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GUIDELINES FOR AIR DISPERSION MODELLING IN MANITOBA

By Air Quality Section
Programs Division
November 2006

Report No. 2006-0x

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FORWARD

This document reflects the expectations of Manitoba Conservation for the preparation and submission of air dispersion modelling projects. The information requirements described in this document may change as the technology, methodologies or policies related to air dispersion modelling evolve. It is also understood that portions of this document may not apply to every air dispersion modelling situation.

Proponents are encouraged to discuss any questions that they may have with Manitoba Conservation during the initial stages of the project. Proponents are also encouraged to submit an air dispersion modelling proposal for review by Manitoba Conservation prior to undertaking the modelling. Without the pre-approval of the proposal, there is a risk that the air dispersion modelling may not be considered adequate.

Readers and users of this document are advised that it has been prepared solely for the convenience of readers and users, and as such it has no legal or other official sanction. Site-specific factors must always be investigated and taken into consideration. Manitoba Conservation, its Directors and other employees take no responsibility for any loss, damage or injury that may result from the use of the methods described herein. This document does not replace any Act or Regulation, and readers and users are reminded to always consult the appropriate legislation for the purposes of interpreting and applying the law.

For further information on *Guidelines for Air Dispersion Modelling in Manitoba*, contact Manitoba Conservation at (204) 945-7100.

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GUIDELINES FOR AIR DISPERSION MODELLING IN MANITOBA

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I. INTRODUCTION

There is an increased awareness and concern by regulatory agencies, industry and the general public regarding air emissions associated with different types of developments. To adequately assess the potential impacts of these emissions in an acceptable and cost effective manner, computer models have been developed which estimate the resulting environmental concentrations based on source air emissions, meteorological data, and other information.

These guidelines were developed to give direction to proponents who have been requested to undertake air dispersion modelling. Air dispersion modelling may be requested as part of the assessment process under the Manitoba *Environment Act* or *Dangerous Goods Handling and Transportation Act*. The intent of these guidelines is to provide a level playing field for developments and to allow an expeditious and consistent evaluation by Manitoba Conservation of all air dispersion modelling that is undertaken.

The following guidelines should be followed wherever possible. Any questions or concerns regarding a specific modelling project should be directed to Manitoba Conservation. It is recognized that there may be unique features or special circumstances associated with specific projects. In all cases, the air dispersion model chosen should be appropriate for the situation, including consideration of the operating and emission characteristics of the development.

II. AIR DISPERSION MODEL SELECTION

1. Background

There are many models currently available, both from regulatory agencies and from the private sector for the air dispersion modelling of various contaminants. These models can deal with varying degrees of complexity of sources, events, operating conditions and terrain.

Special modelling may be necessary on a case by case basis. For example, the release of water plumes from facilities using cooling towers may be of concern if the cooling towers are located near a major roadway. As well, the models and guidelines presented in this document do not apply to emergency conditions such as sudden gas releases, dense gas releases, or other unique situations.

For most situations, the latest versions of the following US EPA models are recommended by Manitoba Conservation:

- Screening Models[1]
  - Screen3
- Refined Models
  - AERMod Modelling System

[1] AERScreen, a screening level model based on the more refined AERMod dispersion modelling system, is currently under development by the U.S. EPA. A Beta version is scheduled to be released in 2006.

- Industrial Source Complex (ISC3)
- Industrial Source Complex-Prime (ISC-Prime)
- CalPuff Modelling System

Other models will be considered at the proponent's request. Any valid model which can reasonably estimate the pollutant concentration given the specific modelling parameters or limitations may be accepted.

Some factors to be considered by the proponent in the selection of a model for a specific situation are:

- type of source (*e.g.*, point, area, line, volume, fugitive, *etc.*)
- appropriate averaging times for the pollutants being released (*e.g.*, 1-hour, monthly, annual, *etc.*)
- terrain features (*e.g.*, simple, complex, valley effects, *etc.*)
- land use in the vicinity (*e.g.*, urban, rural, *etc.*)
- need for screening or refined assessment

The air dispersion model, including version and issue date, should be identified along with the rationale for the choice of model. Any limitations regarding the appropriateness of the proposed model should be discussed.

