

**USING
AMBIENT AIR QUALITY OBJECTIVES
IN
INDUSTRIAL DISPERSION MODELLING
AND
INDIVIDUAL INDUSTRIAL SITE
MONITORING**

Revised October 1, 2013

**Using
Ambient Air Quality Objectives
in
Industrial Dispersion Modelling
and
Individual Industrial Site Monitoring**

Alberta Environment and Sustainable Resource Development

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PREFACE

The Alberta Environment and Sustainable Resource Development document entitled *Using Ambient Air Quality Objectives in Industrial Dispersion Modelling and Individual Industrial Site Monitoring* (Guideline) was developed as a guideline document to ensure consistency in the interpretation of the use of Ambient Air Quality Objectives within Alberta's Industrial Air Management System.

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TABLE OF CONTENTS

PREFACE	i
1.0 ISSUE	1
2.0 THE INDUSTRIAL AIR QUALITY MANAGEMENT SYSTEM	2
2.1 System Description	3
2.1.1 Approvals	3
2.1.2 Source Emission Standards.....	3
2.1.3 Ambient Air Quality Objectives	3
2.1.4 Dispersion Modelling.....	4
2.1.5 Monitoring	4
2.1.6 Environmental Reporting.....	5
3.0 IMPLEMENTING NEW OR CHANGED AMBIENT AIR QUALITY OBJECTIVES	6
3.1 Revision to Existing Ambient Air Quality Objectives	6
3.2 New Ambient Air Quality Objectives for Additional Substances	6
4.0 INTERPRETING AND ACTING ON RESULTS OF DISPERSION MODELLING	7
4.1 Hourly averages	7
4.2 Averaging Periods 24 Hours and Greater	7
4.3 Existing Facilities.....	8
4.4 Additional Monitoring Stations	8
5.0 INDIVIDUAL INDUSTRIAL SITE AMBIENT AIR MONITORING	9
5.1 Additional Monitoring	9
5.2 Procedure for Calculation of Concentrations Over Different Averaging Times	9
6.0 REFERENCES	10

1.0 ISSUE

Alberta's Industrial Air Quality Management System has a number of components that work together to maintain acceptable air quality. A number of questions have arisen about the specific interrelationships between Ambient Air Quality Objectives, modelling, and monitoring.

This Guideline is issued by Alberta Environment and Sustainable Resource Development, under Section 14 (4), the *Environmental Protection and Enhancement Act, 1992* (EPEA) and outlines the process for:

- the implementation of new or revised Ambient Air Quality Objectives (AAQO);
- interpreting and acting on modelled concentrations in relation to Ambient Air Quality Objectives;
- setting additional individual industrial site monitoring; and
- specifying a procedure for calculating ambient concentrations over different averaging times.

The guidelines set out in this document are subject to *Environmental Protection and Enhancement Act* approval terms and conditions.

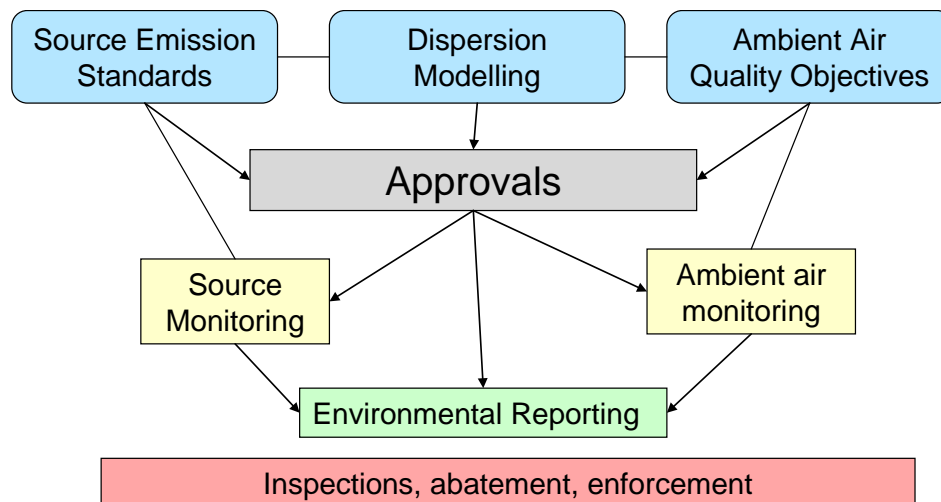
This Guideline is subject to *Environmental Protection and Enhancement Act* approval terms and conditions to the contrary. Where these guidelines do not align with approval requirements, the approval is paramount and the approval holder must comply with the approval requirements.

