Montana Department of
ENVIRONMENTAL QUALITY

State of Montana Modeling Guideline for Air Quality Permit Applications

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Permitting and Compliance Division /
Air Resources Management Bureau

Disclaimer

This document does not have the force and effect of a rule and is not intended to supersede statutory or regulatory requirements or recommendations of the State of Montana or the United States Environmental Protection Agency. It is provided as general guidance and does not alter the discretionary authority of the Montana Department of Environmental Quality (MDEQ).

Preface

This Montana Modeling Guideline for Air Quality Permits (Guideline) presents current MDEQ modeling guidance for estimating impacts from stationary sources of air pollution. This document addresses modeling requirements for all sources requiring an Montana Air Quality Permit including: minor sources, major sources subject to the Prevention of Significant Deterioration (PSD) regulations, and sources located in non-attainment areas.

The Guideline is intended to help MDEQ staff, permit applicants, and others understand MDEQ's expectations for ambient air impact analyses and to prevent unnecessary delays in the permitting process. To avoid any misunderstandings, the most recent version of the Guideline should be used in conjunction with the current regulations and applicable U.S. Environmental Protection Agency (EPA) documents. The latest version of this document may be obtained on MDEQ's website (http://www.deq.mt.gov).

In general, the procedures in the EPA document "Guideline on Air Quality Models" (40CFR51 Appendix W, most recent version) should be followed when conducting the modeling analysis. In cases of contradictions between the Guideline and EPA guidelines or the Administrative Rules of Montana (ARM), the EPA documents and the ARM prevail.

Printed copies of the State of Montana Air Quality Rules are available at the MDEQ Air Resources and Management Bureau, located in the Lee Metcalf Building, 1520 East Sixth Avenue, Helena, Montana.

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Glossary of Acronyms and Symbols

AERMOD	AMS/EPA Regulatory Model
AIRS	Aerometric Information Retrieval System
AMS	American Meteorological Society
AQCR	Air Quality Control Region
AQRV	Air Quality Related Values
ARM	Administrative Rules of Montana
ARMB	Air Resources Management Bureau
BACT	best available control technology
BPIP	EPA's Building Profile Input Program
CFR	Code of Federal Regulations
CO	carbon monoxide
DEM	digital elevation model
EPA	U.S. Environmental Protection Agency
FCAA	Federal Clean Air Act
FLM	Federal Land Manager
FLAG	Federal Land Managers Air Quality Related Values Workgroup.
GAQM	EPA's Guideline on Air Quality Models, 40CFR51 Appendix W, most recent version
GEP	good engineering practice
g/s	grams per second
HAPs	hazardous air pollutants
H_2S	hydrogen sulfide
ISC3	EPA's Industrial Source Complex model
ISC-PRIME	ISC3 with plume rise model enhancements model
K	degrees Kelvin
km	kilometer(s)
lb/day	pound(s) per day
MAAQS	Montana Ambient Air Quality Standard(s)
MAQP	Montana air quality permit
MCA	Montana Code Annotated
MCAA	Montana Clean Air Act
MDEQ	Montana Department of Environmental Quality
m	meter(s)
m/s	meter(s) per second
m^3/s	cubic meter(s) per second
$\mu g/m^3$	microgram(s) per cubic meter
NAA	non-attainment area
NAAQS	National Ambient Air Quality Standard(s)
NAD27	North American Datum of 1927
NAD83	North American Datum of 1983
NCDC	National Climatic Data Center
NSR	new source review
NWS	National Weather Service
NO	nitrogen oxide

NOx	nitrogen oxides
NO_2	nitrogen dioxide
O_3	ozone
OLM	ozone limiting method
Pb	lead
PM_{10}	particulate matter with an equivalent aerodynamic diameter less than or equal to a nominal 10 microns
$PM_{2.5}$	particulate matter with an equivalent aerodynamic diameter less than or equal to a nominal 2.5 microns
ppb	parts per billion
ppm	parts per million
PRIME	Plume Rise Model Enhancements model
PSD	Prevention of Significant Deterioration
ROI	radius of impact
RFP	reasonable further progress
SCRAM	EPA's Support Center for Regulatory Atmospheric Modeling
SIA	significant impact area
SIP	State Implementation Plan
SIL	Significant Impact Level
SO_2	sulfur dioxide
tpy	ton(s) per year
USGS	United States Geological Survey
UTM	Universal Transverse Mercator projection
VOC	volatile organic compound(s)
WGS84	World Geodetic System 1984
§	section

Definitions

Note: The following explanations of terms are included solely for the reader's convenience; they do not replace any full, formal definition in state or federal laws, rules, or regulations.

Air Pollutants – One or more air contaminants that are present in the outdoor atmosphere.

Air Quality Related Value(s) (AQRV) – Valued resources that could potentially be impacted by air pollutant emissions, including but not limited to: visibility, odor, flora, fauna, geological resources, archeological, historical, and other cultural resources; and soil and water resources.

Ambient Air – That portion of the atmosphere, external to buildings, to which the general public has access.

Class I Area – An area defined by Congress that is afforded the greatest degree of air quality protection. Class I areas are deemed to have special natural, scenic, or historic value. The PSD regulations provide special protection for Class I areas in which little deterioration of air quality is allowed. Increases in ambient concentrations of NOx, SO_2 and PM_{10} must be below the PSD Class I increments.

Class II Area – Non-Class I areas that are in attainment with the NAAQS, or are not classified. Moderate deterioration of air quality associated with well-managed industrial growth is allowed in Class II areas. Increases in ambient concentrations of NOx, SO_2 and PM_{10} must be below the PSD Class II increments.

Class III Area – A Class II area that has been re-designated as Class III, after consultation with local elected officials, and approved by the State Governor or Indian Governing Body. Increases in ambient concentrations must be below the PSD Class III increments, which allow for larger increases in ambient concentrations than Class I or Class II increments. There are currently no designated Class III Areas in Montana.

Complex Terrain – Complex terrain is any terrain exceeding the height of the stack being modeled. This definition includes terrain that is commonly referred to as intermediate terrain, that is, those receptors between stack height and plume height.

Criteria Pollutant – A pollutant for which a national ambient air quality standard has been defined (SO_2, NO_2, PM_{10}, $PM_{2.5}$, Pb, CO, O_3).

Digital Elevation Model (DEM) – An array of elevations and associated geographic coordinates, usually at regularly spaced intervals, for a number of ground positions.

Federal Land Manager(s) (FLM) – Agencies that administer the nation's Federal Class I areas including the U.S. Department of Agriculture Forest Service (USDA/FS), the National Park Service (NPS) and the U.S. Fish and Wildlife Service (FWS).

Guideline on Air Quality Models (GAQM) – 40CFRPart 51 Appendix W, most recent version. This document contains EPA's recommended air quality modeling techniques that should be applied to permit application modeling. The reader is advised to obtain the most recent version of this reference from EPA's website.

Hazardous Air Pollutant (HAP) – Any pollutant subject to a standard promulgated under the federal Clean Air Act (CAA), §112 (relating to hazardous air pollutants).

Increment – See PSD increment.

Isopleth – A line on a map connecting points of constant value, usually used in air permit applications to show lines of equal air pollutant concentration.

Major Source (PSD Permitting) – The term major may refer to the total emissions at a stationary source or to a specific facility. For PSD review, once a site or project is major for one pollutant, all other pollutant emissions are compared to significance levels in 40 CFR 52.21(b)(23).

- A named major source is any source belonging to a list of 28 source categories in 40 CFR 52.21(b)(1) which emits or has the potential to emit 100 tons per year (tpy) or more of any pollutant regulated by the FCAA.

- A major stationary source is any source not belonging to the list of 28 source categories in 40 CFR 52.21(b)(1) that emits or has the potential to emit 250 tpy or more of any pollutant.

Major Source (Title V Operating Permit) – A major source, for Title V permitting purposes, is any source that emits 10 tpy or more of any single HAP or 25 tpy or more of any combination of HAPs under FCAA §112(b).

Major Modified Stationary Source or Facility – Used in the context of a PSD or NAA permitting action. The phrase "major modified stationary source or facility" refers to a change in operation that results in a significant net increase of emissions for any pollutant for which a NAAQS has been issued. New sources at an existing major stationary source are treated as modifications to the major stationary source.

Minor Source – As used in this document, a minor source is any stationary source that is not defined as a major stationary source by ARM 17.8.801(22)(a). The definition of minor source may vary based on the context in which it is used.

Model – A quantitative or mathematical representation or a simulation that attempts to describe the characteristics or relationships of physical events (GAQM).

Montana Ambient Air Quality Standards (MAAQS) – A permissible level of an air contaminant in the ambient air as defined by the maximum frequency with which a specified level may be exceeded or by a maximum level of an air contaminant in or on body or plant tissues (ARM 17.8.201).

National Ambient Air Quality Standards (NAAQS) – The Federal Clean Air Act established two types of national ambient air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against visibility impairment, damage to animals, crops, vegetation, and buildings (40 CFR §50.2).

National Geodetic Vertical Datum of 1929 – Reference surface established by the U.S. Coast and Geodetic Survey in 1929 as the datum to which relief features and elevation data are referenced in the conterminous United States; formerly called "mean sea level 1929."

Nearby Sources – A nearby source is any major source or minor source that causes a significant air pollutant concentration gradient in the vicinity of a new or modified source.

Non-attainment Area – An area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for a criteria pollutant.

North American Datum of 1927 (NAD27) – NAD27 is defined with an initial point at Meads Ranch, Kansas, and by the parameters of the Clarke 1866 ellipsoid. The location of features on most USGS topographic maps, including the definition of 7.5-minute quadrangle corners, is referenced to the NAD27.

North American Datum of 1983 (NAD83) – NAD83 is an Earth-centered datum and uses the Geodetic Reference System 1980 (GRS 80) ellipsoid. Please note: because the NAD83 surface deviates from the NAD27 surface, the position of a point based on the two reference datums will be different.

Other Background Sources – Other background sources include all sources of air pollution other than the source under review and those identified as nearby sources. Examples include area and mobile sources, natural sources, most minor sources, and distant major sources.

Prevention of Significant Deterioration (PSD) terminology – The following terms are relevant to the implementation of the PSD regulations:

> **PSD Increment** – The maximum permissible level of air quality deterioration that may occur beyond the baseline air quality level as defined in the PSD regulations.
>
> **Trigger Date** – The date after which the minor source baseline date may be established. It is August 7, 1977 for particulate matter and SO_2, and February 8, 1988 for NO_2 [40 CFR 52.21(b)].

Major Source Baseline Date – The date after which emissions from major sources consume or expand PSD increment. For particulate matter and SO_2 the major source baseline date is January 6, 1975, and for NO_2 it is February 8, 1988 [40 CFR 52.21(b)].

Minor Source Baseline Date – The earliest date after the trigger date on which a major stationary source or a major modification subject to PSD regulations submits a complete application [40 CFR 52.21(b)].

Baseline Area – The area in which the major source or major modification establishing the minor source baseline date would construct or would have an air quality impact equal to or greater than one microgram per cubic meter ($\mu g/m^3$) on an annual average, of the pollutant for which the minor source baseline date is established.

Receptor – A location where the public has access and could be exposed to an air contaminant (or pollutant) in the ambient air. Air quality models are used to estimate impacts at specific receptors.

Refined Model – An analytical technique that provides a detailed treatment of physical and chemical atmospheric processes, and requires detailed and precise input data. Specialized estimates are calculated that are useful for evaluating source impact relative to air quality standards and allowable increments. The estimates are more accurate than those obtained from conservative screening techniques (GAQM).

Screening Technique – A relatively simple analytical technique used to determine whether a given source is likely to pose a threat to air quality. Concentration estimates from screening techniques are considered conservative (GAQM) but less accurate than a refined model analysis.

Significant Impact – A concentration in ambient air that exceeds a modeling significance level.

Unclassified Area – Any area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for the pollutant.

Universal Transverse Mercator (UTM) – The UTM system is a plane coordinate system that uses distances from a specified reference point as the basis for all locations. It is based on a transverse Mercator projection that divides the Earth's surface into zones, each spanning six degrees of longitude and oriented to a meridian.

World Geodetic System 1984 (WGS 84) – The WGS 84 datum was developed as a replacement for WGS 72 by the military mapping community as a result of new and more accurate instrumentation and a more comprehensive control network of ground stations.

1.0 Introduction

The Montana Modeling Guideline focuses on the application of air dispersion models and general procedures for meeting the Montana Department of Environmental Quality (MDEQ) air permitting requirements. It is assumed that the reader has a basic knowledge of modeling theory and techniques. This Guideline, as applied to individual modeling projects, provides a minimum level of analysis to be used to demonstrate that the public's health, general welfare, and physical property are protected. In addition, this Guideline provides consistency in the selection and application of air dispersion models to ensure a common basis for estimating pollutant concentrations, assessing control strategies, and specifying emission limits – without compromising accuracy.

1.1 Purpose of Air Dispersion Modeling

Air dispersion modeling is a tool used to predict ambient air quality concentrations based on emissions from one or more sources of air pollution. A variety of air dispersion models have been developed for different pollution sources, meteorology, downwind distances, and other factors that affect how pollutants are dispersed in the atmosphere. In general, all of these models require information about the source being modeled and information about the dispersing characteristics of the meteorology surrounding the source. A model uses this information to mathematically simulate the pollutant's downwind dispersion in order to derive estimates of concentration at a specified location (receptor). Some models simulate chemical transformations and removal processes that can occur along the transport path.

Air dispersion models are used during the air quality permitting process to verify that new or modified sources of air pollution will not cause or contribute to an exceedance of the National Ambient Air Quality Standards (NAAQS), Montana Ambient Air Quality Standards (MAAQS), and applicable Prevention of Significant Deterioration (PSD) increments. An air quality preconstruction permit may not be issued to a new or altered source unless the applicant demonstrates that the source and/or stack can be expected to operate in compliance with the standards and rules adopted under the Montana Clean Air Act (MCAA), the applicable regulations and requirements of the Federal Clean Air Act (FCAA), and any applicable control strategies contained in the Montana State Implementation Plan (SIP), and that it will not cause or contribute to a violation of any MAAQS or NAAQS [ARM 17.8.749(3)].

MDEQ personnel use the results from air dispersion models in their review of air quality permit applications. Modeled predictions are one of the many parameters considered in the technical review process. A modeled prediction of an exceedance of an ambient standard may be used as the basis to modify permitted allowable emission rates, stack parameters or operating conditions, or require a SIP review for criteria pollutants.

1.2 Guidance Philosophy

This document is a guide to typical air dispersion modeling techniques and procedures. MDEQ's goal is to use worst-case assumptions and conditions to conduct the minimum amount of modeling necessary to demonstrate that the modeled source is not expected to cause or contribute to an exceedance of an ambient standard or increment. If the modeler can demonstrate that techniques other than those recommended in this document are more appropriate, MDEQ may approve their use. However, methods that deviate from this document and/or EPA's Guideline on Air Quality Models (GAQM) should be discussed with the MDEQ prior to conducting a modeling analysis. It is highly recommended that these methods be documented through the use of a protocol to prevent any misunderstandings. Any demonstration that deviates from recommended procedure must be fully documented in the air quality analysis and MDEQ will not guarantee acceptance.

1.3 DEQ Air Permitting Section Coordination

The applicant's contact with MDEQ should be coordinated through the assigned permit writer. The applicant should provide enough information to enable the permit writer to determine the need for regulatory modeling. Regulatory modeling is any air dispersion modeling used in the permitting process. The permit writer determines the need for modeling and the scope of involvement of other MDEQ staff.

The modeling support staff will review air dispersion modeling and provide feedback to the permit writer and the applicant. The review will evaluate the technical quality of air quality analyses to ensure that predicted concentrations accurately represent potential impacts, demonstrate compliance with federal and state regulations and guidelines, and can be used by the staff in the technical review process. MDEQ encourages applicants to submit modeling protocols for PSD and other complex modeling projects. In addition, MDEQ recommends that the applicant allow time for MDEQ staff to review the modeling protocol before modeling, in order to conserve time and resources.

MDEQ's air quality modeling review checklist is included in Appendix A of this Guideline. The checklist is available from MDEQ in MSWORD file format as well.

1.4 Sources Required to Perform Air Dispersion Modeling

Sources requiring a Montana air quality permit may be required to perform air dispersion modeling depending on the emissions and location of the proposed source. The extent of the required modeling necessary will vary from one source to another. The following sources will always be required to provide modeling:

- Major stationary sources or modifications, as defined in PSD regulations
- Incinerators
- Sources located in or near nonattainment areas

The following sources do not need to model unless directed by MDEQ:

- Open-burning
- Portable sources

MDEQ may determine that modeling is not required for minor sources applying for a new Montana air quality permit (MAQP) or for existing sources applying for a permit alteration, if the entire facility's proposed allowable emissions are less than the thresholds identified in Table

1. If the facility's allowable emissions are above the threshold identified in Table 1, dispersion modeling analysis will be required.

Table 1. Modeling Thresholds (for Attainment Areas)

Pollutant	Threshold	
	lb/day	tons/yr
Particulate Matter ≤ 10μm (PM_{10})	274	50
Particulate Matter ≤ 2.5μm ($PM_{2.5}$)	63.9	12
Sulfur Dioxide (SO_2)	274	50
Nitrogen Dioxide (NO_x)[(a)]	548	100
Carbon Monoxide (CO)[(b)]	548	100
Volatile Organic Compounds (VOC)[(c)]	548	100
Lead (Pb)	27.3	5

(a) Modeling for mobile NOx sources may be required on a case-by-case basis.
(b) If NOx modeling is conducted on the same emission point, then CO modeling will not be required.
(c) VOC modeling may be required for ozone compliance. Modeling for hazardous air pollutants (HAPs) will be on a case-by-case basis.

The thresholds listed in Table 1 are contained in MDEQ guidance and are not established by rule. The final determination of whether or not modeling is required will be made by MDEQ. Modeling may be required for sources falling below the thresholds in Table 1 if there is concern that the source will cause or contribute to a violation of the NAAQS, MAAQS, or other applicable regulations.

