

Chapter 8: Dispersion Modeling Analysis

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Chapter 8

Dispersion Modeling Analysis

8.1 Overview

This chapter covers general modeling requirements and analyses associated with permitting new major air pollution sources or major modifications to existing sources subject to the PSD provisions in 40 CFR § 52.21. References to additional guidance on the technical aspects of a dispersion modeling analysis are located at the end of this chapter. A discussion related to modeling under new NSR Reform options is also provided in this chapter.

8.2 PSD Modeling Overview

Major new air pollution sources or major modifications to existing sources subject to NSR/PSD (known as a PSD project) must model air pollution impacts of all pollutants for which the project's potential emissions exceed the significant emission rates listed in Table 8-1.

Table 8-1. PSD Significant Emission Rates (SERs)

Pollutant	SER (tons/year)
Carbon Monoxide (CO)	100
Nitrogen Oxides (NO _x)	40
Sulfur Dioxide (SO ₂)	40
Particulate Matter less than 10 microns (PM ₁₀)	15
Total Particulate Matter	25
Ozone (volatile organic compounds)	40
Lead	0.6

One component of the NSR/PSD program is completion of an ambient air quality analysis, which is detailed in 40 CFR 52.21(k)–(m). Permit applicants under PSD are required to demonstrate in the ambient air quality analysis that their project will not cause or contribute to an adverse impact on air quality. At a minimum, the ambient air quality analysis consists of evaluating impacts within 50 km of the source.

The air quality analysis must demonstrate that the project will not exceed NAAQS/MAAQS or PSD increments for those pollutants with emissions greater than the significant emission rates found in 40 CFR 52.21. The NAAQS/MAAQS analysis considers all pollutant sources; the PSD increment analysis considers the change in air quality since the minor source baseline date. In addition to conducting the NAAQS/MAAQS and increment analyses, applicants need to provide an additional impacts analysis in 40 CFR 52.21(o) assessing air quality related values (AQRVs). The AQRV analysis has three parts: growth, soils and vegetation, and visibility. Dispersion modeling may be necessary to show no significant adverse impact of visibility at a federal Class I Area.

Minnesota's requirements for PSD modeling of the NAAQS/MAAQS and increments can be found at <http://www.pca.state.mn.us/publications/modeling-title5.pdf>. Selected portions of the MPCA modeling guidance are described in this section.

8.3 Dispersion Modeling Protocol

The purpose of the MPCA modeling guidance is to enable a consistent approach to modeling analyses. However, because each facility and modeling analysis have certain unique characteristics (e.g., topography, sources, etc), a "cookbook" modeling methodology is not possible. To assure that a modeling analysis is conducted properly, applicants are strongly advised to submit their modeling protocol to the MPCA before completing the air quality analysis.

8.3.1. PSD Modeling Protocol Requirements

While it is not a formal requirement, a modeling protocol should be submitted to MPCA prior to modeling impacts from a facility or modification. The protocol should describe how the modeling evaluation will treat:

- Model selection, options
- Meteorological data
- Building downwash
- Receptor grid
- Background sources/concentrations
- Source emission rates and modeling parameters
- If possible, it should include preliminary BPIP input/output files
- If possible, it should include a preliminary VISCREEN level-1 analysis

If a Class I visibility analysis is required, submitting a copy of the modeling protocol to the FLM is also recommended.

The following sections describe in more detail the individual components of a modeling protocol, with references to the application forms containing the modeling information given where appropriate.

Model Selection

Models used for air quality analyses are separated into screening and refined models. Screening models are very easy to use but incorporate conservative assumptions to estimate air concentrations. If modeling shows attainment using a screening level model, then no further analysis is required.

Screening models are typically appropriate for a single source (for example, a single emission unit modification). Multiple emission unit sources generally require refined models.

Appendix W to 40 CFR Part 51 is the *Guideline on Air Quality Models*. The preferred models for regulatory applications are contained in this guideline, and it was developed to provide consistency in the application of models. Despite this, the guideline acknowledges that each modeling application is different. Use of other models is always an option for the applicant; however, any model needs to be approved by the MPCA for the particular application.

