2015 Updates to the Air Dispersion Modelling Guideline

February 29th, 2016

Environmental Monitoring and Reporting Branch

Background

- Last update to ADMGO[1] was in 2009
  - Some of the guidance provided was out of date
  - Some new/additional guidance was required due to regulatory updates
  - Some topics required clarification
- Revised ADMGO posted to EBR for comment
  - Comment period was Dec 18th, 2015 – Feb 16th, 2016

[1]ADMGO – Ontario's *current* Air Dispersion Modelling Guideline (2009).

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Update Topics

- Regulatory Model Version updates
- Meteorological Data
- Modelling Open Flares
- Miscellaneous
  - Modelling for annual average concentrations
  - Use of NO_2, SO_2, $PM_{2.5}$ NAAQS[2] processing methodology
  - Modelling Roadways
  - Downwash in SCREEN3
  - Shoreline dispersion effects
  - ASHRAE 2011

[2]National Ambient Air Quality Standards (NAAQS)

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Regulatory Model Version Updates

- MOECC formally adopted updated regulatory versions on Nov 2nd, 2015
  - AERMOD v14134 in conjunction with AERMET v14134
  - ASHRAE 2011
- Reprocessed Regional Met Data (AERMET v14134) is available on Ontario.ca
- Any modelling done in support of O.Reg.419/05 (ECA application, ESDM reports, etc) after this date must be completed using the new regulatory versions unless you have a valid s7(1) Notice
  - The adoption of new model versions does not necessarily trigger re-modelling

Regulatory Model Version Updates-2

- Use of newer AERMOD versions (i.e. v15181) will require:
  - approval under s7(1)
    - Need to include rationale for moving to the newer version (e.g. v15181 computes proper annual averages)
  - met data processed with AERMET v15181
    - Submit a request for site specific met data under s13(1), **OR**
    - Request the reprocessed the site specific met data already approved under s13(1) from EMRB[3], **OR**
    - Reprocess the regional data with AERMET v15181 (SCRAM files are available on ontario.ca) – submit to EMRB for review[3]
- Next potential update of regulatory version may occur in April 2017
  - US EPA likely to release updated version this year as part of changes to their Appendix W

[3]EMRB email: MetDataENE@ontario.ca

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Meteorological Data

- Met data used with AERMOD must be processed with the corresponding version of AERMET
  - All regional met data sets posted on ontario.ca have been reprocessed with AERMET v14134
  - Proponents with existing site specific met data sets approved under s13(1) were contacted and sent reprocessed with AERMET v14134 upon request
    - if you have s13(1) approved met and didn't receive a reprocessed data set, contact EMRB and include a copy of your existing s13(1)
- Use of any met data sets other than the regional sets posted on Ontario.ca[4] requires a s13(1) approval

[4]Ontario.ca "Rules on air quality and pollution" website: https://www.ontario.ca/page/rules-air-quality-and-pollution

