Technical Bulletin: Approaches for Assessing Emissions from Continuous and Batch Drop Operations

This technical bulletin is to clarify acceptable approaches for estimating emissions from continuous and batch drop operations for hot mix asphalt, concrete batching and similar operations.

1.0 Introduction

This technical bulletin outlines a procedure for estimating emission rates, for the purpose of preparing Emission Summary and Dispersion Modelling (ESDM) Reports, from continuous and batch drop point sources in hot mix asphalt, concrete batching and similar operations. Specifically, this procedure addresses Suspended Particulate Matter (< 44 µm diameter) and Silica - respirable (<10 µm diameter).

As outlined in the Procedure for Preparing an Emission Summary and Dispersion Modelling Report (Guideline A-10), emission rate estimation is an iterative process where estimates start out conservative and may be refined to be more representative of emissions from the facility.

This technical bulletin outlines a procedure for this conservative and refinement process for estimating emission rates, where applicable.

2.0 Material Drops

Continuous and batch drop sources occur when material is dropped causing fugitive dust emissions. For example, dropping material from a delivery truck to a storage bin would be a batch drop source and dropping material from a stacker to a storage pile would be a continuous drop source.

The United States Environmental Protection Agency (US EPA) has published emission factors for a variety of common industrial operations in US EPA Document Number AP-42, Compilation of Air Pollutant Emission Factors (AP-42). This document includes sections on Hot Mix Asphalt Plants (Ch. 11.1), Concrete Batching (Ch. 11.12), Sand and Gravel Processing (Ch. 11.19.2), and Aggregate Handling and Storage Piles (Ch. 13.2.4) as well as many other operations.

To quantify particulate emissions generated by either type of drop operations, (kilogram (kg) of particulate per tonne or megagram (Mg) of materials transferred), AP-42 Chapter 13.2.4 includes the following equation, commonly referred to as the “drop equation”.

$$E = k\,(0.0016)\,\frac{(\frac{U}{2.2})^{1.3}}{(\frac{M}{2})^{1.4}}\ \ [\mathrm{kg/Mg}]$$

Where:

E – emission factor

k - particle size multiplier (dimensionless)

M – material moisture content (% by weight)

U - wind speed in metres per second (m/s) at the material drop point

The drop equation retains the assigned quality rating of A (or Above-Average Data Quality, as per Guideline A-10) if applied within the ranges of source conditions that were tested in developing the equation – please refer to AP-42 Chapter 13.2.4 for more details.

The ministry recommends deriving emission factors directly from the drop equation which allows for Ontario specific and site-specific parameters to be taken into account as detailed in the sections below.

The following sections discuss each parameter in the drop equation. Where appropriate, the procedures outlined below follow the tiered approach to refining emission estimates, starting with the most conservative and refining with more site- specific data to reduce this conservatism. Note that users do not have to follow each tier and may at any time in their assessment skip conservative assessments and go straight to a more refined assessment.

2.1 Particle Size Multiplier (k)

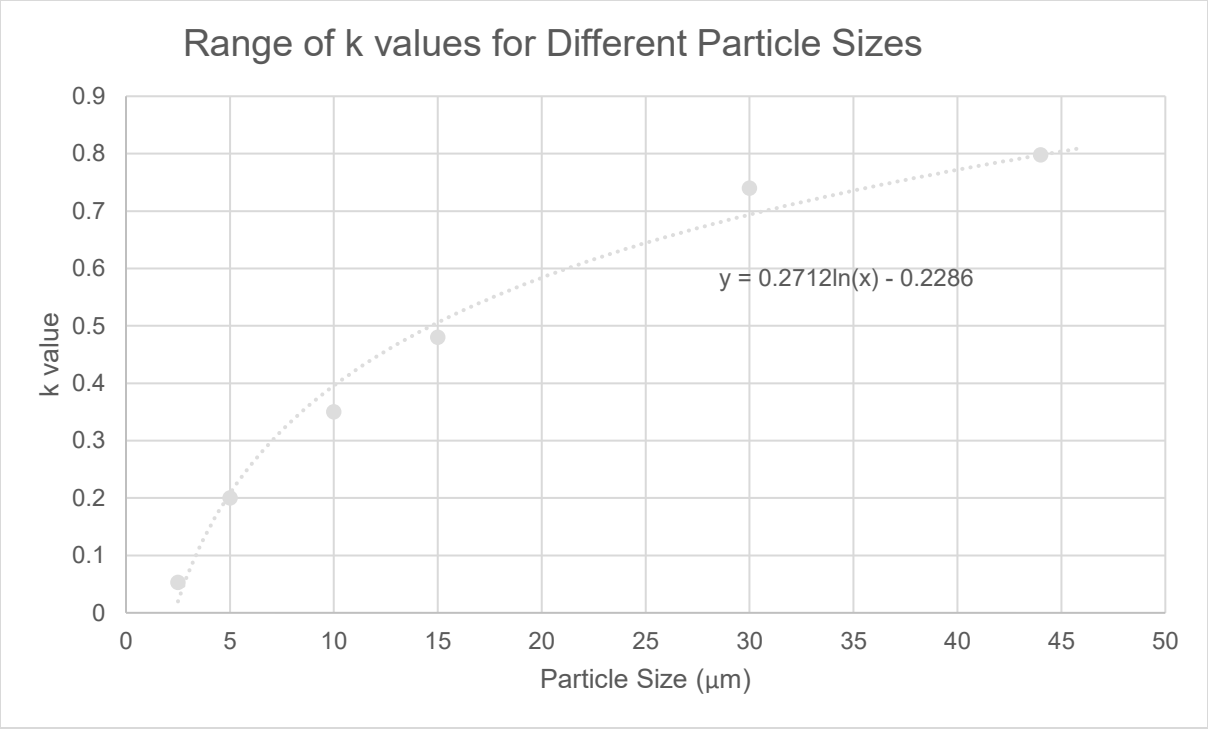
AP-42 Chapter 13.2.4 indicates that the particle size multiplier (k value) varies with aerodynamic particle size range. Chapter 13.2.4 provides five different k values for different particle sizes as shown in Table 1.