Currently, the ISC models are approved for PSD permit applications. In all cases where downwash is present (which is most facilities), the ISC-PRIME model is required for use.

AERMOD has been approved by the MPCA for various applications, and USEPA is scheduled to officially promulgate use of AERMOD in 2004. AERMOD includes advanced representation of the atmospheric boundary layer (better science) and includes the PRIME downwash algorithms. One potential drawback to using AERMOD is that additional meteorological parameters are required to be specified by the user and there currently is not any guidance on how best to determine these values. While applicants are encouraged to use AERMOD, there can be additional expense and review time for evaluating the modeling results.

A facility may benefit from conducting multiple analyses with different models. As discussed in the final section, additional permit conditions may be necessary if the ISC-PRIME model showed attainment and AERMOD did not show attainment.

The CALPUFF model has been approved for modeling involving long-range transport (from 50 to 300 km) for determining compliance with Class I area increments. CALPUFF is also used for Class I area visibility analysis. The modeling requirements for CALPUFF can be significant and are not described in this chapter.

Meteorological Data

Meteorological data for ISC applications is available from the MPCA website:
<http://www.pca.state.mn.us/air/modeling.html#data>.

Completed AERMET data sets are not yet available from the MPCA for AERMOD applications, and applicants using AERMOD will need to develop the appropriate AERMET input files. The proper selection for user-specified values of the meteorological parameters albedo, surface roughness, and Bowen ratio will need to be negotiated with the MPCA modelers.

CALPUFF meteorological data requirements will need to be established with the FLM. There is a version of CALPUFF which uses ISC-type meteorological data; however, such meteorological data run counter to the purpose of using the CALPUFF model.

Building Downwash

The form MI-02 (see Appendix D) contains information on the building coordinates that will form the basis of the BPIP analysis. For modeling, all coordinates need to be converted to UTM NAD-83.

Receptor Grid

The model receptor grid needs to be sufficiently dense to ensure that the maximum modeled impact is identified. The MPCA includes recommended grid spacing in its modeling guidance. Receptor elevations will be required for air quality analysis. The DEM (digital elevation model) data necessary for determining receptor elevations are available from <http://edcwww.cr.usgs.gov/doc/edchome/ndcdb/ndcdb.html>.

The AERMAP component of the AERMOD model is a receptor data processor. Conducting an AERMAP analysis is a more involved process than identifying receptors for the ISC models.

Background Sources/Concentrations

Facility data from nearby sources can generally be obtained from the MPCA. MPCA's Delta database provides PSD project applicants with the information needed to include other sources in the modeling. In some instances, applicants will need to obtain emission inventory data from the MPCA to determine the appropriate modeling parameters from other sources.

Ambient air background data are also available from the MPCA. In most cases, either representative or conservative background data are available. For example, there are a limited number of SO₂ ambient air monitors in the state; however, an applicant could choose the highest background for each averaging period recorded anywhere in the state as the background concentration. While this is conservative, if the modeled impacts are well below standards, then this would be an acceptable value to use. In some instances, applicants may need or want to conduct ambient monitoring for at least one year prior to construction. Ambient monitoring requirements and data representativeness are included at the end of this chapter.

Source Emission Rates and Modeling Parameters

The source emission rates and modeling parameters are also included on forms in Appendix D. These data are very important, as these values will become permit limits in most instances. For example, any changes that a facility makes (after obtaining the PSD permit) that result in less dispersive characteristics generally will require re-modeling of the facility. It is important that applicants use parameter values that they are comfortable with as permit limits.

The source emission rates need to be representative (or conservative) of the averaging period for the modeling. Generally short-term emission rates (24 hours or less) are modeled using the potential pound per hour emission rate. Annual standards are typically modeled using annual emission rates.

