

TECHNICAL BULLETIN

Standards Development Branch

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METHODOLOGY FOR MODELLING ASSESSMENTS OF CONTAMINANTS WITH 10-MINUTE AVERAGE STANDARDS AND GUIDELINES for Odour under O. Reg. 419/05

EXECUTIVE SUMMARY

This Technical Bulletin has been developed to clarify technical modelling issues associated with the use of odour based standards or guidelines with 10-minute averaging periods. The bulletin provides some clarification of the potentially challenging process of incorporating advanced dispersion models and hourly meteorology in the assessment of contaminants with 10 minute average standards and guidelines. The goal of this Technical Bulletin is to outline an appropriate modelling approach and scenario that reasonably represents a facility's operating conditions. This technical bulletin presents a tiered approach to modelling that begins with a conservative assessment but can also lead to more refined modelling assessments if initial attempts appear likely to exceed a Ministry of the Environment and Climate Change (the Ministry) standard or guideline. As with other Ministry standards or guidelines, once refined modelling indicates an exceedence of a standard or a guideline, notification under section 28 of Ontario Regulation 419/05: Air Pollution – Local Air Quality (O. Reg. 419) is required.

1. PURPOSE OF THIS TECHNICAL BULLETIN

The purpose of this Technical Bulletin is to clarify the modelling aspects related to the use of 10-minute odour based standards and guidelines as part of O. Reg. 419/05. Schedule 3 of O. Reg. 419/05 has 10-minute odour-based standards for some offensive odorous contaminants that includes total reduced sulphur (TRS), hydrogen sulphide (H₂S) and mercaptans. The Ministry also publishes a list of Point of Impingement (POI) guidelines that includes odour based guidelines with 10-minute averaging periods. The use of standards and guidelines with 10-minute averaging periods would generally only apply to facilities governed by section 20 of O. Reg. 419 (i.e. Schedule 3 standards) or section 19 facilities completing an ESDM report as if section 20 applies under O. Reg. 419/05, section 24(2).

This technical bulletin should not be used by facilities assessing against half hour standards as per section 19 of O. Reg. 419/05. In particular, it is not appropriate to apply a frequency of exceedences to Schedule 2 half hour standards. Section 19 facilities that would like to consider the frequency of exceedences must request a speed up under section 20(4) to apply Schedule 3 standards for the contaminant(s) in question. Similarly, a facility should not apply a frequency of exceedence for half hour

guidelines. The Ministry will consider a frequency of exceedence when guidelines with 10-minute averages are being assessed.

O.Reg. 419/05 explicitly states that odour-based standards do not apply to: agricultural operations, alarm systems or warning systems and dimethyl disulphide from regulated pesticides. It also states that it is an offence to discharge a contaminant with a standard that is in Schedule 3 with a 10-minute averaging time such that the concentration exceeds the standard at any locations where and when human activities regularly occur. This offence relates to a monitored or measured exceedence.

Section 20 of O. Reg. 419 states:

(2.1) Subsections (1) and (2) do not apply with respect to a standard set out in Schedule 3 for a 10 minute averaging period.

(2.2) A person shall not discharge or cause or permit the discharge of a contaminant listed in Schedule 3 into the air if a standard is set out in Schedule 3 for the contaminant for a 10 minute averaging period and the discharge results in the concentration of the contaminant exceeding that standard at a point of impingement where human activities regularly occur at a time when those activities regularly occur.

(2.3) Subsection (2.2) does not apply if the discharge arises from,

- (a) an agricultural operation to which subsection 2 (1) of the Farming and Food Production Protection Act, 1998 applies; or***
- (b) the use of an alarm system or warning system for health or safety reasons, including the use of an alarm system in an underground mine in accordance with Regulation 854 of the Revised Regulations of Ontario, 1990 (Mines and Mining Plants) made under the Occupational Health and Safety Act.***

Often, dispersion modelling is used in the absence of monitoring or measured exceedences to help determine whether or not a facility is likely to exceed a standard or a guideline.