2.0 THE INDUSTRIAL AIR QUALITY MANAGEMENT SYSTEM

This section provides a general description of Alberta's Industrial Air Quality Management System. Alberta Environment and Sustainable Resource Development has a number of key policies that guide the management of industrial emissions to the atmosphere, as follows:

- industrial facilities must be designed and operated to prevent pollution;
- each industrial source must use technology that allows for a high level of control of emissions as outlined in an applicable source emission standards document or approval;
- residual emissions must be dispersed through a stack designed to keep ambient concentrations below ambient air quality objectives;
- cumulative impacts from multiple sources must be assessed and remain below the assimilative capacity of the airshed as defined by ambient air quality objectives;
- industrial operators are generally responsible for monitoring source emissions and the resulting ambient concentrations around their facilities as specified in their approvals, to demonstrate compliance with emission limits and ambient air quality objectives, and
- industrial operators must report, or cause to be reported in cooperation with others as part of an air quality monitoring zone, the monitoring results to the regulatory agency.

The following diagram illustrates the major components of Alberta's Industrial Air Quality Management System.



The subsequent sections provide a basic description of the components of the management system; however, only the following three aspects are addressed in this document:

- Ambient air quality objectives;
- Dispersion modelling; and
- Individual industrial site ambient air monitoring.

2.1 System Description

2.1.1 Approvals

Regulatory Approvals issued under *EPEA* are the key regulatory implementation tools for the operation of the Industrial Air Quality Management System. They incorporate:

- source emission limits;
- required pollution control equipment/technologies and allowable emission sources;
- operational procedures and parameters required to minimize emissions;
- stack design criteria based on plume dispersion modelling to ensure that air quality remains below ambient air quality objectives; and
- environmental monitoring and reporting requirements, including emission inventory data.

Under *EPEA*, an integrated, single environmental approval is issued to cover all phases of an industrial operation including: construction; operation; and reclamation. Integrated approvals include air quality as only one of many components.

Alberta's *Industrial Release Limits Policy* document outlines how approval limits are to be determined.

2.1.2 Source Emission Standards

Emissions of various substances must be restricted to ensure that the quality of the ambient air is maintained below ambient air quality objectives. This is done through regulations, approvals, or Codes of Practice. Source emission standards can be used to calculate limits, which are specified in approvals issued to individual facilities. Source emission standards are typically set at levels which minimize emissions by specifying:

- numerical emission rate, such as mass per unit production or mass per unit time;
- concentration of a substance in fuel or effluent;
- type of equipment or procedure; or
- prohibited practices.

Alberta may adopt or use agreed upon national or international source emission standards or may set emission standards based on its own review.

2.1.3 Ambient Air Quality Objectives

Ambient air quality objectives provide a basis of determining acceptable air quality and are used in a number of ways:

- Determining adequacy of facility design, considering all sources in the area;

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- Establishing stack heights and release conditions for each source;
 - Assessing facility air quality performance;
 - Guiding special ambient air quality monitoring surveys; and
 - Reporting on the state of the atmospheric environment in Alberta.

The ambient air quality objectives represent choices about what risk to health and ecosystems is acceptable. Various circumstances that are considered include, but are not limited to:

- the need to balance concerns regarding health or environmental effects,
- achievability within a reasonable time frame,
- existing background levels,
- the type of actions that will be triggered, and
- trends and forecasts of future emissions.

The numerical value chosen for a particular ambient air quality objective not only considers health and environmental impacts but most often also reflects social, technological, economic and political factors. They try to balance the need to address public health and environmental concerns against air pollutant levels that can be practically maintained or achieved within a reasonable time period.

The document entitled *Alberta Ambient Air Quality Objectives and Guidelines* provides a complete listing of objectives and guidelines.

2.1.4 Dispersion Modelling

Dispersion models are tools that link residual source emissions (after pollutant minimization) to ambient air concentrations in a given area. Once an emission limit, based on technology capability as outlined in an approval, has been proposed for a particular source, computer models are used to determine the required stack height or source release conditions to disperse residual substances such that the concentrations resulting from all cumulative emissions in the area remain below the Alberta Ambient Air Quality Objectives. Dispersion modelling is also used in the siting of ambient air monitoring stations in the vicinity of industrial facilities, and takes into account the cumulative impact of all other sources emitting similar substances in the area.

Alberta's requirements on how dispersion modelling is to be conducted are outlined in the document entitled *Alberta Air Quality Model Guideline*.