Stack and building data for modeling are required in metric units. Locations are required in UTM NAD83 coordinates. For many facilities, plot plans may be available in site coordinates. Facilities may want to locate stacks and building corners using GPS technology. Visually inspecting stack and building coordinates for accuracy is always recommended. Other stack data required for modeling includes stack diameter, temperature, flow rate, presence of a rain cap or other stack, and discharge direction.

Modeling requires several other important components which may or may not be as important for other areas of the PSD application, including insignificant activities (see form IA-01) and fugitive source characterization. Insignificant activities can be significant for modeling purposes, and insignificant activities with potential emissions greater than 0.1 lb/hr need to be included in the modeling. Requirements for modeling insignificant activities are included in the MPCA modeling guidance.

Similarly, the appropriate modeling characterization of fugitive sources is very important. Generally, fugitive particulate sources require additional modeling attention. For example, emission calculations for fugitive particulate sources may address hourly and annual rates; however, these rates can depend on average or maximum values of a meteorological parameter such as wind speed. Refined modeling allows for varying emissions by hour of day or wind speed. These refined modeling techniques will not be reflected in the emission calculation forms available on the MPCA website at <http://www.pca.state.mn.us/air/permits/forms.html>.

BPIP

BPIP is the building profile input program available from the USEPA. In general, applicants will use BPIP-PRIME to also obtain the dimension parameters needed to run the PRIME algorithms in either ISC-PRIME or AERMOD. The input data requirements are identical for BPIP and BPIP-PRIME, so there is no additional burden for applicants.

VISCREEN

VISCREEN is a screening model for evaluating visual impacts within 50 km of the source. VISCREEN modeling generally selects a nearby state park or community outdoor area where visual impacts are more sensitive. The VISCREEN analysis is not applicable for long range transport Class I Area analysis.

For new units, modeling needs to be representative of the proposed unit before the unit is installed. It is typical that the exact parameters of the new unit (e.g., location) will not be known until after the unit is installed, well after the construction permit is authorized. Generally, applicants need to make a best guess as to the new unit specifications. If multiple options are being considered, then the modeling will have to address each of these options. The modeling should be conservative: applicants should use the lowest temperature, stack height, and stack velocity that are likely to be encountered, as these parameters maximize ground level concentrations but also may become permit limits.

Criteria pollutant emissions from fugitive sources are generally either VOCs or PM₁₀. SO₂, NO_x and CO are typically combustion-related pollutants emitted through a stack or vent. Because modeling is not required for VOCs, it is modeling of particulate fugitive sources which can be cumbersome. Applicants need to determine the appropriate modeling parameters. Fugitive sources can be modeled as area or volume sources. Emission rates can vary based on wind speed or even by hour of day. For example, it is possible to calculate emission for each modeled hour and use those emission for modeling input. Needless to say, this level of sophistication in the models requires more extensive review by the MPCA.

8.3.2. PSD analysis and results

The following general steps are recommended when conducting a PSD dispersion modeling analysis.

Conduct significant impact analysis

The first step in a PSD modeling analysis is to compare modeled impacts from the project to significant impact level (SIL) values in Table 8-2. The results must include impacts of all stack and fugitive emissions from new construction or modifications. No further modeling is required if the highest impacts resulting from modeling five years of meteorological data are below SIL values.

Determine radius of impact

The next step is determining the radius of air quality impact for the proposed project. The radius of impact for the modeled source extends from the facility to the farthest impacted receptor and is useful for determining the extent of the receptor grid and identifying nearby sources to include in the modeling analysis. USEPA's *Draft New Source Review Workshop Manual*, dated October 1990, provides further details on determining the radius of impact and other PSD issues that are not covered here in detail. It is available at <http://www.epa.gov/ttn/nsr/gen/wkshpman.pdf>.

Conduct PSD Increment Analysis

Important note

PSD **minor source baseline date (MSBD)** emissions may differ from PSD applicability baseline emissions under old NSR rules and NSR Reform rules effective March 3, 2003.

