ADEC Modeling Review Procedures Manual

October 8, 2018

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Notice

This manual provides general guidance to Alaska Department of Environmental Conservation (ADEC) staff reviewing air quality modeling assessments submitted by regulated sources or the public in support of a permit action, permit-avoidance action, or petition to revise Air Quality Control **Regulations**. This guidance may also be used by staff reviewing an existing source assessment under 18 AAC 50.201. The manual provides general guidance for reviewing common modeling assessments. It does not cover all cases that may occur in Alaska, and does not prohibit staff from using alternative approaches when warranted. It is also a "living document" that will be updated as national modeling techniques and tools change.

ADEC developed this manual to help staff conduct efficient air quality modeling reviews. It was *not* developed to impose requirements on model users (including permit applicants), and cannot be used as such, absent future public review and adoption in accordance with the Alaska Administrative Procedures Act (AS 44.62).

This manual references several commercial modeling programs that provide a Graphical User Interface (GUI) for use with the public-domain programs provided by the U.S. Environmental Protection Agency (EPA). ADEC often uses one of these programs in conducting its modeling reviews, and has included various comments regarding the use of this program as an aid to staff. However, the use of other commercial programs, or none at all, in conjunction with the EPA public-domain tools remains appropriate. ADEC's reference to specific products or services does not convey, and should not be interpreted, as conveying a formal approval, endorsement, or recommendation.

ADEC has made several updates to this manual over the past several years. In this update, ADEC incorporated EPA's December 2016 revision to the *Guideline on Air Quality Models* (Guideline), which ADEC has adopted by reference in 18 AAC 50.040(f).

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Table of Contents

List of Appendices

List of Figures

List of Tables

1. Quick Guide

Chapter 1 of the review manual provides short explanations and guidance for conducting efficient modeling reviews. The key is to use a modeling review checklist and to document your findings in your modeling review report as you proceed with the review.

The ADEC Air Permit Program (APP) developed two checklists to help you keep track of where you are at in your review. One of the checklists pertains to minor permit modeling assessments. The other checklist regards ambient assessments submitted in support of a Prevention of Significant Deterioration (PSD) permit application. These checklists are available on the Juneau server at: G:\AQ\PERMITS\Modeling\Documents\Internal Review Procedures\Review Checklists.

Section 1.1 of the Quick Guide presents general notes and tips that are applicable to both checklists and the legislative metric for conducting timely reviews. Section 1.2 presents additional items that only pertain to the minor permit checklist and Section 1.3 presents additional items that only pertain to the PSD checklist. For additional information, tips and suggestions regarding a particular topic, see the "Detailed Discussion" in Section 2, or the applicable appendix.

1.1 General Review

The general notes and tips in this section apply to both the minor permit modeling review and PSD permit modeling review.

Conducting a Timely Review

ADEC is supposed to issue 95 percent of our final New Source Review (NSR) permit decisions within 130 days of receiving a complete application.

- Upon receipt of an application, we have 60 days (per Alaska Statute (AS) 46.14.160) to notify the applicant if the application is incomplete and if so, what information is missing.
- If we <u>do not notify</u> the applicant within 60 days, the application is considered complete, leaving only 70 days to issue a final decision.
- If we <u>do notify</u> the applicant that the application is incomplete, once the missing information is provided by the applicant, the 130-day clock restarts.

Documentation on Hand

Collect all the necessary pieces to perform your review.

- the permit application and modeling report (if submitted separately),
- supplemental information provided by the applicant (if any),
- the modeling protocol and our reply (if these were developed),

- electronic files,
- paper (real or electronic) to record your findings, and
- the applicable template for modeling reviews.

Note: A modeling protocol is not generally required; however, it is very helpful to ensure that the modeling tools, procedures, input data, and assumptions that are used by an applicant are consistent with State and Federal guidance. Modeling protocols are also recommended by EPA (e.g., see Section 9.2.1 of the Guideline).[1]

Helpful tip:

Check the "AirFacs" directory on the Juneau server to see if there was a "pre-application" folder created for this project that includes additional correspondence with the applicant regarding issues that may be pertinent to the ambient demonstration.

Completeness, Preliminary Review and Coordination with the Lead Permit Engineer

- Perform a preliminary review of the modeling analysis, supporting documentation, and electronic files to determine if there are any obvious missing elements.
- Supporting documentation may include plot plans of the facility, topographic maps, and aerial photographs. Applicants sometimes forget to provide the input, output and data files for preprocessor programs or sometimes overlook the modeling files for a particular pollutant.
- The lead permit engineer may have special conditions or circumstances that you may need to be aware of. Have you had discussions with the engineer before beginning your review?

Missing items should be noted and requested through an incompleteness finding ***if*** the application is still in the completeness review phase. If APP has already deemed the application as "complete," you may still ask the applicant for additional information under AS 46.14.160(c). ***However, coordinate this action with the permit engineer and supervisor – do not take this action unilaterally***. An incompleteness finding should also be noted in **AirTools** (the permit management database). You, or the permit engineer, may also need to place the application "on hold," unless there are other aspects of the permit process that can be worked on while waiting for the requested information.

Performing the Review

As you perform your review, be sure to document your findings at each step along the way rather than waiting until the end. This is especially beneficial if the review cannot be completed at one sitting or in a short period of time or you need to wait for additional information to be returned by the applicant.

[1] All Guideline citations refer to the December 2016 version, published in Federal Register 82 FR 5182 on January 17, 2017, unless noted otherwise. EPA has provided a courtesy copy of the Guideline on SCRAM at: https://www3.epa.gov/ttn/scram/appendix_w/2016/AppendixW_2017.pdf

As you perform the review, you will likely need to compare the discussion in the report to the actual data and parameters in the modeling files.

Project Description and Classification

The applicant should describe the basic who, what, where, and when aspects of their proposed project. They should also clearly identify what air quality permit(s) they believe the project triggers – and for which air pollutants (if applicable), along with the ambient demonstrations required (if any) for those permit classifications. It may be helpful to ask yourself the following questions during your initial review:

- Do I understand what the applicant wants to build or modify? (If not, ask them to clarify what they are proposing to do.)
- Do I understand where the project would be located? (If not, ask them to provide a regional/state map that shows the project location.)
- Has the applicant clearly and accurately identified the permit classifications for this project and the associated ambient demonstration requirements?
- Do you and the permit engineer agree with these classifications?

  Helpful tips:

  Use the tables shown in the Model Review Checklist to summarize what ambient assessments are required or requested.

  Take the time to enter the project classification and obligations/requests, especially if you are juggling multiple projects. It will help you quickly recall the project scope if your review becomes interrupted.

If a modeling protocol was submitted, compare the protocol (and any comments by ADEC) to the applicant's modeling report to determine if there are substantive changes that warrant further consideration.[2] If the applicant did deviate from the protocol, evaluate whether the changes are appropriate.

Model Selection and Model Options

- Is the model and version (for the model and associated preprocessors or post-processors) appropriate for the pollutants and regulatory obligations? Check all models if more than one was used for the modeling demonstration.
- If the applicant modified a model, was the modification approved and is adequate justification for the change, along with any correspondence showing the approval, provided in this document?

[2] As noted in Section 9.2.1(a) of the Guideline, "… it is not intended that [the] protocol be a binding, formal legal document. Changes in such a protocol or deviations from the protocol are often necessary as the data collection and analysis progresses. However, the protocol establishes the common understanding of how the demonstration required to meet regulatory requirements will be made."

- Each model (and associated preprocessor program(s)) has its own unique set of options. Since each model has its own unique requirements to control the processing, refer to the user's guides for each model's settings.
- Are the options in the input files appropriate for the intended purpose? Caution: Sometimes a seemingly unimportant option or keyword carries a big consequence if used incorrectly. The dispersion model (or a preprocessor or postprocessor) may run, but it may not provide the correct results for the given project classification, pollutant, or averaging time.
- Were any non-regulatory options used? If so, be sure adequate justification is provided.

Meteorological Data

The meteorology determines where and by how much the pollutants are transported and dispersed in the atmosphere. The level of modeling – screening or refined – determines the meteorological data for the modeling.

- Was screening or refined meteorology used?
- For screening meteorology,
  - Were appropriate parameters used to develop the meteorology?
- For refined meteorology,
  - Review the source of the meteorological data. Is it based on actual measurements or is it prognostic data?

    Note: *prognostic data introduces a host of additional questions that must be worked through with the meteorologist in the Air Monitoring & Quality Assurance (AM&QA) program, and possibly with the Region 10 office of EPA (R10).*
  - Is the meteorological data model-ready? If so, how was it obtained and was it previously approved by ADEC?
  - If the data are not model-ready and need preprocessing, how was the preprocessing performed? Is there an adequate description of the process (including program options)?
  - **And the most important question**: Are the data representative of the plume transport conditions for the modeled emissions units? Even model-ready data may not be representative.

- AERMET, AERSCREEN, and CALMET require information regarding nearby land use/land cover (LULC). Determine if appropriate data/information were used for deriving these values. When using site-specific meteorological data, check the Quality Assurance Project Plan (QAPP) for information and pictures regarding the project site. The United States Geological Survey (USGS) can also be a source for LULC data, but it may not be in a format that can be used in the current AERSURFACE preprocessor for AERMET/AERSCREEN. (See the *ADEC Guidance re*

AERMET Geometric Means for guidance regarding a possible alternative to AERSURFACE.)

- LULC data are used to develop surface characteristics that are input to AERMET and AERSCREEN. Is there a sufficient discussion on the development of these parameters? Are the resulting surface characteristics reasonable?
- Is there a discussion of missing meteorological data (if any are in the data)?

Terrain

Review the geographic coordinate system used as well as any datum and projection information needed in any of the modeling or preprocessing of terrain data. AERMOD typically uses Universal Transverse Mercator (UTM) coordinate system whereas a modeling demonstration using CALPUFF would likely use a Lambert Conformal Conic (LCC) coordinate system.

AERMAP is the usual way to obtain terrain elevations for the modeled emissions units (EUs) and receptors and the hill height scale for receptors in AERMOD. AERMAP processes digital data to generate the elevation data.

- Review where the applicant obtained the terrain data. The USGS is probably the most common source, but other sources are available.
- If the AERMAP preprocessor is used, examine the domain limits to be sure the applicant is not ignoring an important, possibly controlling, terrain feature.

Emissions Units – Inventory, Characterization, and Emission Rates

Depending on the purpose of the modeling and what preliminary modeling shows (if conducted), the number of modeled sources could be small or extensive.

- Check whether the applicant submitted a project impact analysis[3] and/or a cumulative impact analysis. Did they use the proper approach for the given situation?

Use of the proper emissions rate and release parameters are essential in air dispersion modeling.

- Did the applicant provide a scaled plot plan of sufficient resolution to identify the EU and building locations, ambient air boundaries, and any nearby meteorological or air quality monitoring sites used in the analysis?
- Were appropriate short-term and long-term emission rates modeled for the corresponding short-term and long-term modeling assessments?

[3] A "project impact analysis" is called a "single-source impact analysis" in Section 9.2.3 of the Guideline.

- The permit application must present the source type, emission rate, and associated release parameters in a clear and concise manner for each EU. Is each EU characterized correctly?
- Do the emission rates equal or exceed the emissions rates in the permit application?

  Note: *applicants may model emission rates that are larger than those presented in the permit application as long as it does not cause or contribute to a modeled violation of the air quality standards or increments (as applicable).*

- Verify consistency between the modeling files and information provided in the modeling report.
- Are the emission and release parameters in appropriate units for the given model?
  - EPA's air quality dispersion models typically require metric inputs. If the vendor or reference information is in English units, then the values will likely need to be converted to metric. However, the third party software for AERMOD will accept either metric or English input and then convert the input to the requisite format prior to the actual analysis.
  - Did the applicant use absolute temperature (Kelvin) for the stack release temperatures?

    Note: *the use of relative temperature scales (such as Centigrade or Fahrenheit) may lead to erroneous results.*

  - Did the applicant use actual exhaust flow rates for the exhaust stacks, rather than flow rates based on "standard temperature and pressure" (STP)?

    Note: *The STP flow rate for a combustion source can be a third of the actual flow rate. This substantive difference in flow rates can therefore lead to modeling errors.*

- Are intermittent EUs properly accounted for and if omitted, a justification provided?
- Are dates and times of operation incorporated into the modeling?
- Was a part load assessment performed (See Section 2.7.5)?
- If the applicant is using a "source group" option for reporting the impacts from various combinations of the modeled EUs, do the source groups include the appropriate EUs for the given scenario? [4]

[4] AERMOD does not currently check for spelling errors in the source IDs listed within a source group. Therefore, you should check to make sure that modeled impacts were not inadvertently excluded from the reported results due to typographical errors. The EUs selected for a given source group can typically be easily checked through the visual aids provided in a third party GUI.

Pollutant-Specific Modeling Considerations

Some air pollutants undergo chemical reactions in the atmosphere which can affect their resulting air quality concentrations. Additional tools or assumptions may, therefore, be needed for estimating the resulting concentrations. The criteria pollutants where atmospheric transformation can be a factor include nitrogen dioxide (NO_2), particulate matter with an aerodynamic diameter of 2.5 microns or less (PM-2.5), and ozone (O_3). Atmospheric effects can also be a consideration in deposition and regional haze assessments.

NO_2

- Did the applicant use one of the techniques listed in Section 4.2.3.4 of the Guideline to estimate how much of the NO emissions are converted to NO_2 in the atmosphere, or did they use an alternative modeling technique that requires case-specific approval under 18 AAC 50.215(c)?
- If the applicant used the Tier 2 approach (i.e., ARM2), did they use an appropriate minimum ambient NO_2-to-oxides of nitrogen (NOx) ratio?
- If the applicant used a Tier 3 approach (i.e., OLM or PVMRM):
    - Did they use representative hourly ozone data?
    - Did they use an appropriate NO_2/NOx in-stack ratio (ISR) for each EU?
- If the application is subject to PSD-review, did you discuss the OLM/PVMRM analysis with R10, as required under Section 4.2.3.4(e) of the Guideline?

  Note: *R10 does not require a project-specific discussion prior to using OLM/PVMRM in a modeling analysis submitted as part of a minor permit application. They stated, "Instead, consultation for routine minor NSR can be fulfilled by the general ongoing informal communication between Region 10 and Alaska regarding Alaska's methods and experience applying Tier 3 models.*" [5]

- If the applicant used a model other than AERMOD, did they provide sufficient information for you to confirm whether they appropriately applied OLM/PVMRM?

PM-2.5

- If the applicant conducted a cumulative PM-2.5 impact analysis, did they adequately account for secondary PM-2.5 formation?

Possible PSD Considerations

- If warranted, did the applicant follow the Interagency Workgroup on Air Quality Modeling and *Federal Land Managers' Air Quality Related Values Workgroup*

[5] Email from Jay McAlpine (R10) to Alan Schuler (ADEC); *minor NSR request response*; March 28, 2017.

(FLAG) guidance to account for the formation of pollutants that contribute to regional haze?

Building Information and Downwash

AERMOD

AERMOD uses building dimensions developed by the Building Profile Input Program for PRIME (BPIPPRM) for incorporating downwash into the analysis.

- Review any Good Engineering Practice analyses. Does the analysis agree with the maps and dimensions provided?
- Review the building information to ensure all structures are accounted for that could impact pollutant dispersion. Are the EU and building locations consistent with the facility plot plan? Are the stack and building heights reasonable and consistent with any other information available for this stationary source (e.g., photos from a recent ADEC inspection)?
    - Use of a third party GUI allows a visual comparison of the spatial relationships between the EUs and buildings.
    - Check AirFacs for possible photographs of the stacks (which can help provide a visual assessment of the relative building to stack ratio).
    - Consult current or previous compliance inspectors who have been assigned to an existing stationary source. They may recall the configuration of stacks and the general layout of the facility from their on-site inspections.
- Did the applicant use true base elevations in their BPIPPRM run or take the simpler approach of using "0" for all elevations? If the modeling is for a reasonably flat area, this assumption may be fine. For even moderately more complex terrain, the true base elevations should be used for all EUs, receptors, and structures.

Offshore and Coastal Dispersion (OCD)

The downwash algorithm in OCD is fairly simple in that it is based on a single building height and width per EU. OCD Version 5 will not accept data from BPIPPRM. Applicants should generally use the height and width of the dominant structure near each EU in their OCD analysis.

Receptors

- Check the location of the applicant's ambient air boundary and whether they have an adequate means for precluding public access.

    Note: *You may see the ambient air boundary referred to as the fence line or property boundary and the terms used interchangeably. Be sure the applicant correctly applied EPA's ambient air guidance.*

- Receptors can be specified in numerous ways, especially for AERMOD. Is the range and density of receptors sufficient for finding the maximum impact from the modeled sources?
- Is the receptor grid used in the cumulative impact analysis (if applicable) limited to the modeling domain? (See Section 9.2.2(d) of the Guideline.)
- Are there any flagpole receptors?
- Are receptors located at worker housing, if any (inside the ambient boundary)?
- Are any receptors placed within the ambient air boundary in areas that are not actually ambient air? Modeled concentrations that exceed the value of the AAAQS are not actually violations if they do not occur in ambient air; therefore, placing receptors within the ambient air boundary (except for situations where that particular area is ambient air, such as worker housing areas, right-of-ways, or leases) is unnecessary and can lead to erroneous results.

  Note: *You may need to view an applicant's receptor placement through the use of a GUI to reliably determine their physical location with regard to an ambient air boundary.*

- Plotting the receptors and concentration isopleths in a third party product specific for dispersion modeling or other software (e.g. Golden Software's Surfer®) will greatly assist you in evaluating the adequacy of the applicant's receptor grid.

Off-site Contributions and Background Air Quality Data

EPA no longer endorses their past practice of using the significant impact area (SIA) to determine which off-site stationary sources should be included in a cumulative impact analysis; which they previously described in Chapter C, Section IV.C.1 of their October 1990 draft *New Source Review Workshop Manual*. They have subsequently stated that following the SIA approach "in a literal and uncritical manner may in many cases result in cumulative impact assessments that are overly conservative and could unnecessarily complicate the permitting process in some cases." [6]

Section 8.3.3(b) of the Guideline states, "All sources in the vicinity of the source(s) under consideration for emissions limits that are ***not*** adequately represented by ambient monitoring data should be explicitly modeled" (emphasis added). Assessing the adequacy of the ambient monitoring data for representing the off-site sources is, therefore, the key criteria for determining which off-site sources need to be modeled. See Section 8.3 of the Guideline and Section 2.14.3 of this manual for additional details and comments.

Reiterating the key points: when conducting a cumulative AAAQS analysis, applicants should evaluate the adequacy of the background data and explicitly model all nearby stationary sources that are not represented in the data. Distant stationary sources, along

[6] EPA Memorandum; *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard*, Tyler Fox to Regional Air Division Directors; March 1, 2011.

with natural impacts, may generally be represented through the monitoring data. The applicant should likewise generally model all nearby increment consuming sources, when conducting a cumulative increment analysis.

- Has the applicant identified nearby sources and appropriately included their impacts in the various cumulative impact analysis (as applicable)?
- Did the applicant include an appropriate ambient background concentration for each pollutant and averaging period (as applicable) in their cumulative AAAQS analysis?

Post-Processing Modeling Results

Did the modeling results require post-processing, e.g. using LEADPOST to obtain the quarterly impacts from AERMOD? If so, was the post-processing properly conducted? Similarly, if CALPUFF was used to examine visibility impacts, was CALPOST properly applied?

If additional post-processing was conducted without the use of model-associated postprocessors, is there sufficient explanation of the processing and analysis? Are spreadsheets or other electronic files included in the submission?

Ambient Air Assessments

An applicant's ultimate goal is to obtain the permit. This is accomplished by demonstrating compliance with all the necessary provisions and regulations and air quality standards.

The type of permit being sought (minor or PSD) will prescribe the analyses required to be completed, but there are elements common to both. Below are common elements with permit-specific elements in the next two sections.

- Was the ambient assessment conducted according to 18 AAC 50.215(b) – (d)?
- If the applicant compared their project impact to the applicable significant impact level (SIL), did they come to the correct conclusion regarding the need for a cumulative impact analysis?

  Note: *Applicants have the option of just conducting a cumulative impact assessment without first going through a project impact analysis.*

- Examine the analyses. Did the applicant demonstrate compliance with each AAAQS and increment triggered for the given permit classifications? Did they provide the modeling files needed to review their analysis and did they present the results in a format that you can follow and understand? If not, ask them to clarify what you don't understand.
- Are the applicable Alaska Ambient Air Quality Standards (AAAQS), increments, and other thresholds clearly identified for comparison to the modeling results?

- Representative background air quality data are a required part of an applicant's cumulative AAAQS analysis. Is there adequate explanation and justification on what values were used?

1.2 Minor Permit Modeling Review

Fast-Track Demonstration

A fast-track demonstration under 18 AAC 50.542(b) allows an applicant to receive a minor permit within 30 days of submitting an application if certain procedures are followed.

- Does the application qualify for fast-track procedures? Be sure the area is not excluded from using fast-track procedures.
- If a screening analysis was performed, is it complete and properly conducted? This would include developing the screening meteorology.

1.3 PSD Permit Modeling Review

- Under PSD permitting, the Federal Land Manager (FLM) must be notified of all PSD projects within 100 kilometers (km) of the Class I area that they manage, or "very large [PSD] sources" located beyond 100 km. Did you comply with the FLM notification requirements in 40 CFR 52.21(p)? Did the FLM want to be involved? If so, to what extent?
- Did the applicant provide a Class I Air Quality Related Value (AQRV) analysis requested by the FLM under 40 CFR 52.21(p)(2), if applicable?
- Were the proper stack characteristics used for both increment baseline and increment consuming nearby stationary sources?

  Note: *Actual emissions should be used to estimate baseline concentrations, not potential emissions. The stack characteristics of the time should likewise be used, not the current stack height/design if there has been a subsequent change.*

- Did the applicant adequately include the "secondary emissions" in their ambient demonstrations, as required under 40 CFR 52.21(k)? (See 40 CFR 52.21(b)(18) for EPA's definition of "secondary emissions.")
- Are there any temporary construction activities for which an exclusion applies?
- If PM-2.5 was a triggered PSD-pollutant, did the analysis adequately address the PM-2.5 impacts from secondary formation?
- Was the assessment of visibility impairment, vegetation, and soil impacts under 40 CFR 52.21(o) adequately addressed, e.g. through reliance upon the secondary National Ambient Air Quality Standards (NAAQS)?
- Was a Class I area assessment required? Did ADEC consider FLM comments, if any were provided, in evaluating the assessment?
- If a Class I assessment was conducted, was the assessment acceptable?

- If ozone was a triggered PSD-pollutant, did the analysis adequately demonstrate the ambient air is protected?
- Did the applicant meet the 40 CFR 52.21(m)(1) obligation for pre-construction monitoring – i.e., collect local data, provide surrogate data, or demonstrate that the project impacts are less than the applicable Significant Monitoring Concentration (SMC)? The answer to this question may vary by pollutant.

2. Detailed Discussion

Chapter 2 of the review manual contains the following information. Section 2.1 provides general introductory material, including an overview of ADEC's regulatory requirements, and both EPA and Federal Land Manager (FLM) guidance; and a background discussion on PSD increments. Section 2.2 presents an overview of a suggested procedure for performing an efficient review of an ambient air quality assessment. Sections 2.3 through 2.16 present detailed discussions and "expert tips" on various technical items, such as meteorological data processing and receptor grid generation.

Additional details may be found in the appendices. Appendix A presents additional information and expert tips on the dispersion models commonly used in New Source Review (NSR) ambient assessments, including VISCREEN, AERSCREEN, AERMOD, OCD, and CALPUFF. Appendix B contains frequently asked questions about dispersion modeling.

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2.1 Introduction

APP developed this Modeling Review Procedures Manual to provide you, as the model reviewer, general information you should know for efficiently reviewing a permit applicant's ambient demonstration. However, it should *not* be used in lieu of sound judgment, or to circumvent the modeling requirements listed in 18 AAC 50.215 or the Guideline – which is adopted by reference in 18 AAC 50.040(f). You should also utilize the guidance documents posted on APP's modeling web-page (see http://dec.alaska.gov/air/air-permit/dispersion-modeling/) and the information posted on EPA's Support Center for Regulatory Atmospheric Modeling (SCRAM) website (see https://www.epa.gov/scram).

Disclaimer. This manual provides guidance for reviewing common modeling assessments. It does not cover all cases that could arise or have arisen in Alaska.

2.1.1 Perspective

By its nature, ambient air quality modeling is very detail oriented. As human beings, we are prone to errors.

> *Key point:*
>
> *Nearly every modeling analysis contains errors of some kind.*
>
> *Your job is not only to identify these errors, but to discern their significance and, as needed, to provide feedback to the applicant.*

The analysis does not need to be "perfect" in order to proceed with a permit decision. Some errors may have trivial or inconsequential influence on the results and conclusion. If you're uncertain, you can correct a mistake and rerun the model to determine if the change is significant. If not, you can document the change and continue with the review, without delaying the review process. If the mistake appears to be more substantive, then it's best to have the applicant correct it.

Attitude plays a key role in expediting the modeling review. While you, as a reviewer, are responsible for ensuring that a technically correct ambient impact analysis was conducted, you must also not serve as a stop gap to the process. Consequently, having a "client-service" perspective is also required. You should ask what you can do to help the process along. While reviewing the modeling files, you are encouraged to conduct sensitivity tests of a questionable input parameter, or make small changes if needed.

Finally, judgment is often required in knowing how much to review. You often don't have the luxury of reviewing every detail of the analysis. While this manual offers guidance on many aspects of conducting a modeling review, it can't address every scenario. Perhaps the following quote will offer some guidance….

> *"The closer they are to the standard (or increment), the harder you look".*
>
> \- *Rob Wilson, R10*

2.1.2 ADEC Regulatory Requirements

ADEC's air quality control regulations are in 18 AAC 50.[7] The permitting and ambient demonstration requirements for ***major*** stationary sources are in **Article 3**, and the permitting and ambient demonstration requirements for ***minor*** permit applicants are in **Article 5**. ADEC may also request an ambient demonstration (modeling analysis) as part of an ambient air quality investigation under 18 AAC 50.201.

18 AAC 50.215 contains additional requirements regarding the data and techniques for conducting ambient air quality analysis. ADEC has also adopted various federal provisions by reference in 18 AAC 50.035 – 040. Alaska's Ambient Air Quality Standards (AAAQS) and maximum allowable increases (increments) are listed in 18 AAC 50.010 and 18 AAC 50.020, respectively. There are four "air quality control regions," which are listed in 18 AAC 50.015(c)(1) and illustrated below in Figure 1. ADEC does not require permit applicants to model "air toxics" emissions, unless it's specifically requested as part of an 18 AAC 50.201 ambient air quality investigation.

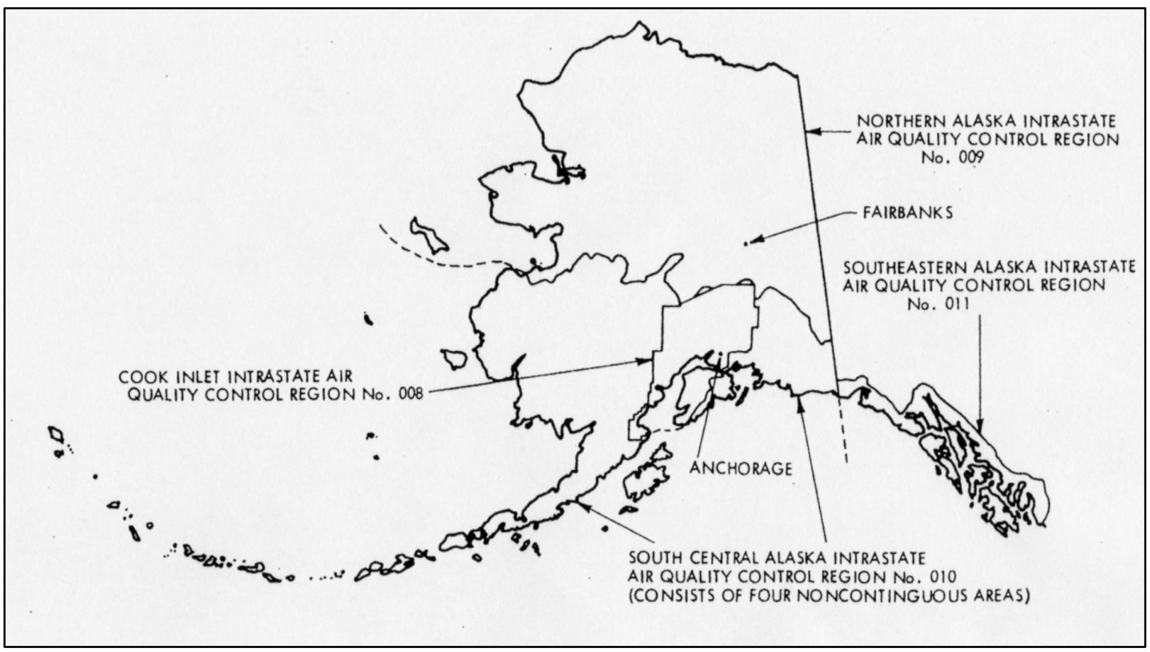

Figure 1. Air Quality Control regions in Alaska

PSD applicants must also conduct an analysis of the impact from the project and associated growth on visibility, vegetation and soil, in addition to demonstrating compliance with the PSD-triggered criteria pollutants. PSD applicants may also need to conduct an AQRV analysis, consistent with the Class I area FLM requirements, to assess the impacts within a "nearby" Class I area.