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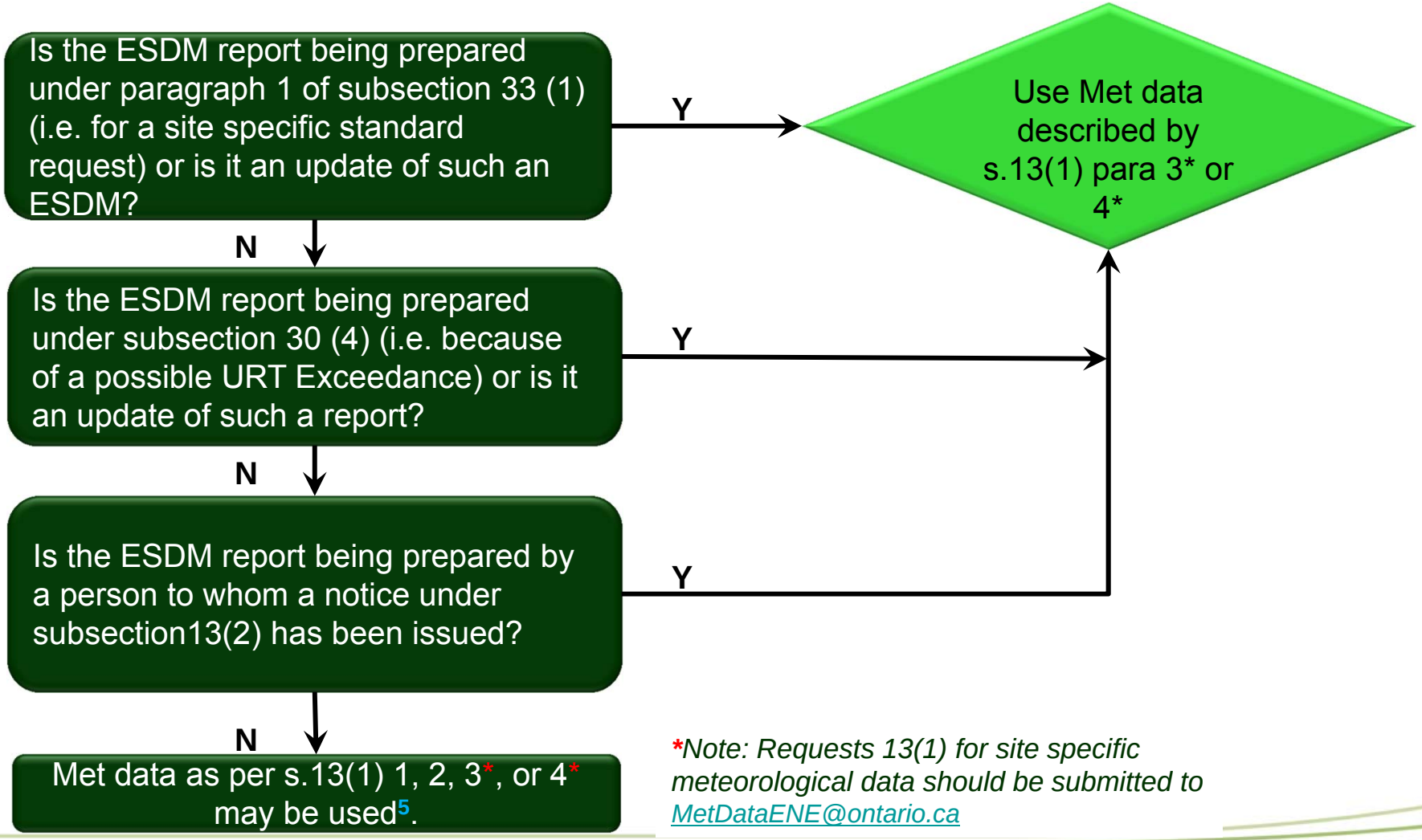
Meteorological Data - 2

- Regional meteorological data sets
  - pre-processed regional met data sets are to be used when the surface characteristics within 3 km from your site are reasonably represented by one of the data sets
    - CROPS, FOREST, URBAN
  - If the land use, and resulting surface characteristics, vary significantly within the 3 km, these data sets should be refined to reflect the local land use conditions
    - Particularly important if a facility is located near a water body
      - EMRB can provide refined data sets upon request
      - Refined data sets prepared by proponents should be submitted to EMRB for review
        - » s13(1) approval is not required

Requirements to use Specified Meteorological Data Sets



**Note: Requests 13(1) for site specific meteorological data should be submitted to MetDataENE@ontario.ca*

[5]Unless prescribed by an ECA condition or other requirement

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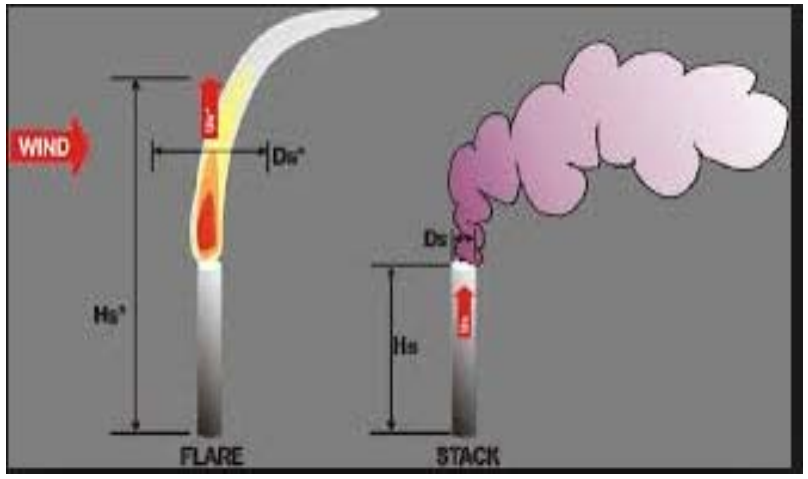
Modelling Open Flares

- Flares are emission sources and are modelled in ESDM reports completed under O.Reg.419/05
- Open flares are unique and challenging sources to model
- Produce hot, buoyant plumes, often with a large amount of momentum
- Have a jet-like flame, with contaminants emitted from the top of the flame (flame tip)
  - Flare's flame length acts as additional "stack" height
- Modelling flares using SCREEN3
  - FLARE source type must be used "as is"
  - use of a "point" source with pseudo-parameters is not appropriate

Modelling Open Flares - 2

- Many advanced air dispersion models, including AERMOD, do not have a “flare” source type
- Instead, flares are modelled as “point” sources with calculated exhaust “pseudo-parameters”
  - the model uses reasonably representative values for plume spread and plume rise



- Also must consider radiative heat losses from the plume
  - Affects plume rise and buoyancy flux
- Pseudo Input Parameters that need to be calculated **<u>at the flame tip</u>**[6]:
  - Effective Stack Height, H_{eff}
  - Effective Exit Velocity, V_{eff}
  - Effective Diameter, D_{eff}

[6]Note that the values of these pseudo parameters are very different than those calculated at the flare nozzle due to air entrainment in the plume.

