# Air Assessment Guidance Document

Direction for EA/environmental approval holders and applicants

Air Quality Unit, Department of Environment and Climate Change

NOVA SCOTIA

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## Document Version Record

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# Acronyms

| | |
|---|---|
| AAQC | Ambient Air Quality Criteria |
| AAQS | Ambient Air Quality Standards |
| ARM | Ambient Ratio Method |
| AST | Atlantic Standard Time |
| BATEA | Best Available Technology Economically Achievable |
| BOP | Best Operating Practice |
| BPIP | Building Profile Input Program |
| CAAQS | Canadian Ambient Air Quality Standards |
| CCME | Canadian Council of Ministers of the Environment |
| CDED | Canadian Digital Elevation Data |
| CEMS | Continuous Emissions Monitoring System |
| CGA | Cylinder Gas Audit |
| COPD | Chronic Obstructive Pulmonary Disease |
| DEM | Digital Elevation Model |
| EA | Environmental Assessment |
| ECC | Environment and Climate Change |
| ECCC | Environment and Climate Change Canada |
| EQS | Environmental Quality Standards |
| FEM | Federal Equivalent Method (US) |
| FRM | Federal Reference Method (US) |
| FTP | File Transfer Program |
| GLCs | Ground-level Concentrations |
| HAPs | Hazardous Air Pollutants |
| IA | Industrial Approval |
| MECP | Ministry of the Environment, Conservation and Parks |
| MMIF | Mesoscale Model Interface Program |

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| MOVES3 | Motor Vehicle Emission Simulator |
| NAPS | National Air Pollution Surveillance program |
| NIST | National Institute of Standards and Technology (United States) |
| NO | Nitric oxide |
| $NO_2$ | Nitrogen dioxide |
| $NO_x$ | oxides of nitrogen, including nitric oxide and nitrogen dioxide |
| NPRI | National Pollutant Release Inventory |
| NRC-MSS | National Research Council of Canada Measurement Science and Standards Research Centre |
| NWP | Numerical Weather Prediction |
| $O_3$ | Ozone |
| OLM | Ozone Limiting Method |
| OU | Odour Units |
| $OU/m^3$ | Odour units per cubic metre |
| PEMS | Predictive Emissions Monitoring System |
| PM | particulate matter |
| $PM_{2.5}$ | particulate matter ≤2.5 µm in diameter (fine) |
| $PM_{10}$ | particulate matter ≤10 µm in diameter (coarse) |
| PRIME | Plume Rise Model Enhancements |
| PVMRM | Plume Volume Molar Ratio Method |
| QA/QC | Quality Assurance/Quality Control |
| RATA | Relative Accuracy Test Audit |
| SCRAM | Support Center for Regulatory Atmospheric Modelling |
| $SO_2$ | Sulphur dioxide |
| TRS | Total Reduced Sulphur |
| US EPA | United States Environmental Protection Agency |
| USGS | United States Geological Survey |
| VEC | Valued Environmental Components |
| VOCs | Volatile Organic Compounds |

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| WHO | World Health Organization |
| WRF | Weather Research and Forecasting |

## Definitions

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| Acceptance criteria | the maximum allowable difference (discrepancy) between an instrument's response versus a known concentration of contaminant (as determined during a zero check, span check, or multipoint verification) beyond which data must be invalidated. |
| Activities Designation Regulations | Nova Scotia's *Activities Designation Regulations* NS Reg 60/2019. |
| Activity | any industrial process defined by the Activities Designation Regulations. |
| Air Quality Regulations | Nova Scotia's *Air Quality Regulations* NS Reg 8/2020. |
| Applicant | a person or corporate body who has submitted and is active in the process of an application for an environmental assessment or Industrial Approval with respect to air quality. |
| Baseline concentrations | the ambient concentration of a pollutant at a given location resulting from all sources excluding contributions from the designated activity. |
| Calibration | adjustment of an instrument or firmware to establish/re-establish the relationship between instrument response and expected concentration. It compares the values generated by a device that is being tested to those of a calibration standard of known accuracy. |
| Completeness | comparison of the valid data collected versus the total number of data points expected for the measurement period. |
| Cumulative impacts | effects from exposure to all sources of air pollutants. |
| Cylinder gas audit | test performed on a gas analyzer using reference gas at known concentrations. |
| Datalogger/data acquisition system | device that collects data and other information from instruments at the monitoring site. |
| Data validation | process of examining objective evidence to confirm that the data are fit for purpose. |
| Dispersion modelling report | the final report for a dispersion modelling assessment, demonstrating impacts using isopleths and a table of maximum concentrations predicted at specific (sensitive) receptors. The report should contain the required input and output files. |

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| Emissions data | the data that are collected during the source testing activities and presented in a final report. |
| Environment Act | Nova Scotia's *Environment Act* 1994-95 as amended. |
| Federal equivalent method | an analytical procedure (method) for measuring the concentration of an air pollutant that has been designated as equivalent (in terms of accuracy) to the Federal reference method for that contaminant. |
| Federal reference method | an analytical procedure (method) that has been adopted by the United States Environmental Protection Agency (US EPA) as the standard against which other methods for the same pollutant are validated. |
| Final Report | means the phase of the source testing activities that provides such items as the raw data, calculations, results, and a discussion of the results of the source testing program. |
| $g/cm^3$ | grams per cubic centimetre. |
| m/s | metres per second. |
| Method deviations | any testing procedures that are performed outside of the accepted reference methods or other pre-approved methods during the source testing program. |
| Mitigation methods | technologies and/or practices that are used to minimize concentrations of pollutants in the atmosphere as a consequence of emissions from a designated activity. |
| Monitoring report | a report prepared by the Applicant that details the results of ambient air monitoring over a specified period of time. |
| Multi-point verification | establishes and subsequently verifies the accuracy and linearity of the instrument at regular intervals to ensure data validity. |
| Periodic sampling | the collection of air contaminants into a single sample over an extended period. |
| Pre-test Plan | means a summary of the sampling protocols and testing to be employed by the Applicants during emission source testing. |
| Qualified person | *Qualified Person as it relates to ambient (outdoor) air quality, means one who has certified post-secondary education and/or* |

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| | *professional training in ambient (outdoor) air quality, and a minimum of 5 years of experience in the field of ambient (outdoor) air quality, or as otherwise authorized by the Department.*<br><br>Where 'certified' means recognized education in air quality, either as e.g., an air quality degree, or where air quality was taught as part of a degree (a module) that can be proven through the presentation of a certificate or transcript.<br><br>Where 'professional' means either through a certified training course (proven through the presentation of a certificate) or in a professional setting under the supervision of a qualified person (CV or list of workplaces with details of the supervisor, projects, roles undertaken). |
| Quality assurance and quality control (QA/QC) | procedures and systems used to ensure and verify that collected data meets defined standards of quality. |
| RAW/raw data | data that have not been edited/modified. |
| Reference standard | the standard (maintained by a standard-setting authority) against which all other gas mixtures or instruments are compared. |
| Relative accuracy test audit | comparison of gas analyzer data against simultaneously collected reference method test data to assess accuracy of the gas analyzer. |
| Residence time | the amount of time that it takes for a sample of air to travel from the sampling inlet to the instrument. |
| Routine Maintenance | work that is planned and performed on a routine basis to maintain and preserve the condition of the boiler combustion, turbine or heat recover units and associated pollution control equipment. |
| Sampling inlet/probe | an opening through which air enters the sampling system before continuing to an analyzer, monitor or sampler. |
| Sensitive receptor | humans and/or biological species in the natural environment, that are particularly susceptible to impacts from air pollution. Examples of sensitive humans are the young, very old, pregnant, and immunocompromised. |
| Source | the location where air contaminants are released to the atmosphere. |
| Source testing activities | all the phases of source testing, which include the Pre-test Plan, the source testing program, and the Final Report. |

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| Source testing program | the phase of the source testing activities that involves the site set-up and actual testing to determine the concentration and/or emission rate of contaminants being released from the source to the atmosphere. |
| Source testing method | the approved reference methods adopted by the Department that may be issued by Environment and Climate Change Canada, the United States Environmental Protection Agency, or other agencies. Approved source testing methods are listed in Appendix A. |
| Specific receptors | identified locations used in dispersion modelling. |
| The Department | Nova Scotia Department of Environment and Climate Change. |
| The document | the Air Assessment Guidance Document. |
| Vulnerability categories | with respect to health; at-risk populations that are potentially exposed to harm from air pollution. |

# Preface

Air quality impacts all living organisms on the planet. Quality of life is influenced by the air that we breathe, hour by hour, year by year. The air is a complex mixture of chemicals – some are required for life, while others can result in health issues that can limit enjoyment of life or even result in death. The World Health Organization (WHO) estimates that 7 million people globally die prematurely per year as a result of exposure to air pollution (WHO, 2021). While reports of poor air quality in other parts of the world are becoming more noticeable in the news, Nova Scotia is not immune. Health Canada (Health Canada, 2019) estimates that every year, 260 Nova Scotians die prematurely due to exposure to air pollution. Added to this is the cost to the Nova Scotia economy of medical treatment and lost workdays which was estimated in 2008 to reach $320 million by 2031 (Canadian Medical Association, 2008).

From a regulatory perspective, there are four sources of air pollutants (see Figure A). These are:

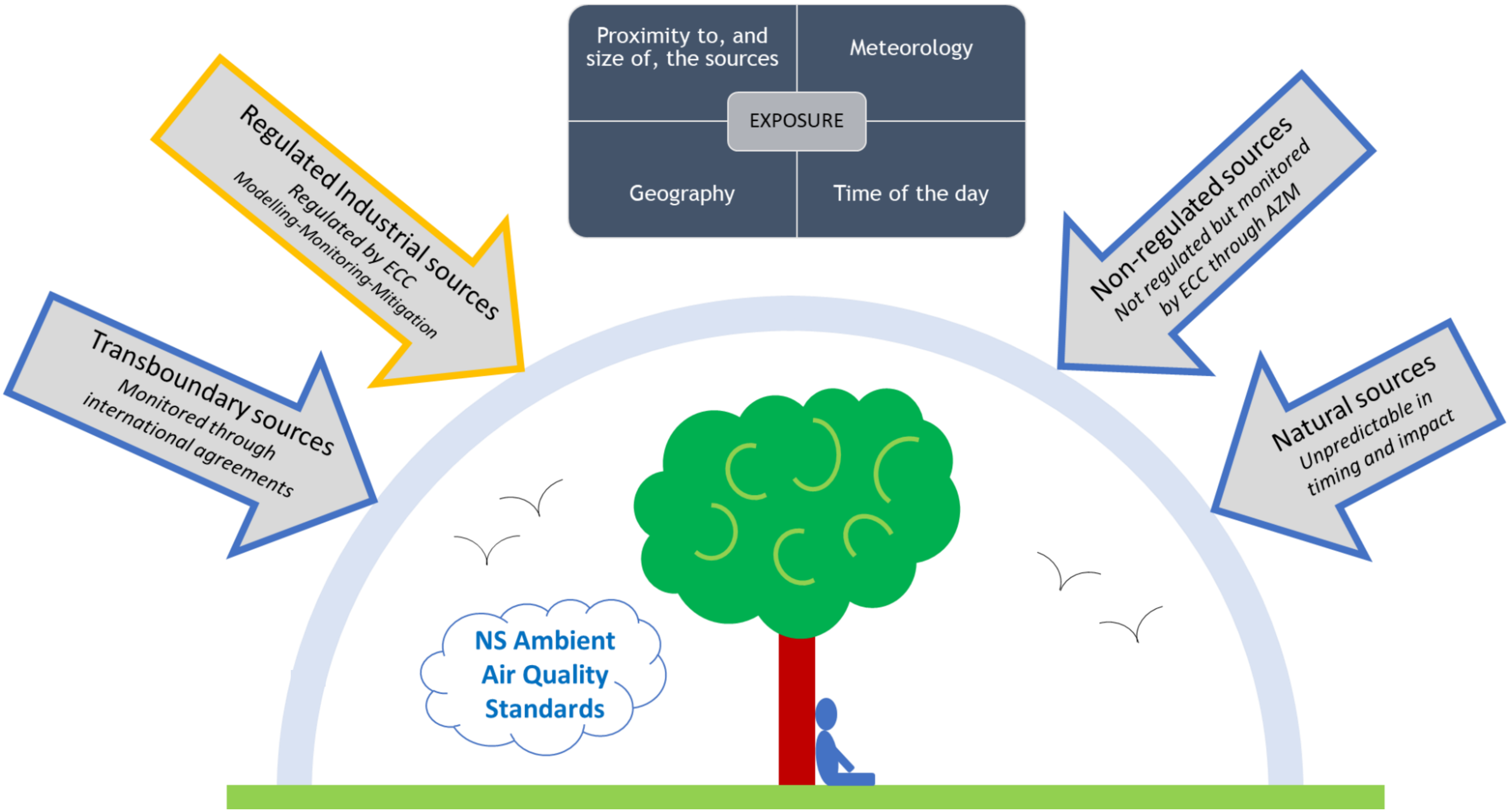
- Natural sources e.g., natural environmental cycles, wildfires, volcanic eruptions;
- Non-regulated sources e.g., vehicles, home heating – these are largely controlled through other means such as emissions control technologies;
- Transboundary pollution i.e., pollution that arrives in Nova Scotia from other places – largely controlled in other jurisdictions and through international agreements; and
- Regulated sources i.e., emissions from activities that fall under Nova Scotia's Activities Designation Regulations.

Together, these sources are known as 'cumulative impacts'. The relative impact of each of these sources on the air that an individual breathes is determined by the individual's proximity to the source, the time of day (e.g., peak hour traffic flows vs the middle of the night), the geography of the area (e.g., can pollutants disperse easily?) and the meteorology at the time of exposure (e.g., wind speed and direction, precipitation).

The WHO reports that there are no known levels of exposure to air pollutants that are risk free – air quality is about managing risks (WHO, 2021). The Nova Scotia Ambient Air Quality Standards (AAQS) are based on concentrations shown to be low risk to the majority of a healthy population when individuals are exposed to air from all sources. Regulated emissions make up a part of the total exposure. Exposure to all sources must be considered when assessing risks.

For healthy Nova Scotian communities, workforce and environments, and a reduced impact on the economy, the Department is committed to ensuring that the air quality in Nova Scotia makes the Province an attractive place to live, work and visit.

**Figure A: the air that an individual breathes is influenced by many sources and conditions.**



# Section 1: Introduction

The Air Assessment Guidance Document (the document) is intended to provide comprehensive guidelines for anyone preparing to provide air quality submissions to the Nova Scotia Department of Environment and Climate Change (the Department). Applicants should ensure that they are using the most up to date version of the guidance by referring to the version guide, as amendments will be made periodically as new science and/or guidance becomes available.

## 1.1 Purpose of the Document

The purpose of this document is to help Applicants to understand what the Department expects to have in successful applications and other submissions that have an air assessment component. This document describes each element of the air assessment in detail and should be consulted in advance of, and referred to regularly, throughout undertaking any activity where air quality is considered.

The clarity and consistency provided by the document will ensure that responsible emitters contribute to improving the health of Nova Scotians and the safeguarding of the Nova Scotia environment and will support Provincial goals with respect to the environment and climate change. **Compliance with this guidance does not, however, guarantee that a project will be approved at the Environmental Assessment stage and/or be granted an Industrial Approval.**

## 1.2 Comparison with Ambient Air Quality Standards

During the transition period from the 'old' ambient air quality criteria (AAQC) to the 'new' ambient air quality standards (AAQS), it is the responsibility of Applicants to ensure that air assessments reflect the transition timelines detailed under the *Air Quality Regulations.* For clarity, this document refers to the preparation of air assessments with respect to the 'new' AAQS. Where the 'old' AAQC are used, the guidance in this document must still be followed.

The AAQS ensure that human health is the primary consideration of all air quality decisions in Nova Scotia. It is also imperative to strive for continuous improvement in air quality because for some pollutants there are no lower thresholds below which public health effects are not found. The AAQS are not limits that the air can be polluted up to. Instead, they represent the concentrations beyond which, the risk to Nova Scotians is unacceptable. The document demonstrates how monitoring and modelling assessments should be developed for comparison with the AAQS, to ensure that impacts on human health are minimized. For example, modelling assessments must include baseline concentrations so that standards are not used as pollute-up-to limits and cumulative impacts can be assessed.

The standards will be reviewed in accordance with the Environmental Goals and Climate Change Reduction Act and re-aligned with global scientific advice, as applicable to Nova Scotia. Applicants should be aware of this and plan for continuous improvement.

## 1.3 Responsibilities of Applicants

For the purpose of clarity, any activity that is regulated under the *Activities Designation Regulations,* and generates atmospheric emissions, will be subject to the requirements established within this guidance.

Air assessments must, as a minimum, demonstrate the impacts from the maximum emissions anticipated from the proposed activity. Extrapolation from small scales studies is not permitted. In the interest of completeness, this document contains guidance on certain *best practices*. These items are described in the text as “not required, but recommended”, or as items that “should” be done (rather than items that “must” be done). Items described in this way are recommended but are not required to be implemented.

In circumstances where mitigation is required, Applicants must illustrate how the choice of mitigation method was made, including providing evidence of its effectiveness (e.g., through additional modelling or monitoring, provision of case studies, etc.). All assessments must demonstrate which methods will be used to ensure continuous improvement.

Some people are more vulnerable to exposure and impacts of air pollution. These include the young, old, pregnant, and immunocompromised. Applicants must apply sufficiently conservative standards at these locations, and present justification for the standard selection, to ensure that impacts on health based sensitive receptors are limited. Additionally, there are requirements for the assessment of impacts on biodiversity and country foods. Applicants are required to undertake a thorough review for potential sensitive receptors as part of any air assessment (see Section 6).

It is the applicant’s responsibility to ensure that all relevant aspects of this document are adhered to when making a submission to the Department. Failure to follow the guidance in this document may result in delays, requests for further work and, potentially, further costs, or may be interpreted as regulatory non-compliance.