2. Screening Model Assessment

Screening-level air dispersion modelling is undertaken using either simplified models and/or more advanced models with reduced meteorological input data. This modelling tends to be the simplest to undertake and provides conservative, worst-case estimates of environmental air pollutant concentrations resulting from a facility in a cost-effective manner. For sources that are sufficiently complex with multiple buildings of varying heights, different types of releases (*e.g.*, stack and fugitive), and numerous release points, then a screening assessment should not be undertaken; instead, the proponent should undertake a more refined air dispersion modelling project.

Screening modelling is generally used to:

- estimate the worst case pollutant concentrations
- identify the approximate area of impact
- identify the need for further, more refined air dispersion modelling

For a screening model assessment, the plant operating conditions and resulting emissions that will lead to the maximum pollutant concentrations in the environment are to be incorporated. The effect of facility start-up, shutdown or upset conditions on the air pollutant emission rates are also to be assessed.

Screening model output must include:

- predicted maximum concentrations due to the facility
- location of these maximum concentrations
- greatest distance from the source where significant impacts might occur
- stack parameters (*e.g.*, height, diameter, exit velocity, stack temperature, pollutant emission rates, *etc.*) for all load, operating and fuel conditions

If screening modelling indicates that significant impacts are not likely to occur based on the maximum estimated concentrations[2], then more refined air dispersion modelling will normally not be required. If the results of this conservative modelling, however, show potentially elevated environmental concentrations, then more refined and detailed air dispersion modelling would need to be undertaken.

3. Refined Model Assessment

Refined air dispersion modelling should be undertaken if the facility is sufficiently complex or if the screening model assessment indicates potential concerns with the projected environmental concentrations of the air pollutants. The proponent should consult with Manitoba Conservation before undertaking a more refined modelling program to ensure that all appropriate variables are considered.

For a refined air dispersion modelling assessment, the following factors should be taken into consideration:

- normal plant operating conditions and the resulting emissions, including any variation in the emissions on a daily, weekly, monthly or longer cycle
- peak plant operating conditions and the resulting emissions
- facility start-up, shutdown or upset conditions and the resulting emissions during these time periods

All model options incorporated in the modelling, such as plume rise, buoyancy induced dispersion, vertical potential temperature gradients, treatment of calms, wind profile exponents and enhanced dispersion coefficients, must be documented. An explanation must be provided if the regulatory default mode was **not** implemented.

III. PROJECT DESCRIPTION

1. Project Overview

The description of the air dispersion modelling project should clearly state the goals of the project. The rationale for the approach, model selection, *etc.* should be sufficiently detailed.

[2] As identified using the methods in **Section VI Analysis of Results.**

2. Facility Description

The proponent is to provide a physical description of the facility, including the following minimum information requirements:

- name of facility and its address
- type of facility (*e.g.,* incinerator, power plant, *etc.*)
- map with an appropriate scale showing the location of the facility, significant receptors of interest, and topographic features within a 5 km radius

A site plan for the facility is to be submitted which identifies:

- all property lines
- all fences or other physical barriers
- the location and orientation of the buildings
- all building dimensions (length, width, height) such that good engineering practice (GEP) stack heights may be determined
- a scale, identification key and an indication of true North
- location of all emission sources whether point, line, area or volume

The locations of the source(s) and receptors are to be presented in a table format with coordinates (UTM (Universe Transverse Mercator) or other suitable coordinate system) such that all locations are clearly identified and able to be referenced.