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Flare Modelling Guidance

- ADMGO[1] currently contains general guidance on modelling flares
  - applies to all facilities in the province that operate flares under all circumstances
  - current guidance is unclear
    - includes basic calculation methodologies with limited detail
    - this has resulted in use of inconsistent approaches and assumptions
- MOECC has developed a comprehensive Technical Bulletin (TB)[7] to replace the existing guidance on flaring
    - Circulated to stakeholders for comment (until March 31st)
    - updates and clarifies existing requirements and detailed calculation methodologies
    - based on an extensive review of current literature and jurisdictional requirements

[7]Included in the EBR posting for the revised ADMGO is a reference to a TB to update the guidance on modelling flares.

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Estimating H_{eff}

$$H_{eff} = H_s + 4.56 * 10^{-3} * Q_n/4.1868)^{0.478}$$
$$Q_n = Q_T * (1-f)$$

where:

- H_s = stack height above ground
  - Includes the flame length
  - Assumes 45° flame tilt due to wind
- Q_T = total heat
  - Sensible and radiative heat loss estimated based on the properties of the flared gas stream including the pilot fuel
- f = % heat lost by radiation, used to calculate net heat release (Q_n)
  - Previous guidance recommended a typical value of 25%
    - SCREEN3 uses a more conservative value of 55%
  - MOECC is proposing to change these values

Revised Methodology to Select f

- **Proposed Approach** is to use a hybrid combination of empirical relationships and literature values to develop varying f values to be used based on ranges of molecular weight (MW) of the flared gas stream
  - Requires proponents to choose the appropriate f value based on the stream composition for each scenario being considered
  - Includes the use of sweep or lift gas
  - Requires documentation to verify or support the stream composition for each scenario[8]

MW	f
≤ 20	25%
21 - 35	30%
36 - 50	35%
51 - 65	40%
66 - 80	45%
81 - 95	50%
>95	55%

[8]In the absence of sufficient information to verify or support the calculation of the MW, facilities will use an f value of 55%.

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Estimating V_{eff}
Proposed Revised Approach

- Based on revised approach used by Alberta Environment (2013)
- Calculate V_{eff} based on the conservation of both buoyancy flux (F_b) AND momentum flux (F_m)

$$F_m = \rho_{gas}/\rho_{air}/4 * (D_{nozzle})^2 * (V_s)^2$$

$$F_{b,\,actual} = g * Q_n / (\pi \times \rho_{air} * T_{amb} * C_{p,\,air})$$

Where ρ_{gas}, ρ_{air} = density of gas and air
D_{nozzle} = flare nozzle diameter
V_s = actual exit velocity at flare nozzle
Q_n = net heat release
$C_{p,air}$ = specific heat of dry air, constant

The effective velocity is then calculated as follows:

$$V_{eff} = g * F_m / F_{b,\,actual} * (T_{stack} - T_{amb}) / T_{amb}$$

Where $F_{b,\,actual}$ = buoyancy flux
T_{stack} = stack temperature (MOECC assumes 1273 K)
T_{amb} = ambient temperature

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Estimating D_{eff}
Current Approach – To Remain Unchanged[9]

- D_{eff} is calculated such that the buoyancy flux ($F_{b,estimated}$) calculated by the model (point source virtual flare) is equivalent to $F_{b,actual}$ of the exhaust stream
  - Intent is to get a reasonable approximation of the plume rise
- $F_{b,estimated}$ is typically estimated using the Briggs plume rise equation
  - Set $F_{b,estimated}$ equal to $F_{b,actual}$, and rearranged to solve for D_{eff}

$$D_{eff} = 2 * \sqrt{(F_b * T_{stack})/(g * V_{eff} * (T_{stack} - T_{amb}))}$$

- This approach for calculating D_{eff} is widely used by most other regulatory agencies and the US EPA.