## 1.4 Advice for Applicants

While the guidance is designed to comprehensively describe the requirements for air quality submissions, it should be noted that not all of the guidance is applicable to all activities. For example, small emitters may not be required to undertake some of the requirements of this document (e.g., dispersion modelling) under certain circumstances where those requirements can be demonstrated to be economically unviable and the human health and environmental risk is determined to be very low. Similarly, some requirements may be waived where an activity can be shown to be less polluting, such as through the use of screening models or new technology that already has stringent emissions control devices applied.

**If you are unsure whether particular sections of the document are applicable to the activity under investigation, contact the Department for advice before commencing any assessment.**

# Section 2: Ambient Air Monitoring

## 2.1 Context

### 2.1.1 Purpose

The *Nova Scotia Activities Designation Regulations* require that designated activities must have, and be operated in accordance with, Industrial Approvals (Approvals) that are issued by the Minister of Environment and Climate Change (ECC). These Approvals can include a variety of conditions that the Applicant must comply with. Certain industries in Nova Scotia that generate air emissions are required, through their Approval conditions, to conduct ambient air quality monitoring in the areas surrounding their facilities. This document provides technical guidance for the siting and operation of these air quality monitoring networks.

The requirements defined in this document are consistent with the National Air Pollution Surveillance (NAPS) Networks' Ambient Air Monitoring and Quality Assurance/Quality Control Guidelines CCME (2019).

### 2.1.2 Scope & Limitations

The guidance below describes the *minimum requirements* to show to the Department that conditions of the Approval associated with ambient air quality monitoring, which are set out in required monitoring plans, are being complied with and the quality of data being collected is acceptable.

Applicants may choose to follow additional or more stringent procedures, provided that they do not conflict with those provided in this document and that prior approval is obtained from the Department.

This document is not exhaustive and does not provide guidance for all types of equipment in all possible monitoring scenarios. Applicants should always follow manufacturer instructions when operating ambient air quality monitoring equipment.

## 2.2 Ambient Air Monitoring Plan

If required, a monitoring plan must be developed by the Applicant and submitted to the Department for review and acceptance prior to undertaking the assessment. The Department must provide written authorization of acceptance of the plan prior to commencing air monitoring.

A monitoring plan must include, at minimum:

- objectives of the monitoring program;
- expected duration of the monitoring program to support how objectives will be met;
- description of the identified and suspected air emission sources;
- organizational structure and roles of responsibility;
- number and location of monitoring sites, including meteorological sites, and justification as to how the proposed number/location of monitors will be sufficient in meeting monitoring objectives;

- proposed monitoring station locations presented on a map of the regional area with current or proposed development;
- details of any logistical considerations for monitor locations;
- description of how meteorological data and dispersion modelling results were used to determine appropriate monitoring locations;
- how receptors and sensitive receptors (if present) will be appropriately monitored;
- air quality parameters to be monitored and the monitoring frequency;
- monitoring methods and instruments to be used, including justification for the selection;
- analytical methods and procedures;
- QA/QC plan to demonstrate conformance with network requirements;
- inspection schedule and actions for troubleshooting/correction if issues are identified;
- data acquisition and reporting procedures; and
- auditing procedures.

The above items are notwithstanding Approval conditions that may differ from the guidelines, where deviations exist, the conditions of the Approval hold. Deviations from the air monitoring guidelines presented in this document must be outlined in the monitoring plan and approved by the Department.

## 2.3 Siting Criteria

The following sections describe a variety of physical requirements and recommendations for the location, design, and layout of monitoring stations. These requirements and recommendations reflect an ideal scenario, which we understand cannot always be met under the constraints of existing conditions that may be beyond the Applicant's control.

For existing stations, the requirements below are not to be interpreted as a requirement for the relocation of a station (except under special circumstances identified by the Department). However, modification of existing stations may be required where siting conditions negatively impact data quality. Where modification is not feasible, alternative solutions can be discussed with the Department.

For new stations, the requirements listed below must be met. Where this is not feasible, variances may be considered and must be approved in writing by the Department.

### 2.3.1 Ambient Monitoring Location Siting

The following items should be considered when selecting an appropriate ambient monitoring location:

- choose best general location considering the air dispersion modelling results;
- property ownership – ability to acquire a lease or agreement from property owner to install a monitoring station;
- ability to obtain permit(s) to install and operate the monitoring station;
- sampling inlet spacing (see Section 2.3.5);
- site suitability in terms of terrain and soil conditions;
- security against unauthorized access and vandalism;
- site safety;

- availability of power;
- available communication systems;
- year-round accessibility; and
- long-term viability of the site.

Applicants must present proposed station locations to the Department and be provided written approval on the final locations.

### 2.3.2 Pollutant Selection & Monitoring Methods

The following should be considered when choosing pollutants to monitor and the applicable methods to be used:

- the monitoring objectives;
- the pollutants to include should be based on a qualified person's judgement of the process and associated emissions, along with predicted concentrations from dispersion modelling results. Some pollutants will require monitoring regardless of whether standard exceedances are modelled or expected;
- the monitoring requirements stipulated in Terms and Conditions of Approvals;
- all ambient air quality monitors, that are used for compliance purposes, must satisfy the requirements of the United States Environmental Protection Agency (US EPA) as "federal reference methods" (FRM) or "federal equivalent methods" (FEM). In the absence of an FRM/FEM method, the method must be reviewed and approved by the Department on a case-by-case basis;
- alternative methods for monitoring for other purposes, such as to inform adaptive management, may be proposed for consideration by the Department; and
- meteorological parameters to be monitored and the proposed monitoring method must also be included.

### 2.3.3 Shelter Requirements

The proper design of a monitoring station is crucial and takes into consideration air sample integrity, instrument requirements, functionality, and operator safety. Requirements and considerations for station design include the following:

- stations must be secure, with restricted access to the public;
- all electrical circuits should adhere to any applicable Federal and provincial electrical codes. Electrical circuits should use ground-fault circuit interrupters and be able to support load demands;
- stations and monitoring systems must adhere to any applicable provincial safety codes;
- stations should be designed with sufficient lighting, access to instrumentation and a workspace for the station operator;
- stations must be designed with reliable power and communications systems. For sites with transient power, a line and power conditioning system should be added;
- stations must be ventilated, heated, and cooled to maintain a stable temperature in the desirable range of 20-30°C throughout the year;

- instrument racks inside a station should be properly secured, and instruments must be installed to allow air to circulate freely to avoid overheating;
- the station should be designed to ensure safe access to the roof, if required, including appropriate guardrails (as required by local safety codes) to prevent falls;
- gas cylinders should be properly secured when they are present in the station; and
- recommended that analyzer exhaust vents outside, away from the sample inlet. If venting to the outside is not possible, the exhaust should be scrubbed before venting into the station.

Portable generators used as power for an ambient air monitoring station are not recommended, but if their use cannot be avoided, siting criteria are as follows: When using a portable generator, the person responsible must locate the portable generator exhaust at least 30 metres downwind of the air sample inlet of any ambient air monitoring station.

### 2.3.4 Sampling Inlet System Design

Components of a sampling inlet system vary by monitoring method and can include a particulate matter-size selective inlet, an inlet line or probe, a manifold, filters, and sample lines to the instruments. The sampling inlet system should be designed to prevent water from entering the air stream (using a rain cover such as a funnel).

One important consideration for the sampling inlet system is that all components in close or direct contact with the air sample prior to analysis (including the tubing and manifold) must be non-reactive (see Table 2.1) with the pollutants measured. Also, to reduce residence time (Rt) within the inlet system, all sample lines should be kept as short as possible.

**Table 2.1** Sampling Inlet Material and Residence Time (Rt)

| Pollutant | Inlet System Components | Lines to Manifold | Sample residence time |
|---|---|---|---|
| CO | Borosilicate glass (e.g., Pyrex®), quartz or Teflon® | Clear Teflon® ¼” (FEP, PFA, PTFE) | <20 seconds[4] |
| $O_3$ | | | |
| $NO_X$ | | | |
| $SO_2$ | | | |
| PM | Borosilicate glass (e.g., Pyrex®), quartz or conductive material, such as stainless steel or anodized aluminum[1,2] | NA | |
| PAH | Conductive material, such as stainless steel or anodized aluminum[1,2] | N/A | |
| VOC | Borosilicate glass (e.g., Pyrex®), quartz or stainless steel[2] | Clear Teflon® ¼”[3] | |

*[1]For PM instruments, anodized aluminum inlet systems are often provided by manufacturers.*
*[2]Teflon® or other plastics are not acceptable materials for PM and PAH monitoring, because these materials can become statically charged and attract particles.*
*[3]Sampler line to a Summa canister must be stainless steel or nickel.*
*[4]Although <20 seconds is required, approximately 10 seconds is recommended to allow for possible changes over time.*

A manifold system with a water trap to collect condensation is preferable for a monitoring station with multiple gas analyzers, rather than separate sample lines for individual instruments.
If separate sample lines are being used, it would be beneficial for each to have a water trap installed along the sample line.

For continuous and periodic PM monitoring, manifold systems are not recommended. These instruments should use individual inlets, and the sampling tube from inlet to instrument should be as vertical as possible to avoid particle loss due to impaction.

NOTE: See Section 8 of the NAPS guidelines (CCME, 2019) for further information on manifold design, residence time calculations and pressure drop measurements.

### 2.3.5 Inlet Siting, Sampling System & Setback Requirements

To obtain a representative air sample, placement of the sampling inlet must meet the following recommended spacing criteria for height, obstructions, roadways, and distance between inlets.

In addition to the requirements listed in the sections below, sampling inlet placement should consider the following:

- for flow rates less than 20 litres per minute (L/min), sampling inlets must be at least 1 m apart and at least 2 m apart for flow rates greater than 20 L/min (distance measured from centre of inlets);
- sampling inlets for co-located instruments should be no greater than 4 m from each other;
- if an inlet is located on the side of a building, ideally it must be located on the side of prevailing winds;
- inlets should not be placed in close proximity to air outlets (e.g., exhaust fans);
- to avoid undue local influences, inlets should be located away from minor sources such as fugitive emissions, exhausts, or stacks;
- inlets should be located away from dirty or dusty areas (such as dirt roads); and
- areas subject to possible heavy snow accumulation should be avoided.

#### 2.3.5.1 Setbacks from Roadways

Specifications for spacing of sampling inlets[1] relative to roadways at neighbourhood and urban scales (from NAPS) are presented below in Table 2.2.

**Table 2.2** Minimum Roadway Setback Requirements

| Average Daily Traffic (vehicles per day) | ≤10,000 | ≤15,000 | ≤20,000 | ≤40,000 | ≤70,000 | ≥110,000 |
|---|---|---|---|---|---|---|
| Minimum Distance between Roadway and Inlet (metres)[2] | ≥10 | 20 | 30 | 50 | 100 | ≥250 |

[1]For traffic influenced sites (where AADT value exceeds 15,000), the inlet must be located within 100 metres (maximum) of the roadway
[2]Distance to the nearest traffic lane. The distance for intermediate traffic counts should be interpolated.

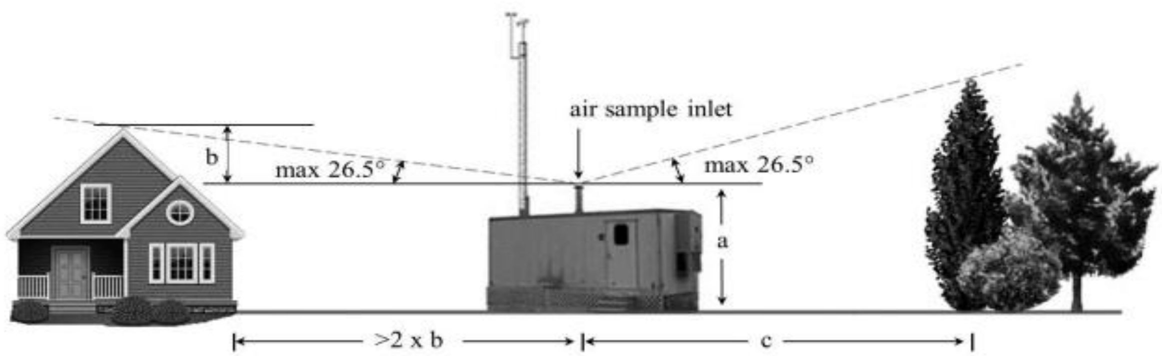
### 2.3.5.2 Continuous Analyzer Siting Requirements

The following siting criteria are required for continuous analyzers:

- sampler inlet height must be 2-15 meters above ground;
- separation distance >20 metres horizontally from trees;
- the distance from the sample inlet to any air flow obstacle, e.g., buildings, is greater than 2 times the height of the obstacle above the inlet;
- the elevation angle is 26.5° or less from the sample inlet to the top of any obstacle; and
- air flow is unrestricted in 3 of the 4 wind quadrants (2, if located on the prevailing wind side of a building).

The above siting criteria are illustrated in Figure 2.1.

**Figure 2.1** Schematic of spacing requirements for sampling inlets of standard continuous ambient air monitoring sites (AEP, 2016)




Note: All angles of projection are measured from the sample inlet and all heights measured relative to the base of the instrumentation.

Where:

a = height of sample inlet above ground (Table 1)
b = distance from sample inlet to any air flow obstacle (e.g., buildings) must be greater than 2 times the height of the obstacle above the sample inlet (SS 2-D (c))
c = sample inlet must be greater than 20 metres horizontally from trees (SS 2-D (b))

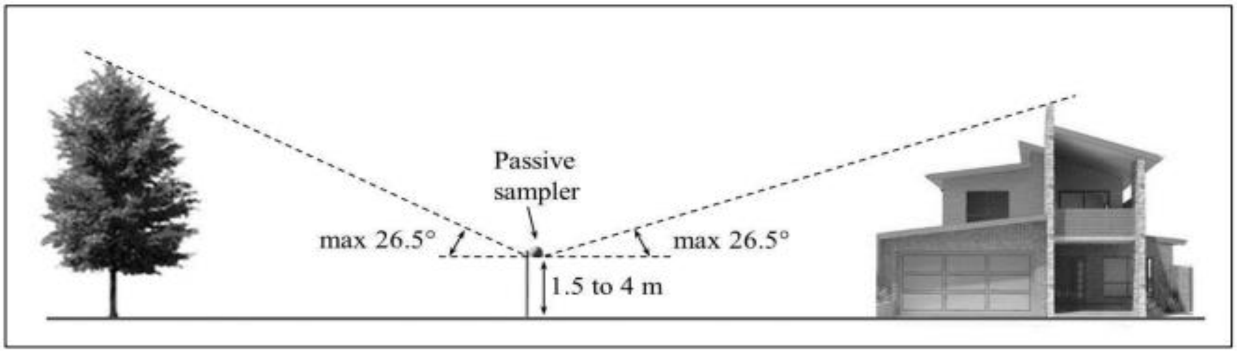
### 2.3.5.3 Passive Sampler Siting Requirements

The following siting criteria are required for passive samplers:

- diffusion barrier surface height above ground should be between 1.5 to 4 metres;
- should be mounted on a supporting structure, such that air flow will not be restricted; and
- elevation angle is 26.5 or less from the diffusion barrier surface to the top of any obstacle.

The above siting criteria are illustrated in Figure 2.2.

**Figure 2.2** Schematic of spacing requirements for sampling inlets of passive samplers (AEP, 2016)




### 2.3.5.4 Periodic Sampler Siting Requirements

The following siting criteria are required for Periodic Samplers:

- sampler inlet height must be 2-15 meters above ground;
- distance from an obstacle must be greater than 2.5 times the height of the obstacle above the sampler; and
- must have unrestricted air flow in 3 to 4 wind quadrants.

### 2.3.5.5 Wind Instrument Siting Requirements

The following siting criteria are required for wind instruments:

- height above ground greater than 2.5 times the shelter height (minimum of 10m);
- height above any obstacle greater than 2m, and surroundings for 100m radius must be uniform;
- in addition to the above listed requirements, distance from obstacles should be greater than 10 times the obstacle height, wherever possible;
- Applicants shall orient wind direction instruments with respect to True North; and
- Applicants shall ensure that the instrument remains upright at a 90 degree angle with the ground.

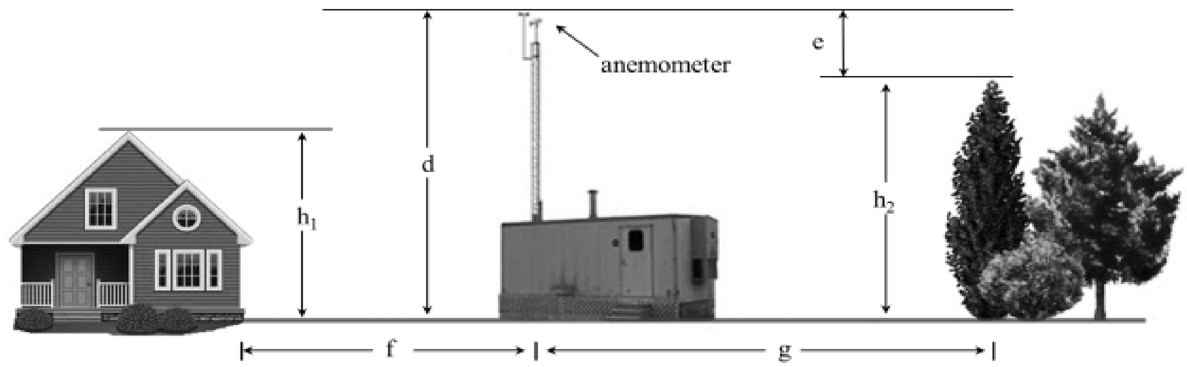
The above siting criteria are illustrated in Figure 2.3.

## 2.4 Instrument Verification, Maintenance & Calibrations

Instrument verification, maintenance & calibrations are necessary to confirm the accuracy of the data being collected by the equipment. Applicants should always follow manufacturers' instructions for conducting maintenance and the timing of such maintenance on ambient air monitoring equipment. Tolerance levels and acceptance criteria have also been established through the NAPS QA/QC guidelines (CCME, 2019) and are used to ensure that instruments are properly maintained, and any potential issues are investigated in a timely manner.

***A Tolerance level*** is the point where corrective action is required and may include the need for multipoint verification, calibration, adjustment, or repair is required.