[7] See http://dec.alaska.gov/air/air-permit/permit-regulations/

2.1.3 EPA Guidance on General Modeling Procedures

EPA's guidance for performing air quality analyses is set forth in the Guideline, codified in 40 C.F.R. Part 51 Appendix W, which is adopted by reference in 18 AAC 50.040(f). Modeling analyses are typically performed in two phases: a preliminary project impact analysis[8] and a cumulative impact analysis.

In the project impact analysis, the applicant models the emissions from just the proposed project (i.e., the emissions increases associated with the permit application). The results of the project impact analysis are then compared to the applicable significant impact level (SIL) in Table 5 of 18 AAC 50.215(d) to determine whether the impacts are significant.[9] If they are, the applicant must perform a cumulative impact analysis to demonstrate compliance with the applicable AAAQS or increment. Background concentrations, and off-site impacts, are not included in the project impact analysis. However, the applicant may need to assess the effect of various operating loads (see Section 2.7.5), to ensure that the maximum project impacts are not underestimated.

> Note: *Applicants may generally bypass the project impact analysis if they want, and instead, just conduct a cumulative impact analysis. This can save them and ADEC time, especially if it's clear that the project impacts will likely exceed the SILs. The only exception would be for a minor permit applicant in a non-attainment area who needs to demonstrate compliance with the non-attainment pollutant. In this case, the applicant must demonstrate that their project impacts are less than the applicable SIL since the cumulative impacts are known to exceed the AAAQS.*

In the cumulative impact analysis, the applicant must estimate what the total air quality concentration, or total increment concentration, would be (as applicable). This means the concentration from non-project sources must be included in the analysis.

EPA's recommended approach for incorporating the impact from non-project sources has changed over time. EPA previously recommended in their draft *New Source Review Workshop Manual*,[10] that the applicant determine the extent of the geographical area for which the project impact exceeded a given SIL. This was referred to as determining the "significant impact area" (SIA). The applicant would then model the emissions from both the proposed project and other existing sources within the SIA in the cumulative impact analysis. The draft manual stated the SIA could not extend beyond 50 km – which is the maximum range of a "Gaussian" dispersion model. However, the draft manual stated that applicants may nevertheless need to include large sources located beyond the SIA, if it appeared that those sources had significant concentrations that overlapped with the applicant's SIA.

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8 A "project impact analysis" is called a "single-source impact analysis" in Section 9.2.3 of the Guideline.

9 In January 2013, the District of Columbia Circuit Court of Appeals revoked the PM-2.5 SIL. Regulatory changes may be forthcoming from EPA and/or ADEC. Check EPA and ADEC websites periodically and before you begin a review to see if new regulations have been put in place.

10 *New Source Review Workshop Manual*; Draft – October 1990.

The 2016 version of the Guideline limits the maximum range for including off-site sources to just those off-site sources located within the SIA, or within 50 km of the applicant's source, whichever is less. EPA calls this area the "modeling domain" in Section 8.1 of the Guideline. Section 8.3 of the Guideline further indicates that when demonstrating compliance with an ambient air quality standard, the impact from most off-site sources could likely be represented through ambient monitoring data. EPA has further stated in various venues that that the past approach of modeling all sources within the SIA, and large sources beyond the SIA, may lead to overly conservative results.

The results from the cumulative analysis are used to demonstrate compliance with the AAAQS and/or PSD increments, as applicable. For those pollutants with both AAAQS and PSD increments, the cumulative impact analysis may need to consist of two separate analyses: one for AAAQS compliance and one for PSD increment compliance (the selection of sources and emission rates for the AAAQS and PSD increment analyses use different criteria, and will be discussed later in this review manual).

If the cumulative analysis demonstrates violations of any AAAQS or PSD increment, ADEC can still permit the proposed project if the applicant can demonstrate that the emissions from the applicant's project do not result in ambient concentrations that exceed the SIL at the same time and location of any modeled violation. In other words, the applicant must demonstrate that the proposed project would not "significantly contribute" to any modeled violation.

2.1.4 General Discussion Regarding PSD Increments

In 1977, Congress mandated that EPA prevent the significant deterioration of air quality in areas that comply with the NAAQS. Congress did not want to cap air pollution to their existing levels since doing so could curb economic growth. However, Congress also did not want air quality to degrade to levels that barely comply with the NAAQS on a nation-wide basis. Congress therefore set numerical limits on the "maximum allowable increase" (i.e., change) that would be allowed for ambient SO_2 and particulate matter (PM)[11] concentrations.[12] Air pollution levels could increase beyond a "baseline" concentration for a given area, but not beyond the NAAQS. This two-prong criteria means that the allowed degradation will either be limited by the allowed change in concentration (i.e., "increment limited") or by the air quality standard (i.e., "NAAQS limited"). The initial concern and solution are respectively illustrated below in Figure 2 and Figure 3.

[11] When Congress amended the Clean Air Act in 1977, the PM NAAQS were expressed in terms of Total Suspended Particulates (TSP).

[12] The SO_2 and PM increments established by Congress are listed Section 163 of the Clean Air Act.

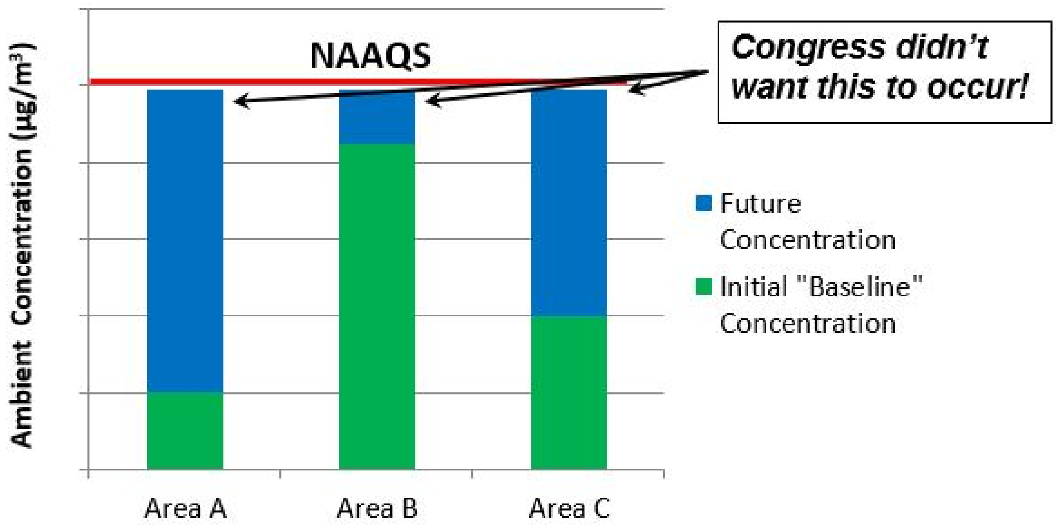

Figure 2. Illustration of Degradation Concern

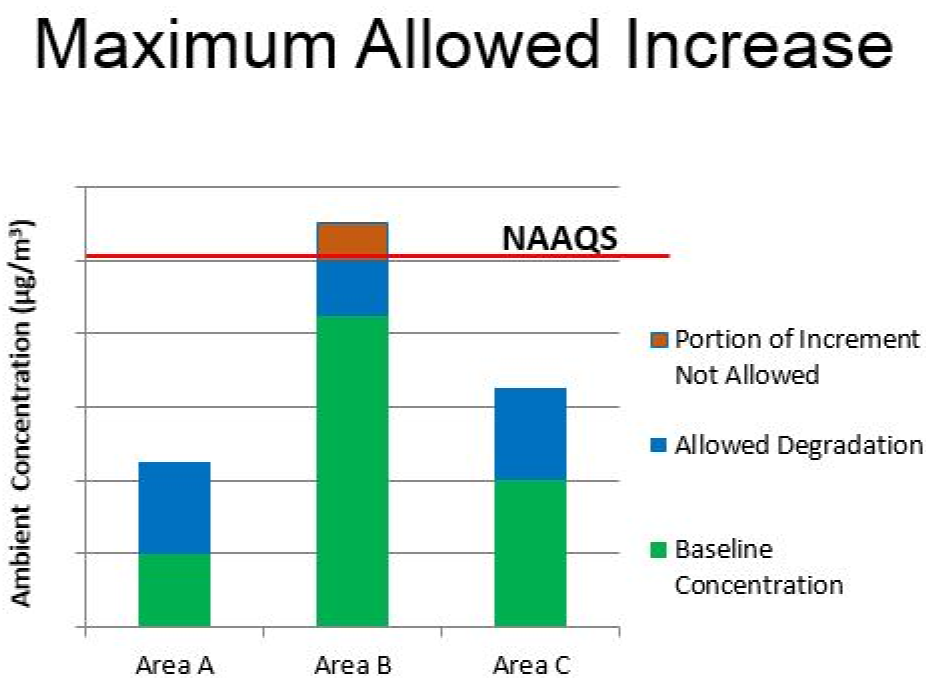

Figure 3. Maximum Allowable Increase (Increment) Illustration

ADEC mostly manages increment consumption through its PSD permit program. Minor permit applicants are not generally required to demonstrate compliance with the PSD increments, nor are Title V permit applicants – with the following exceptions:

- Minor permit applicants may not revise or rescind a Title I permit condition previously established to protect a PSD increment without showing the effect of the proposal on the underlying increment demonstration (see 18 AAC 50.540(k)(3)(C)); and
- Title V applicants for "temporary operations" may need to demonstrate compliance with a PSD increment, per AS 46.14.215.[13]

2.1.4.1 Baseline Concentrations, Dates and Areas

The baseline concentration essentially represents the ambient concentration that existed at a set date, with several exceptions. In general, the submittal date of the first complete PSD permit application in a particular area is the operative "baseline date." On or before the date of the first complete PSD application, emissions generally are considered to be part of the baseline concentration, except for certain emissions from major stationary sources, as explained in the following discussion of baseline dates. Most emission increases that occur after the baseline date will be counted toward the amount of increment consumed. Similarly, emissions decreases after the baseline date restore or expand the amount of increment that is available.

In practice, three dates related to the PSD baseline concept are important in understanding how to calculate the amount of increment consumed— (1) Trigger date; (2) major source baseline date; and (3) minor source baseline date. The **trigger date**, as the name implies, triggers the overall increment consumption process for the given pollutant and averaging period. Congress defined the trigger date as August 7, 1977 for PM (regulated as TSP) and SO_2. EPA established the trigger dates for the NO_2 and PM-2.5 increments through regulation. The trigger date for NO_2 is February 8, 1988, and the trigger date for PM-2.5 is October 20, 2011.

The two remaining dates (the minor source baseline date and the major source baseline date) are used to determine which emissions are part of the "baseline concentration" and which emissions consume increment. The **major source baseline date**, which *precedes* the trigger date, is the date after which actual emissions increases associated with construction at any *major* stationary source consumes PSD increment. Congress defined the major source baseline date for the statutory increments of PM and SO_2 as January 6, 1975. EPA selected February 8, 1988 as the major source baseline date for the annual NO_2 increment, and October 20, 2010 as the major source baseline date for the PM-2.5 increments.

For purposes of the PM (PM-10), SO_2 and PM-2.5 increments, the **minor source baseline date** is the earliest date *after* the trigger date on which an applicant submits the

[13] AS 46.14.215 essentially incorporates a provision of the federal Title V permit program in 40 CFR 71.2, where the definition of "applicable requirement," "means… (13) Any national ambient air quality standard or increment or visibility requirement under part C of title I of the [Clean Air Act], but only as it would apply to temporary sources permitted pursuant to section 504(e) of the [Clean Air Act]."

first complete PSD application within the given air quality control region. Once established, any increase in actual emissions from minor sources (which includes area and mobile sources) within that air quality control region consumes PSD increment for that pollutant. For NO_2, Alaska established the minor source baseline date as the same date as the major source baseline date (February 8, 1988). The minor source baseline dates for Alaska are listed in Table 2 of 18 AAC 50.020. As discussed in Section 2.1.2, Alaska is divided into four Intrastate Ambient Air Quality Regions: No. 008--Cook Inlet Intrastate Region, No. 009--Northern Intrastate Region, No. 010--Southcentral Alaska Intrastate Region, and No. 011--Southeastern Alaska Intrastate Region (see Figure 1).

The trigger dates, major source baseline dates, and minor source baseline dates for most pollutants reiterated below in Table 1. The minor source baseline dates for SO_2, PM-10 and PM-2.5 are not listed since they vary by air quality control region.

Table 1. Dates Associated with PSD Increments

Pollutant	Trigger Date	Major Source Baseline Date	Minor Source Baseline Date
NO_2	Feb. 8, 1988	Feb. 8, 1988	Feb. 8, 1988
SO_2	Aug. 7, 1977	Jan. 6, 1975	See Table 2 of 18 AAC 50.020
PM-10	Aug. 7, 1977	Jan. 6, 1975	
PM-2.5	Oct. 20, 2011	Oct. 10, 2010	

2.1.4.2 How PSD Increments Vary by Area Classification

The amount of allowed degradation varies by how the geographical area is classified. Congress defined three types of areas. They designated "Class I" areas (including certain national parks and wilderness areas) as areas of special national concern that warrant the most stringent limits. Congress set the numerical values for the SO_2 and PM Class I increments at roughly 10 percent of the NAAQS. The rest of the country is currently classified as Class II areas. Congress set the numerical values for SO_2 and PM Class II PSD increments at roughly 25 percent of the NAAQS in order to allow for a moderate degree of emissions growth. Class III areas represent former Class II areas that States formally redesignated as an area of industrial development that would be allowed the greatest amount of pollution increases. Congress set the numerical values for the SO_2 and PM Class III increments at roughly 33 percent of the NAAQS. However, no State has gone through the redesignation process so there are currently no Class III areas in the country.

The terms and values for the PM increments have changed over time.[14] EPA has also established annual NO_2 increments based on the authority granted them through the Clean Air Act (CAA). There are currently no increments for 1-hour NO_2, 1-hour SO_2, or carbon monoxide (CO). The current federal PSD increments are listed in both

[14] Congress allowed EPA to substitute particulate matter with an aerodynamic diameter of 10 microns or less (PM-10) for the PM increment provisions listed in the Clean Air Act as part of the 1990 Clean Air Act amendment. EPA subsequently established the PM-2.5 increments through regulatory action.

40 CFR 51.166(c) and 40 CFR 52.21(c). ADEC has incorporated the federal increments in its air quality program. The PSD increments used by ADEC are listed in Table 3 of 18 AAC 50.020.

2.1.4.3 Increments with No Air Quality Standards

EPA has changed the PM and SO_2 NAAQS subsequent to the 1977 Congressional development of the SO_2 and PM PSD increments. EPA rescinded the annual PM-10 NAAQS when they promulgated the annual PM-2.5 NAAQS, and they rescinded the 24-hour and annual SO_2 NAAQS when they promulgated the 1-hour SO_2 NAAQS.[15] While EPA has the authority to revise the NAAQS, they do not have the authority to revise the increments listed in the CAA – only Congress can do that. Therefore, the annual PM-10, 24-hour SO_2 and annual SO_2 increments remain effective, even though there are no current federal air quality standards for these pollutants and averaging periods.

2.1.4.4 Modeling PSD Increments

Applicants may need to develop a different set of modeling files for demonstrating compliance with a PSD increment than the set of files used to demonstrate compliance with the AAAQS. Different files may be warranted due to differences in the modeled inventory (on-site or off-site), the potential need for including baseline or retired EUs (see Section 2.7.7), differences in how the design concentration is calculated (see Section 2.13), and differences in how the area sources of emissions are accounted for.

2.1.5 FLAG Guidance on Class I Analysis Procedures

Section 165(d)(2)(B) of the CAA states, "*The Federal Land Manager and the Federal official charged with direct responsibility for management of such lands shall have an affirmative responsibility to protect the air quality related values (including visibility) of any such lands within a Class I area and to consider, in consultation with the Administrator, whether a proposed major emitting facility will have an adverse impact on such values*". Class I areas are defined as national parks over 6,000 acres and wilderness areas and memorial parks over 5,000 acres, established as of 1977. All other federally managed areas are designated Class II. The Class I areas within Alaska are described in Table 1 of 18 AAC 50.015 and illustrated in Figure 4 below.

[15] ADEC has also rescinded the annual PM-10 AAAQS in 18 AAC 50.010. However, ADEC is unable to rescind the 24-hour SO_2 and annual SO_2 AAAQS until a year after EPA approves Alaska's 1-hour SO_2 SIP. The 24-hour SO_2 and annual SO_2 AAAQS therefore remain effective, even though there is no equivalent federal air quality standards.

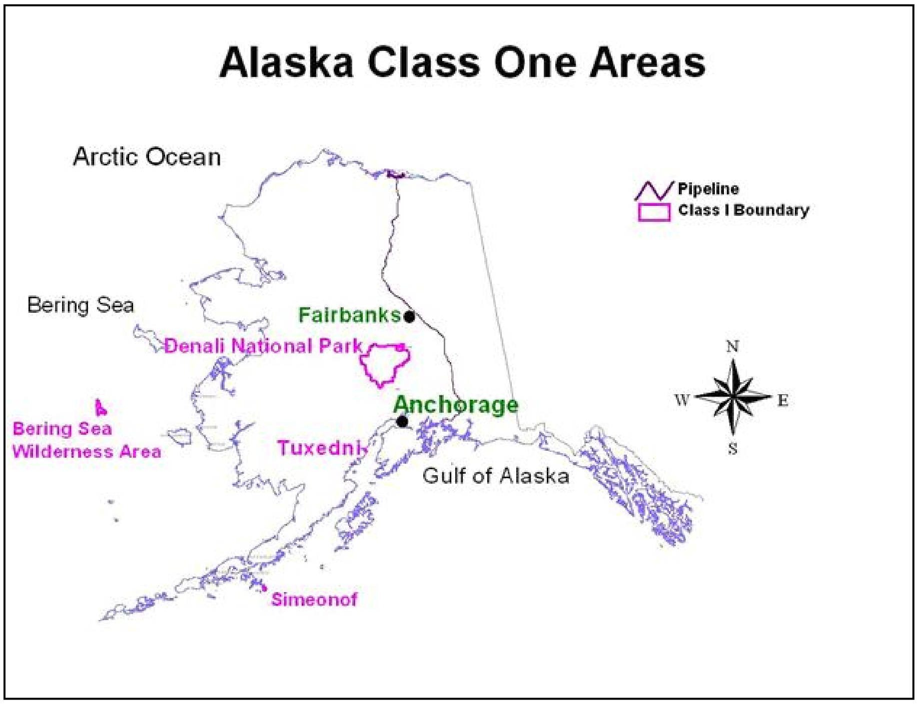

Figure 4. Class I Areas within Alaska

Section 165(d)(2)(A) of the CAA requires the permitting authority to notify the FLM of any PSD application that the permitting authority receives for a project that may impact a Class I area. EPA has elaborated on this requirement by issuing guidance that says the permitting authority must provide timely notification of all PSD projects located within ***100 km*** of the Class I area and or for "very large [PSD] sources" located beyond 100 km.[16]

The FLM will decide whether they want to be involved in the PSD project once they are notified of the project. Their approach for making this decision, and the types of assessments that they may ask for, is described in the 2010 version of the *Federal Land Manager's Air Quality Related Values Work Group (FLAG) Phase I Report*. The FLMs developed this report to provide consistent policies and processes both for identifying AQRVs and for evaluating the effects of air pollution on AQRVs.

Expect FLM involvement for any PSD project located within 50 km of a Class I area. For more distant PSD projects, the FLM will likely want to be involved if the annual emissions divided by distance is greater than 10.[17] Promptly notify the FLM in this

[16] EPA has issued a number of guidance documents over the past few decades that reference the 100 km notification range. EPA summarized this long-standing policy in a January 11, 2017 letter from Anna Marie Wood (Director, Air Quality Policy Division) to Carol McCoy (Chief, Air Resources Division of the National Park Service).

[17] Annual emissions in this context are the combined emissions of SO_2, NOx, PM-10 and H_2SO_4 in tons per year, based on the 24-hour maximum allowable emissions, and distance is expressed in kilometers.

situation to determine whether they will want the applicant to provide additional Class I assessments under 40 CFR 52.21(p).

> Note: *The FLMs used to have written guidance that stated they do not need to be notified of PSD projects located more than 300 km from a Class I area. While this threshold is not in the 2010 version of the FLAG Phase I Report, some FLMs have verbally stated that they still use the 300 km threshold to help manage their workload. Therefore, you may need to check what the current practice is, or just have the applicant provide their "Q/D" value, as described in Section 2.2.1 of the 2010 Phase I report*.

It is important to engage the FLM early in the process. Contacting them during the pre-application phase is ideal. Additional timelines kick-in for projects that may affect a Class I area once we receive the permit application. ***See 40 CFR 52.21(p) for details***. The FLM usually reviews the Class I analysis for regional haze and acid deposition impacts, whereas ADEC reviews the Class I PSD increment and air quality standard analysis. Hence, the applicant and ADEC must coordinate with the FLM's during the review process for any PSD project that may impact a Class I area. Additional guidance on FLM notification can be found Section 2.2.1 of the 2010 Phase I Report.

2.1.6 Levels of Modeling Sophistication

The level of sophistication of the modeling analysis will be dictated by the size and complexity of the proposed project, the nature of the surrounding terrain, and the available meteorological data. For simple projects with relatively small emissions, a simple "screening" analysis may be appropriate. For more complex facilities, facilities located close to "complex terrain" (defined as terrain higher than the final plume height of a particular stack), or facilities with significant building downwash[18], more sophisticated or "refined" models may be required.

EPA lists the refined air quality models preferred for regulatory assessments of criteria air pollutants in Appendix A of the Guideline. The listed models are: AERMOD, OCD, and CTDMPLUS. Only AERMOD and OCD are further discussed in this manual. CTDMPLUS is not further discussed since it has never been used by an Alaskan NSR applicant and it is unlikely that it ever will due to the extensive meteorological data requirements. "Non-guideline" (aka "alternative") models may be used on a case-specific basis upon approval by ADEC and EPA, but ADEC must then also allow for public comment regarding the use of the non-guideline model for the given application. The following paragraphs briefly describe the AERMOD and OCD refined dispersion models, along with the VISCREEN and CALPUFF screening-level models.

[18] Wind flows are disrupted by aerodynamic forces in the vicinity of buildings and other solid structures. A "cavity" region is produced in the lee of the structure that has circulating eddies and a highly turbulent flow. When pollutants are emitted from stacks located near this cavity region, the emissions can quickly be mixed down to ground level and result in high concentrations. This effect is called "aerodynamic downwash".

2.1.6.1 AERMOD

The AERMOD Modeling System consists of three components: AERMAP (used to process terrain data and develop elevations for the receptor grid/EUs), AERMET (used to process the meteorological data), and the AERMOD dispersion model (used to estimate the ambient concentrations). AERMOD is a steady-state plume dispersion model for assessment of pollutant concentrations from a variety of sources. AERMOD simulates transport and dispersion from multiple point, area, volume, or open pit sources based on a characterization of the atmospheric boundary layer.

In addition to these three components, there are two support programs: AERSURFACE (estimates the land-use dependent albedo, Bowen ratio, and roughness length) and AERMINUTE (reads 1-minute National Weather Service (NWS) Automated Surface Observing System (ASOS) data and calculates a 1-hour average wind speed and wind direction to supplement the standard hourly ASOS observations). The current version of AERSURFACE (version 13016 as of October 8, 2018) only processes 1992 land use/land cover data which is typically not available for Alaska. ADEC has alternative guidance to calculate albedo, Bowen ratio, and roughness length which can be found at http://dec.alaska.gov/air/air-permit/dispersion-modeling/ (see the document *Geometric means for AERMET surface parameters; Rev. 2; Revised 6/17/09*).

2.1.6.2 OCD

The OCD model[19] was developed by the US Department of Interior, Bureau of Ocean Energy Management (BOEM), formerly the Minerals Management Service or MMS, to simulate plume dispersion and transport from offshore point, area, or line sources to receptors on land or water. It is most commonly used for off-shore drilling operations, which typically occur from elevated platforms.

The OCD model is an hour-by-hour steady state Gaussian model with enhancements that consider the differences between over-water and over-land dispersion characteristics, the sea-land interface, and platform aerodynamic effects. OCD will also simulate effects from various stack angles, including a downward pointing stack.

[19] DiCristofaro, D. and S. Hanna. November 1989. *The Offshore Coastal Dispersion Model. Volume 1: User's Guide*. Report No. A085-1. Prepared for Minerals Management Services, U.S. Dept. of the Interior. Herndon, VA https://www3.epa.gov/ttn/scram/userg/regmod/ocdugsup.pdf

Alaskan applicants have used OCD to model offshore platforms located in either Cook Inlet or the Beaufort Sea during open water periods. However, AERMOD has been used for North Slope offshore locations for ice conditions. EPA has also developed a non-Guideline variation of AERMET, called AERCOARE, for processing overwater meteorological data. The intent is to someday replace the antiquated OCD model with AERMOD.[20] In the mean-time, applicants may request case-specific approval to use AERCOARE with AERMOD under the alternative modeling provision in 18 AAC 50.215(c).[21]

2.1.6.3 VISCREEN

The Plume Visual Impact Screening Model (VISCREEN)[22] is used to assess plume coloration and contrast (referred to as plume blight), but not regional haze. It can model plume blight from an individual emission point, for both forward and backscattering viewing situations against a sky and terrain background. It calculates plume blight for a user-defined meteorological condition. Typically, the model is run with worst-case short-term emission rates because the visibility guidelines do not have specified averaging periods. VISCREEN may be run at one of two levels of refinement: Level 1 and Level 2. In a Level 1 analysis (the default case), VISCREEN uses the absolutely worst-case stability class (F) and wind speed (1 meter/sec). In the Level 2 analysis, the modeler enters the actual worst-case meteorological conditions obtained from local (representative) hourly meteorological data. The modeler may also modify the plume particle size and density to account for more representative conditions.

2.1.6.4 CALPUFF

CALPUFF [23] may potentially be used to quantify pollutant concentrations, regional haze, and acid deposition impacts. CALPUFF incorporates more sophisticated model physics and chemistry than AERMOD, but also requires more extensive input data. Therefore, use of a model protocol for CALPUFF is highly recommended.

CALPUFF has historically been used to assess the Long Range Transport (LRT) impacts at Class I areas (i.e., at distances greater than 50 km from the applicant's stationary source). However, EPA downgraded the status of CALPUFF in the 2016 revision to the

[20] Additional revisions to AERMOD, such as algorithms for shoreline fumigation and elevated platform downwash, would likely be needed before EPA could replace OCD with AERMOD.

[21] R10 has already allowed the use of AERMOD-AERCOARE as an alternative modeling technique for a permit applicant: Shell Offshore Incorporated (SOI). SOI requested permission to use AERMOD-AERCOARE for a drilling/exploration project in the Beaufort and Chukchi Seas. R10's April 1, 2011 approval, and the subsequent May 6, 2011 concurrence from the EPA Model Clearinghouse, may be found on the Juneau network at: \\jn-svrfile\groups\AQ\PERMITS\Modeling\Documents\AERMOD-COARE.