Facility-wide modeling for existing sources may be necessary, regardless of the emissions change associated with the application. Modeling may be required if there is not an approved facility-wide modeling analysis on file with MDEQ, or if there has been an increase in background sources or changes in air quality in the area. Modeling may also be required when there is a significant change in the dispersion characteristics of a source, even if the modification results in a small increase or a decrease in emissions.

A NOx emissions source of any size proposing to locate in the following Montana counties will be expected to submit dispersion modeling: Blaine, Gallatin, Park, Wheatland, Sweetgrass, Golden Valley, Stillwater, Musselshell, Yellowstone, Carbon, Treasure, Big Horn, Rosebud, Custer, Powder River or Carter.

1.5 Major Sources Within 10 Kilometers of a Class I Area

Any net emissions increase of a regulated pollutant at a major stationary source located within 10 kilometers (6.2 miles) of a Class I area should be modeled to determine if a maximum 24-hour average impact in the Class I area exceeds 1.0 microgram per cubic meter ($\mu g/m^3$) on a 24-hour basis. If the 24-hour impact of PM_{10}, NOx or SO_2 exceeds 1 $\mu g/m^3$, the emission increase is considered significant and the modification constitutes a major modification subject to PSD review (ARM 17.8.801). The Class I significance level of 1.0 $\mu g/m^3$ on a 24-hour basis is only intended to determine if a modification is major. It should not be used to determine if the impact in a Class I area is significant.

Table 3 in Section 2.2 contains a list of Class I areas in Montana. Figure 1 shows the locations of the Class I areas.

1.6 Exemptions from Modeling

Modeling is generally not required for the following situations, as long as the source emissions are below the levels in Table 1.

- Sources exempt from preconstruction permitting requirements;
- Sources not required to obtain a preconstruction permit;
- Emergency and backup generators – Modeling is not routinely required for emergency backup generators. It may be required if the equipment could be operated in a way that might result in a violation of an ambient standard; and
- Minor permit revisions – A revision to a permit or a permit condition is generally exempt from modeling as long as it does not involve a modification such as a physical change (e.g., addition of new equipment), a change in the method of operation (e.g., production increase), a change that would increase emissions, or a change in the dispersion characteristics.

The applicant should supply MDEQ, in writing, the reasons supporting their determination that modeling isn't necessary.

2.0 Applicable Standards and Regulations

Applicants preparing regulatory analyses are required to address all applicable NAAQS, MAAQS, and PSD increment averaging periods that apply to the pollutant being modeled. Modeling results must be provided for each pollutant and averaging period for which there is an applicable standard or increment.

This section provides summary information on aspects of the modeling guidance that are unique to Montana.

2.1 Montana and National Ambient Air Quality Standards

The MAAQS are listed in ARM Chapter 17.8, Subchapter 2, Ambient Air Quality. Montana's standards are as stringent as, or more stringent than, the NAAQS. Some of MAAQS have different averaging periods or have been converted from concentration units (ppm) to mass units ($\mu g/m^3$) using different standard conditions. Montana's defined standard conditions are contained in ARM 17.8.201(28).

Table 2 lists the current NAAQS and MAAQS, as per the date of this Guideline. The reader should verify the NAAQS and MAAQS before submitting the modeling report. NAAQS can be found in the CFR Title 40, Part 50, §50.1 *et. seq*.

Table 2. NAAQS and MAAQS

Pollutant	Averaging Period	Primary NAAQS	Secondary NAAQS	MAAQS
Carbon Monoxide (CO)	1-hour	40,000 $\mu g/m^3$ 35 ppm [(a)]	---------	26,450 $\mu g/m^3$ 23 ppm [(a)]
	8-hour	10,000 $\mu g/m^3$ 9 ppm [(a)]	---------	10,000 $\mu g/m^3$ 9 ppm [(a)]
Lead (Pb)	Calendar Quarter	1.5 $\mu g/m^3$ [(b)]	1.5 $\mu g/m^3$ [(b)]	---------
	90-day Average	---------	---------	1.5 $\mu g/m^3$ [(b)]
Nitrogen Dioxide (NO_2)	1-hour	---------	---------	564 $\mu g/m^3$ 0.30 ppm [(a)]
	Annual	100 $\mu g/m^3$ 0.053 ppm [(b)]	100 $\mu g/m^3$ 0.053 ppm [(b)]	94 $\mu g/m^3$ 0.05 ppm [(b)]
Ozone (O_3)	1-hour	235 $\mu g/m^3$ 0.12 ppm [(a)]	235 $\mu g/m^3$ 0.12 ppm [(a)]	196 $\mu g/m^3$ 0.10 ppm [(a)]
	8-hour	157 $\mu g/m^3$ 0.08 ppm [(a)]	157 $\mu g/m^3$ 0.08 ppm [(a)]	---------
Particulate Matter $\leq$ 10 µm (PM_{10})	24-hour	150 $\mu g/m^3$ [(c)]	150 $\mu g/m^3$ [(c)]	150 $\mu g/m^3$ [(c)]
	Annual	---------	---------	50 $\mu g/m^3$ [(d)]
Particulate Matter $\leq$ 2.5 µm ($PM_{2.5}$)	24-hour	35 $\mu g/m^3$ [(e)]	35 $\mu g/m^3$ [(e)]	---------
	Annual	15.0 $\mu g/m^3$ [(f)]	15.0 $\mu g/m^3$ [(f)]	---------

Pollutant	Averaging Period	Primary NAAQS	Secondary NAAQS	MAAQS
Sulfur Dioxide (SO_2)	1-hour	---------	---------	1,300 $\mu g/m^3$ 0.5 ppm [(g)]
	3-hour	---------	1,300 $\mu g/m^3$ 0.5 ppm [(a)]	--------
	24-hour	365 $\mu g/m^3$ 0.14 ppm [(a)]	---------	262 $\mu g/m^3$ 0.10 ppm [(a)]
	Annual	80 $\mu g/m^3$ 0.030 ppm [(b)]	---------	52 $\mu g/m^3$ 0.02 ppm [(b)]
Hydrogen Sulfide (H_2S)	1-hour	---------	---------	70 $\mu g/m^3$ 0.05 ppm [(a)]
Fluoride in Forage	Monthly	---------	---------	50 μg/gm [(b)]
	Grazing Season	---------	---------	35 μg/gm [(b)]
Settled Particulate Matter	30-day	---------	---------	10 gm/m^2 [(b)]
Visibility	Annual			3 x 10^{-5}/m [(b, h)]

(a) Not to be exceeded more than once per calendar year.
(b) Not to be exceeded in the averaging period specified.
(c) Not to be exceeded more than once per year, as determined in accordance with 40CFR50 Appendix K.
(d) Not to be exceeded in a calendar year, as determined in accordance with 40CFR50 Appendix K.
(e) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each monitor must not exceed 35 ug/m^3.
(f) To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple monitors must not exceed 15.0 ug/m^3.
(g) Not to be exceeded more than eighteen times in twelve consecutive months.
(h) Scattering coefficient of particulate mater; applicable to Class I areas only.
Sources: 40CFR50, July 1, 2004. ARM 17.8.210-230, updated through September 30, 2004.

2.2 Montana Class I Areas

Class I areas are defined by Congress and are afforded the greatest degree of air quality protection. Class I areas are deemed to have special natural, scenic, or historic value. Table 3 lists Class I areas located in Montana or nearby in neighboring states. Figure 1 shows locations of the mandatory Class I areas in and near Montana. The figure also shows locations of Montana's Indian Reservations, three of which are non-mandatory Class I areas.

The modeling analysis must include Class I increment analysis for all Class I areas and visibility analysis for mandatory Class I areas.

Table 3. Class I Areas in and Near Montana

Class I Area Name	Federal Land Manager
Mandatory Class I Areas[(a)]	
Anaconda Pintler Wilderness Area	USDA Forest Service
Bob Marshall Wilderness Area	USDA Forest Service
Cabinet Mountains Wilderness Area	USDA Forest Service
Gates of the Mountains Wilderness Area	USDA Forest Service
Glacier National Park	National Park Service
Medicine Lake Wilderness Area	U.S. Fish and Wildlife Service
Mission Mountain Wilderness Area	USDA Forest Service
Red Rock Lakes Wilderness Area	U.S. Fish and Wildlife Service
Scapegoat Wilderness Area	USDA Forest Service
Selway-Bitterroot Wilderness Area	USDA Forest Service
UL Bend Wilderness Area	U.S. Fish and Wildlife Service
Yellowstone National Park	National Park Service
North Absaroka Wilderness Area, Wyoming	USDA Forest Service
Theodore Roosevelt National Park, North Dakota	National Park Service
Non-mandatory Class I Areas[(b)]	
Northern Cheyenne Indian Reservation	EPA on behalf of the Northern Cheyenne Tribe
Flathead Indian Reservation	EPA on behalf of the Salish Kootenai Tribe
Fort Peck Indian Reservation	EPA on behalf of the Fort Peck Tribe
(a) Mandatory Class I Areas defined in ARM 17.8.806 and 40CFR81. (b) Non-mandatory Class I Areas defined in 40 CFR52.1382(c)(1).	

2.3 Non-attainment Areas in Montana

A non-attainment area is an area that does not meet (or that contributes to the ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for a criteria pollutant. The permit applicant needs to be aware of the locations of these areas when performing air quality modeling. Treatment of non-attainment areas in the modeling process is discussed in Section 4.9.

Montana non-attainment areas, as defined in 40CFR81.327, are listed Table 4. The rest of the state is designated attainment, which means monitoring has shown attainment, or unclassifiable, which means that monitoring has not been performed. The list in Table 4 is current as of the date of this Guideline. The applicant needs to verify the status of Montana's non-attainment areas by checking 40CFR81.327 for specific information on each non-attainment area.

Figure 1. Class I Areas and Indian Reservations

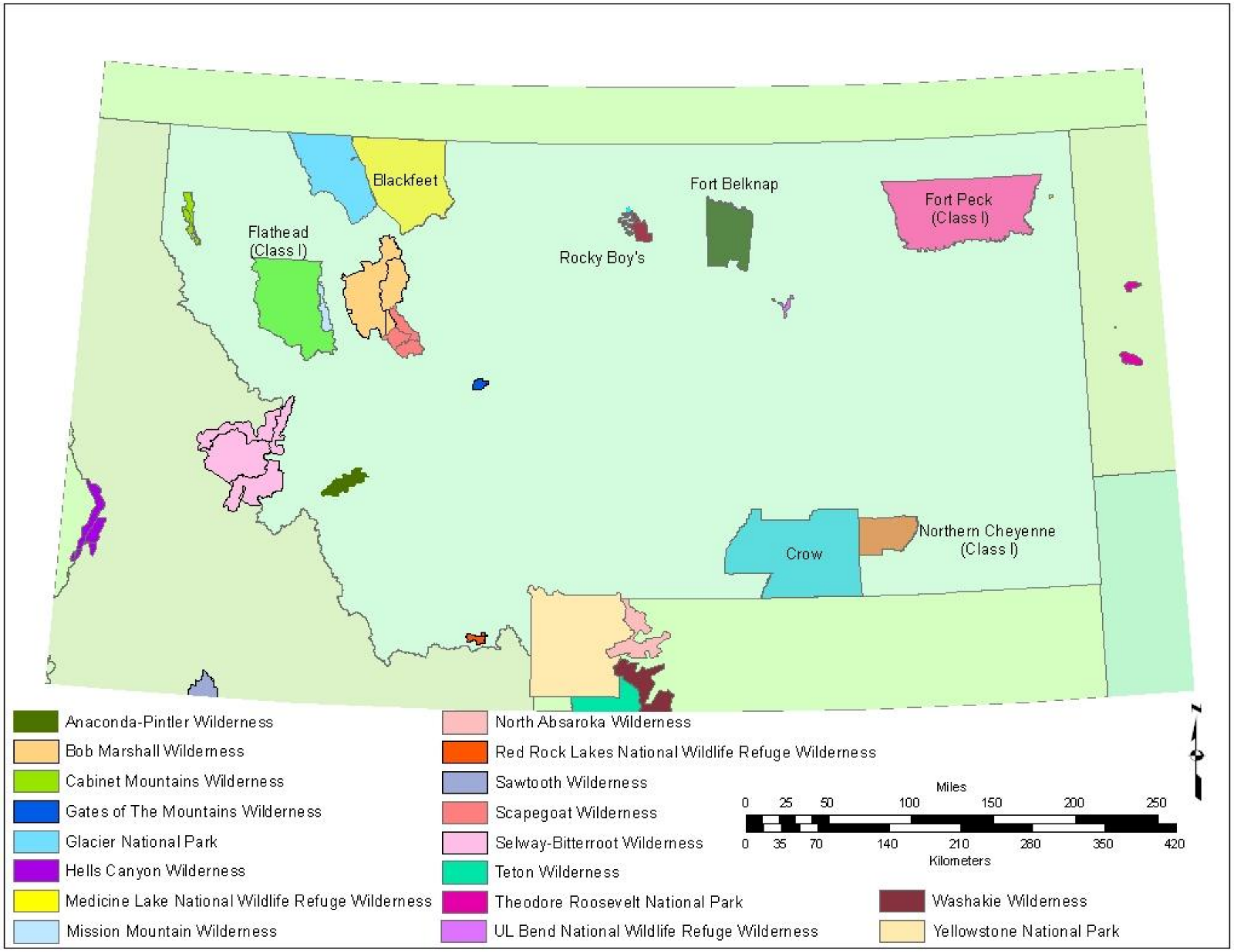


Table 4. Montana Non-attainment Areas

Pollutant	County	Non-Attainment Area
Sulfur Dioxide	Yellowstone County	Laurel area
	Lewis & Clark County	East Helena area
Carbon Monoxide	Missoula County	Missoula and vicinity
Lead	Lewis & Clark County	City of East Helena and vicinity
Ozone	None	
PM_{10}	Flathead County	Kalispell and vicinity
		Columbia Falls and vicinity
		Whitefish and vicinity
	Lake County	Ronan
		Polson
	Lincoln County	Libby and vicinity
	Lewis and Clark County	East Helena area
	Missoula County	Missoula and vicinity
	Rosebud County	Lame Deer
	Sanders County	Thompson Falls and vicinity
	Silver Bow County	Butte and vicinity
Nitrogen Dioxide	None	
$PM_{2.5}$	Lincoln County	Libby and vicinity

2.4 Existing/Background Air Quality in Attainment Areas

Information on existing or background air quality is used in the ambient impact analysis to determine the total ambient concentration. Table 5 lists the background or existing air quality values used in most of Montana.

Table 5. Typical Attainment Area Background Values

Pollutant	Averaging Period	Background[(a)] ($\mu g/m^3$)
PM_{10}	Annual	8
	24-hour	30
$PM_{2.5}$[(b)]	Annual	8
	24-hour	30[(c)]
SO_2	Annual	3
	24-hour	11
	3-hour	26
	1-hour (19th)	35
CO	8-hour	1150
	1-hour	1725
NO_2	Annual	6
	1-hour	75

(a) Data developed from SALEM site operated during 1980 and 1981 by the Montana Power Company at a site located about 10 miles east-northeast of Great Falls, Montana.
(b) $PM_{2.5}$ background values assumed to be PM_{10} values.
(c) Value may not be valid in urban or mountainous areas. Contact DEQ for $PM_{2.5}$ 24-hour background value.

Use of the values in Table 5 assumes that all local significant emission sources are included in the model. Applicants are encouraged to use existing air quality data collected in the project area, with approval from MDEQ. MDEQ will supply background concentration values for use in or near non-attainment areas on a case-by-case basis.

2.5 Conversion of NOx to NO_2

Combustion source NOx emissions include NO and NO_2, as well as lesser amounts of other nitrogen oxides. Emission factors are typically expressed as NOx, while the ambient standards are for NO_2. Three methods are available for converting modeled NOx concentrations to NO_2 concentrations. The most conservative method is to assume that all the NO emissions are converted to NO_2 in the environment. The total modeled NOx concentration is therefore assumed to be NO_2 and is compared to the NAAQS, MAAQS and PSD increments for NO_2.

The second method is called the ambient ratio method and is described in Appendix B of this document as well as the GAQM. In the ambient ratio method, the modeled NOx concentration is multiplied by an empirically derived NO_2/NOx ratio to determine the NO_2 concentration. The national default ambient ration method NO_2/NOx ratio is 0.75 for annual averaging periods (Chu and Meyer, 1991). MDEQ will also accept the ozone limiting method (OLM) to demonstrate compliance with the 1-hr NO_2 MAAQS. Refer to Appendix B for instructions and acceptable assumptions to apply this method.

2.6 Montana's Incinerator Rule Modeling

An application for a permitting action involving incineration must include a risk assessment as per Montana's air quality regulations. The applicant needs to contact the Air Permitting Section Supervisor for an evaluation of whether the proposed project is defined as an incinerator. Additional permitting requirements for incinerators are contained in ARM 17.8.770.

An applicant for a Montana air quality permit for an incineration facility shall submit a human health risk assessment protocol and a human health risk assessment as part of the air quality permit application. The human health risk assessment must demonstrate that the ambient concentrations of pollutants resulting from emissions from the incineration facility constitute no more than a negligible risk to the public health, safety, and welfare. The applicant should contact MDEQ for assistance and guidance in conducting the risk assessment modeling.

3.0 Model Selection and Application

The applicant is responsible for determining current modeling procedures at the time the modeling is submitted. The primary EPA modeling guideline is 40CFR51 Appendix W, the Guideline on Air Quality Models (GAQM). The GAQM and EPA modeling information can be found on EPA's Technical Transfer Network Support Center for Regulatory Atmospheric Modeling (SCRAM) at this internet address: http://www.epa.gov/scram001.

Although the GAQM was developed to address PSD and SIP modeling issues, MDEQ uses this guidance for most modeling demonstrations to maintain a consistent approach for all projects. Procedures and models other than those recommended by EPA or in this Guideline may be approved on a case-by-case basis if there is sufficient technical justification; however, EPA approval may also be necessary in some instances. Refer to EPA guidance for the use of alternative models.

Model selection and application should be consistent with the GAQM, EPA guidance and EPA model user guides. Approved dispersion models and supporting documentation are available to the public free of charge via the SCRAM site. The most recent version of EPA-approved models must be used. Use of older versions of any of the models or processors requires prior MDEQ approval.