The purpose of this technical bulletin is to present the preferred methodology for the modelling assessment of contaminants with 10-minute odour-based standards and guidelines and does not apply to monitored or measured exceedences. This modelling methodology allows for the consideration of:

- A location where human activities regularly occur at a time when those activities regularly occur; and
- The frequency of exceedences of the 10-minute odour-based standards and guidelines at the above locations.

Ministry standards and guidelines are contaminant-specific under the context of O. Reg. 419/05, and are used to assess emissions from a single facility. Odour impacts are typically addressed in relation to adverse effects as defined in Section 14 of the Environmental Protection Act (EPA). As such, odour impacts due to aggregate exposure to a mixture of odorous compounds (usually expressed in odour units (OU)) are not addressed in this technical bulletin. In addition, this technical bulletin does not address odourous emissions from multiple facilities. This technical bulletin only deals with a preferred technical method for modelling assessments of contaminant specific standards and guidelines with 10-minute averages concentrations as they apply to individual facilities.

2. A TIERED APPROACH TO ASSESSING 10-MINUTE AVERAGE CONCENTRATIONS

The following sections provide further details on location and frequency, as well as a tiered approach to assess 10-minute odour-based standards and guidelines.

2.1. General Information

This document builds on existing Ministry guidelines^{1,2} in an attempt to highlight (and clarify) a tiered approach for the assessment of 10-minute odour-based standards and guidelines. This tiered approach is presented in this document in order to provide guidance for facilities that are developing Emission Summary and Dispersion Modelling (ESDM) Reports. The concept is that the proponent needs to refine their approach until compliance is demonstrated or abatement is required.

A proponent may choose to go directly to a more refined approach and skip any of the tiers. In some situations, for example, with an existing odour issue at a facility, the Ministry may require a proponent to proceed directly to a more refined approach. However, it is important that the method for assessing odour-based standards and guidelines is done consistently by all facilities.

Modelling may be first undertaken with a simple approved model that requires no meteorological inputs such as SCREEN3 or using an approved model such as AERMOD with an appropriate regional meteorological data set. If this modelling shows that the standard or guideline will be met at all locations within the modelling domain, the facility is deemed, for assessment purposes, to meet the standard/guideline and no further assessment is necessary.

¹ "Procedure for Preparing an Emission Summary and Dispersion Modelling (ESDM) Report" (PIBs # 3614e04) (as amended)

² "Air Dispersion Modelling Guideline for Ontario (ADMGO)" (PIBs # 5165e) (as amended)

In cases where the standard/guideline is not met everywhere within the modelling domain, then the concentrations at the location(s) of where human activities regularly occur (human receptors) may be examined using an approved model under section 6 of O. Reg. 419/05 that uses hourly meteorological data with approved site-specific meteorological data³ (O. Reg. 419/05, section 13(1)). Alternative models such as CALPUFF, CALQ3HC etc. may also be appropriate (O. Reg. 419/05, if section 7(1)) Ministry approval is obtained for their use⁴). If the standard or guideline will be met at all human receptor locations within the modelling domain, the facility is deemed, for assessment purposes, to meet the standard/guideline and no further modelling assessment is necessary.

If the maximum modelled concentration is above the 10-minute standard/guideline at a location of one of the human receptors, then the frequency of exceeding the standard/guideline may be determined using the same model run. While almost every meteorological data set will contain the set of worst 1 hour and 24 hour meteorological conditions for a given facility in every direction, determining the *frequency* of exceeding a criterion requires the site-specific meteorology to be as representative as possible for the site. If the modelled number of exceedences at a human receptor are below a prescribed amount (0.5% of the time on an annual basis) then the facility is deemed, for assessment purposes, to meet the standard/guideline.