Table 1: Aerodynamic Particle Size Multiplier (k)

< 30 µm	< 15 µm	< 10 µm	< 5 µm	< 2.5 µm
0.74	0.48	0.35	0.20	0.053

The Ontario Regulation 419/05 Schedule 3 standard for suspended particulate matter is for PM_{44} and, therefore, the emission estimate should be representative of PM_{44}. Since the values provided by AP-42 increase with increased particle size, it is reasonable to assume that the k value for PM_{44} will be higher than the k value for PM_{30}. As such, using the k value for PM_{30} to represent PM_{44} would underestimate emissions.

The ministry recommends using a k value of 0.8 to represent PM_{44}. This value was derived by graphing the k values from AP-42 Chapter 13.2.4 and extrapolating the data. The figure below presents the graphed k values and trend line used to extrapolate the k value for PM_{44}.



2.2 Moisture

The moisture content of a material has a significant impact on emissions from material drops. It can also be challenging to choose an appropriate value for moisture, since moisture can change throughout the day, based on controllable factors such as facility procedures, or outside factors such as weather conditions.

To assist with the selection of a moisture value for the drop equation, the ministry is recommending a tiered approach with four options.

The references [5], [6], [7] and [8] were used in the development of the recommended moisture contents in Options 1 to 3 below.

Option 1: Dry Material

The first and most conservative option is to choose moisture contents to represent uncontrolled, dry operations (no visible moisture on the surface). These moisture contents may be used as a conservative, first pass for controlled or moist operations as well. The following moisture contents may be used for Option 1:

- Aggregate: 0.5% and
- Sand: 1.5%.

Additional controls may be considered when using the minimum moisture content. Controls are discussed in section 4 below.

Moisture testing of processed (dropped) materials would not be required. However, the facility shall operate controls, if any, according to the ESDM Report and comply with Environmental Compliance Approval (ECA) conditions, such as the requirement to prepare and implement a dust Best Management Practices Plan.

Option 2: Moist Material

Moist material is defined as material having visible moisture on the surface (not dry but not wet). Typically, wet aggregate material contains more than 1.5% moisture as per AP-42.

This option is to be used for material that has visible surface moisture. The following moisture contents may be used for Option 2:

- Aggregate: 1.5%
- Sand: 1.9%

Additional controls may be considered when using these moisture contents. Controls are discussed in section 4 below.

The Best Management Practices Plan for the facility should specify that only moist material is processed and that the purpose of the Best Management Practices Plan is to ensure that there are no visible dust emissions from the operations at and beyond the property line at any time.

Moisture testing of processed (dropped) materials would not be required. However, the facility shall operate controls, if any, according to the ESDM Report and comply with ECA conditions, such as the requirement to prepare and implement a dust Best Management Practices Plan.

Option 3: Wet Material with Visibility Condition and 95% Control Efficiency

The third option allows facilities to use the following moisture contents:

- Aggregate: 1.77% and
- Sand: 4.17%.