If a PSD project exceeds SIL values, a full PSD increment analysis will be required. MPCA maintains a list of county baseline dates and a limited collection of source data for increment-consuming sources that are available upon request. Applicants can further refine or update data from these increment consuming sources by reviewing MPCA permitting files. If impacts cross state lines, data from sources in adjacent states should also be included.

Evaluate PSD Increment Ceilings and Future Growth

PSD modeling results should be compared to appropriate increment values in Table 8-2. Predictions exceeding PSD increment ceilings must be rectified before MPCA can issue a PSD permit. Note that MPCA generally requires a future growth "cushion" equal to SIL values in order to accommodate future PSD projects, post-MSBD changes, etc. For cases with future growth less than SIL values, MPCA has required previous PSD sources to model any and all subsequent changes including insignificant activities.

Conduct NAAQS Analysis

For comparison with NAAQS, shown in Table 8-2, potential emissions of a new source or an existing source with new modifications must be modeled along with nearby sources. As with the increment analysis, concentrations must be below relevant NAAQS and a "cushion" should be left for future growth.

Table 8-2. National and Minnesota Ambient Air Quality Standards, PSD Increments, and Significant Impact Levels

Pollutant	Averaging Period	Primary NAAQS (ug/m3)	Secondary NAAQS (ug/m3)	PSD Class II Increment (ug/m3)	PSD Class I Increment (ug/m3)	Significant Impact Level [#] (ug/m3)
SO ₂	1-Hour*	1300	1300	512	25	25
	3-Hour	None	1300***	512	25	25
	24-Hour	365	None	91	5	5
	Annual	60**	None	20	2	1
PM ₁₀	24-Hour	150	150	30	8	5
	Annual	50	50	17	4	1
PM _{2.5}	24-Hour	65	65	None	None	None
	Annual	15	15	None	None	None
NO ₂	Annual	100	100	25	2.5	1
CO	1-Hour	40,000	40,000	None	None	2000
	8-Hour	10,000	10,000	None	None	500
O ₃	1-Hour	235	235	None	None	None
	8-Hour	157	None	None	None	None
Pb	Quarterly	1.5	1.5	None	None	None

*Minnesota state 1-hour SO₂ standard and surrogate PSD and SIL values. No federal 1-hour values exist.

**Minnesota state annual SO₂ standard. Federal annual standard is 80 ug/m3.

***Minnesota state 3-hour SO₂ standard for Northern Minnesota is 915 ug/m3.

#PSD Class II areas. PSD Class I Area 24-Hour value is 1 ug/m3.

Minnesota ambient air quality standards are located at <http://www.revisor.leg.state.mn.us/arule/7009/0080.html>.

Minnesota episode levels are located at <http://www.revisor.leg.state.mn.us/arule/7009/1060.html>.

National ambient air quality standards are listed at http://www.access.gpo.gov/nara/cfr/cfrhtml_00/Title_40/40cfr50_00.html.

8.4 NSR Reform

The NSR Reform elements of Clean Unit Designation (CUD), Pollution Control Project (PCP), or Plantwide Applicability Limit (PAL) still need to meet the air quality analysis requirements of the PSD program. See Chapter 5 for more information on NSR Reform. However, the specifics of the air quality analysis can be different. Modeling requirements specific to NSR Reforms can be found at <http://www.pca.state.mn.us/publications/manuals/nsr-reformmodelingpolicy.pdf>. Selected portions of the MPCA NSR Reform modeling guidance are described here.

8.4.1. Overview

Each procedure outlined below begins with the assumption that a modeling analysis is required. For Clean Units, modeling is required for the pollutant for which BACT or BACT-equivalent controls have been installed; for Pollution Control Projects, modeling is required for the pollutant with an increased emission rate; and for a Plantwide Applicability Limit, modeling is required for the pollutant being limited.

While NSR requires a modeling analysis for "other PSD pollutants," this is rare. Modeling for other PSD pollutants is not required unless:

- the source is seeking a Clean Unit designation for any of the other PSD pollutants,
- the Pollution Control Project increases one of the other PSD pollutants, or
- the source wishes to include other PSD pollutants as part of a PAL.