3.1 Preferred/Recommended Models

The preferred/recommended dispersion models are listed in the GAQM and are required to be used for SIP revisions for existing sources and for the New Source Review (NSR) and PSD programs. EPA recommends using a steady-state Gaussian plume model such as AERMOD for dispersion modeling within 50 kilometers (km) of the modeled source. EPA recommends the use of CALPUFF for dispersion modeling beyond a distance of 50 km but less than 300 km. Any proposed use of CALPUFF for nearby receptors needs to be pre-approved by MDEQ.

The applicant must use the most current EPA-approved version of the models. The preferred models include the following:

AERMOD Modeling System – A steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain.

AERSCREEN – Proposed screening model for AERMOD. The model will produce estimates of regulatory design concentrations without the need for meteorological data and is designed to produce concentrations that are equal to or greater than the estimates produced by AERMOD with a fully developed set of meteorological and terrain data. AERSCREEN may be accepted for single source applications when available.

CALPUFF Modeling System – A non-steady state puff dispersion model that simulates the effects of time-varying and space-varying meteorological conditions on pollution transport, transformation, and removal. CALPUFF can be applied for long-range transport and for complex terrain.

CALPUFF modeling for permit applications, including visibility analyses, must use the most recent EPA-approved version of CALPUFF.

Other Models – Other dispersion models include BLP, CALINE3, CAL3QHC/ CAL3QHCR, CTDMPLUS, and OCD.

3.2 Status of Older Models

AERMOD has replaced ISC3 as the preferred Gaussian plume model for near-field dispersion. Beginning August 2006, MDEQ will not accept new models using ISC3 or ISC-PRIME. MDEQ will assist applicants with conversion of ISC3 models to AERMOD as necessary.

SCREEN3, the screening version of ISC3, may be accepted for simple sources until AERSCREEN becomes available.

MDEQ is no longer accepting the CALPUFF screening methodology described in the "Guide for Applying the EPA Class I Screening Methodology with the CALPUFF modeling System, Earth Tech, Inc., December 2000." The decision to stop using this methodology was made based on advice from the Federal Land Managers (FLM's).

3.3 Modeling Protocols

DEQ recommends that the applicant submit a written modeling protocol before conducting any refined modeling analysis. The protocol should detail the modeling analysis methodology including model selection, meteorological data, additional sources in the area, etc. The protocol development process is intended to minimize the chances of misunderstandings and to avoid delays during the permit process. The protocol should explain how the modeling analysis will be performed, how the results will be presented, and how compliance with the applicable requirements will be demonstrated.

Protocols are required in the following situations:

- Modeling to support risk assessments (ARM 17.8.770);
- Non-steady state modeling; or
- Non-guideline model use.

Submission of a modeling protocol is recommended for:

- New sources and modifications subject to PSD requirements;
- Complex new sources or modifications such as mining operations or complex industrial facilities; and
- New sources or modifications in or near non-attainment areas.

Appendix C of this Guideline provides a suggested modeling protocol outline.

3.4 Proprietary Models and Software

MDEQ recognizes the use of proprietary software packages to perform regulatory modeling analyses. If these programs are used, the modeling must not include modeling options or source types that are not supported by the latest EPA version of the regulatory models.

Regardless of the software package used, the applicant must submit input files that can be used in the most current DOS version of the EPA regulatory models. The input files must have the *.dta extension for clarity. The applicant must also submit standard output files in ASCII format, using the *.lst extension.

3.5 Data Submitted is not Proprietary

Any source characteristic, meteorological, terrain, topographical, or other model input data submitted to MDEQ in support of a modeling analysis is considered part of the public record and will be available to the public.

4.0 General Modeling Methodology

This section describes modeling analysis methodologies and applicable requirements. Section 5 contains specific instructions for setting up and running air dispersion models.

4.1 Scope of Modeling Analysis

Montana's air quality regulations address three general categories of Montana air quality permit (MAQP) applications:

- Major new source review permitting actions subject to PSD review;
- Minor source permitting actions subject to general air quality permit requirements (minor new source review); and
- Major or minor source permitting actions subject to non-attainment area review.

The type of MAQP determines the complexity of the modeling analysis. Table 6 summarizes the goals of the modeling analysis for different permit types. MDEQ may require dispersion modeling for other regulatory programs or concerns not covered in this table.

Table 6. Goals of the Impact Analysis for Air Quality Permits

Permit Type	Area Classification	Goals of Ambient Air Impact Analysis
Minor new sources or modifications not subject to PSD rules	Attainment, Unclassifiable	NAAQS and MAAQS compliance, PSD increment compliance in some areas
Major new sources or modifications subject to PSD rules	Attainment, Unclassifiable	NAAQS, MAAQS, and PSD increment compliance
		Class II AQRV and associated growth analyses
		Class I AQRV analysis
		Visibility in mandatory Class I Areas
		Pre- and post-construction monitoring determination
Any source defined as an incinerator	Any classification	Risk assessment
Minor sources or minor modifications (<100 tpy)	Nonattainment	NAAQS and MAAQS compliance or reasonable further progress (RFP) analysis
Major sources or major modifications (≥100 tpy)	Nonattainment	NAAQS and MAAQS compliance or RFP analysis
		Lowest achievable emission rate
		Emission offsets that provide a positive net air quality benefit
		Net air quality benefit analysis

Modeling must be included for every criteria pollutant that is emitted from the source, with the exception of ozone. The need for VOC modeling to determine ozone compliance will be determined on a case-by-case basis. Hydrogen sulfide (H_2S) and Pb emissions should also be modeled. The model output must include results for every averaging period for which there is a corresponding standard or increment.

4.2 Screening vs. Refined Modeling

The complexity of the modeling analysis depends on the size and location of the proposed project, existing air quality in the project area, proximity of nearby sources and distance to sensitive areas. There are two levels of modeling complexity used in the air quality analysis process: screening and refined. Modeling results from either level, as appropriate, may be used to demonstrate compliance with the ambient standards or increments.

The least complex form of modeling involves the use of screening procedures or models. Screening models are used to simulate a worst-case condition (i.e., highest predicted impact). These models take less computer time and are more conservative than refined models. Screening models use simple algorithms and conservative techniques to either verify compliance or determine that more detailed modeling is necessary.

Screening models are usually designed to evaluate a single source or sources that can be merged into a single representative source (Section 5.7.3). Multiple sources can be modeled individually and then the maximum concentration from each source summed for an overall estimate of the facility-wide maximum concentration. This technique is highly conservative since the impacts from each source are added without regard to location or timing of the maximum impact.

The screening analysis should be performed in a manner consistent with guidance contained in the GAQM, and appropriate screening modeling guidance documents, such as the Screening Procedures for Estimating the Air Quality Impact of Stationary Sources (EPA 450/R-92-019). SCREEN3 is a computer model that implements EPA's screening procedures. EPA is developing AERSCREEN which will eventually replace SCREEN3.

Refined modeling is necessary if the screening analysis predicts source impacts that could exceed a standard, a de minimis level, or a staff-identified percentage of a standard. Refined modeling requires more detailed and precise input data, and uses more complex models in order to provide more accurate concentration estimates. The primary model used for refined modeling is EPA's AERMOD model, which is available for download from the EPA's SCRAM website.

4.3 Modeling for Minor New Source Review

Minor new source review permitting applies to sources that require a MAQP, are not subject to PSD requirements, and are not located in or within 10 km of a non-attainment area. The goal of minor source new source review modeling is to demonstrate that the source will not cause or contribute to a violation of NAAQS or MAAQS. MDEQ may require additional modeling demonstrations if the project location or source parameters give rise to specific environmental concerns.

The minor source permit modeling methodology should follow the requirements of the GAQM as closely as possible. Modeling for a new facility should include all emissions from that facility. Modeling for changes at an existing facility should include all emission sources at the facility, including the changed sources. Emissions from other permitted industrial sources within 2 km of the proposed (or modified) facility should be included in the modeling demonstration. After seeing the results of the modeling demonstration, DEQ will determine whether additional off-site sources should be added to the modeling analysis.

MDEQ may accept significant impact analysis for minor sources, as described in Section 4.4.1. If the proposed emission changes associated with the minor source permitting action do not result in significant Class II impacts (Table 7), a full impact analysis may not be required. The modeling report or permit application should state the distance to the nearest non-attainment area(s) and Class I area(s). If the minor source is located within 50 km of a Class I area, the modeling should include receptors at the closest point in the Class I area.

Minor sources may need to demonstrate compliance with PSD increments as described in Section 4.5 below.

4.4 Modeling for Major Sources and Major Modifications

Applicants should submit a PSD permit modeling protocol prior to beginning modeling for major sources and major modifications. The protocol should specifically address the models and methodologies to be used in the PSD modeling demonstrations.

Modeling for PSD-major sources and major modifications is based in EPA's New Source Review Workshop Manual, Draft, (EPA, 1990). EPA recommends a two-phase process for PSD modeling. The first phase is the significant impact analysis and the second phase is the full impact analysis. The results of the significant impact analysis determine if the applicant is required to perform the full impact analysis. PSD modeling requires numerous additional impact analyses including AQRVs and visibility analysis. Figure 3 shows the basic steps in the air quality analysis for MAAQS, NAAQS and PSD increment compliance.

4.4.1 Significant Impact Analysis

The significant impact analysis identifies predicted impacts due to increased potential emissions from a proposed new source or the net emissions increase from a proposed modification. Results from the significant analysis are compared to the PSD modeling significant impact levels (SIL's) to determine if the impact is significant. Background concentrations and impacts from other sources are not considered in the significant impact analysis. If the modeled concentration is below the applicable SIL for each pollutant and averaging period, no further analysis is typically required to demonstrate compliance with the NAAQS, MAAQS, or PSD increments. If the impact exceeds any SIL, the source or modification has a significant ambient impact and a full impact analysis is required.

The highest modeled concentrations at receptors in Class II areas are compared to the SIL's in Table 7 to determine if the impact is significant. All areas of Montana are designated as Class II except for those areas identified in Table 3. The highest modeled concentrations at receptors in Class I areas are compared to the Class I SIL's in Table 8 to determine whether additional analyses will be needed. EPA's 1990 PSD modeling guidance stated that if a proposed source is located within 100 km of a Class I area, an impact of 1 $\mu g/m^3$ on a 24-hour basis (at a Class I area receptor) is considered significant (EPA, 1990). MDEQ uses the Class I SIL's in Table 8 to provide better protection of Class I areas.

Table 7. Modeling Significance Levels for Class II Areas

Pollutant	Averaging Period/Significance Level				
	Annual ($\mu g/m^3$)	24-hr ($\mu g/m^3$)	8-hr ($\mu g/m^3$)	3-hr ($\mu g/m^3$)	1-hr ($\mu g/m^3$)
Sulfur Dioxide (SO_2)	1	5	---	25	25[(a)]
Total Suspended Particulate (TSP)	(No Longer in Use)		---	---	---
Particulate Matter ≤10 µm (PM_{10})	1	5	---	---	---
Particulate Matter ≤2.5 µm ($PM_{2.5}$)[(b)]	0.3	1.2	---	---	---
Nitrogen Oxides (NOx)	1	---	---	---	---
Carbon Monoxide (CO)	---	---	500	---	2,000
Ozone (O_3)	A 100 tpy net emissions increase of VOC subject to PSD requires ozone ambient impact analysis.				

Source: EPA 1990, Table C-4.
(a) Determined on a project-basis by MDEQ for modeling 1-hour SO_2 impacts in Montana.
(b) Ratioed from PM_{10} significance levels based on comparable NAAQS.

Table 8. Tentative Modeling Significance Levels for Class I Areas

Pollutant	Averaging Period/Significance Level				
	Annual ($\mu g/m^3$)	24-hr ($\mu g/m^3$)	8-hr ($\mu g/m^3$)	3-hr ($\mu g/m^3$)	1-hr ($\mu g/m^3$)
Sulfur Dioxide (SO_2)	0.1	0.2	---	1.0	---
Particulate Matter ≤10 µm (PM_{10})	0.2	0.3	---	---	---
Particulate Matter ≤2.5 µm ($PM_{2.5}$)	0.06	0.07	---	---	---
Nitrogen Oxides (NO_x)	0.1	---	---	---	---

Source: Inferred from Class II significance levels. These values should only be used if there is agreement between the MDEQ and the affected FLM that levels are appropriate for a given Class I area.

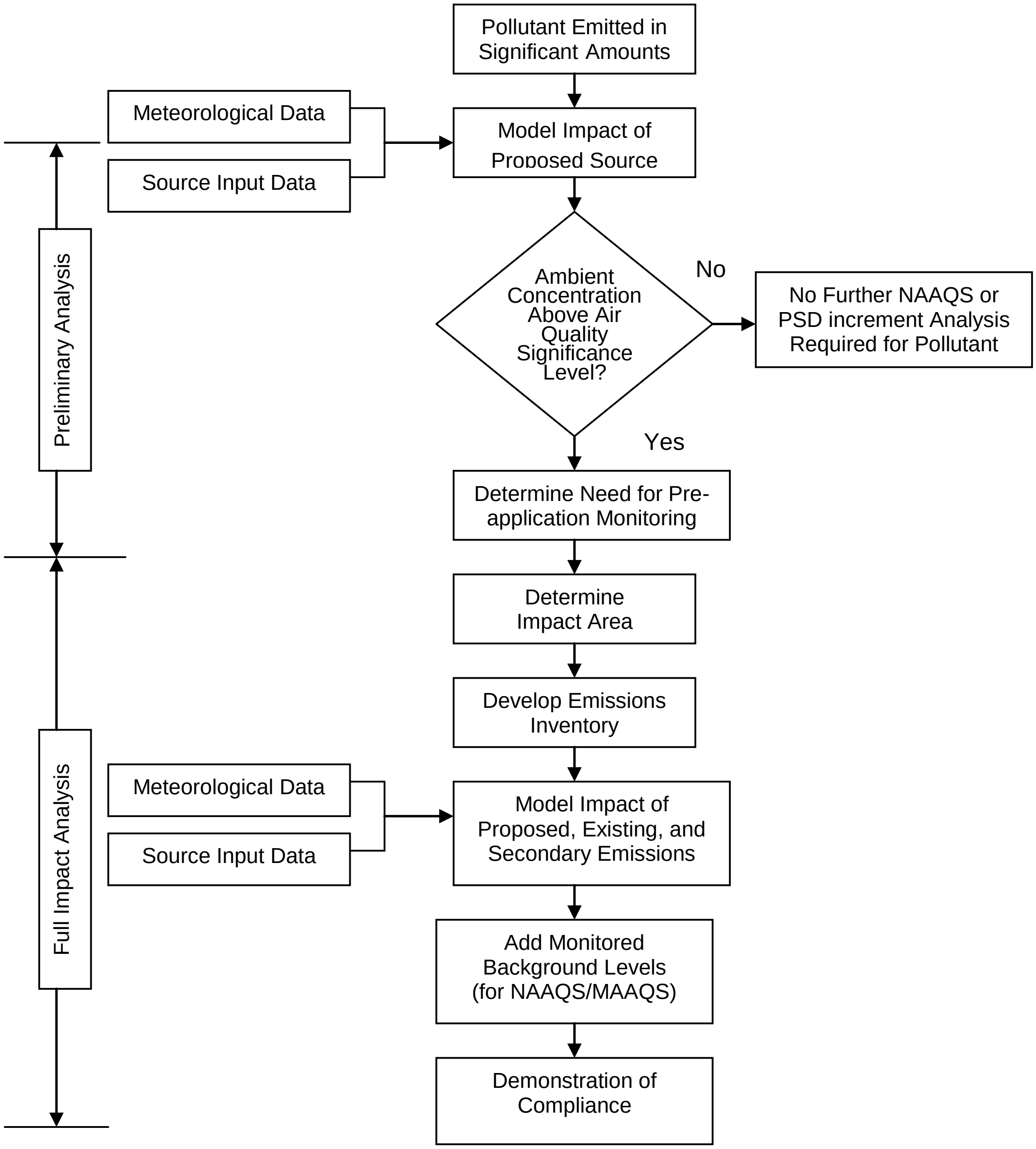
For modifications/alterations to existing facilities not subject to PSD or non-attainment area permitting, where approved facility-wide modeling is on file with MDEQ, only the facility-wide net emissions increase for the modification/alteration may need to be modeled. For sources where facility-wide modeling has not been conducted for previous permits, all sources at the facility must be modeled for each applicable pollutant. Sources that previously modeled using ISC3 should redo the facility-wide model using AERMOD where appropriate.

The significant impact analysis establishes a radius of impact (ROI) or "footprint" for the proposed source or modification. The ROI is the geographical area for which the required air quality analyses for the NAAQS and PSD increments are carried out. The ROI is established by drawing a circle with radius equal to the most distant point where the model predicts a significant ambient impact. The modeling report should identify the ROI for each pollutant and averaging period.

Figure 2. Basic Steps in the Air Quality Analysis

(NAAQS/MAAQS and PSD Increments)

From EPA, 1990, Figure C-3



4.4.2 Full Impact Analysis

A full impact analysis is required for any pollutant for which a proposed source's estimated ambient pollutant concentration exceeds the significant ambient impact levels identified in Table 7 for Class II areas and Table 8 for Class I areas. For major sources and modifications subject to PSD review, the elements of the "additional impact analysis" in Class I and II areas must be addressed even if the estimated impacts are below the modeling significance levels.

The full impact analysis expands the significant impact analysis to include impacts from:

- All other sources at the facility under review;
- "Nearby" (off-site) sources;
- "Nearby" sources which have received PSD permits but are not yet in operation;
- Proposed "nearby" PSD sources which have submitted complete PSD applications to a regulatory agency, but have not yet been issued permits;
- "Other background" sources; and
- Emissions from growth in residential, commercial, and industrial sources associated with, but not part of, the proposed source. The growth analysis applies only to major sources and modifications subject to PSD review.

Refer to Section 5.2.2 for guidance on selecting "nearby" and "other background" sources to include in the modeling. For the NAAQS demonstration, sources not included in the model (e.g., mobile sources, small stationary sources, and distant large sources) are accounted for by adding a background concentration from a representative air quality monitoring site.