3. Process Description

In order to be able to model the air emissions from the facility, an understanding of the production processes occurring at the facility, including material handling, is needed. These processes will determine which air pollutants are released, how they are released, and in what quantities. As a minimum, the proponent is to provide information relating to the following:

- any facility process(es) including processing equipment, input materials, products, and any by-products which have the potential to release air pollutants; all sources of air emissions, whether they are directly emitted through stacks or vents or indirectly released as fugitive emissions
- material quantities processed at the facility (*e.g.,* raw material inputs, products, *etc.*)
- any material handling at the facility and potential release points for air emissions (*e.g.,* front end loaders, conveyors, transfers of product to truck or rail cars, *etc.*)
- any pollutants emitted (*e.g.,* composition, emission rates, release points, *etc.*)
- for any combustion sources such as boilers or heaters at the facility, the type and quantity of fuel used

- any proposed or existing air pollution control equipment specifying the type of equipment and design efficiency (Note: for existing air pollution equipment, provide the year of installation and any recent source testing information including efficiency tests)

Any other process information that is relevant for the modelling of air releases from the facility should also be provided.

IV. AIR DISPERSION MODEL INPUTS

The specific inputs needed will depend on the air dispersion model being used. The user's manual for the specific model should be consulted if there are any questions regarding the input data requirements.

1. Source Data

The emissions from each source for each pollutant must be stated as annual emissions in tonnes/year and average and maximum hourly emissions in grams/hour. The preferred source of emission rate data is site-specific source sampling. Where measured emissions rates are not available, emissions may be estimated using emission rate factors. The source of these factors must be referenced, and the supporting quality and quality of data on which they have been based must be discussed.

Other point source stack parameters include:

- stack height
- stack exit diameter
- exit gas velocity
- exit gas flow rate
- exit gas temperature

All normal operating conditions of equipment and processes must be considered and represented in the modelling. The emissions and parameters should and will be considered to reflect operating conditions at 100% load. Any variability in operating conditions on a daily, weekly or longer cycle must be noted and incorporated in the modelling.

As a minimum, operating conditions of 100% design load and as well as those that will generate the maximum concentration impact must be modelled. For point sources, the load or operating conditions that generate the maximum ground level concentration must be identified. These peak concentrations may arise, for example, if the design load is exceeded. Another potential case is that operating levels are less than design load but adjustments made to the stack discharge parameters result in excessive ground level concentrations for significant time periods.

2. Receptors

2.1 Screening Assessment

For a screening model assessment, the following receptors should be taken into consideration:

- a maximum receptor grid spacing of 100 metres in areas of maximum concentrations
- discrete receptors located at the property boundaries and other receptor identified in the surrounding area

2.2 Refined Assessment

Similarly, for refined air dispersion modelling, both a receptor grid and specific discrete receptors need to be incorporated in the modelling. The receptor grid must cover all areas where emissions may have a significant impact. A coarse and a fine grid approach may be implemented. The coarse grids should have an appropriate spacing for the size of the impacted area to ensure that the locations of maximum impacts are identified. As a minimum, the receptor grid should cover a distance of 5 kilometres from the source.

The grid can be defined using polar and/or Cartesian coordinates. When using a polar grid, the first 10 kilometres should be divided into 10 equally spaced concentric circles with 36 radii at 10° intervals for a total of 360 receptors. Larger areas will require additional receptors. Fine grids containing 50 to 100 receptors should be located around the locations of highest impact with a 50 to 100 metre grid spacing.

Discrete receptors should be located at the plant boundaries, at the highest terrain elevation in the area or the nearest terrain above stack top, at any ambient air monitoring stations in the area, and in sensitive areas such as schools, hospitals, seniors homes, parks, *etc.* Any elevated structures such as apartment balconies, building rooftop air intakes, should be identified as flag pole receptors and be modelled as several equally spaced receptors with heights varying from ground level to roof top.

3. Meteorological Data

3.1 Screening Assessment

When screening air dispersion modelling is performed, the worst case meteorological conditions must be used to estimate short-term conditions.

For short term modelling, the meteorological conditions listed in Table 1 are the default in the US EPA Screen3 model. These meteorological conditions should also be considered if more complex models such as ISC or AerMod are used in a screening mode.