**Figure 2.3** Schematic of spacing requirements for wind instruments (AEP, 2016)




Where:

- $h_1$ = height of obstacle 1
- $h_2$ = height of obstacle 2
- d = must be greater than 2.5 times the shelter height (minimum of 10 metres) (Table 3 A)
- e = height above any obstacle greater than 2 metres (Table 3 B)
- f = distance must be minimum 10 times $h_1$ (Table 3 C)
- g = distance must be minimum 10 times $h_2$ (Table 3 C)

***Acceptance Criteria*** establish the point at which data are considered invalid. Should an instrument exceed the established acceptance criteria, data should be invalidated back to the last point where the results are known to be valid. There may be cases where there is justification for the validity of this data, but these instances must be analyzed on a case-by-case basis.

### 2.4.1 Gas Analyzers

The routine Quality Control (QC) checks, multi-point verification, and calibration of gas analyzers are three tools used to help ensure that instrument data being collected is correct. QC checks refer to regular span/zero checks where results are compared to a reference value that is established at the time of analyzer calibration. Multipoint verifications compare results to a known traceable standard, where no adjustments are made. A calibration refers to an adjustment in the instrument or software based on this comparison.

#### 2.4.1.1 Gas Analyzers QC checks, Verification, Maintenance & Calibrations

Table 2.4 below establishes the minimum requirements for gas analyzer QC checks, multipoint verification & calibrations.

#### 2.4.1.2 Gas Analyzers Tolerance Levels and Acceptance Criteria

The purpose for QC check tolerance levels for gas analyzers is to give the technician a cut off point where they should schedule a visit to complete a multipoint verification of the analyzer using known traceable standards. Tolerance levels for $NO_2$, $SO_2$ and TRS gas analyzers are shown in Table 2.5.

**Table 2.4** Minimum Required Frequencies for Verification and Calibration Activities for Gas analyzers

| Analyzer/sampler | Activity | Minimum Frequency |
|---|---|---|
| Continuous gas analyzers | Analyzer Quality Control (Zero and Span) checks | Weekly[1] |
| | Analyzer Multi-Point Verification | Upon installation or relocation<br>Before and after any repairs that may affect calibration[2]<br>Before instrument calibration<br>Every 6 months (semi-annually) if zero/span checks are performed daily<br>Every 3 months (quarterly) if zero/span checks are performed on any other schedule than daily<br>Before instrument shut down<br>When span check exceeds tolerance levels |
| | Analyzer Calibration | In response to exceedance of the multi-point verification tolerance levels and acceptance criteria[3]. |

[1]Zero and span checks can be automated to be performed daily.
[2]Verification prior to repair may not be possible.
[3]Additional verification checks of the zero and at least one upscale point after a calibration are recommended to ensure the instrument was appropriately calibrated.

**Table 2.5** QC check tolerance levels for $NO_2$, $SO_2$ and TRS gas analyzers

| Instrument/Parameter | Check Type | Tolerance Level |
|---|---|---|
| $NO_2$ | Zero | ± 2.0 ppb |
| | Span | ≤±10% of reference value |
| $SO_2$ | Zero | ± 1.0 ppb |
| | Span | ≤±10% of reference value |
| TRS | Zero | ± 1.0 ppb |
| | Span | ≤±10% of reference value |

The established tolerance levels and acceptance criteria for the multipoint verification establish the point where a technician needs to make an adjustment to the instrument (tolerance level) and also where issues of data validity are present (acceptance criteria).

Table 2.6 outlines the tolerance levels and acceptance criteria associated with multipoint verification of gas analyzers.

**Table 2.6** Multipoint Verification Tolerance Levels & Acceptance Criteria

| Activity | Instrument | Tolerance Level | Acceptance Criteria |
|---|---|---|---|
| Zero Point | $NO_2$ | 1.0 ppb | Not Applicable |
| | $SO_2$ | 0.5 ppb | |
| | TRS | 0.5 ppb | |
| Upscale Point<br>(maximum % difference) | $NO_X$, $SO_2$, TRS | >± 4% | ≤± 15% |
| Molybdenum Converter Efficiency<br>($NO_2$ Coefficient) | $NO_2$ | 96% to 104% | ≤± 15% |

## 2.4.2 Particulate Matter (PM) Instruments

The parameters that can be verified and/or calibrated on a PM instrument are system leaks, flow, temperature, barometric pressure, relative humidity, etc. For these instruments, "calibration" refers to the verification and adjustment of these, and potentially other operating parameters. Ensuring that these and other operating parameters are within specification ensures the accuracy of the PM readings the instrument is generating. It is essential that the calibration be performed according to the manufacturer's operating instructions.

### 2.4.2.1 PM Instrument Verification, Maintenance & Calibration

Table 2.7 establishes the minimum requirements for instrument checks, verification & calibrations.

**Table 2.7** Minimum Required Frequencies for Verification and Calibration Activities for PM Instruments

| Analyzer/sampler | Activity | Minimum Frequency |
|---|---|---|
| Continuous & periodic PM samplers | PM Instruments QC Checks<br>(One-point Flow, Temperature, Pressure and Leak check) | Upon installation or relocation<br>Before and after any repairs that may affect instrument calibration[1]<br>Before instrument calibration<br>Every 2 months for continuous monitors<br>Every 6 months for manual/integrated samplers<br>Before instrument shut down |

[1] Verification prior to repair may not be possible.

#### 2.4.2.2 PM Instrument Tolerance Levels and Acceptance Criteria

Table 2.8 below outlines the tolerance levels and acceptance criteria associated with verification and calibration of PM instruments.

**Table 2.8** Multipoint Verification Tolerance Levels & Acceptance Criteria

| Activity | Tolerance Level | Acceptance Criteria |
|---|---|---|
| Flow Rate (set point vs. standard) | ≤± 4% | ≤± 7% |
| Temperature (reading vs. standard) | ≤± 2°C | N/A |
| Barometric Pressure (reading vs. standard) | ± 10 mmHg | N/A |
| Relative Humidity (reading vs. standard) | ≤± 10% | N/A |
| Leak Check | As per instrument manual | As per instrument manual |

### 2.4.3 Traceability of Calibration and Verification Equipment

Materials and devices used for verifying and calibrating equipment must be certified either to recognized primary standards or traceable to one.

- All multipoint verification and calibration gases must be US EPA-certified protocol gases and the certification must not have expired.
- Verification and Calibration equipment must be certified as traceable to a US National Institute of Standards and Technology (NIST) or National Research Council of Canada Measurement Science and Standards Research Centre (NRC-MSS) standard or transfer standard. This can typically be done by the manufacturer of the device. Documented certification and/or verification must not have expired.

Applicants are responsible for ensuring that equipment certifications have not expired, re-certifications are obtained as necessary and copies of certification documents are maintained.

### 2.4.4 Troubleshooting & Corrective Actions

Monitoring plans must include a schedule/plan to get failures back online in a timely manner. To minimize data loss from sudden instrument malfunction, it is recommended (but not required) that replacement instruments and devices be acquired and available for deployment, should they be required.

## 2.5 Data Collection & Management

Data collection is the process of acquiring data from monitoring instruments, while data verification and validation includes techniques used to accept, reject, modify, and qualify data. Applicants are responsible for collecting and validating monitoring data according to the guidelines presented in this section.

Monitoring plans should demonstrate the methods and processes used to ensure data quality is maintained.

Dataloggers and software packages are commercially available for collecting, verifying, validating, and reporting air quality data. For non-continuous sample methods the sampling schedule may vary from project to project and must be discussed with the Department while developing a monitoring plan.

The following sections discuss considerations for data collection.

### 2.5.1 Sample Rates

Sample rates are the intervals at which a datalogger retrieves a value measured by an instrument, which is subsequently used to generate averaged values. Most modern dataloggers are capable of sample rates of at least once per second and can be configured to calculate and store data intervals such as 1-minute, 5-minute and 1-hour averages.

For continuous gas analyzers, applicants must identify in their monitoring plan the sample rates intended for storage.

For non-continuous sampling methods, the sampling schedule may vary from project to project and must be discussed with the Department while developing a monitoring plan.

### 2.5.2 Timestamps

Data must be reported in Atlantic Standard Time, which is Universal Coordinated Time minus 4 hours (UTC-4), year-round. This means your loggers and instruments must NOT be set up to adjust for Daylight Savings Time. Also, please ensure that your data logging equipment and your instruments are set to the same time zone.

All hourly data must be reported as “time ending”. This means that the timestamp must reflect the end of the time period being referenced, e.g., an hourly value recorded for 14:00 would reference the time period from 13:00 to 14:00.

### 2.5.3 Units of Measurement

Units of measurement should be kept consistent with the units used during the modelling process.

### 2.5.4 Data Averaging & Completeness

When calculating and/or reporting an average, a minimum of 75% of the constituent data points are required for the calculation to be valid (e.g., a 1-hour average must include 45 of the minutes in that hour to be considered valid). If the 75% completeness criterion are not met, then the resulting average must be marked “invalid”.

### 2.5.5 Average Calculation

Averages must be calculated as the arithmetic mean of the valid values. Invalid values must not be included in the calculation and cannot be represented as 0 (zero).

### 2.5.6 Rounding

Finalized data must be rounded to 1 decimal place.

## 2.6 Data Quality Assurance/Quality Control (QA/QC)

Applicants are responsible for ensuring that continuous, passive, and periodic data are collected and validated following the procedures documented by this document and manufacturers' instructions.

In their monitoring plans, Applicants must demonstrate how they will meet the minimum requirements for data QA/QC discussed in the sections below.

### 2.6.1 Data Completeness

Applicants must demonstrate that they have met the following data completeness requirements:

- 85% annual 1-hour average data capture;
- 50% monthly 1-hour average data capture; and
- Any data loss exceeding 24 consecutive hours needs to be explained in validation activity logs.

### 2.6.2 Data Verification & Validation Schedule

Table 2.9 identifies the minimum expectations for data verification and validation. For additional info on data validation and adjustment, please refer to NAPS guidelines Section 12 (CCME, 2019).

**Table 2.9** Minimum Data Verification/Validation Schedule

| Frequency | Items to verify |
|---|---|
| 1 to 7 days (document findings & actions in applicable logs) | • Identify periods of missing data and flag<br>• Review daily/weekly zero and span results<br>• Review 1-hour data for all sites, all parameters including meteorological data<br>• Review diagnostics data and alarms/alerts<br>• Review of time stamps against correct time<br>• Identify suspicious data<br>• Flag any known errors and/or incomplete data and invalidate<br>• Identify any corrective action that is required |
| Following multi-point verification/calibration (document findings & actions in applicable logs) | • Review initial Verification<br>• Review of field records<br>• Review of data and operational information<br>• Review of verification/calibration results - reconcile data.<br>• Apply any necessary adjustments to data and flags (e.g., over-range, baseline, below zero adjustments)<br>• Investigate suspicious data using sub-hourly data |
| Annual | • Review prior Verifications<br>• Apply any remaining necessary adjustments (e.g..: negative value adjustments)<br>• Prepare annual report |

## 2.7 Reporting Requirements

Applicants shall prepare an annual report each year by the date identified in the Approval. The annual report shall be available in hard copy and digital format, maintained for the duration of the Approval, and made available to the Department upon request and/or by the date identified in the Approval. The annual report should include, but is not limited to, the following information related to ambient air monitoring:

- a summary of any air quality related emergency and non-emergency incidents pursuant to the *Environment Act,* the *Air Quality Regulations,* or the Approval;
- a summary of % monthly and annual data capture for each monitored air contaminant, as well as operational problems related to ambient air monitors, including the date and time of the incident(s) and action taken to resolve the issue (see Section 2.6.1);
- a summary of any complaints received from the public and how they were responded to by the Applicant, including the date and time of the incident;
- monthly summaries of the quality assured, quality controlled (QA/QC) ambient air quality data from the ambient air monitor(s) identifying the concentrations for each air contaminant and their associated averaging periods as specified in the *Air Quality Regulations*, as well as any additional contaminants the Applicant has been required to monitor;
- include the minimum, maximum and average concentrations for each air contaminant, and for each applicable AAQS, hourly average wind speed and wind direction, including the dates used to calculate the averages;
- include annual trends for each contaminant at each monitoring station and link operational activities to trend shifts were possible;
- include monthly and annual pollution roses for each air pollutant, developed from validated data and presenting wind “blowing from”; and
- Include calibration certificates for the monitoring calibration equipment and standard gases, as well as calibration results.

The above list is specific to the annual report requirements related to ambient air monitoring. Depending on the facility and the Approval requirements, the annual report may also require additional information (e.g., stack testing results, CEMS, fuel usage/composition, etc.). Additional data (e.g., raw data) may be requested by the Department.

The Regional Office should be consulted with respect to the preferred method of submission.

The Department may require Applicant’s to report monitoring data in the statistical format of the Canadian Ambient Air Quality Standards (CAAQS) to assist in development of air zone management plans.

In addition, any exceedance of an AAQS must be reported to the Department at the time of the occurrence, along with a report of the corrective action taken.

## 2.8 Auditing

Performance and administrative audits are independent evaluations of data quality. An administrative audit reviews the entire monitoring system documentation and procedures for the station siting, instrumentation calibration and maintenance, and data collection and validation. A performance audit focusses on station operation (e.g., instrument performance, inlet manifold, siting, maintenance, safety). These audits should be performed routinely, as described in the Approval holder's air quality monitoring plan, by qualified persons as it relates to ambient monitoring. The Department may also perform audits as deemed necessary.

The Department recommends a third-party audit be conducted every 2 years to ensure the quality of the data being produced meets all the requirements in this document and the Approval. The Department may require a third-party system and/or performance audit upon request to ensure this guidance is being followed.

# Section 3: Emissions Monitoring

## 3.1 Introduction

This section considers the approaches required to undertake satisfactory monitoring of emissions at source. Such monitoring may be discrete monitoring (source testing) and/or continuous emissions monitoring (CEMS). The type of monitoring that is required will be outlined in the Industrial Approval for the activity and or through direction from the Department.

## 3.2 Source Testing

### 3.2.1 Objective

This document applies to all stationary source testing activities required under the *Environment Act* or as part of an Industrial Approval, and aims to:

(a) specify methods and protocols to be used for the measurement of atmospheric emissions;

(b) facilitate the collection of air emissions data that are representative, reliable, and scientifically defensible;

(c) provide consistency, accuracy, and uniformity among industry and source testing consultants in the conduct of source testing activities; and

(d) ensure source testing is carried out by a qualified person as it relates to source testing.

### 3.2.2 General Information

The source testing methods listed in Appendix A shall be used in the conduct of source testing activities, wherever possible. This list is not meant to exclude the use of other suitable source testing methods, provided these methods are described in the Pre-test Plan for the source, and subsequently approved by the Department. Any protocol or method deviations not approved in the Pre-test Plan may result in the source testing and the final report being held invalid. Applicants are responsible for ensuring that all source testing activities are conducted in compliance with the document.

A minimum of four (4) months shall pass between consecutive source testing on the same source, unless otherwise stated in the Approval.

### 3.2.3 Pre-test Plan

A written site-specific Pre-test Plan must be submitted to the Department at least 30 days in advance of the proposed start date of a source testing program. Source Testing shall only proceed once written approval of the site-specific Pre-test Plan for the source has been received from the Department.

Pre-test activities include all activities and information needed prior to any source testing program. A Pre-test Plan shall include, at minimum, the following elements:

(a) facility identification: facility location/address and the name and information for the facility contact;

(b) source identification: number of sources, source name(s) or identification number(s), type of operation; physical properties of the source (e.g., stack height, sampling location height, stack diameter, stack orientation, diameters upstream and downstream of ports, number of accessible ports, number of ports used, port length); effluent parameters of the source; anticipated operating conditions; normal and maximum operating conditions/capacity; source test location (in the source stack or breaching); and site plan showing the location of the sources at the facility;

(c) a list of parameters to be tested; test methods, procedures, and protocols to be followed; number of tests per visit per source; number of traverses and points per traverse for each test; sampling times; method deviations or modifications needed, and equipment required;

(d) a description of the calibration checks that will be conducted on the source testing equipment prior to, during, and after testing;

(e) a description of any third-party laboratories that will be used for sample analysis, including the name and location of the laboratory, the laboratory's credentials, or accreditation if applicable, the parameter to be analyzed, and the method to be used for analysis;

(f) project responsibilities, including determining the sampling team, determining the data, and reporting team, and scheduling of site visits and source tests;

(g) a description of the qualifications and credentials of the source testers; and

(h) abatement systems information.

Where a site-specific Pre-test Plan as described in Section 3.2.3 of this document has previously been approved by the Department, Section 3.2.3 may be waived by the Department provided that there have been no modifications to the source since the Pre-test Plan was submitted, and the following information is submitted in writing to the Department:

(a) a reference to the previously approved site-specific Pre-test Plan, including the name and address of its author, and the date submitted;

(b) a proposed detailed schedule for the source testing program; and

(c) a description of the anticipated source operating conditions during the source testing program.

### 3.2.4 Source Testing

Source Testing shall proceed in strict accordance with the information submitted in the approved site-specific Pre-test Plan for the source, as well as with any specific directives from the Department in its written Approval of the Pre-test Plan. Only those reference methods for source testing listed in Appendix A of this document, or other methods as approved by the Department upon review of the Pre-test Plan, shall be used. For each source, the test shall consist of a preliminary survey, and at least three (3) repetitions using an appropriate source testing methodology. Stack testing results are only considered valid if the results of each of the three repetitions are within 35% of the mean of the results of all three repetitions. i.e., no test can be >35% off from the average.

### 3.2.5 Final Report

All facilities that are regulated by the Department to undertake source testing activities shall submit a Final Report to the Department in accordance with the dates specified in the Approval, or in accordance with the dates specified by the Department. The Regional Office should be consulted with respect to the preferred method of submission.