A control efficiency of 95% may be applied to the drop equation when using the above moisture contents. This control efficiency will cover any controls, whether procedural or physical, used for the material dropping operations. It is the responsibility of the facility to ensure that appropriate controls are applied. These controls should be included in the

Best Management Practices Plan for the facility but do not need to be described in detail in the ESDM Report.

The 95% control is intended to represent all emission controls. If it is applied, no additional credit for other control methods shall be used for dropping operations.

If this option is used to estimate emissions, the ministry will include a visible dust condition in the ECA. An example of this condition is included below.

1. The Company shall ensure that visible fugitive dust emissions from activities where material is dropped:
    a. will not extend more than 30 metres in any direction from the activities, excluding no more than 6 minutes in any hour; and
    b. will not extend beyond the property boundary at any time.
2. The Company shall determine visible fugitive dust emissions using Method 22, at the closest practical observation location as described in Method 22.

Method 22 refers to US EPA Method 22 – Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares, dated January 14, 2019, as amended.

Moisture testing of processed (dropped) materials would not be required. However, the facility shall operate controls, if any, according to the ESDM Report and comply with ECA conditions, such as the requirement for a dust Best Management Practices Plan.

Option 4: Site Specific Data/Other Operating Conditions

This option will allow the use of site/process specific moisture based on moisture testing, provided it is supported with appropriate information such as: number of tests, test procedure, conditions during testing, rationale for moisture tests being appropriate for maximum operating scenario.

The facility would be required to submit, with the application, a procedure on how moisture will be maintained. The facility shall operate controls, if any, according to the ESDM Report and comply with ECA conditions, such as the requirement for a dust Best Management Practices Plan and the requirement to implement the procedure for maintaining moisture at the facility.

The ministry recommends a pre-consultation to discuss the requirement/expectations for using this option.

2.3 Wind Speed

As a conservative approach, the maximum wind speed based on the ministry's AERMOD-ready regional or site-specific meteorological data sets for the facility location is recommended as a conservative estimation method.

The maximum wind speed from each meteorological data set is presented in Table 2.

Table 2: Drop Equation U Values
Regional Maximum Wind Speed

Meteorological Data Set	Maximum Wind Speed (m/s)	Ministry Region	Ministry District/Area
Toronto	18.5	Central	Toronto, York-Durham, Halton-Peel, Barrie, Owen Sound
London	19	Southwestern	London, Windsor, Sarnia
London	19	West Central	Hamilton, Niagara, Guelph
Ottawa	18	Eastern	Ottawa, Peterborough, Belleville
Sudbury	16	Northern	Sudbury, North Bay, Sault Ste. Marie, Timmins
International Falls	14.4	Northern	Thunder Bay, Kenora
Massena	15.4	Eastern	Kingston, Cornwall

This conservative emission estimate would then be used in a ministry approved dispersion model as a fixed emission rate. This approach is inherently conservative since it uses an emission rate generated under maximum wind conditions and applies it to hours where the modelled wind speeds are lower. This means that, it is likely that less emissions are generated in these hours, leading to a potential over-estimate in ground level concentrations.

The emission rate may be refined by varying wind speed using variable emissions or hourly emissions in AERMOD.

The variable emission by wind speed category option may be used to more realistically, but still conservatively, represent the emissions that are generated in each hour based on categories of wind speeds. When using this option in AERMOD, the upper threshold of the wind speed category is used to calculate an emission factor for each wind speed category. When the model is run, the emission rate used for each hour will be the

emission factor for the appropriate wind speed category multiplied by the entered emission rate for the source.

For the highest wind speed category, the maximum value is used based on the ministry's regional or site-specific meteorological data set for the facility location. Table 3 presents the wind speed categories in AERMOD. Table 3 also presents example factors for a facility using the Toronto Meteorological Data Set (maximum wind speed 18.5 m/s) and an AERMOD emission rate calculated based on the Class F wind speed.

Table 3: Default Wind Speed Categories in AERMOD

Wind Speed Classes	Maximum Wind Speeds (m/s)	Example Factors (Toronto Met Data)
Class A	1.54	0.04
Class B	3.09	0.10
Class C	5.14	0.19
Class D	8.23	0.35
Class E	10.8	0.50
Class F	Maximum Value of meteorological data set being used. See Table 2 for maximum regional values	1

Hourly variable emissions may also be used in AERMOD to vary emissions by hourly wind speed. This option is more flexible than the method described above since it allows emissions to be varied by other factors, such as operating hours or production data, as well as by wind speed.