TABLE 1. Meteorological Conditions For Short Term Screening Model Assessment[3]

Atmospheric Stability Class		Wind Speed (m/s)
A	Unstable	1.0, 1.5, 2.0, 2.5, 3.0
B	Unstable	1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0
C	Neutral	1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 8, 10
D	Neutral	1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 8, 10, 15, 20
E	Stable	1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0
F	Stable	1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0

Upon consultation, short-term 1- hour pollutant concentrations from screening modelling may be converted to 3-hour, 8-hour, 24-hour and annual average concentrations by applying factors of 0.9, 0.7, 0.4 and 0.08, respectively.[4]

3.2 Refined Assessment

For more complex modelling, the five most recent, consecutive years of meteorological data with five concurrent years of mixing height data, including hourly observations of wind direction and speed, temperature, cloud cover, and ceiling height is required. These meteorological data should be from the nearest representative weather station. If possible, the surface temperature data should be from the same station as the mixing height data.

If a minimum of one year of site specific[5] hourly data that has undergone QA/QC[6] is available, the five year requirement may be waived. Any meteorological data gaps should be identified as well as how they were dealt with.

The quality and quantity of the meteorological data input will, in part, determine the level of confidence given to the modelling results. A discussion of the meteorological data to be used and the appropriateness of these data to the specific site needs to be included in the report. As well, if relevant to the specific modelling project, a discussion of the effect of the following factors on the modelling situation should be provided: fumigation, wind direction shear, lee side affects, building wake or terrain induced downwash, deposition,

[3] United States Environmental Protection Agency, "Screen3 Model User's Guide", Office of Air Quality Planning and Standards, EPA-454/B-95-004, September 1995.
[4] United States Environmental Protection Agency, "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised", Office of Air and Radiation, Office of Air Quality Planning and Standards, EPA-454/R-92-019, October 1992
[5] The specific details of what constitutes acceptable site-specific meteorological station can be determined through consultation with Manitoba Conservation.
[6] QA/QC: quality assurance/quality control

chemical transformation of pollutant, variable plume trajectories and long range transport.

4. Land Use Analysis

The land use in the surrounding area must be assessed and be designated as either rural or urban so that the appropriate dispersion coefficients may be incorporated in the model. The following methodology shall be applied in this assessment:

- an area within a 3 km radius of the source shall be described using the Auer land use classification method (see Appendix A)
- if land use types I1, I2, C1, R2 and R3 account for greater than 50% of the area, the urban dispersion coefficients shall be applied; otherwise, the rural dispersion coefficients shall apply
- in cases where the urban/rural determination is ambiguous, consult with the Department for clarification.

5. Topography

The topography in the region of the source shall be identified as simple or complex based on the elevation being above or below stack top. The following items shall be addressed:

- identification of any terrain above the top of the stack within 50 km of the source
- description of the general terrain features within a 3 km radius of the facility
- identification of any predominant features (*e.g.*, high-rises, valleys, lakes, *etc.*) in the vicinity of the facility
- identification of the closest provincial or international boundary and the distance and direction to the boundary
- identification of any large water bodies within 20 km of the facility

6. Background Ambient Air Quality

If a source has a potentially significant impact, background ambient air quality also needs to be considered and included in the air dispersion modelling results. These background concentrations must be considered in the assessment of both screening and refined modelling. The background air concentrations of pollutants in the study may be due to either natural or other man-made sources in the area.

The ambient air quality data should be representative of the area under review and it should be from air monitoring stations located in the area. Any available data should be collected and analyzed and be shown to meet the quality assurance criteria of representativeness, completeness, precision and accuracy.

If it is determined that impacts from another source might be significant, then the assessment must consider these sources within the area of impact for their contribution to

the existing background concentrations. Modelling may be applied to determine their contribution.

If ambient air quality data from a local air monitoring station are not available, then data from a station located in a similar area (*e.g.*, rural or urban) can be considered. This option, however, must first be discussed with Manitoba Conservation to determine whether the surrogate station is reasonably representative of the study area.