All submitted Final Reports shall contain, as a minimum, the following information where applicable:

(a) a summary table of the results, including but not limited to: source name; date, time, and duration of all tests; type of fuel; operating conditions during all tests; stack gas temperature; moisture content; velocity; flow rate; percent oxygen; percent carbon dioxide; and emissions data corrected to required conditions (e.g., percent oxygen, pressure, and temperature as defined in the Approval), for each parameter being tested;

(b) a description of parameters being tested, and the associated methods or protocols used for source testing;

(c) a description of equipment calibrations and checks conducted before, during, and after testing;

(d) a description of the QA/QC procedures;

(e) an interpretation of the results including a comparison with emission limits from the source's Approval, where applicable;

(f) a discussion of any difficulties encountered during the tests, including any method deviations;

(g) an Appendix showing the Approval issued by the Department;

(h) an Appendix showing site-specific Pre-test Plan approved by the Department;

(i) an Appendix showing the source physical properties and sample location details for each test;

(j) an Appendix containing all the raw data from the source testing equipment and the gravimetric analyses;

(k) an Appendix containing a sample of all calculations;

(l) an Appendix containing all pertinent calibration data which shall include, as a minimum, the dry gas meter data, pitot tube calibration data, gas analyzer span concentrations, and calibration data; and

(m) any other pertinent information that the Department may request.

### 3.2.6 Quality Assurance and Quality Control

The following checks must be performed within the given timeframes, and recorded in the log:

(a) The dry gas meter and orifice meter of the source testing equipment shall be calibrated twice per year in accordance with Environment and Climate Change Canada (ECCC) EPS 1/RM/8 Method F.

(b) The pitot tube shall be calibrated twice per year in accordance with ECCC EPS 1/RM/8 Method F. The calibration must be performed with the entire sampling assembly.

(c) The barometer must be calibrated against a primary standard prior to the source testing program. Alternatively, the uncorrected atmospheric pressure provided by the local weather office may be used with an adjustment for the elevation above sea level of the sampling site.

(d) The temperature sensors must be calibrated according to accepted routine procedures and the calibration values checked every six months.

(e) The nozzle inside diameter must be measured three times prior to use.

(f) The source testing equipment used to measure gases shall be calibrated using appropriate calibration gas concentrations before each source testing program and checked for instrument drift after each source testing program.

(g) The calibration gas to be used to calibrate the source testing equipment used to measure gases shall be a certified calibration gas. A calibration gas certificate shall be included in the final report.

## 3.3 Continuous Emissions Monitoring System

### 3.3.1 Objective

The Department Continuous Emissions Monitoring Systems (CEMS) guidance establishes a program for the installation, certification, and continued operation of CEMS to maintain continuous data quality. The CEMS guidance aims to provide a structured approach to help ensure consistent CEMS operations across the province.

This guidance applies to any facility with a CEMS component in the Approval. A CEMS installation must meet the requirements presented in ECCC Reference Method EPS 1/PG/7 when developing a site-specific CEMS program.

This guidance outlines minimum requirements and is not intended to exclude other CEMS programs that meet or exceed the requirements in Reference Method EPS 1/PG/7.

The use of a Predictive Emissions Monitoring System (PEMS) program in place of a CEMS program may be considered by the Department on a case-by-case basis. Any PEMS program must be shown to fulfill the requirements set out in the Approval and be deemed equivalent to CEMS. The PEMS must meet performance specifications outlined in Table 3 of the EPS 1/PG/7.

### 3.3.2 General

Reference Method EPS 1/PG/7 was developed for monitoring $NO_x$ and $SO_2$ from thermal power generation, however the Method thoroughly outlines procedures that are adoptable for the continuous measurement of other air contaminants (ECCC, 2005). Sections 3.3.4 and 3.3.5 of this guidance propose amendments to elements of Reference Method EPS 1/PG/7 to include specifications for the measurement of air contaminants other than $NO_x$ and $SO_2$.

Reference Method EPS 1/PG/7 describes gas analyzer specifications, analyzer installation specifications, system certification procedures, and quality assurance and quality control activities for a robust CEMS program (ECCC, 2005). Where the Applicant is required to monitor opacity, the facility should operate an opacity CEMS that meets or exceeds the requirements of ECCC Reference Method EPS 1-AP-75-2. Where the Applicant is required to monitor Total Hydrocarbons (THC), the facility should operate a THC CEMS that meets or exceeds the requirements of the US Environmental Protection Agency (EPA) Method 25A/US EPA PS 8A.

### 3.3.3 Design Specifications

This guidance does not specify a specific measurement technique for gas analyzers. Any analyzers capable of meeting or exceeding the certification performance specifications in Section 3.3.4 of this guidance and in Table 3 of Reference Method EPS 1/PG/7 are acceptable. Refer to Table 1 and Table 2 from Reference Method EPS 1/PG/7 for design specifications for system type, gas analyzers, flow monitors, data acquisition system, and overall system configuration.

### 3.3.4 Certification Performance Specifications

Analyzer certification specifications, including: calibration drift, electronic drift, system response time, relative accuracy, bias, and orientation sensitivity specifications, are reported in Table 3 of the Reference Method EPS 1/PG/7. Table 3 is reproduced below as Table 3.1 with amendments that are specific to regulated activities based in Nova Scotia (amendments *italicised*).

This Table may be updated as needed to reflect the use of other gas analyzers required in Approvals issued by the Department.

### 3.3.5 Quality Assurance and Quality Control

To facilitate the collection of high-quality CEMS data, the facility must have a quality assurance (QA) and quality control (QC) plan. QA refers to the policies and QC to the procedures in place ensure the collection of high-quality data. The QA/QC Plan must be developed by the Applicant and submitted to the Department for review and acceptance prior to undertaking the CEMS installation. Deviations from the CEMS Guidance presented in this document must be outlined in the CEMS QA/QC Plan and approved by the Department.

A comprehensive overview of the minimum requirements for QA/QC plans is presented in Table 5 of Reference Method EPS 1/PG/7. Additionally, the QA plan should include the relevant training and qualifications of CEMS users at the facility.

**Table 3.1** Nova Scotia Certification Performance Specifications (ECCC, 2005; Government of Alberta, 2021; USEPA, 2017c, USEPA, 2020).

| Parameter | Component | Level | Specification | References (1/PG/7) | |
|---|---|---|---|---|---|
| | | | | Specifications | Test Procedures |
| 24-hour calibration drift | $SO_2/NO_x$ | Low level (0-20% FS)<br>Mid level (40-60% FS)<br>High level (80-100% FS) | ≤ the greater of<br>2.0% FS or 2.5 ppm absolute dif.<br>2.0% FS or 2.5 ppm absolute dif.<br>2.5% FS or 2.5 ppm absolute dif. | 5.1.2 | 5.3.2 |
| | *$TRS/H_2S$* | - | *5.0% FS* | - | - |
| | *Hg* | - | *10.0% FS* | - | - |
| | *THC* | *Zero level (0-0.1% FS)*<br>*Mid level (30-40% FS)*<br>*High level (70-80% FS)* | *5.0%*<br>*5.0%*<br>*5.0%* | - | - |
| Relative accuracy (RA) | $SO_2/NO_x$ | - | ≤ the greater of<br>10.0% RA or 8.0 ppm avg. absolute dif. | 5.1.5 | 5.3.4 |
| | *$TRS/H_2S$* | - | *≤ the greater of*<br>*20.0% RA or 2.0 ppm avg. absolute dif.* | - | - |
| | *Hg* | - | *20.0% RA* | - | - |
| | *THC* | - | 10.0% RA | - | - |
| Bias | $SO_2/NO_x$ | - | ≤ the greater of<br>5.0% FS value or 5 ppm avg. absolute dif. | 5.1.6 | 5.3.5 |
| | *$TRS/H_2S$* | - | *5.0% FS value* | - | - |
| | *Hg* | - | *5.0% FS value* | - | - |
| | *THC* | - | *5.0% FS* | - | - |

A summary of the daily, quarterly, semi-annual, and annual performance evaluation criteria (QC) for CEMS programs is presented in Table 6 of the Reference Method EPS 1/PG/7. Table 6 is reproduced here as Table 3.2 with amendments that are specific to regulated activities based in Nova Scotia (amendments *italicised*).

**Table 3.2** Quality Control Criteria for CEMS in Nova Scotia (ECCC, 2005; Government of Alberta, 2021; USEPA, 2017a, USEPA, 2017b, USEPA, 2017c, USEPA, 2017d, USEPA, 2020)

| Parameter | Component | Level | Specification | References (1/PG/7) | |
|---|---|---|---|---|---|
| | | | | Specification | Test Procedures |
| **Daily performance evaluations** | | | | | |
| 24-hour calibration drift | $SO_2/NO_x$ | Low level (0-20% FS)<br>High level (80-100% FS)<br>Out-of-control condition | ≤ the greater of<br>2.0% FS or 2.5 ppm absolute dif.<br>2.0% FS or 2.5 ppm absolute dif.<br>Exceedance of twice the above levels | 6.4.1 | 5.3.4/<br>6.4.1 |
| | *$TRS/H_2S$* | - | *5.0% FS* | - | - |
| | *Hg* | - | *10.0% FS* | - | - |
| | *THC* | *Zero level (0-0.1% FS)*<br>*High level (70-80% FS)* | *5.0%*<br>*5.0%* | - | - |
| **Quarterly performance evaluations** | | | | | |
| Cylinder gas test | $SO_2/NO_x$ | Low level (0-20% FS)<br>Mid level (40-60% FS)<br>High level (80-100% FS)<br>Out-of-control condition | ≤4.0% FS or 5.0 ppm absolute dif.<br>≤4.0% FS or 5.0 ppm absolute dif.<br>≤5.0% FS or 5.0 ppm absolute dif.<br>Exceedance of the above levels | 6.3.1 | 6.3.1 |
| | *$TRS/H_2S$* | *Low level (0-20% FS)*<br>*Mid level (40-60% FS)*<br>*High level (80-100% FS)*<br>*Out-of-control condition* | *≤5.0%*<br>*≤5.0%*<br>*≤5.0%*<br>*Exceedance of the above levels* | - | - |
| | *Hg* | *Low level (0-20% FS)*<br>*Mid level (40-60% FS)*<br>*High level (80-100% FS)*<br>*Out-of-control condition* | *≤15.0%*<br>*≤15.0%*<br>*≤15.0%*<br>*Exceedance of the above levels* | - | - |
| | *THC* | *Zero level (0-0.1% FS)*<br>*Mid level (30-40% FS)*<br>*High level (70-80% FS)*<br>*Out-of-control condition* | *≤5.0%*<br>*≤5.0%*<br>*≤5.0%*<br>*Exceedance of the above levels* | - | - |
| **Semi-annual and annual performance evaluations** | | | | | |
| Relative accuracy | $SO_2/NO_x$ | Out-of-control condition<br>- | ≤ the greater of<br>10.0% RA or 8.0 ppm avg. absolute dif.<br>Exceedance of the above levels | 6.4.1 | 5.3.4/<br>6.4.1 |
| | *$TRS/H_2S$* | Out-of-control condition<br>- | ≤ the greater of *20.0% RA or 2.0 ppm avg. absolute dif.*<br>*Exceedance of the above levels* | - | - |
| | *Hg* | Out-of-control condition<br>- | *20.0% RA*<br>*Exceedance of the above levels* | - | - |
| | *THC* | *Out-of-control condition*<br>- | *10.0% RA*<br>*Exceedance of the above levels* | - | - |
| Bias | $SO_2/NO_x$ | *Representative load level*<br>*Out-of-control condition* | ≤ the greater of<br>5.0% FS value or 5 ppm avg. absolute dif.<br>Exceedance of the above levels | 6.4.1 | 5.3.5/<br>6.4.1 |
| | *$TRS/H_2S$* | *Representative load level*<br>*Out-of-control condition* | *5.0% FS value*<br>*Exceedance of the above levels* | - | - |
| | *Hg* | *Representative load level*<br>*Out-of-control condition* | *5.0% FS value*<br>*Exceedance of the above levels* | - | - |
| | *THC* | *Representative load level*<br>*Out-of-control condition* | *5.0% FS value*<br>*Exceedance of the above levels* | - | - |

| Parameter | Component | Level | Specification | References (1/PG/7) | |
|---|---|---|---|---|---|
| | | | | Specification | Test Procedures |
| **Semi-annual and annual performance evaluations - continued** | | | | | |
| Availability | *Non-peaking units* | - | ≥90% annually in first year<br>≥95% annually thereafter | 6.5.1 | 6.5.1 |
| | *Peaking units* | - | ≥80% annually | | |

### 3.3.6 Reporting Requirements

The Applicants must maintain records of CEMS data, emission calculations, calibrations, audits, and any other items outlined in the Approval for a minimum of seven (7) years and make these records available to the Department upon request.

The Applicants shall notify the Department of any failure of QA/QC testing described in the Reference Method EPS 1/PG/7, within thirty (30) days of the completion of the test.

The Applicants shall submit an annual report to the Department as required in the Approval. The annual report could include, but is not limited to, the following information related to CEMS:

1. source Information: name and address of source owner, fuel type, description of pollution control systems, and any other source information specified in the Approval;
2. data: monthly and annual availability, monthly gas analyzer results (1-hour average), 720-hour rolling average for gas analyzers (min, max, and average), comparison to applicable Approval limits, monthly generation/operational hours, annual generation rate graphs (if applicable), summary of backfilled data, opacity reports with daily data (daily average 6-min average, daily min 6-minute average, daily max 6-minute average);
3. annual trends for each contaminant and link operational activities to trend shifts were possible;
4. system performance information: daily calibration drift checks, quarterly CGAs, quarterly stack gas flow tests, RATA results, system evaluation observations and recommendations, and corrective actions taken;
5. manufacturer, model, and serial number of all analyzers;
6. maintenance records and calibration records; and
7. operational updates.

The above list is specific to the annual report requirements related to CEMS. Depending on the facility and the Approval requirements, the annual report may also require additional information (e.g., stack testing results, ambient air monitoring, fuel usage/composition, etc.). Additional data (e.g., raw data) can be requested by the Department.

# Section 4: Air Dispersion Modelling Assessments

## 4.1 Introduction

This section provides guidance on the acceptable methods and approaches used in dispersion modelling studies conducted for regulated activities located in Nova Scotia. This document provides a structured approach to the selection and application of dispersion models across the province to help ensure consistent modelling application. The guidelines outlined in this document are also intended to be used to help determine compliance with the AAQS, in effect under the *Air Quality Regulations* prescribed under the *Environment Act.*

### 4.1.1 Air Quality Dispersion Models

An air quality dispersion model calculates predicted ground-level concentrations (GLCs) of emitted air contaminants using inputted information related to the emission sources and the atmospheric environment. They use a set of mathematical equations to simulate the dispersion and/or deposition of a substance from emission source to receptor.

Air quality models can be used to predict compliance with ambient standards such as the AAQS. There are numerous dispersion models available, from both regulatory agencies and from private sector, that vary in degree of complexity and capabilities. Section 4.2 details the dispersion models that are preferred for usage in Nova Scotia and the conditions in which each should be applied. Other models will be considered at the Applicant's request but require approval from the Department prior to application. Air quality modelling assessments must be undertaken by a qualified person as it relates to dispersion modelling.

## 4.2 Preferred Models

The Department has designated three models for dispersion modelling assessments. These are a screening model (AERSCREEN), a refined model (AERMOD), and a specialized model (CALPUFF). A brief description of the preferred dispersion model options is presented in Table 4.1. The preferred dispersion models range in complexity depending on the needs of the project. There are several factors that must be considered when choosing the appropriate dispersion model for a project, which are detailed in the following subsections.

While moving from a screening model to a refined or specialized model is a tiered approach, there is no succession between refined and specialized models. There are specific circumstances in which specialized models are required regardless of whether the refined model can demonstrate compliance (as discussed in Section 4.2.1). It should also be noted that it is not required to run the screening model prior to running a refined or specialized model. The use of a model not listed in Table 4.1 must be approved by the Department in advance.

The different capabilities that each of the preferred models have, are summarized below in Table 4. For most applications, the refined model, AERMOD, is a suitable model of choice. There are certain criteria in which the specialized model CALPUFF must be used, such as when there is complex terrain or large bodies of water in the modelling domain. Details on considerations for choosing the refined model AERMOD or the specialized model CALPUFF are provided in Section 4.2.1.

**Table 4.1** Preferred Dispersion Models

| Model Category | Description | Preferred Model(s) |
|---|---|---|
| Screening | Screening assessments predict "worst-case" concentration of project impacts. They may be used as an initial screening process, moving to the usage of a refined or specialized model if the screening predicts an exceedance to an AAQS. Screening does not require meteorological data to be inputted as the model estimates hourly concentrations for a range of different combinations of meteorological data. | AERSCREEN |
| Refined | Refined assessments are more sophisticated than screening, requiring more detailed input data and as such provide better predictions to actual air quality impacts. Refined models can provide concentration predictions for short-term (hourly) and long-term (multi-hour, daily, monthly, seasonally, or annual) durations. Refined models also provide details on the location and time of predicted concentrations. | AERMOD |
| Specialized | Specialized assessments are to be applied for specific circumstances based on the requirements of the assessment and/or the topography of the modelling domain. Similar to the refined model, the preferred specialized model also requires detailed input data and provides spatiotemporal results. The requirements for applying the specialized model over the refined model are described in Section 2.1. | CALPUFF |

**Table 4.2** Summary of Preferred Model Capabilities

| | Terrain (above stack base) | Hourly Meteorological Data | 3-D Meteorological Data | Multi-Source | Point, Area, Volume Sources | Line Sources | Horizontal and Capped Stacks | Variable Emission Rates | Chemical Transformation | Building Downwash | Plume Visibility and Fog | Stagnant Conditions | Deposition (gaseous/particles) | Acid Deposition | Shoreline Coastal Effects | Regional Air Zone Modelling | Longrange Transportation (>50 km) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AERSCREEN | ✓ | | | | ✓ | | | | | ✓ | | | | | | | |
| AERMOD | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | | ✓ | | | | |
| CALPUFF | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

If a modeller is unsure which model would be the most appropriate to use in the assessment, it is recommended that they contact the Department to confirm their proposed approach in advance.

### 4.2.1 Refined vs. Specialized Assessment Considerations

The following items should be considered when determining whether to use the refined model, AERMOD, or the specialized model, CALPUFF:

- The complexity of the terrain in the study domain;
- The area of the study domain (i.e., the transport distance);
- The requirement for acid deposition; and
- The proximity of the emission sources to a coastal region.