[22] See *Workbook For Plume Visual Impact Screening and Analysis (Revised)*; EPA-454/R-92-023; October 1992 at https://www3.epa.gov/ttn/scram/userg/screen/WB4PlumeVisualOCR.pdf.

[23] EPA listed CALPUFF as a preferred model for long-range transport in the October 2005 version of the Guideline. EPA changed the status from "preferred" to "screening technique" in the December 2016 version. While this change means it may be less likely for an applicant to use CALPUFF to estimate their long-range impacts, ADEC left much of the previously developed CALPUFF discussion/references in the manual since it could still be helpful for those situations where CALPUFF is used.

Guideline. It may still be used as a screening technique for estimating the project impacts in a LRT analysis, but it now requires approval as an alternative modeling technique if used in a cumulative impact analysis. CALPUFF may also be used to assess AQRVs, if so directed under FLM guidance.

The CALPUFF Modeling System is managed by a private developer who periodically issues updates to the various components. However, not all components are approved by EPA for regulatory use. Check SCRAM for the latest versions that have been accepted by EPA.

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2.2 General Procedures for the Modeling Review

The phases of the modeling review include the completeness determination, the technical review, and documenting the review via a report. Each of these phases is described below.

ADEC has a legislative metric for issuing Title I permit decisions (minor and PSD). We are supposed to issue 95 percent of our final permit decisions within 130 days of receiving a complete application.

Upon receipt of an application, ADEC has 60 days per AS 46.14.160 to notify the applicant if the application is incomplete and if so, what information is missing. If ADEC <u>does not notify</u> the applicant within 60 days, the application is considered complete, leaving only 70 days to issue a final decision. If ADEC <u>does notify</u> the applicant that the application is incomplete, once the missing information is provided by the applicant, the 130-day clock restarts.

Since some time may pass between notifying the applicant of an incomplete application and receiving a response, notes made during the completeness review may help you reacquaint yourself with the application once any missing information is provided.

ADEC can still ask for information from the applicant after an application is deemed complete – per AS 46.14.160(c) – but receipt of that information does not reset the 130-day clock.

Most Title I permit actions require a 30-day public comment period. "Fast-track" minor permits do not – see 18 AAC 50.542(b). The public notice package includes the preliminary permit decision and support documents – such as ADEC's justification for accepting or rejecting the ambient analysis. ADEC must issue a final construction/minor permit decision no more than 30 days after a comment period closes (per AS 46.14.170). Therefore, ADEC must either make a preliminary decision within 70 days of receiving a complete application, or not take the full 30 days to issue a final decision.

Since the modeling review report is the ultimate work product associated with ADEC's review of an ambient demonstration, APP encourages its staff to begin writing their findings at the onset of the review.

<u>Key points</u>:

- ***Promptly check whether the applicant has submitted all of the required elements, prior to conducting a technical review***
- ***Begin documentation at the onset of the project.***
  - ✓ ***If you are reviewing an ambient demonstration, begin preparing either a deficiency notice or a modeling review report.***

A modeling protocol is not generally required by ADEC, but they are recommended by both ADEC and EPA (e.g., see Section 9.2.1 of the Guideline). They can be valuable tools for identifying and resolving potential areas of concern early in the process, as well as assisting the applicant in preparing a modeling analysis that is consistent with State and Federal guidance.

Figure 5 illustrates the steps involved in a modeling review. These steps are summarized below and elaborated on in the following sub-sections.

At the onset of the review, gather together the following documents or files:

1. air quality modeling checklist,
2. the modeling review report template,
3. a blank document to record deficiencies,
4. the modeling protocol and ADEC comments and correspondence,[24]
5. the applicant's modeling discussion, and
6. the applicant's electronic modeling files.

When reviewing a modeling analysis, open the protocol and ADEC's comments on the protocol (if a protocol was submitted and approved), the applicant's modeling discussion, and the template for the modeling review report.

Step 1 Once the documents are open, quickly read the protocol and ADEC's comments to refresh your memory of the accepted approach. Preview the applicant's modeling discussion to comprehend the "big picture" of the approach actually used by the applicant. After you have first obtained an overview, then go through the modeling discussion in detail.

The applicant's modeling discussion hopefully includes a summary which answers the general questions of "who, what, where, why, when, and how." Reading this summary and understanding the basic project makes it easier to review and evaluate the details. Enter this information, as warranted, in your modeling report.

Step 2 Use the PSD/minor air quality modeling review checklist (as applicable) to guide you through the detailed review.[25] See Section 2.3 of this manual for more details on reviewing project information.

- Open the corresponding modeling files and make certain the information is consistent with the applicant's modeling discussion and

[24] Check the "AirFacs" directory on the Juneau server to see if there was a "pre-application" folder created for this project that may contain additional information of which you may need to be aware.

[25] As discussed in Section 1, the checklists are available on the Juneau server at: G:\AQ\PERMITS\Modeling\Documents\Internal Review Procedures\Review Checklists.

permit application. Make certain the modeling discussion is technically complete.

- Promptly document your findings in the modeling report or the deficiency letter, and then begin reviewing the next section.

- Should the review be interrupted, be certain to save the documents, and make a quick note to yourself as to where to resume.

Step 3 Repeat Step 2 until the entire analysis has been reviewed.

Waiting to send comments to the applicant until the entire analysis has been reviewed will decrease the number of iterations between ADEC and the applicant, which makes the overall review and permit issuance more efficient.

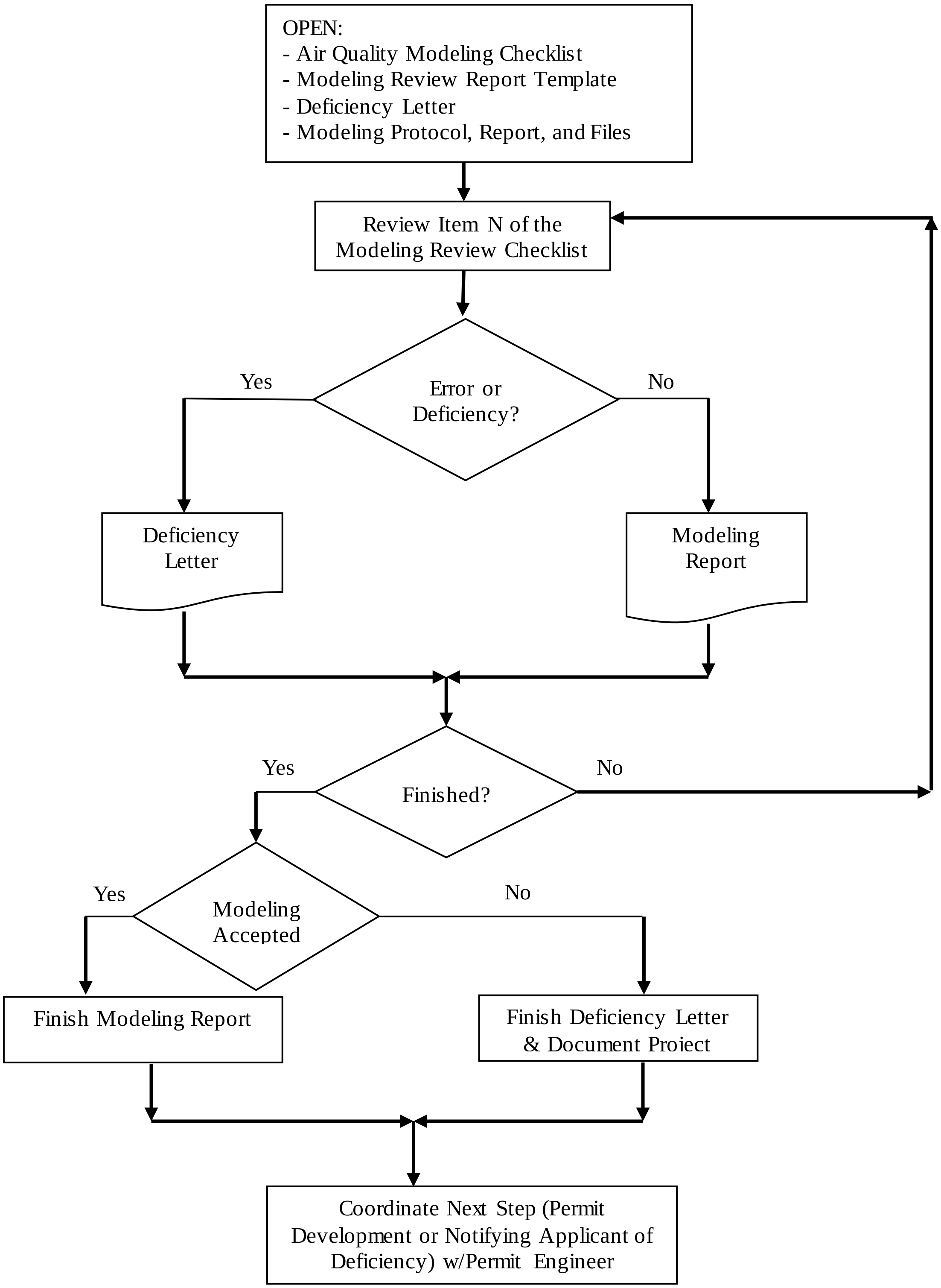

Figure 5. Modeling Review Procedures

2.2.1 Completeness and Technical Review Phase

The completeness review is intended as a first level review of the permit application (which includes the modeling analysis), to ensure ADEC has received all of the components required by regulation for the given permit classification. Per AS 46.14.160 applications default complete within 60 days of receipt, unless we otherwise notify the applicant in writing.

- ✓ Use the applicable air quality checklist (PSD or minor) to keep track of the review.

ADEC has developed two air quality modeling checklists - one for PSD applications and the other for minor permit applications - which may be used to assist you in determining that all components of the modeling analysis have been addressed. During the review process, use this form to track the presence and acceptability of each component of the modeling analysis. Place a check-mark by the items you have reviewed and approved. This manual serves to provide additional details to help answer technical questions during the review process. If you are unable to complete your review of the modeling analysis, the checklist serves as a reminder of the project status at a glance.

Some items may require re-review if the applicant makes changes to address a modeled violation or is changing the project design (which does happen for some applicants). This can make the tracking of the project status tricky. Often, revisions are submitted several months after the review has been initiated. Sometimes the changes (both direct and indirect) are unclear; so much time is spent identifying these, along with how it impacts what has already been reviewed. See the example below (after the ‘Document changes’ checkmark) of direct and indirect changes.

- ✓ Keep organized.

Organization is the key to efficiency. Ideally, when a revision has been submitted you would know the current status of the review, how these changes affect previously reviewed materials, and materials not yet reviewed. Refer to your partially completed checklist, modeling review memo, and/or deficiency letter for an indication of project status.

- ✓ Document changes.

Whether a revised analysis is in response to ADEC comments on a previous submittal or the analysis is an unsolicited submission from the applicant to correct inaccuracies or provide additional information, take a moment to consider what potential impacts these changes would have to the analysis as a whole. Use the checklist to review potential areas that may change, and document changes accordingly. It may be helpful to write the details within the modeling report and on the form, to keep track of changes. The background section of the modeling report is the appropriate place to document the date the revision is received and how it affects the analysis.

As an example, if the applicant submits changes to the modeling due to new emissions information (direct change), theoretically there should be no changes to the meteorology, receptor grid, or model options. However, these changes may result in a need to revise the load screening analysis (if applicable), the significant impact analysis, the cumulative AAAQS and PSD increment inventories, and the corresponding compliance analysis (indirect changes).

- ✓ Take a moment to consider the impact of these changes and then document the receipt of the changes and likely steps that should be revised. Then, complete the technical review.

Judgment is required to discern the amount of documentation necessary to track the revisions. Revisions may be small and only affect a single model run (e.g., annual NO_2 for the AAAQS analysis). Other projects consist of multiple operating scenarios for multiple pollutants, in which the applicant has submitted numerous partial revisions over several months. Such a scenario may require a spreadsheet to keep track of all the changes.

- ✓ In some cases, you may wish to incorporate minor changes yourself to expedite the review. Under such circumstances, you should document your change in your modeling review report.

The technical review is the means by which ADEC, the applicant, and the public are assured that the correct input data, tools, methodologies, and assumptions were used in the analysis. Consequently, the conclusions of the analysis are supportable and credible, and the model results are reproducible. The technical review consists of performing the tasks described in the remaining sections of this manual. Hence, it provides the bulk of the effort during the review process.

2.2.2 Preparation of the Modeling Review

The technical analysis report (TAR) is an all-encompassing permit document created by the lead permit engineer. The findings of the modeling review are one aspect of the TAR. However, because the modeling review is often performed separately and perhaps at different times from the rest of the permit application review, ADEC typically develops a separate modeling review document to communicate the findings of the modeling review, which is then included as an attachment to the TAR. The modeling review report is discussed in detail in this section.

The modeling review report serves two purposes: (1) it provides a public record of the basis of the permit and (2) internal to ADEC, it provides a record of what was done and what decisions were made. This may be very helpful a few years in the future, when you are attempting to understand details about a previously issued permit. The modeling review report should not repeat everything in the applicant's modeling report. Instead, the report should summarize the key findings of the modeling analysis, describe what was done during the review, highlight any unusual or controversial issues, and document changes made to the information in the original application and how any issues were resolved.

- ✓ Start creating the modeling review report at the onset of the project.

Templates for the modeling review report are available electronically on the Juneau server at: G:\AQ\PERMITS\Modeling\Documents\Internal Review Procedures\Review Templates. One template is for PSD permits and the other is for minor permits. The templates may be used as a starting point for developing the project-specific report. They provide examples of how you, the reviewer, could articulate your findings regarding an applicant's ambient demonstration. However, be aware that the templates are broadly written to accommodate a wide-variety of modeling scenarios. You will therefore need to revise, add and delete various sections to make it focused and applicable for the given analysis that you're reviewing. You may also develop an extremely short (abridged) report if the applicant is only revising a portion of a previously approved analysis. In that type of situation, you may reference the previous report(s) or memoranda and only note those items that have changed or otherwise warrant discussion. In all cases, state whether you (ADEC) agrees or disagrees with the approach used by the applicant. Specific statements may be warranted in the various subsections, especially in situations where the applicant used a unique or controversial approach.

2.2.3 Coordination of Modeling Reviewer with Permit Engineer

The modeling review must occur in coordination with the permit engineer to ensure consistency of technical information and communication.

- ✓ Ensure that the modeled EU inventory and emission rates are consistent with those presented in the permit application being reviewed by the permit engineer.
- ✓ In addition to checking the consistency of the technical aspects of the modeling submittal, keep the permit engineer informed throughout the review process of milestones of progress (e.g., protocol approval, completeness, technical approval, etc.) and any communication between you and the applicant or applicant's consultant. Be certain to provide the permit engineer with a copy of any communication, including emails and letters.
- ✓ Communicate to the permit engineer any restrictions in operations that were necessary in the modeling compliance demonstration.

Permit terms such as limiting operating load, sulfur content of fuel, or the number of EUs operating at a single time may be required to demonstrate compliance with the short-term standards or increments. Restricting the annual operating hours to less than 8,760 may be necessary to demonstrate compliance with the annual AAAQS/ increments. It is not generally necessary to impose operational restrictions for purposes of complying with the AAAQS/increments if the applicant is able to demonstrate compliance with unrestricted emissions. However, you may still need to determine whether the assumed stack heights/orientation, or means for precluding public access, need to be imposed as ambient air conditions.

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2.3 Project Information

One of the most important aspects of the modeling review is to ensure that you have a good understanding of the proposed project, EUs, and methods of operation. Without a good general understanding of the project, it is possible that certain EUs or operating scenarios may not be properly accounted for. You should also discuss the project scope and permit classification with the permit engineer in case there are aspects or findings that may affect either effort.

The air quality analysis requires specific information on the EU location and physical characteristics (e.g., emission rate, stack height, stack diameter, exit velocity, and temperature), nearby structures, ambient air boundaries, and receptors. These topics are generally discussed in this section. Additional details may be found in other sections of this manual.

2.3.1 Project Location Map, Topographical Data, and Land Use Analysis

The applicant should provide a project location map in sufficient resolution to identify the source location, ambient air boundary, nearby terrain features (if any), and any meteorological or air quality monitoring sites used in the analysis. Generally, a USGS topographical quadrangle map (7.5 minute scale or 24k Digital Raster Graphics [DRG] digital files) or a high resolution Digital Ortho Quarter Quadrangle (DOQQ) photograph is sufficient for this purpose. The applicant should also provide a scaled site plan or plot plan in sufficient resolution to identify the EU and buildings locations, property and ambient air boundary, and roads. The coordinates and site plan orientation should be identified. Rather than plant coordinates, the Universal Transverse Mercator (UTM) coordinate system is strongly recommended.

ADEC generally recommends that the applicant submit the project location map and site plan not only in the application as "hard-copies", but also as digital files. This will expedite the review of this information.

Topographical data and base elevations of EUs can be reviewed and verified using either topographical maps and/or graphical plots of USGS National Elevation Data (NED) terrain data.[26] The GUI modeling systems previously described can be efficiently used to load digital DRG and/or NED data for the topographical review.

A "rural" vs. "urban" land use analysis is not typically required in Alaska unless the stationary source is located in the greater Anchorage area (all other areas of the state are rural). However, land use data will nevertheless still be needed when AERMOD is used (see Section 2.6.4.2). Land use data is available from USGS in ArcGIS formats.[27]

2.3.2 Layout of EUs and Structures

The modeled location of the EUs and structures (if applicable), should match the actual/proposed layout. Fugitive emissions from area or volume sources require special

[26] Past projects may have relied on USGS Digital Elevation Model (DEM) terrain data. DEM data is no longer supported by the USGS and may not be as accurate as the newer NED data.

[27] Land use information may be available at: http://eros.usgs.gov.

attention. Take the time to understand the nature of the fugitive emission process, understand where these processes occur, and ensure that they are accurately represented in the analysis.

- ✓ Verify that the applicant has correctly located all EUs, structures, and receptor grids.

The relative stack height to building height is also a critical parameter for simulating downwash in AERMOD/AERSCREEN and OCD. Stack and building heights, must therefore be checked for accuracy in addition to the EU location.

There are several software programs available for AERMOD, which allow you to graphically review project data. These programs include BEEST by Providence/Oris, AERMOD View™ by Lakes Environmental, and BREEZE software by Trinity Consultants. There are also graphical and GIS software programs which are not specifically developed for regulatory dispersion models but could be useful in a modeling review. SURFER® graphics by Golden Software is one such commonly used general graphics and mapping program.

The AERMOD GUIs will graphically display the building, stack/EU and receptor locations, and plot the modeled concentrations. Reviewers can also overlay the layout/results on an imported topographical map (e.g., a USGS Quad map). All of these visual features/options are extremely helpful in a modeling review.

- ✓ Make a 3-D plot of the buildings/stacks using the graphical software of your choice and verify that the plot looks reasonably close to that submitted on the plot plan and photographs (if available). Check that the base elevation of the buildings and stacks are consistent (see Section 2.8.1 for additional discussion).

Additional details regarding AERMOD and downwash may be found in Section 2.8 of this manual. Additional details regarding OCD and downwash may be found in the OCD section of Appendix A.

2.3.3 Location of Fence Line, Property, and Ambient Air Boundaries

The AAAQS and increments only apply in "ambient air" locations, which has been defined by EPA as "that portion of the atmosphere, external to buildings, to which the general public has access." [28] Applicants should provide a site plan that clearly shows the ambient air boundary, and property boundary (if applicable), in relation to their receptor grid. As part of your graphical review, check whether the receptor grid starts at the indicated ambient air boundary. See Section 2.11 for additional information regarding the ambient air boundary, and for information regarding the treatment of worker housing areas within an ambient air boundary. Refer to Section 2.12 for additional information regarding receptor grids.

[28] The term "ambient air" is defined in 40 CFR 50.1, which the Alaska Legislature adopted by reference in AS 46.14.90(2).

2.4 Pre-construction Monitoring (PSD Requirement)

Section 165(e)(2) of the CAA requires PSD applicants to submit ambient air quality monitoring data as part of their PSD permit application. The CAA further states that the data "shall be available at the time of the public hearing on the application for such permit." Since the data are required prior to constructing the stationary source or modification, they are commonly referred as "pre-construction monitoring" data.

40 CFR 52.21(m)(1), which ADEC has adopted by reference in 18 AAC 50.040(h)(11), provides additional details regarding this basic element of the PSD permit program. For example, PSD applicants are required to submit ambient monitoring data for each PSD-triggered criteria pollutant, unless the existing concentration or the project impact is less than the Significant Monitoring Concentration (SMC) provided in 40 CFR 52.21(i)(5).[29] Additional guidance regarding pre-construction monitoring may be found in EPA's, *Ambient Monitoring Guidelines for Prevention of Significant Deterioration* (EPA-450/4-87-007), which ADEC has adopted by reference in 18 AAC 50.035(a)(5). The general ambient monitoring requirements in 18 AAC 50.215(a) also apply to pre-construction monitoring.

With one exception, applicants have three possible methods for meeting the preconstruction monitoring requirement. The preferred option can vary by pollutant. Your job is to review their submittal (or proposal) and determine whether they have adequately met the applicable requirements.

The first, and most obvious method for meeting the pre-construction monitoring requirement, is to actually collect PSD-quality ambient monitoring data. However, applicants must collect the data at a location and in a manner that is consistent with EPA's PSD monitoring guidance. In summary, the data must be collected at the location(s) of existing/proposed maximum impact(s), the data must be current, and the data must meet PSD quality assurance requirements.

The second possible method that applicants have for meeting the pre-construction monitoring requirement is to provide existing ambient data as a surrogate of the expected maximum concentration(s) at their project site. This surrogate data should be current PSD-quality data that reflects an upper bound estimate of the maximum concentrations that the applicant would have measured through a monitoring effort conducted in accordance with EPA's PSD monitoring guidance. (See additional discussion later in this section.)

The third method is to submit a modeling analysis which shows that the project impacts are below the SMC. If the predicted impact is less than the SMC for that pollutant, then the project impact may be considered too small to accurately detect with current monitoring techniques. ADEC may then generally consider the SMC analysis as adequate for meeting the pre-construction monitoring requirement. ADEC additionally notes, however, that the SMC for PM-2.5 was vacated on January 22, 2013 by the District of Columbia Circuit Court. Therefore, projects that trigger PSD review for PM-

[29] Pre-construction monitoring could also be required for non-criteria pollutants – see 40 CFR 52.21(m)(ii).

2.5 must include pre-construction data for this pollutant, regardless of their project impacts.

2.4.1 Additional Considerations Regarding Pre-Construction Data

The previously cited rules and guidance provide additional details regarding pre-construction monitoring. Some of the key points are summarized below.

Monitoring Period

At least one year (12 continuous months) of PSD-quality data is generally required to meet the pre-construction monitoring requirement, per both the CAA and 40 CFR 52.21(m)(1)(iv). However, shorter periods may be considered if "a complete and adequate analysis" can still be accomplished. The bare minimum monitoring period is four (4) months.

ADEC has allowed some applicants to limit their ozone (O_3) monitoring to just the summer O_3 season, but rarely allows less than a year of data for other pollutants since the source and atmospheric conditions that lead to peak concentrations are more difficult to predict. Applicants who request a shorter monitoring period may need to provide historical data or dispersion modeling that shows when the maximum concentrations are expected. You should discuss any request for a shortened monitoring effort with the Air Monitoring & Quality Assurance (AM&QA) supervisor, or their designee, prior to providing a formal response to the applicant.

- ✓ ADEC rarely allows less than 12continuous months of data, due to seasonal variations in ambient concentrations. If a specific request arises, staff should discuss the issue with the AM&QA supervisor.

Siting Requirements

The PSD Monitoring Guidelines state that "Existing monitoring data should be representative of three types of areas: (1) the location(s) of maximum concentration increase from the proposed source or modification, (2) the locations(s) of the maximum air pollutant concentration from existing sources, and (3) the location(s) of the maximum impact area, i.e., where the maximum pollutant concentration would hypothetically occur based on the combined effect of existing sources and the proposed new source or modification. Basically, the location and size of the three types of area are determined through the application of air quality models. The areas of maximum concentration or maximum combined impact vary in size and are influenced by factors such as the size and relative distribution of ground level and elevated sources, the averaging times of concern, and the distances between impact area and contributing sources."

It is the applicant's responsibility to propose the pre-construction monitoring site(s) for our review and approval. However, they typically discuss their PSD project and data needs with APP and AM&QA prior to submitting an actual siting request, in order to talk through various aspects of the project and pre-construction monitoring program. These tend to be very worthwhile meetings/teleconferences and can save time in the long-run, especially when the applicant is able to describe the proposed source/modification, project location, and likely permit classifications. The meetings tend to be less beneficial if the applicant is still evaluating a wide range of project designs or locations.

Applicants and ADEC generally look for a single monitoring site that best meets the above criteria for all pollutants of concern. However, EPA's PSD monitoring guidance clearly indicates that a monitoring network (i.e., more than one station) may be needed in some situations.

The areas of maximum impact may vary by pollutant and averaging period, but will generally be located downwind of the predominate sources of the given pollutant. Therefore, the general areas of concern can frequently be determined by laying a wind rose of the local wind data on top of a map that shows the source locations. This approach works best for areas with very predominate wind-directions and for pollutants with annual averaging periods. It does not work as well for areas with widely scattered winds or for pollutants with very short averaging periods, especially the 1-hour averaging period.

As noted by EPA, applicants can use modeling to more accurately determine the areas of concern. However, just be aware that models tend to be more accurate at estimating the maximum concentrations than they are at pinpointing the exact locations as to where those concentrations occur. Therefore, the modeling results should not be used to determine the specific coordinate for placing the monitoring station. The results should instead be used as one of several factors for siting the monitoring station(s).

The additional factors include practical considerations, such as access, security, power and telemetry. There are also pollutant-specific requirements regarding probe placement/set-back that must also be considered. These factors are typically reviewed by the AM&QA program. The review of a proposed pre-construction monitoring site is therefore typically a coordinated effort between AM&QA and the APP modeler assigned to the project.

Quality Assurance Requirements

A person who submits ambient monitoring data under AS 46.03, AS 46.14, or 18 AAC 50 shall obtain the data in accordance with ADEC's *Quality Assurance Project Plan for the State of Alaska Air Monitoring & Quality Assurance Program*, adopted by reference in 18 AAC 50.030, for PM-2.5, PM-10, TSP, lead, carbon monoxide, nitrogen dioxide, sulfur dioxide, ozone, and ammonia. The guidance requires a minimum of 80 percent valid data capture per quarter. In addition to the capture rate, the data must be reviewed and meet all other PSD quality requirements before it may be used to support a permit decision.

Ambient data reviews are currently summarized in an Excel spreadsheet that is kept on the Juneau server. The summary file (*\\jn-svrfile\groups\AQ\PERMITS\Monitoring\QAPP and Data Review\QAPP & Data & Site Review Project List.xlsx*) is located under the folder *G:\AQ\Permits\Monitoring\QAPP and Data Review*.[30] The detailed findings

[30] QAPP and data reviews may someday be tracked through the AirTools database.

regarding the review are stored in the Juneau "AirFacs" directory, under the "Monitoring" sub-folder for the given data owner and monitoring site.

Use of Surrogate Pre-Construction Data

Surrogate pre-construction data refers to existing ambient data from an off-site location that an applicant proposes to use instead of collecting their own pre-construction data. The use of existing data may be allowed on a case-specific basis per Sections 2.1 and 2.4 of EPA's PSD monitoring guidance. EPA states that if the proposed source or modification is in an area that is generally free of impacts from other sources associated with human activity, then monitoring data from a 'regional' site may be considered. Such a site must be similar in nature to the impact area. EPA further states that the intent of this provision is to allow use of a 'regional' site in remote areas rather than multi-source areas.

It is the applicant's responsibility to demonstrate to our satisfaction that the proposed dataset meets the pre-construction monitoring requirements. The data must:

1) meet all of the previously discussed PSD quality assurance requirements;

2) be *current* – see the following sub-section, *How Old Can the Data Be*; and

3) represent the maximum ambient concentrations within the applicant's project area – or at least provide an upper bound estimate of the maximum concentrations.

Evaluating the proposed use of surrogate data in a situation where the applicant is planning to modify an existing stationary source is more challenging than evaluating a request for a new stationary source at a "green-field" (undeveloped) location. In the modification scenario, the air quality impacts from the existing source must somehow be represented by the ambient dataset. The applicant will therefore likely need to describe how the following factors compare between the project site and the surrogate data area:

a) the emission rates for the averaging periods associated with the given pollutant;

b) the release characteristics; and

c) the meteorological conditions during the periods of concern.