8.4.2. Clean Unit Designation (CUD)

For Clean Units, modeling may be required for the pollutant for which BACT or BACT-equivalent controls have been installed.

8.4.3. Pollution Control Project (PCP)

Modeling may be required for sources seeking approval of a pollution control project with an emissions increase in a collateral pollutant. If there is no emissions increase in collateral pollutants, then modeling is not required.

8.4.4. Plantwide Applicability Limit (PAL)

Modeling may be required for sources seeking a PAL. It is likely that the MPCA will require a demonstration that the NAAQS and MAAQS, PSD increment (where one exists), and AQRV are protected as part of the permitting process.

Modeling for PALs is potentially the most difficult of the required NSR Reform modeling. The simplest PAL modeling uses the maximum allowable hourly emission rate for each PAL emission unit. If the ambient air standards are protected, then the modeling is done. However, it is not usually the case for a facility with multiple sources that all sources operating at allowable emission rates meet the standards. Detailed PAL modeling requires multiple iterations of ranking the modeled results and emission unit impacts by receptor. This multi-layered modeling approach can be time-consuming, as well as potentially limiting operational flexibility. A PAL for VOC may not be so difficult because modeling is not required. For a facility with only a small number of sources, a PAL may not be the preferred permitting option, as it may be easier to maintain individual source permit conditions. PALs can be effective if emissions can go through multiple pathways, but not necessarily at the same time.

The PAL modeling demonstration requires that the source can demonstrate through modeling that the impact from all sources (based on allowable emissions) plus the monitored background plus twice the significant impact levels is less than the air quality standard. (In PSD modeling the MPCA generally requires a future "growth" cushion equal to SIL values. This is important to accommodate future PSD projects, post minor source baseline date condition changes, etc.) Although clean units and pollution control projects set future growth at one times the SIL values, PAL projects set future growth at twice the

SIL values to address possible unforeseen adverse future changes. Clean units and pollution control projects don't have the uncertainty of unforeseen adverse changes.)

In some cases, to simplify the iterative approach, a source may elect to take individual emission limitations on a number of sources within the PAL. This approach can preserve the operational flexibility of critical emission units where flexibility is most needed, while limiting the number and extent of emission limitations needed to demonstrate compliance with the NAAAQS/MAAQs or PSD Increments.

8.5 Additional Impacts Analysis

The primary concerns when modeling for additional impacts are the Class I Air Quality Related Values (AQRVs). AQRVs include visibility, soils and vegetation. Generally, only visibility modeling must be considered. This is based on agency staff opinion that visibility is generally the most restrictive AQRV and that focusing on visibility will streamline the modeling process.

For NSR Reform projects, the policy requires modeling for visibility for Clean Unit(s) and Pollution Control Projects unless the source qualifies for an off-ramp based on emissions and the distance of the source from Class I areas. For PAL projects, the policy requires modeling for visibility on a case-by-case basis. The agency plans to notify Federal Land Managers of applications for CUDs, PCPs, and PALs for projects within 300 kilometers of a Class I area.

The Class I areas are protected wilderness areas under the jurisdiction of the Federal Land Managers (FLMs). Class I Areas for Minnesota are the Boundary Waters Canoe Area (BWCA) and Voyageurs National Park. Other nearby Class I areas which may be important for Minnesota PSD projects are the Rainbow Lakes Wilderness Area in northwest Wisconsin and Isle Royale National Park in Michigan.

Federal Land Managers have jurisdiction over the Class I Areas and can require an air quality analysis for projects located up to 300 kms from the Class I Area. The Class I Area analysis can be very time consuming, so applicants are advised to contact the FLM regarding the scope of analysis required for the Project. The size of the project and its proximity to the Class I Area determines the extent of the analysis required by the FLM.

