I. **Source Category:** Mining and Quarrying

II. **Pollutants:** PM$_{10}$ and PM$_{2.5}$

III. **SCC:**
2325000000 – Industrial Processes – Mining and Quarrying – All Processes

IV. **Description:**
This document describes the methodology to be used to calculate emissions of particulate matter with an aerodynamic diameter of less than or equal to 2.5 microns (PM$_{2.5}$) from mining and quarrying activities.

V. **Current Methodology:**
Total PM$_{10}$ and PM$_{2.5}$ for mining and rock quarrying is the sum of these emissions from metallic ore, nonmetallic ore, and surface coal mining. Four specific operations are included: overburden removal, drilling and blasting, loading and unloading, and overburden replacement. Not included are transfer and conveyance operations, crushing and screening operations, and storage. A particulate size fraction of 0.2, based on measurement data is used to estimate PM$_{2.5}$ from PM$_{10}$.

VI. **Emission Calculation:**

A. **Annual Emissions**
Regional metallic and non-metallic crude ore handled at surface mines can be obtained from the USGS. The USGS publishes summary statistics on mining and quarrying with a one year delay. Some state level estimates are withheld by the USGS to avoid disclosing proprietary data. Regional production figures for surface coal mining operations can be obtained from the Coal Industry Annual.

The emission factors presented in AP-42 represent emissions from western mining operations. They were developed through field sampling of various western surface mine types and are applicable to any of the surface coal mines located in the western United States. Because EPA does not present any emission factors specific to the eastern United States, these emissions may not be entirely representative of emissions in MANE-VU. If alternative emissions factors for the eastern United States exist they may be used in lieu of the emission factors presented in AP-42. EIIP cites a variety of emission factors to use in calculating mining and quarrying emissions. EIIP guidance should be reviewed when choosing appropriate emission factors.

1. **Metallic Mining**

The following equation estimates emissions from overburden removal, drilling and blasting, and loading and unloading during metallic mining operations.
See EIIP Table 13.4-1 for more information on available emission factors including; AP-42, San Diego APCD, TNRCC, Wisconsin DNR, and the Mojave Desert AQMD.

a. PM\(_{10}\) Emissions

\[ E_m = \left[ A_m \times EF_o + (B \times EF_b) + EF_l + EF_d \right]/2000 \]

Where:
- \( E_m \) = PM\(_{10}\) emissions in tons
- \( A_m \) = Metallic crude ore handled at surface mines (1000 short tons)
- \( EF_o \) = PM\(_{10}\) open pit overburden removal emission factor for copper ore processing (lbs/ton)
- \( B \) = fraction of total ore production that is obtained by blasting at metallic mines
- \( EF_b \) = PM\(_{10}\) drilling/blasting emission factor for copper ore processing (lbs/ton)
- \( EF_l \) = PM\(_{10}\) loading emission factor for copper ore processing (lbs/ton)
- \( EF_d \) = PM\(_{10}\) truck dumping emission factor for copper ore processing (lbs/ton)

b. PM\(_{2.5}\) Emissions

Apply a particulate size fraction of 0.2, which is based on measurement data, to estimate PM\(_{2.5}\) from PM\(_{10}\) by using the following formula:

\[ \text{PM2.5 Emissions} = 0.2 \times \text{PM10 Emissions} \]

2. Nonmetallic Mining Operations

The following equation estimates emissions from overburden removal, drilling and blasting, and loading and unloading during non-metallic mining operations.

See EIIP Table 13.4-1 for more information on available emission factors including; AP-42, San Diego APCD, TNRCC, Wisconsin DNR, and the Mojave Desert AQMD.

a. PM\(_{10}\) Emissions

\[ E_n = \left[ A_n \times (EF_o + (B \times EF_b)) + EF_l + (0.5*EF_e + 0.5*EF_i) \right]/2000 \]

Where:
- \( E_n \) = PM\(_{10}\) Emissions in tons
- \( A_n \) = Nonmetallic crude ore handled at surface mines (1000 short tons)
- \( EF_o \) = PM\(_{10}\) open pit overburden removal emission factor at western surface coal mining operations (lbs/ton)
- \( B \) = fraction of total ore production that is obtained by blasting at nonmetallic mines
b. PM$_{2.5}$ Emissions

Apply a particulate size fraction of 0.2, which is based on measurement data, to estimate PM$_{2.5}$ from PM$_{10}$ by using the following formula:

$$\text{PM2.5 Emissions} = 0.2 \times \text{PM10 Emissions}$$

3. Coal Mining

The following equation estimates emissions from overburden removal, drilling and blasting, and loading and unloading during coal mining operations.