Air quality modeling could be used to compare the ambient air concentrations between the surrogate data area and the PSD project area. However, a simpler approach could also be used in some situations. For example, some applicants compare the emission inventories between the project area and the data collection area. This approach works best for areas with similar (if not identical) meteorology and emission release characteristics. The applicant must also use reasonable and similar domains for summing the emissions. In situations where the maximum impacts are predominately related to downwash (which is the common case), the emissions tally should be limited to just the stationary source(s) associated with that downwash. Including other regional sources, or the much larger borough-wide emissions from the National Emissions Inventory (NEI), could bias the comparison and lead to unsound decisions.

How Old Can the Data Be?

Section 2.4.3 of EPA's PSD monitoring guidance states the pre-construction data should generally "have been collected in the 3-year period preceding the permit application." The purpose for this provision is to ensure the data are representative of *current* conditions – as required under 40 CFR 52.21(m)(1)(iv). ADEC has accepted older data on a case-by-case basis, but only in situations where the area has not seen an increase in local emissions. It is the applicant's responsibility to demonstrate to our satisfaction that the existing data represents the ambient concentration from "the year preceding receipt of the application" (40 CFR 52.21(m)(1)(iv)). The older the data, the more uncertainty there is as to whether it accurately reflects current conditions. Requests to use existing data should generally be discussed with the AM&QA supervisor, or their designee.

2.4.2 Comparison of Modeled Impacts to the SMC

Some PSD applicants choose to compare their project impacts to the applicable SMCs in an effort to demonstrate that pre-construction monitoring is not required.[31] As in the case of the significant impact analysis, the maximum emissions allowed during the given averaging period should be used for the modeling analysis, rather than actual or anticipated emissions. The corresponding stack parameters should also be used, unless the source is subject to load screening, in which case the emissions scenario with the maximum ambient impact should be used. The SMC provision in 40 CFR 52.21(i)(5) does not allow for periodic exceedances of the listed threshold. Therefore, applicants must compare the high, first-high (H1H) modeled impact to a short-term SMC, rather a modeled impact that is consistent with the form of the short-term AAAQS or increment. They likewise must compare the highest annual impact to an annual SMC, rather than the multi-year average of the annual impact.

- ✓ Be certain that all EUs associated with the PSD project are included in the SMC analysis.

- ✓ Be certain that the applicant is comparing the H1H impact to the short-term SMCs, rather than a ranked value (e.g., the high second-high impact).

[31] As previously discussed, applicants may not rely on modeling to avoid pre-construction PM-2.5 monitoring since the District of Columbia Circuit Court of Appeals vacated the PM-2.5 SMC.

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2.5 Model Selection

It is important to match the level of model sophistication to the scope of the proposed project, to effectively use resources. For example, modeling the ambient impacts of an isolated 1,000 brake horsepower (bhp) engine may only require a screening analysis to confirm impacts are less than the triggered AAAQS/PSD increments. Conversely, modeling of more complex facilities such as a power generation facility or refinery located near other sources will likely require more refined approaches, such as AERMOD.

Models are often best suited for particular scales of motions. This can range from microscale motions to global models. Regulatory dispersion models are typically applied at two scales of motion: near-field and long-range transport. Near-field models are designed to assess impacts from 10 meters (m) to 50 km, as the dispersion algorithms and model evaluations have been conducted for these distances. Common near-field dispersion models include AERSCREEN, AERMOD, and OCD. The commonly used near-field plume blight model is VISCREEN. Long-range transport models are designed to assess impacts between 50 and a few hundred kilometers. They are most often used in Class I area impact assessments. CALPUFF was the preferred long-range transport model, but it was downgraded to a screening technique in EPA's 2016 revision to the Guideline.

2.5.1 Model Setup and Use of Regulatory Default Options

Model setup and selection of "regulatory default model options" are specific to the individual model being used. Some models allow the user to select a "regulatory default option" switch, which then selects a suite of options typically preferred by regulatory agencies.

When the MODELOPT keyword is selected in AERMOD, the model implements the following default options:

- elevated terrain algorithm
- stack-tip downwash (except in building downwash situations)
- the calm processing routines
- the missing data routines
- a four-hour half-life routine for determining SO_2 concentration for urban sources.

The number of options available to the user in AERMOD is extensive – see the AERMOD User's Guide for additional details.[32]

2.5.2 Selection of Dispersion Coefficients (urban/rural)

With the promulgation of AERMOD and introduction of AERSCREEN, selection on whether to use the rural or urban dispersion coefficients is no longer required. OCD and

[32] EPA periodically updates their *AERMOD User's Guide*. Therefore, check SCRAM (https://www.epa.gov/scram) for possible updates or addendums.

AERMOD use surface characteristics that are a function of land use classification and do not require the specification of "rural versus urban" characteristics. AERMOD does include the URBANOPT modeling option (CO pathway) to identify urban areas that may be affected by increased surface heating on dispersion under stable conditions.

> *Key point:*
>
> *With the exception of certain parts of Anchorage, the applicant should not use the URBANOPT keyword for Alaska regulatory modeling analyses.*

A more rigorous demonstration using the Auer[33] land use analysis is not required, except possibly for analyses in the greater Anchorage area.

2.5.3 Averaging Periods

Applicants typically need to model each averaging period associated with the AAAQS/increment for the triggered pollutant, unless otherwise noted in our regulations. For example, if the application triggers the modeling requirements for SO_2, then the applicant would generally need to model the 1-hour, 3-hour, 24-hour, and annual average SO_2 impacts.[34] On the other hand, 1-hour NO_2 modeling is not generally required of minor permit applicants who trigger the NO_2 modeling requirements – per 18 AAC 50.540(l).

- ✓ Verify that the applicant modeled the applicable averaging periods for the triggered pollutants. You will also need to verify that they used the appropriate short-term/long-term emission rate for the given averaging period.

Often, separate modeling files are necessary to estimate the impacts from pollutants with different short-term and annual average emission rates. With the recent introduction probabilistic standards (e.g., 98th percentile for the 1-hour NO_2 standard), the pollutant identifier (on the POLLUTID keyword in AERMOD) in combination with the averaging time now plays an important role in determining the model runs. The user must also be aware that some combinations of pollutant ID and averaging times might not produce the desired results. For example, if NO_2 is specified as the pollutant ID and 1 and 24 are entered for the averaging periods, the results for the one-hour averages will not give the 98th percentile value to compare to the standard. The model run for the one-hour NO_2 standard must be a separate run.

For screen-level modeling applications, some models only provide one-hour pollutant concentrations as model output. In such cases, the user must apply a scaling factor to obtain concentrations for other averaging periods. For point sources, the EPA scaling factors shown in Table 2 automatically convert one-hour concentration estimates from

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[33] Auer., A.H. 1978. Correlation of Land Use and Cover with Meteorological Anomalies. J. of Applied Meteorology. Volume 17, p. 6A-80 - 6A-87.

[34] The 24-hr and annual NAAQS for SO_2 were revoked on June 22, 2010 (75 FR 35520), with the final rule effective on August 23, 2010. However, the air quality standards remain applicable at the State level until a year after EPA approves the State's 1-hour SO_2 designations – which has not yet occurred. The 24-hr and annual SO_2 increments also remain in place at both the Federal and State level, even though the NAAQS have been revoked.

AERSCREEN to other averaging periods. Refer to Appendix A for AERSCREEN modeling tips.

Table 2. Point Source Scaling Factors for AERSCREEN

Averaging Period	EPA Scaling Factor for Point Sources [a]
3-hour	1.00
8-hour	0.90
24-hour	0.60
Annual	0.10
[a] Per Section 1.1 of the *AERSCREEN User's Guide*[35]	

2.5.4 Geographical Projection Information

A consistent coordinate system should be used for the identification of receptors, building locations, and EUs. Coordinate systems consist of both horizontal and vertical coordinates to identify a location on the planet. This is often accomplished by using a separate coordinate system for the horizontal and vertical components. Horizontal coordinate systems all project the shape of the 3-dimensional earth onto a 2-dimensional field. Consequently, each coordinate system has distortions associated with it.

2.5.5 Coordinate Systems

Common horizontal coordinate systems include user-defined coordinates, Universal Transverse Mercator (UTM), Lambert-Conical, Alaska State Plane, and latitude – longitude. Vertical coordinates are always specified as elevation above the earth's surface. While a user-defined coordinate system may be sufficient for some modeling applications (e.g., flat terrain), for application where plume-terrain interactions may occur, (e.g., complex terrain), the UTM coordinate system (the same system for which DEM data is available) is greatly preferred. A UTM system also allows you to compare the source/receptor coordinates with areas of interest on a USGS quad map, and is necessary when importing off-site sources from a previous analysis. For these reasons, ADEC encourages applicants to use UTM coordinates in their AERMOD analysis.

The UTM grid divides the world into 60 zones, extending north-south, each zone covering 6 degrees wide in longitude. These zones are numbered consecutively beginning with zone 1, located between 180 degrees and 174 degrees west longitude, and progressing eastward to zone 60, between 180 degrees and 174 degrees east longitude. The north slope of Alaska extends across UTM zones 5 and 6, while all of Alaska spans zones 1 through 9, illustrated below in Figure 6.[36]

[35] *AERSCREEN User's Guide*; EPA-454/B-16-004; December 2016.

[36] Source: http://rockyweb.cr.usgs.gov/outreach/gps/, accessed on September 24, 2012.

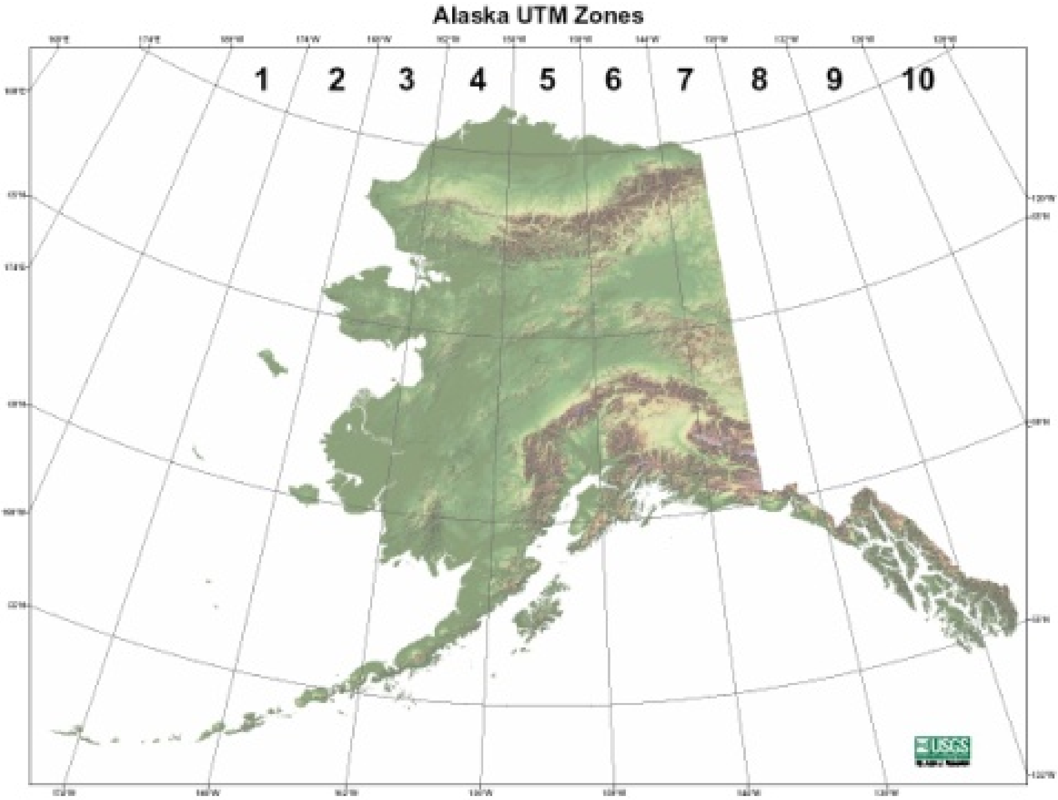

Figure 6. UTM Time Zones for Alaska

The northing values are measured continuously from zero at the equator, in a northerly direction. A central meridian through east zone is assigned an easting value of 500,000 meters. Grid values to the west are less than 500,000; to the east, more than 500,000.

If sources and/or receptors span more than one UTM zone, care must be taken when specifying the UTM coordinates. In such a case, the easting coordinate of one UTM zone must be converted to the neighboring zone to ensure a consistent frame of reference.

✓ When using the UTM coordinate system, make certain that the receptors, building, and source information is specified relative to the same datum and zone.

Two of the most common datums are the North American Datum of 1927 (NAD27) and the more recent North American Datum of 1983 (NAD83). There can be significant differences (as much as 200 m or more) between NAD27 and NAD83 for the same UTM coordinate. The USGS DEM data is often specified in NAD27, but check with the specific dataset to be certain. Global position systems (GPS) often use WGS84, which is very similar to NAD83. Errors can occur when a GPS system is used to define the building and stack locations and USGS DEM data are used to define the receptor coordinates.

2.6 Meteorological Data

Models require meteorological data or assumptions to estimate plume dispersion. Screening models, such as AERSCREEN, use an internal matrix of generated or assumed wind speed, stability, and other parameters to estimate worst-case ambient impacts. For more refined analyses, actual hourly meteorological data are required.

The meteorological data requirements for air quality modeling are discussed in Section 8.4 of the Guideline. Section 8.4.1(c) describes three potential sources of hourly meteorological data that could be used in a refined, near-field analysis. The potential sources of these data, listed by preference, are:

- Site-specific data – i.e., data measured at/near the project site;
- NWS or NWS-comparable data; and
- Prognostic data – i.e., data computer-generated from a three-dimensional mesoscale model.[37]

The overarching consideration is that the meteorological data needs to adequately represent the transport and dispersion conditions at the given stationary source, and it must meet certain quality assurance requirements. The number of years of data must also meet the minimum requirements for the given category. Data from personal "weather stations," including stations operated under a cooperative agreement with the NWS, may not be used for air quality modeling purposes since they do not undergo the same level of quality assurance review as data collected by the NWS.

Most stationary sources in Alaska are located beyond the representative range of the nearest NWS station. Therefore, most applicants have historically needed to obtain at least one year of site-specific meteorological data in order to conduct a refined modeling analysis.

2.6.1 What is Representative Meteorological Data?

Section 8.4.1(b) of the Guideline states, "The meteorological data used as input to a dispersion model should be selected on the basis of spatial and climatological (temporal) *representativeness* as well as the ability of the individual parameters selected to characterize the transport and dispersion conditions in the area of concern" (emphasis added). This means the meteorological data must be evaluated and purposely selected, rather than selected just because it is available.

The spatial representativeness of the data can be adversely affected by large distances between the source and receptors of interest and the differing topographic/land use characteristics of the source and meteorological data areas. For example, surface winds should reflect the transport conditions that emission releases would experience. Over large, open expanses, the surface winds may be more uniform, whereas the winds can vary greatly in more complex terrain, e.g., valleys and ridges, where heating and cooling

[37] Prognostic meteorological data runs are currently conducted on a Unix/Linux platform, rather than a MS Windows operating system. The datasets are also extremely large. The datasets therefore require off-network storage.

of the earth's surface can play an important role in how the wind field develops. Hourly surface winds should reflect the transport conditions, whether it is meteorological in nature (such as existing weather conditions) or terrain-induced (such as flow down a valley) or other factors, that the emission releases would experience.

The representativeness of the data is therefore dependent on:

(1) the proximity of the meteorological monitoring site to the project area;

(2) the complexity of the terrain;

(3) the exposure of the meteorological monitoring site; and

(4) the period of time during which data are collected.

Data representativeness should be evaluated on a parameter-by-parameter basis and is dependent on the purpose for which the parameters are required in the dispersion model. When selecting meteorological data for the AERMOD Modeling System, Section 8.4.2(b) of the Guideline states:

> Data representativeness, in the case of AERMOD, means utilizing data of an appropriate type for constructing realistic boundary layer profiles. Of particular importance is the requirement that all meteorological data used as input to AERMOD should be adequately representative of the transport and dispersion within the analysis domain. Where surface conditions vary significantly over the analysis domain, the emphasis in assessing representativeness should be given to adequate characterization of transport and dispersion between the source(s) of concern and areas where maximum design concentrations are anticipated to occur.

The applicant should provide a sufficient discussion regarding the meteorological data to demonstrate that the data is representative of the local transport conditions. Wind roses (a frequency diagram that displays both wind speed and wind direction in a single plot) are excellent tools for illustrating the wind flow pattern of the given dataset. The dataset must also meet the temporal requirements, which are summarized in Section 2.6.2 of this manual. The AM&QA program has a meteorologist who you may contact to help assess whether a particular dataset is representative of the expected transport conditions for the given source.

2.6.1.1 Tower Measurements

Typically, several meteorological parameters required for dispersion modeling are collected from instrumentation on a tower. The height of this tower and the height at which the measurements are made vary from one application to another. All instrumentation used in a site-specific monitoring program must be sited in accordance with Section 3 of EPA's *Meteorological Monitoring Guidance for Regulatory Modeling Applications,*[38] which ADEC has adopted by reference in 18 AAC 50.035(a).

Anemometer

A major component of dispersion models is the transport of pollutants downwind. Section 3.2.1.1 and 3.3.1 of EPA's meteorological monitoring guidance says wind data is supposed to be representative of stack-top conditions or 100m (whichever is lower). However, does that mean a 10m tower cannot be used for a 15 m stack? AERMET requires wind observations between $7z_0$ (where z_0 is the surface roughness length and is discussed elsewhere in the manual) and 100 m. So how does one reconcile these requirements? The answer actually depends on where the source is located. ADEC has allowed the use of 10 m anemometer heights for modeling 10 – 50 m North Slope stacks. However, the Alaskan interior can have extremely shallow winter inversions where the wind flow can greatly vary at levels below this, in which case a 10 m anemometer height may not be appropriate for measuring transport conditions of a stack taller than 10 m.

Temperature Difference

If the height of a tower in a site-specific monitoring effort is higher than 10 m, the temperature difference, ΔT, should still be collected at the 2-meter and 10-meter levels for determining stability. While AERMOD will accept any pair of heights, the temperature dynamics are strongest near the surface (i.e., a ΔT over a larger height difference may incorrectly lead to neutral stability determinations). Therefore, the conventional (10 m – 2 m) height should be used, unless there is a locally compelling reason to use other measurement heights.

2.6.1.2 Prognostic Meteorological Data

Prognostic meteorological data refers to data that was computer-generated using a three-dimensional mesoscale computer model, such as the Weather Research and Forecasting (WRF) model, or the 5th Generation Penn State/NCAR Mesoscale Model (MM5). Of these, WRF data is generally preferred since it is based on the latest algorithms.

Prognostic meteorological data has been routinely used for long-range transport modeling. As of the 2016 revision to the Guideline, it may now be considered for near-field assessments as well. EPA has also released the Mesoscale Model Interface Program (MMIF) for extracting the meteorological parameters for a given location within the given WRF/MM5 domain. These parameters could then be used by AERMOD, or other various models, for the simulation.

Section 8.4.5.1(a) of the Guideline states prognostic meteorological data may be considered for those situations where there is no representative NWS station, and it may be infeasible or cost prohibitive to collect adequate site-specific data. However, the prognostic data must be adequately representative of the given location. If the prognostic meteorological data "are not representative of transport and dispersion conditions in the area of concern, the collection of site-specific data is necessary."

[38] *Meteorological Monitoring Guidance for Regulatory Modeling Applications*; EPA–454/R–99–005; February 2000. (https://www3.epa.gov/ttn/scram/guidance/met/mmgrma.pdf).

Section 8.4.5.2 of the Guideline provides a general discussion regarding the types of evaluations that the applicant would need to conduct and provide as part of their request to use prognostic meteorological data. Section 8.4.5.2(a) states, the prognostic data should be compared to "NWS observational data or other comparable data in an effort to show that the data are adequately replicating the observed meteorological conditions of the time periods modeled."

The mechanism for developing, reviewing, and using prognostic meteorological data are not as developed as the concept. ADEC has not yet processed a request to use prognostic data (as of October 8, 2018), nor has a request been approved anywhere in the country.[39] As noted in the January 10, 2018 *Frequently Asked Questions* (FAQ) that ADEC posted regarding the regulatory adoption of the 2016 version of the Guideline: [40]

> There are a lot of details regarding this approach that still need to be developed. Applicants who desire to use this approach must not only develop the dataset, but they must also show that their approach provides representative data at the appropriate resolution for the given situation. The first few applicants who desire to use this approach will, therefore, need to closely work through these issues with the Department, and possibly, the Region 10 Office of EPA. Subsequent applicants will still need to provide an adequate demonstration that their approach provides representative data, but the effort should become more streamlined as the techniques and guidance is developed over time.

Applicants will need to show that the prognostic data adequately represents the meteorological data within the modeling domain. METSTAT is a commonly used program for conducting a statistical comparison of the modeled meteorological data to actual meteorological data. However, other evaluations will also be needed. For example, we should also ask the applicant to provide a comparison of the prognostic and observational wind roses. Wind roses do not provide the detailed statistical comparison that METSTAT offers, but they allow for a quick visual comparison of the winds.

You, or an ADEC contractor, would also need to review the MMIF extraction (see Section 2.6.6 of this manual for additional comments regarding MMIF). As noted in Section 8.4.5.2(b) of the Guideline, "When processing MMIF data for use with AERMOD, the grid cell used for the dispersion modeling should be adequately spatially representative of the analysis domain." EPA further notes that, "professional judgement may be needed to select the appropriate grid cell to use." You may therefore need to discuss the grid cell selection with the AM&QA meteorologist. Once again, wind roses can be a useful tool for conducting the *initial review* of the grid cell that would be extracted. You should therefore ask the applicant to overlay a wind rose (of the extracted surface winds) on a topographical map of the project area.

[39] The Washington Department of Ecology is in the process of reviewing the nation's first request to use prognostic meteorological data for a near-field PSD modeling analysis, but the results of this review are still pending.

[40] The January 10, 2018 FAQ may be found at: http://dec.alaska.gov/media/8234/faq-re-2017-guideline-adoption-final.pdf

The additional tools for evaluating the adequacy of a prognostic meteorological dataset, and for determining whether the extracted parameters are adequately representative of the transport conditions, are still being developed. As noted in Section 8.4.5.2(c) of the Guideline, the grid resolution of the prognostic meteorological data is a key consideration, especially for sources located in complex terrain. In the mean-time, you should discuss with the AM&QA meteorologist and if warranted, with R10, any request to use prognostic meteorological data in a near-field modeling analysis.

> Note: *EPA is hoping to develop a three-year 9 km WRF dataset for Alaska, which could presumably be used as the starting point for a project-specific modeling analysis. Applicants may need to nest the run down to an appropriate scale for the given topography (see Section 8.4.5.2(c) of the Guideline), but having the EPA dataset means they may not need to start the WRF analysis from scratch. Either way, it is the responsibility of the applicant to show to our satisfaction that the data are both adequately representative and of acceptable quality (see the related discussions in Sections 2.6.2 and 2.6.3.2). However, as noted in the above discussion, the details for making that demonstration have not yet been developed.*
>
> *As of August 28, 2018, EPA was still running the first year of the 9 km WRF dataset. R10 estimated that once the run was completed, it would take an additional 4 – 6 months to conduct the quality assurance review. EPA is planning to run the two additional years after the first year is completed, but at last report, they had not yet obtained the funding to do so.*

2.6.2 Length of Data Record

The applicant should use a sufficiently long record of meteorological data to ensure that worst-case meteorological conditions are adequately represented in the model results. The minimum requirements, per Section 8.4.2(e) of the Guideline, are:

- at least 1 year (12 consecutive months) of site-specific data;
- 5 years of adequately representative NWS or comparable meteorological data; or
- at least 3 years of prognostic meteorological data.

> Note: *While a minimum of 1 year of site-specific data is allowed, up to 5 years of site-specific data are preferred. EPA further notes that consecutive years are preferred (if the data record is adequately complete). Each of the annual data periods shall consist of four consecutive quarters of acceptable data, per Section 5.3.2 of EPA's Meteorological Monitoring Guidance for Regulatory Modeling Applications.[38] Applicants are not allowed to create a composite annual dataset from non-consecutive monitoring efforts.*

2.6.3 Quality Assurance Requirements for Meteorological Data

The quality and completeness of a site-specific dataset is critical to its use in air dispersion modeling. Before using the data, it must also be reviewed and approved as PSD-quality. If NWS or Federal Aviation Administration (FAA) Automated Weather Observing Station (AWOS) data are used, it is assumed that the data meet their quality assurance requirements. However, that does not mean the applicant should not review the NWS/FAA data. There may be trends or anomalies (such as large periods of missing data) that could cause problems in the model or result in inaccurate results.

A person who submits meteorological data under AS 46.03, AS 46.14, or 18 AAC 50.215(a)(3) shall obtain the data in accordance with EPA's *Meteorological Monitoring Guidance for Regulatory Modeling Applications*.[38] The guidance requires a minimum of 90 percent valid data capture per quarter, on a joint recovery basis for wind speed, direction, and other relevant parameters. These data capture requirements apply to raw data and do not allow for missing data substitution to achieve the 90 percent requirement (except from equivalent backup sensors at the monitoring station).

2.6.3.1 Site-Specific Meteorological Data

Site-specific data must meet minimum EPA requirements for accuracy, sensitivity, and completeness, as described in EPA's *Meteorological Monitoring Guidance for Regulatory Modeling Applications*.[38] Typically, a site-specific monitoring program requires the submittal and approval of a Quality Assurance Project Plan (QAPP), regular audit and calibration reports that document system accuracy and sensitivity, passing those audits and calibrations, and a data report that presents all data collected and compiles data recovery rates and audit /calibration results or "completeness" information.

EPA's 90 percent recovery requirement applies to the meteorological parameters required to run the given air quality dispersion model. However, ADEC accepts less than 90 percent recovery for non-required parameters, such as vertical wind-speed. This optional parameter may be collected for use in AERMET if the standard deviation of vertical wind speed (sigma-w) is also calculated from the vertical wind speed measurements.[41] It is a difficult parameter to collect however, especially in freezing conditions, which means 90 percent data recovery is rarely seen. Since it is an optional parameter, AERMET will use the data available and internal default algorithms for when it is not available.

Site-specific meteorological data is either reviewed by the AM&QA program or under a term contract managed by APP. Data reviews are summarized in an Excel spreadsheet and are kept on the Juneau server. The summary file (*QAPP & Data & Site Review Project List.xlsx*) is located under the folder *G:\AQ\Permits\Monitoring\QAPP and Data Review*.[42] The detailed findings regarding the review are stored in the Juneau "AirFacs" directory, under the "Monitoring" sub-folder for the given data owner and monitoring site.

[41] The use of turbulence measurements, such as standard deviation of horizontal wind direction (sigma-theta) data and/or sigma-w data requires case-specific approval under Section 3.2.2 of the Guideline when used in an AERMOD analysis in conjunction with the ADJ_u* option for adjusting the surface friction velocity.

[42] QAPP and data reviews may someday be tracked through the AirTools database.

Sidebar Discussion: Applicants who plan to use their meteorological data for estimating their wind-blown dust emissions should design their data logging system so that it keeps the 2-minute wind speed data, rather than dumping it once the hourly wind speed is calculated. You may need to point this issue out to the applicant when discussing their meteorological monitoring plans. See the *Wind-Blown Emissions* discussion of Section 2.7.1 for more details.

2.6.3.2 Prognostic Meteorological Data

The quality assurance requirements for prognostic meteorological data are intertwined with the evaluation as to whether the extracted data is adequately representative of the transport conditions within the modeling domain. See Section 2.6.1.2 of this manual.

2.6.4 Meteorological Data Processing and Use w/in the AERMOD System

This section discusses various aspects of processing and using meteorological data within the AERMOD Modeling System. The meteorological data processor for AERMOD is AERMET. The meteorological data generator for AERSCREEN is MAKEMET.[43] Both programs require data that characterizes the local surface conditions, which is also discussed below. There is also a sub-section that discusses previously processed AERMOD-ready meteorological data that has or should be posted on our web-site so that it can be used by future applicants. The applicants would still need to show to your satisfaction that the dataset represents the plume transport conditions at their stationary source, but using posted data can expedite one aspect of the analysis and your review.