For larger facilities, Manitoba Conservation may require the proponent to perform on-site ambient air quality monitoring if there is a potential for significant impacts and no representative data exist. A minimum of one year of collected air quality data of representative air pollutants is required. These data may, in certain circumstances, be gathered during the construction stage of a development but prior to its operation.

7. Good Engineering Practice (GEP) Stack Height Analysis

A stack designed to GEP standards offers an allowable dispersion of contaminants such that properly controlled emissions will result in a minimum and acceptable ground level concentration. The establishment of the GEP stack height prevents the practice of unacceptable air dispersion practices. GEP shall be calculated as follows:

$$\mathbf{GEP = H_b + 1.5\,L}$$

where:

GEP	=	formula GEP stack height measured from the ground level elevation at the base of the stack
H_b	=	height of adjacent or nearby building measured from the ground level elevation at the base of the stack
L	=	lesser of the height or maximum projected width of adjacent or nearby building

In calculating H_b, "nearby" is considered to be within 5L of the stack from the downwind edge but is not to exceed 0.8 km.

The site plan discussed in Section III.2 should provide sufficient detail to enable a determination of GEP as well as the potential for building wake downwash. The following information must be provided:

- the height above grade for each structure
- for all buildings within 0.8 km of the stack which have the potential to create emission downwash:
  - building height
  - maximum projected building width[7]
  - distance from stack
  - distance which represents 5L from stack

[7] May be the diagonal distance.

- calculated GEP stack height

V. ASSESSMENT OF AIR QUALITY MODELLING RESULTS

1. Environmental Assessment

The environmental assessment process will consider information provided by properly conducted air dispersion modelling. To be included in the discussion of the air dispersion modelling results are:

- the location and magnitude of predicted concentrations for each pollutant for each averaging period of concern where the predicted concentrations include the existing background concentrations (the data for specific receptors should be provided in a table format while that for the receptor grid should be provided as isopleths (See Section III.6 for a discussion of the receptors))
- a comparison of the predicted concentrations to available Manitoba air quality criteria[8] for each pollutant and each relevant averaging period (Note: if Manitoba air quality criteria are not available, then air quality criteria from other jurisdictions[9] are to be included)
- if screening air dispersion modelling had been conducted and none of the air pollutants exceeded the relevant criteria, then no further air dispersion modelling assessment will usually be required; if any criteria had been exceeded, then Manitoba Conservation may require that refined air dispersion modelling be undertaken but this should be discussed further with Manitoba Conservation
- if refined air dispersion modelling had been conducted and exceedances of air quality criteria are predicted for one or more of the pollutants, then the exceedances should be discussed further (*e.g.*, did the background levels exceed criteria?, how frequent were the exceedences?, what was the distribution of the predicted concentrations?, *etc.*)

2. Health Risk Assessment

A health risk assessment may be requested based on the air pollutants being emitted and the modelling results. This assessment will likely be requested for any air pollutants that are carcinogens or have other chronic long-term health effects. If requested, the methodology and level of detail shall be determined on a case specific basis.

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[8] Manitoba Air Quality Criteria: www.gov.mb.ca/conservation/airquality/aq-criteria/ambientair_e.html

[9] Canadian Council of Ministers of the Environment: www.ccme.ca/publications/ceqg_rcqe.html
Ontario Ministry of the Environment: www.ene.gov.on.ca/envision/gp/index.htm#PartAir
California Air Resources Board Table of Approved Risk Assessment Health Values: www.arb.ca.gov/toxics/healthval/healthval.htm
United States Environmental Protection Agency Integrated Risk Information System (IRIS): www.epa.gov/iris

3. Documentation

The air dispersion modelling report should include the information discussed in Sections II, III and IV, as well as the results of the air dispersion modelling and any health risk assessment. The report should contain a discussion of the input data, and a description of the modelling methodology and modelling results in sufficient detail to allow Manitoba Conservation to verify the results. Any maps, diagrams and tables relevant to the discussion should be included. Attention should be paid to documentation of GEP and urban/rural land use analysis and to the identification of significant terrain and sensitive receptors.