Since the approved model used produces a minimum of 1 hour average output, the results from the model must be converted to an equivalent 10-minute average concentration using the equation in s.17 of O.Reg. 419/05 (in this case $(60/10)^{0.28}$ or 1.65). An example of the conversion of a modelled maximum 1 hour average concentration of $23 \mu\text{g}/\text{m}^3$ to an equivalent maximum 10 minute average concentration is shown below:

$$\frac{23 \mu\text{g}}{\text{m}^3} \times \left(\frac{60 \text{ min}}{10 \text{ min}} \right)^{0.28} = \frac{38 \mu\text{g}}{\text{m}^3}$$

1hr-avg 10 min-avg

As outlined in the Ministry guidance document entitled “Air Dispersion Modelling Guideline for Ontario (ADMGO)” (as amended), a proponent or the Ministry may, in special situations, demonstrate that the use of an alternative conversion approach may be more appropriate or required (O. Reg. 419/05, section 17(3)). Approval must be obtained from the Environmental Monitoring and Reporting Branch (EMRB) prior to the use of any alternate conversion approach.

³ Ministry Form required to request approval under s.13(1) of Regulation 419/05, for use of site specific meteorological data. (PIBs # 5350e)

⁴ Ministry Form: Request under s.7(1) of Regulation 419 for Use of a Specified Dispersion Model (PIBs # 5352e)

2.2. Emission Rate and Operating Conditions

The Ministry guideline document titled “Procedure for Preparing an Emission Summary and Dispersion Modelling (ESDM) Report”, (as amended), provides guidance on the determining emission rates. In general, the emission rate scenario must match the time averaging period of the standard or guideline. However, there may be technical barriers to determining the maximum 10-minute emission rates (i.e. for operations that do not operate continuously or at a sufficient duration to measure the short term maximum emission rates). For the processes that operate continuously, a maximum 1-hour average emission rate may be used to undertake the modelling assessment for odour based standards and guidelines. For processes that do not operate continuously, a 10 minute average emission rate would likely be higher and hence, proponents must provide appropriate justification for the emission rate used.

The modelling of the emissions may also be more refined, if there is a periodicity to the emission rates (i.e. certain operations that occur over particular hours of the day or if the facility operates a limited number of hours per day, days per week or seasonally). This type of operating condition refinement is generally allowed as per section 10 of O. Reg. 419/05. Source testing or a modelling/monitoring assessment may also be used to refine the emission rates for the contaminant of concern, and may allow for the determination of 10-minute maximum emission rates. As required under section 3 of O. Reg. 419/05, the modelling must include all emissions of the contaminant that occur as part of a facility’s operations.

If no exceedence of the odour-based standard or guideline is modelled to occur using the conservative maximum emission rate then no further refinement is necessary. However, if modelling shows an exceedence, the emission rate or the operating conditions may be refined as per section 12 of O. Reg. 419/05.

2.3. Modelling Human Receptors

The modelling assessment may be undertaken at the human receptor locations. While some human receptor locations, such as a single residence, may be adequately represented by a single modelled grid point, others, such as a residential subdivision, will require more grid points to ensure that the maximum impact within that human receptor location is determined. By using the spacing of the receptor grid, as required by section 14 of O.Reg. 419/05, there should be adequate densities of receptor grid points within the larger areas where human activities regularly occur. In some cases it may be desirable to place an additional separate discrete receptor to represent a particular human receptor.

2.4. Meteorology

The Ministry guideline document entitled “Air Dispersion Modelling Guideline for Ontario (ADMGO)”, (as amended), provides guidance on the appropriate meteorological data,

dispersion models, and other modelling parameters that are to be considered in the implementation of the Ministry standards and guidelines.

However in order to assess maximum concentrations at specific receptor locations, and/or for the frequency of exceedences to be estimated correctly, approved site-specific meteorological data that is representative of the facility site must be used.

2.4.1. Regional Meteorological Data Sets

Since the regional meteorological data sets were chosen to represent a geographical region, it can be assumed that parameters such as temperature and general distributions of atmospheric stability are similar within the region. There will be differences in frequency of wind direction within the region as local features steer the wind direction. For facilities with a history of complaints or ongoing odour issues, the use of approved site-specific meteorological data as detailed in section 2.4.2 is strongly recommended.

Since the Ministry's regional meteorological data sets include 5 years (43,800 hours) of data and it is highly likely that every possible combination of wind speed, atmospheric stability and direction will have occurred at least once in those data sets, the regional meteorological data set may be used to determine if the highest modelled concentration located anywhere within the regulatory modelling grid is below the 10-minute average standard or guideline. If this is the case then no more modelling is required and the facility is considered likely to meet the standard or guideline.