4.5 PSD Increment Compliance Demonstration

Major sources and major modifications subject to the PSD regulations are required to comply with the PSD increments contained in 40CFR51.166(c) and ARM 17.8.804 and listed in Table 9. PSD increments have not yet been developed for $PM_{2.5}$.

Table 9. PSD Increments

Pollutant	Averaging Period	Class I ($\mu g/m^3$)	Class II ($\mu g/m^3$)	Class III ($\mu g/m^3$)
NO_2	Annual [(a)]	2.5	25	50
SO_2	3-hr [(b)]	25	512	700
	24-hr [(b)]	5	91	182
	Annual [(a)]	2	20	40
PM_{10}	24-hr [(b)]	8	30	60
	Annual [(a)]	4	17	34

(a) Never to be exceeded.
(b) Not to be exceeded more than once per year.

Background concentrations are not added to the modeled impacts for purposes of PSD increment compliance. However all impacts from sources which consume PSD increment need to be included in the PSD increment analysis. MDEQ can provide a list of PSD increment-consuming emissions and modeling source parameters. PSD increment-consuming sources may include area and mobile source emissions as well as stationary point sources.

Minor sources requiring Montana air quality permits may need to demonstrate compliance with the PSD increments, depending on their location. A minor source located within the impact area of a source that has triggered the PSD minor source baseline date needs to demonstrate that the proposed minor source permitting action will not cause or contribute to a violation of the PSD increment. If the minor source impact is below the significant impact level, the PSD increment analysis is considered complete. If a complete analysis for PSD impacts is needed, MDEQ can supply a list of the PSD major source emissions and source parameters. Figure 3 shows the locations of PSD-major sources and their significant impact areas.

4.6 Additional Requirements for PSD-Major Applications

This section is intended for new sources and modifications subject to PSD rules that are located in attainment or unclassified areas of Montana. Sources located in non-attainment areas should also read Section 4.9.

4.6.1 Pre-construction Monitoring

Montana and federal PSD regulations require that any application for a PSD permit contain an analysis of ambient air quality in the area that the emissions from the major stationary source or major modification would affect. ARM 17.8.822(5) specifies that the analysis contain continuous air quality monitoring data gathered for purposes of determining whether emissions of that pollutant would cause or contribute to a violation of the MAAQS/NAAQS or any PSD increment.

ARM 17.8.818(7)(a) allows MDEQ to exempt a source from pre-construction monitoring based on modeled impacts. MDEQ may exempt a proposed major stationary source or major modification from the requirements of ARM17.8.822, with respect to monitoring for a particular pollutant, if the emissions increase of the pollutant from a new stationary source or the net emission increase of the pollutant from a modification would cause, in any area, air quality impacts less than the amounts listed in Table 10. The demonstration of eligibility from exemption from pre-monitoring is made based on modeling.

If pre-construction monitoring is required, the timeline for submitting a PSD application could be affected by the requirement to collect ambient data. A full year of data must be collected and approved by MDEQ before the permit application can be processed and deemed complete. The applicant should contact MDEQ monitoring staff early in the permitting process to discuss the need to conduct pre-construction monitoring. If monitoring is proposed or required, a monitoring plan consistent with recent EPA and MDEQ monitoring guidance (e.g., policy) should be submitted for approval.

Figure 3. Existing PSD Significant Impact Areas

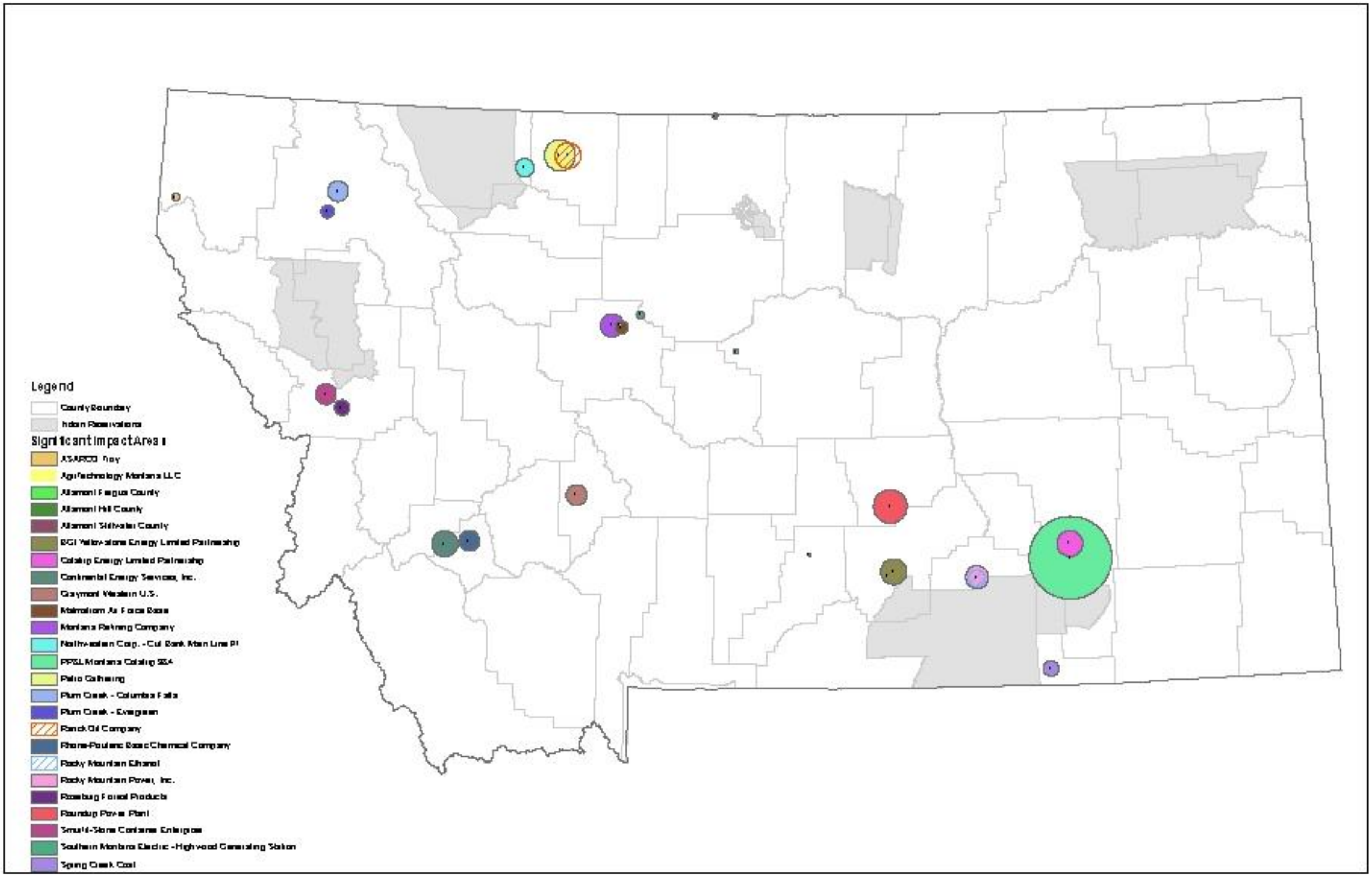


Table 10. PSD Pre-monitoring Exemption Eligibility Levels

Pollutant	Averaging Period	Exemption Eligibility Level ($\mu g/m^3$)[a]
PM_{10}	24-hr	10
$PM_{2.5}$[b]	24-hr	2.3
NO_2	Annual [c]	14
CO	8-hr	575
SO_2	24-hr	13
Pb	3-month	0.1
O_3	If net increase of VOC is less than 100 tpy, source may be exempt from O_3 monitoring.	

(a) All concentrations are 1st-high for comparison to the pre-monitoring exemption levels.
(b) Ratioed from PM^{10} level.
(c) The ambient ratio method can be used to convert NOx to NO_2.

4.6.2 Post-construction Monitoring

MDEQ can potentially require a permit applicant to conduct post-construction monitoring. ARM 17.8.822(8) states "The owner or operator of a major stationary source or major modification shall, after construction of the stationary source or modification, conduct such ambient monitoring as the department determines is necessary to determine the effect emissions from the stationary source or modification may have, or are having, on air quality in any area."

In accordance with ARM 17.8.822 (8), the decision to require post-construction monitoring is discretionary as suggested by federal regulations. MDEQ has a policy to help determine whether facility will be required to conduct monitoring. The policy can be obtained upon request from the assigned permit writer.

4.6.3 Air Quality Related Values (AQRVs) Analysis

The additional analyses required for Class I areas address potential impacts to Air Quality Related Values (AQRVs), including visibility. Visibility analysis is addressed in Section 4.7. The goal of the Class I impact analysis is to determine if the levels of change to AQRVs are acceptable for a given Class I area. Refer to ARM 17.8.825 for the regulatory requirements.

The additional impact analysis should be based on the appropriate models and procedures recommended in federal guidance documents and publications (e.g., FLAG, 2000; EPA, 1998) The modeling approach may be unique for each Class I area depending on the FLM's assessment of whether or not an adverse impact would occur. The assessment is based on the sensitivity of the AQRVs at the particular FLM area under consideration. Consequently, MDEQ recommends that the Class I modeling approach be presented in a written modeling protocol to both MDEQ and the affected FLM(s).

In general, the AQRV analysis should include analysis of the impacts on visibility, soils, water, odor, flora, and fauna that would occur as a result of the new source or modification, in conjunction with all other emission sources affecting an area. Also, an air quality impact analysis is required to predict the effects of general commercial, residential, industrial, and other growth associated with the source or modification.

The additional impact analysis in Class II areas includes a soils and vegetation analysis, a water analysis, and a visibility impairment analysis. A growth analysis will be required only if a full impact analysis is triggered. The soils and vegetation analysis is intended to provide information about the potential for adverse impacts on soils and vegetation.

4.7 Visibility Analysis

Visibility requirements for new sources and modifications subject to PSD rules are found in Subchapter 8, PSD (ARM 17.8.824 and 825) and Subchapter 11 Visibility Impact Assessment (ARM 17.8.1101 – 1111).

The applicant for a major source permitting action should contact MDEQ and affected FLMs at the beginning of the permitting process to determine the visibility impact analysis requirements. Visibility is an AQRV that is protected in the mandatory Class I areas, as listed in Table 3. Administrators of the tribal Class I areas may request a visibility analysis for informational purposes, though the results would not be binding. In addition, MDEQ may request visual impact analysis for sensitive Class II areas if impacts are of particular public concern.

VISCREEN can be used to determine visual plume impacts on Class I areas within 50 km of the project. If the highly-conservative VISCREEN Level I analysis does not show impacts below significant levels, the application can move to more-refined VISCREEN analyses or PLUVUEII analyses. These analyses should be described in the Class I modeling protocol.

Visibility impacts at distances greater than 50 km are generally referred to as regional haze impacts. Regional haze impact analyses should follow the guidance document titled “Federal Land Manager’s Air Quality Related Values Workgroup (FLAG): Phase I Report” (FLAG, 2000). Any differences between the submitted analysis and the FLAG guidelines should be discussed with MDEQ prior to the application submittal.

Regional haze modeling should be done using the CALPUFF modeling system. MDEQ has prepared checklists for the recommended CALMET/CALPUFF modeling parameters, which are available upon request. The application should include the MDEQ checklists so the chosen parameters can be easily compared to the recommended parameters. Any differences between the recommended and chosen parameters should be explained in the modeling report. CALPUFF modeling for regional haze evaluation must be based on the maximum 24-hour emission rates. Post-processing using CALPOST must include CALPOST Method 2 and CALPOST Method 6 results. Other post-processing results can be presented, but the analysis is incomplete without Method 2 and Method 6 results.

4.8 Deposition Analysis

MDEQ will direct the applicant to contact affected FLMs to determine whether additional Class I analyses are requested. Deposition modeling to determine potential impacts on sensitive water bodies is commonly required for PSD permit applications. MDEQ can help the applicant obtain a list of sensitive lakes to be evaluated and FLM guidance for lake analyses.

4.9 Non-attainment Area Impact Analysis for Minor and Major Sources

Major sources locating in or near non-attainment areas must comply with the requirements of ARM 17.8.901 *et. seq.* The definition of a major source for purposes of non-attainment area permitting is different than for PSD permitting. An applicant proposing a major (≥100 tpy) source in or within 10 km of a non-attainment area should contact the Air Permitting Section early in the permitting process.

Sources located in or impacting non-attainment areas can demonstrate that the proposed source or modification will not cause or contribute to a violation of the NAAQS or MAAQS based on the significance levels contained in 40CFR51 Appendix S. The non-attainment area significance levels are listed in Table 11.

Table 11. Non-attainment Area Significant Impact Levels[a]

Pollutant	Annual	Averaging Time (hours)			
		24	8	3	1
SO_2	1.0 µg/m^3	5 µg/m^3	---	25 µg/m^3	25 µg/m^3 [b]
PM_{10} (TSP)	1.0 µg/m^3	5 µg/m^3	---	---	---
NO_2	1.0 µg/m^3	---	---	---	---
CO	---	---	500 µg/m^3	---	2000 µg/m^3
$PM_{2.5}$	To Be Determined		---	---	---

(a) Significance levels are compared to the high-first-high modeled impact.
(b) Determined on a project-basis by MDEQ for modeling 1-hour SO_2 impacts in Montana.

Sources that cannot demonstrate non-significant impacts based on the Table 11 need to submit a full impact analysis, as would be required in an attainment/unclassified area. Existing background concentration values for the full impact analysis need to be obtained from MDEQ for the specific non-attainment area.

5.0 Model Input Data Requirements

Technical options to be selected for regulatory modeling are outlined in the GAQM. Any selection of a technical option that deviates from Montana or EPA regulatory guidelines is subject to prior approval by MDEQ.

The internal source codes for regulatory models should not be modified in a manner that would change the basic algorithms used by the model to calculate ground-level concentrations, without MDEQ review and comment. Minor changes unrelated to model algorithms, such as re-dimensioning the source or receptor arrays do not require MDEQ coordination. The applicant must document and submit substantial preprocessor/postprocessor programs or subroutines to the MDEQ.

5.1 Modeling Emissions Inventory

The emissions inventory for the proposed project is the most important part of the modeling analysis. Emission rates determine which type of permit is required, which type of modeling analyses need to be conducted and largely control the impact. The emission inventory will be reviewed by the permit writer during the permit application review.

The modeling emissions inventory consists of the emission points of the sources to be permitted, as well as other applicable on- and off-property emission points, including exempt and grandfathered sources. Modeling parameters for off-property sources can be obtained from MDEQ modeling staff. In some cases, neighboring source data from other states may be required. MDEQ can provide some data for neighboring states, but the applicant is responsible for verifying any missing data with the other states.

5.1.1 Emissions Inventory for New Sources and Modifications

For a new source or modification, the requested emission rate, operating rate, or maximum design rate (after controls) must be modeled. If the requested emission or operating rate used in the modeling is less than the maximum design rate, it may become a permit condition.

The emissions estimates used for modeling should be consistent with recommendations contained in the GAQM and other applicable EPA guidance. The applicant should refer to EPA guidance if the model is to be used to establish emission limits for a source. Most modeling emissions are based on peak emission rate and peak operation rate. Some source types have higher emission rates at lower operating loads (e.g. 50%, 75%) and need to be modeled at various operating loads. When modeling at less than 100% load, the modeled stack parameters need to be adjusted as appropriate. The permit writer can help identify cases in which variable load modeling is needed.

Permit conditions may be proposed based on the information used in the modeling. For example, if the operating level is limited or if the modeling uses a restricted operating schedule (i.e., less than 24 hours per day), the operating conditions may become permit conditions.

5.1.2 Emission Inventory for Nearby and Other Background Sources

In this document, the terms “nearby sources” and “other background sources” refer to existing sources at the facility under review and existing off-site sources. It does not include the new source or modification under permit review. Nearby and other background sources must be considered if a full impact analysis is required. The emission estimates used in modeling nearby and other background sources should be consistent with EPA recommendations in the GAQM and other applicable EPA guidance.

EPA requires that, at a minimum, all “nearby” sources must be explicitly modeled as part of the NAAQS analysis. “Other background” sources usually are accounted for by using an appropriate background concentration. If suitable ambient background concentration data is not available, background concentration can be determined by application of a model using inventory recommendations from the GAQM and approved by MDEQ.

MDEQ does not recommend a specific objective procedure for determining which sources should be classified as “nearby” and which should be classified as “other background sources.” All surrounding sources that will “significantly” (as defined in the EPA’s New Source Review Workshop Manual) contribute to the impact area of the new or modified source must be included in the modeling analysis. All sources with emissions greater than 25 tpy, located within 50 km of the subject source’s area of significant impact, should be included in the analysis. The applicant should contact MDEQ for a list of stationary sources within 50 km of the significant impact area of the new source or modification under review. Sources beyond 50 km may need to be included if long-range transport modeling is being performed for a Class I area.

The procedure used to select sources should use professional judgment and be determined on a case-by-case basis after considering local conditions such as topography, dispersion characteristics, availability of ambient monitoring data, existing air quality, and other relevant factors. The procedure should include an examination of the modeling results to ensure that all sources that should have been included were included.

Determination of the nearby sources accounted for by the background concentration can be rather subjective. Consequently, the modeler should review the location and collection date of the background data with respect to nearby sources to determine how it should be incorporated into the overall modeling procedure. Unless site specific or more appropriate background values are available, the background values listed in Table 5 should be added to modeling concentrations where all significant local sources have been included.

The use of background concentrations for PSD increment modeling is not recommended due to the difficulty in determining which portion of the background is from increment-consuming sources.

5.2 Meteorological Data

Air dispersion modeling requires hourly meteorological parameters including wind speed, wind direction, temperature and cloud cover data. The objective of modeling for permit applications is to ensure that ambient standards and increments will not be exceeded by predicting the highest possible impacts from the source. Therefore, meteorological data is often selected to provide a conservative modeling result rather than to predict time-specific impacts. In most dispersion modeling analyses, the user should attempt to define the worst-case scenario for pollutant dispersion in order to model the highest possible predicted concentration.