For projects located in complex terrain regions, CALPUFF is the preferred model. The criteria determining whether terrain is classified as simple or complex is as follows (Rowe, 1982):

- Simple terrain (parallel flow): terrain in which the elevation does not exceed 2/3$^{rd}$ the plume height (stack height + plume rise) at a Pasquill stability category F (moderately stable conditions), a wind speed of 1 metre per second (m/s), and a flow rate of Qmax/2 (half of the maximum flow rate).
- Complex terrain: terrain elevations that are greater than those used to determine simple terrain.

A simple rule that can be applied is that if the terrain elevations are below the height of the stack, it is considered simple terrain. Otherwise, the above criteria should be used to determine whether the terrain is simple or complex.

The appropriate choice between CALPUFF and AERMOD also depends on the area of the domain of study (i.e., the transport distance). AERMOD is considered a short-range model and can predict air quality within 50 kilometres (km) of the source, whereas CALPUFF can be applied for up to approximately 200 km from the source. For larger modelling domains, CALPUFF is the more appropriate dispersion model to use.

Large water bodies have a significant affect on meteorology near shoreline areas due to the difference in surface roughness and differential heating between land and water. For situations where shore/coastal effects are present, CALPUFF in Hybrid mode is the most appropriate model.

If regional acid deposition is a required, CALPUFF, or an alternative acid deposition model with acceptance from the Department, may be used. AERMOD should not be used to assess acid deposition.

In summary, CALPUFF is the most appropriate model when assessing areas of complex terrain, for domain areas greater than 50 km, when acid deposition is required, and for projects nearby coastal areas.

### 4.2.2 AERSCREEN Overview

The preferred screening model AERSCREEN estimates single source worst-case concentrations for averaging time factors of 1-hour, 3-hour, 8-hour, 24-hour and annual.

AERSCREEN is based on the AERMOD model code but uses an input matrix of meteorological conditions representing a variety of possible conditions using the MAKEMET option. As such, hourly meteorological data is not required. The default MAKEMET option should be used. If buildings are located in expected zones of influence (refer to Section 4.3.6), then the Plume Rise Model Enhancements (PRIME) downwash algorithms should be used (refer to Section 4.3.6). The terrain should be processed using AERMAP.

For screening assessments with multiple sources, follow the recommendations outlined in Section 4.3.5.

The most current version of AERSCREEN posted by the US EPA on the Support Center for Regulatory Atmospheric Modelling (SCRAM) website[1] is preferred.

### 4.2.3 AERMOD Overview

The preferred refined model AERMOD is a multi-source steady-state Gaussian plume model developed by the US EPA (2004) in collaboration with the American Meteorological Society. The AERMOD model incorporates concepts such as planetary boundary layer theory and methods for handling complex terrain. The latest version of AERMOD also incorporates the PRIME building downwash algorithms, allowing for a more realistic approach to handling downwash than former versions.

The AERMOD modelling system is comprised of AERMOD (calculates concentrations), AERMET (prepares meteorological inputs), and AERMAP (prepares terrain inputs).

The AERMET preprocessor prepares meteorological inputs for use by AERMOD. Meteorological data must be inputted to AERMET, such as hourly surface observation data, upper air soundings, and data collected from a local or on-site weather station tower. AERMET requires the input of surface characteristics such as surface roughness, Bowen ratio, and albedo. These can be inputted manually or through the use of AERSURFACE.

The AERMAP preprocessor prepares terrain data used to produce base elevations of receptors and sources, and to estimate the hill height scale for each receptor.

The most current version of the AERMOD modelling system posted by the US EPA on the SCRAM website[1] is preferred.

### 4.2.4 CALPUFF Overview

The preferred specialized model CALPUFF is a multi-source, non-steady-state Lagrangian puff dispersion modelling system able to simulate the effects of hourly and spatial variations in meteorological conditions on contaminant transport, transformation, and removal. There are three main components making up the CALPUFF modelling system: CALMET (meteorological model), CALPUFF (simulates concentration and deposition), and CALPOST (post-processing tool).

CALMET is a meteorological model that develops hourly wind and temperature fields in three-dimensions, allowing for wind speeds and directions to vary both horizontally and vertically. CALMET also produces mixing heights, surface characteristics, and dispersion properties in two-dimensions. The inputs to CALMET include surface observation data and upper air soundings, along with the option to use gridded meteorological data produced from a numerical weather prediction (NWP) model (e.g., the Weather Research and Forecasting (WRF) model).

[1] https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models

CALPUFF simulates transport and dispersion of puffs of material from emission sources. It uses the fields generated by CALMET or can use simple single-station winds similar to those used in steady-state Gaussian models, to simulate transport of the puffs.

CALPOST is used to process the output files generated by CALPUFF, producing results summary tables.

There are different "modes" in which CALPUFF can be run, depending on the source of the input meteorology processed with CALMET. Refer to Section 4.5.2 for information on selecting the appropriate mode. The default model options/switches for CALMET and CALPUFF serve as the basis of the model options to be used, however, the Department recommends deviations from these options for certain parameters. The recommended non-default parameterization for CALMET/CALPUFF are presented in Appendix B. As every CALPUFF application is unique, a qualified person's judgement is required when choosing the appropriate parameters for modelling. Justification must be provided in situations that parameters are altered from default/those recommended.

CALPUFF is considered a specialized model as it can simulate specific conditions more accurately than AERMOD, such as complex terrain, sources near coastal regions, and long-range (up to 200 km) transport.

The most current version of the CALPUFF modelling system posted by the US EPA on the SCRAM website[2] is preferred.

## 4.3 Dispersion Model Inputs –Source Input Data

The preferred air dispersion models require input data related to the pollutant being emitted, the emission source parameters, and the environment to which the emission occurs. This section outlines the dispersion model inputs related to emission sources, including the development of the emission rate inventory.

### 4.3.1 Source Types

Emission sources can be categorised into four types based on the physical geometry of the source: point, area, volume, and line. The dispersion models listed in Section 4.2 have the ability to implement all of the source types, however, AERSCREEN has limitations for multiple source situations.

**Point Source:** A point source is a discrete stationary source that emits from a specific point of origin, such as a stack. Flares are considered point source but require special treatment (see Section 4.3.1.1).

**Area Source:** An area source represents emissions that are evenly distributed over a stationary two-dimensional spatial area that is low to or at ground level, such as a landfill or a lagoon.

**Volume Source:** A volume source represents the release of emissions that are evenly distributed from a three-dimensional box, such as dust emissions from an aggregate storage pile or emissions from tanks.

**Line Source:** A line source represents emission sources that are distributed over a linear area, such as a road, rail line, or conveyor belt. If a model does not explicitly define line sources, sources of this type can be represented as area sources (long, thin rectangles) or as a string of volume sources.

[2] https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models

#### 4.3.1.1 Flaring

Flares are used as destruction or control devices for a variety of sources. They are often necessary for the destruction of excess gases at oil and gas facilities, or during upset conditions, to avoid venting to atmosphere.

AERSCREEN has an emission source type specific for flaring. It uses a default radiative heat loss fraction of 55%, a value that has been shown to be conservative (Guigard *et al.*, 2002). Radiative heat loss fractions that deviate from this default must be justified in the modelling report.

While AERMOD does contain a specific source type for the modelling of flares, it is recommended that flares be modelled as point sources with modified, pseudo-stack parameters that capture plume rise from flares. The following equations should be applied to estimate the pseudo-stack parameters, which include an effective stack height and effective stack diameter:

$$H_e = H_s + (4.56 * 10^{-3}) * Q^{0.478}$$

$$D_e = 0.0122 \sqrt{\frac{T_s * Q * 1 - F}{g * (T_s - T_a) * V_s}}$$

Where:

$H_e = effective\ stack\ height\ (metres, m)$

$H_s = physical\ stack\ height\ (m)$

$Q = total\ heat\ release\ (calories\ per\ secdond, \frac{cal}{s})$

$D_e = effective\ stack\ diameter\ (m)$

$T_s = effective\ stack\ exit\ temperature\ (Kelvin, K)$

$F = radiative\ heat\ loss\ fraction\ (\%)$

$g = acceleration\ due\ to\ gracity = 9.81\ m/s^2$

$T_a = ambient\ temperature\ (K)$

$V = effective\ stack\ exit\ velocity\ (\frac{m}{s})$

It is recommended that the pseudo-stack parameters be estimated using the following:

- The total flare heat release, Q (cal/s), can be estimated by summing the heat of combustion from each of the individual flared gas components based on the volume flared over one second;
- Set the effective stack exit velocity to 20 m/s;
- Ambient temperature is typically set to 293 K; and
- Radiative heat loss fraction set to 55%.

If alternative pseudo-stack parameters are proposed for modelling, they must first be approved by the Department.

More recent versions of CALPUFF have flare-source types. They can be modelled using the flare source or using a point source with the above pseudo-parameters.

Flares that operate continuously can be modelled as a continuous point source, however, often flaring occurs over short-term periods with variable emissions in which adjustments are required to account for the variations. There are two methods that can be used to assess shorter releases (less than one hour):

- Adjust the shorter-term maximum emission rate to an hourly emission rate. For example, if the release occurs over 10-minutes, divide the 10-minute emission rate by 6 (as there are 6 x 10-minute periods in 1-hour), and model using the adjusted hourly emission rate. The resulting concentration can be compared directly to a 1-hour standard.
- Model the short-term emission rate without adjustment, as if the release occurred over the entire hour. Assume the estimated concentration occurs over the shorter time-period and that the remainder of the hour has a concentration of zero, adjust the concentration to 1-hour. For example, if the release occurs over 10-minutes, model the 10-minute emission rate over the entire hour and adjust the predicted concentration to 1-hour by dividing by 6.

Emergency, upset, or abnormal events are not required to be assessed. Routine maintenance (e.g., blowouts) are required to be assessed.

### 4.3.2 Emission Scenarios

Air emission sources can exhibit variability in emission rates over time. For compliance purposes, it is important to consider the operating scenario that corresponds to the worst-case GLCs. The scenario that corresponds to the worst-case GLCs is not necessarily the scenario of maximum emissions, for example, for a source operating at reduced capacity, the corresponding reduction in plume rise could result in a higher GLC. It is up to a qualified person's judgement to determine the scenario which is expected to correspond to the worst-case GLC. Justification must be provided in the report as to why a scenario was chosen. A screening model (i.e., AERSCREEN) can be used to determine the worst-case scenario.

The worst-case concentration scenario may not be representative of typical operations. Typical emissions are released by a facility that is operating under normal stable conditions and should be representative of how a facility operates most of the time. Worst-case conditions may include, but are not limited to, start-up and shut-down events, combustion sources operating at reduced load, and/or routine maintenance.

Upset conditions or emergency events are not required to be assessed as these are unpredictable events and are not anticipated emissions.

#### 4.3.2.1 Refined Emissions

Modelling maximum emissions from all sources simultaneously 24/7/365 is often not representative of actual operations. It can lead to over-prediction of longer averaging period concentrations, such as 24-hour or annual, especially if the facility has intermittent operations.

To be representative of actual operations, a refined emissions scenario can be modelled that considers a facility's operations, such as the hours of operation, the variability of emission rates, intermittent emission sources, and meteorological conditions. Both AERMOD and CALPUFF allow for several variable emission scenarios to be considered for modelling using emission scale factors. Emission scale factors are multipliers relative to the maximum emission rate, specific for a source that represents emission rates during other conditions, such as by a time-period (e.g., day of week, month, season, hour of day, etc.) or wind speed. Alternatively, source-specific hourly emission rate files can be generated that contain emission rates corresponding to every hour during a year.

For information on the implementation of variable emissions, please refer to the model user's guides, AERMOD User's Guide (US EPA, 2004) or CALPUFF User's Guide (Scire *et al*., 2000).

The refined emissions scenario must still correspond to the expected actual worst-case scenario. Modelling using variable emissions or an hourly emissions input file can limit a facility's operational flexibility in terms of constraints on the allowable time (e.g., time of day, days of week, months of year, etc.) and/or duration of operations. For example, if a facility assesses variable emissions by time of year during winter months, say December to April, then the facility is limited to operating during these months as compliance has not been assessed outside of these months. It is recommended that the use of variable emissions and/or hourly emission files be discussed with the Department in advance.

### 4.3.3 Significant Contaminants and Sources

An air quality assessment must account for all sources with the potential to have air emissions and assess all contaminants expected to be released from the facility. The significance of sources and contaminants can be assessed to eliminate those that are determined to be negligible from further analysis, i.e., those that do not need to be modelled.

The assessment must consider the potential releases of all contaminants with provincial AAQS adopted under the *Air Quality Regulations*. The provincial list is not necessarily an extensive list of all required contaminants to be included in the assessment. If a facility's operations are known to emit air contaminants that are not presented in the provincial list, these contaminants should be included in the assessment and compared against standards established by other jurisdictions. The applicability of standards from other jurisdictions (e.g., Ontario MECP Air Contaminants Benchmarks, Quebec MELCC air quality standards and criteria, Alberta Ambient Air Quality Objectives and Guidelines, etc.) must be approved by the Department.

#### 4.3.3.1 Screening out Negligible Contaminants

In some cases, contaminants have emission rates that are low enough relative to the magnitude of their AAQS that they can be considered negligible. The emission threshold method for identifying significant contaminants presented in Section 7.1.2 of the Ontario Ministry of the Environment, Conservation, and Parks (MECP) Guideline A-10[3] Procedure for Preparing an Emission Summary and Dispersion Modelling Report (MECP, 2018) is recommended to be used when determining whether contaminants can be screened out from requiring further assessment. The estimated facility-total emission rate of the contaminant is compared against the threshold value to determined whether it can be screened out. Note that in place of the "Ministry POI Limit" in the equation, the respective Nova Scotia AAQS must be used (where applicable).

When applying this screening method, a sample calculation, and a table presenting the estimated thresholds and results of the screening against the thresholds, must be provided.

[3] https://files.ontario.ca/books/20180309_moecc_65_emission_aoda_en-aoda.pdf

#### 4.3.3.2 Screening out Negligible Sources

Sources may be able to be screened out as negligible if they emit a negligible amount of a contaminant relative to the total facility emissions. In most cases, sources that in combination release less than 5% of the total facility-wide emissions of a contaminant can be considered negligible. This general rule may not be applicable if a source is in close proximity to receptors or is from a source with notably poor dispersion.

### 4.3.4 Emissions Inventory Development

It is important to develop an emissions inventory to input into the model that accurately captures the facility operations and demonstrates the worst-case expected impacts.

There are several methods that can be used when developing the emissions inventory used in the dispersion modelling. The following methods can be used to determine emission rates:

- Maximum approved/proposed emission limits.
- CEMS conducted following the guidelines in Section 3.
- Manual source testing surveys conducted following the guidelines in Section 3.
- Site specific source measurement.
- Equipment manufacturer's specifications.
- Design and engineering estimates (including mass balances).
- Published Emission factors.

Supporting data and documentation that are used to develop the emission rates and stack parameters must be provided in the dispersion modelling report. This includes, but is not limited to, equipment specification, manufacture guarantees, engine tier data, supporting laboratory analysis, stack testing reports, etc.

The following sections go into detail on the different methods that can be used to estimate emission rates.

#### 4.3.4.1 Approved/Proposed Emissions Limits

Operating Approvals often set maximum allowable emission limits that can conservatively be used in the emission inventory. Emission limits in the form of in-stack concentrations can be combined with volume-flows to estimate the contaminant mass emission rate of the contaminant being assessed.

#### 4.3.4.2 Source Emission Testing

Emission rates and source parameters, measured from source testing at the facility, can be used in the dispersion modelling emission inventory if they are obtained during operations corresponding to the expected maximum GLCs (based on a qualified person's judgement). Source testing is to be conducted following the guidelines outlined in Section 3.

#### 4.3.4.3 Continuous Emissions Monitoring

Industrial facilities that are equipped with CEMS can utilize the data to develop appropriate emission rates and source parameters for dispersion modelling. CEMS must be operated according to the guidelines established in Section 3.

As described in Section 4.3.2, the operating scenario expected to correspond to the worst-case GLC must be assessed. CEMS emission data collected should be used to develop the emission inventory for the worst-case scenario.

CEMS emissions corresponding to all routine operations should be considered when assessing the operating scenario expected to correspond to the worst-case GLC. Routine operations include, but are not limited to, normal operation, start-up and shut-down events, and routine maintenance. CEMS emissions collected during periods of emergency events or upset conditions are not required to be assessed through dispersion modelling.

To assess the worst-case scenario, the CEMS recorded emission rate expected to correspond to the maximum GLC may be used over the entire modelling period for each averaging period, e.g., if the 1-hour maximum emission rate captured during routine operations is expected to produce the maximum predicted 1-hour GLC, then it should be applied to assess compliance against the 1-hour standard over the full 5-year modelling period.

Modelling maximum emissions from all sources simultaneously 24/7/365 is often not representative of actual operations. It can lead to over-prediction of longer averaging period concentrations, such as 24-hour or annual, especially if the facility has intermittent operations. As described in Section 4.3.2.1, a refined emissions scenario can be applied for operations that are intermittent. CEMS data can be used to develop variable emissions by time-periods (e.g., day of week, month, season, hour of day, etc.) for operations that are periodic. For example, if a facility operates at a lower capacity on weekends, then variable emissions by day of week can be modelled using scaling factors estimated from daily CEMS data. Alternatively, CEMS data can be used to generate hourly emission rate files that contain emission rates corresponding to every hour during a year. Using variable emissions may result in operational constraints, e.g., limits on the time or duration in which certain operations can occur. It is recommended that the use of variable emissions be discussed and approved by the Department prior to conducting the dispersion modelling assessment.

As emission rates can be variable over time, emission rates obtained from CEMS can be adjusted for the respective averaging period being modelled as described in Section 4.3.5.1.

#### 4.3.4.4 Equipment Manufacturers' Emission Specifications

Manufacturer's specifications for emission parameters can be used in the development of the emission inventory. Emission parameters may be provided for different operating conditions and load capacities, it is up to a qualified person's judgement to choose those that are expected to correspond with the worse-case GLC. Equipment specifications used to estimate emission rates must be provided with the dispersion modelling report.

