DRILLING & BLASTING OPERATIONS

Date Initiated:

June 7, 1993

Dates Modified / Updated:

October 28, 1993
February 3, 1994
January 4, 1999
April 24, 2008
June 26, 2013
December 2023

PROCESS DESCRIPTIONS:

Some mineral product industry quarry locations require rock drilling and blasting to loosen desired aggregate deposits. Particulate emissions occur whenever rock and soil are drilled and blasted. The following calculation procedures are used to estimate particulate emissions from wet drilling and associated blasting operations. The wet drilling PM10 emission factor is based on information published in Section 11.19.2 of AP-42 (1/95) for crushed stone processing operations. The blasting procedure is based on an emission estimation technique provided in Section 11.9.2 of AP-42 (Reformatted 1/95) for coal or overburden. A PM10 fraction of 52% is assumed for blasting emissions. The combined procedures are;

Ea = [(Ua x EF) + (N x 0.000014 x A^1.5 x 0.52)] x

Ci Eh = [(Ua x EF / H) + (0.000014 x A^1.5 x 0.52)]

x Ci

Where:

Ea = Annual emissions of each listed substance, (lbs/year)

Eh = Maximum hourly emissions of each listed substance, (lbs/hour)

Ua = Annual amount of quarry material blasted, (tons/year)

EF = Particulate emission factor for wet drilling, (lbs/ton of material quarried)

= 0.00008 (lbs/ton of material quarried)

H = Hours of quarry operation, (hours/year)

N = Number of annual quarry blasts, (blasts/year)

0.52 = PM-10 fraction (lb PM-10/lb TSP)

A = Average horizontal area per blast, (ft2/blast)

Ci = Concentration of each listed substance in the quarried material, (lbs/lb)

Additional emissions of NOx, CO, and/or SOx are released from the detonation of the explosives used in the blasting. As specified in Section 13.3 of AP-42 (2/80), four primary types of explosives are used at most quarry operations; dynamite, dynamite with ammonium nitrate, dynamite with nitroglycerine, and ammonium nitrate with fuel oil. The AP-42 emission factors for explosive's detonation are based on tons of explosives used. Using these factors, District calculation procedures are;

Ea = (Blasts/year) x (avg. charges/blast) x (avg. lbs/charge) x 1/2000 x

EF Eh = (Max. charges/blast) x (avg. lbs/charge) x 1/2000 x EF

Where:

Ea = Annual emissions of each listed substance, (lbs/year)

Eh = Maximum hourly emissions of each listed substance, (lbs/hour)

EF = Emission factor for explosive's detonation, (lbs released/ton of explosive used)

= 281 (CO), No Data (NOx),

= 63 (CO), No Data (NOx),

= 104 (CO), 53 (NOx), and 1 (SOx) for dynamite with nitroglycerin,

= 67 (CO), 17 (NOx), and 2 (SOx) for ammonium nitrate with fuel oil

EMISSIONS INFORMATION:

A series of meetings was held in 1995 and 1996 between AWR Consultants, the San Diego County Mineral Products Industry, and the District regarding particulate emission estimation techniques applicable to aggregate operations. A District policy was drafted on 4/9/96 regarding standard Mineral Industry calculation procedures. This policy did not include an agreed upon approach to evaluating emissions from blasting operations. While several proposals were exchanged regarding blasting operations, no final resolution was drafted.

The final AWR - Mineral Industry proposal was received by the District on March 18, 1996. The use of the published AP-42 emission factor for wet drilling (0.00008 lbs/ton = ~0.04 grams/ton of material quarried) was acceptable to the MPI group. The industry group was "willing to allow the use" of the AP-42 procedure for blasting overburden at western surface coal mines provided the District modify the EPA calculation method in the following four ways;

1) The AWR - MPI group requested a silt content correction factor (% actual silt content / 7%) be directly applied to the AP-42 estimation technique. A default silt content value of 1% for shot rock was also

proposed. This proposal would reduce estimated emissions from shot rock to (1/7) of the standard AP-42 overburden method. No test information supporting this proposal was provided to the District and the recommendation has not been implemented.

2) An additional 25% fugitive dust control efficiency was proposed by the AWR-MPI group for any site that possessed "land use conditions" requiring special preparation of the blast area surface before detonation. No applicable sites were identified and no specific surface preparation procedures were defined. No test information supporting this proposal was provided to the District and the recommendation has not been implemented.