2.4.2. Refinement of Meteorological Data

If the standard or guideline was modelled to be exceeded somewhere within the modelling domain, then the assessment may be refined by examining the maximum modelled concentrations at the locations of the human receptors using an approved model with approved site-specific meteorological data. If the modelled maximum 10-minute concentrations at the location of the human receptors are below the standard or guideline then no more modelling is required and the facility is considered to meet the standard or guideline.

If the modelling predicts that the standard or guideline is exceeded at any of the human receptors, then the frequency of the exceedence can be determined using the same model run and may be considered by the Ministry. To determine the frequency of exceedence at the location of a particular human receptor it is necessary to use representative site-specific meteorology. While the meteorological conditions that lead to the maximum concentration are likely to occur at least once in every direction during a 5 year data set, the percentage of the time that particular wind directions occur that will blow from the source to the human receptor in question is site-specific. The use of

non-representative meteorology may result in a frequency that is either an over or under prediction of the actual number of exceedences.

All local or site-specific meteorological data used for compliance assessment must be approved⁵ by the Ministry. The Environmental Monitoring and Reporting Branch (EMRB) can provide the most appropriate, approved local meteorological data set for the facility being modelled. Suitable site-specific meteorological data may also be prepared from nearby well-maintained, well-verified and well-sited stations (Environment Canada and others) or on-site stations (O. Reg. 419/05, section 13(3)) and submitted to the Ministry for approval. Alternately, site-specific meteorological data may be extracted from a suitable weather model or other computational method (O. Reg. 419/05, section 13(4)) and submitted for approval.

2.5. Locations Where Human Activities Regularly Occur

In the context of O. Reg. 419/05, the assessment of impacts of a contaminant is to be performed at all “points of impingement” as defined in the regulation. By definition, this would include assessment at the location where the maximum point-of-impingement concentration of that contaminant would occur. For 10-minute odour-based standards and guidelines this assessment is also to be carried out at the time and place “where human activities regularly occur”. Examples of these locations of human receptors that may be considered for the assessment of compliance with 10-minute odour-based standards and guidelines would include:

- residences;
- health care facilities;
- senior citizen’s residences or long-term care facilities;
- child care facilities;
- camping grounds;
- schools;
- community centres;
- day care centres;
- recreational centres and sports facilities;
- outdoor public recreational areas; or
- other locations as specified by the Ministry.

Please see attached Table 1 for more guidance on locations where human activities regularly occur.

⁵ Ministry Form: Request for Approval under s.13(1) of Regulation 419 for use of Site Specific Meteorological Data (PIBs # 5350e)

In certain circumstances, the Ministry may exercise discretion regarding the implementation of 10-minute odour-based standards and guidelines at specific locations in the vicinity of a facility, especially as related to surrounding land use and the potential for land use to change over time. Note that despite using the methodology described in this Technical Bulletin to show compliance at a human receptor, the obligation to comply with section 14 of the EPA still exists (i.e. no adverse effect).

2.6. Times When Human Activities Regularly Occur

The time when human activities regularly occur may also be taken into consideration. For example, when assessing the modelled impact on a day care facility, only the hours of operation of the facility need to be taken into account when determining the maximum concentration or the frequency of exceedence. Generally for a golf course or an amusement park which has no access during the off-season only the time when it is open needs to be considered. See Table 1 for more guidance on when human activities regularly occur.

2.7. Frequency

The methodology described in this technical bulletin allows, for assessment purposes only, a certain modelled frequency of exceeding a 10-minute odour-based standard or guideline. As indicated previously, in order to assess frequency, a more advanced air dispersion model with site-specific hourly meteorological input (e.g. AERMOD,) must be used.

For a facility that emits a contaminant with a 10-minute odour-based standard or guideline, and for assessment purposes only, it is considered acceptable if the modelling shows that at a location of a human receptor the standard or guideline is exceeded less than 0.5% of the time, which corresponds to approximately 44 hours per year. This means that 99.5% of the time in any given year, the 10-minute odour-based standards and guidelines will be met, assuming that the emission scenario used in the modelling is accurate.