In those cases where exceedences are predicted, a discussion of the options for attaining compliance with licensing requirements shall also be included.

APPENDIX A. IDENTIFICATION AND CLASSIFICATION OF LAND USE

Using the land use typing scheme established by Auer[10], classify the land use within the total area circumscribed by a 3 km radius circle about the source. This land use approach considers four primary land use types: industrial (I), commercial (C), residential (R), and agricultural (A) and the goal is to estimate the percentage of the area that is urban type and the percentage that is rural type. Industrial and commercial areas are classified as urban; agricultural areas are classified as rural.

If the land use types heavy industrial (I1), light-moderate industrial (I2), commercial (C1), single-family compact residential (R2) and multifamily compact residential (R3) account for 50 percent or more of the total area, use urban dispersion coefficients in the air dispersion modeling; otherwise, use rural dispersion coefficients.[11] (See Table A-1)

Table A-1. Identification and Classification of Land Use Types

Type	Use	Typical Structures	Vegetation
I1	Heavy industrial	Major chemical, steel and fabrication industrials; generally 3-5 story buildings with flat roofs	Grass and tree growth extremely rare; <5% vegetation
I2	Light-moderate industrial	Railyards, truck depots, warehouses, industrial parks, minor fabrications; generally 1-3 story buildings, flat roofs	Very limited grass, trees almost totally absent; <5% vegetation
C1	Commercial	Office and apartment buildings, hotels; >10 story heights, flat roofs	Limited grass and trees; <15% vegetation
R1	Common residential	Single-family dwellings with normal easements; generally one story, pitched roof structures; frequent driveways	Abundant grass lawns and lightly to moderately wooded; >70% vegetation
R2	Compact residential	Single, some multiple, family dwellings with close spacing; generally <2 story, pitched roof structures; garages, no driveways	Limited lawn sizes and shade trees; <30% vegetation
R3	Compact residential	Old multi-family dwellings with close (<2 m) lateral separation; generally 2 story,	Limited lawn sizes, old established shade trees; <35% vegetation

[10] Auer, August H. Jr., "Correlation of Land Use and Cover with Meteorological Anomalies," Journal of Applied Meteorology, pp. 636-643, 1978.

[11] United States Environmental Protection Agency, "Guideline on Air Quality Models (Revised), EPA-450/2-78/027R, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, July, 1986.

Type	Use	Typical Structures	Vegetation
		flat roof structures; garages (via alley) and ash pits, no driveways	
R4	Estate residential	Expensive family dwellings on multi-acre tracts	Abundant grass lawns and lightly wooded; >80% vegetation
A1	Metropolitan natural	Major municipal, state, or federal parks, golf courses, cemeteries, campuses; occasional single story structures	Nearly total grass and lightly wooded; >95% vegetation
A2	Agricultural rural		Local crops (e.g., corn, soybeans); 95% vegetation
A3	Undeveloped	Uncultivated, wasteland	Mostly wild grasses and weeds, lightly wooded; >90% vegetation
A4	Undeveloped rural		Heavily wooded; 95% vegetation
A5	Water surface	Rivers, lakes	

APPENDIX B. INFORMATION RESOURCES

1. Air Dispersion Models

United States Environmental Protection Agency Support Center for Regulatory Atmospheric Modeling (SCRAM). http://www.epa.gov/ttn/scram/

United States Environmental Protection Agency, "Guideline on Air Quality Models (Revised)", EPA-450/2-78/027R, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, December, 2005. http://www.epa.gov/scram001/guidance/guide/appw_05.pdf

United States Environmental Protection Agency, "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised", Office of Air and Radiation, Office of Air Quality Planning and Standards, EPA-454/R-92-019, October 1992. http://www.epa.gov/scram001/guidance/guide/scrng.wpd

United States Environmental Protection Agency, "Screen3 Model User's Guide", Office of Air Quality Planning and Standards, EPA-454/B-95-004, September 1995. http://www.epa.gov/scram001/userg/screen/screen3d.pdf

2. Air Pollutant Emission Factors

Environment Canada National Pollutant Release Inventory (NPRI) Toolbox. http://www.ec.gc.ca/pdb/npri/documents/2004ToolBox/toolBox_e.cfm

United States Environmental Protection Agency Factor Information Retrieval (FIRE) Data System. http://www.epa.gov/ttn/chief/software/fire/index.html.