5.2.1 Screening Meteorology

Screening models use a worst-case screening meteorology data set instead of actual meteorology to show compliance with standards and increments. Screening categories were defined in the user's guide for EPA's SCREEN3 model (EPA, 1995). MDEQ has also constructed a worst-case data screening set using meteorological data assumptions from the SCREEN3 model for use with the ISCST3 model (for modeling multiple, more complex sources). EPA has not yet provided guidance on screening meteorological data to be used with the AERSCREEN or AERMOD models.

5.2.2 Hourly Meteorological Data

Meteorological data used in a refined modeling analysis for a major or minor source should be approved by MDEQ prior to conducting the modeling analysis. Applicants are strongly encouraged to submit meteorological and ambient air monitoring data to MDEQ before modeling to prevent unnecessary delays during the permit review process. This can be done prior to the modeling submittal or as part of the modeling protocol review.

PSD regulations require that modeling for major source applications be based on at least one full year of site-specific data or five years of representative National Weather Service (NWS) data. MDEQ applies this standard to modeling for non-PSD permit applications as well.

Representative data should appropriately represent meteorological conditions at the project site. To demonstrate that the data is representative of the project site, the applicant may provide an analysis comparing the physiographic and meteorological parameters of the data site using the minimum requirements outlined in Montana's Minimum Requirements to Establish Representative Data, which is available upon request.

Anemometer height from the data collection tower is an important modeling parameter. The applicant is responsible for verifying the actual anemometer height for the data used.

5.2.3 On-site Meteorological Data

Sources proposing PSD permitting actions should expect to collect on-site meteorological data if they are not located within 50 km of a NWS site. Any source intending to collect site-specific data should contact the MDEQ prior to establishing a monitoring program in order to ensure that EPA and MDEQ requirements for ambient air monitoring projects are met. When deciding if on-site data must be collected, MDEQ modeling staff will consider the following:

- Existing air quality in the area;
- Proposed emission levels from the new source or modification;
- Dispersion characteristics of the source under review;
- Meteorological and dispersion issues associated with complex terrain;
- Distance to the nearest Class I area (for new sources and modifications subject to PSD rules);
- Likelihood that the source will have an adverse impact on ambient air quality;

- Whether or not the source is subject to PSD rules (monitoring is more likely to be required for major new sources or major modifications subject to PSD rules than for minor sources); and
- Other relevant factors.

Actual meteorological data is necessary if the source cannot show compliance with ambient standards or PSD increments using screening meteorology. Sources may elect to voluntarily reduce emissions to show compliance through modeling with screening meteorology rather than choosing to collect on-site meteorological data.

5.3 Available Meteorological Data

Surface observational meteorological data for Montana can be obtained in a number of formats, as listed below. MDEQ may be able to assist the applicant in selecting and obtaining meteorological data.

SCRAM Archived Data (TD-1440): Compressed WBAN Hourly Surface Observations (TD-1440) format data, provided through compressed data files containing 1984-1992, with all 9 years in a single file. Although this database is no longer supported by NCDC and is not Y2K compliant, some meteorological processors, such as PCRAMMET, MPRM, and AERMET, can accept this format. SCRAM data can be obtained from EPS's SCRAM website. The following is a list of the Montana NWS stations for which SCRAM data is available.

- MT24033 Billings/Logan Int'l Airport
- MT94008 Glasgow/Int'l Airport
- MT24143 Great Falls/Int'l Airport
- MT24144 Helena Airport
- MT24146 Kalispell/Glacier Park Int'l Airport
- MT24036 Lewistown/FAA Airport
- MT24037 Miles City/Municipal Airport
- MT24153 Missoula/Johnson-Bell Field

SAMSON (Solar and Meteorological Surface Observation Network): Data containing U.S. surface and solar data for 1961-1990. This dataset contains all of the observed data parameters taken at 1st order National Weather Service locations, as well as solar data as provided by the National Renewable Energy Laboratory (NREL). NCDC provides this data on 3 CDs. SAMSON data is available on the NCDC CDs for the following Montana stations.

Name	WBAN #	Latitude	Longitude	Elevation (m)
Billings	24033	N 45 47	W 108 31	1088
Cut Bank	24137	N 48 35	W 112 22	1170
Glasgow	94008	N 48 13	W 106 37	700
Great Falls	24143	N 47 28	W 111 22	1116
Helena	24144	N 46 35	W 112 0	1188
Kalispell	24146	N 48 17	W 114 16	904
Lewistown	24036	N 47 2	W 109 26	1264
Miles City	24037	N 46 25	W 105 52	803
Missoula	24153	N 46 55	W 114 4	972

HUSWO (Hourly Surface Weather Observations): These data contain all observed U.S. surface data for 1990-1995 taken at 1st order National Weather Service locations. These data are a follow-up to the SAMSON data (partially funded by EPA), but do not contain solar data. NCDC provides this data on 1 CD. The following is a list of Montana Stations for which HUSWO data is available.

- WBAN #24033 Billings/Logan Int'l Airport
- WBAN #94008 Glasgow/Int'l Airport
- WBAN #24143 Great Falls/Int'l Airport
- WBAN #24144 Helena/ Airport
- WBAN #24146 Kalispell/Glacier Park Int'l Airport
- WBAN #24153 Missoula/Johnson-Bell Field

Precipitation Database (TD-3240): A precipitation-only database, where data is compiled from cooperative station information, with a station number based on the cooperative network. There are 2 formats available, fixed and variable length, which most models readily accept. Information for individual station use is provided by NCDC. TD-3240 data is provided by NCDC on 2 CDs, and contains data January 1948 through June 1998, although some data starting in 1900 are available. Precipitation data for numerous sites around Montana can be obtained from the NCDC website (www.ncdc.noaa.gov/oa/ncdc.html).

ISHD (Integrated Surface Hourly Data): ISHD data are provided by NCDC in their new standard surface data format, consisting of DATSAV3, TD-3280, and TD-3240 databases for 1995-2005 for 12,000 global stations. MDEQ has DATSAV3 data for 2000 through 2004 that is available for processing.

SCRAM Mixing Height Archived Data (Upper Air Data). Hourly mixing height files are available on the SCRAM bulletin board. Each file contains multiple mixing height files for upper air sites across the U.S. for 1984-1991. SCRAM mixing height data for Montana is available from the Great Falls NWS station for Eastern Montana and the Spokane, Washington NWS station for Western Montana.

Radiosonde Data of North America (RDNA). This is a standard upper air database containing 1946-1997 data, provided by NCDC on 4 CDs in the original FSL (Forecast Systems Laboratory) format. Upper air data for 1998 - present are also available on the internet (http://raob.fsl.noaa.gov).

5.4 Receptor Grid Design

The creation of receptor grids varies with the goals of each modeling study and requires case-by-case professional judgment. Factors such as the source's release height; proximity of emission points, fugitive areas, and other sources to the property line; the location of nearby residences and other sensitive receptors and monitors; topography, density of nearby sources, meteorology, and requirements of the selected model should be considered before selecting receptor locations and spacing.

MDEQ does not place any limits on the number or spacing of receptors for the purpose of coarse grid modeling but the grid must be able to define the areas of highest possible impact. After the hotspots have been located, the user is required to remodel these areas with a receptor grid tight enough to ensure the maximum point of impact has been identified. In general, Cartesian receptor grids are preferred over Polar receptor grids because the receptor spacing for Polar grids becomes too wide as distance increases from the source. Polar receptor grids should only be used for coarse grid and single stack modeling.

It is the applicant's responsibility to demonstrate that the final receptor network is sufficiently dense to identify the maximum estimated pollutant concentrations for each averaging period. This applies to modeling performed to demonstrate compliance with the PSD increments, NAAQS, and MAAQS. While source specific issues such as expected plume rise and topography must be considered in developing receptor grids, the following recommendations provide a good starting point for developing an acceptable Cartesian receptor grid:

- For distances up to 1 km – 100 m receptor spacing;
- From 1 to 3 km – 250 m spacing;
- From 3 to 10 km – 500 m spacing;
- Beyond 10 km – grid with 1 km spacing extending at least to the farthest ROI of the project;
- Along fence lines – 50 to 100 m spacing;
- If no fence or boundary – 50 m spacing near the source under review;
- Discrete receptors for sensitive nearby sites (e.g., residences, schools) unless the grid is sufficient to quantify impacts;
- If the modeled maximum concentration from the facility under review (or the maximum concentration in a full impact analysis) occurs in a "coarse" receptor grid, additional modeling should be performed with a fine grid to find the maximum concentration; and
- Additional fine receptor grids or discrete receptors may be necessary in complex or sensitive areas to clearly define the area of maximum impact.

5.4.1 Ambient Air Quality Boundary

Receptors may be omitted from the property of the facility under review, provided it is inaccessible to the general public. If there is not a physical barrier (e.g., fence, wall, etc.) receptors should be located in the property of the applicant. MDEQ and/or EPA approval is necessary if the applicant wants to use a physical barrier such as a canyon, river, tailings pile, or other physical features as the ambient air boundary. If a physical barrier is approved to preclude public access, frequent posting is usually necessary along with routine security patrols; in addition, points of public access in the posted area (e.g., roads trails etc.) must be fenced or gated. Additional EPA guidance regarding ambient air boundary can be found on the SCRAM website (www.epa.gov/scram001/guidance_clearinghouse.htm).

Receptors located within the air quality boundary of an off-site facility need to be treated carefully when performing cumulative impact modeling. The modeler should follow EPA guidance on the treatment of receptors located within the ambient air quality boundary of a source being included in the cumulative impact modeling.

5.4.2 Projections and Coordinate Systems

Proper use and description of coordinate systems will allow for efficient modeling analysis review. The following guidelines should be followed to establish consistent coordinate systems:

- Enter all receptor locations into dispersion models in Universal Transverse Mercator (UTM) coordinates. This will make the modeling consistent with on- and off- property emission point locations, Section 4.3 of the permit application, emission inventory databases, and other reference material, such as U.S. Geological Survey (USGS) topographic maps.
- Do <u>not</u> use local coordinate systems based on plant coordinates or other applicant-developed coordinate systems.
- Provide the UTM zone and the datum used for the UTM coordinates. Applicable UTM zones in Montana are 11, 12, and 13. Common datums are NAD27 or NAD83 for the continental U.S.
- Elevation units should be clearly identified as meters or feet relative to the National Geodetic Vertical Datum of 1929 (NGVD29).
- The applicant should write the horizontal datum used (NAD83 or NAD27) on Section 4.3 of the permit application forms.

Large-scale modeling using CALPUFF may require use of a Lambert Conformal Conic (LCC) projection system. In that case, the applicant should use the Montana State Plane coordinate

```
Montana State Plane Coordinates

Projected Coordinate System:
NAD_1983_StatePlane_Montana_FIPS_2500
Projection: Lambert_Conformal_Conic
False_Easting: 600000.00000000 meters
False_Northing: 0.00000000 meters
Central_Meridian: -109.50000000
Standard_Parallel_1: 45.00000000
Standard_Parallel_2: 49.00000000
Latitude_Of_Origin: 44.25000000
Linear Unit: Meter (1.000000)

Geographic Coordinate System:
GCS_North_American_1983
Datum: D_North_American_1983
Prime Meridian: 0
```

system, with the following metadata:

5.4.3 Terrain Elevation Data for Sources and Receptors

Simple terrain (terrain with elevations below the level of pollutant release) and complex terrain (terrain elevations above the level of pollutant release) must be addressed in all modeling analyses if terrain within the vicinity of the source is expected to have an effect on the pollutant dispersion. Modeling analyses that involve both simple and complex terrain must conform to the EPA intermediate terrain policy. Terrain elevations for sources and receptors should be used as appropriate (refer to EPA guidance).

Elevations for modeling receptors should be extracted from the same database to avoid discontinuities. If elevations are extracted from different sources of data, the grid should be reviewed with a computer visualization application to check for significant discontinuities that could affect the modeling results. For fine grid analyses with receptor spacing of 100 meters or less, USGS 7.5-minute series quadrangles (1:24,000) should be used.

USGS Digital Elevation model (DEM) should be used if possible for all receptor elevations. A DEM is a digital file consisting of terrain elevations for ground positions at regularly spaced intervals. Each 7.5-minute unit of DEM coverage consists of a regular array of elevations referenced horizontally in the UTM projection coordinate system. These horizontally referenced data may be in NAD27 or NAD83 for the continental United States, with elevation units in meters or feet relative to NGVD29.

The applicant should be aware of the datum of the DEM data and maintain consistency throughout the modeling process. All receptor, building, and source locations must be in UTM coordinates and must originate in, or be converted to, the same horizontal datum.

5.5 Building Wake Effects (Downwash)

Airflow over and around buildings and other structures may restrict the dispersion of a pollutant source. A modeling analysis of point sources with stack heights that are less than good engineering practice (GEP) stack height should consider the impacts associated with building wake effects (also referred to as downwash). Building wake effects are not considered for area or volume sources.

As defined by the Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations, EPA, 1985), GEP height is calculated as:

$GEP = H_b + 1.5L$

Where :

H_b = the building height

L = the lesser of the building height or the greatest crosswind distance of the building (also known as maximum projected width)

This formula defines the stack height above which building wake effects on the stack gas exhaust may be considered insignificant.

A building or structure is considered sufficiently close to a stack to cause wake effects when the minimum distance between the stack and the building is less than or equal to five times the lesser of the height or projected width of the building (5L). This distance is commonly referred to as the building's region of influence. If the source is located near more than one building, assess each building and stack configuration separately.

If a building's projected width is used to determine 5L, determine the apparent width of the building. The apparent width is the width as seen from the source looking towards either the wind direction or the direction of interest.

Sources with release points located near the facility property boundary with stack heights less than GEP are required to submit a cavity region analysis with the modeling submittal. Cavity concentrations are considered to be a valid ground-level concentration when addressing NAAQS and PSD increment consumption, if the length of the cavity extends beyond a restricted property boundary.

Due to the complexity of GEP guidance, the EPA has developed computer programs for calculating downwash parameters for use with refined dispersion models. The most current downwash program is the Building Profile Input Program (BPIP) (EPA, 1993a), with the Plume Rise Model Enhancements (PRIME) model. The integrated downwash model is called BPIP-PRIME.

AERMOD incorporates the PRIME algorithms for determining the impact of downwash on ambient concentration, and uses them to determine refined concentration estimates.

To account for downwash, the SCREEN3 model requires the entry of a building or structure height and the respective maximum and minimum horizontal dimensions. Generally, include the building with dimensions that result in the highest GEP stack height for that source to evaluate the greatest downwash effects. When determining downwash from tanks, SCREEN uses the square root of the sum of the individual squares of both the width and length for a structure in order to calculate the projected width. Because most tanks are round, the projected width is constant for all flow vectors. However, using the actual tank diameter for both width and length will result in a projected width that is too large. Therefore, when screening tanks, a modeler should divide the diameter of the tank by the square root of 2.

5.6 Additional Modeling Variables

5.6.1 Variable Emission Rate Option

When sources can operate only during specified hours, the variable emission rate option may be used to restrict the modeling analysis to the hours of operation only. If this option is used, permit conditions may restrict the operation of the permitted source to the time period modeled. The variable emission rate option may also be used to simulate other operating scenarios as necessary to design permit conditions.

5.6.2 Urban Versus Rural Dispersion Options

The applicant should select rural dispersion characteristics for all locations in Montana.

The classification of the land use in the vicinity of air pollution sources is necessary because dispersion rates differ between urban and rural areas. In general, urban areas have greater rates of dispersion because of increased turbulent mixing and buoyancy-induced mixing. The turbulent mixing results from the combination of greater surface roughness caused by more buildings and structures, and greater amounts of heat released from concrete and similar surfaces.

EPA guidance provides two procedures to determine if an area is predominantly urban or rural. One procedure is based on land-use typing while the other is based on population density. Both procedures require an evaluation of the characteristics within a 3 km radius from a source. The land-use typing method is the preferred method because it is more directly related to the surface characteristics of the evaluated area that affect dispersion rates. This method will result in the selection of rural dispersion at virtually all locations in Montana.

5.6.3 Merging Stack Emission Points

Regulatory modeling should reflect the actual characteristics of the proposed or existing emission points. Therefore, emission points should not be merged except in well-justified circumstances. For example, merging may be appropriate when the number of points at a large site exceeds the capability of the model. Modeling convenience or the desire to reduce model run time is not an acceptable justification.

Merging stacks may be appropriate for both screening and refined analyses if the individual emission points emit the same pollutant(s); have stack heights, volumetric flow rates, or stack gas exit temperatures that do not differ by more than about 20 percent; and are within about 100 meters of each other.

Use the following equation (EPA, 1992) to determine the worst-case stack:

$$M = \frac{h_s * V * T_s}{Q}$$

Where:

- M = a parameter that accounts for the relative influence of stack height, plume rise, and emission rate on concentrations
- h_s = the physical stack height (m)
- V = stack gas flow rate in (m^3/s)
- T_s = the stack gas exit temperature in degrees Kelvin (K)
- Q = pollutant emission rate (g/s)

The stack that has the lowest value of M is used as a "representative" stack. The sum of the emissions from all stacks is assumed to be emitted from the representative stack; that is, the stack whose parameters resulted in the lowest value of M.

For sources located more than 10 km past the radius of impact, all stacks at the facility may be considered as one stack. This stack should be modeled with the parameters of the stack with the lowest value of M as the "merging" stack, regardless of the differences in parameters and distance between stacks at the facility.

5.6.4 Modeling of Horizontal or Capped Stacks

The modeler should refer to the AERMOD Implementation Guidance in Appendix D for guidance on modeling horizontal or capped stacks using AERMOD. Any modeling methodology that differs from the guidance needs to be identified in a modeling protocol to be reviewed prior to the modeling submittal.

Horizontal or capped stacks should be treated the same in CALPUFF modeling as they are in AERMOD modeling.

6.0 Modeling Results and Report

MDEQ will review the modeling submittal to ensure that the modeling output is technically representative and sufficient and that any deviations from EPA guidance do not significantly affect the compliance demonstration. The modeling report should follow reporting requirements listed in this section and provide clear documentation of how the modeling was done and what assumptions were made. In addition, the report should include any calculations used to develop the input data required to run the selected model.

