North Dakota Department of Health, Division of Air Quality
Air Quality Dispersion Modeling Analysis Guide
June 21, 2013

The following Air Quality Modeling Analysis Guide is provided by the North Dakota Department of Health (Department) to aid air permit applicants in the process of developing an air dispersion modeling protocol and in conducting an air dispersion modeling analysis. This general Guide outlines common topics that should be addressed in a dispersion modeling analysis and report for projects located in North Dakota. As each project is unique, the Guide should not be considered "all inclusive" and some important items for a given project may not be reflected in the itemized list below. The Department should be consulted at an early stage in the project to assure that essential items are addressed in any final modeling analysis.

The Department strongly encourages the development of a pre-application dispersion modeling protocol in consultation with the Department in order to expedite the ultimate project review process. This Guide will aid in the development of that protocol.

A list of applicable State issued modeling guidance documents covering specific issues is included at the end of this Guide. Note that these documents include criteria to determine whether modeling will be required for a permit-related project. Also included is guidance related to air toxics analyses. Please contact the Department with any project-specific questions or concerns by calling 701.328.5188.

To the extent applicable, the information in this Guide is consistent with the EPA Guideline on Air Quality Models[1]. The Department Guide is intended to clarify EPA Guidance for applicability to North Dakota regulatory projects, and to supplement EPA guidance on issues where guidance is not specifically provided. This Guide assumes basic familiarity with regulatory air quality modeling applications on the part of the reader.

It is expected that the information contained in this Guide will be updated frequently, so the Department's Web site[2] should be actively monitored for the most recent version. At this time, the Guide applies primarily to local scale modeling analyses for NAAQS, PSD Class II increments, and air toxics thresholds. Future updates to this Guide or supplemental documents will include modeling guidance for Class I PSD increments and air quality related values (AQRVs). If you anticipate that your project will need to address one of these two conditions or any other item not specifically covered by the Guide at this time, please consult with the Department directly for further information and guidance.

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[1] CFR, 2005. EPA Guideline on Air Quality Models. 40 CFR (Code of Federal Regulations) Part 51, Appendix W.

[2] http://www.ndhealth.gov/AQ/DispersionModeling.htm

I. Modeling for NAAQS, NDAAQS, PSD Class II increments, Air Toxics thresholds

A. Screening Analyses (optional for isolated single source)

1. Model selection:

☐ AERSCREEN – applicable if significant terrain height variations involved. Because of the relative complexity (for a screening tool) involved in executing and reviewing AERCREEN analyses, the NDDH discourages the use and submittal of AERSCREEN screening techniques for projects in North Dakota. Direct application of refined modeling using AERMOD is recommended if significant terrain height variations are associated with an isolated single source.

☐ SCREEN3 – applicable only in relatively level terrain.

2. Model input/execution:

☐ AERSCREEN – Refer to AERSCREEN User's Guide for information on input data and execution for AERMOD. As noted above, the NDDH discourages the use of AERSCREEN for projects in North Dakota.

☐ SCREEN3 - Command line program which prompts user for all necessary input data (EPA version).

B. Refined Analyses (SIL and cumulative)

1. Model selection:

☐ AERMOD (provide version number)

2. Emission inventory:

☐ Subject source

- ☐ Point source fixed stack characteristics for each emission unit:
  - ○ Location (e.g., UTM coordinates)
  - ○ Stack height
  - ○ Stack base elevation (above MSL)

- Stack exit diameter
- Stack orientation (e.g., vertical up, vertical down, horizontal, rain caps, etc.)

☐ Point source variable stack characteristics for each emission unit. Ensure that worst case emission scenarios are accounted for (i.e., consider multiple operating loads, start-up, shut-down) For combustion turbines, where emissions are particularly sensitive to ambient temperature, emission scenarios should also account for a range of ambient temperatures.

- Emission rate for each applicable pollutant species
- Stack exit velocity
- Stack exit temperature

☐ Appropriate adjustment of stack exit velocity based on stack orientation (See AERMOD Implementation Guide[3])

☐ Appropriate determination of point source stack characteristics for flares (See Flare Guidance). Stack characteristics which are adjusted for flares include stack height, stack diameter, exit velocity, and exit temperature.

☐ Area source characteristics for each emission unit (if any):

- Emission rate for each applicable pollutant species
- Boundary of area
- Effective height of area emissions

☐ Volume source characteristics for each emission unit (if any):

- Emission rate for each applicable pollutant species
- Effective dimensions
- Height of center of volume source
- The NDDH does not require inclusion of paved road fugitive emissions in modeling analyses.