2.6.4.1 AERMET Data Processing

AERMET develops hourly boundary layer parameters and profiles for AERMOD using representative hourly meteorological observations and land use data. It is the required meteorological preprocessor for all regulatory applications of AERMOD, per Section 8.4.2(a) of the Guideline. It will accept NWS hourly surface observations[44] and/or data collected from a site-specific measurement program, and NWS twice-daily upper air soundings. AERMET should also be used for processing prognostic meteorological data for purposes of a regulatory AERMOD analysis (after it has been extracted with MMIF), per Sections 8.4.2(a) and 8.4.5.1(b) of the Guideline.[45] However, AERMET should not be used to process offshore meteorological data (see Section 2.1.6.2 if you are reviewing a modeling analysis for an offshore stationary source).

[43] ADEC has occasionally allowed applicants to run AERMOD with MAKEMET-generated meteorology. See the AERSCREEN and AERMOD discussions in Appendix A, and the AERSCREEN User's Guide, for additional details.

[44] Representative FAA AWOS data may generally be used in lieu of NWS ASOS data.

[45] Section 8.4.2(a) of the Guideline states, "When processing prognostic meteorological data for AERMOD, the Mesoscale Model Interface Program (MMIF) should be used to process data for input to AERMET." Section 8.4.5.1(b) of the Guideline states, "When using MMIF to process prognostic data for regulatory applications, the data should be processed to generate AERMET inputs and the data subsequently processed through AERMET for input to AERMOD."

AERMET is designed to be run as a three-stage process (with a single executable). The first stage extracts (retrieves) data and assesses data quality. The second stage combines (merges) the available data for 24-hour periods and writes these data to an intermediate file. The third and final stage reads the merged data file and develops the necessary boundary layer parameters for dispersion calculations by AERMOD.

It is beyond the scope of this manual to describe the details of how to use AERMET, the expected data files, and formats. Refer to the AERMET User's Guide[46] for a complete description of these programs and data requirements.

NWS Surface Data

Although most NWS measurements are typically made at a standard height of 10 meters, the actual anemometer height should be used as input to the preferred model. Hourly NWS wind direction data are reported to the nearest 10 degrees (e.g., 23 for 230, 08 for 80), while the 1-minute ASOS data are reported to the nearest degree. The use of wind direction data reported to the nearest 10 degrees could lead to a bias in the modeling results. EPA has, therefore, developed an algorithm in AERMET to adjust the wind direction by ± 5-degrees using a specific set of randomly generated numbers. The randomization option should be used for processing hourly NWS (or equivalent) data, but it should not be used for processing 1-minute ASOS data. (See Section 3.1 of EPA's March 8, 2013 memorandum, *Use of ASOS meteorological data in AERMOD dispersion modeling*.)

- ✓ The option to randomize the wind direction may be found in the stage 3 input control file (i.e., METHOD WIND_DIR RANDOM). EPA changed the default setting from "no randomization" to "randomization" beginning with AERMET version 16216.

A file of upper air soundings is also required to estimate the mixing height on an hourly basis. These data can be obtained for free from the National Climatic Data Center (NCDC) website at http://www.esrl.noaa.gov/raobs/.

If the applicant is using representative NWS data, the modeling submittal should describe the data processing performed with AERMET.

AERMINUTE

EPA developed a preprocessor to AERMET in February 2011, called AERMINUTE, which can read 1-minute ASOS data and calculate hourly average wind speeds and directions. It is an established fact that the hourly weather observations observed with ASOS produce more calm winds, and resulting gaps in the data, than when human observers took the measurements. The AERMINUTE program was developed "to address concerns regarding the impact of large data gaps on the adequacy and representativeness of ASOS wind data for regulatory dispersion modeling".[47]

[46] *User's Guide for the AERMOD Meteorological Preprocessor (AERMET)*; EPA-454/B-18-002; April, 2018.

[47] EPA Memorandum; *Use of ASOS Meteorological Data in AERMOD Dispersion Modeling*, Tyler Fox to Regional Modeling Contacts; March 8, 2013.

AERMINUTE reads 2-minute average ASOS winds (reported every minute) that are available from the NCDC in the TD-6405 format.[48] The use of AERMINUTE for processing ASOS data should reduce the number of calm winds provided to AERMOD. The AERMINUTE User's Guide provides more information on how to obtain the 1-minute data from NCDC.

- ✓ EPA recommends that data processed with AERMINUTE be routinely used to supplement the standard ASOS data with hourly-averaged wind speed and direction to support AERMOD dispersion modeling.

When reviewing an AERMINUTE analysis, check whether the applicant used the correct setting/start-up date for the Ice Free Winds (IFW) setting (the date the NWS started using a sonic anemometer to measure wind speed and direction). APP has found user errors with respect to this setting, which affected the number of alleged calms. See Section 4.1.2 of the AERMINUTE User's Guide[49] for additional information regarding the IFW setting.

Note: *FAA Automated Weather Observing Station (AWOS) data is adequately equivalent to hourly NWS data for quality modeling purposes, but it cannot currently be preprocessed with AERMINUTE.*

Site-specific Meteorology

The minimum hourly near-surface data requirements to run AERMET with site-specific data are (with some typical heights for each measurement): wind speed and wind direction (10 meters), ambient temperature (2 meters), temperature difference (10 meter – 2 meter temperatures), and solar radiation (at or near the ground). As with processing NWS data only, a file of upper air sounding is also required to estimate the mixing height on an hourly basis. Although AERMET can accommodate a site-specific estimate of the mixing height for each hour, the only time such data might be encountered is with a short-term scientific field experiment and likely only for short periods of time over the course of a day.

One of the advancements in the AERMOD Modeling System is the use of the solar radiation/delta-T (SRDT) method to estimate atmospheric stability. This method makes it unnecessary to observe cloud cover and ceiling height in a site-specific monitoring program. AERMET includes a "bulk Richardson" method which utilizes the temperature difference data to estimate atmospheric stability at night and solar radiation data to estimate stability during the daytime. Since cloud cover is generally not observed with an on-site measurement program, the bulk Richardson method is the preferred means available in AERMET to determine atmospheric stability when using site-specific data. To use this option in stage 3, include METHOD STABLEBL BULKRN.

[48] The data are available at ftp://ftp.ncdc.noaa.gov/pub/data/asos-onemin/ (since this is an ftp site you may need to copy and paste this link into Windows Explorer (or its equivalent) rather than clicking the link and opening a web browser).

[49] *AERMINUTE User's Guide*; EPA-454/B-15-006; October 2015.

An important keyword that is mandatory in stage 1 is the wind speed threshold value (THRESHOLD). This value informs AERMET of the minimum wind speed that the anemometer can detect. However, the larger of the "wind speed starting threshold" and the "wind direction starting threshold" should actually be used, per Section 8.4.6.1(b) of the Guideline. (When using a mechanical anemometer, the anemometer will not correctly measure the wind speed if it has not fully turned into the wind.) AERMET treats site-specific wind speeds below the threshold value as calms. There is no default value but the value cannot exceed 1.0 meters per second (m/s), otherwise AERMET generates an error condition. If the threshold value is greater than 0.5 m/s, AERMET will use the value but a warning message is generated.

You should check the applicant's threshold value in the AERMET input control file. ADEC's findings report/memorandum regarding the meteorological data, or the report generated by ADEC's contractor, should have the correct threshold value. If not, the threshold wind speeds should be provided in the vendor information that the applicant provided as part of the QAPP for the site-specific monitoring effort. The reviews and QAPPs are kept in the Juneau AirFacs directory, under a "Monitoring" sub-folder for the given applicant/stationary source.

Another area to check is the definition used by the applicant for temperature difference. When temperature differences are processed in AERMET, the assumption is made that the difference is the temperature at the upper height minus the temperature at the lower height (e.g., 10m – 2m). If these temperatures are reversed, the stability of the atmosphere will be incorrect, which will lead to errors in the modeling analysis. This should be easily detected in the surface output file since the direction of the sensible heat flux at the surface would be reversed from normal, which is upward (positive) during the day and downward (negative) at night (see example in Figure 7). However, check the value during summer months, since the winter "day time" hours in much of Alaska can have negative numbers due to arctic conditions.

	61.15N		151.06W				UA_ID:
6	5	1	121	1	[illegible]	0.587	-9.000
6	5	1	121	2	-14.2	0.175	-9.000
6	5	1	121	3	-12.8	0.171	-9.000
6	5	1	121	4	-62.7	0.546	-9.000
6	5	1	121	5	-50.5	0.340	-9.000
6	5	1	121	6	-55.2	0.380	-9.000
6	5	1	121	7	-11.4	0.486	-9.000
6	5	1	121	8	18.3	0.211	0.328
6	5	1	121	9	40.8	0.261	0.624
6	5	1	121	10	57.5	0.288	0.842
6	5	1	121	11	73.1	0.271	1.011
6	5	1	121	12	[illegible]	0.339	1.159
6	5	1	121	13	99.4	0.486	1.311
6	5	1	121	14	99.3	0.508	1.450
6	5	1	121	15	83.2	0.528	1.443
6	5	1	121	16	77.9	0.464	1.462
6	5	1	121	17	53.3	0.495	1.311
6	5	1	121	18	34.6	0.534	1.147
6	5	1	121	19	12.4	0.467	0.818
6	5	1	121	20	0.8	0.387	0.324
6	5	1	121	21	-13.0	0.191	-9.000
6	5	1	121	22	-7.9	0.129	-9.000
6	5	1	121	23	-24.6	0.249	-9.000
6	5	1	121	24	-2.3	0.056	-9.000

Figure 7. Negative and positive sensible heat flux values in an AERMET surface file.

✓ Check the sensible heat flux sign during a *summer* day. The sensible heat flux during winter "day time" hours can be negative in Alaska.

Note: *The columns in the surface files are unlabeled. However, the columns are described in Section 3.5.1 of the AERMOD User's Guide. The surface heat flux is in the sixth column. The year, month and day of month are in the first, second and third columns.*

If an applicant utilizes custom data processing programs for site-specific data, then the modeling submittal must include a description and demonstration of how the custom programs meet the requirements in Section 6 of the EPA Meteorological Monitoring Guidance.

Note: *In Alaska, it is common to only have surface observations from a site-specific data collection program, i.e., no NWS hourly weather observation. If this is your case, AERMOD still requires that a (fictitious) NWS station identifier be entered on the ME path for the SURFDATA keyword (see the AERMOD User's Guide for a complete discussion of the path and keyword concept). Another option is to specify a blank station ID on the SURFDATA keyword using double quotes to delimit the missing station ID field. The SURFDATA keyword also requires a year entry for "the year of data being processed." The date is used by AERMOD for various internal processing decisions. Therefore, use the starting year of the site-specific data.*

Vertical Wind Speed Note: ADEC received a copy of a 2005 email exchange between EPA's AERMOD consultant and an applicant's consultant regarding the use of vertical wind speed standard deviation (sigma-w) measurements. Anomalous results were found when using wind speed values that were below the instrument's measurement threshold. EPA's consultant recommended resetting the low values to missing.[50]

Resetting sigma-w values that are less than 0.1 m/s to missing is consistent with EPA guidance.[51] Section 4.5.5 of the AERMET User's Guide states:

> *There are no provisions for automatically replacing missing site-specific values in AERMET, or adjusting values that are outside the range of acceptable values. It is up to the user to review the QA summary information and, using sound meteorological principles and any regulatory guidance, either replace the value in question or leave it alone.*

However, applicants should clearly disclose and discuss these adjustments in their modeling report. These types of adjustments may be legitimate, but they should be noted and understood.

Output Review

Figure 8 presents the first few lines of the message output file created in Stage 1 processing of a surface observation file.

- ✓ Notice the summary statements to ensure the correct data was extracted, that an end of file was encountered, and the number of expected observations was extracted, 8760 hours in this case.

The next few lines warn the user that several parameters that were expected are missing. These include PRCP (precipitation amount) and HZVS (horizontal visibility), and calm winds. Since the neither precipitation amount, nor horizontal visibility is required to run AERMET, these optional parameters create unnecessary warning messages, and could have been avoided by using the non-default QA specification parameters.

[50] As discussed in Section 2.6.3.1 of this manual, and EPA's AERMET guidance, sigma-w data should not generally be used when using the Adjusted-u* algorithm in AERMET.

[51] The required wind speed resolution for vertical wind speed in Table 5-1 of EPA's *Meteorological Monitoring Guidance for Regulatory Modeling Applications* is 0.1 m/s.

```
JOB      I19  SETUP: "END OF FILE" ON UNIT 5 AFTER RECORD # 14
JOB      I25  TEST: SUMMARY: NO DATA EXTRACTION FOR UPPERAIR
JOB      I25  TEST: SUMMARY: NO DATA QA FOR UPPERAIR
JOB      I27  TEST: SUMMARY: NO DATA QA FOR ONSITE
SURFACE  I40  SFEXT: *** SURFACE OBSERVATION EXTRACTION ***
SURFACE  I49 GETSFC: END-OF-FILE ENCOUNTERED
SURFACE  I49  SFEXT: 8760 SURFACE RECORDS EXTRACTED
930101 SURFACE   Q49 SFQASM: PRCP MISSING FOR HR 00
930101 SURFACE   Q49 SFQASM: HZVS MISSING FOR HR 00
930101 SURFACE   Q49 SFQASM: PRCP MISSING FOR HR 01
930101 SURFACE   Q49 SFQASM: HZVS MISSING FOR HR 01
930101 SURFACE   CLM SFQASM: CALM WINDS FOR HR 01
```

Figure 8. Example of Messages Generated From Stage 1 Processing of Surface Data

The example output above only shows a portion of the message file. Depending on the data being processed and with updates to AERMET, many more and different types of messages may appear. Due to the thousands of error messages generated in AERMET, a difficult situation arises.

✓ While many of the error messages are not significant, you must make certain that you are not missing a significant error message that offers insight into possible modeling errors.

It's easy to get lulled into thinking all of them are not significant, when in fact, there may be something significant in the output file. Fortunately, AERMET offers the user summary QA files which provide an additional means of quickly assessing the validity of the data. See the AERMET User's Guide for additional details.

2.6.4.2 Surface Characteristics

The area surrounding the meteorological tower (or the area representing the grid cell when using prognostic meteorological data) must be characterized with respect to the following three surface characteristics when using AERMET: surface roughness length, Bowen Ratio, and noontime surface albedo. MAKEMET requires the same information for the area surrounding the emissions release. For a complete description of these characteristics, see the *AERMOD Implementation Guide*.[52] EPA also states in Section 3.1.1 of the AERMOD Implementation Guide, "the determination of representativeness of site-specific data for AERMOD applications should also include an assessment of surface characteristics of the measurement and source locations and cannot be based solely on proximity."

The user provides the surface characteristics during Stage 3 of the AERMET run. You should check the State 3 input or output files to see if the values are consistent with the values approved during the protocol phase (if applicable), or as otherwise justified in their modeling report. Using incorrect values can lead to unrealistic estimates of

[52] AERMOD Implementation Guide (April 2018) at https://www3.epa.gov/ttn/scram/models/aermod/aermod_implementation_guide.pdf

boundary layer parameters (e.g., stability parameters, mixing heights) required by AERMOD.

- ✓ Since the AERMOD-predicted concentrations are very sensitive to surface roughness length, verify the correct values have been used.

AERMET will allow the user to change the surface characteristics on a "seasonal" or monthly basis. The monthly approach should be used within Alaska since Alaskan winters are longer than the December through February period assumed under the "seasonal" keyword. There are several sources or methods for obtaining representative surface characteristics.

AERMET User's Guide[46] and Other Literature

The AERMET User's Guide presents several tables with appropriate values of each of these as a function of land use classification (e.g., forest, snow, grassland, etc.). The land use classifications are not extensive and if the applicant uses those tables, a judgment on your part will have to be made to determine if the values are appropriate for the application.

The applicant is not limited to the values listed in the AERMET User's Guide. Values also are available in the literature, but may not contain the same land use classifications. If the user obtains values from the literature, a citation to the document is required to be able to confirm the values. For example Roland Stull's book *An Introduction to Boundary Layer Meteorology*[53] contains a figure for surface roughness for typical terrain types.

AERSURFACE

EPA developed a program, AERSURFACE,[54] to assist the user in deriving the applicable surface characteristics from digital land use/land cover (LULC) data. A key word here is 'assist'. AERSURFACE gives the user a first guess based on the LULC categories, but the user still must determine if the resulting values are appropriate, especially since the digital data could lag current LULC data by many years. Adjustment or replacement of those values may be required if the user has knowledge of LULC changes. Also, there is some judgment in defining the directional sectors for AERSURFACE/AERMET.

Manual Calculations

Unfortunately, the version of AERSURFACE available on SCRAM can only process 1992 USGS land cover data, which does NOT include Alaska. According to EPA, a future update to AERSURFACE will include the capability to process 2001 and 2006 USGS land cover data, which does include coverage in Alaska.

[53] Stull, R., 1988: *An Introduction to Boundary Layer Meteorology*, Kluwer Academic Publishers.

[54] *AERSURFACE User's Guide*; EPA-454/B-08-001; January 2008 (Revised 01/16/2013).

ADEC has posted a Guidance Document[55] on how to calculate these values manually. Topographic maps, aerial/surface photos, and professional judgment may be used to derive the values. Note that EPA is working on a revised method in AERSURFACE to replace the current computation of the surface roughness length. As always, check SCRAM to see if any updates are available.

North Slope Parameters

Currently EPA does not have recommended values for tundra. A literature search by a permit applicant led to reasonable values for North Slope locations (onshore and offshore), which are reitereated in Table 3. ADEC has used these values for subsequent North Slope applications as well. For the North Slope and Beaufort Sea, summer has been assumed to be June through September and winter as October through May.

A combination of these pareameters may be needed if the meteorological tower is near the coast. In that case, multiple wind direction sectors should be used to define the surface characteristics (note that AERMET can process up to 12 non-overlapping sectors).

Table 3. Surface Characteristics for North Slope Applications

North Slope Onshore	Winter Value	Summer Value
Albedo	0.8	0.18
Bowen Ratio	1.5	0.80
Surface Roughness Length (m)	0.004	0.02
Beaufort Sea	Winter Value	Summer Value
Albedo	0.8	0.1
Bowen Ratio	2.0	0.1
Surface Roughness Length (m)	0.001	0.001

Table Note: For the North Slope and Beaufort Sea, summer has been assumed to be June through September and winter as October through May.

2.6.4.3 Missing Data Substitution

Applicants should treat missing site-specific data in accordance with Section 8.4.4.2(c) of the Guideline. In summary, absent data should be coded as missing *unless* there is a representative dataset that can be used to provide substitute values. Applicants may not use interpolation, "average" values, or other similar approaches for filling in missing wind data. EPA allows for limited use of interpolated values to substitute for missing cloud cover or temperature data in an AERMOD analysis, but that is best handled through AERMET (see Section 4.7.6.5 of the AERMET User's Guide).

When using the **DFAULT** option in AERMOD, AERMOD will treat missing hours of meteorological data in the same way it processes "calms" (i.e., it sets the concentration

[55] *ADEC Guidance re AERMET Geometric Means: How to Calculate the Geometric Mean Bowen ratio and the Inverse-Distance Weighted Geometric Mean Surface Roughness Length in Alaska*; Revised June 17, 2009.

to zero for that hour, and calculates the short-term averages according to EPA's calms policy). An adequate analysis can therefore be conducted with missing data, as long as the site-specific dataset meets the 90 percent data capture requirement per quarter (per EPA's Meteorological Monitoring Guidance) or contains "reasonable" data capture when using multi-year NWS datasets.

Some applicants may be able to substitute NWS temperature data for missing site-specific temperature data, but there is no way to substitute temperature data alone through the current substitution options in AERMET. Using the **SUBNWS** option in AERMET will substitute missing wind data as well, which in most cases, would not be representative of the site (especially if the applicant was required to collect site-specific data). Note: *all other NWS parameters (e.g., cloud cover and station pressure) are automatically substituted by AERMET even without using the **SUBNWS** option.*

- ✓ Do NOT use the **SUBNWS** option (**METHOD REFLEVEL SUBNWS**) *unless* the NWS temperature and wind data are representative of the transport temperature and wind conditions at the applicant's stationary source.

- ✓ AERMET will automatically incorporate NWS cloud cover data from the **SURFACE** dataset, even when the SUBNWS option is not used.

2.6.4.4 Posted AERMET Data

You should ask the APP web-master to post the AERMOD-ready meteorological data that you've approved so that it's available for general use. You will also need to prepare a data summary sheet for each dataset that summarizes where the data came from, who processed it, and the AERMET version used to process the data. See the previously posted datasets and summaries at http://dec.alaska.gov/air/air-permit/aeromod-met-data/ for examples.

Keep a copy of the original data files, AERMET input/output files, and summary on the Juneau server at G:\AQ\PERMITS\Modeling\Approved_AERMET_Data so that the dataset can be readily reprocessed with a subsequent version of AERMET, or accessed if there are questions. Replace existing datasets/summaries with reprocessed/updated datasets, when warranted.

Applicants who use posted AERMOD-ready meteorological data do not need to provide the quality assurance information previously used to approve the data or the supporting AERMET files. They likewise do not generally need to re-justify the surface characteristics or AERMET settings used to process the meteorological data. ***However, the applicant needs to demonstrate to your satisfaction that the meteorological data are representative of the transport conditions at their stationary source***. Applicants may also need to reprocess the meteorological data if EPA has released an updated version of AERMET (or an AERMET preprocessor), or if EPA has released substantive revisions to an underlying guidance, or if there has been major development in the area that has likely changed the surface characteristics. In all cases, the presence of posted data does not mean that it's pre-approved for a stationary sources. APP is posting previously processed AERMET data as a convenience, not as a default.

2.6.4.5 Meteorology and Model Runs

Once the meteorological data are ready for use in AERMOD, there are still things to check. The first is the "PROFBASE" keyword on the ME pathway in AERMOD. This keyword requires at a minimum one parameter – the base elevation (above mean sea level) of the surface station. This value is used to develop the potential temperature profile (from the surface to 4,000 meters) that AERMOD generates each hour to use in its calculations. An optional parameter is the units of the base elevation. Valid values are METERS or FEET, with METERS the default units.

Once the AERMOD run is complete, the output file (AERMOD.OUT) should be reviewed for warning messages with regard to the meteorology. AERMOD will write various messages to this file if the values for various parameters (e.g., the wind speed, ambient temperature, and friction velocity) are out of range. Other parts of the output file should also be reviewed for other processing information, such as the number of calm wind conditions is reported. These messages and information may be an indication that there is an error in the meteorological data or that it did not run as intended. If true, then the modeling analysis may need to be rejected.

2.6.5 CALMET

Using hourly meteorological observations, terrain information, and land use data, CALMET develops 3-dimensional fields of winds and temperature, and 2-dimensionsal fields of several other parameters.

Prior to running CALMET, the user might need to run several other "pre" pre-processors that operate on data that is provided to CALMET. An example of this is SMERGE, a program that merges two or more hourly surface observation files (usually NWS) into a single file. Another program is MAKEGEO that combines terrain and land use data to create a file of geopysical inputs for CALMET. The input to MAKEGEO, in turn, requires running several additional programs.

Running CALMET also requires understanding of all the available processing options and parameter requirements and the consequences of setting each option and data parameter. This is no small task as a CALMET input control file has nine different groupings of options and data parameter requirements. The user must also realize that the magnitude of the resulting output file can easily be several gigabytes, depending on the size of the modeling domain, and that the output is not an ASCII file that is easily opened with a text editor.

It is well beyond the scope of this manual to discuss the various programs and input options. Refer to the CALMET User's Guide.

2.6.6 MMIF

As previously discussed, the Mesoscale Model Interface Program (MMIF) is used to extract meteorological parameters for a given location from a prognostic meteorological dataset. Section 8.4.5.2(b) of the Guideline describes how the grid cell should be selected when using MMIF for a regulatory AERMOD analysis. Additional guidance may also be found in the EPA documents, *Guidance on the Use of Mesoscal Model Interface*

Program (MMIF) for AERMOD Applications,[56] and *Evaluation of Prognostic Meteorological Data in AERMOD Applications*.[57] The MMIF User's Guide, which was developed by Ramboll Environ US Corporation, describes the various options and techniques for running the MMIF program.[58]

R10 highlighted in an April 26, 2018 email[59] that their MMIF guidance "has been updated to recommend that the minimum wind speed (MMIF keyword AER_MIN_SPEED) from MMIF to AERMET or AERMOD is now **0 m/s** because prognostic data has no starting threshold as found with anemometers." The update may be found in Section 3.4 (Treatment of low winds) of *Guidance on the Use of Mesoscal Model Interface Program (MMIF) for AERMOD Applications*.

[56] https://www3.epa.gov/ttn/scram/models/relat/mmif/MMIF_Guidance.pdf; EPA-454/B-18-005; April 2018.

[57] https://www3.epa.gov/ttn/scram/models/relat/mmif/MMIF_Evaluation_TSD.pdf; EPA-454/R-18-002; April 2018.

[58] *User's Manual – THE MESOSCALE MODEL INTERFACE PROGRAM (MMIF);* Ramboll Environ US Corporation; December 9, 2016.

[59] Email from Jerrold McAlpine (R10) to R10 air modeling community; *MMIF guidance Update*; April 26, 2018.

2.7 Emissions and EU Characterization

This section provides general information on the common types of EUs in Alaska and helpful tips for reviewing the emission rates and release characteristics for these EUs. Section 2.7.1 provides general information regarding emission rates and release parameters. Section 2.7.2 provides more detailed information regarding various types of EUs. Sections 2.7.3 through 2.7.8 provide additional comments regarding operating scenarios, small EUs, part load assessments, temporary construction activities, the baseline EUs used in an increment analysis, and source groups.

2.7.1 Emission Rates and Release Parameters

Use of the proper emission rate is essential in air dispersion modeling. The appropriate short-term and long-term emission rates must be modeled for the corresponding short-term and long-term modeling assessments. Often, separate modeling runs are required for pollutants with different short-term and annual average emission rates. Separate runs may be necessary to account for the form of the standard, e.g., the 99th percentile for the 1-hour SO_2 standard.

Some sources may not operate continuously throughout a day, or throughout the year. If specific times or dates of operation are known or proposed, the "emission factor option" contained in certain models such as AERMOD may be employed to specify the periods when the emission source is operating. This may occur for sources which operate for certain hours of the day, or for certain months of the year.

- ✓ Ensure the modeled emission rate and applicable factors are correctly applied, and that this information is communicated to the permit engineer so that appropriate permit limits are imposed.

Required source data for dispersion models will be dependent upon the source type. Currently, models such as AERMOD can be used to represent five basic source types. Each of these types of sources is discussed later in this section.

The applicant should present the emissions and release characteristics (e.g., stack parameters) in a clear and concise format for each EU. Tables or spreadsheets provide the best format for reviewing and crosschecking this information. This is especially true when there are several identical or similar EUs. Spreadsheets can also contain the emission factors and assumed operating limits used to calculate the modeled emission rates, as well as the conversion factors used to transform vendor data into the stack parameters needed by the model. Therefore, ADEC encourages applicants to provide tables in the modeling report that compiles the emission and release characteristics, and to provide an electronic copy of any spreadsheet used to calculate the modeled emission rates and release parameters.

- ✓ Open the model output file(s) and review the emission rate(s) and release parameters for each source to verify consistency with the information provided in the modeling report.

Stack tests are often used as a means of quantifying the emission rate and stack parameters from an existing EU. Sometimes, manufacturers may also provide this information to prospective buyers. However, vendors frequently express the exhaust rate as a mass flow rate (e.g., lbs/hr). In these cases, the applicant should convert the mass flow rate to a volumetric flow rate (e.g., m^3/sec), in order to derive the stack exit velocity.

- ✓ If the vendor or source test data provides the exhaust flow rate on a mass basis, make sure the applicant has correctly estimated the volumetric flow rate (exit velocity) used in the modeling analysis.