Additionally, as per "Air Dispersion Modelling Guideline for Ontario" (Guideline A-11), other modelling approaches may be acceptable on a case-by-case basis.

3.0 Additional Controls

The following control methods and control efficiencies can be applied to continuous, and batch drop points.

Table 4: Control Methods and Efficiencies

Control Method	Control Efficiencies (%) up to
Water Sprays	70%
Chemicals/foam	80%
wind shield on two sides	25%

Wind shields on three sides	50%
Wind shield on 3 sides plus roof	75%
Full enclosure (Wind shields on all four sides plus roof, i.e.; fully enclosed building)	90%

4.0 Emission Estimates for Silica Emissions

Emissions of respirable silica should be considered from any operations, including crushing and screening, of silica containing material, with the exception of reclaimed asphalt pavement (RAP). When estimating respirable silica emission from dropping operations, the drop equation may be used. The Ontario guidelines (Air Contaminants Benchmarks (ACB) List: standards, guidelines and screening levels for assessing point of impingement concentrations of air contaminants) for respirable silica are for PM_{10}. Therefore, a k value of 0.35 should be used in the drop equation as presented in Table 1.

The total PM_{10} emission rate is then multiplied by the bulk percent by weight of silica. In Ontario, silica content varies by material and region.

The Ontario Road Builders' Association and Concrete Ontario have performed bulk silica testing across different regions in the province (OBRA/CO Report). This data has been used to develop Table 5.

Table 5: Maximum Silica Content by Material and Region

Material	Region	Maximum Silica wt%
Limestone *	Eastern	4.50
Mixed Stone/Gravel *	Eastern	20.06
Dolomite/Other	Eastern	No Data Currently Available
Granite	Eastern	No Data Currently Available
Sand *	Eastern	32.60
Recycled Concrete *	Eastern	21.80
Limestone	Central/Southwestern	1.80

Mixed Stone/Gravel	Central/Southwestern	21.30
Dolomite/Other	Central/Southwestern	No Data Currently Available
Granite	Central/Southwestern	32.1
Trap Rock *	Central/Southwestern	45.10
Sand	Central/Southwestern	34.40
Recycled Concrete	Central/Southwestern	21.55
Limestone *	Northern	2.55
Mixed Stone/Gravel *	Northern	4.97
Dolomite/Other	Northern	No Data Currently Available
Granite	Northern	66.95
Quartzite *	Northern	90.32
Sand *	Northern	75.3
Recycled Concrete	Northern	No Data Currently Available

Notes:

1. When no data is available for recycled concrete, the average silica content of produced concrete at the proposed site and/or the sand and stone processed at the proposed site may be used to estimate silica content.

2. Due to limited data available for the material types with an * the Marginal or Uncertain Data Quality should be assumed for presented silica content in Table 5.

3. Table 5 may be periodically updated when more testing data is available.

4. Mixed stone/gravel material is sourced from a sand and gravel pit.

To improve data quality (or to refine emission estimates), the facilities may also use site-specific silica content for processed materials. If site-specific silica content is used it must be accompanied with supporting data, such as local suppliers' data, material bulk

silica testing, etc. Silica testing must include a description of the testing including material tested, test method and laboratory results.

REFERENCES

1. Guideline A-10: Procedure for preparing an Emissions Summary and Dispersion Modelling (ESDM) Report (Version 4.0), as amended.

2. Guideline A-11: Air Dispersion Modelling Guideline for Ontario (Version 3.0), as amended.

3. Ontario Regulation 419/05, as amended.

4. Air Contaminants Benchmarks (ACB) List: Standards, guidelines and screening levels for assessing point of impingement concentrations of air contaminants (version 3.0 - April 2020), as amended.

5. United States Environmental Protection Agency, AP-42: Compilation of Air Emission Factors.

6. South Coast Air Quality Management District, Particulate Matter (PM) emission Factors For Processes/Equipment at Asphalt, Cement, Concrete and Aggregate Product Plants (Revised December 2021), https://www.aqmd.gov/docs/default-source/planning/annual-emission-reporting/pm-emission-factors-for-processes-and-equipment-at-asphalt-cement-concrete-and-aggregate-product-plants-revised.pdf?sfvrsn=8.

7. California Air Resources Board, https://avaqmd.ca.gov/emissions-inventory-program.

8. Ontario Ministry of Mines, Absorption Capacity of Ontario Stone, http://www.geologyontario.mndm.gov.on.ca/mndmaccess/mndm_dir.asp?type=pub&id=MRD297.

9. Aggregate material Silica Laboratory Test Results Provided by Ontario Road Builders' Association and Concrete Ontario