#### 4.3.4.5 Published Emission Factors

Published emission factors can be used to estimate emissions when no measured or site/equipment specific data are available. Emission factors are normally presented as the mass of contaminant released per unit activity rate (e.g., fuel consumed, electricity generated, product processed, etc.). A common source of emission factors is the US EPA's AP-42: Compilation of Air Emissions Factors[4] (US EPA, 1995a),

[4] https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors

in which the US EPA and other regulatory agencies compiled data from past source testing campaigns to develop emission factors for a wide variety of industrial processes. The AP-42 emission factors are rated by quality from A to E depending on their uncertainty. Some resources for emission factors include:

- US EPA AP-42: Compilation of Air Emissions Factors (US EPA, 1995a).
- Environment Canada and Climate Change's (ECCC) National Pollutant Release Inventory (NPRI) Toolbox[5] (ECCC, 2021).
- Australian National Pollutant Inventory (NPI) Emission Estimation Technique Manuals[6] (Australian Government, 2015).
- NCASI emission factors.

Where emission factors are based on reference materials or other similar installations, their use must be accompanied by a justification for their applicability to the operation.

#### 4.3.4.6 Modelled Emissions

There are various software and tools available that can be used to model emission rates from specific source activities. Several of these models are available from the US EPA's Emissions Estimation Tools webpage[7], including, but not limited to:

- Refinery wastewater emissions tool spreadsheet;
- TANKS software to estimate volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) from storage tanks;
- LandGEM model to estimate landfill gas emission rates; and
- WATER9 model to estimate air emissions from wastewater treatment.

In addition to the models presented above, the US EPA MOtor Vehicle Emission Simulator (MOVES3) can be used to simulate air emissions from mobile sources. Mobile sources should always be included in the assessment where they occur as an integral part of the operation AND within the site boundary. Where mobile sources occur on non-public highway roads, an assessment should consider impacts on any receptors in at least a qualitative manner.

#### 4.3.4.7 Engineering Estimates and Mass Balances

Engineering estimates can be used to develop emission parameters from fundamental scientific principles and measurements, such as operating conditions, data from literature, and thermodynamic and physical properties. Derived emission formulas that are well documented also can be considered engineering estimates.

A mass balance equation balances the material mass into and out of a process or reaction, applying the conservation of mass, such that the quantity entering must equal the quantity leaving. For contaminants that are not chemically transformed through the process, assuming 100% of the material used is emitted to air is conservative. For contaminants that undergo chemical reactions to form alternative species, stoichiometry must be applied to estimate the quantity of potential products released. It can

[5] https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/report/sector-specific-tools-calculate-emissions.html
[6] http://www.npi.gov.au/reporting/industry-reporting-materials/emission-estimation-technique-manuals
[7] https://www.epa.gov/air-emissions-factors-and-quantification/emissions-estimation-tools

conservatively be assumed that 100% of a material will react to form each expected product if the quantities of limiting reactants are unknown. However, if the material is not expected to completely react, the unreacted quantity released to air must also be included.

Sample calculations must be provided when using engineering estimates or mass balances along with justification if it is not assumed 100% release to air.

#### 4.3.4.8 Emission Data Quality

To capture the uncertainty of emission estimations, emission rates must be rated in terms of data quality, in which the higher the quality, the higher the accuracy. Section 9.2 of the Ontario Guideline A-10 - Procedure for Preparing an ESDM Report (MECP, 2018) contains detailed descriptions of how to classify emission data quality. It is recommended that their rating system be used for establishing the data quality of the emission rates used in the dispersion modelling study.

#### 4.3.4.9 Appropriate Averaging Times

As emission rates can be variable over time, the maximum short-term (e.g., 1-hour) emission rate experienced over a longer-term period (e.g., 24-hour or annual) can be much greater than the average emission rate over that period. To demonstrate compliance with various averaging periods, the following is recommended:

- For 1-hour averaging periods, use the maximum 1-hour emission rate over the full modelled period;
- For 24-hour averaging periods, use the maximum 24-hour emission rate over the full modelled period; and
- For annual averaging periods, use the annual average emission rate over the full modelled period.

An emission rate corresponding to a shorter averaging period can conservatively be applied for longer term simulations, e.g., a 1-hour maximum emission rate can be applied conservatively to estimate an annual concentration. However, a longer-term emission rate cannot be used for a shorter-term averaging period.

For annual averaging periods, results for each individual modelled year must be predicted and the maximum year be compared against the AAQS.

Note that if emission rate averages are being used, then variable emissions (as described in Section 4.3.2.1) cannot also be applied.

### 4.3.5 Grouping Multiple Sources (AERSCREEN)

AERSCREEN is only able to account for a single source in each model run. The emissions from a facility often come from a number of sources of different types, locations, and characteristics. When assessing a facility with multiple sources using AERSCREEN, the following is recommended:

- Model each source separately and conservatively estimate the concentration by the direct addition of the predicted maximum concentration for each source, regardless of location;
- Stacks that are located less than one stack diameter apart, with the same release height, and with similar exit velocities and flow rates can be grouped together and treated as a single source. The process for grouping stacks together into a “representative stack” is outlined in Section 2.2 of the

US EPA Document "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources" (1992); and

- A refined model must be considered if sources cannot be grouped.

AERMOD and CALPUFF are capable of modelling multiple sources. However, these models do not include the merging of plume rises for sources that are close together.

### 4.3.6 Building Downwash

The effects of local buildings on the dispersion of emissions from nearby stacks must be accounted for. Stacks located on top of, or adjacent to, a building require the consideration of building downwash effects. Area or volume sources do not require analysis of building downward. AERSCREEN, AERMOD and CALPUFF can handle down wash effects from a single or several buildings with varying dimensions and orientations.

For stacks located on a building, as a general rule, building downwash may occur if the height of the top of the stack is less than 2.5 times the height of the building it is on. For stacks adjacent to buildings, it may be necessary to consider adjacent buildings within a distance from the stack of 5 times the lesser of the building height or the projected width of the building, a region often referred to as the "region of influence." For stacks located near multiple buildings, each building and stack configuration must be assessed separately.

The Building Profile Input Program for the Plume Rise Model Enhancements (BPIP-PRIME) can be used to generate building downwash input parameters. BPIP-PRIME estimates the zone of influence to determine whether a stack is impacted by nearby structure(s) and calculates the building heights (BH) and projected building widths (PBW) for those affected by building wakes.

The US EPA developed the Building Profile Input Program (BPIP) to estimate building downwash parameters (US EPA, 1995b). BPIP-PRIME can produce the required inputs to account for building downwash for AERSCREEN, AERMOD, and CALPUFF.

In addition to BPIP-PRIME, CALPUFF can incorporate building downwash using the Industrial Source Complex (ISC) model. Is has been shown that ISC performs better for buildings with aspect ratios (building width/building height) greater than 5. As such, it is recommended that the ISC method be used if aspect ratios are greater than 5.

### 4.3.7 Particle Deposition and Size Fractions

AERMOD and CALPUFF both have the ability to model particle deposition. To model deposition, the user must specify the particle sizes, mass fractions, and densities for a range of particle size categories.

The CALPUFF detail $PM_{10}$ and $PM_{2.5}$ particle distribution curves can result in concentrations of $PM_{2.5}$ greater than $PM_{10}$, as such, the INPUT GROUP 8 in the CALPFUFF input file needs to be defined. When setting up CALPUFF for $PM_{10}$ and $PM_{2.5}$ deposition, the particle distributions defined in Table 4. can be used (BC, 2015).

By defining the species size categories in the CALPUFF input, the default size categories specified by the "NINT" switch are ignored. The CALPUFF "NINT" switch defines the number of particle-size intervals used to evaluate effective particle deposition velocity. By setting the Geometric Standard Deviation to 0.0, CALPUFF assigns the specified diameter to the entire bin. The particle sizing presented in Table 4.

corresponds to the following size categories for $PM_{10}$ and $PM_{2.5}$, which can be used in the post-processing stage (using CALSUM or POSTUITL) by summing the relevant size categories as follows:

$$PM_{2.5} = P1 + P2 + P3 + P4$$

$$PM_{10} = P1 + P2 + P3 + P4 + P5 + P6$$

For larger particles, such as total particulate matter (TPM), the size parameterization presented in Table 4. is preferred (Lawrence, 2012).

**Table 4.3** Particle Sizing Distribution for CALPUFF Modelling of $PM_{10}$ and $PM_{2.5}$

| PM Species | Size Range (micron) | Geometric mean diameter (microns) | Geometric Standard Deviation (microns) | Affiliation | |
|---|---|---|---|---|---|
| | | | | $PM_{10}$ | $PM_{2.5}$ |
| P1 | 0.5 - 0.75 | 0.625 | 0.0 | x | x |
| P2 | 0.75 - 1.0 | 0.625 | 0.0 | x | x |
| P3 | 1.0 - 1.25 | 1.125 | 0.0 | x | x |
| P4 | 1.25 - 2.5 | 1.875 | 0.0 | x | x |
| P5 | 2.5 - 6 | 4.25 | 0.0 | x | |
| P6 | 6 - 10 | 8 | 0.0 | x | |

**Table 4.4** Particle Sizing Distribution for Modelling of TPM

| Particle | Geometric mean diameter (microns) | Geometric Standard Deviation (microns) | Particle size Intervals (NINT) | Effective Particle Minimum Size (microns) | Effective Particle Maximum (microns) |
|---|---|---|---|---|---|
| P1 | 1.25 | 1.2418578 | 5 | 0.625 | 2.5 |
| P2 | 5 | 1.241858 | 5 | 2.5 | 10 |
| P3 | 20 | 1.241858 | 5 | 10 | 40 |

The particle sizing presented in Table 4..4 corresponds to emission rates of TPM, $PM_{10}$, and $PM_{2.5}$ defined as follows:

$$PM_{2.5} = P1$$

$$PM_{10} = P1 + P2$$

$$TPM = P1 + P2 + P3$$

The particle density of all particles in CALPUFF is assumed to be 1 gram per cubic metre ($g/cm^3$). There is no option in the input control file to adjust the particle density. As this particle density does not apply to all situations, an “effective” Geometric mass mean diameter can be used that would mimic how a particle would react if it had a density of 1 $g/cm^3$. Refer to Table 2.6.2 in the Newfoundland and Labrador Guideline for Plume Dispersion Modelling[8] (Lawrence, 2012) for the "effective" Geometric mass mean diameters to apply for various particle densities.

### 4.3.8 Acid Deposition

For regional acid deposition modelling, the usage of CALPUFF is recommended (not AERMOD). The appropriate chemical transformation mechanisms must be applied (i.e., through use of the chemical transformation schemes MESOPUFF II, RIVAD/ISORROPIA + aqueous). If a modeller proposes to use another acid deposition model, approval by the Department must be granted prior to its usage. The inclusion of acid deposition is not a requirement of every dispersion modelling study. It is only necessary at the request of the Department.

### 4.3.9 Odour Modelling

Projects that have the potential to cause odours off-site should consider odour as a contaminant in their dispersion modelling assessment. Emissions of odour should be estimated following methods prescribed in Section 4.3.4, similarly to emissions of other contaminants. Odour emissions should be quantified in units of odour units per second (OU/s) and modelled to provide concentration results in units of odour unit per cubic meter ($OU/m^3$). This requires changing the units in the model from the default to those specific for odour.

As dispersion models usually capture hourly averaging periods as the minimum concentration output, odour should be modelled on an hourly basis and the concentration results converted to a 10-minute averaging period following the methods described in Section 4.6.3 – Averaging Period Conversion.

The removal of meteorological anomalies as described in Section 4.6.2 is permitted, however, inclusion of such anomalies is a more conservative approach to the assessment of frequency.

## 4.4 Dispersion Model Inputs – Modelling Domain, Terrain and Receptors

Each of the preferred dispersion models, AERSCREEN, AERMOD, and CALPUFF, require a modelling domain to be established that adequately captures the area of pollutant impacts. Within this domain, receptors must be defined. The model computes concentration results at the defined receptors. Terrain elevation data must be inputted to the model as terrain influences the flow of pollutants. The following section goes into detail about setting up the modelling domain, terrain data, and receptors.

### 4.4.1 Modelling Domain

The physical extent of the modelling domain must adequately capture the project impacts on the surrounding environment. The domain will generally be greater for tall stacks with buoyant emissions, whereas a smaller domain may be more appropriate for shorter stacks. A general rule is to establish the domain size that captures project-only concentrations representative of 10% of the ambient air quality standard. Establishing the domain must also consider sensitive receptors (e.g., hospitals, schools) (see Section 6).

[8] https://www.gov.nl.ca/ecc/files/env-protection-science-gd-ppd-019-2.pdf

Ultimately, the domain size should be established based on professional judgement. It is recommended that if there is doubt on whether the defined domain size adequately captures the extent of impacts, that it be discussed with the Department prior to modelling. The project facility should be placed at the centre of the study domain.

### 4.4.2 Terrain Elevation Data

The terrain within the modeling domain can have a significant influence on the flow of pollutants. There are numerous sources of available terrain elevation data suitable for input to AERMOD and/or CALPUFF, including the following:

- Natural Resources Canada's Canadian Digital Elevation Data (CDED) data base. The CDED data is available in United States Geological Survey (USGS) Digital Elevation Model (DEM) file type for a 1:50,000 map scale with a grid resolution range of 0.75 to 3-arc seconds (approximately 20 x 30 m across the province at 1-arc second). This data can be inputted directly to AERMAP or TERREL without conversion.
- GeoNova provides NS specific gridded Enhanced Digital Elevation Model data at a resolution of 20 m. This data is developed from 1:10,000 Digital Resource Mapping Series. The gridded DEM data must be converted to either an XYZ terrain elevations data file or a USGS DEM format to be read by AERMAP or TERREL, by using commercially available software or special processing by the user.
- Terrain data can be manually extracted from a contour map or survey data and used to develop XYZ (where X and Y correspond to the coordinates, and Z to the terrain elevation) format data.

It should be noted that digital surface data is different from digital elevation data. Digital surface data indicates the elevation including treetops/canopy heights and building heights, whereas digital elevation data indicates the ground-level elevation. Bare-earth digital elevation model data is more appropriate for use in dispersion modelling.

### 4.4.3 Receptor Grid

Receptors are user-defined spatial points, at which the dispersion model computes concentrations and deposition predictions. Receptors must be placed more densely in locations that maximum impacts are expected.

The maximum spacing beyond the defined property boundary should consider the following spacing:

- 50 m receptor spacing within 500 m from the sources of interest;
- 100 m receptor spacing within 1000 m from the sources of interest;
- 250 m spacing within 2000 m from the sources of interest;
- 500 m spacing within 5000 m from the sources of interest; and
- 1000 m spacing beyond 5000 m from the sources of interest.

Fenceline receptors should be spaced at 20 m along the defined property boundary.

Unless otherwise directed by the Department, the model outputs are to be computed at a flagpole height of 0 m, or ground-level, at any given receptor.

### 4.4.4 Property Boundary

The areas of applicability of the Nova Scotia AAQS are not defined in the *Air Quality Regulations*. They are intended to be applied at areas in which there is public access (i.e., beyond the facility's property boundary). Compliance is to be assessed at and beyond the facility's property boundary. In the case that a public access road passes through the facility's property, the facility boundary is defined as the perimeter along the road allowance (i.e., compliance is to be assessed along the road).

### 4.4.5 Sensitive Receptors

It is important that sensitive receptors in the study area are identified and captured in the modelled results. Sensitive receptors include, but may not be limited to, residences, schools, health care facilities, day cares, long-term care facilities, campgrounds, parks, and recreational areas. Both AERMOD and CALPUFF have the ability to output results at specified discrete receptors in addition to the receptor grid. In addition to sensitive receptors, discrete receptors can be placed at other desired locations such as at the location of a monitoring station.

## 4.5 Dispersion Model Inputs – Metrological Data

AERSCREEN does not require inputted meteorological data, it generates a site-specific worst-case meteorological data set using variations of different meteorological conditions.

It is recommended that a five-year meteorological data set be used for refined and specialized modelling. The preferred approach for generation of required meteorological data is to use mesoscale (prognostic) data, such as that generated using numerical weather prediction models (NWP). It is recommended that the Weather Research and Forecasting Model (WRF) be used as opposed to the Penn State/NCAR mesoscale model (MM5) as it is the succession model. The meteorological input data can be prepared using the Mesoscale Model Interface Program (MMIF) to convert to AERMET or CALMET-ready data.

If a facility has meteorological data from an on-site station judged to be representative of the modelling domain and that meets specific criteria, the modeller may use this meteorological data instead of the NWP data. When determining whether on-site data is appropriate, it is suggested to follow the criteria presented in Section 6.0 of the Alberta Air Quality Model Guideline (AEP, 2021).

### 4.5.1 Surface Characteristics

Surface characteristics determine the influence of wind flow across a surface due to ground turbulence and are a function of the land use. AERSCREEN, AERMOD, and CALPUFF all require some degree of inputted data related to surface characteristics.

#### 4.5.1.1 AERSCREEN and AERMOD (AERMET)

The AERMET meteorological processor requires the input of specific surface characteristics, such as surface roughness, Bowen ratio, and albedo. These parameters can be entered manually following the guidance provided in the AERMOD implementation Guide (US EPA 2021a), or using AERSURFACE, a program that determines surface characteristics from land cover data. The input data required for AERSURFACE (USGS National Land Cover Data, 1992) is not available outside of the USA, and as such, the surface characteristic parameters should be entered manually.

The modeller should obtain an aerial view map or image (e.g., from Google Earth images, GeoGratis land cover data, Bing images, etc.) and draw a 3 km radius around the location of the meteorological collection site. There are 8 land-use types that the area within the radius should be broken into: water (fresh water and sea water), deciduous forest, coniferous forest, swamp, cultivated land, grassland, urban, and desert shrubland. The area can be broken up into 12 different sectors, each a minimum of 30 degrees. The end of one sector must match the beginning of the next such that the full 360° is complete. Once the land use type has been defined, then the corresponding surface parameters (roughness height, albedo, and Bowen ratio) are to be assigned for the sectors. AERMET allows surface parameters to be defined monthly, seasonally, or annually. As there is a range of surface conditions over a year, it is recommended that surface conditions be specified seasonally at a minimum.