You may assume that a combustion gas follows the **Ideal Gas Law**. For purposes of estimating the volumetric (stack) flow rate from combustion sources, the ideal gas law may be expressed as the following equation of state:

$$\dot{V} = \frac{\dot{m} \cdot R \cdot T}{P}$$

where:

$\dot{V}$ = volume flow rate of a gas (m^3/sec)

P = pressure (1 atm = 101 kPa = 101 kN/m^2)

$\dot{m}$ = mass flow rate of exhaust gas (kilograms/second)

T = stack gas exit temperature (K)

and:

$$R = \frac{\overline{R}}{MW}$$

where:

$\overline{R}$ = universal gas constant = $8.314 \dfrac{kN-m}{gmole-K}$

MW = molecular weight (gmole/g)

Note: In many cases, the vendor or source test report does not provide a specific MW for the combustion products. In these cases, you may use the R value for dry air, where

$$R = 0.287 \frac{kN-m}{kg-K}$$

Be certain to use the stack gas exit temperature to calculate the volumetric flow rate, as actual flow rates should be used, not flow rates at standard conditions. Additionally, be aware of the required units (as noted above) for each parameter.

Many dispersion models (including AERMOD) require the user to express the release characteristics as a stack gas exit velocity expressed in units of meters per second. In these cases, an exhaust flow rate must be converted to an exit velocity. This is accomplished by dividing the volumetric flow rate (expressed in units of m^3/sec) by the area of the stack at the point of discharge to the atmosphere (expressed in units of m^2).

Point Sources

Point sources include EUs that exhaust through stacks, chimneys, or vents. The required input data include emission rate, stack height, stack diameter, stack exit temperature, and stack diameter. The base elevation of the stack should be based upon local topographic data.

In calculating emissions, applicants may use a combination of data sources. The preferred data source for most pollutants is manufacturer specific information or source test data. Mass-balance should generally be used for estimating SO_2 emissions. EPA's Compilation of Emission Factors (commonly referred as AP-42) may generally be used if unit-specific information is unavailable.

A discussion of stack orientation and capped stacks can be found in the section entitled Treatment of Horizontal Stacks and Rain Caps below.

Area Sources

Area sources are identified as sources with low level or ground level releases with no thermal or momentum plume rise, and include material storage piles, lagoons and other low lying sources. In AERMOD, individual area sources may be represented as rectangles with aspect ratios (length/width) of up to 100 to 1 before issuing a warning message. Model Change Bulletin 3 (for version 09292) states:

> "Modified criterion for issuing a warning message regarding aspect ratio for rectangular AREA sources being out of range, from an aspect ratio of 10:1 to an aspect ratio of 100:1. The upper limit of aspect ratio for stable performance of the numerical integration algorithm for area sources has not been fully tested and documented, and may vary depending on the specifics of the application. A ratio of 10:1 is probably too strict and may unnecessarily lead to a large number of warning messages in some cases. Users should always carefully quality assure the source inputs provided to AERMOD for accuracy and appropriateness for the application."

Rectangles may be rotated in a clockwise (positive angle value) or counterclockwise (negative angle value) direction, relative to a north-south orientation. The rotation angle and the location of the source are specified relative to the location of the southwest corner of the source. In AERMOD, irregular shaped sources may be represented by a series of smaller rectangles, or a polygon, or more simply, the AREAPOLY source type can be specified. A circular area source can be specified using the AREACIRC source type.

The emission rate for the area source (Q) is expressed as g/sec/m^2.

✓ Ensure that the g/sec/m^2 emission rate multiplied by the source area is equal to the emission rate as calculated by the applicant (g/sec).

In addition to the emission rate, release height (h), physical dimensions and orientation of the area source, the applicant may optionally provide the initial vertical dimension (Szinit; you may see σ_{z0} in the equations and user's manuals for this parameter) of the area source plume. The initial vertical dimension is calculated differently depending on the emission release height and the presence of buildings. The following criteria should be applied:

Criteria	Szinit equals
Surface-Based source (h ~ 0)	vertical dimension of source divided by 2.15
Elevated source (h > 0) on or adjacent to a building	building height divided by 2.15
Elevated source (h > 0) not on or adjacent to a building	vertical dimension of source divided by 4.3

Area sources are not affected by downwash in the models. Additionally, elevated terrain is not considered when modeling impacts from area sources. Models like AERMOD treat area sources as if in flat terrain, even if elevated receptors are incorporated.

<u>Volume Sources</u>

Volume sources are sources that have initial dispersion prior to release, such as building roof monitors, vents and conveyor belts. Volume sources can also be used to characterize the mobile/fugitive emissions associated with construction activities or haul roads (see the subsequent discussion regarding **Roadways and Line Sources**).

The location of the volume source is specified relative to the location of the center of the source. Volume sources are characterized by a volume emission rate (in g/s), an emission release height, an initial lateral dimension (Syinit; you may see σ_{y0} in the equations and user's manuals for this parameter), and an initial vertical dimension (Szinit). The release height is the center of where most of the plume is emitted from (i.e., the center of the initial volume). For buoyant sources, such as engine emissions associated with construction/yard activities, assume that the volume height equals the plume height under annual average (or period average) conditions. The initial lateral and vertical dimensions represent one standard deviation of the plume. Therefore, the initial dimensions can be smaller than the release height. The initial vertical dimension is calculated in the same manner as for area sources, shown above. In estimating Szinit for the fugitive dust from truck tire, h~ 0 (i.e., a surface-based release), so Szinit = plume height/2.15. For stack emissions, h > 0, so Szinit = plume height/4.3. The initial lateral dimension is calculated differently depending on whether the source is a single volume source or a line source. The following criteria should be applied:

Criteria	Syinit equals
Single volume source	length of side divided by 4.3
Line source represented by adjacent volume sources	length of side divided by 2.15
Line source represented by separated volume sources	center to center distance divided by 2.15

Like area sources, volume sources are not affected by downwash in the models.

Roadways and Line Sources

Line sources are sources that may be represented as a series of volume or area sources, such as roads, runways or conveyor belts. Near ground level sources may be modeled using a series of area sources. Line sources with an initial plume depth, such as a conveyor belt or rail line, may be modeled as a series of volume sources. The number of line sources required to represent the source, N, is calculated as the length of the line source divided by its width.

In the case of a long and narrow line source such as a rail line, it may not be practical to divide the source into N volume sources. It is acceptable to approximate the representation of the line source by placing a smaller number of volume sources at equal intervals along the line source. In general, the spacing between individual volume sources should not be greater than twice the width of the line source. However, a larger spacing can be used if the ratio of the minimum source-receptor separation and the spacing between individual volume sources is greater than about 3. The total line source emission rate is divided equally among the individual volumes used to represent the line source, unless there is a known spatial variation in emissions.

Haul Roads

A subset of roadways and line sources are haul roads. Haul trucks are used to move materials at mining operations, logging sites, and other activities. These trucks can generate large amounts of dust emissions along the haul roads.

In 2009 EPA formed the Haul Road Workgroup to identify and recommend a technically supportable approach to characterize haul road re-entrained fugitive dust. The workgroup issued its final report and recommendations to EPA in December 2011, which EPA forwarded to the Regional Office modeling contacts under a March 2012 memorandum.[60] The report discusses the advantages and disadvantages of various modeling approaches for characterizing the fugitive dust emissions from haul roads. The Workgroup generally recommended the volume source approach, except for cases where receptors are located within the volume's "exclusion zone." In those situations, the Workgroup recommends using the area source approach. EPA noted in their transmittal memorandum that they are not endorsing the recommendations "as the definitive methodology for characterizing and addressing fugitive dust emissions from haul roads;" however, the recommendations

[60] https://www3.epa.gov/ttn/scram/reports/Haul_Road_Workgroup-Final_Report_Package-20120302.pdf

should be considered a "best practice approach." See the report for details, including the Workgroup's recommendations for determining the volume/area source dimensions.

Wind-Blown Emissions

Mining or aggregate handling operations typically need to include wind-blown dust emissions in their PM-10/PM-2.5 modeling assessments (as applicable). Most applicants use AP-42 to estimate these emissions. The variable nature of these emissions, and the various ways to characterize them in a modeling analysis, merits discussion.

Section 13.2.5 (Industrial Wind Erosion) of AP-42 describes the approach for estimating wind-blown emissions from exposed stockpiles. As discussed by EPA, these fugitive dust emissions occur when the wind speed over a freshly exposed surface exceeds the threshold friction velocity for the given material. This means the emissions do not occur during low speeds or from crusted material, and that when the fugitive emissions do occur, the quantity varies by wind-speed and exposed area.

AP-42 requires "fastest-mile" (2-minute average) wind speed data for estimating the wind-blown emissions from stockpiles. EPA assumes the user can obtain the 2-minute wind speed data from a representative NWS dataset. Since representative NWS data is not generally available within Alaska (see Section 2.6), most applicants need to pull the fastest 2-minute wind speed data from their site-specific meteorological data. This means applicants who have fugitive dust sources should save their 2-minute wind speed data. For those situations where that does not occur, they will need to submit for ADEC review and approval, some other approach for estimating the local fastest mile wind speeds. Recent examples include: the use of regional NWS wind speed data from a location that is windier than the applicant's location (see the Modeling Review Report for Minor Permit AQ1227MSS04); and, the use of a multiplier for estimating the maximum 2-minute wind speeds from hourly wind speed data (see the Protocol Approval for Construction Permit AQ0934CPT01).

It is worth noting that wind-blown emissions are associated with intermittent wind gusts, but they are generally assumed to occur for the entire hour for NSR modeling purposes. Assuming the emissions continuously occur for an entire hour is very conservative, but it's the only practical approach for characterizing the release when using a model with one-hour time steps (e.g., AERMOD).

Some applicants assume the worst-case conditions/emissions occur on a constant, year-round, basis for modeling purposes. This is the simplest approach for including wind-blown emissions in the modeling analysis, but it tends to substantially overstate the 24-hour and annual average impacts. Some applicants therefore propose/use various methods for incorporating the on/off nature of these fugitive emissions. It is your job to review their approach to determine if it's reasonable. ADEC has allowed applicants to use the WSPEED option in AERMOD to vary the emission rates by the hourly-average wind speed. ADEC has also allowed applicants to use an external emission file which contains the actual emission rate for each hour of the meteorological data period. (See Section 3.3.11 of the AERMOD User's Guide for details regarding both of these modeling options.)

Section 13.2.4 of AP-42 (Aggregated Handling and Storage Piles) describes the method for estimating the quantity of dust generated from loading and unloading operations. This procedure requires the use of a *mean* wind speed, rather than the *fastest-mile* wind speed. The emissions are nevertheless still variable, and the previously discussed methods for simulating variable emissions may still be considered.

Open Pit Sources

The open pit source algorithm is available only in AERMOD. This option is used to model particulate emissions from open pits, such as surface coal mines, and rock quarries and addresses the reduced wind speeds and dispersion inside such a pit. The option can also be used to model gaseous emissions within an open pit. The pit is represented as a rectangle. Unlike area sources, unusual shaped pits cannot be represented by a series of smaller sources. Consequently, the area of the rectangle should be equal to the area of the pit. In addition to the emission rate, the modeler must specify the release height (above the pit base, but less than or equal to the top of the pit), the length and width, the pit volume, and the orientation angle. The length to width ratio of open pit sources should be less than 10 to 1. Note that this aspect ratio for pit sources (10:1) differs from the aspect ratio for area sources (100:1). Receptors should not be located within the boundaries of the pit; concentration and/or deposition at such receptors will be set to zero.

Treatment of Horizontal Stacks and Rain Caps

A unique approach may be needed to characterize an exhaust stack with a rain cap or horizontal orientation since the vertical component of the exit velocity is effectively removed. Using the proper approach is important since capped/horizontal stacks generally have higher impacts in the immediate near-field than what would occur from uncapped, vertical releases.

The general purpose for a rain cap or horizontal outlet is to keep precipitation out of the exhaust stack. However, not all capped stack designs lead to a reduced vertical exit velocity. A common example is the use of a “flapper” on a reciprocating engine stack (see Figure 9 below). They are essentially counter-weighted lids that easily open when there is exhaust gas moving through the stack (i.e., when the engine is operating). This approach does not hinder the vertical momentum of the exhaust plume. A stack with a flapper type of rain cap should therefore be treated in the same manner as an uncapped stack.

Figure 9. Example of Open and Closed Flapper Rain Caps

For stack designs that do affect the vertical component of the exit velocity, the approach for characterizing the stack varies by model. The approaches are summarized below (see the applicable user's guide or user's guide addendum for details).

- **AERMOD**: EPA describes their recommended approach for characterizing capped/horizontal stacks in Section 6.1 of their *AERMOD Implementation Guide*.[52] They also developed an option in AERMOD that will automatically revise the stack and exhaust parameters according to their recommended procedure for any stack identified as horizontal (using the POINTHOR keyword) or capped (using the POINTCAP keyword) in the Source (SO) pathway. Use of this option ensures the correct adjustments are made to the stack characteristics. See Section 3.2.2.3 of the AERMOD User's Guide for additional information regarding the POINTHOR and POINTCAP source designations within AERMOD.

  An alternative approach needs to be used for stacks that are partially offset from vertical (e.g., stacks that are angled at 45 degrees from vertical). AERMOD does not include an algorithm for handling this situation, which means the user must derive the appropriate revisions to the stack characterization. A reasonable approach would be to reduce the exit velocity by the offset angle. To account only for the vertical component of plume rise, set the exit velocity $v_v = v * \cos(Y)$, where Y is the offset angle from vertical. The stack exit diameter would be treated in the same manner as described in the AERMOD Implementation Guide for horizontal stacks (i.e., the approach depends on whether the stack is subject to building downwash). The stack orientation should not affect the exhaust temperature; therefore, it's reasonable to keep the exhaust temperature as is.

- **OCD**: OCD handles horizontal and tilted stacks internally – just enter the stack orientation angle. Use the SCREEN3 approach for capped stacks:

  1. Assume the exit velocity = 0.001 m/s

2. Assume the stack diameter equals the value needed to conserve the stack flow rate. This artificial diameter “d_{eq}” may be determined using either of the following equations. (*Note: these artificial diameters can be <u>very</u> large.*)

(1) $$\mathbf{d_{eq}} = \mathbf{d}\sqrt{\frac{v}{0.001}} = \mathbf{31.6\ d}\sqrt{v}$$

where

d_{eq} = the equivalent stack diameter in meters (m),

v = the *actual* exit velocity in meters per second (m/s), and

d = the *actual* stack diameter in meters (m);

-- or --

(2) $$\mathbf{d_{eq}} = \sqrt{\frac{4\dot{V}}{\pi \cdot v}} = \sqrt{\frac{4\dot{V}}{\pi \cdot 0.001}} = \mathbf{35.68}\sqrt{\dot{V}}$$

where

d_{eq} = the equivalent stack diameter in meters (m), and

$\dot{V}$ = stack flow rate in cubic meters per second (m^3/s).

- **AERSCREEN**: AERSCREEN uses an interactive prompt-response method to develop the necessary input to run AERMOD in a screening mode. In the interactive mode, the user responds to the AERSCREEN prompt for source type. By entering an “S” or “s” for a capped point source or “H” or “h” for a horizontal stack, a capped or horizontal stack can be modeled. AERSCREEN will prompt the user for the source parameters (the same parameters are entered for a point, capped, or horizontal stack). AERMOD will then use the option described above to invoke the algorithms for horizontal and capped stacks.

<u>Treatment of Cooling Towers</u>

Cooling towers should also be modeled as point sources as each cell in the cooling tower has associated with it a diameter, exit temperature, and exit velocity. Often, cooling tower plumes are quite buoyant and therefore are best represented as point sources. The primary emission from cooling towers is PM-10 and PM-2.5 (and some Hazardous Air Pollutant compounds). Often, cooling towers are subject to downwash effects from the cooling tower structure itself.

✓ Make certain building downwash effects from the cooling tower structure and stacks were accounted for (i.e., entered into BPIPPRM).

Non-buoyant Plumes

The stack gas exit temperature may be set to zero in AERMOD to invoke an internal algorithm which sets the stack gas temperature equal to the ambient temperature.

2.7.2 Additional Information on Common Types of EUs

Most Alaskan permit applicants have one or more of the following types of EUs at their stationary source: reciprocating engines, boilers/heaters, or combustion turbines. Flares are also fairly common. The emissions, stack and load characteristics of each type is described in the following subsections. Each subsection also contains background information regarding these types of combustion sources.

2.7.2.1 Reciprocating Engines

The compression of the fuel/air mixture in a reciprocating internal combustion (IC) engine leads to higher combustion temperatures and NOx emission rates than what is found in an external combustion source (e.g., a boiler/heater).

Applicants periodically rely on a combination of data sources for calculating emissions. The preferred data source is source test data (if it represents the desired load), manufacturer- or vendor-specific information, followed by general AP-42 equations. Mass-balance should be used for calculating SO_2 emissions. For example, an applicant could be using manufacturer data for estimating their NOx and CO emissions, mass-balance for SO_2, and AP-42 for PM-10 and VOCs.

EPA's general emission factors for diesel-fueled engines are contained in Section 3.3 and 3.4 of AP-42. Section 3.3 is appropriate for diesel engines up to 600 bhp, and Section 3.4 is used for larger engines. If the engine or generator set identified in the permit application is identified by some other metric, then you or the permit engineer should determine the equivalent bhp-rating to make certain the applicant used the correct section of AP-42. Errors are often made when the applicant refers to the generator capacity, rather than the engine capacity, in determining the engine size and applicable emission factor. See the Background Information section below for additional details.

Per the Section 8.2.2(d) of the Guideline, applicants may need to consider the effects of partial load operation in their ambient demonstration (see Section 2.7.5). In those situations, EPA recommends a screening analysis where a range of operating conditions are assessed (e.g., the 100 percent, 75 percent, and 50 percent load points), in order to determine which load causes the maximum ground-level concentrations. Part-load vendor or source test data should be used when available for making this type of screening-level analysis. When vendor or source test data is not available, applicants may assume that the actual flow rate varies linearly with load (i.e., multiply the vendor's 100 percent load data by 0.75 for the 75 percent load scenario and by 0.50 for the 50 percent load scenario) as a reasonable rule-of-thumb. For estimating the part-load exhaust temperature (in degrees K), applicants may multiply the 100 percent load data by 0.90 for the 75 percent load scenario, and by 0.85 for the 50 percent load scenario.[61]

[61] The flow rate and exhaust temperature assumptions are based on an ADEC analysis of IC engine exhaust parameters.

Please note that these assumptions may not be appropriate for other permitting aspects, such as PSD avoidance caps.

Background Information – Reciprocating Engines

Diesel-fired or gas-fired reciprocating engines are commonly used in Alaska for a wide variety of purposes, including electrical power generation. All reciprocating engines operate by the same basic process. A combustible air-fuel mixture is first compressed in a small volume between the head of a piston and its surrounding cylinder. The mixture is then ignited (through either a spark or through the compression process), and the resulting high-pressure products of combustion push the piston down the cylinder, converting the energy to rotary motion of the crankshaft. The piston returns, pushing out the exhaust gases, and the cycle is repeated.[62] Because the combustion process occurs at relatively high temperatures, there is a relatively high concentration of thermally-formed NOx in the exhaust. Other pollutants in the exhaust gases include CO, particulates, and VOCs, which all result from incomplete combustion of the fuel. There are two different general designs of IC engines, referred to as “rich-burn” or “lean-burn”. Rich-burn engines have an air-to-fuel ratio operating range that is near stoichiometric or fuel-rich of stoichiometric and as a result the exhaust gas has little or no excess oxygen. A lean-burn engine has an air-to-fuel operating range that is fuel-lean of stoichiometric; therefore, the exhaust from these engines is characterized by medium to high levels of O_2. The most common NOx emission control techniques are injection timing retard (ITR), pre-ignition chamber combustion (PCC), and computerized air-to-fuel ratio adjustments.

If the engine is used for electricity generation, the shaft of the engine is connected to an electrical generator. Often, a manufacturer will sell the generator and engine together as a matched package, referred to as a “generator set”, but in some cases the engine may be under- or over-sized with respect to the generator. The distinction between the power rating of the engine and output electrical capacity of the generator is important, especially in calculating emissions and stack parameters.

Engine capacities are commonly provided in terms of “brake horsepower,” which reflects the mechanical shaft power output. However, generator sets may be rated in terms of the generator output – e.g. kilowatts (kW) or megawatts (MW). Engines can also be rated by fuel consumption, which would typically be provided in terms of either maximum heat input (e.g., million British thermal units per hour (MMBtu/hr)), or maximum volumetric flow (e.g., gallons per hour (gal/hr)). The various points of measurement discussed above are illustrated in Figure 10.

[62] The entire process will take either one set of up and down motion of the piston (commonly referred as a “two-stroke” design) or two sets of up and down motion (commonly referred as a “four-stroke” design).

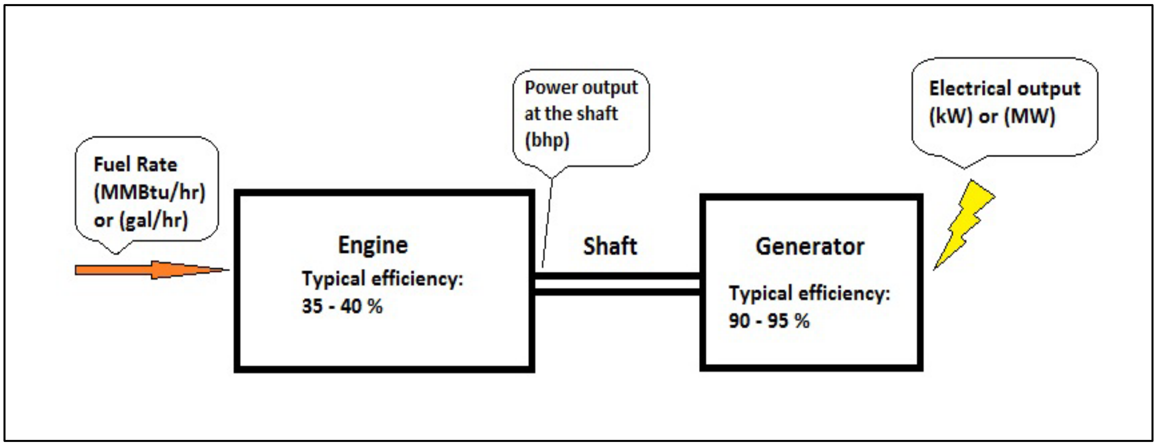

Figure 10. Illustration of Typical Generator Set Measurement Points

The engine rating may need to be converted to some other reference point and units of measure in order to estimate the emissions. For example, a kW rating for a generator set would need to be converted to the mechanical shaft output rating in order to use an AP-42 pound per horsepower-hour (lb/hp-hr) emission factor. The following two factors would therefore need to be considered in making this conversion: 1) what's the generator efficiency (i.e., how much of the engine output is converted into electricity); and 2) what's the kW to hp conversion factor? The answer to question 2 is straight-forward: 1 hp equals 0.746 kW.

The answer to the first question varies by generator design and size. As a rule of thumb though, generators typically convert 90 to 95 percent of the shaft mechanical power to electrical power. For example, in a matched engine/generator system, an engine rated at 900 bhp (671 kW of mechanical power output), would likely only produce 604 – 637 kW of electrical power.

The overall efficiency of using a reciprocating engine to convert fuel into mechanical shaft power also varies by size and design, but it roughly ranges from 35 to 40 percent. This translates into a conversion from heat input rate in MMBtu/hr to output power rate of bhp/hr of approximately 0.007 MMBtu/bhp-hr (7,000 Btu/bhp-hr).

2.7.2.2 Boilers and Heaters

External combustion sources (e.g., boilers and heaters) typically have lower emission rates, smaller exit velocities (volumetric flow rates) and cooler exhaust temperatures than internal combustion sources.

Stack flow rates and temperatures should be taken from manufacturer's data, when available. If not, it is possible to estimate the stack flow rate using the heat input rate and the appropriate "F-factor".[63] An F-factor is the ratio of the combustion gas volume to the heat content of the fuel, expressed as standard cubic feet per million Btu (scf/MMBtu).[64] F-factors are listed under Method 19 of 40 CFR 60, Appendix A. The "wet" F-factor includes all the products of combustion, including water. The "dry" F-factor excludes water vapor. The wet F-factor should be used for modeling purposes.

The range of wet F-factors for bituminous coal, oil, and natural gas range from 10,320 to 10,640 wscf/MMBtu. However, F-factors are based on theoretical combustion with stoichiometric air/fuel ratios, while boilers are typically operated with "excess air" to maintain good combustion. The amount of excess air typically ranges from 3 to 20 percent. Therefore, the F-factors need to be adjusted to account for excess air (which is directly related to oxygen concentration in the exhaust), using the following equation

$$F_{wO_2} = \quad F_w * \left[\frac{20.9}{(20.9 - \%O_2)} \right]$$

For example, the adjustment for a gas-fired process heater with 3 percent excess oxygen would change the wet F-factor for natural gas from 10,610 to 12,388 wscf/MMBtu.

The typical stack temperature for boilers/heaters are in the 400 to 550 K range. However, as always, stack parameters are very EU-specific so don't be surprised if you see some other value that is supported by vendor or source test data.

Emissions from boilers depend on the type and composition of the fuel, the type and size of the boiler, the firing and loading practices used, and the level of equipment maintenance. In calculating emissions, applicants may use a combination of data sources. The preferred data source is manufacturer specific information, followed by general AP-42 equations, and mass-balance calculations. For example, an applicant may use manufacturer data for estimating the emissions of NOx and CO, mass-balance for SO_2, and AP-42 for PM-10 and VOCs. AP-42 Sections 1.1 and 1.2 present coal-fired emission data, Section 1.3 oil-fired emission, and Section 1.4 gas-fired emission data. The emission factors may be expressed in terms of heat input rate (lb/MMBtu), or as a function of fuel input rates: lb/ton of coal fired, lb/1,000 gallons of oil fired, or lb/mscf (pound per 1000 standard cubic feet) of gas fired. AP-42 presents some assumed heat

[63] F-factors may be used to estimate the stack flow rate for external combustion sources, such as boilers and heaters. They should *not* typically be used to estimate the stack flow rate for internal combustion sources, such as compression ignition engines and turbines, unless the amount of excess air associated with the compression process is known.

[64] The standard temperature used with "F-factors" is 20°C (68°F) or 293K.

contents for oil (see footnote "d" of Table 1.3-2) and natural gas (footnote "a" of Table 1.4-1). Note that PM-10 emissions used in any modeling analysis should include both filterable and condensable components.

As previously noted in the reciprocating engine discussion (Section 2.7.2.1), applicants may need to consider the effects of partial load operation in their ambient demonstration. In those situations, EPA recommends a screening analysis where a range of operating conditions are assessed, (e.g., 100 percent, 75 percent, and 50 percent load). Part-load vendor or source test data should be used when available. When vendor or source test data is not available, applicants may assume that the actual flow rate varies linearly with load when there are no SO_2 scrubbing systems used for pollution control (i.e., multiply the vendor's 100 percent load data by 0.75 for the 75 percent load scenario, and by 0.50 for the 50 percent load scenario). In the absence of vendor or source test data, applicants may assume the exhaust temperature is constant with load (when there are no SO_2 scrubbing systems used for pollution control). [65] Please note that these assumptions may not be appropriate for other permitting aspects, such as PSD avoidance caps. See Section 2.7.5 for additional information regarding the modeling of partial load conditions.

Background Information – Boilers/Heaters

A boiler is defined as any enclosed combustion device that extracts useful energy in the form of steam and is not an incinerator. A process heater is defined as an enclosed combustion device that primarily transfers heat liberated by burning fuel directly to process streams or to heat transfer liquids other than water. (The definitions are from the Petroleum Refinery MACT II standard, 40 CFR 63.1579.) They both rely on an "external" combustion process, consequently their emissions and stack parameters may be treated similarly. For purposes of this discussion, references will be made to boilers, since they are more common, but similar information (except for references to steam) may be applied to process heaters.

Steam pressures and flow rates can vary dramatically, from 1,000 to 10,000,000 lb/hr steam flow, and pressures/temperatures from 14.7 pounds per square inch (psi) at 100 degrees Centigrade (°C) to 4500 psi and 593°C. Fuels can include coal, oil, gas, biomass, and material by-products such as municipal solid-waste. Boiler design can run from small package boilers to large power plant boilers.

The major boiler configurations are watertube, firetube, cast iron, and tubeless design. Boilers are classified according to design and orientation of heat transfer surfaces, burner configuration, and size. These factors can all strongly influence emissions as well as the potential for controlling emissions.