United States Environmental Protection Agency Factor Technology Transfer Network (TTN) Clearinghouse for Inventories and Emission Factors (CHIEF). http://www.epa.gov/ttn/chief/

United States Environmental Protection Agency Factor Technology Transfer *Compilation of Air Pollutant Emission Factors Vol. 1: Stationary Point and Area Sources*, U.S. EPA, AP-42, 5th Edition (1996), and AP-42 Supplements A, B, C, D, E, and F (1996, 1997, 1998, 1999, and 2000). http://www.epa.gov/ttn/chief/ap42/index.html

United States Environmental Protection Agency Guidance Documents for Reporting to the Toxics Release Inventory. http://www.epa.gov/tri/guide_docs/index.htm

3. Air Quality Criteria

Manitoba Conservation: www.gov.mb.ca/conservation/airquality/aq-criteria/ambientair_e.html

Ontario Ministry of the Environment:
http://www.ene.gov.on.ca/envision/gp/2424e04.pdf (sorted alphabetically);
http://www.ene.gov.on.ca/envision/gp/2424e05.pdf (sorted by CAS number)

Canadian Council of Ministers of the Environment:
www.ccme.ca/publications/ceqg_rcqe.html

United States Environmental Protection Agency Integrated Risk Information System (IRIS): www.epa.gov/iris

California Air Resources Board Table of Approved Risk Assessment Health Values: www.arb.ca/gov/toxics/healthval/contable.pdf

4. Air Dispersion Modelling Guidelines In Other Jurisdictions

British Columbia:

"Guidelines For Air Quality Dispersion Modelling in British Columbia (Draft)". British Columbia Ministry of Environment, Environmental Protection Division, Water Air and Climate Change Branch, Air Protection Section, July 2005. http://www.env.gov.bc.ca/air/airquality/pdfs/airdispmodelguide_july%2005.pdf

"A Primer on the Guidelines for Air Quality Dispersion Modelling in British Columbia". British Columbia Ministry of Environment, Environmental Protection Division, Water, Air and Climate Change Branch, Air Protection Section, October, 2005. http://www.env.gov.bc.ca/air/airquality/pdfs/aq_dis_mod_primer.pdf

Alberta:

"Air Quality Model Guideline". Alberta Environment, Science and Standards Branch, Revised March 2003. http://www3.gov.ab.ca/env/air/pubs/AirQualityModelGuideline_Final.pdf

Ontario:

"Air Dispersion Modelling Guideline for Ontario, Version 1.0 - Guidance for Demonstrating Compliance with the Air Dispersion Modelling Requirements set out in Ontario Regulation 419/05 Air Pollution – Local Air Quality made under the *Environmental Protection Act*", PIBS # 5165e".

Ontario Ministry of the Environment, Environmental Modelling and Data Analysis Section, Environmental Monitoring and Reporting Branch, July 2005.http://www.ene.gov.on.ca/envision/gp/5165e.pdf

5. Other

United States Environmental Protection Agency, "Meteorological Monitoring Guidance for Regulatory Modeling Applications", EPA-454/R-99-005, Office of Air and Radiation, Office of Air Quality Planning and Standards, February 2000. http://www.epa.gov/scram001/guidance/met/mmgrma.pdf

United States Environmental Protection Agency, "Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) (Revised)", EPA-450/4-80-023R, Office of Air Quality Planning and Standards, June 1985. http://www.epa.gov/scram001/guidance/guide/gep.pdf