[9]Note that although the approach for calculating D_{eff} does not change, the value of D_{eff} does change since the newly calculated V_{eff} is used in the calculation

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Modelling for Annual Averages

- AERMOD v14134 (and earlier versions) do not compute true “annual” averages
  - Selecting “annual” or “period” when running the full 5 years of meteorological data results in the generation of 5 year average POI concentrations rather than an annual average
    - To determine the max annual POI, evaluate the maximum POI for each of the 5 years in the met data set, by running each year individually. This is the MOECC’s PREFERRED approach.
    - Alternately, the 5 year average POI may be multiplied by 140% and compared to the annual standard as a screening check
      - If this value is greater than the annual standard, the MOECC PREFERRED approach must be used
- AERMOD v15181 computes true “annual” averages
  - s7(1) approval is required for use of new model version

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Use of NAAQS Contaminant IDs in AERMOD

- AERMOD now contains some data processing algorithms that are specifically applicable to demonstrate compliance with US NAAQS standards
  - These algorithms provide ranked maximum daily values (i.e. for SO_2 the program will output the 99^{th} percentile of the maximum daily 1-hour values, averaged over 3 years)
  - This will result in erroneous predictions of maximum POI concentrations
- Where possible the use of contaminant IDs for NO_2, SO_2 and $PM_{2.5}$ should be avoided, or the NAAQS processing algorithms must be disabled in the control section of the model inputs

Modelling Roadways

- Roadway sources may need to be modelled in some instances
- There are various modelling approaches that can be used for road sources, primarily “volume” or “area” source based
  - MOECC would prefer the volume source approach be used to model roads
- Model receptors should not be placed directly on roadways
  - Includes property lines that intersect roadways
    - Generally, receptors can be offset from the roadway edge by a distance of 1.5X the road width
- Recommendations from the US EPA Haul road Working Group are to be followed in modelling emissions from haul roads

Downwash Effects in SCREEN3

- AERMOD v11059 removed the 2.5x limitation for GEP[10] height on building downwash
- SCREEN3 has not been changed[11], and uses the GEP height to determine whether downwash will occur
- This results in:
  - a potential inconsistency between AERMOD and SCREEN3 modelling results for stacks greater than 2.5x building height
  - reduced conservatism in the SCREEN3 modelling results
- Approaches for addressing this potential inconsistency:
  - use SCREEN3 and set the stack height at 2.4x the building height
  - use AERMOD

[10]Good Engineering Practice (GEP) height

[11]SCREEN3 is the O.Reg.419/05 Tier 1 screening model. The US EPA has proposed the replacement of SCREEN3 with AERSCREEN as their regulatory screening model.

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Shoreline Dispersion Effects

- ADMGO has always recognized that AERMOD does not consider the potential for shoreline fumigation effects for facilities located near water bodies with stack/point emission sources.
- Section 8.2 of the current (2009) version of ADMGO:

> *Neither AERMOD nor ISCPRIME treats the effects of shoreline fumigation. Shoreline fumigation may occur along the shore of an ocean or a large lake. When the land is warmer than the water, a sea breeze forms as the warmer, lighter air inland rises. As the stable air from over the water moves inland, it is heated from below, resulting in a turbulent boundary layer of air that rises with downwind distance from the shoreline. The plume from a stack source located near the shoreline may intersect the turbulent layer and be rapidly mixed to the ground, a process called "fumigation," resulting in high ground level concentrations.* ***In these and other situations, the use of alternative models may be desired or required by the MOE***.

Shoreline Dispersion Effects

- Updated ADMGO clarifies the existing guidance for facilities located within approximately 1 km of the shoreline of a large water body, with stack/point sources
  - use with SCREEN3 to assess the ***potential*** for shoreline fumigation effects.
  - If SCREEN3 indicates that shoreline fumigation could occur, proponents will have to use an alternate model to calculate the maximum POI concentrations resulting from these fumigation events
    - Shoreline Dispersion Model (SDM)
      - Can be used to identify the hours where fumigation is likely to occur and assess POI concentrations during those hours, in addition to use of AERMOD during all other hours
    - CALPUFF
    - S7(1) approval would be required to use these alternative models

ASHRAE
(Same Structure Contamination)

- Used to assess concentrations due to same structure contamination (i.e. at an air intake or building opening of another owner/tenant, that is located on the same building as your exhaust)
- Regulatory version is ASHRAE 2011
- When using ASHRAE, the following must be provided:
  - Site drawing(s) showing Plan and Elevation views
    - Building height, length and width
    - Source and receptor (intake/opening) locations and distances
    - Source parameters (stack height, flow rate, diameter)
    - Full calculations for all wind speed ranges searched
  - ASHRAE 2011 requires a surface roughness value to be used in the calculations
    - This value should be consistent with the surface roughness value(s) in the meteorological data set used with AERMOD

Questions?

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