☐ Building downwash characteristics for each affected (less than GEP height) point-source stack, developed using the EPA BPIPPRM program (include a plant layout drawing):

- Building height for 36 wind directions
- Effective building width for 36 wind directions
- Building length for 36 wind directions
- X offset for 36 wind directions (XBADJ)
- Y offset for 36 wind directions (YBADJ)

[3] EPA, 2009. AERMOD Implementation Guide: March 19, 2009. Accessed at: http://www.epa.gov/scram001/7thconf/aermod/aermod_implmtn_guide_19March2009.pdf. June 20, 2013

☐ Off-site (nearby) sources (not applicable for SILs or Air Toxics analyses). For PSD projects, the impact of emissions from all sources located within 50 km of the subject source should generally be included in the modeling analysis. For non-PSD projects, the impact of emissions from all sources located within 20 km of the subject source should generally be included in the modeling analysis. Impact from sources not explicitly modeled will be accounted for with the background concentration(s).

- ☐ Point source stack characteristics for each nearby-source unit:
  - ○ Emission rate for each applicable pollutant species. Emission rate should reflect maximum allowable (permitted). For PSD increment analyses, or if maximum allowable not available for AAQS analyses, actual emission rate may be used.
  - ○ Location (e.g., UTM coordinates)
  - ○ Stack height
  - ○ Stack base elevation (above MSL)
  - ○ Stack exit diameter
  - ○ Stack exit velocity
  - ○ Stack exit temperature
  - ○ Stack orientation (e.g., vertical up, vertical down, horizontal, rain caps, etc.)
- ☐ Appropriate adjustment of stack exit velocity based on stack orientation (See See AERMOD Implementation Guide[4])
- ☐ Appropriate determination of point source stack characteristics for flares (See Flare Guidance). Stack characteristics which are adjusted for flares include stack height, stack diameter, exit velocity, and exit temperature.
- ☐ The NDDH should be consulted regarding the need for including building downwash effects for nearby sources.

NOTE: Stack characteristics for nearby sources can typically be obtained from the Department. Please contact the Department for more information.

3. Meteorological data:

☐ Selection of meteorological observations:

- ☐ Five consecutive years of recent representative National Weather Service (NWS) hourly surface observations (identify station).

[4] EPA, 2009. AERMOD Implementation Guide: March 19, 2009. Accessed at: http://www.epa.gov/scram001/7thconf/aermod/aermod_implmtn_guide_19March2009.pdf. June 20, 2013

- ☐ Five concurrent years of NWS twice-daily upper-air observations (identify station).
- ☐ Surface observations from non-NWS sites may be considered as an option (e.g., on-site, Department monitoring sites), but the Department should be contacted regarding the availability and acceptability of such data, as well as pairing such data with NWS upper-air observations.

☐ Application of AERSURFACE (specify version number) to process land surface characteristics for use with AERMET. (See Department guidance for AERSURFACE input settings.)

☐ Application of AERMET (specify version number) to process surface observations, upper-air observations, and AERSURFACE output in order to create the SURFACE and PROFILE files required by AERMOD.

NOTE: AERMET-compatible surface and upper-air five-year meteorological data sets for a number of NWS stations located in and near North Dakota are available via the Department's FTP site[5].

4. Receptor locations:

☐ Specify primary receptor network (a case-by-case determination will likely be required, but the following is a typical configuration for medium-buoyancy sources):

- ☐ Receptors spaced at 25 m along the limited access (fenced) boundary (ambient air boundary). If access is not limited, receptor coverage must include entire property area.
- ☐ Nested Cartesian receptor grids outside of the fenced boundary. Resolution of nested receptor grids should proceed in a geometric pattern, e.g., 50 m for the inner grid, 100 m for the next grid, 250 m for the next grid, and 500 m for the outside grid. The maximum extent of the outside grid will depend on the buoyancy (plume height) of the source. Generally, a grid extending out to 10 km from the source will be adequate for a medium-buoyancy source.

☐ In addition to the primary network, additional receptors may be needed to address isolated terrain features, impact from low-level sources located near the facility fence line, and to refine predictions when the maximum modeled impact occurs at a receptor located in a relatively coarse portion of the primary receptor network.

☐ If the analysis includes nearby sources, the Department may request that additional receptors are placed to account for the maximum combined impact of the subject source and the nearby source.

[5] ftp://ftp.state.nd.us/AirQuality/AERMOD/

☐ Obtain digital elevation data (e.g., NED) for the modeling domain.

☐ Application of AERMAP (specify version number) to receptor locations and digital elevation data in order to determine receptor elevation and hill-height scale needed for AERMOD.

☐ Provide map showing receptor locations and elevation with respect to source location(s).