3) An additional 75% fugitive dust control efficiency was proposed by the AWR-MPI group for "sites with non-monolithic deposits which are loosened by bumping". Bumping operations are imprecisely defined as the loosening of mineral deposits without displacing the material as would occur if the blast area were on the side of a cliff. The current unmodified AP-42 procedure provides the following emission estimates for TSP and PM10 emissions assuming an average material density of 2 tons/yd3;

Blast Area	Typical Dimensions	Blasted Material	lbs TSP/Blast	lbs PM10/Blast
100 ft2	20' x 5' x 50'd	370 tons	0.014 lbs	0.007 lbs
1,000 ft2	50' x 20' x 50'd	3,700 tons	0.44 lbs	0.23 lbs
10,000 ft2	200' x 50' x 50'd	37,000 tons	14 lbs	7.3 lbs
100,000 ft2	1,000' x 100' x 50'd	370,000 tons	442.7 lbs	230.2 lbs

Based on the above numbers, the unmodified AP-42 procedure already appears to quantify the type of blasting emissions expected from "bumping" rather than "cliff side detonations". The blast areas listed above would emit only 0.3 to 10 grams of PM10 per ton of material blasted (0.00004% to 0.001% by weight). No site specific blasting information was provided to the District and this recommendation has not been implemented.

4) Finally, the AWR - MPI group insisted that "under no circumstances could the AP-42 overburden blasting procedure, even with adjustments, be used to predict 1 - hour concentrations" for acute health risk assessment purposes. While it is possible that blasting emissions would not occur simultaneously with maximum hourly plant production rates and worst case meteorological conditions, no justification or reasoning for ignoring health effects from these emissions was provided to the District. This recommendation has not been implemented.

Trace metal concentrations in aggregate dust released from drilling and blasting operations can vary between sites. The following default trace metal concentrations should be used to estimate compound specific emissions where representative site specific information is unavailable. These estimates are based upon test results from several San Diego County mineral product facilities provided to the District by AWR Consultants in July 1996 (Profile 2 - Crushed Fines Drill & Shoot);

DEFAULT VALUES - TRACE METAL CONCENTRATIONS

Trace Metals	Typical Range (ppmw)	Default Value (ppmw)
Aluminum	6,00 to 21,000	21,000
Arsenic	1 to 50	15
Barium	75 to 300	120
Beryllium	0.5 to 2	1
Cadmium	0.5 to 2	1
Hexavalent Chromium	non - detectable	0
Chromium (total)	5 to 60	46
Cobalt	5 to 20	18
Copper	20 to 100	94
Lead	5 to 120	30
Manganese	200 to 1200	565
Mercury	non-detectable	0
Nickel	15 to 50	30
Selenium	0.5 to 5	1
Silica (crystalline)	10% to 75%	10%
Zinc	30 to 300	100
Asbestos	non-detectable	0

The Office of Environmental Health Hazard Assessment (OEHHA) has adopted a chronic reference exposure level (REL) for respirable crystalline silica, cristobalite (CAS 14464-46-1) and quartz (CAS 14808-60-7). The REL is based on the PM4 fraction of crystalline silica which is expected to have associated health risks. The District has chosen to implement a health protective value of 7.95% default PM4 to PM10 ratio from published data[1] in order to more accurately estimate the health risks associated with respirable crystalline silica. If available, the District recommends using District approved site-specific data to refine the PM4 to PM10 ratio.

The District's current default crystalline silica emission factor is based on local test results, which is 10% of the PM10 default emission factor. The PM4 to PM10 ratio can be accurately applied to the crystalline silica default emission factor [2]since the test results were sized to -10 micron which was used to represent the average composition of PM10. Both crystalline silica as PM10 and respirable crystalline silica as PM4 should be estimated.

ASSUMPTIONS / LIMITATIONS:

- Use site specific test data and trace metal concentrations instead of default values where applicable.

- Wet drilling emissions can be expected to be relatively consistent between sites. Blasting emissions are most likely dependent on many site-specific conditions including type of geological deposit, silt content,

[1] Richards, J. R., Brozell, T., Rea, C. E., Boraston, G., & Hayden, J. (2009). PM_4 Crystalline Silica Emission Factors and Ambient Concentrations at Aggregate-Producing Sources in California. Journal of the Air & Waste Management Association, 59(11), 1287–1295. https://doi.org/10.3155/1047-3289.59.11.128

surface preparation, terrain configuration, explosive type, charge density, charge depth, and ambient wind conditions. Since little reliable test information exists regarding blasting emissions, the unmodified version of the AP-42, Section 11.9 (9/88) procedure for coal overburden should be used until otherwise advised.

- No additional control efficiency will be applied to either the "wet drilling" factor or the blast procedure listed above.