Values for these surface parameters based on land-use categories are presented in the US EPA's User's Guide for the AERMOD Meteorological Preprocessor (AERMET) (US EPA, 2021b). It is recommended that the most recent version of the AERMET User's Guide be used when choosing surface parameters. The land use type, and associated surface characteristics, should be determined from the land use within a 3 km radius of the input meteorological data.

In addition, for AERMOD modelling, the urban surface roughness category is defined as either rural or urban based on the dominant land use within a 3 km radius of the source. If greater than 50% of the land use is categorized as heavy or light industrial, commercial, and/or compact residential, it is considered urban. Otherwise, the rural option should be used, with the exception of forests, which should be classified as urban.

#### 4.5.1.2 CALPUFF (CALMET)

CALMET requires an input file (GEO.dat) containing gridded land use type, gridded terrain elevations, and land use weighted fields of surface parameters (surface roughness length, albedo, Bowen ratio, soil heat flux, vegetation leaf area index, and anthropogenic heat flux). The pre-processor CTGPROG can be used to process land use data which is then used by MAKEGEO to generate the gridded land use type and surface parameters that make up part of the GEO.DAT file. There are various sources in which the land use data can be processed from, including:

- GeoGratis Land Use Data (Circa 2000 – Vector)[9] – Data is in polygonised format and requires to be rasterized and further processed for CTGPROG (CALPUFF's land use processor) to use;
- USGS Global Land Use Characterization Data[10] for North America – The data has 1 km resolution that can be read and processed by CTGPROG; and
- Manually extracted from aerial images/maps (e.g., Google Earth images, land use maps, etc.).

Table 4-46 of the CALMET User's Guide (Scire *et al.*, 2000) presents the extended list of numbering associated with the land use categories that can be input to CALMET.

It is recommended that seasonable surface parameters be utilized to pick up the range of surface conditions over a year.

[9] https://geogratis.gc.ca/api/en/nrcan-rncan/ess-sst/643c4911-475b-4765-b730-2dde9be50d5b.html
[10] https://www.usgs.gov/centers/eros/science/usgs-eros-archive-land-cover-products-global-land-cover-characterization-glcc?qt-science_center_objects=0#qt-science_center_objects

The BC Air Quality Dispersion Modelling Guidelines Table 4.14 (BC, 2015) presents the CALMET land use type numerical values that can be used to convert those defined in GeoGratis. These values can be used to convert GeoGratis land-use types to those that are able to be read by CALMET.

To manually process land use types using contour maps, aerial images (e.g., Google Earth images), land use maps, etc., the land cover in the domain should be examined and each grid point assigned a numerical land use type (refer to the CALMET User Guide, Scire *et al*., 2000) based on the usage. A generic land use data file in the format of XYZ, where X is the CALMET land use type, and Y and Z are the longitude and latitude coordinates, is to be generated for input to CTGPROG. The default table in Subgroup (4b) of the MAKEGEO input file (MAKEGEO.INP) is to be replaced by the output of CTGPROG. MAKEGEO is to be run with the outputs from both CTGPROG and TERREL to generate the required GEO.DAT file for CALMET.

### 4.5.2 CALMET Metrological Modelling

There are three different modes in which CALMET can be run, as follows:

1) No Observation (No-Obs): CALMET relies only on NWP meteorological data with no observation data.
2) Observation Only (Obs-Only): CALMET Relies only on observation meteorological data with no NWP data.
3) Hybrid: CALMET uses observations and NWP model output.

Unless a full year of representative on-site meteorological data exists, the observation only mode must not be used. The preferred method is to use either the no-obs mode or the hybrid mode. Recommendations related to each mode are provided in the following sections.

#### 4.5.2.1 No Observation Mode (No-Obs)

The no observation (no-obs) mode uses only meteorological data generated from an NWP model. An important consideration when using this mode is whether the key features of the complex flow can be resolved by the NWP grid resolution output.

#### 4.5.2.2 Observation Only Mode (Obs-Only)

The observation only (obs-only) mode relies solely on meteorological observation data (i.e., station data). To fully rely on observation data for complex flow scenarios, CALMET would require a network of surface and upper air stations to properly model the meteorological fields. The availability of networks in Nova Scotia would make this difficult to achieve.

This mode is not recommended to be used unless the facility has a full year of representative on-site meteorological data and the flow in the region is considered simple (non-complex). If CALPUFF is being used because of complex flow/coastal region, then the obs-only mode is not adequate.

#### 4.5.2.3 Hybrid Mode

The hybrid mode combines NWP simulated meteorological data with surface (or both surface and upper air station) data. Hybrid can also include overwater buoy data and precipitation data. The NWP output is interpolated to the CALMET grid, and coarse NWP data can be adjusted in CALMET using fine-resolution terrain and observations to produce a “Step 2” wind field.

As upper air stations are less available than surface stations, the hybrid approach allows for the “filling in” of upper air information.

When observation data is used in CALPUFF, there are seven user defined parameters required in the input, which require professional judgement: BIAS, IEXTRP, RMAX1, RMAX2, TERRAD, R1, and R2. Please refer to Table 6.1 of the British Columbia Air Quality Dispersion Modelling Guideline (BC, 2015) for explanation and guidance on these parameters.

## 4.6 Model Outputs, Post Analysis, and Reporting

The predicted dispersion modelled GLCs, combined with applicable baseline concentrations, are compared to AAQS to determine compliance. The Department expects GLCs predicted through modelling, including baseline concentrations, to have zero exceedances of ambient standards to meet compliance. This section outlines the inclusion of baseline concentration data and the steps to develop baseline concentrations, the allowable removal of anomalies, and the required data to present in the dispersion modelling report.

### 4.6.1 Inclusion of Baseline Concentrations

While knowing the predicted project air quality contribution is of use, it is the cumulative air quality that is important to protect human health and the environment. The cumulative air quality concentration (baseline plus project contribution) must be used for comparison against AAQS. For existing operational facilities, the cumulative concentration can be determined through the inclusion of baseline concentration data.

Applicants must use available data and/or a program of monitoring data to establish baseline concentrations. Baseline concentrations must represent the cumulative impacts of all sources of air pollutants (anthropogenic and natural) in the vicinity of the proposed activity. Where it is necessary to establish baseline concentrations for operational activities, data must be obtained from locations that are minimally impacted by emissions from the activity (e.g., locations that are shown to be upwind of the activity). Choosing appropriate baseline concentrations requires considerable professional judgement. When choosing an appropriate ambient monitoring station to derive baseline concentrations, Applicants must consider the similarity of the monitoring location to the project, e.g., similar topography, climate normal, and air quality regimes. A clear rationale for the selection of baseline concentrations must be included in modelling submissions to the Department. Section 7.2 of the Alberta Air Quality Model Guideline (AEP, 2021) provides guidance on determining baseline concentrations that can be referred to.

If there are known proposed industrial facilities within 5 km of the project boundary that are not yet operational (i.e., their concentration contribution would not be captured in existing baseline concentration data), their emissions must be considered in the modelling assessment. Failure to do so may result in additional cumulative effects modelling being requested. It is the responsibility of the Applicant to obtain representative emissions data from proposed non-project sources.

### 4.6.2 Removal of Meteorological Anomalies

It is recognized that there are extreme weather conditions that can be considered outliers. Nova Scotia is adopting an approach to removing predicted concentrations that correspond to meteorological anomalies in-line with the approach implemented in Ontario under O. Reg. 419/05 and described in the MECP Guideline A-11 Air Dispersion Modelling Guideline for Ontario (MECP, 2017).

For 24-hour averaging periods, the first highest predicted 24-hour average concentration in each single meteorological year can be removed, for a total of five 24-hour average concentrations over the 5-year modelling period. For 1-hour averaging periods, the eight hours with the highest predicted 1-hour concentrations in each single meteorological year can be removed, for a total of 40 hours over the 5-year modelling period. For the 1-hour averaging period, this method is not the same as outputting the 9$^{th}$ highest concentration at each receptor per year, as that will likely remove more hours than eight. When assessing annual concentrations, the single highest annual concentration in the 5-year modelling period will be considered without the removal of anomalies.

The correct removal of anomalies per year can be done manually. Some commercially available modelling software packages, such as AERMOD, can automatically select the values to report after anomaly removal by selecting the Maximum Values Table (MAXTABLE) option in the Output Pathway. Refer to Appendix B of the MECP Guideline A-11, 2017 on how to use the MAXTABLE to eliminate meteorological anomalies.

Compliance will be assessed against the highest concentration after removal of the anomalies, plus added baseline concentration, as noted above. Removed anomalies, along with the meteorological conditions that prompted the anomaly, must be reported.

This approach is applicable to modelled predicted concentrations only and does not apply to measured or monitoring concentrations. The choice to not remove anomalies is acceptable as the results will be conservative.

### 4.6.3 Averaging Period Conversion

Some species may have air quality standards with averaging periods that the dispersion model does not output directly, for example 10-minute or 4-minute averaging periods. Predicted concentrations can be converted to concentrations for other averaging periods using the following formula:

$$C_0 = C_1 \times \left(\frac{t_1}{t_0}\right)^n$$

Where:

$C_0 = the\ concentration\ at\ the\ averaging\ period\ t_0$

$C_1 = the\ concentration\ at\ the\ averaging\ period\ t_1$

$t_1 = the\ averaging\ period\ of\ the\ modelled\ concentration$

$t_0 = the\ averaging\ period\ of\ the\ converted\ concentration$

$n = 0.28$

The concentration units must be consistent between the initial and converted concentration. It is also important to note that the averaging periods must be in consistent units, e.g., if converting from 1-hour to 10-minutes, $t_1$=60 minutes while $t_0$=10 minutes. The exponent, n, is generally representative of average conditions across a range of atmospheric stabilities. Alternative exponents can be used with proper justification and if approved by the Department.

### 4.6.4 NO to $NO_2$ Conversion

Nitrogen oxides (NOx) is composed of nitric oxide (NO) and nitrogen dioxide ($NO_2$). Of the species that make up NOx, only nitrogen dioxide $NO_2$ has a specific AAQS. The NOx concentration in exhaust from typical combustion sources generally is comprised of 5-10% $NO_2$. The conversion of NO to $NO_2$ continues in the plume due to reactions with atmospheric ozone and volatile organic compounds (VOCs).

The conversion of NO to $NO_2$ must be accounted for when predicting concentrations of $NO_2$. This can be achieved using one of several approaches, as follows:

- Total Conversion Method.
- Ambient Ratio Method.
- Plume Volume Molar Ratio Method.
- Ozone Limited Method.

Each of these conversion methods are described in more details in the following sections.

#### 4.6.4.1 100% Conversion

The most conservative approach which can be used with any of the recommended models in this document is to assume that 100% of the NO is converted immediately to $NO_2$. If this method produces exceedances of ambient $NO_2$ standards, then an alternative method can be applied.

#### 4.6.4.2 Ambient Ratio Method

The ambient ratio method (ARM) estimates conversion of NOx to $NO_2$ through a conversion factor developed from monitored concentrations of NO and $NO_2$. It is based on the premise that a plume's $NO_2$/NOx ratio eventually reaches an equilibrium value some distance from the source. It requires monitors being placed at precise locations and distances to correctly capture the equilibrium $NO_2$/NOx ratio, which can be difficult to achieve.

The Department recommends following the guidelines presented in Section 7.3.2 of the Alberta Air Quality Model Guideline Document (AEP, 2021).

#### 4.6.4.3 Plume Volume Molar Ratio Method

The plume volume molar ratio method (PVMRM) is an option when modelling with AERMOD and AERSCREEN.

The PVMRM approach limits the conversion of NO to $NO_2$ based on availability of ozone ($O_3$) in the plume and accounts for the changing plume volume due to dispersion. This method also accounts for the merging of plumes from multi-source modelling scenarios. To apply the PVMRM approach, inputs for baseline $O_3$, the $NO_2$/NOx equilibrium ratio, and the in-stack $NO_2$/NOx ratios must be defined. The following inputs are recommended when using the PVMRM:

- For baseline $O_3$, it is preferred to use a time-series of on-site measured hourly $O_3$ concentrations, if available. Alternatively, a single value based on the maximum hourly O3 concentration measured from the most recent year of representative monitoring data can be used;
- A default $NO_2$/NOx equilibrium ratio of 0.9 unless justification is provided for using an alternative value; and
- A default $NO_2$/NOx in-stack ratio of 0.1 unless justification is provided for using an alternative value.

#### 4.6.4.4 Ozone Limiting Method

The ozone limited method (OLM) requires hourly ambient ozone concentrations to be defined. It is preferred that on-site measured $O_3$ data be used, if available.

OLM compares the ambient concentration of $O_3$ to the maximum predicted concentration of NOx to determine the limiting factor in the generation of $NO_2$. If the $O_3$ concentration is greater than 90% of the predicted NOx concentration, then total conversion is assumed. When this condition is not met, the $NO_2$ formation is limited by the ambient $O_3$ concentration. The resulting $NO_2$ concentrations are then estimated from the sum of $NO_2$ produced by in-stack thermal processes and the conversion of NO to $NO_2$ by oxidation with ambient $O_3$. The OLM approach uses the following equation to estimate the $NO_2$ concentration (Cole and Summerhays, 1979; Owen and Brode, 2014):

$$If\ [O_3]_{ambient} > 0.9 * [NO_x]_{predicted,i}\ then\ [NO_2]_{predicted,i} = [NO_x]_{predicted,i}$$

$$otherwise\ [NO_2]_{predicted,i} = [O_3]_{ambient} + ISR_i * [NO_x]_{predicted,i}$$

Where $ISR_i$ refers to the source in-stack ratio for the $i^{th}$ source which should follow the same method as described for the PVMRM method (see Section 6.4.3). All concentrations must be in ppm.

#### 4.6.4.5 Treatment of NO2/NOx Conversion in CALPUFF

Estimating the $NO_2$/NOx conversion in CALPUFF can be done using either the No Chemistry option or the Chemistry option (i.e., MESOPUFF II, RIVAD/ISORROPIA).

For the no chemistry option, $NO_2$ concentrations can be estimated using total conversion or ARM/ ARM2 methods that are directly available in post-processing (CALPOST and CALSUM) and should be applied following guidance in Sections 6.4.1 and 6.4.2. Note that the emissions should be inputted as NOx (not $NO_2$) to use these methods. The OLM can also be applied to estimate $NO_2$ conversion, following guidance in Section 8.4, however, it requires each source to be treated separately and then summed to determine ground level $NO_2$. CALSUM does not have a script to perform this task, as such, a user defined one must be applied. The PVMRM is not available in CALPUFF.

The CALPUFF chemical transformation options (i.e., MESOPUFF II, RIVAD/ISORROPIA) are also able to predict $NO_2$ concentrations. It requires the NOx emissions to be entered as NO and $NO_2$ based on in-stack ratios that should be determined as per the ARM2 method (as described in Section 4.6.4.2).

### 4.6.5 Reporting

A modelling plan is not required to be developed and approved by the Department prior to conducting modelling. However, it is recommended that any deviation from the core modelling methodologies presented in this document be presented to the Department for approval prior to modelling and again outlined in the final dispersion modelling report.

A dispersion modelling report must be developed for the modelling assessments that describes the application of an approved dispersion model for determining compliance with the *Air Quality Regulations* and provided to the Department. It must include details on the model setup and inputs, the emission inventory development, and discussion on the predicted GLCs. It is important that the dispersion modelling report contains enough detail on the methodology and lists any assumptions made such that the reviewer can understand the steps involved.

The dispersion modelling report could include, but is not limited to, the following information:

- Description of the typical facility operations and the operating conditions that are expected to result in the maximum GLC;
- A site plan figure that presents, but is not limited to, the location of sources, buildings, and the property boundaries;
- A figure that presents the modelling domain, facility boundary, and terrain;
- A figure that presents the modelling receptor grid and discrete receptors;
- Details supporting the use of the preferred model;
- Description of the emission rate estimation methods associated sample calculations, and classification of the data-quality (refer to Section 3.4.9). Supporting data, such as manufacturer specifications or laboratory analysis that were used in the development of the emission inventory, must be appended to the report;
- Justification for source and/or contaminant negligibility, if applicable;
- A section outlining the input parameters used for dispersion modelling, including but not limited to, the local land use conditions, the terrain data, the receptor gridding;
- A section outlining the development of the meteorological data and the required meteorological input parameters;
- A source summary table that presents emission source parameters and emission data, suggest referring to the format presented in the Ontario Guideline A-10 (MECP, 2018); and
- Summary of baseline concentration data (station(s) used, years considered, data completeness, and statistics of data).

The dispersion modelling report must also, at minimum, present the results in the following manner:

- A table presenting the overall maximum predicted concentration for each modelled contaminant and each applicable averaging period after the allowable removal of anomalies, including a percent comparison of the predicted GLC to the respective standard. It is suggested to refer to the format presented in the Ontario Guideline A-10 (MECP, 2018);
- Figures showing the maximum concentration isopleths for modelled contaminants that are above 50% of their respective air quality standard. These must be generated for all respective averaging periods in which 50% of the air quality standard is exceeded. The isopleths must clearly indicate the project boundary and location of discrete receptors; and
- If exceedances are predicted, frequency analysis above the specified AAQS illustrated by isopleths for the study area and a table for discrete receptors.

In the case that a maximum predicted GLC (including baseline) exceeds an AAQS, the Applicant must contact the Department to discuss the next steps to address the predicted exceedances.

#### 4.6.5.1 Presentation of Pollutant Concentrations

When presenting pollutant concentrations in figures, the following guidance must be adopted for clarity:

- All figures must include an isopleth, coloured red, that is equivalent to the relevant AAQS.
- Concentrations below the AAQS must be shaded in blues and greens.
- Concentrations above the AAQS must be shaded in yellows, oranges, and reds, with reds illustrating the highest concentrations above the AAQS.