5. Background concentrations (account for contribution of natural and non-modeled anthropogenic sources, not applicable for SILs or Air Toxics analyses):

☐ Fixed background concentrations for SO_2, NO_2, PM_{10}, $PM_{2.5}$, and CO (all averaging times) are provided in Table 1. These fixed background levels reflect default values which are representative for the entire State of North Dakota. The Department should be contacted regarding representativeness and current status of these values for a particular modeling project.

☐ Variable (hourly) background concentration files for SO_2 and NO_2 are available for several locations on the Department's FTP site[6]. These hourly background files cover a five-year period and are concurrent with the meteorological data sets also provided on the FTP site.

☐ Hourly ozone background concentration files are also provided on the Department's FTP site for several locations. These ozone data sets are provided to implement the Ozone Limiting Method (OLM) for NO_2 Tier 3 analysis.

NOTE: The use of hourly background concentration data for SO_2 and NO_2, if representative data are available for the project location, will produce the least conservative results when added to model output (i.e., less conservative than use of fixed background concentrations).

Table 1
Fixed Background Concentrations for North Dakota
(µg/m^3)

Pollutant	Averaging Period				
	1-hour	**3-hour**	**8-hour**	**24-hour**	**Annual**
SO_2	13	11	---	9	3
NO_2	35	---	---	---	5
PM_{10}	---	---	---	30	15
$PM_{2.5}$	---	---	---	13.7	4.75
CO	1149	---	1149	---	---

[6] ftp://ftp.state.nd.us/AirQuality/AERMOD/

6. AERMOD execution:

☐ Execute AERMOD for emission inventory, meteorological data, receptor locations, and with background concentrations, as outlined above:

- ☐ Use regulatory default option.
- ☐ Specify rural source (urban may be appropriate in rare cases).
- ☐ Use appropriate options for processing form of new 1-hour NAAQS for SO_2 and NO_2, and 24-hour NAAQS for PM_{10} and $PM_{2.5}$.
- ☐ Use proper settings to implement Tier 3 NO_2 analysis (if applicable):
  - ○ The Department prefers the OLM option to PVMRM.
  - ○ With OLM, use setting "OLMGROUP ALL".
  - ○ Use hourly ozone background data file (above).
  - ○ Contact vendor and Department for appropriate in-stack ratios of NO_2 to NO_X. Use of a default value of 0.5 is acceptable without justification.
  - ○ Note that EPA approval is needed regarding protocol for Tier 3 NO_2 analysis.
- ☐ Add background concentrations to model results (not applicable for SILs or Air Toxics analyses, and generally not applicable for PSD increment analyses).

7. Interpretation of model output:

☐ Comparison of results with acceptable air quality thresholds:

- ☐ Significant impact levels (see Table 2)
- ☐ NAAQS/NDAAQS (see Table 3)
- ☐ PSD Class II increments (see Table 4)
- ☐ Air Toxics thresholds (MICR and Hazard Index, see State Air Toxics Policy)

☐ Provide receptor location of maximum impact for each species and averaging time~~s~~. Location of maximum impact should be subsequent to processing the form of the NAAQS (e.g., 5-year average of annual 99^{th} percentile of daily maximum 1-hour average concentration for SO_2).

8. Submittal of modeling report:

☐ A modeling report, including a detailed description of all input data, model execution, and results, should be prepared and provided with the permit application.

☐ All computer modeling files should be submitted along with the modeling report.

☐ An electronic copy of the modeling report should be submitted along with at least three hard copies. Electronic submittal should included both PDF and MS Word (or other native) versions.

Table 2
Class II Area Significant Impact Levels
(µg/m^3)

	Averaging Period				
Pollutant	**1-hour**	**3-hour**	**8-hour**	**24-hour**	**Annual**
SO_2	7.8	25	---	5	1
NO_2	7.5	---	---	---	1
PM_{10}	---	---	---	5	1
$PM_{2.5}$	---	---	---	1.2	0.3
CO	2000	---	500	---	---

Table 3
North Dakota and National Ambient Air Quality Standards (AAQS)
Criteria Pollutants (µg/m^3)

Pollutant	Averaging Period	N.D. AAQS	National AAQS
Sulfur Dioxide (SO_2)	1-hour	196[2]	196[2]
	3-hour	1309[1]	1309[1]
	24-hour	---	365[1]
	Annual	---	80
Nitrogen Dioxide (NO_2)	1-hour	188[3]	188[3]
	Annual	100	100
Inhalable Particulate (PM_{10})	24-hour	150[1]	150[1]
Particulate ($PM_{2.5}$)	24-hour	35[4]	35[4]
	Annual	15[5]	12[5]
Carbon Monoxide (CO)	1-hour	40,000[1]	40,000[1]
	8-hour	10,000[1]	10,000[1]
Lead (Pb)	Quarterly	1.5	1.5

[1] One exceedance per year is permitted.
[2] Based on 3-year average of annual 99th percentile (4th highest) of daily maximum 1-hour average concentration.
[3] Based on 3-year average of annual 98th percentile (8th highest) of daily maximum 1-hour average concentration.
[4] Based on 3-year average of annual 98th percentile 24-hour concentration.
[5] Based on 3-year average of annual average concentrations.