2.1.5 Monitoring

Industries may be required to do ambient air monitoring or source emissions monitoring as part of the conditions in their approvals. The document entitled *Air Monitoring Directive* specifies environmental monitoring and reporting requirements and guidelines for Alberta.

2.1.5.1 Individual Industrial Site Ambient Air Monitoring

Some industries are required to conduct ambient air quality monitoring for specific substances as part of the conditions in their Approvals. Other facilities jointly operate within the context of an air quality monitoring zone, where the goal is to measure and publically report air quality in the area. The number of monitoring stations, frequency and duration of monitoring or sampling, measuring or sampling techniques, and analytical methods, if necessary, are dependent upon the substance to be monitored and its emission rate.

Ambient monitoring can take various forms:

- Continuous monitoring in a station located permanently or for a specified time period at or near the point of predicted maximum ground level concentration, maximum frequency of exposure direction, or for other considerations;
- Passive or active integrated sampling that collects or absorbs gaseous pollutants over a specified time period and sampling schedule; or
- Innovative ambient monitoring programs using techniques such as remote sensing.

2.1.5.2 Source Emission Monitoring

Source emission monitoring may be specified when an Approval is issued to a facility. Requirements vary depending on the substance monitored and the size and nature of the industrial facility. Source emission monitoring serves a number of purposes including;

- ensuring pollution control technologies are operating effectively;
- characterizing complex emissions;
- providing information for provincial and national emission inventories; and
- providing data for tracking trends.

Monitoring can be either in-stack emission monitoring (continuous or intermittently) or fugitive emission monitoring.

2.1.6 Environmental Reporting

Industry is required to submit monitoring reports to Alberta Environment and Sustainable Resource Development and the reporting requirements are specified in their Approval. The reports summarize required monitoring data and provide information on the quality assurance and quality control measures performed to ensure the data is accurate. The reports also outline problems which may have arisen, and what corrective actions were taken.

For certain types of environmental incidents, immediate reporting is required under *EPEA* and the associated *Release Reporting Regulation*. A document entitled *Release Reporting Guideline* has been prepared, which provides additional details on what types of situations require immediate reporting.

3.0 IMPLEMENTING NEW OR CHANGED AMBIENT AIR QUALITY OBJECTIVES

As the ambient air quality objectives are in many cases not entirely protective of human health and the environment, efforts are made to improve air quality in order to stay well below ambient air quality objectives and if the circumstances warrant, to lower the ambient air quality objectives over time.

3.1 Revision to Existing Ambient Air Quality Objectives

- Existing facilities that emit and are required to monitor the substance must report against the revised AAQO within 90 days of the effective date of the objective.
- Whenever new dispersion modelling is required (renewal or amendment of source emission limits), ambient concentrations must be compared against the revised ambient air quality objective following the *Alberta Air Quality Model Guideline* and section 4.0 of this document.
- New or renewal applications submitted after the effective date of the revised AAQO must conduct dispersion modelling using the revised ambient air quality objective.

3.2 New Ambient Air Quality Objectives for Additional Substances

- Existing facilities that emit the specified substance must conduct dispersion modelling for the new AAQO when the approval is up for renewal or is amended.
- When existing facilities do not meet the new AAQO based on this modelling, changes to facility design or operation is expected within two years in order to meet the AAQO. If this is impractical, a management plan must be developed and implemented through the facility's approval (see Section 4.2).
- New facilities that emit the substance must conduct and submit dispersion modelling as a part of their application.
- New or renewal applications submitted after the effective date of the new AAQO must conduct dispersion modelling using the new AAQO.

Regardless of the modelling conducted, ambient air monitoring must not show exceedances of a new or revised ambient air quality objective.

4.0 INTERPRETING AND ACTING ON RESULTS OF DISPERSION MODELLING

This section is intended to be applied after modelling protocols have been completed as outlined in the document entitled *Air Quality Model Guideline, Section 2.0*.

4.1 Hourly averages

As stated in the *Alberta Air Quality Model Guideline, Section 4.1* “the highest eight 1-hour predicted average concentrations for each receptor in each single year should be disregarded”.

If the ninth highest hourly model prediction (including all sources in the area) exceeds the AAQO, the applicant **must**:

- Step 1** Review the design of the facility, including the pollution control equipment, to make the necessary changes or improvements to meet the AAQO.
- Step 2** If unsuccessful in meeting the AAQO **after** improvements to the facility, a management plan must be developed and implemented through the facility’s approval that will reduce the likelihood of exceeding the AAQO.
- Step 3** In exceptional circumstances, redesign may be conditional on the results of additional ambient air monitoring to determine whether predicted exceedances do in fact occur. A redesign of the facility may not be required if **all** the following criteria are met:
 - a) Modelled emission scenarios are **realistic** worst cases;
 - b) The facility stack design and pollution control equipment (as outlined in an applicable source emission standards document) is acceptable in the opinion of the regulatory agency for this industry or facility;
 - c) The modelled exceedance takes place under upset conditions or during down time of pollution control technology;
 - d) The frequency of modelled exceedance is less than 1%; and
 - e) The 9th highest modelled concentration is < 1.5 times the AAQO.