See EIIP Table 13.4-1 for more information on available emission factors including; AP-42, San Diego APCD, TNRCC, Wisconsin DNR, and the Mojave Desert AQMD.

a. PM$_{10}$ Emissions

$$E_c = \left[ A_c \times (10 \times (EF_{to} + EF_{or} + EF_{dt} + EF_o) + (B \times EF_b) + EF_l + (0.5 \times EF_e + 0.5 \times EF_t)) \right]/2000$$

Where:

- $E_c$ = PM$_{10}$ Emissions in tons
- $A_c$ = Coal production at surface mines (1000 short tons)
- $EF_{to}$ = PM$_{10}$ emission factor for truck loading overburden at western surface coal mining operations (lbs/ton of overburden)
- $EF_{or}$ = PM$_{10}$ emission factor for overburden replacement at western surface coal mining operations (lbs/ton of overburden)
- $EF_{dt}$ = PM$_{10}$ emission factors for truck loading: bottom dump-overburden at western surface coal mining operations (lbs/ton)
- $EF_o$ = PM$_{10}$ open pit overburden removal emission factor at western surface coal mining operations (lbs/ton)
- $B$ = fraction of coal production that is obtained by drilling/blasting
- $EF_b$ = PM$_{10}$ drilling/blasting emission factor at western surface coal mining operations (lbs/ton)
- $EF_l$ = PM$_{10}$ coal loading emission factor at western surface coal mining operations (lbs/ton)
EF_c = PM10 truck coal unloading: end dump-coal emission factor at western surface coal mining operations (lbs/ton)
EF_t = PM10 truck coal unloading: bottom dump-coal emission factor at western surface coal mining operations (lbs/ton)

b. PM_{2.5} Emissions
Apply a particulate size fraction of 0.2, which is based on measurement data, to estimate PM_{2.5} from PM_{10} by using the following formula:

PM_{2.5} Emissions = 0.2 * PM_{10} Emissions

**VII. Point Source Adjustments:**
It is possible that states will require large mining and quarrying operations to be inventoried as point sources. Estimated area source activity of emissions should be adjusted by subtracting the activity or emissions attributable to point sources. See EIIP Volume III, Chapter 1, Section 4 for methodology to account for point sources in an area source emissions inventory.

**VIII. Adjustments for Controls:**
Regulations for emissions from mining and quarrying are unlikely to affect the estimated emissions of this source.

**IX. Spatial Adjustments:**
EPA used the following equation to spatially allocate mining and quarrying emissions to county level:

\[
\text{County Emissions} = \frac{\text{Regional Emissions}}{\text{Number of counties in Region}}
\]

**X. Temporal Adjustments:**
Emissions from mining and quarrying may be assumed to be constant through the year.

**XI. Uncertainties/Shortcomings:**
A. Assumption for the PM_{10} emission values are based on a limited number of source data
B. Coal mining includes two additional sources of PM10 emissions compared to the sources considered for metallic and nonmetallic minerals. The two additional sources are overburden replacement and truck loading and unloading of that overburden. Assumption is that the ratio of overburden material handled is equal to 10 times the product mined.
C. The emission factors used to calculate the PM_{10} emissions from western surface coal mining are used for all mining activities
D. PM_{10} percentage of TSP is assumed to be numerical constants for the county
E. Some state-level estimates of ore handling are adjusted from historical data
F. Regional estimates of total emissions are allocated equally to all counties in the region
G. There may be over/under coverage of small quarries since some are included as point sources

XII. Assumptions:
A. Total metallic crude ore handled (USGS)
B. Total non-metallic crude ore handled (USGS)
C. Total coal production from surface mine (USGS)
D. Emission factors developed for the western U.S. are representative of emissions in the eastern U.S.

XIII. Rule Effectiveness:
Not applicable.

XIV. Recommendations to Improve Methods/Data
A. Obtain local mining information on overburden/product removal
B. Review mine and quarry permits
C. Identify the mines and quarries by counties

XV. Additional Information/Guidance:
EPA Contact: Mr. William B. Kuykendal, MD-14
Emission Factor and Inventory Group
E-mail: kuykendal.bill@epa.gov
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www.epa.gov/tnn/chief/publications.html

NEI Methodology Description:
www.epa.gov/tnn/chief/net/index.html#doc

AP-42, Section 11.9

XVI. References:

Emission Inventory Improvement Program, EIIP Document Series - Volume IX, Particulate Emissions, Fugitive Dust from Mining and Quarrying

New Jersey Department of Environmental Protection, PM2.5 Area Source Category Calculation Methodology Sheet, Mining and Quarrying, October 2002.