Table 4
North Dakota / National Prevention of Significant Deterioration (PSD) Increments
Criteria Pollutants (µg/m^3)

Pollutant	Averaging Period	Class I	Class II	Class III
Sulfur Dioxide (SO_2)	3-hour	25[1]	512[1]	700[1]
	24-hour	5[1]	91[1]	182[1]
	Annual	2	20	40
Nitrogen Dioxide (NO_2)	Annual	2.5	25	50
Particulate (PM_{10})	24-hour	8[1]	30[1]	60[1]
	Annual	4	17	34
Particulate ($PM_{2.5}$)	24-hour	2[1]	9[1]	18[1]
	Annual	1	4	8

[1] One exceedance per year is permitted.

II. Guidance Documents

The North Department has developed the following guidance and policy documents to assist permit applicants in the process of drafting complete permit applications.

The first three documents referenced below can be accessed via the links posted under the document title. The remainder of the documents can be found on the Department's FTP site under "Guidance and Policy Documents".

To request access to the FTP site, or for more information on Dispersion Modeling, please direct questions or comments to the North Dakota Department of Health at 701.328.5188.

Intradepartmental Memorandum - Criteria Pollutant Modeling Requirements for a Permit to Construct: September 12, 2006
http://www.ndhealth.gov/AQ/AirPermitting_files/Modeling%20Memo.pdf

> The Department has developed a set of guidelines to determine what modeling requirements apply to a facility as part of the application for a Permit to Construct (PTC). This document outlines the requirements for projects subject to the Prevention of Significant Deterioration of Air Quality (PSD) rules and for projects not subject to PSD; and also includes additional information applicable to all projects (both PSD and non-PSD).

Policy for the Control of Hazardous Air Pollutant Emissions in North Dakota (Air Toxics Policy): August 25, 2010
http://www.ndhealth.gov/AQ/Toxics/North%20Dakota%20Air%20Toxics%20Policy.pdf

> This document establishes the policy for the evaluation of sources emitting Hazardous Air Pollutants (HAPs) into the ambient air. It includes a description of the three-tiered approach to calculating the maximum off-property ground-level ambient concentration of each HAP.

Dispersion Modeling Requirements, Compressor Engines and Glycol Dehydration Units
May 16, 2011
http://www.ndhealth.gov/AQ/AirPermitting_files/Compressor%20Engine%20&%20Dehydrator%20Policy.pdf

This document clarifies when dispersion modeling is required to be submitted for facilities which include compressor engine(s) and/or glycol dehydration unit(s) as the primary source(s) of emissions. Both criteria pollutants and hazardous air pollutants (air toxics) are addressed.

Model Input Parameters for Flares
November 10, 2010
Flare Plume Rise.pdf

This document outlines the Department recommended approach for developing the model input parameters of stack temperature, diameter, exit velocity, and stack height to allow a given refined air quality model (e.g. AERMOD, ISC-PRIME) to accurately calculate a buoyancy representative of the conditions above the flare.

Recommended AERSURFACE Inputs (North Dakota)
September 16, 2010
AERSURFACE Inputs.pdf

This document provides Department recommended inputs for AERSURFACE, a surface land cover characteristics preprocessor for AERMOD, appropriate for modeling in North Dakota.

User's Instructions for HRLYNAAQS.
September 24, 2010
HRLYNAAQS User's Guide.pdf

The software program HRLYNAAQS is provided by the Department (on request) to assist permit applicants and consultants in the demonstration of modeled compliance with the new 1-hour National Ambient Air Quality Standards (NAAQS) for NO_2 and SO_2. HRLYNAAQS provides the annual 98th (NO_2) or 99th (SO_2) percentile of maximum daily 1-hour concentrations averaged across five years, for each receptor location. Along with the total concentration, HRLYNAAQS also provides individual contributions for up to five source groups.

AERMET Surface Meteorology Stations (2004-2008)
AERMET Upper-Air Meteorology Stations (2004-2008)
Met Stations 2004-2008 WBAN.pdf

This document provides the locations of surface and upper-air meteorology stations in North Dakota for which meteorological data suitable for use with AERMET is provided by the Department (available on request).

Hourly Ozone Sites (2004-2008)
Ozone Sites 2004-2008.pdf

This document provides the locations within North Dakota of hourly ozone ambient monitoring sites as well as information on the formatting of the hourly ozone source data files (available on request).