Watertube boilers are used in a variety of applications ranging from supplying large amounts of process steam to providing space heat for industrial facilities. In a watertube boiler, combustion heat is transferred to water flowing through tubes which line the furnace walls and boiler passes. The tube surfaces in the furnace (which houses the burner flame) absorb heat primarily by radiation from the flames. The tube surfaces in the

[65] The flow rate and exhaust temperature assumptions are based on an ADEC analysis of boiler exhaust parameters.

boiler passes (adjacent to the primary furnace) absorb heat primarily by convective heat transfer.

Firetube boilers are used primarily for heating systems, industrial process steam generators, and portable power boilers. In firetube boilers, the hot combustion gases flow through the tubes while the water being heated circulates outside of the tubes. At high pressures and when subjected to large variations in steam demand, firetube units are more susceptible to structural failure than watertube boilers. This is because the high-pressure steam in firetube units is contained by the boiler walls rather than by multiple small-diameter watertubes, which are inherently stronger. As a consequence, firetube boilers are typically small and are used primarily where boiler loads are relatively constant. Nearly all firetube boilers are sold as packaged units because of their relatively small size.

Another type of heat transfer configuration used on smaller boilers is the tubeless design. This design incorporates nested pressure vessels with water in between the shells. Combustion gases are fired into the inner pressure vessel and are then sometimes recirculated outside the second vessel.

A cast iron boiler is one in which combustion gases rise through a vertical heat exchanger and out through an exhaust duct. Water in the heat exchanger tubes is heated as it moves upward through the tubes. Cast iron boilers produce low pressure steam or hot water, and generally burn oil or natural gas. They are used primarily in the residential and commercial sectors.

The capacity of a boiler or heater is usually expressed in terms of heat input (e.g., the fuel rate times the heat content of the fuel. However, the heat output can also be used. Small boilers are also sometimes rated in terms of "boiler horsepower" rather MMBtu/hr. (Note: *the boiler horsepower rating is sometimes abbreviated as "bhp." This is the same acronym as used for "brake horsepower," but the terms are not interchangeable*.) You can find boiler horsepower to MMBtu/hr conversion factors on the internet or in various reference books, but just be aware that they don't always state whether they are also assuming a boiler efficiency factor.

Appendix A of AP-42 provides the following general conversion factor:

1 boiler horsepower (heat output) = 45,000 Btu/hr heat input

AP-42 also notes that the actual conversion factor could range from 40,000 Btu/hr to 50,000 Btu/hr.

Since most smaller packaged heating boilers are approximately 40 percent thermally efficient, when converting fuel input heat to steam output heat, the output heat rate expressed as MMBtu/hr can be multiplied by 2.5 to estimate the heat input rate in MMBtu/hr. This approach should not be used, however, for larger, more efficient boilers. In all cases, check the vendor data (if available) for details regarding the applicant's boiler or heater.

2.7.2.3 Combustion Turbines

Combustion turbines are commonly used to generate electricity or provide shaft power to compressors, pumps, and other machinery. Power plants that use combustion turbines are characterized as either simple cycle or combined cycle plants. Simple cycle refers to using a combustion turbine to generate mechanical shaft power, which then turns an electrical generator similar to an IC engine. A combined cycle system recovers waste heat in the turbine exhaust gas in a Heat Recovery Steam Generator (HRSG). The HRSG may simply recover heat from the turbine exhaust, or may have additional burners so that the steam output can be greater. The steam produced in the HRSG then drives a steam turbine electrical generator. Combined cycle plants are more thermally efficient, hence more commonly used as a primary power source, whereas simple cycle technology is typically used for peaking stations to supplement the power supply during periods of high demand.

Combustion turbines consist of four parts, the inlet, the compressor, the combustion chamber, and the generator. The inlet is where the air enters the engine. The compressor squeezes the air flowing into the engine by increasing the pressure of the air flowing into the combustion chamber. The result is that more power can be generated. The high pressure air from the compressor travels into the combustion chamber, where the air is mixed with the fuel. The fuel/air mixture is ignited causing rapid expansion of the gas. The pressure of the gas begins to drop after exiting the combustion chamber, resulting in an increase in velocity as traveling through the turbine blades. There are two sets of turbine blades, one connected to the power output shaft, and the other connected to the compressor, which drives more air into the inlet. The power output shaft can then be connected to electrical generators, or other mechanical devices such as pumps and gas compressors. The capacity of smaller turbines used for oil and gas applications is typically expressed as shaft power output, in either units of bhp or mechanical kW, and the manufacturer’s data also includes heat input ratings. For larger turbines used for power generation, it is common to express the turbine/generator system capacity in terms of generated electrical kW or MW.

The combustion process in a gas turbine can be classified as diffusion flame combustion, or lean-premix staged combustion (commonly called dry-low-NOx combustion). In the diffusion flame combustion, the fuel/air mixing and combustion take place simultaneously in the primary combustion zone. For dry-low-NOx combustors, fuel and air are mixed in an initial stage before being delivered to a secondary stage where the main combustion takes place. The dry-low NOx process typically requires the turbine to be operated at loads of approximately 50 percent or greater; under lower loads the turbine usually reverts back to diffusion flame combustion mode. In general, at full loads, dry-low NOx turbines have lower NOx emissions, but higher CO and VOC emissions than traditional diffusion flame turbines.

Emissions from combustion turbines depend on the type and composition of the fuel, the design and size of the turbine, and to a great extent the density of the ambient air (air temperature and site elevation). In calculating emissions, applicants may use a combination of data sources. The preferred data source is manufacturer specific information, followed by general AP-42 equations and mass-balance calculations. For example, an applicant may use manufacturer’s data for estimating the emissions of NOx and CO, mass-balance for SO_2, and AP-42 for PM-10 and VOCs. AP-42 Section 3.1 presents emission data for combustion turbines. The emission factors are typically expressed in terms of heat input rate (lb/MMBtu), or as a concentration level in the exhaust stream (units of parts per million by volume, dry (ppmvd) at specific oxygen levels). It is difficult to convert exhaust gas concentrations to mass emission rates, and typically the manufacturer supplies data tables with this information. Note that PM-10 emissions used in any modeling analysis should include both filterable and condensable components.

NOx emission control technologies typically applied to simple-cycle turbines are either dry-low NOx combustors or water/steam injection. NOx emission control technologies that can be applied to combined-cycle turbines include Selective Catalytic Reduction (SCR) controls.

SO_2 emissions must not only account for the conversion of elemental sulfur in the fuel gas, but also H_2S. The following methodology should be used.

$$H_2S + 1\tfrac{1}{2}\ O_2 \rightarrow SO_2 + H_2O$$

Therefore,

1 mole of H_2S produces 1 mole of SO_2.

Often, the H_2S content of the fuel is expressed in units of ppm. Given the heat input rate of the combustion unit (MMBtu/hr), the lower heating value (LHV) of the fuel (Btu/scf), one can calculate the SO_2 emission rate, as follows.

SO_2 (lb/hr) = [heat input rate (MMBtu/hr)] * [10^6 Btu/MMBtu] *

[1/LHV (scf fuel/Btu)] * [H_2S content/10^6 (scf H_2S/10^6 scf fuel)] *

[1 scf SO_2/1 scf H_2S] * [lb-mole/359 scf] * [64 lb/lb-mole (the molecular weight of SO_2)]

Note: *The "standard" condition of the 359 scf per lb-mole molar volume is at 32°F.*

Unlike boiler load screening analyses, load screening for combustion turbines present a special situation because air temperature plays such a dominant role in calculating emissions and stack flow parameters. As the density of air entering the turbine increases (colder temperatures), the mass of air flowing through the turbine increases as does the turbine output power, gas flow, and mass emissions. Therefore, it is reasonable to calculate annual emission and stack parameters at a representative annual temperature, but short-term emissions and stack parameters may need to be bounded using reasonable minimum and maximum temperatures that can be expected at the site. In addition to ambient temperature, other factors such as operating load, water/steam injection, and inlet temperature control will also affect the turbine emissions and stack parameters. In order to calculate the worst-case air quality impacts, the screening analysis may need to analyze multiple operating scenarios (based on operating load and atmospheric conditions) in order to predict the highest ambient impacts on a pollutant-specific basis.

Turbine start up presents another operating scenario that may need to be considered. Because emissions of CO can significantly increase during startups and shutdowns, a separate load screening analysis for CO may be needed.

Applicants may need to provide manufacturer stack parameter and emission data for various ambient temperature and loads as part of a combustion turbine analysis. If manufacturer or source test data is not available, applicants may multiply the manufacturer's full-load actual flow rate by 0.80 for the 75 percent load scenario and by 0.70 for the 50 percent load scenario. For estimating the part-load exhaust temperature (in degrees K), applicants may multiply the full-load temperature by 0.95 for the 75 percent load scenario and by 0.70 for the 50 percent load scenario.[65] Please note that these assumptions may not be appropriate for other permitting aspects, such as PSD avoidance caps. See Section 2.7.5 for additional information regarding the modeling of partial load conditions.

2.7.2.4 Flares

Flares can be tricky EUs to model. The operating scenario should be defined as to whether the applicant is modeling a flaring event or just the pilot, purge gas, and assist gas. A flare typically operates in a standard mode and an event mode. In the standard mode, a small flame is present, resulting from the combustion of pilot, purge, and assist gas. A flaring event is usually characterized by a large flame, due to rerouting of product during the temporary shutdown of a process or control unit.

The following definitions, provided by BP Exploration (Alaska), Inc. may be helpful in understanding flare terminology.

Pilots: Pilot gas is the component of the flared gas needed to insure continuous ignition of any gas flared from the facilities. This is analogous to the pilot found of a natural gas furnace or water heater in your home. The amount of pilot gas required is dependent on the type and number of pilots. The number of pilots is dependent on the design of the flare which takes into account flare size and configuration. The rate for each pilot is constant after it is set initially to establish a stable flame resistant to being blown out by high winds.

Purge Gas: Purge gas, sometimes called sweep gas, is the component of the flared gas used to prevent the formation of an explosive mixture through ingress of air into the piping of the flare system. The normal purge rate is calculated for no influence by wind and is dependent on the pipe diameter, type of flare tip, and the number of flare tips. Purge gas volumes are sometimes adjusted above the normal rate to overcome the effects of wind gusts. These effects including blowing air back through the tips, blowing the burning flame back inside the flare tip, and blowing the flame out.

Assist Gas: Facilities may operate two separation systems, high pressure and low pressure, for processing of incoming hydrocarbons. These systems separate gas, oil, and water streams in a series of separation vessels which operate at successively lower pressure. Consequently the flare system consists of high pressure and low pressure flares for use with the appropriate level and operating pressure. Because of less volatile hydrocarbon components and lower gas velocities in the low pressure system, combustion of this gas is less efficient and unassisted burning may result in the formation of black smoke. Therefore, in order to assure more complete combustion and minimize the generation of black smoke from flaring of low pressure gas, assist gas from the high pressure system is combined with the low pressure gas at the flare.

Flares are identified as a unique point source as they do not have a defined stack exit diameter. For modeling, it is necessary to compute equivalent emission parameters, i.e. adjusted values of stack height and “stack” diameter.

AERSCREEN has a source category for flares, and makes these adjustments internally based on the user input data. AERMOD does not have a source category for flares, and therefore, would need to have the adjustments made by the modeler outside the model prior to running AERMOD. The approach is as follows (the equations below are the more commonly used form expressing the total heat release in MMBtu/hr; they have been changed from the form found in EPA manuals in which the total heat release is expressed in calories/second):

1. Compute the adjustment to stack height ($H_{equiv.}$) as a function of total heat release Q in MMBtu/hr:[66]

   $$H_{equiv.} = H_{actual} + 0.944 * (Q)^{0.478}$$

   where $H_{equiv.}$ and H_{actual} have units of meters;

   <u>Note</u>: *1) some flares are rated in calories per second and the conversion factor is 1 Btu/hr for every 0.06993 cal/s; and 2) the adjustment accounts for flame length and assumes the flame is tilted 45-degrees from the vertical.*

2. Assume a temperature of 1,273 °K;

3. Assume an exit velocity of 20 meters/sec;

4. Assume an effective stack diameter (d_{eff}) of

   $$d_{eff} = 0.1755 * (Q)^{0.5}$$

   <u>Note</u>: *Some stationary sources in Prudhoe Bay have horizontal flares. In these cases, an exit velocity of 0.001 m/s should be used when modeling with AERMOD (see the discussion on horizontal stacks in* *Section 2.7.1**).*

Effective diameter is applicable for both vertical and horizontal flares since it's back-calculated from a buoyancy flux assumption. Buoyancy flux is not a function of flare orientation. Therefore, the equation can be used for both horizontal and vertical flare orientations.

This method pertains to the "typical" flare, and will be more or less accurate depending on various parameters of the flare in question, such as heat content and molecular weight of the fuel, velocity of the uncombusted fuel/air mixture, presence of steam for soot control, etc. Hence, this method may not be applicable to every situation. For example, the Central Compressor Plant in Prudhoe Bay utilizes "candle" flares for some of their flaring needs. A methodology was developed with R10 in the early 1990's to model the candle flares as area sources. Other unique situations may also exist, in which case the applicant may submit his own properly documented method for review and approval.

The calculation of PM-10 and PM-2.5 emissions from flares is not straight forward. Section 13.5 of AP-42 presents guidance on calculating emissions from industrial flares. Table 13.5-1 of that document presents an emission factor for soot, but not PM-10. Furthermore, the soot concentration is expressed in units of micrograms per liter (µg/l) of

[66] The equation for adjusting the flare stack height was originally published by M. Beychok in *Fundamentals of Stack Gas Dispersion* (1979).

exhaust gas, as a function of the amount of smoke in the flare (e.g., lightly smoking, heavily smoking, etc.).

As an alternate method, ADEC has allowed applicants to conservatively estimate PM-10 emissions from flares as a function of the uncombusted fuel mass. If one knows the mass flow of the fuel and the combustion efficiency of the flare (obtained from the manufacturer), the residual amount of unburned fuel mass emission rate is assumed to be the mass emission rate of PM-10.

2.7.2.5 Marine Vessels

The modeling of marine vessel emissions warrants discussion, especially since the associated regulations and guidance is confusing, and in at least one situation, inconsistent with a court ruling. In short, vessels are sometimes considered as their own stationary source. At other times, their emissions, or portions thereof, are considered mobile source emissions, part of a shore-side stationary source, or as "secondary emissions" – depending on the circumstances. The approach for modeling marine vessels will therefore depend on whether the emissions are considered as part of the applicant's stationary source (if not the entire stationary source), or whether they are "off-site" sources (e.g., secondary emissions).

According to 40 CFR 51.166(b)(5), a "stationary source" is defined as "*any building, structure, facility, or installation which emits or may emit a regulated NSR pollutant*." The Alaska definition for "stationary source" adopts this same federal definition under AS 46.14.990(26).

The phrase, "building, structure, facility, or installation" is defined in 40 CFR 51.166(b)(6) as, "*all of the pollutant-emitting activities… <u>except the activities of any vessel</u>…*" (emphasis added). The definition in 40 CFR 52.21(b)(6) includes this same exemption.

EPA further discusses vessel emissions in its definition of "secondary emissions" in 40 CFR 51.166(b)(18) and 40 CFR 52.21(b)(18). These citations include the sentence, "*… Secondary emissions <u>do not</u> <u>include</u> any emissions which come directly from a mobile source, such as emissions from the tailpipe of a motor vehicle, from a train, <u>or from a vessel</u>.*" (emphasis added).

While the above CFR definitions seem to provide the framework for addressing marine vessel emissions, they are inconsistent with a 1984 Court of Appeals for the D.C. Circuit ruling. ADEC does not know why EPA has not subsequently revised the CFR definitions so that they would be consistent with the ruling.

The Court essentially vacated the total exclusion of vessel emissions from the stationary source and secondary emissions definitions. The context of the Court ruling regarded "marine terminals," although the resulting action has broader implications. The Court stated that EPA acted "far too precipitously" in concluding that it had no authority to attribute any vessel emissions to marine terminals. The Court further stated that EPA should have examined the nature of the interactions between a vessel and a terminal to determine specifically which categories of emissions, if any, should be attributed to the terminal.

As stated in a January 8, 1990 letter from John Calcagni (Director of EPA's Air Quality Management Division) to Ken Waid (President of Waid and Associates),

> The Court affirmed the portion of the 1982 promulgation that excluded "to and fro" vessel emissions from attribution to the terminal as secondary emissions, but vacated EPA's 1982 blanket repeal of the dockside vessel emissions component from PSD emissions counting as either primary or

> secondary emissions. In so doing, the Court acknowledged that, with the exception of to and fro emissions, it implicitly reinstated the PSD regulations promulgated on August 7, 1980 (45 FR 52676)…

The Alaska Legislature included some types of vessel operations in its definition of "building, structure, facility, or installation" in AS 46.14.990(4). This statute applies when determining if a vessel is in of itself a stationary source. This leads to some vessels, such as an offshore seafood processor, being treated as a stationary source for air quality permitting purposes. In these situations, the NSR modeling analysis should be based on the vessel's allowable emissions (see Table 8-2 of the Guideline). Assumptions used in the modeling analysis could also be imposed as permit conditions to protect the modeled ambient air quality standards and increments.

The emissions used to solely support vessel operations, such as hoteling emissions from a cargo ship docked at a shore-side stationary source, are not generally included as part of the shore-side stationary source emissions. The emissions associated with maintaining a supply vessel's position alongside an offshore oil and gas platform are likewise not generally included as part of the platform stationary source emissions. Like all other off-site emissions, the vessel emissions in these types of situations would not be included in a project impact analysis. Applicants could also use the "nearby source" approach in Table 8-2 of the Guideline for including these emissions in a cumulative impact analysis. Under this approach, applicants could likely use actual operating factors for estimating the annual average emissions rather than using the potential emissions. As off-site emissions, the assumptions used to model the vessel emissions could <u>not</u> be imposed as ambient air conditions in the NSR permit for the platform/shore-side stationary source.

Vessels are sometimes used to support shore-side activities. In those situations, the vessel EUs used to help conduct the onshore activities are considered as part of the shore-side stationary source, while the EUs used solely to support the vessel operations are not. Examples include the use of a ship-board crane to conduct onshore operations or the use of a ship's electrical generator sets for providing shore-side power at a shore-side facility. In these situations, the allowable emissions from the shore-support EUs should be used in the NSR modeling analysis, while the actual emissions from the other EUs could be used in the cumulative impact analysis.

The above discussion only provides a general outline of how vessel emissions may need to be handled in a NSR modeling analysis. Variations may be warranted based on the details of a given project, subsequent rule interpretations from EPA or ADEC, or subsequent revisions to the underlying rules. When in doubt, discuss the issue with the permit engineer and permit supervisor to ensure consistency between the modeling analysis and the other parts of the permit decision.

2.7.3 Additional Comments Regarding Operating Scenarios

Some applicants intend to operate their stationary source under various operating scenarios. The various scenarios could reflect a phased development/expansion of the stationary source, an alternative fuel condition, periodic maintenance activities, a startup/shutdown condition, or some other situation that is specific to their stationary source.

In some circumstances, a modification to an existing stationary source may "debottleneck" the overall operation and allow the fuel and/or process throughput to increase at other points within the facility. These changes in overall operation may therefore, lead to an increase in emissions, or a change in emission characteristics, from other EUs within the facility.

Applicants do not need to model each and every scenario, as long as the worst-case condition that would be authorized by the permit demonstrates compliance with the applicable AAAQS/increments. For example, some applicants choose to model the continuous full-load operation of all EUs, even though they do not intend to concurrently operate all EUs. Other applicants choose to model the scenario that has the largest emissions and worst-case release/dispersion conditions.

You will need to assess whether the submitted analysis/analyses adequately demonstrates compliance for the stated range of operating scenarios. In some cases, it may not be obvious which operating scenario would create the worst-case impacts. The best solution in those cases may be to ask the applicant to model the operating scenario in question. In other cases it may be more expedient to just conduct a sensitivity analysis to see whether the aspect in question is substantive. Feel free to discuss the issue with your supervisor, the permit engineer, and/or the applicant, if it is unclear whether the submitted demonstration addresses the applicant's desired range of operating scenarios.

2.7.4 Quick Note Regarding Small EUs

Some stationary sources may have EUs that are too small to reasonably characterize through modeling, or too small to even warrant the effort. In these situations, it may be appropriate to make a case-specific determination regarding a minimum size-threshold for the modeling analysis. For example, ADEC allowed the U.S. Air Force to exclude EUs rated at less than 50 bhp from a modeling analysis they conducted in 2003 for Eielson Air Force Base. North Slope applicants may exclude construction-related internal combustion units rated at less than 400 bhp and construction-related boilers/heaters with a heat input rating of less than 2.8 MMBtu/hr from their construction phase modeling analysis if they comply with the fuel sulfur restriction in Policy and Procedure 04.02.104. North Slope applicants may likewise exclude similarly rated intermittent well servicing equipment from their modeling analysis if they comply with the fuel sulfur restriction in Policy and Procedure 04.02.105. These, and other air permit policy documents, may be found at http://dec.alaska.gov/air/air-permit/policies/.

2.7.5 Additional Comments Regarding Part Load Assessments

Section 8.2.2(d) of the Guideline states changes in operation that affect the "physical emission parameters (e.g., release height, initial plume volume, and exit velocity) shall be considered" to ensure the maximum impacts are found. EPA further states that a load screening analyses should be conducted if the source operates at greater than design capacity "for periods that could result in violations of the [AAAQS/increments]," and in those situations where "the source operates at substantially less than design capacity, and the changes in the stack parameters associated with the operating conditions could lead to higher ground level concentrations". At a minimum the EU should be modeled using the design capacity (100 percent load), or any higher load rates if it can be operated at those higher rates. Sources that operate for appreciable amounts of time at loads less than the design capacity require an analysis at partial loads, such as 50 percent and 75 percent, to identify the operating condition that causes the maximum ground-level concentration. The worst-case scenario can also vary by pollutant, especially when the pollutants have inconsistent emissions-to-load trends/curves.

Use judgment in assessing which EUs warrant load screening. The evaluation of part-load conditions for all EUs at a stationary source with numerous EUs can become burdensome. In these situations, it is also nearly impossible to evaluate all of the possible combinations of some EUs operating at a given load while other EUs are operating at some other load. Therefore, ADEC typically works with the applicant to select the EUs/loads for evaluation. In general, we only ask for a load analysis for the larger EUs. It is clear that only EUs that operate for significant amounts of time, at more than or less than the rated design capacity should be considered. Load screening for emergency and intermittently used equipment is not generally required. Applicants should describe their proposed part-load approach and assumptions in the modeling protocol.

Some applicants choose to model the worst-case emissions and stack parameters as an alternative to the load analysis, even if that given set of parameters would not all occur at the same load (i.e., unpaired parameters). For example, an applicant may choose to model their full-load NOx emissions (since the maximum NOx emissions generally occur at full-load) and their 50 percent load exhaust parameters (since near-field concentrations tend to increase as plume buoyancy decreases). This simplified approach works where it's generally clear what the worst-case scenario would be for the given parameter and source-receptor layout. However, the answer is not always clear. In those cases, it may be better to just ask for a load sensitivity analysis. Changes in ambient temperature can also lead to changes in emissions and ambient impacts when modeling a combustion turbine. Refer to Section 2.7.2.3 for a discussion of the basis for this phenomenon and recommended conditions for screening.

Summary and tips:

- ✓ Be aware that ambient impacts can increase during part-load conditions.
- ✓ However, use judgment in assessing which EUs warrant load screening.
- ✓ Verify worst-case scenario was selected for each pollutant, and applicable averaging period.
- ✓ Verify the results of the load-screening analysis were actually used in the project/cumulative impact analyses.

2.7.6 Secondary Emissions

PSD applicants must include "secondary emissions" in their ambient demonstration, per 40 CFR 52.21(k)(1). EPA defines the term in 40 CFR 52.21(b)(18) as, "emissions which would occur as a result of the construction or operation of a major stationary source… but do not come from the major stationary source…" However, secondary emissions do not include "any emissions which come directly from a mobile source." Secondary emissions can also include marine vessels, as previously discussed in Section 2.7.2.5 of this manual. Subsequent EPA guidance further clarifies that the definition in 40 CFR 52.21(b)(18) "sets out four tests to be used in determining whether such emissions are to be included in air quality impact assessments for PSD purposes: the emissions must be specific, well defined, quantifiable, and impact the same general area." [67]

<u>Construction Emissions</u>

Construction emissions are the predominant, if not the only, secondary emissions that typically occur for Alaskan PSD projects. PSD applicants may therefore need to include an ambient demonstration for the construction phase of their PSD project. Minor permit applicants may likewise need to include construction emissions in their ambient demonstration, per 18 AAC 50.540(c)(2).

The details and approach for addressing construction emissions have varied over time, plus they can be very case-specific. In many cases, the normal operating phase provides the worst-case scenario for the triggered pollutants. This can be especially true if the triggered pollutants do not include PM-10 or PM-2.5 (as a direct pollutant). In these cases, it may be possible for the applicant to demonstrate that the construction emissions will comply with the AAAQS by demonstrating that the normal operating phase emissions will comply with the AAAQS. (See the related discussion in Section 2.7.3 of this manual.)

Projects that trigger a PM-10 and/or a PM-2.5 ambient demonstration can introduce additional factors that you and the applicant may need to consider in determining whether the construction phase emissions should be modeled. The potential for fugitive dust is the most common factor that must be considered. It's typically a non-buoyant, ground-level release that disperses differently than the buoyant, stack releases that would occur during the normal operating phase at most stationary sources. ADEC has therefore frequently required applicants to model the PM emissions associated with the construction phase.

While modeling has been the typical past approach for assessing construction phase emissions, ADEC has recently observed that modeling the construction phase PM emissions generally leads to a permit condition that imposes compliance with a fugitive dust control plan (FDCP). ADEC is therefore contemplating whether it makes more sense to just impose a FDCP, with post-construction PM monitoring (during the construction phase), than to require modeling and then imposing a FDCP. This is a new

[67] EPA letter from Edward F. Tuerk (Acting Assistant Administrator for Air, Noise and Radiation) to Allyn M. Davis (Director, Air and Hazardous Materials Division); *PSD Evaluation of Secondary Emissions for Houston Lighting and Power*; March 17, 1981.

concept as of October 8, 2018, so it is unknown whether it will be viable from a regulatory/permitting aspect.

Temporary construction activities do not need to be included in an increment analysis per 18 AAC 50.215(b)(2)(A). Temporary construction activities are defined in 18 AAC 50.990(107) as construction that is completed in 24 months or less from the date construction begins, and includes any period of inactivity during that 24-month period. The definition for "begin actual construction" in 40 CFR 52.21(b)(11) can be used to define "date construction begins":

> *Begin actual construction means, in general, initiation of physical on-site construction activities on an emissions unit which are of a permanent nature. Such activities include, but are not limited to, installation of building supports and foundations, laying underground pipework and construction of permanent storage structures. With respect to a change in method of operations, this term refers to those on-site activities other than preparatory activities which mark the initiation of the change.*

North Slope Construction Phase Emissions

As previously noted in Section 2.7.4 of this manual, ADEC allows North Slope applicants to exclude select construction phase emissions from their modeling analysis if they agree to only use fuel with a maximum sulfur content of 15 parts per million by weight (ppmw) in all diesel-fired construction equipment operated at the stationary source.[68] Diesel fuel that meets this fuel sulfur requirement is commonly known as Ultra-Low Sulfur Diesel (ULSD). In accordance with this guidance, the applicant may exclude construction-related internal combustion equipment that is rated at less than 400 bhp, or boilers/heaters with a heat-input rating of less-than 2.8 MMbtu/hr, from their construction phase modeling analysis. The Department may impose these fuel restrictions as permit conditions.

2.7.7 Baseline EUs

Actual emissions, rather than potential emissions, must be used when modeling the baseline EUs in an increment analysis. Using the potential emissions for modeling baseline EUs may increase the baseline concentration, which would then reduce the subsequent change in concentration – i.e., it may underestimate the resulting increment consumption.

Most facility operators do not change an exhaust stack once it's built. However, changes can occur. In those situations, the stack location/configuration that existed during the baseline year should be used when simulating the baseline concentrations, and the current/proposed stack location/configuration should be used when simulating the current/future impacts. For example, an owner/operator may have increased a stack height to reduce problems from downwash, or change a horizontal release to a vertical release, subsequent to the baseline year. In these situations, the stack height/orientation that existed during the baseline year should be used for modeling the baseline

[68] Policy and Procedure 04.02.104: *Construction Phase Air Emissions at Oil Fields*; November 20, 2006.

concentrations, and the current height/orientation should be used for modeling the current/future air quality impacts.

