Alberta’s Air Quality Model Guideline:
draft update 2020

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Alberta’s Air Quality Model Guideline: draft update 2020

Outline

Alberta’s Air Quality Model Guideline: Draft Update 2020

Copy: https://www.alberta.ca/air-quality-modelling-overview.aspx

Comments: David.Lyder@gov.ab.ca
Closing date for comments: Midnight, October 2, 2020
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AQMS Overview

Modelling Approach
- Tiering
- Scenarios
- Source Types
- Terrain, receptors and modelling domain
- Meteorology

Model Output
- Sub/super-hourly averaging times
- Baseline concentrations
- Chemistry:
  - NO₂/NOₓ conversion
  - Other chemistry
- TRS
- Acid Deposition

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AQMS Overview

- Source Emission Standards
- Plume Dispersion Modelling
- Ambient Air Quality Objectives
- Approvals
  - Source Monitoring
  - Ambient air monitoring
  - Environmental Reporting
  - Inspections, abatement, enforcement
## Modelling Approach

### Tiering

- **Screening** – simple cases/preliminary look at problem/nearby sources
- **Refined/Advanced** – consider terrain/alternate switches
- **Alternate** – specialized/one of Alberta’s Air Quality Model Guideline: draft update 2020

<table>
<thead>
<tr>
<th>Air Quality Assessment</th>
<th>Approved Air Quality Model</th>
<th>Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening</td>
<td>AERSCREEN</td>
<td>≤ 50 km</td>
</tr>
<tr>
<td></td>
<td></td>
<td>REGULATORY MesoScale + onsite (if available)</td>
</tr>
<tr>
<td>Refined</td>
<td>AERMOD</td>
<td>≤ 200 km</td>
</tr>
<tr>
<td></td>
<td></td>
<td>REGULATORY MesoScale + onsite (if available)</td>
</tr>
<tr>
<td>Advanced</td>
<td>AERMOD</td>
<td>≤ 50 km</td>
</tr>
<tr>
<td></td>
<td></td>
<td>REGULATORY MesoScale + onsite (if available)</td>
</tr>
<tr>
<td>Alternate</td>
<td>Other</td>
<td>≤ 200 km</td>
</tr>
<tr>
<td></td>
<td></td>
<td>REGULATORY MesoScale + onsite (if available)</td>
</tr>
</tbody>
</table>
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Modelling Approach
(Refined/Advanced)

Scenarios

Max = Typical – model max

Max ≠ Typical – more complicated:

Max due to infrequent event – model infrequent event: more tolerant stats (1% of time, 1.5 AAAQO); model typical

Max due to other – model max; model typical: usual stats (0.1% of time, AAAAQO)

New
– estimated rates

Renewal/Amendment – historical average

Figure 3. Generic logic for the selection of emission scenarios required for a modelling assessment. The logic is applicable to new, renewal and amendment applications (see text below for details).
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Modelling Approach

Source Types

Merged Stack Sources

- EPA formulation (EPA 1992)
  - Similar stack parameters
  - Merged sources can be used for screening model
  - Must consider nearby sensitive receptors
  - Must consider downwash
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Modelling Approach

Source Types

- Fugitive Emissions
  - AP42
Modelling Approach

Source Types

Flaring

- Use AER flaring tools to generate pseudo-parameters for all flare modelling
  - Continuous – only pseudo-parameters
  - Non-routine – AER risk-based approach
Modelling Approach

Source Types

Non-vertical releases and caps

- EPA default algorithm
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Modelling Approach

Source Types

Building down wash
Several formulations allowed
  - Prime
  - ISCST3 (under certain configurations)
Alternate
  - ORD
  - Prime2/AWMA
Modelling Approach

Source Types

Low-wind options (AERMOD)
- Use EPA default option at moment
- If EPA sets new parameterization then use these

Coherent plume

Low wind speed disk
Modelling Approach

Source Types

Particulate emission (TSP) from stack surveys

- Distribute emissions per bin
- Aerodynamic profiling for correct transportation

Example:
Create the appropriate input to model TSP and PM$_{2.5}$ from a pulp and paper source that is emitting 10 g/s of TSP. From the AEIR Standard (Alberta Environment and Parks, 2018) a pulp and paper source has (PM$_{2.5}$/TSP) = 0.560 and (PM$_{10}$/TSP) = 0.737 (recall that PM$_{10}$ is cumulative and includes the PM$_{2.5}$ mass fraction).

AERMOD Solution:

To set up AERMOD it is necessary to first define the mass fraction. For this problem a table of input values for particulate deposition modelling is as follows:

<table>
<thead>
<tr>
<th>PM Species</th>
<th>Mean Particle Diameter (µm)</th>
<th>Mass Fraction*</th>
<th>Particle Density (g/cm$^2$)</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1 (PM$_{2.5}$)</td>
<td>0.625</td>
<td>0.1400</td>
<td>1</td>
<td>1.400</td>
</tr>
<tr>
<td>P2 (PM$_{2.5}$)</td>
<td>0.875</td>
<td>0.1400</td>
<td>1</td>
<td>1.400</td>
</tr>
<tr>
<td>P3 (PM$_{2.5}$)</td>
<td>1.125</td>
<td>0.1400</td>
<td>1</td>
<td>1.400</td>
</tr>
<tr>
<td>P4 (PM$_{2.5}$)</td>
<td>1.875</td>
<td>0.1400</td>
<td>1</td>
<td>1.400</td>
</tr>
<tr>
<td>P5 (PM$_{10}$)</td>
<td>4.250</td>
<td>0.0885</td>
<td>1</td>
<td>0.885</td>
</tr>
<tr>
<td>P6 (PM$_{10}$)</td>
<td>8.000</td>
<td>0.0885</td>
<td>1</td>
<td>0.885</td>
</tr>
<tr>
<td>&gt;PM$_{10}$</td>
<td>20.000</td>
<td>0.2630</td>
<td>1</td>
<td>2.630</td>
</tr>
</tbody>
</table>

