissions of pollutant x , where i = 1 to 3 (lb/yr)
$CE_{tier\ i,x}$ = Tier i control efficiency of pollutant x, where i = 1 to 3 (lb/yr)

Example 13.5-4 (Continued)

Summing the Tier i emissions provides an annual estimate, and letting i = 1 to 3:

$$E_{total} = E_{tier\ 1,x} + E_{tier\ 2,x} + E_{tier3,x} \quad (13.5\text{-}5)$$

Given, for a

Tier 1 scenario:

AF = 100 tons rock crushed/hr
EF_{PM10} = 0.015 lb/ton rock crushed
OH = 150 hr/yr
$CE_{tier\ 1,PM10}$ = 50%

For a Tier 2 scenario:

AF = 100 tons rock crushed/hr
EF_{PM10} = 0.015 lb/ton rock crushed
OH = 115 hr/yr
$CE_{tier\ 2,PM10}$ = 75%

For a Tier 3 scenario:

AF = 100 tons rock crushed/hr
EF_{PM10} = 0.015 lb/ton rock crushed
OH = 775 hr/yr
$CE_{tier\ 3,PM10}$ = 90%

$$E_{tier\ \text{“}i\text{”},PM10} = AF * EF_{PM10} * OH * (1 - CE_{tier\ \text{“}i\text{”},x}/100) \quad (13.5\text{-}4)$$

$E_{tier\ 1,PM10}$ = (100 tons rock crushed/hr)*(0.015 lb/ton rock crushed)*(150 hr/yr)(1-50/100)
$E_{tier\ 1,PM10}$ = 112.5 lb/yr

$E_{tier\ 2,PM10}$ = (100 tons rock crushed/hr)*(0.015 lb/ton rock crushed)*(115 hr/yr)(1-75/100)
$E_{tier\ 2,PM10}$ = 43.15 lb/yr

$E_{tier\ 3,PM10}$ = (100 tons rock crushed/hr)*(0.015 lb/ton rock crushed)*(775 hr/yr)(1-90/100)
$E_{tier\ 3,PM10}$ = 116.25 lb/yr

$E_{total} = E_{tier\ 1,PM10} + E_{tier\ 2,PM10} + E_{tier3,PM10}$

E_{total} = (112.5 + 43.15 + 116.25)lb/yr
E_{total} = 271.9 lb/yr

5.4 EXAMPLE CALCULATION USING THE MOJAVE DESERT AQMD GUIDANCE

The Mojave Desert AQMD derived emission factors or emission equations for 15 emission points. The guidance document lists each equation and all the applicable emission factors. In general, the least complex method is similar to Equation 5-1.

Equation 13.5-6 allows estimating emissions from screening operations using their "most complex" method:

$$E_{c,x} = EF_x * AF * (1-(C-(5 * n))/100) \quad (13.5\text{-}6)$$

where:

C = Control efficiency based upon daily opacity readings and control technique used
n = number of transfer points from initial application for a specific control technique

<u>Example 13.5-5</u>

This example shows the use of the Mojave Desert AQMD's "most complex" method in determining emissions from screening operations. The daily opacity reading is less than 10% and the control technique used is a water spray (downstream effect).

EF_{PM10} = 0.017 lb/ton rock crushed
AF = 104,000 tons rock crushed/yr
C = 90%
n = 2

$E_{c,PM10}$ = EF_{PM10} * AF * (1 - (C - (5*n))/100) (13.5-6)

$E_{c,PM10}$ = (0.017 lb/ton rock crushed)*(104,000 tons rock crushed)*(1-(90-(5*2))/100)
$E_{c,PM10}$ = 353.6 lb/yr

5.5 COMPARISON OF THE DIFFERENT METHODS

The following summary compares the different examples with their different methods for estimating annual emissions of PM_{10} from only the screening process.

Emission Point	Estimate Using *AP-42* Guidance: Uncontrolled (lb/yr)	Estimate Using *AP-42* Guidance: Controlled (lb/yr)	Estimate Using San Diego APCD and TNRCC Guidance (lb/yr)	Estimate Using Wisconsin DNR Guidance (lb/yr)	Estimate Using Mojave Desert AQMD Guidance (lb/yr)
Screening	1,560	87.36	156	271.9	353.6

All of these estimates were based on 1,040 operating hours. If a control device was used, then a 90 percent control efficiency was chosen for comparison purposes. The San Diego APCD and TNRCC use *AP-42* default control efficiencies. The Wisconsin DNR weighs emission estimates heavily on satisfying recordkeeping requirements and having trained personnel on-site. The Mojave Desert AQMD developed its own factors and equations to estimate emissions. As the comparison indicates, depending on the method chosen, an emission estimate from screening operations for a controlled scenario can range from 87.36 to 353.6 lb/yr.

This page is intentionally left blank.

6

REFERENCES

Lake, Mike. April 9, 1996. Memorandum entitled *Mineral Industry Emission Calculations Policy*. San Diego Air Pollution Control District. San Diego, California.

Mojave Desert Air Quality Management District. 1997. *Emission Inventory Guidance: Mineral Handling and Processing Industries (Draft)*. Victorville, California.

National Stone Association. July 10, 1997. Internet address: http://webserver.cr.usgs.gov/frirp/NSA.html

Occupational Safety and Health Administration (OSHA). August 6, 1997. Internet Address: http://www.osha.gov/cgi-bin/SIC/SICSER2

Texas Natural Resource Conservation Commission. 1994. *Technical Guidance Package for Mechanical Sources: Rock Crushing Facilities*. Austin, Texas.

U.S. Census Bureau. August 6, 1997. Internet address: http://blue.census.gov/

U.S. Census Bureau. County Business Patterns. 1993. 1989 and 1990 on CD-ROM. U.S. Department of Commerce. Economics and Statistics Administration. Washington, D.C.

U.S. Environmental Protection Agency. 1995. *Compilation of Air Pollutant Emission Factors, 5th Edition and Supplements, AP-42, Volume I: Stationary Point and Area Sources*. Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina.

U.S. Environmental Protection Agency. 1994. *Background Information for Revised AP-42 Section 11.19.2, Crushed Stone Processing Review and Update Remaining Sections of Chapter 8 of AP-42*. Research Triangle Park, North Carolina.

Wisconsin Department of Natural Resources. 1997. *Non-metallic Mining Air Emissions Guidance for the Development of the 1997 Air Emissions Inventory*. Madison, Wisconsin.

This page is intentionally left blank.