The Ministry guidance on the elimination of meteorological anomalies (as described in ADMGO) still applies in this situation. When assessing the frequency of occurrence at locations where human activities regularly occur, the anomalous hours of meteorology determined from the full modelling grid, required under O.Reg. 419/05 (s.14), do not need to be considered. It is always more conservative to include the anomalous hours in the assessment of frequency.

3. Summary Of Procedure For The Implementation Of 10-minute Odour-Based Standards And Guidelines

The following is a summary of the technical method that is suggested to assess 10-minute odour based standards and guidelines in the development of an ESDM report.

(1) (a) Determine the maximum 1-hour average concentration using any of the Ministry approved air dispersion models that can be used to assess compliance with Schedule 3 standards (O. Reg. 419/05, section 6) with the specified grid spacing (O. Reg. 419/05, section 14) within the specified modelling domain (O. Reg. 419/05, section 14). Convert the model output to a 10-minute average concentration using method in section 17 of O. Reg. 419/05. If the odour-based standard or guideline is met at all grid points within the modelling domain then the facility is deemed likely to meet the standard/guideline and no further modelling is required.

(b) If the SCREEN3 model was used and the results show an exceedence of a standard or guideline, a Ministry approved dispersion model (or another pre-approved model under section 7(1) of O. Reg. 419/05) that uses hourly meteorological inputs must be used to determine the maximum 10-minute average concentration as described above. If that model shows the odour-based standard or guideline are met at all grid points within the modelling domain then the facility is deemed likely to meet the standard/guideline and no further modelling is required. If the model results still show an exceedence of a standard or guideline somewhere within the modelling domain, the model should be re-run with an approved site-specific meteorological data set (O. Reg. 419/05 section 13(1)). Meteorological anomalies may be removed (i.e. modelled results during the top 8 hours per year of meteorology used over the entire grid, not the ninth highest concentration at each receptor) as outlined in the ADMGO.

(2) If the modelling completed in (1)(b) above shows that the standard or guideline was predicted to be exceeded somewhere within the modelling domain, then the assessment may be further refined by examining the maximum modelled concentrations at the locations of the human receptors, using an approved model with approved site-specific meteorological data. Using the results from (1b), determine the maximum 1-hour average concentration at locations of all human receptors within the modelling domain. Convert the model output to a 10-minute average concentration using the method in section 17 of O. Reg. 419/05. If the modelling shows that the odour-based standard or guideline is met at the location of all human receptors within the modelling domain then the facility is deemed likely to meet the standard/guideline and no further modelling is required.

If the modelled maximum 10-minute concentrations at the location of the human receptors indicate exceedences of standards or guidelines then the modelling may be further refined by removal of meteorological anomalies as outlined in (3) below and/or determination of frequency of exceedence as outlined in (4) below. Note that removal of meteorological anomalies is optional and thus proponents may calculate the frequency of exceedence without removal of meteorological anomalies, which will be conservative.

- (3) Using the same model run used in (2), remove the results during the hours considered to be meteorological anomalies from the human receptor locations (i.e. modelled results from the top 8 hours per year of meteorology in each year modelled, as identified in (1b) above, over the entire grid) as outlined in the ADMGO. Note that these are the same anomalous hours identified from the model run over the entire receptor grid, not the results from the top 8 hours at the human receptor locations. If the odour-based standard or guideline is met at locations of all human receptors then the facility is deemed likely to meet the standard/guideline and no further modelling is required. If not, the procedure in (4) below should be used to determine the frequency of exceedence of the standards or guidelines.
- (4) Using the same model run in (2) or the result from (3) above, determine the frequency of exceedence at the location of the human receptors. If the modelled frequency of exceedence is below 0.5% annually at the location of all human receptors within the modelling domain, then the facility is deemed likely to meet the standard/guideline.