4.2 Averaging Periods 24 Hours and Greater

For averaging periods of 24 hours or greater, no modelled exceedances of the ambient air quality objective are acceptable. If the model prediction exceeds the AAQOs, the applicant must review the design of the facility (including pollution control equipment) or develop a management plan implemented through a facility’s approval that will ensure that an actual exceedance does not take place.

4.3 Existing Facilities

The applicant may use historical ambient air quality monitoring (at least three full years) to demonstrate that the model over predicted the ambient concentration. Compliance with the AAQO must be demonstrated using relevant quality assured monitoring data.

4.4 Additional Monitoring Stations

When additional ambient monitoring is required to address case specific circumstances, the additional monitoring stations should remain on site for at least 3 to 5 years (see section 5.0).

The number of stations required is a function of the maximum predicted ambient ground level concentration and the frequency of the predicted exceedance. The following table gives the **minimum** number of additional monitoring stations that are required based on the ratio of the maximum predicted concentration to the AAQO and the frequency of modelled exceedance. Alberta Environment and Sustainable Resource Development may require more stations, based on case specific circumstances. Continuous monitoring will be required to demonstrate compliance with an hourly or daily ambient air quality objective; integrated and/or passive monitoring may be used to confirm compliance with an AAQO with an averaging period of one month or more.

Frequency of exceedance (%)	Ratio (maximum predicted/AAQO)	
	1 to 1.2	1.21 to 1.5
0.01 to 0.5	1	2
0.501 to 1	2	3

The shaded area in the table indicates the **minimum** number of monitoring stations required for the corresponding ratio and frequency.

The monitoring stations are used to provide assurance that the AAQOs are not exceeded.

The purpose of monitoring stations is not to calibrate the Air Quality Dispersion Models or to test their validity.

5.0 INDIVIDUAL INDUSTRIAL SITE AMBIENT AIR MONITORING

5.1 Additional Monitoring

Some facilities may be required to perform additional monitoring in their approvals as a result of, but not limited to, the following:

- specific issues raised in statements of concern;
- the environmental impact assessment process or approval process, which may highlight sensitive receptors whose exposure needs to be monitored;
- the environmental performance history of an existing facility (for example, frequent upsets or ambient exceedances); or
- an inability to make design changes to eliminate modelled exceedances.

If, at the end of the required monitoring period, the data from additional monitoring stations does not show any exceedances of ambient air quality objectives, then the additional monitoring may be discontinued. However, if any of the other specific concerns remain, the additional monitoring must continue.

5.2 Procedure for Calculation of Concentrations Over Different Averaging Times

In some situations, monitoring techniques generate data on different averaging times than the ambient air quality objective. In this case, an estimate of the **maximum concentration for the averaging time of the existing ambient air quality objective** can be derived from the **maximum concentration of the monitoring data** using the power law:

$$C_{m,2} = C_{m,1} (t_2 / t_1)^b \quad (1)$$

Where:

- $C_{m,1}$ is the peak concentration, averaged over time t_1 ($t_1 = 1$ hr),
- $C_{m,2}$ is the peak concentration averaged over time t_2 ($t_2 = 24$ hr) and
- -0.5 is the value of the exponent b .

Note: This procedure can only be used for conversions between hourly and 24-hour averages.

This square root relationship is supported by a survey of theoretical and empirical studies in the literature and an analysis of Alberta data (Wong *et al.*, in preparation).

6.0 REFERENCES

Alberta Environment, 1989. *Air Monitoring Directive*

Alberta Environment. 2000. *Industrial Release Limits Policy*

Alberta Environment, 2005. *Release Reporting Guideline*

Alberta Environment, 2006. *2006 Amendments to Air Monitoring Directive, 1989*

Alberta Environment, 2009. *Air Quality Model Guideline*

Alberta Environment. *Alberta Ambient Air Quality Objectives and Guidelines*, as periodically updated

Alberta Environment, *Release Reporting Regulation*

Wong, R., Angle, R. and Kuhn, R. *Averaging time relations for estimation of air quality standards*. AENV technical report. In preparation.