* The mass fraction is assumed to be distributed uniformly amongst the different diameter bins associated with a particular PM species.
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Modelling Approach

Terrain, receptors and modelling domain

**Receptors** – standard distribution: 20 m nearby, 50 m further away, etc.

Exception: facilities with large boundaries (mines) – relax if no sensitive receptors nearby

**Modelling domain** – 5 km minimum from fence line, larger domain if cumulative impact

- can be determined from screening
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Modelling Approach

Meteorology

No change at this time:
- MM5
- 5 years (2002 – 2006)
- 12 km resolution

(will be updated in near future)
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Modelling Output

**Hourly**
- May exclude top 8 values (top 0.1%)

**Super-Hourly**
- Must include all hourly values
  - 8-hour average remove top value
  - 24-hour average and longer no removal allowed

**Sub-Hourly**
- Restricted to odour management AAAQGs
- 30 minute average period
- Must be based on include all hourly values
  - May exclude top 0.5% (based on Ontario guidance) – exclude top 44 “sub-hourly” values based on hourly data

\[
C_{\text{sub-hour}} = C_{\text{hour}} \times (\text{sub-hourly time/hour})^{-0.28} = C_{\text{hour}} \times 1.21
\]
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Modelling Output

Baseline concentrations

- Averaged over last three years
- Check for analyzer changes (do not average if noticeably different – jumps, waves, other discontinuities)
- Each year must be 75% complete
- Screening: 99.9% value; Refined/advanced: 90%

Example: Pollutant with hourly AAAQO.

- Last three years: 93%, 97% and 83% complete.

Hourly:

First and Second year: Remove top 8 hourly values
Third year: Remove top 7 hourly values
Baseline hourly value: Average of remaining top values from three years
Model Output

Chemistry

\( \text{NO}_2/\text{NO}_x \)

1. Total Conversion Method (always)
2. PVMRM/OLM (AERMOD)/ OLM: use in-stack ratios if available

\[
\begin{align*}
\text{If } & [\text{O}_3]_{\text{ambient}} > 0.9 \cdot [\text{NOx}]_{\text{predicted},i} \text{ then } [\text{NO}_2]_{\text{predicted},i} = [\text{NOx}]_{\text{predicted},i} \\
\text{otherwise } & [\text{NO}_2]_{\text{predicted},i} = [\text{O}_3]_{\text{ambient}} + \text{ISR}_i \cdot [\text{NOx}]_{\text{predicted},i}
\end{align*}
\]

For each \( i \)th source determine predicted \( \text{NO}_2 \). Sum all sources at each receptor.
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Model Output

Chemistry

\[ \text{NO}_2/\text{NO}_x \]

3. RIVAD/ISORROPIA (CALPUFF): Use Alberta default NH\(_3\) and H\(_2\)O\(_2\) values if no better available

4. ARM (AERMOD and CALPUFF): Use downwind monitoring ratios
   Default value = 0.7
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Model Output

Chemistry

\( \text{NO}_2/\text{NO}_x \)

5. ARM2 (AERMOD and CALPUFF):

Use current EPA methodology if \( \text{NO}_2 \) (project, total) \( \leq 200 \) ppb use as is

If \( \text{NO}_2 \) (project, total) > 200 ppb modify based on ISR.

If all project ISR \( \leq 0.2 \) then use default

If any project ISR > 0.2 then use stack ISRs
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Model Output

Chemistry

$\text{NO}_2/\text{NO}_x$

In Stack Ratios (ISRs):

1. Stack testing
2. Manufacturer’s data
3. EPA list of acceptable ISRs
4. Default values if no better information available:
   - Project ISRs = 0.5
   - Non-project = 0.2
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Model Output

Other chemistry

$\text{SO}_2$, $\text{SO}_4$, etc. (acid deposition)

Use CALPUFF or other AEP recommended model (not AERMOD)

Use RIVAD/ISORROPIA chemistry (CALPUFF): Use Alberta default $\text{NH}_3$ and $\text{H}_2\text{O}_2$ values if no better available

TRS

Reported as TRS, use as is

Reported as mix (e.g., $\text{H}_2\text{S}$, $\text{CS}_2$, etc.), then form simple mass sum
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Model Output

Acid Deposition

When required:

1. The proponent’s combined emissions of SO$_2$, NO$_x$, and NH$_3$ are greater than 0.175 t/d of H$^+$ equivalent, i.e.,

   \[
   \text{Total H}^+ \text{ equivalent (t/d)} = 2\left(\frac{\text{SO}_2 \text{ t/d}}{64}\right) + 1\left(\frac{\text{NO}_x \text{ t/d}}{46}\right) + 1\left(\frac{\text{NH}_3 \text{ t/d}}{17}\right), \tag{5}
   \]

   or

2. There is evidence that regional soil and surface water is more sensitive to acidification than is estimated in the provincial framework, or

3. There is existing deposition and/or acidification impact monitoring that indicates a potential concern if acid deposition increases.
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Model Output

Acid Deposition
Acidifying deposition from assessment used as input into Acid Deposition Management Framework (ADMF) to determine if critical load is exceeded

Base Cation Deposition: Incorporated into ADMF already (do not add it to acidifying deposition)

Meteorology: Use median average deposition value based on five year regulatory data set
Questions?

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