If MDEQ finds errors or discrepancies, they will attempt to evaluate the submittal and determine whether the errors or discrepancies would cause a significant change in the magnitude or locations of the predicted concentrations. This evaluation may determine whether the submittal is technically representative and usable by the staff to determine if the permit should be issued. MDEQ's modeling staff will work closely with the permit writer and the applicant's modeler to resolve omissions, unclear documentation, or other problems.

If MDEQ cannot resolve a modeling deficiency, then the modeling submittal will not be accepted, and recommended corrective actions or deficiency items will be forwarded to the permit writer. The permit writer will subsequently issue an incompleteness letter to resolve any modeling deficiencies or other deficiencies identified during the review of the permit application.

6.1 Model Output

Modeling must be included for every criteria pollutant that is emitted from the plant, with the exception of ozone. The need for VOC modeling to determine ozone compliance will be determined on a case-by-case basis. Hydrogen sulfide (H_2S) emissions should also be modeled as appropriate. The model output should include results for every averaging period for which there is a corresponding standard or increment. Table 2 lists all the NAAQS and MAAQS and Table 9 lists the PSD increments.

The appropriate compliance demonstration for each ambient standard is based on the form of the standard. Typically, compliance with annual, quarterly or 90-day standards is based on the highest modeled concentrations. Compliance with 24-hour, 8-hour, 3-hour or 1-hour standards is based on the high-second-high concentration at any receptor. Compliance based on high-second-high impact is appropriate for standards that allow only one exceedance (at any location) per year.

Compliance demonstrations for the PM_{10} and $PM_{2.5}$ 24-hour standards are more complex. The model output used to demonstrate compliance with the 24-hour PM_{10} standard depends on the number of years of meteorological data modeled. If one year of met data is used, compliance is based on the high-second-high modeled impact. If three years of met data are modeled, compliance is based on the high-fourth-high modeled impact, and if five years of met data are modeled, compliance is based on the high-sixth-high modeled impact (email communication from EPA).

Montana's 1-hour SO_2 standard is not to be exceeded more than 18 times in any 12 months. Compliance with this standard is based on the high-19th-high modeled concentration, which is not readily obtained from the EPA models. The applicant should attempt to demonstrate compliance with Montana's 1-hour SO_2 standard using the high-6th-high 1-hr average. If the high-6th-high modeled concentration exceeds the standard, the applicant should contact MDEQ for specific guidance on determining the high-19th-high impact.

6.2 Modeling Report

The following items, information, and documents should be submitted with any modeling analysis:

- A completed copy of the modeling checklist (Appendix A).
- A detailed description of the new source's proposed activity. For modified sources, a description of the proposed modification and the source's activity prior to the proposed modification.
- A detailed description of the proposed new emission or change in emission level.
- Point Sources – emission rate, stack height, stack inside diameter, temperature, exit velocity, and nearby building dimensions (downwash). The stack outlet configuration must be specifically described including vertical or horizontal outlet and rain caps.
- Area Sources – the height, area/dimensions, and average emission rate per unit area. Road emissions should include the length, width, surface type, silt content, and location/orientation.
- Volume Sources – the release height, initial vertical and horizontal dimensions, and emission rate.
- Flare Sources – emission rate, stack height, stack diameter, exit velocity, and total heat content.
- A USGS – 1:24000 scale map showing the locations of all sources and receptors used in the analysis.
- A description of the model(s) selected and why it (each) was (were) selected.
- A description of the site topography and receptor grids used in the analysis.
- A description of meteorological data and why it is representative. Quality assurance documentation should also be included.
- Technical support documentation for any assumptions made in the modeling analysis, which deviated from the GAQM.
- Model input (regulatory compatible version) and output files in DOS format with file descriptions.

The report needs to contain a summary of model predictions showing compliance with NAAQS and PSD increment ceilings for both Class I and Class II areas as appropriate. The summary must include the information described below. Section 6.3 contains sample report table formats.

MAAQS/NAAQS Compliance

- Table showing the pollutants, averaging periods, ambient standards, background concentration, highest (and second, fourth, sixth, etc. highest, if appropriate) modeled concentration, the model used, and the impact location in UTM coordinates.

- Concentration isopleth maps with the facility boundary for each pollutant and averaging periods out to 5 percent of the applicable standard, with the ASCII file containing the x, y, and Q (concentration) coordinates from which the isopleths were plotted.

PSD Increment Compliance

- Table showing pollutants, averaging periods, maximum increment consumed by both major and minor sources within 50 km of the subject source since the baseline date, the model used, and the impact location in UTM coordinates.

- Increment consumption isopleth maps with the facility boundary, for each pollutant and averaging periods out to 5 percent of the increment ceiling, with the ASCII file containing the x, y, and Q (concentration) coordinates from which the isopleths were plotted.

6.3 Sample Report Table Formats

MDEQ prefers that all applications use the following table formats in their modeling reports. We can provide the applicant with the sample report table formats in MSWord format upon request.

Sample Table A. Class II Significant Impact Modeling

Pollutant	Avg. Period	Modeled Conc. ($\mu g/m^3$)	Class II SIL[(a)] ($\mu g/m^3$)	Significant (Y/N)	Radius of Impact (km)
PM_{10}	24-hr		5 (1)[(b)]	Y/N	
	Annual		1	Y/N	
$PM_{2.5}$	24-hr		Look up and cite values from EPA reference	Y/N	
	Annual			Y/N	
NO_x [(c)]	Annual		1	Y/N	
CO	1-hr		2,000	Y/N	
	8-hr		500	Y/N	
SO_2	3-hr		25	Y/N	
	24-hr		5 (1) [(b)]	Y/N	
	Annual		1	Y/N	
O_3	Net Increase of VOC: ??? tpy. Less than 100 tpy, source is exempt from O_3 analysis.				

(a) All concentrations are 1st-high for comparison to SIL's.
(b) If a proposed source is located w/in 100 km of a Class I area, an impact of 1 $\mu g/m^3$ on a 24-hour basis is significant.
(c) SIA based on NOx impact (rather than NO_2).

Sample Table B. Class II PSD Increment Compliance Demonstration

Pollutant	Avg. Period	Met Data Year	Modeled Conc. ($\mu g/m^3$)$^{(a)}$	Class II Increment ($\mu g/m^3$)	% Class II Increment Consumed	Peak Impact Location (UTM Zone ??)
PM_{10}	24-hr			30		
	Annual			17		
$PM_{2.5}$	24-hr			Look up and cite values from EPA		
	Annual					
SO_2	3-hr			512		
	24-hr			91		
	Annual			20		
NO_2	Annual$^{(b)}$			25		

(a) Compliance with short-term standards is based on high-2nd-high impact.
(b) Annual NO_x impacts are compared to the NO_2 standards.

Sample Table C. Impact Compared to Pre-monitoring Exemption Levels

Pollutant	Avg. Period	Modeled Conc. ($\mu g/m^3$)	Exemption Level ($\mu g/m^3$)$^{(a)}$	Eligible for Exemption (Y/N)	How Source is Complying with Pre-monitoring Requirement
PM_{10}	24-hr		10	Y/N	
$PM_{2.5}$	Look up		Look up	Y/N	
NO_2	Annual$^{(b)}$		14	Y/N	
CO	8-hr		575	Y/N	
SO_2	24-hr		13	Y/N	
Pb$^{(c)}$	3-month		0.1	Y/N	
O_3	Net Increase of VOC: ??? tpy. Less than 100 tpy, source is exempt from O_3 monitoring.				

(a) All concentrations are 1st-high for comparison to the pre-monitoring exemption levels.
(b) The ambient ratio method has not been used to convert NOx to NO_2; value is NOx impact.
(c) Pb result is based on monthly averaging period

Sample Table D. NAAQS/MAAQS Compliance Demonstration

Pollu-tant	Avg. Period	Modeled Conc.[(a)] (μg/m³)	Backgrnd Conc. (μg/m³)	Ambient Conc. (μg/m³)	NAAQS (μg/m³)	% of NAAQS	MAAQS (μg/m³)	% of MAAQS
PM_{10}	24-hr		30		150		150	
	Annual		8		50		50	
$PM_{2.5}$	24-hr		30		35		------	------
	Annual		8		15		------	------
NO_2	1-hr	--[(b)]	75		------	------	564	
	Annual	--[(c)]	6		100		94	
CO	1-hr		1150		40,000		26,450	
	8-hr		1725		10,000		10,000	
SO_2	1-hr		35		------	------	1,300	
	3-hr		26		1,300		------	-----
	24-hr		11		365		262	
	Annual		3		80		52	
Pb	Quarterly[(d)]		Not. Avail.		1.5			
	90-day[(d)]		Not. Avail.		-----	-----	1.5	

(a) Concentrations are high-second high values except annual averages and SO_2 1-hr, which is high-6th-high.
(b) One-hour NOx impact is converted to NO_2 by applying the ozone limiting method, as per MDEQ guidance.
(c) Annual NOx is converted to NO_2 by applying the ambient ratio method, as per MDEQ guidance.
(d) Typically report monthly average impact for compliance demonstration.

Sample Table E. Class I PSD Increment Compliance Demonstration

Pollutant	Avg. Period	Met Data Year	Modeled Conc. (μg/m³)[(a)]	Class I Increment (μg/m³)	% Class I Increment Consumed	Peak Impact Location (UTM Zone 12)
PM_{10}	24-hr			8		
	Annual			4		
$PM_{2.5}$	24-hr			Look up and cite values from EPA		
	Annual					
SO_2	3-hr			25		
	24-hr			5		
	Annual			2		
NO_2	Annual[(b)]			2.5		

(a) Compliance with short-term standards is based on high-second-high impact.
(b) Annual NO_x impacts are compared to the NO_2 standards.

6.4 Additional Information

- The modeling report must clearly identify the GEP stack height for each point source.

- The modeling report must include the name of the USGS 7.5' quadrangle used, referenced to the electronic data files. For example: 1653520.zip contains 8386_75.dem, which is the "Two Mile" quadrangle.

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6.5 Electronic Files

All modeling input and output files need to be provided on electronic media, either a CD or a DVD. Meteorological data input files need to be provided in ASCII format appropriate for the model used. AERMOD input files must be presented in the format that can be run in DOS with the current EPA version of the model. The input files must have the *.DTA extension. BPIP and PRIME input and output files must be included, including the *.SO file.

7.0 References

Chu, S.H. and E.L. Meyer, 1991. Use of Ambient Ratios to Estimate Impact of NOx Sources on Annual NO_2 Concentrations, Proceedings, 84th Annual Meeting & Exhibition of the Air & Waste Management Association, Vancouver, B.C.; 16-21 June 1991 (16 pp.) (Docket No. A-92-65, II-A-9)

EPA, 1980. A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animal, Final Report. December 12, 1980. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina.

EPA, 1985. Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) (Revised). EPA-450/4-80-023R, June, 1985. U.S. Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards, Research Triangle Park, NC.

EPA, 1990. New Source Review Workshop Manual. Draft, October, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC.

EPA, 1992. Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised, EPA-450/R-92-019, October 1992. U.S. Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards, Research Triangle Park, NC.

EPA, 1993. User's Guide to the Building Profile Input Program, October, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Technical Support Division, Research Triangle Park, NC.

EPA, 1998. Interagency Work Group on Air Quality Modeling Applications (IWAQM) Phase II Summary Report and Recommendations for Modeling Long Range Transport and Impacts. EPA-454/R-98-019, December 1998.

EPA, 2004. User's Guide for the AMS/EPA Regulatory Model – AERMOD. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions Monitoring and Analysis Division, Research Triangle Park, North Carolina. EPA-454/B-03-001, September 2004.

FLAG, 2000. Federal Land Manager's Air Quality Related Values Workgroup (FLAG): Phase I Report. U.S. Forest Service, National Park Service, U.S. Fish and Wildlife Service, December.

40CFR51. Code of Federal Regulations, Title 40 (Protection of Environment), Part 51. Office of the Federal Register National Archives and Records Administration.

40CFR52. Code of Federal Regulations, Title 40 (Protection of Environment), Part 52. Office of the Federal Register National Archives and Records Administration.

APPENDIX A

Montana's Air Quality Modeling Checklist

Montana's Air Quality Modeling Checklist

1. Name of applicant ____________________
   Name of facility ____________________

2. Permit no. ____________________

3. UTM coordinates of facility: UTM Easting________ UTM Northing __________
   Zone __________ Elevation __________ Air Quality Control Region: __________
   (Do not use local coordinate systems.) Datum____________________

4. Name of applicant's modeling contact/consultant ____________________
   Phone number of applicant's modeling contact/consultant ____________________

5. Date of initial contact with DEQ modeling staff ____________________
   Name of modeling contact ____________________
   Type of contact (include dates):
   Phone ____________________
   Written ____________________
   Meeting ____________________

6. Was a written modeling protocol submitted to MDEQ? Yes ________ No __________
   If yes, what date was protocol submitted? ____________________

7. Is the proposed facility/modification located in a nonattainment area? Yes ______ No _____
   If yes, for what pollutants? ____________________

8. Has an Emission Summary Table been submitted? Yes ________ No __________

9. Do modeled emissions agree with requested maximum permitted emission levels?
   Yes ________ No __________

10. Were all existing and proposed emissions from this source included in the analysis?
    Yes ________ No __________

11. Is a plot plan summary showing UTM coordinates and the following items included with the analysis? Yes ________ No __________
    Emission Release Locations Yes ________ No __________
    Nearby Buildings Yes ________ No __________
    Property Lines Yes ________ No __________
    Fence Lines/ Areas of Controlled Access Yes ________ No __________
    Roads Yes ________ No __________
    UTM Coordinates (shown on axes) Yes ________ No __________
    Cross Section Directions Yes ________ No __________

12. Are topographic maps showing the following items included with the analysis?

Source Locations Yes ________ No __________
Contour Lines Yes ________ No __________
Receptor Locations Yes ________ No __________
Maximum Impact Locations Yes ________ No __________
UTM Coordinates Yes ________ No __________

13. Are cross-section diagrams included with the analysis? Yes ________ No __________

Showing buildings and stacks Yes ________ No __________
At least 2 cross-sections at right angles Yes ________ No __________
Supporting photographs of cross-sections (if an existing sources)
Yes ________ No __________

14. Are all stack heights at or below GEP stack height? Yes ________ No __________

Are downwash input and output files submitted? Yes ________ No __________
Table of building heights included in report? Yes ________ No __________

15. Model Selection

a. Terrain modeled: Simple ______ Intermediate ______ Complex______
b. Models used, version number:
SCREEN3 ____
T-SCREEN ____
ISC3 ____
AERMOD ____
VISCREEN ____
PLUVUEII ____
CALPUFF * ____
* If using CALPUFF, contact DEQ for modeling requirements.
c. Were other models used? Yes ________ No __________
If so, which model(s) was used? ______________________________
Why? ____
d. Was building downwash modeled? Yes ________ No __________
If so, which downwash program was used? ______________________________
Why? ____

16. Do the model-input options elected for the analysis agree with EPA's ***Guideline on Air Quality Models***? Yes ________ No __________
If no, explain options used, and why they were selected in report.

17. Was deposition modeled near the facility? Yes ________ No __________

18. Was the Rural land use designation used in the analysis? Yes ________ No __________

19. Meteorology
   a. Was screening meteorology used? Yes ________ No _________
      i. If yes, for simple terrain impacts, was the full meteorology array used? Yes ________ No _________
      ii. If yes, was the neutral/unstable mixing height set equal to 1 m above plume height (with a minimum of 320 m)? Yes ________ No _________
      iii. If yes, do the screening wind directions include the 36 radials plus "line up" directions (with corresponding receptors for each wind direction)? Yes ________ No _________

   b. Was actual meteorological data used? Yes ________ No _________
      If yes, where was the meteorological data collected?
      i. Surface Site ____
         Location: (coordinate system) ______________________________
      ii. Upper Air Site ____
         Location: (coordinate system) ______________________________
      iii. Who did you contact within the Department regarding the adequacy of using this data? ______________________________ When? ___________
      iv. Is a Wind Rose illustrating the data provided? Yes ____ No ____ Page No: _________
      v. Did you document periods of missing data and how were they filled in? Yes _____ No__________ Page No.________________
      vi. How many years of meteorological data were used in the analysis? _______________
      vii. Meteorological years used ______________________________________

20. Receptors
   a. Were actual terrain elevations used for each receptor? Yes ___________ No ________
      If yes, what was the source and scale of the terrain elevations?
      (e.g., 7.5' USGS maps, 1:24,000 DEM data) ________________________________

   b. DEQ recommends the following parameters for minimum receptor coverage:
      a. Use Cartesian receptor grids (instead of polar grids)
      b. for distances up to 1 km – 100 m receptor spacing;
      c. from 1 to 3 km – 250 m spacing;
      d. from 3 to 10 km – 500 m spacing;
      e. beyond 10 km – grid with 1 km spacing;
      f. along fence lines – 50 to 100 m spacing;
      g. if no fence or boundary – 50 m spacing near the source under review;
      h. discrete receptors for sensitive nearby sites (e.g., residences, schools);
      i. hotspot receptors around peak impacts with spacing $\leq$100 m

   c. Describe process for verifying DEM elevation data using USGS 7.5' quadrangle maps (paper)? ____

21. Impact Analysis Summary
  a. Were the modeling results summarized for each pollutant and for each averaging period? Yes ________ No_______________

  b. Are maximum impacts compared against NAAQS, MAAQS, and PSD increments? Yes ________ No_______________

  c. Are the controlling meteorology conditions summarized? Yes _______ No ___________

  d. Are the controlling receptor locations and elevations summarized? Yes ________ No____________

  e. Were all existing and proposed emissions from this source included in the analysis? Yes ________ No_______________
     If no, why not? ____

  f. Were ambient background levels included on the MAAQS/NAAQS analysis results? Yes ________ No_______________
     What was the source of the background information? ______________________

  g. Were impacts on PSD Class I areas evaluated in the analysis? Yes______ No ________
     Class I Area Name: _______________________ Closest Distance: ___________________
     Class I Area Name: _______________________ Closest Distance: ___________________
     Class I Area Name: _______________________ Closest Distance: ___________________

22. PSD Sources
  a. Have you contacted affected FLM's? Yes ________ No ______________
  b. Were other Air Quality Related Values addressed? Yes ____________ No ___________
  c. Was a visibility analysis performed for any Class I area? Yes _______ No ___________
  d. Was a PSD increment analysis performed for any Class I area? Yes ______ No _______
  e. Was it necessary to include the impact of other contributing sources on the analysis? Yes ___________ No ___________
  f. If yes, were those sources included on the Emissions and Stack Parameters Summary? Yes ___________ No____________

23. Have you included input, output, meteorological data, and technical support files along with a detailed description of these files on or CDs or DVDs with your modeling analysis submittal? Yes ___________ No ___________
  a. BPIP input/output? Yes ___________ No____________
  b. EPA Dispersion model input ready for execution? Yes ___________ No____________
  c. Dispersion model output Yes ___________ No____________
  d. Meteorological data (in ASCII format)? Yes ___________ No____________
  e. Post processing programs & files? Yes ___________ No____________
  f. Emissions and maximum impact summary tables? Yes ___________ No____________

APPENDIX B

Estimating NO_2 Emissions

Estimating NO_2 Emissions

In September 1995, EPA promulgated Supplement C to the GAQM. This revision replaced the Ozone Limiting Method (OLM) (Cole and Summerhays, 1979) with the Ambient Ratio Method (ARM) (Chu and Meyer, 1991), which uses empirically derived nitrogen dioxide to oxides of nitrogen (NO_2/NOx) ratios for estimating NO_2 concentrations that can be applied during screening modeling or refined modeling. The OLM is now considered a 'non-guideline' screening technique, available for use on a case-by-case basis by the reviewing authority.