### 4.6.6 Electronic Copies

The Regional Office should be consulted with respect to the preferred method of submission. Electronic files of the input files and critical output files for each model run must be compiled and submitted to the Department upon submission of the Dispersion Modelling Report. The electronic submission can be submitted to the Department via USB, CD, or File Transfer Program (FTP). If issues occur through transferring files via FTP (e.g., due to file size), the Department can request the files be provided by alternative methods.

# Section 5: Mitigating Emissions Using BATEA, Capital Stock Turnover And BOP

## 5.1 Introduction

While air pollution is a consequence of industrial activity, it is incumbent on all emitters to limit, and continually reduce air pollution where possible. As technology and operational methodologies continues to evolve, more solutions become available to limit impacts to the environment and human health while still achieving the desired process outcomes. Therefore, emitters must consider the principles of 'Best Available Technology Economically Achievable' (BATEA) and 'Best Operating Practices' (BOP) when submitting their operational plan to the Department. The principle of BATEA requires emitters to consider the range of technology that is commercially available for the mitigation of pollutants that are emitted from the proposed activity. The BOP principle requires emitters to ensure that operations (including maintenance activities) are conducted in a way that minimizes air emissions."

## 5.2 BATEA - Making The Case

When selecting mitigation technology/devices, emitters should consider the following questions:

- What pollutants should be mitigated?
- What control methods are commercially available?
- What control methods are appropriate for the process in question?
    - Should more than one pollutant be mitigated?
    - Are there conflicts between methods?
    - What is the efficiency of each method?
- What is the cost?
    - Initial installation?
    - Ongoing costs?
    - Waste disposal?
- Is the cost economically viable?

BATEA illustrates that mitigation is not a one size fits all. Mitigation methods should be carefully considered by an appropriately qualified person, and in a holistic manner. Applicants should describe the evaluation process that was undertaken to determine the final selection of technology and mitigation when submitting to the Department. The evaluation must include clear explanations of assumptions, cited references and a summary of the cost benefit analysis.

## 5.3 Application Of Capital Stock Turnover

BATEA must be considered within the context of capital stock turnover. Emissions reductions are achieved as control technologies develop, therefore newer machinery and vehicles will pollute less than their older counterparts.

Procurement should be based on the purchase of new machinery and vehicles in order to comply with 'Best Available Technology'. In addition, emitters must have a program of replacement to ensure that old technology is replaced in a timely manner. Emitters must have a strategy for continual improvement with regard to emissions of air pollutants.

## 5.4 Best Operating Practice

Best Operating Practice (BOP) minimizes emissions by adopting specific practices. Often, adopting such practices can have economic benefits too. Such practices include:

- Reducing the need for vehicles to reverse (route planning and vehicle management);
- Turning off engines rather than idling;
- Reducing speeds on haul roads;
- Dust suppression/watering of roads and/or stockpiles;
- Vehicle wash/wheel shaker stations;
- Reducing stockpile drop heights;
- Covering material being transported;
- Managing stockpiles;
- Installing wind breaks;
- Operating at a steady state rather than peak/trough;
- Considering the impacts of meteorological conditions;
- Reducing the number of start ups required; and
- Routinely checking and maintaining equipment to ensure its functioning efficiently.

This is not an exhaustive list. BOP must be identified in submissions to the Department and included in the activity's Environmental Management Plan. All relevant personnel must be trained in the specific practices employed at the site, and site management must maintain oversight to ensure that BOP is being adhered to.

## 5.5 Summary

Mitigation of emissions must be considered as an integral part of any process. BATEA is the method by which technology and mitigation methods are initially selected, while life cycle analysis ensures that this principle is used to continually improve operations over time. BOP prevents unnecessary emissions. Evidence of the BATEA process, life cycle analysis and BOP must be included in any submissions by Applicants to the Department.

# Section 6: Protection of Sensitive Receptors

## 6.1 Introduction

The AAQS, in effect under the *Air Quality Regulations*, are based the risks associated with public exposure to air pollutants. However, such standards may not always be sufficient to protect sensitive receptors. 'Sensitive receptors' may refer to humans and/or biological species in the natural environment, that are particularly susceptible to impacts from air pollution, as defined in Sections 6.2 and 6.3.

Where a sensitive receptor is identified, additional mitigation may be required. The aim of the additional mitigation is to reduce air pollutant concentrations to a level that will not result in additional significant impacts on the identified sensitive receptors.

It is incumbent on Applicants to determine if an activity, that is subject to an Environmental Assessment or Industrial Approval application/renewal, is located in the vicinity of a sensitive receptor. As stated in Section 4, Applicants must demonstrate compliance through the submission of dispersion modelling, which clearly details emission sources and proposed mitigation (see Section 5). Applicants should note that an assessment relating to the protection of sensitive receptors is in addition to the assessment of air quality impacts with respect to the AAQS.

## 6.2 Protection of Human Health

This section refers to individuals who may fall into one or more vulnerability categories. Individuals who do fall into vulnerability categories include children, the elderly, the pregnant, and those who are sick. These individuals can be found, during a significant part of the day, at e.g., schools, day care centres, hospitals, and long term care facilities. With respect to dispersion modelling, such locations are identified as 'specific receptors'.

Applicants should complete a survey that identifies e.g., all schools, daycare centres, hospitals, and long-term care facilities within the impacted area. Once identified, Applicants must demonstrate that the concentration of air pollutants, at these specific receptors, is sufficiently protective of human health through comparison with appropriately conservative standards. Applicants should justify the choice of the standards that are used. Where necessary, additional mitigation must be applied. Dispersion modelling, that details the proposed mitigation methods, should be submitted to the Department as part of the application/review process. It must demonstrate compliance with the AAQS at the specific receptors.

## 6.3 Protection of Biodiversity

This guidance is pertinent to EA applications. 'Sensitive receptors' with respect to biodiversity means any species that is identified in the *Endangered Species Act*. These species could be potentially adversely impacted by a change in the local environment. Such changes may result from increased deposition of air pollutants and/or acid deposition above baseline concentrations, causing habitat deterioration or destruction.

Where Applicants identify sensitive receptors in the vicinity of a proposed activity, Applicants must demonstrate that atmospheric emissions from the project, when added to baseline data, do not result in significant impacts on the identified species. Applicants should present dispersion modelling that highlights the location of the sensitive receptor(s) and illustrates the predicted impacts (project +

baseline). Any mitigation that would be applied to minimize impacts should also be reported (see Section 5). Further information can be obtained from [Biodiversity Data and Information | novascotia.ca].

## 6.4 Protection of Country Foods

This guidance is pertinent to EA applications. Sensitive receptors' with respect to country foods means any biological system that could result in human exposure to air pollutants through direct deposition or bioaccumulation in the food chain. Applicants should demonstrate that pollutant concentrations in country foods do not exceed toxicological reference values through the preparation of a Human Health and Environment Risk Assessment. The link between project emissions, total deposition and human exposure should be clearly identified. Further information can be obtained by contacting the Department's Environmental Health – Food Safety Team.

## 6.5 Summary

The applicability of methods contained in this section can only be determined on a project-by-project basis. Where sensitive receptors are identified, Applicants should consider, for example:

- Does the activity have to be sited in this location or is there another location that could be used?
- What mitigation measures should be employed?
- Are the mitigation measures effective enough? Are they reliable?
- Is the proposed Environmental Management Plan sufficient to ***prevent*** impacts on sensitive receptors?
- What could be done differently to prevent impacts?

Where a monitoring or modelling program may form part of an Environmental Assessment submission or an application for a new or renewed Industrial Approval, Applicants are encouraged to discuss the proposed activity with the Department to identify an appropriate and acceptable methodology. This will allow a thorough and timely review of impacts.

Furthermore, the Environmental Management Plan must contain procedures to prevent impacts on sensitive receptors, that personnel are trained on the actions required, that there are clear and timely triggers for implementing the plan, and that there is a clear chain of responsibility.

# Section 7: Summary

This Air Assessment Guidance Document is intended to provide comprehensive advice for Applicants who make air quality submissions to the Department. It is the responsibility of Applicants to ensure that all the advice that is applicable to the activity in question has been followed, and that the advice has been followed correctly. Applicants are encouraged to contact the Department to discuss applications prior to commencing any assessment.

Any questions regarding the document or its applicability to activities, should be directed to the Department through one of the following methods:

| | |
|---|---|
| Email: | air@novascotia.ca |
| Telephone: | 902-424-3600 |
| Postal address: | Air Quality Unit<br>Nova Scotia Environment and Climate Change<br>1903 Barrington St.<br>Suite 2085<br>Halifax, NS, B3J 2P8 |

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# Appendix A: Source Testing Reference Methods

| Parameter | Reference Sampling Method |
|---|---|
| Antimony (Sb) | US EPA 40CFR60 Method 29 |
| Ammonia | US EPA Method CTM 27 |
| Arsenic (As) | US EPA 40CFR60 Method 29 |
| Barium (Ba) | US EPA 40CFR60 Method 29 |
| Beryllium (Be) | US EPA 40CFR60 Method 29 |
| Cadmium (Cd) | US EPA 40CFR60 Method 29 |
| Carbon Dioxide ($CO_2$) | Environment Canada Method EPS 1/PG/7<br>Environment Canada Method EPS 1/RM/8 |
| Carbon Monoxide (CO) | US EPA 40CFR60 Method 10,10A,10B |
| Chlorine ($Cl_2$) | NCASI Special Report 91-07 |
| Chlorine Dioxide ($ClO_2$) | NCASI Special Report 91-07 |
| Chromium (Cr) | US EPA 40CFR60 Method 29 |
| Cobalt (Co) | US EPA 40CFR60 Method 29 |
| Copper (Cu) | US EPA 40CFR60 Method 29 |
| Chlorobenzenes | Environment Canada Method EPS 1/RM/2 |
| Dioxins | Environment Canada Method EPS 1/RM/2 |
| Furans | Environment Canada Method EPS 1/RM/2 |
| Formaldehyde | NCASI A105 |
| Halides and Halogen (Hydrogen Chloride (HCl), Hydrogen Bromide (HBr), Bromine (Br2)) | US EPA 40CFR60 Methods 26,26A |
| Lead (Pb) | US EPA 40CFR60 Method 29 |
| Lead in Particulate | Environment Canada Method EPS 1/RM/7 |
| Manganese (Mn) | US EPA 40CFR60 Method 29 |
| Mercury (Hg) | US EPA 40CFR60 Method 29 |
| Mercury (Hg) | Environment Canada Method EPS 1/RM/5<br>US EPA 40CFR60 Method 101 |
| Mercury Speciation | ASTM Method D6784-02 |
| Nickel (Ni) | US EPA 40CFR60 Method 29 |
| Nitrogen Oxides ($NO_x$) | Environment Canada Method EPS 1/PG/7<br>Environment Canada Method EPS 1/RM/15<br>US EPA 40CFR60 Method 7,7A,7B,7C,7D,7E |
| Oxygen ($O_2$) | Environment Canada Method EPS 1/PG/7<br>Environment Canada Method EPS 1/RM/8 |
| Polycyclic aromatic hydrocarbons (PAHs) | Environment Canada Method EPS 1/RM/2 |
| Filterable Particulate Matter (FPM) | Environment Canada Method EPS 1/RM/8<br>EPA Method 5 |
| Condensable Particulate Matter (CPM) | Environment Canada Method EPS 1/RM/55, Method H<br>EPA Method 202 |
| Total Particulate Matter (TPM) | Combination of FPM + CPM |
| $PM_{10}/PM_{2.5}$ | US EPA Method 201A |
| Polychlorinated biphenyls (PCBs) | Environment Canada Method EPS 1/RM/2 |

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| Phosphorus (P) | US EPA 40CFR60 Method 29 |
| Selenium (Se) | US EPA 40CFR60 Method 29 |
| Silver (Ag) | US EPA 40CFR60 Method 29 |
| Sulphuric Acid Mist | US EPA Method 8 |
| Sulphur Dioxide ($SO_2$) | Environment Canada Method EPS 1/PG/7<br>Environment Canada Method EPS 1/RM/15<br>US EPA 40CFR60 Method 6,6A,6B,6C |
| Thallium (Tl) | US EPA 40CFR60 Method 29 |
| Total Non Methane Hydrocarbons (TNMHCs) | US EPA Method 25A |
| Total Reduced Sulphur (TRS) | US EPA Method 16/16A/16B |
| Volatile Organic Compounds (VOCs) | US EPA Method 30<br>US EPA Method 18; NMAM 6010, 6013 Analysis<br>EPA T015 |
| Zinc (Zn) | US EPA 40CFR60 Method 29 |

# Appendix B: CALMET/CALPUFF Model Options

The following Table provides guidance on the switches/options and user-defined factors for CALMET/CALPUFF input. For parameters not defined in the following table, the default model option should be used.

As every CALPUFF application is unique, a qualified person's judgement is required when choosing the appropriate parameters for modelling. Justification should be provided in situations that parameters are altered from those recommended.

| Parameter | Parameter Interpretation | Recommended Value | Value Justification |
|---|---|---|---|
| ***CALMET*** | | | |
| NOOBS | Indicates whether meteorological input data is observation, NWP, or a combination of observation and NWP | 0, 1, or 2 | 0 = observation data only (use only when site-specific data is available, refer to Section xx)<br>1 = combination of observation and NWP data<br>2 = NWP data only |
| MCLOUD | Cloud Cover Data | 4 (preferred) or 1 | For NWP data, use cloud cover derived from the meteorological inputs (4) unless a complete set of surface observation data is available (1). |
| IWFCOD | Wind field module used | 1 | Use diagnostic wind module for wind field creation |
| IEXTRP | Control variable for vertical extrapolation of surface wind observations to upper levels | +/- 1, -4 | When NoObs = 2, IEXTRP = +/- 1, use default (-4) when observation data is being used to extract surface winds to the upper layers. See note 2. |
| IPROG | Control variable for whether gridded NWP data is used as input | 14* | Where NWP data is being used, use as initial guess field. |
| RMAX1 | Maximum radius of influence over land in the surface layer (km) | Varies* | Requires user input based on a qualified person's judgement. Not used in no-obs mode. See note 2. |
| RMAX2 | Maximum radius of influence over land in layers aloft (km) | Varies* | Requires user input based on a qualified |

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|---|---|---|---|
| | | | person's judgement. Not used in no-obs mode. See note 2. |
| RMAX3 | Maximum radius of influence overwater (km) | Varies* | Requires user input based on a qualified person's judgement. Not used in no-obs mode. See note 2. |
| TERRAD | Radius of influence of terrain features (km) | Varies[1] | See note 2. |
| R1 | Weighting parameter for the diagnostic wind - field in the surface layer (km). Distance from a surface observation station at which the obs and 1st guess field are equally weighted. | Varies[1] | See note 2. |
| R2 | Weighting parameter for the diagnostic wind field in the layers aloft (km). Distance from an upper air station at which the obs and 1st guess field are equally weighted. | Varies[1] | See note 2. |
| ITWPROG | Overwater lapse rates used in convective mixing height growth | Varies[1] | Set as required when considering assessments over water |
| ***CALPUFF*** | | | |
| MBDW | Method used to simulate building downwash | 1 or 2 | Use the Prime algorithm for downwash (2) unless the aspect ratios of W/H > 5 are met, then use the ISC type (1), see the discussion on downwash in Section 3.6. |
| MSHEAR | Vertical wind shear modeled above stack top | 0 | No vertical wind shear above stack top modeled in plume rise |
| MSPLIT | Puff splitting allowed? | 0 or 1 | 0 = no puff splitting<br>1 = puff splitting, may be necessary for long-range transport |
| MCHEM | Chemical Transformation Scheme | 0 or 6 | No chemical transformation (0) or transformation calculated internally using RIVAD/ISORROPIA (6) |
| MAQCHEM | Aqueous phase chemistry | 1 | Used only if MCEHM = 6 |

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|---|---|---|---|
| | | | Transformation rates and wet scavenging coefficients adjusted for in-cloud aqueous phase reactions |
| MLWC | Liquid Water Content Flag | 1 | Used only if MAQCHEM = 1. MLWC = 1 if gridded liquid water content data is available (obtained from CALMET from MM5/WRF output) |
| MWET | Wet removal modeled | 0 or 1 | 0 = no<br>1 = yes<br>Depending on application |
| MDRY | Dry deposition modeled | 0 or 1 | 0 = no<br>1 = yes<br>Depending on application |
| MDISP | Method used to generate the horizontal and vertical dispersion coefficients | 2 | Turbulence based dispersion coefficients recommended |
| MPARTLBA | Partial plume penetration from buoyant area sources | 1 | Allow for partial penetration of plume into elevated inversions. |
| MPDF | Probability distribution function for dispersion under convective conditions | 1 | As MDISP = 2, set MPDF to 1 |
| MSGTIBL | Subgrid scale thermal internal boundary layer (TIBL) module used for shoreline | 0 or 1 | 0 = not used<br>1 = used for applications along a coastline. Requires a coastline file (COASTLN.DAT) to be prepared to specify the location of the land-water boundary |
| MREG | Test options for conformity to US Regulatory values | 0 | No MREG checks are made |
| MOZ | Ozone data input option | 0 | Use a monthly background ozone data |
| MHN3 | Monthly ammonia data input option | 0 | Use monthly background ammonia value for all layers |
| MH2O2 | Monthly $H_2O_2$ data input option | 0 | Only used if MCHEM = 6 and MAQCHEM = 1<br>Use monthly background H2O2 value |

| | | | |
|---|---|---|---|
| BCKO3 | Monthly background ozone concentrations (in ppb) | Varies[1] | Specify 12 ozone concentration values, one for each month |
| BCKNH3 | Monthly background ammonia concentrations (in ppb) | Varies[1] | Specify 12 ammonia concentration values, one for each month |
| BCKH2O2 | Monthly background $H_2O_2$ concentrations (in ppb) | Varies[1] | Specify 12 $H_2O_2$ concentration values, one for each month |

[1] A qualified person's judgement should be used and justification should be provided.

[2] Please refer to Table 6.1 of the British Columbia Air Quality Dispersion Modelling Guideline (BC, 2015) for explanation and guidance on these parameters.

# Templates