Visibility is not an AQRV for the Rainbow Lakes Wilderness Area, and visibility has not been approved as a surrogate for other AQRVs at the Rainbow Lakes area. For projects within 300 kms of the Rainbow Lakes area, the MPCA will notify the Rainbow Lakes FLM and consult with the FLM to determine whether modeling may be required. It is recommended that the MPCA be contacted as early as possible to allow time to determine whether modeling may be required for the project.

8.6 MPCA Review Procedures

The MPCA review of a PSD project's air quality analysis can be broken down into five areas:

- Completeness Check
- Modeling Review
- Draft Permit Conditions
- Permit Negotiations
- Permit Issuance (see Major Modification Process)

8.6.1. Completeness Check

When MPCA receives the information, the Agency:

- Checks it (simple QA/QC tests; view/plot it)
- Stores it (AQ DELTA database or elsewhere)
- Extracts it (ready-to-run model formats)
- Shares it with others (esp. PSD projects near borders or Class I areas)
- Reviews it (identify NAAQS/MAAQs or PSD Increment problems)
- Amends permits & sets limitations based on modeling inputs (especially maximum allowable emission rates and related stack parameters)

8.6.2. Modeling Review

PSD Modeling Final Report Requirements:

- Full discussion of items listed in modeling protocol and used in analysis
- Building Profile Input Program (BPIP) input/output electronic files (USEPA format)
- ISCST3 (or alternate) model input/output electronic files
- ISCST3 (or alternate) model plot/event/threshold electronic files (if possible)
- Meteorological electronic data files
- Isoleth maps (from PLOTFILE outputs)
 - Concentration maps for all models
 - Terrain elevations for AERMOD
 - Hill scale factors for AERMOD
- Culpability tables (from EVENTFIL runs)
- PSD Class I analyses (per FLM recommendations)

Common Modeling Mistakes to Watch For

In the review of modeling submittals, the MPCA has compiled a list of the most common modeling mistakes. They include:

- Math errors and logic errors
- Wrong anemometer height
- Not using regulatory options (e.g., DFAULT)
- Ignoring condensable PM10 emissions (e.g., stack tests)
- Outdated emission factors (esp. fugitive sources for PSD purposes)
- Overly optimistic assumptions (esp. fugitive sources)
- Actual emissions greater than allowable emissions (esp. fugitive sources)

- Hardcopy report and modeling files are inconsistent (cut and paste mistakes)
- Using H6H values for 24-hour PM10 increment modeling. Should use H2H values for each year
- Using H2H values for 24-hour PM10 NAAQS modeling. Should use H6H values over five years of meteorology!

8.7 Resources

- MPCA air dispersion modeling web site (<http://www.pca.state.mn.us/air/modeling.html>) with:
 - MPCA Modeling Guidance for Title V/PSD Air Dispersion Modeling;
 - MPCA Title V Modeling – Fugitive PM10 Emission Spreadsheet;
 - Instructions for “Modeling Information” Requirement in Title V permits;
 - Several ready-to-run meteorological data sets for models like ISCST3 and ISCPRIME.
- USEPA Support Center for Regulatory Air Models (SCRAM) has USEPA modeling guidance, dispersion models, and related items. Click on <http://www.epa.gov/scram001/>
- USEPA Draft New Source Review Workshop Manual. October 1990. Click on <http://www.epa.gov/ttn/nsr/gen/wkshpman.pdf>
- USEPA Clearing House for Inventory and Emission Factors (CHIEF) has information on
- USEPA emission factors (e.g., AP-42). Click on <http://www.epa.gov/ttn/chief/>
- USEPA Air Graphics displays air emissions data and ambient air quality monitoring data. Click on <http://www.epa.gov/agweb/>
- United States Geological Survey (USGS) has digital elevation model (DEM) terrain data. Click on <http://edc.usgs.gov/geodata>
- A web site with USGS topographic maps and USGS aerial photos on-line. Click on <http://terraserver.homeadvisor.msn.com/default.asp>
- National Climatic Data Center. Click on <http://www.ncdc.noaa.gov/>