MDEQ requires that the ARM be used to obtain annual averages of NO_2 from point sources for NSR analysis including PSD, and source review analysis, and for SIP planning purposes. However, MDEQ allows the OLM method to be applied to demonstrate compliance with the 1-hour NO_2 MAAQS. Techniques for applying both methods are outlined below.

Ambient Ratio Method: This method consists of two approaches. One approach applies a conversion factor to the emission rate, and the other applies a conversion factor to the predicted concentration. The process is outlined in the following steps; they do not need to be applied in sequence.

Step 1: Use the NO_X emission rate as a surrogate for the NO_2 emission rate and assume total conversion of NO_X to NO_2. Conduct screening or refined modeling, as applicable. This approach is conservative but is not realistic. If the concentration exceeds the de minimis or NAAQS (with background concentration added), go to Step 2.

Step 2: Apply a conversion factor to the predicted concentration.

Step 2a: Assume limited conversion of NO_X to NO_2. Multiply the predicted annual NO_X concentration by the national default of 0.75. This approach is conservative. If additional refinement is needed, go to Step 2b, if applicable.

Step 2b: Obtain a representative factor for conversion of NO_X to NO_2. Multiply the predicted annual NO_X concentration by a measured NO_2 / NO_X ratio obtained from a site-specific or representative regional air monitor.

Step 3: Apply a conversion factor to the emission rate.

Step 3a: Assume limited conversion of NO_X to NO_2. Multiply the NO_X emission rate by the national default of 0.75; this approach is conservative. Conduct screening or refined modeling, as applicable. If additional refinement is needed, go to Step 3b, if applicable.

Step 3b: Obtain a representative factor for conversion of NO_X to NO_2. Multiply the emissions rate by a measured NO_2 / NO_X ratio obtained from a site-specific or representative regional monitor. Conduct screening or refined modeling, as applicable

Ozone Limiting Method: This method consists of two approaches. One approach applies a conversion factor to the emission rate, and the other applies a conversion factor to the predicted concentration. The process is outlined in the following steps.

Step 1: Use the NO_X emission rate as a surrogate for the NO_2 emission rate and assume total conversion of NO_X to NO_2. Conduct screening or refined modeling, as applicable. This approach is conservative but is not realistic. If the concentration exceeds the MAAQS (with background concentration added), go to Step 2.

Step 2: Apply the following equation to the predicted concentration.

$$[NO_2]_{1\text{-}hr} = \{(0.1) * [NO_X]_{pred}\} + MIN\ \{(0.9) * [NO_X]_{pred}, \text{ or } (46/48) * [O_3]_{bkgd}\} + [NO_X]_{bkgd}$$

Where:

0.1	The OLM assumes that 10% of the NO_X in the exhaust is converted to NO_2 and no further conversion by this reaction occurs once the exhaust leaves the stack. This assumption is thought to be conservative and should be used in most cases. However, information obtained by MDEQ suggests that for some sources such as diesel-powered generators, 30% should be used. Applicants should check with MDEQ before assuming the default value of 10% is acceptable.
$[NO_2]_{1\text{-}hr}$	is the predicted 1-hr NO_2 concentration.
$[NO_X]_{pred}$	is the model predicted 1-hour concentration.
MIN	means the minimum of the two quantities within the brackets.
$[O_3]_{bkgd}$	is the representative 1-hr average ambient O_3 concentration. Absent any monitoring data, the 1-hr O_3 standard, 196 $\mu g/m^3$, should be used.
(46/48)	is the molecular weight of NO_2 divided by the molecular weight of O_3.
$[NO_X]_{bkgd}$	for areas with no other significant sources the annual background concentration is 6 $\mu g/m^3$ and 75 $\mu g/m^3$ for the 1-hr.

Step 2a: If the predicted concentration exceeds the MAAQS (with NO_2 background concentration added) from Step 2 then proceed to Step 2b and evaluate whether the modeled concentration occurs outside of the O_3 season. If the predicted concentration does not exceed the MAAQS (with NO_2 background concentration added), then the demonstration is completed.

Step 2b: If the peak modeled concentration from Step 2 falls outside of the O_3 season, it is permissible to assume that the O_3 is at 25% of the standard or 49 $\mu g/m^3$ for the background concentration of O_3. Montana assumes the O_3 season is June 1 through October 31. However, the peak modeled concentration during O_3 season must be modeled and Step 2 must be repeated using the 196 $\mu g/m^3$ as the O_3 background concentration to ensure that the standards are also met during O_3 season.

References

Cole, H.S. and J.E. Summerhays, 1979. A Review of Techniques Available for Estimating Short Term NO_2 Concentrations. Journal of Air Pollution Control Association, Vol. 29, No. 8, pp.812-817, August 1979.

APPENDIX C

Modeling Protocol Guidance

Modeling Protocol Guidance

A modeling protocol and checklist serves as an outline to follow to conduct a modeling analysis. Protocols are more formal and more detailed than checklists. Protocols are not mandatory but MDEQ encourages the applicant to submit them for PSD and complex preconstruction permit modeling projects.

The applicant should follow the guidance shown in Table C-1 to develop protocols. In addition, the applicant should submit a completed Montana modeling checklist (Appendix A of the Guideline). Items in the table apply to all analyses unless noted otherwise.

Table C-1. Protocol and Permit Modeling Guidance

1.0 Project Identification Information

Provide the following information to clearly identify the analysis:

- Applicant
- Facility
- Permit Number (if available)
- Nearest City and County

2.0 Project Overview

- Provide a brief discussion of the plant process(es), and types and locations of emissions under consideration. Attach additional data as applicable for project overview.
- Type of Permit Review – Indicate the type of permit review required by the permit engineer (e.g., PSD, NAA etc.).
- Pollutants to be Evaluated – List all pollutants to be evaluated.

3.0 Plot Plan

Depending on the scope of the project, several plot plans may be needed to present all requested information. Provide a plot plan that includes:

- A clearly marked scale.
- All property lines. **For PSD analyses**, include fence lines.
- A true-north arrow.
- UTM coordinates along the vertical and horizontal borders (Please do not use plant or other coordinates). Provide the datum of your coordinates.
- Reference UTM coordinates and locations of all emission points including fugitive sources modeled.
- Buildings and structures on-property or off-property which could cause downwash. Provide length, width, and height dimensions.

- An indication of the shortest distance to the property line from any of the sources in the facility to be permitted.

4.0 Area Map(s)

- Add UTMs to the horizontal and vertical dimensions of the map section, as well as the date and title of the map. Provide the datum of your coordinates.
- Annotate schools within 914 m (3,000 ft) of the sources nearest to the property line.
- Any on-site or local meteorological stations, both surface and upper-air.

For PSD Analyses

- Provide a copy of the area map submitted with the permit application. If the map is an extract, it should be full scale (no reduction or enlargement) and cover the area within a 3 km (1.9-mile) radius of the facility if used for the Auer land-use analysis.
- Provide maps that show the location of PSD Class I areas within 100 km (62 miles).
- Urban areas, nonattainment areas, and topographic features within 50 km (31 miles) or the distance to which the source has a significant impact, whichever is less.

5.0 Air Quality Monitoring Data

For PSD Analyses

- Discuss how ambient background concentrations will be obtained. That is, preconstruction monitoring or state/local/on-site monitoring networks. Ideally, conduct the monitoring analysis before a PSD permit application is submitted, as monitoring could take as long as one year if representative monitored data are not available.
- Provide a summary of observations for each pollutant and averaging time, if available.
- Discuss how concentrations will be adjusted, if all nearby and background point sources are modeled in the vicinity of a monitor, if applicable.

6.0 Modeling Emission Inventory

Sources to be Permitted

Provide a copy of the Emissions Table to be submitted with the permit application. Note that if stack parameters for any averaging period or load level are different, additional entries are required on the Table.

- Identify special source types such as covered stacks, horizontal exhausts, fugitive sources, area sources, open pit sources, volume sources, roads, stockpiles, flares, and how they will be modeled.
- Provide all assumptions and calculations used to determine as appropriate the size, sides, rotation angles, heights of release, initial dispersion coefficients, effective stack diameter, gross heat release, and weighted (by volume) average molecular weight of the mixture being burned.
- Specify particulate emissions as a function of particle size, mass fraction for each particle size category, and particle density for each particle size category, as applicable.
- In addition, it would be helpful to provide a table with stack parameters converted to metric units.

Other On-Site and Off-Site Sources
Advise how other on- and off-site sources' modeling parameters will be obtained.

Table Correlating the Emission Inventory Source Name with the Source Number in the Modeling Output
Provide a table that cross-references the source identification numbers used in the modeling if they are different from the Emissions Table or from any additional list of sources.

Stack Parameter Justification
Provide the basis for using the listed stack parameters (flow rates, temperatures, stack heights, velocities) if known before the protocol is submitted. This should include calculations if necessary for justification.

Scaling Factors
Discuss how emission scalars will be developed and used in the modeling, if applicable.

7.0 Models and Modeling Technique

Identify proposed models, model version numbers, and the model entry data options such as the regulatory default option and the period option.

- Discuss any proposed specialized modeling techniques such as screening, collocating sources, and ratioing.
- Provide assumptions and sample calculations, as applicable.

8.0 Building Wake Effects (Downwash)

State whether the EPA's Building Profile Input Program and Plume Rise Enhancements Model (BPIP-PRIME) or another software package that employs the BPIP-PRIME algorithms will be used. Provide any computer assisted drawing files.

9.0 Receptor Grid—Terrain and Design

- Discuss if terrain should be considered and how the terrain for individual receptors will be determined.
- Ensure that the higher terrain in any direction from the source is included in the modeling—not just the highest.
- DEM. Provide the datum of your coordinates. If 7.5-minute DEM data are not available for the entire receptor grid, ensure 7.5-minute DEM data are used for receptors within approximately 3–5 km of the property line/fence line.
- Discuss how the receptor grids will be determined for each type of analysis.
- Provide a diagram of each grid and include any reference labels or nomenclature, if available before the protocol is submitted.
- Provide the datum of your coordinates.

10.0 Meteorological Data

- Indicate the surface station, surface station anemometer height, upper-air station, and period of record.
- **For PSD**, five consecutive years of the most recent, readily available, hourly and annual National Weather Service (NWS) data, or one or more years of on-site data.
- Discuss how any meteorological data was determined or replaced, if done before the protocol is submitted. MDEQ should approve substitutions before modeling begins. In addition, submit all the supplementary data used to develop the specific input meteorological parameters required by the PCRAMMET or AERMET programs.

11.0 Modeling Results

- Discuss how the modeling results for each averaging period relative to applicable de minimis values, standards etc. will be presented. Tabulated results are preferred when several constituents are addressed.

For PSD, the following items must also be included.

- **Additional Impacts Analysis,** Discuss what methods will be used to evaluate each of the following: visibility, growth, soils and vegetation analyses, and water, if any, for this project.
- **Class I Area Impacts Analysis,** Discuss what methods will be used to evaluate Class I area impacts, if any, for this project.

APPENDIX D

AERMOD Implementation Guide

AERMOD IMPLEMENTATION GUIDE

Last Revised: October 19, 2007

AERMOD Implementation Workgroup
U. S. Environmental Protection Agency
Office of Air Quality Planning
and Standards Air Quality Assessment Division
Research Triangle Park, North Carolina

PREFACE

This document provides information on the recommended use of AERMOD for particular applications. The following recommendations augment the use of experience and judgment in the proper application of dispersion models. Advanced coordination with reviewing authorities, including the development of modeling protocols, is recommended for regulatory applications of AERMOD.

ACKNOWLEDGMENTS

The AERMOD Implementation Guide has been developed through the collaborative efforts of EPA OAQPS, EPA Regional Office, State and local agency dispersion modelers, through the activities of the AERMOD Implementation Workgroup. The efforts of all contributors are gratefully acknowledged.

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1.0 WHAT'S NEW IN THIS DOCUMENT

<u>Revisions dated October 19, 2007:</u>

This is the first update to the AERMOD Implementation Guide since it was first released September 27, 2005. In addition to the changes identified below, the document has been restructured to better accommodate current and future updates.
The following sections have been affected by this revision:

3.1 SELECTING SURFACE CHARACTERISTICS

This section includes a note regarding the pending release of the draft AERSURFACE tool and pending changes regarding recommended methods for estimating surface characteristics from land use/land cover data.

3.2 SELECTING UPPER AIR SOUNDING LEVELS

This section addresses the selection of upper air sounding levels for processing in AERMET.

5.1 URBAN/RURAL DETERMINATION

This section includes recommendations for determining whether a source(s) should be modeled as urban or rural.

5.2 SELECTING POPULATION DATA FOR AERMOD'S URBAN MODE

This section includes additional discussion regarding use of population density to determine the urban population for input to AERMOD.

5.3 OPTIONAL URBAN ROUGHNESS LENGTH – URBANOPT KEYWORD

This section addresses the optional surface roughness parameter under the AERMOD urban option.

2.0 DOCUMENT BACKGROUND AND PURPOSE

2.1 BACKGROUND (10/19/07)

In April 2005, the AERMOD Implementation Workgroup (AIWG) was formed in anticipation of AERMOD's promulgation as a replacement for the Industrial Source Complex (ISCST3) model. AERMOD fully replaced ISCST3 as the regulatory model on December 9, 2006[1], after a one-year grandfather period. The primary purpose for forming the AIWG was to develop a comprehensive approach for dealing with implementation issues for which guidance is needed. A result of this initial AIWG was the publication of the first version of the AERMOD Implementation Guide on September 27, 2005.

In 2007, a new AIWG was formed as a standing workgroup to provide support to EPA's Office of Air Quality Planning and Standards (OAQPS). This document represents the combined efforts of AIWG and OAQPS in relation to the implementation of the AERMOD regulatory model.

2.2 PURPOSE (10/19/07)

This document provides information on the recommended use of AERMOD for particular applications. Topics are organized based on implementation issues, with additional information as appropriate on whether they impact the modules of the AERMOD modeling system (AERMOD, AERMET, and AERMAP) or related programs (AERSURFACE, AERSCREEN, and BPIPPRM). The document contains a section which highlights changes from the previous version. This is located in Section 1 of the document for use as a quick reference. Each section is also identified with the date (mm/dd/yy) that it was added or last updated. Only sections with substantive changes or new recommendations are identified with new revision dates. Revision dates are not updated for sections with only minor edits to clarify the wording or to correct typographical errors.

The recommendations contained within this document represent best use practices as determined by EPA, through the implementation of AIWG. The document is not intended as a replacement of, or even a supplement to the *Guideline on Air Quality Models*[2]. Rather, it is designed to provide consistent, technically sound recommendations to specific issues relevant to the regulatory application of AERMOD. As always, advance cooperation with the reviewing authorities on the application of AERMOD is advisable. Modeling protocols should be developed, and agreed upon, in advance of any modeling activity.

3.0 METEOROLOGICAL DATA AND PROCESSING

3.1 SELECTING SURFACE CHARACTERISTICS (10/19/07)

> NOTE: *A draft version of the AERSURFACE tool, designed to assist users with estimating surface characteristics for input to AERMET, is being finalized for release. The methodology implemented in the current draft version of AERSURFACE differs in some respects from the procedures described in this section and in Section 5.4 of the AERMET User's Guide (EPA-454/B-03-002). More details regarding the methodology implemented in AERSURFACE will be provided with the release of the AERSURFACE program and documentation. Appropriate changes to the AERMOD Implementation Guide and AERMET User's Guide will also be released at that time. Users are encouraged to check regularly for these updates. (10/19/07)*

If you are using AERMET to prepare the meteorological data for AERMOD, you must input three surface characteristics, the surface roughness $\{z_o\}$, the albedo $\{r\}$, and the Bowen ratio $\{B_o\}$. When using National Weather Service (NWS) data for AERMOD, data representative-ness can be thought of in terms of constructing realistic PBL similarity profiles. As such, the determination of representativeness will depend on a comparison of the surface characteristics (i.e., z_o, B_o and r) between the NWS measurement site and the source location, coupled with a determination of the importance of those differences relative to predicted concentrations. The discussion in this section related to NWS data also applies to other sources of non-site-specific data.

The degree to which predicted pollutant concentrations are influenced by surface parameter differences between the application site and the NWS site depends on the nature of the application (i.e., release height, buoyancy, design metric, downwash considerations, etc.). For example, a difference in z_o for one application may translate into an unacceptable difference in the design concentration while for another application, the same difference in z_o may lead to an insignificant difference in design concentration. If the reviewing agency is uncertain as to the representativeness of an NWS site, a site-specific sensitivity analysis may be needed in order to quantify, in terms of expected changes in the design concentration, the significance of the differences in each of the surface characteristics.