There are several tools that may be used to make the assessment more accurate that may be applied at any time throughout the above steps. These include:

- Refinement of the source emission rates with source testing or similar methods to better quantify the emissions;
- Use of an operating scenario that reflects the way each source emits – i.e. 8:00h to 17:00h on weekdays only; and/or
- Refine the occupancy of the human receptor to reflect actual use – i.e. seasonal use of amusement parks or golf courses, daytime use of daycare centre.

The proponent must demonstrate for all operating conditions (section 10) that the odour based standard or guideline is met.

If modelling still shows exceedences above a 10-minute standard or guideline, then notification under section 28 of O. Reg. 419 is required.

3.1. Technical Tips

The following are technical tips that may be followed to make assessments easier to accomplish, especially for those assessments involving frequency of occurrence.

- Rather than convert all the 1 hour model outputs to an equivalent maximum 10-minute average concentration, multiply the 1-hour mass emission rate of all of the sources by the 1 hour average to 10 minute average conversion factor (1.65) for direct comparison to the standard or guideline and for ease of determining frequency of occurrence. Note that this will only account for the meteorological variability between a 1-hour average and a 10-minute average concentration and

does not account for any variability between 1-hour maximum and 10-minute maximum emission rates (see chapter 2.2).

- Graphically overlay the grid points with their maximum modelled concentration on a suitable base map that clearly shows where human activities regularly occur. This allows one to readily find the maximum concentration for all of the grid points that fall within any of these locations. Similarly overlaying the frequency isopleths allows one to readily find the maximum frequency of occurrence for each human receptor.
- Use the MAXFILE keyword in AERMOD to create a *.max* file (i.e. a threshold violation file) that contains the location (x and y coordinates), the modelled concentrations and the dates/times for all predictions that are above a threshold value for each hour in the meteorological data set. If the mass emission rates were adjusted by the 1.65 factor as previously suggested, the threshold value should be set at the 10-minute average standard or guideline. For each grid point that represents the location of a human receptor, the number of exceedences must be counted and converted to a percentage. Note that this must be done on an annual basis for each of the 5-years of meteorology. At least one of the common graphical interfaces for the US EPA models automatically determines the number of exceedences for each grid point in the modelling domain and allows the data to be graphically overlaid on a base map. Isopleths of the number of exceedences may also be plotted. It should be noted however that *.max* files can be quite large and may need to be processed with a database or other program. It should also be noted that the grid point with the maximum number of exceedences is not necessarily at the same location as the grid point with the maximum concentration.
- To shorten modelling run times and to reduce the size of *.max* file, the number of grid points may be reduced to only those related to the human receptors that are of concern, or individual *.max* files can be generated for each human receptor location.
- To refine either the operating scenario or the time of occupancy of the human receptor there are several parameters that may be used with the emission factor keyword (EMISFACT) that may be used to adjust the emission rate of each source by:
 - season;
 - month;
 - hour of day;
 - season and hour of day; and
 - season, hour of day and the seven days of the week.
- For the ultimate in flexibility, an hourly input file in which source parameters including emission rate, exit velocity and temperature are adjustable on an hour by hour basis for each source can be used.

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Table 1 – Proposed Clarification of Human Receptors

Receptor Category	Examples	Exposure Type	Type of Assessment
Permanent potential 24 hour sensitivity	Anywhere someone could sleep including any resident or house, motels, hospitals, senior citizen homes, camp grounds, farmhouse, etc.	Individual likely to receive multiple exposures	Considered sensitive 24 hours per day
Permanent daily hours but with definite periods of shutdown/closure	Schools, daycares, community centres, soccer fields, farmland, churches, bicycle paths, hiking areas, lakes, commercial or institutional facilities (with consideration of hours of operation such as night clubs, restaurants, etc.)	Individual could receive multiple exposures	Night time or daytime exclusion only (consider all other hours)
Seasonal variations with clear restrictions on accessibility during the off season	Golf courses, amusement parks, ski hills, other clearly seasonal private property	Short term potential for exposure	Exclusions allowed for non-seasonal use
Transient	Open fields, roadways, easements, driveways, parking lots, pump houses	Very short term potential for exposure, may not be a single resident exposed to multiple events	Generally would not be included as human receptors unless otherwise specified.