If the nearest NWS meteorological site's surface characteristics are determined to NOT be representative of the application site, it may be possible that another nearby NWS site may be representative of both weather parameters and surface characteristics. Failing that, it is likely that site-specific meteorological data will be required.

In defining sectors for surface characteristics, the user should specify a sector no smaller than a 30-degree arc. The expected wind direction variability over the course of an hour, as well as the encroachment of characteristics from the adjacent sectors with travel time, makes it hard to preserve the integrity of very narrow sector characteristics. Thus, the user should apply a weighted average of surface characteristics by surface area within each sector for 3 kilometers upwind. Further information on the definition of sectors for surface parameters is provided in the AERMET user's guide.

Here are some suggestions for determining surface characteristics for specific cases:

3.1.1 Rural sources using rural NWS meteorological data (09/27/05)

Having found an NWS site to be representative of the application site, the values of the surface parameters at the meteorological site should, in general, be used for constructing AERMOD's meteorological profiles. However, as discussed below, it may be acceptable to use regional or application site values for B_o and r. Conversely, for z_o it is generally preferred to use values from the meteorological site since the magnitude of the measured wind speed is intrinsically linked to surface roughness; that is, the higher the surface roughness the greater the mechanical turbulence and the lower the wind speed for a given amount of kinetic energy in the approach flow.

In general, for low-level releases, the effects of local differences in z_o are expected to be considerably more significant than similar differences in either B_o or r. Since the albedo and Bowen ratio are used to determine how much of the incoming radiation is converted to sensible heat flux, they are not a strong influence on the measured winds and for many AERMOD applications, can, in general, be considered more regionally representative. However, as indicated above, this is not the case for z_o. The roughness length directly affects the profiling of the measured wind speed and therefore should generally be associated with the area surrounding the meteorological site.

3.1.2 Urban sources using rural NWS meteorological data (09/27/05)

When modeling an urban source, the urban algorithms in AERMOD are designed to perturb the characteristics of the flow as measured from an adjacent rural area. Therefore, a rural NWS meteorological site that is being used for an urban source should be representative of the rural area that is adjacent to the urban area in which the source is located and must pass the representativeness tests described earlier. Then, the values of the surface parameters (z_o, B_o and r) from the rural meteorological site location can be used for constructing meteorological profiles that are appropriate for the urban source location. This is accomplished by including the "URBANOPT" and the "URBANSRC" keywords in the AERMOD control file.

3.1.3 Urban sources using urban NWS meteorological data (09/27/05)

Most airports are located far enough away from the urban center to be considered rural settings. However, for NWS stations located within the urban area, the basic approach for choosing surface characteristics is similar to that used for rural applications using rural NWS data. That is, values for the surface parameters (z_o, B_o and r) should be taken from the area surrounding the NWS site. However, since profiles constructed from the urban surface measurements will not fully reflect the actual turbulence or the expected development of a nighttime urban mixing height, the user will also need to select AERMOD's URBAN option.

3.1.4 Urban sources using urban site-specific meteorological data (09/27/05)

In most cases site-specific data collected within the urban area should be treated in a manner similar to urban NWS data. That is, the surface characteristics should be selected from the meteorological site and AERMOD's urban options should be applied. Furthermore, in order to avoid double counting the effects of the urban heat island, site--specific measured turbulence data should not be used when applying AERMOD's urban option. However, if the site-specific data is of high enough quality and extent, then it may be possible on a case-by-case basis to apply AERMOD without use of the URBAN option. In order to apply AERMOD in an urban setting without selecting its urban option the meteorological data used must be sufficient to fully define the profiles of wind, temperature and turbulence, as well as including estimates of the urban nighttime mixing height.

3.2 SELECTING UPPER AIR SOUNDING LEVELS (10/19/07)

The AERMET meteorological processor requires full upper air soundings (radiosonde data) representing the vertical potential temperature profile near sunrise in order to calculate convective mixing heights. For AERMOD applications within the U.S., the early morning sounding, nominally collected at 12Z (or UTC/GMT), is typically used for this purpose. Upper air soundings can be obtained from the Radiosonde Data of North America CDs for the period 1946 through 1997, which are available for purchase from the National Climatic Data Center (NCDC). Upper air soundings for the period 1994 to the present are also available for free download from the Radiosonde Database Access website (http://raob.fsl.noaa.gov/).

Both of these sources of upper air data offer the following three options for specifying which levels of upper air data to extract:

1) all levels,
2) mandatory and significant levels, or
3) mandatory levels only.

Options 1 and 2 are both acceptable and should provide equivalent results when processed through AERMET. The use of mandatory levels only, Option 3, will not provide an adequate characterization of the potential temperature profile, and is not acceptable for AERMOD modeling applications.

4.0 TERRAIN DATA AND PROCESSING

4.1 MODELING SOURCES IN GENTLY DOWNSLOPING TERRAIN (09/27/05)

For all situations in which there is a difference in elevation between the source and receptor, AERMOD simulates the total concentration as the weighted sum of 2 plume states[3]: 1) a horizontal plume state (where the plume's elevation is assumed to be determined by release height and plume rise effects only, and thereby allowing for impingement if terrain rises to the elevation of the plume); and, 2) a terrain-responding plume state (where the plume is assumed to be entirely terrain following).

For cases in which receptor elevations are lower than the base elevation of the source (i.e., receptors that are down-slope of the source), AERMOD will predict concentrations that are less than what would be estimated from an otherwise identical flat terrain situation. Therefore, in the case of gently down-sloping terrain, where expert judgment suggests that the plume is terrain following (e.g., down-slope gravity flow), AERMOD will tend to underestimate concentrations. This situation has been examined for low-level area sources by Sears (2003)[4]. Sears has shown that as terrain down-slope increases the ratio of AERMOD to ISC (which assumes flat terrain in this situation) estimates decreases substantially.

To avoid this situation, it may be reasonable, in the case of gently down-sloping terrain, to assume flat, level terrain, especially for low-level sources. This decision should be made on a case-by-case basis, relying on the modelers experience and knowledge of the surrounding terrain and other factors that affect the air flow in the study area.

4.2 AERMAP DEM ARRAY AND DOMAIN BOUNDARY (09/27/05)

Section 2.1.2 of the AERMAP User's Guide states that the DEM array and domain boundary must include all terrain features that exceed a 10% elevation slope from any given receptor. The 10% slope rule may lead to excessively large domains in areas with considerable terrain features (e.g., fjords, successive mountain ranges, etc). In these situations, the reviewing authority may make a case-by-case determination regarding the domain size needed for AERMAP to determine the critical dividing streamline height for each receptor.

4.3 MANUALLY ENTERING TERRAIN ELEVATIONS IN AERMAP (09/27/05)

AERMAP currently does not have the capability of accepting hand-entered terrain data (xyz data). AERMAP can accept terrain data from DEM files only. Therefore, if DEM data is not available, for a particular application, terrain elevations will need to be entered manually in a form that mimics the DEM data format. Instructions for how to accomplish this can be found on the SCRAM web site http://www.epa.gov/scram001/ in a document titled "On inputting XYZ data into AERMAP."

5.0 URBAN APPLICATIONS

5.1 URBAN/RURAL DETERMINATION (10/19/07)

The URBANOPT keyword on the CO pathway in AERMOD, coupled with the URBANSRC keyword on the SO pathway, should be used to identify sources to be modeled using the urban algorithms in AERMOD. To account for the dispersive nature of the "convective-like" boundary layer that forms during nighttime conditions due to the urban heat island effect, AERMOD enhances the turbulence for urban nighttime conditions over that which is expected in the adjacent rural, stable boundary layer, and also defines an urban boundary layer height to account for limited mixing that may occur under these conditions. The magnitude of the urban heat island effect is driven by the urban-rural temperature difference that develops at night. AERMOD currently uses the population input on the URBANOPT keyword as a surrogate to define the magnitude of this differential heating effect. Details regarding the adjustments in AERMOD for the urban boundary layer are provided in Section 5.8 of *AERMOD: Description of Model Formulation* (EPA-454/R-03-004)[3].

Section 7.2.3 of the *Guideline on Air Quality Models*[2] provides the basis for determining the urban/rural status of a source. For most applications the Land Use Procedure described in

Section 7.2.3(c) is sufficient for determining the urban/rural status. However, there may be sources located within an urban area, but located close enough to a body of water or to other non-urban land use categories to result in a predominately rural land use classification within 3 kilometers of the source following that procedure. Users are therefore cautioned against applying the Land Use Procedure on a source-by-source basis, but should also consider the potential for urban heat island influences across the full modeling domain. Furthermore, Section 7.2.3(f) of Appendix W recommends modeling all sources within an **urban complex** using the urban option even if some sources may be defined as rural based on the procedures outlined in Section 7.2.3. Such an approach is consistent with the fact that the urban heat island is not a localized effect, but is more regional in character.

Another aspect of the urban/rural determination that may require special consideration on a case-by-case basis relates to tall stacks located within or adjacent to small to moderate size urban areas. In such cases, the stack height, or effective plume height for very buoyant plumes, may extend above the urban boundary layer height. Application of the urban option in AERMOD for these types of sources may artificially limit the plume height. Therefore, use of the urban option may not be appropriate for these sources, since the actual plume is likely to be transported over the urban boundary layer. A proper determination of whether these sources should be modeled separately without the urban option will depend on a comparison of the stack height or effective plume height with the urban boundary layer height. The urban boundary layer height, z_{iuc}, can be calculated from the population input on the URBANOPT keyword, P, based on Equation 104 of the AERMOD formulation document[3]:

$$z_{iuc} = z_{iu0} (P / P_0)^{1/4}$$

where z_{iu0} is the reference height of 400 meters corresponding to the reference population, P_0, of 2,000,000. Exclusion of these elevated sources from application of the urban option must be justified on a case-by-case basis in consultation with the appropriate reviewing authority.

5.2 SELECTING POPULATION DATA FOR AERMOD'S URBAN MODE (10/19/07)

For relatively isolated urban areas, the user may use published census data corresponding to the Metropolitan Statistical Area (MSA) for that location. For urban areas adjacent to or near other urban areas, or part of urban corridors, the user should attempt to identify that part of the urban area that will contribute to the urban heat island plume affecting the source(s). If this approach results in the identification of clearly defined MSAs, then census data may be used as above to determine the appropriate population for input to AERMOD. Use of population based on the Consolidated MSA (CMSA) for applications within urban corridors is not recommended, since this may tend to overstate the urban heat island effect.

For situations where MSAs cannot be clearly identified, the user may determine the extent of the area, including the source(s) of interest, where the population density exceeds 750 people per square kilometer[5]. The combined population within this identified area may then be used for input to the AERMOD model. Users should avoid using a very fine spatial resolution of population density for this purpose as this could result in significant gaps within the urban area due to parks and other unpopulated areas, making it more difficult to define the extent of the urban area. Population densities by census tract should provide adequate resolution in most cases, and may still be finer resolution than desired in some cases. Since census tracts vary in size and shape, another acceptable approach would be to develop gridded estimates of population data based on census block or block group data. In such cases, a grid resolution on the order of 6 kilometers is suggested. Plotting population density with multiple "contour" levels, such as 0-500, 500-750, 750-1000, 1000-1500, etc., may also be beneficial in identifying which areas near the edge of the urban complex to include even though the population density may fall below the 750 threshold. The user should also bear in mind that the urban algorithms in AERMOD are dependent on population to the one-fourth power, and are therefore not highly sensitive to variations in population. Population estimates to two significant figures should be sufficiently accurate for application of AERMOD.

5.3 OPTIONAL URBAN ROUGHNESS LENGTH – URBANOPT KEYWORD (10/19/07)

The URBANOPT keyword on the CO pathway includes an optional parameter to specify the urban surface roughness length. The urban surface roughness parameter is used to define a reference height for purposes of adjusting dispersion for surface and low-level releases to account for the enhanced turbulence associated with the nighttime urban heat island. This optional urban roughness length is not used to adjust for differences in roughness length between the meteorological measurement site, used in processing the meteorological data, and the urban application site. Details regarding the adjustments in AERMOD for the urban boundary layer, including the use of the urban roughness length parameter, are provided in Section 5.8 of *AERMOD: Description of Model Formulation* (EPA-454/R-03-004)[3].

The default value of 1 meter for urban surface roughness length, assumed if the parameter is omitted, is considered appropriate for most applications. Any application of AERMOD that utilizes a value other than 1 meter for the urban roughness length should be considered as a non-regulatory application, and would require appropriate documentation and justification as an alternative model, subject to Section 3.2 of the *Guideline on Air Quality Models*[2]. The use of a value other than 1 meter for the urban surface roughness length will be explicitly treated as a non-DFAULT option in the next update to the AERMOD model.

6.0 SOURCE CHARACTERIZATION

6.1 CAPPED AND HORIZONTAL STACKS (09/27/05)

For capped and horizontal stacks that are NOT subject to building downwash influences a simple screening approach (Model Clearinghouse procedure for ISC) can be applied. This approach uses an effective stack diameter to maintain the flow rate, and hence the buoyancy, of the plume, while suppressing plume momentum by setting the exit velocity to 0.001 m/s. To appropriately account for stack-tip downwash, the user should first apply the non-default option of no stack-tip downwash (i.e., NOSTD keyword). Then, for capped stacks, the stack release height should be reduced by three actual stack diameters to account for the maximum stack-tip downwash adjustment while no adjustment to release height should be made for horizontal releases.

Capped and horizontal stacks that are subject to building downwash should not be modeled using an effective stack diameter to simulate the restriction to vertical flow since the PRIME algorithms use the stack diameter to define the initial plume radius which, in turn, is used to solve conservation laws. The user should input the actual stack diameter and exit temperature but set the exit velocity to a nominally low value, such as 0.001 m/s. This approach will have the desired effect of restricting the vertical flow while avoiding the mass conservation problem inherent with effective diameter approach. The approach suggested here is expected to provide a conservative estimate of impacts. Also, since PRIME does not explicitly consider stack-tip downwash, no adjustments to stack height should be made.

6.2 USE OF AREA SOURCE ALGORITHM IN AERMOD (09/27/05)

Because of issues related to excessive run times and technical issues with model formulation, the approach that AERMOD uses to address plume meander has not been implemented for area sources. As a result, concentration predictions for area sources may be overestimated under very light wind conditions (i.e., u << 1.0 m/s). In general, this is not expected to be a problem for meteorological data collected using standard wind instruments since instrument thresholds are generally too high. However, the problem could arise with meteorological data derived from very low threshold instruments, such as sonic anemometers. While not currently accepted for regulatory applications of AERMOD, this problem has also arisen when data from a gridded meteorological model was used to drive AERMOD. Meteorological grid models can at times produce extremely light winds. During such conditions time-averaged plumes tend to spread primarily as a result of low frequency eddy translation rather than eddy diffusion. AERMOD treats this meander effect by estimating the concentration from two limiting states: 1) a coherent plume state that considers lateral diffusive turbulence only (the mean wind direction is well defined) and 2) a random plume state (mean wind direction is poorly defined) that allows the plume to spread uniformly, about the source, in the x-y plane. The final concentration predicted by AERMOD is a weighted sum of these two bounding concentrations. Interpolation between the coherent and random plume concentrations is accomplished by assuming that the total horizontal “energy” is distributed between the wind’s mean and turbulent components.

In order to avoid overestimates for area sources during light wind conditions, it is recommended that, where possible, a volume source approximation be used to model area sources. This approach can be applied with confidence for situations in which the receptors are displaced from the source. However, for applications where receptors are located either directly adjacent to, or inside the area source, AERMOD's area source algorithm will need to be used. For these circumstances, caution should be exercised if excessive concentrations are predicted during extremely light wind conditions. On a case-by-case basis, the reviewing authority should decide whether such predictions are unrealistic. One possible remedy would be to treat such hourly predictions as missing data.

It is EPA's intention to correct this problem. A version of AERMOD that includes meander for area sources will be developed as soon as practicable.

7.0 REFERENCES

[1] 40 Federal Register Volume 70, Page 68218.

[2] 40 CFR Part 51 Appendix W.

[3] Cimorelli, A. J., S. G. Perry, A. Venkatram, J. C. Weil, R. J. Paine, R. B. Wilson, R. F. Lee, W.
D. Peters, R. W. Brode, and J. O. Paumier, 2004. AERMOD: Description of Model Formulation, EPA-454/R-03-004.

[4] Sears, C., 2003. Letter to Docket No. A-99-05 Availability of Additional Documents Relevant to Anticipated Revisions to Guideline on Air Quality Models Addressing a Preferred General Purpose (flat and complex terrain) Dispersion Model and Other Revisions (Federal Register / Vol. 68, No. 173 / Monday, September 8, 2003).

[5] Irwin, J.S., 1978. Proposed Criteria for Selection of Urban Versus Rural Dispersion Coefficients. (Draft Staff Report), Meteorology and Assessment Division, U.S. Environmental Protection Agency, Research Triangle Park, NC. (Docket No. A-80-46, II-B-8).

APPENDIX E

Minimum Requirements to Establish Representative Data

Appendix E - Minimum Requirements to Establish Representative Data

A. Physiographic Analysis

Analysis of local terrain features extending out to 1.6 km (1-mile) radius from the site and on a regional scale including several townships for overall impact. The analysis must include the following:

1. Two sites must fall in the same generic category of terrain:
    a. Flat terrain
    b. Shoreline conditions
    c. Complex terrain
        i. Three dimensional terrain
        ii. Simple Valley
        iii. Complex Valley
        iv. Two dimensional terrain

2. For representative sites in complex terrain the following conditions must be similar:
    a. Alignments of major terrain features in north-south orientation
    b. Ratios of height of valley walls to width of valley terrain profiles
    c. Height of ridge to length of ridge
    d. Height of isolated hills to width of hills at the bases
    e. Slope of terrain
    f. Ratio of terrain heights to stack/plume heights
    g. Distance of proposed source from terrain features, i.e., valley wall, ridge, hill etc.

B. Meteorological Analysis Comparison must contain:

1. Comparison of regional meteorology to include typical synoptic weather patterns:
    a. Comparison of site meteorology to include similarity of wind flows, temperatures, inversion types/periods, etc.
    b. Comparisons of the plume rise characteristics for each site.