2.7.8 Source Groups

Source groups are useful in quantifying the air quality impacts from a pre-defined group of EUs. They are identified in the Source Option (SO) pathway of AERMOD. The user must specify the name of the individual sources to be included in the source group. Errors can occur if the character string identified in the source group is not exactly the same as that identified in the source location and parameter lines.

- ✓ If source groups are used, verify that all sources intended to be included in a particular source group actually have been included.

- ✓ Check for misspellings of a source ID in a source group, AERMOD will run and calculate impacts from those units, but impacts from the misspelled source ID will not be included in the source group impacts.

- ✓ Another potential source of error may occur if multiple source IDs are identified by using a “from-to” source ID format in a source group (for example, Group1 Source1-Source6). A source could be accidentally omitted if the source IDs are especially complex names.

A simple way to check sources and source groups is to open a model output file and compare the sources names to the sources identified in each source group.

Source groups are also helpful in performing a culpability analysis. This simplest way to perform a culpability analysis for short-term impacts is to run the EVENT model, but one can also perform the analysis without an event model. One cannot use the EVENT model to perform a culpability analysis of annual impacts. The EVENT model has been incorporated into AERMOD. Refer to the AERMOD User’s Guide for a description of how to run the event model.

In order to understand the use of the EVENT model, consider the following example. Assume the applicant performed an SO_2 analysis for North Slope oil field operations, using five years of meteorological data, a receptor grid containing 2000 receptors, and 30 SO_2 EUs, from different stationary sources. The analysis demonstrated compliance with the SO_2 PSD Class II increments, but upon discovering, correcting an error, and rerunning the model, you find the model now predicts violations of the 24-hour PSD increment. You want to know the contribution from the proposed project.

In the Control Option (CO) pathway, you could specify the EVENT option and run the model as normal. In addition to the normal output, the model will create an event-specific model input file. This file contains a list of events to be modeled. Each event is unique in that it specifies the averaging period, the design concentration (e.g., high, highest second-high, etc.), and the receptor of interest. Upon reviewing the event file, you discover that there was one day in which the model predicted impacts exceeded the 24-hour SO_2 PSD increment at 10 receptors. You can delete all events from the input file (or use comment notation) so that you run only the receptor and day in which the high second-high (H2H) impact occurred.

Run the model again, but this time name the event file as the input file. The output will contain the concentration from each individual source to the receptor for the day of interest. You can then manually sum the impacts from only those sources within the facility of interest to obtain the contribution from that source.

As an alternative to the event model, you can run the same model again using source groups, but only for the receptor and day of interest (i.e., the receptor and day where the H2H was predicted to exceed the PSD increment). You can specify source groups for each facility or the facility of interest and all others. This is somewhat more cumbersome that running the EVENT model, but will work.

One can also perform a culpability analysis for annual impacts using this alternative approach. To do so, one needs to run the model using only a single receptor, user-defined source groups, and the year of meteorological data of interest. Refer to the original model output to identify the year with the highest annual impacts, and use that year to run the model again.

HAVE YOU DOCUMENTED THE RESULTS OF YOUR REVIEW SO FAR?

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2.8 Downwash

Wind flows are disrupted by aerodynamic forces in the vicinity of buildings and other solid structures. Figure 11 (reprinted by permission of Taylor and Francis) [69] illustrates the downwind near wake (cavity recirculation) and far wake (reattachment) associated with building downwash in AERMOD. The structure and distances downwind associated with the wakes are based on the Plume Rise Model Enhancements (PRIME) downwash algorithms. A complete discussion and evaluation of these algorithms can be found on SCRAM. In summary, when pollutants are emitted from stacks subject to downwash, the emissions can quickly be mixed down to ground level and result in high concentrations. Models such as AERMOD and AERSCREEN all make calculations of pollutant concentrations in the building wake zone as well as in the cavity region.

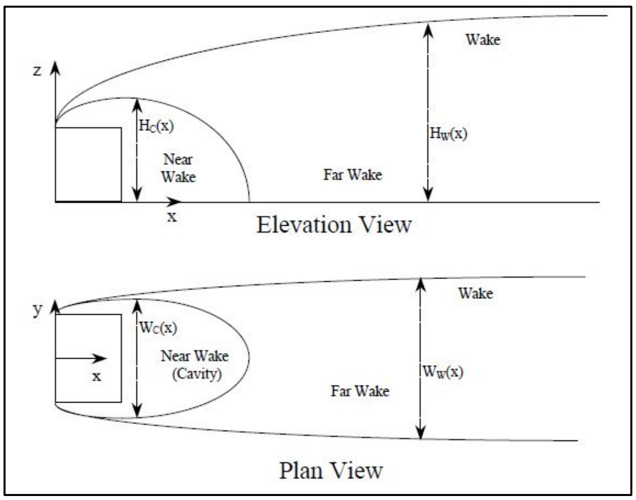

Figure 11. Near and Far Wake in AERMOD
(Schulman *et al.*, 2000; reprinted by permission of Taylor and Francis)[69]

EPA has developed guidance for determining the stack heights necessary to prevent or reduce downwash effects, as described in, *Guidelines for Determining Good Engineering Practice (GEP) Stack Height*, EPA-450/4-80-023R. The GEP stack height is defined as the greater of: 1) a "de minimis" 65-meter height above ground level, or 2) for stacks in existence on January 12, 1979, 2.5 times the height of any nearby influencing structure, or 3) the height plus 1.5L of any influencing structure (with "L" as defined above). The definition of "nearby influencing structure" is when the structure is located within 5L downwind, 2L upwind, or 0.5L crosswind from the stack, as illustrated in Figure 12. Most stacks in Alaska are below formula GEP.

[69] Schulman, L., D. Strimaitis, and J. Scire, 2000: "Development and Evaluation of the PRIME Plume Rise and Building Downwash Model", Journal of the Air and Waste Management Association, 50:378-390 (reprinted by permission of Taylor and Francis (http://www.tandfonline.com)

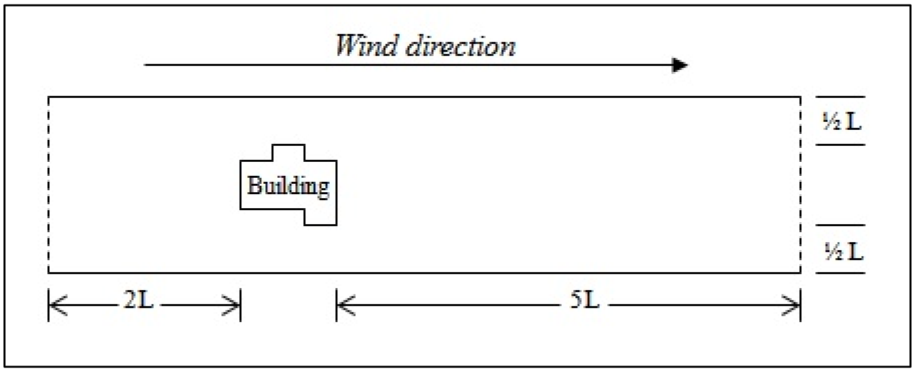

Figure 12. Plan View of Area of Influence of Building Wake Effects

2.8.1 GEP and BPIPPRM Analyses

The following discussion provides additional aspects of the building and EU review discussed in Section 2.3.2. A GEP review must be conducted for each modeled point source to determine if building downwash effects need to be included in the analysis, and to determine the appropriate stack heights to be used with the model(s). Because the calculations for determining GEP can be cumbersome, EPA developed the Building Profile Input Program for PRIME (BPIPPRM[70]) for use with AERMOD.[71] The input data to BPIPPRM includes the coordinates of each structure and stack, the base elevation of each structure and stack, and the heights of each structure and stack. The program then determines the GEP stack height for each stack based on the GEP formula height (BPIPPRM also outputs direction specific building dimensions that can be used to model downwash effects). The GEP determined stack height is the maximum height that can be used or “credited” in the modeling analyses.

If a stack is below formula GEP (which is the typical case in Alaska), the potential for downwash exists and the modeling analysis must consider these effects. The air quality models that can assess downwash effects include AERSCREEN, AERMOD and CALPUFF. These models contain the Plume Rise Model Enhancement (PRIME) downwash algorithms.

For AERMOD and CALPUFF, direction specific building dimensions are used in the model input files. For AERSCREEN building information can be input in two ways for a single source: 1) by entering the minimum and maximum building dimensions, orientation to north, and distance of the stack to the center of the building for a single tier rectangular, or 2) reading and processing a pre-existing BPIPPRM input file.

It is critical to check the BPIPPRM file for consistency with site plans and proposed stack heights.

[70] *User’s Guide to the Building Profile Input Program*; EPA-454/R-93-038; Revised April 21, 2004.

[71] The BPIP program used with AERMOD’s predecessor, ISCST3, does not incorporate the PRIME algorithms and any results from it cannot be used with AERMOD.

The following review steps are recommended:

- ✓ Using the BPIPPRM input file, generate a plot that shows the building locations and stack locations. Compare the plot to the site plan or aerial photo provided by the applicant. See Figure 13 and Figure 14 for an example of an aerial photograph and the representation of the applicant's characterization of the modeled stacks and buildings using a third party GUI.

The applicant may omit small buildings/structures from the BPIPPRM input file as these structures may not contribute to downwash effects. Also note that if plant north is different than true north, the BPIPPRM input file must include a rotation angle. One other note, the plant coordinate system may be different than the modeling coordinate system. This is perfectly acceptable so long as plot generated by reviewer matches the plot plan provided by the applicant.

Figure 13. Aerial View of an Applicant's Stationary Source

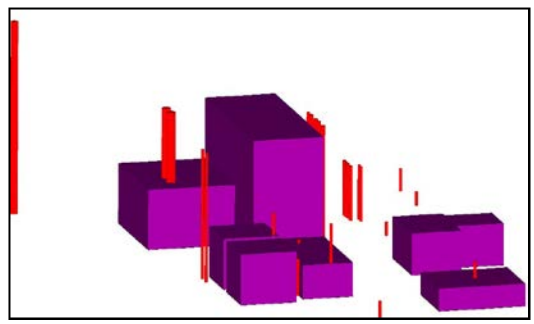

Figure 14. Visualization of an Applicant's Characterization of the Structures and EUs

The BPIPPRM input also requires building base elevation and stack base elevation.

- ✓ Check the base elevations of the buildings and stacks in the BPIPPRM file.

In most instances, stack base elevations and building base elevations are identical, which essentially allows modelers to use either zero (0) elevation, or the actual plant elevation, when running BPIPPRM. Both approaches provide identical results when running the SCRAM version of BPIPPRM. However, the use of zero-meter elevations can lead to errors in the BEEST GUI, since BEEST uses the stack base elevation provided in the AERMOD input file, rather than the stack base elevations provided in the BPIPPRM file. ***For this reason, ADEC encourages applicants to use the actual building and stack elevations in the BPIPPRM analysis.***

Note: You will need to take one of the following two approaches if you wish to verify the BPIPPRM results from an applicant who used zero-meter elevations in the BPIPPRM file:

- Approach 1 – enter the actual building base elevations in the BPIPPRM input file (copy the BPIPPRM input file first – do not edit original files!) and use the third party GUI of your choice to rerun the BPIPPRM analysis; or

- Approach 2 – run the SCRAM version of BPIPPRM using - using a Command Window and running it from the command prompt.

The applicant may characterize buildings with pitched roofs or multiple rooflines as tiered structures. One acceptable method is to assign the building as a multi-tiered structure in BPIPPRM and assign each tier as a separate height. Another method is to list each tier as a separate structure independent of the original, so long as the tier height is identical to the building height at the location of that tier.

In some instances, the applicant may conservatively characterize pitched roofs by assuming that the entire horizontal dimensions are covered by a flat roof at the elevation of the peak of the pitched roof. An acceptable alternative is to assume a building height ½ the distance up the pitched roof and the corresponding horizontal dimensions below that 'roof' (i.e., one horizontal dimension would also be halved), as shown in Figure 15 below.

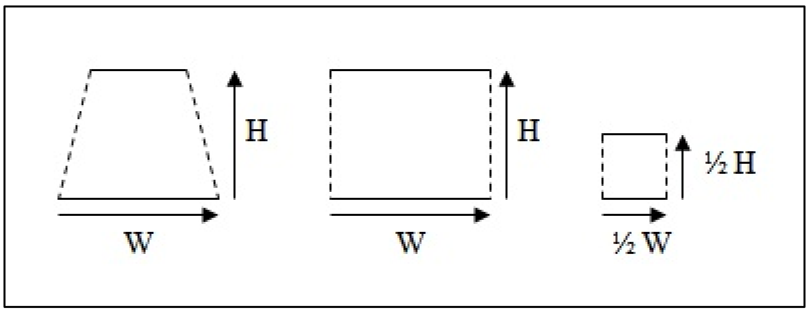

Figure 15. Illustration of Pitched Roof Representations in BPIPPRM

- ✓ Verify that the building heights provided in the BPIPPRM input file(s) are consistent with the data provided in the application or modeling report.

- ✓ After reviewing the BPIPPRM input/output files, check to ensure that the direction specific building downwash parameters were included in the AERMOD input files.

The BPIPPRM output data with the keywords “BUILDHGT”, “BUILDWID” are the same keywords in the AERMOD source data input files and should not be changed.

2.9 Stack Modifications

In some situations, an existing source may wish to modify its stack either by (1) increasing the stack height, (2) changing from a horizontal to vertical discharge position, (3) removing a rain cap, or (4) merging multiple stacks. EPA does not regulate the physical change that may occur, but only the "creditable" portion that may be used in regulatory dispersion modeling. Hence, those stack parameters used in the modeling, may differ from the actual conditions.

40 CFR Part 51 establishes stack height regulations that assure emission limits determined through modeling analyses are not affected by any stack height which exceeds GEP, or by any other enhanced "dispersion technique." The stack height regulations define a number of terms, provide methods for determining GEP height and specify when each method can be used, and limit the use of enhanced "dispersion techniques", such as exhaust gas reheating or stack merging, at existing sources.

The regulation is somewhat confusing. Therefore, ADEC asked Mr. Dave Bray of R10 (the EPA lead on dispersion techniques associated with the GEP rule) to clarify whether applicants may take credit for increasing the stack height up to GEP, removing rain caps, or making a horizontal stack vertical.

Mr. Bray provided the following reply:[72]

> … *EPA, when developing its rules to implement this requirement, made it clear that sources were always free to build stacks, replace stacks, or modify stacks such that they employed good engineering practice. Under the definition of good engineering practice, we provide a default height of 65 meters that is always considered GEP. So, as long as the stack is less than 65 meters in height, any change to the stack height or orientation would always be allowed as representing GEP.*
>
> *The general intent of the dispersion technique provisions are to preclude the use of intermittent and supplemental control systems whereby the source alters production rates based on ambient air quality levels or meteorological conditions. The dispersion technique provisions also preclude some type of exhaust gas manipulation that would be unrelated to having a stack meet GEP (e.g., increasing exhaust gas flow rates beyond what would be needed to prevent stack-tip downwash just to increase final plume rise.*

72 Email from Dave Bray (R10) to Herman Wong (R10) with a cc to Alan Schuler (ADEC) and Rob Wilson (R10); *RE: Stack Modification Question*; August 27, 2003.

18 AAC 50.045 presents the prohibitions for operating an emission source, including use of certain dispersion techniques. A dispersion technique means a technique that attempts to reduce the concentration of an air contaminant in the ambient air by:

- using that portion of a stack that exceeds GEP
- varying the emission rates of an air pollutant according to atmospheric conditions or ambient concentrations of that air contaminant
- increasing exhaust gas plume rise by:
    - manipulating a source process parameter, exhaust gas parameter, or stack parameter;
    - combining exhaust gases from several existing stacks into one stack;
    - other selective handling of exhaust gas streams.

These prohibitions do not limit applicants from making stack changes within GEP (e.g., raising the stack height to GEP, changing the stack orientation, or removing rain caps). Refer to 18 AAC 50.045 for a complete description of dispersion techniques.

The stack height regulations also limit allowable credit at existing stacks for the use of enhanced "dispersion techniques," that are defined to include increases to final plume rise caused by "manipulating source process parameters, exhaust gas parameters, stack parameters, or combining exhaust gases from several existing stacks into one stack." There are two exceptions to the limitation on stack merging. First, if stack merging is part of a pollution control project and there is a net reduction in allowable emissions, the use of stack merging is allowed. Second, if the source's allowable SO_2 emissions are less than 5,000 tons per year (tpy), the use of stack merging is allowed for SO_2 modeling analyses.[73]

When merging of stacks is creditable, the resultant stack exit volume is determined by summing the individual stack volumetric flow rates, and the resultant stack temperature is a volume flow-weighted average (i.e., considering the flow rates of each unit that is merged into the single stack). The final exit velocity is calculated by dividing the summed exit volume by the merged stack area.

EPA's October 10, 1985 memorandum, *Questions and Answers on Implementing the Revised Stack Height Regulation*, provides guidance on how merged stacks should be treated in a modeling analysis when merging is not creditable. EPA recommends that each EU be modeled as a separate source and the combined impact determined, rather than modeling as a single merged stack. The "effective" stack exit velocity and temperature parameters for each modeled source are calculated based on the actual merged stack conditions (as described in the previous paragraph). The "effective" stack diameter for each modeled source would then be based on the calculated "effective" stack

73 Dave Bray (R10) provided a short history and comments regarding the federal SO_2 dispersion technique provision in a December 29, 2015 email to the R10 state modelers. A copy of this email may be found on the Juneau server at: G:\AQ\PERMITS\Modeling\Documents\Dispersion Technique Discussion (Dec 29 2015).pdf.

exit velocity and the volumetric flow from the individual EUs. These procedures ensure that the exit velocity and temperatures for each modeled source reflect the actual conditions of the merged stack, while the increased plume rise resulting from the merged volume is not calculated by the model (i.e., each modeled source's volumetric flow rate is based on the individual EU's flow).

- ✓ If the applicant is proposing merging exhaust gases from new or modified EUs into stacks that also support existing EUs, ensure that the resultant stack parameters are based on the above guidance do not allow for the benefit from enhanced dispersion techniques for existing EUs.

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2.10 Additional Information on Specific Pollutants

Regulatory air quality models can simulate the transport and dispersion of pollutants in the atmosphere, and to a limited degree can also simulate transformations and the generation of "secondary pollutants". Secondary pollutants, such as ozone and components of "secondary particulate matter" including ammonium sulfate, are not directly emitted by sources but are formed by reactions in the atmosphere. The following paragraphs discuss the important transformations that need to be addressed in regulatory dispersion modeling analyses.

2.10.1 NO_2

The NOx emissions from combustion sources are partly nitric oxide (NO) and partly NO_2, even though the mass emission rate for NOx is typically based on the molecular weight of NO_2. After the combustion gas exits the stack, additional NO_2 can be created due to atmospheric reactions. Therefore, a methodology for estimating how much of the released NO is converted to NO_2 is needed in order to compare a modeled concentration to a NO_2 standard or increment.

2.10.1.1 Guideline Methods for Modeling NO_2 Impacts

Section 4.2.3.4 of the Guideline discusses a three-tiered approach for modeling ambient NO_2 impacts. The tiers range from the simple assumption that all NO is converted to NO_2 (i.e., full conversion), to other more complex methods. These methods are illustrated in Figure 16 (which ADEC copied from the Guideline), and are further summarized below. As noted in Section 4.2.3.4(b) of the Guideline, "modeling of negative emissions rates should only be done after consultation with the EPA Regional Office to ensure that decreases in concentrations would not be overestimated."

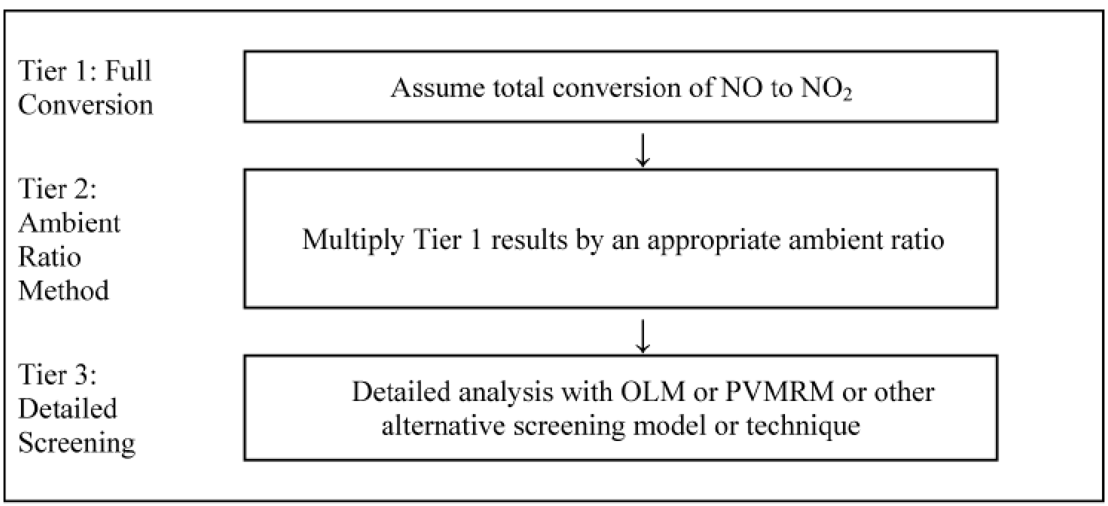

Figure 16. Multi-tiered Approach for Estimating NO_2 Concentrations

Tier 1

In the Tier 1 approach, the model user assumes that 100 percent of the emitted NO is converted to NO_2. Applicants may generally use this approach without justification or request to estimate their *current* or *future* impacts, since it provides the worst-case scenario for atmospheric conversion of NO to NO_2. However, this approach may be inappropriate when estimating the baseline concentrations in a NO_2 increment analysis, or any type of NO_2 "credit," since it likely overstates those concentrations. In those situations, a more accurate technique may be warranted.

Tier 2

The Tier 2 approach employs the method known as the "Ambient Ratio Method 2" (ARM2), "which provides estimates of representative equilibrium ratios of NO_2/NOx value based on ambient levels of NO_2 and NOx derived from national data from the EPA's Air Quality System (AQS)".[74] The previous "Ambient Ratio Method" (ARM) is no longer a preferred option, but applicants can still request to use it – *if warranted* – under the case-specific alternative modeling provisions in Section 3.2 of the Guideline and 18 AAC 50.215(c).

AERMOD includes a default minimum ambient NO_2/NOx ratio of 0.5 and a default maximum ambient NO_2/NO_2 ratio of 0.9. However, we as the reviewing authority, may approve requests to use alternative minimum values based on the EU's in-stack NO_2/NOx ratios. See Section 4.2.3.4(d) of the Guideline for additional information.

OCD does not include an ARM2 option, but R10 proposed an approach for applying ARM2 to the OCD results.[75] They stated, "This required some extra effort by the applicant, but less effort than a full 3.2.2 demonstration" (i.e., request to use ARM). The following is a verbatim reiteration of R10's recommended procedure:

> Step 1) Apply the maximum ARM2 ratio of 0.9 to the modeled results. This approach is conservative and effectively complies with the App. W 4.2.3.4 Guidance for Tier 2 NO2 analysis. If results at receptors exceed the SIL (or exceed NAAQS when background is added, if this step is used for a cumulative analysis), proceed to Step 2:
>
> Step 2) Determine which receptors exceed the SIL (from Step 1) and grab the hourly modeled concentration data from this subset of receptors: OCD allows the user to print out hourly concentrations at each receptor using IOPT(14) = 0; selecting the "hourly summary of receptor concentrations" option. I believe the output is an ordered ASCII file that can be manipulated to fit the results into Excel or processed via Python/R/other system.
>
> Step 3) For the selected receptors, use the ARM2 equation to determine the NO2 concentration for each hour. The ARM2 equation, as coded into the version 16216r version of AERMOD, is available in Section 3.4 (Page 22) of the attached API Evaluation Report. The equation determines the NO2/NOx equilibrium ratio depending on the modeled ambient concentration of NOx (without background added!).

[74] Section 4.2.3.4(d) of the Guideline.

[75] Email from Jay McAlpine (R10) to Alan Schuler (ADEC); *RE: ARM vs. ARM2*; March 24, 2017.

> Step 4) Use the results from Step 3 to determine the NO2 design value for comparison to the NAAQS or SILs.

R10 felt Step 1 would likely suffice for the vast majority of cases. They also stated that they were available to clarify Steps 2 – 4 if needed.

Tier 3

A detailed screening method, such as the Ozone Limiting Method (OLM)[76] or the Plume Volume Molar Ratio Method (PVMRM),[77, 78] may be selected on a case-specific basis in a Tier 3 analysis. However, if the application is subject to PSD-review, then you will need to discuss the proposed approach with R10, per Section 4.2.3.4(e) of the Guideline. R10 has also provided the following clarification:

> Formal approval by the Regional Administrator or a delegated representative is not required for a consultation. Our most formal response for particularly unique or challenging projects would be a short technical report outlining our recommendations. For routine use of Tier 3 methods for any major projects, consultation would likely only involve an email acknowledging the results of the consultation. For routine minor NSR projects, consultation is available if Alaska seeks technical assistance, but approval or notice is not required, given the history of Alaska's experience and history of communication with [R10] regarding this subject. Instead, consultation for routine minor NSR can be fulfilled by the general ongoing informal communication between [R10] and Alaska regarding Alaska's methods and experience applying Tier 3 models.[5]

OLM and PVMRM are both based on the premise that the amount of ozone (O_3) in the lower atmosphere is the predominate factor in converting NO to NO_2. They ignore all other chemical reactions that may occur in the atmosphere and also assumes that the NO_2 emissions remain as NO_2 in the atmosphere – i.e., they ignore the NO_2 + uv (sunlight) $\rightarrow$ NO + O_3 reaction. The basic premise is represented by the following molecular equation:

$$NO + O_3 \rightarrow NO_2 + O_2$$

This equation shows that one mole of NO plus one mole of O_3 creates one mole of NO_2 and one mole of oxygen (O_2). This equation also shows that all of the NO will be converted to NO_2, if there is sufficient O_3. However, if there is insufficient O_3, then the moles of NO converted to NO_2 will be limited by the moles of available O_3. The total

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76 Cole, H.S. and J.E. Summerhays. *A Review of Techniques Available for Estimating Short-Term NO2 Concentrations.* J. of Air Pollution Control Association. 1979. pp. 812-817.

77 Hanrahan, P.L. *The Plume Volume Molar Ratio Method for Determining NO2/NOx Ratios in Modeling – Part I: Methodology.* J. of Air & Waste Management Association. Volume 49, November 1999. pp. 1324-1331.

78 Hanrahan, P.L. *The Plume Volume Molar Ratio Method for Determining NO2/NOx Ratios in Modeling – Part II: Evaluation Studies.* J. of Air & Waste Management Association. Volume 49, November 1999. pp. 1332-1338.

NO_2 concentration is the concentration from direct NO_2 emissions plus the concentration from the NO + O_3 conversion.

The OLM and PVMRM algorithms use different approaches for estimating how much O_3 is available for the NO to NO_2 conversion. Both approaches require representative, hourly O_3 data, but the algorithms reflect different assumptions. OLM essentially assumes the plume and surrounding air are instantaneously and continually mixed, whereby the ambient O_3 concentration is constantly available throughout the plume for converting the NO to NO_2. PVMRM assumes instantaneous, but not continual mixing. PVMRM basically assumes that the volume of the atmospheric that is mixed with the plume is limited to the volume of the plume at any given point.

According to the Guideline, "PVMRM works best for relatively isolated and elevated point source modeling while OLM works best for large groups of sources, area sources, and near-surface releases, including roadway sources." Additional details regarding the incorporation and application of these techniques within AERMOD are provided below.

The OLM algorithm within AERMOD involves an initial comparison of the estimated modeled NOx concentration with the corresponding ambient O_3 concentration to determine the limiting factor to NO_2 formation. To use the OLM option, AERMOD requires the user to specify the NO_2-to-NOx in-stack ratio (ISR) for each EU (see the discussion below for PVMRM on specifying this ratio), which must range between 0.0 and 1.0, inclusive. If the O_3 concentration is greater than (1.0 – ISR) of its corresponding modeled NOx concentration, total conversion is assumed (i.e. all NOx goes to NO_2). Otherwise, if the O_3 concentration is less than or equal to (1.0 – ISR) of its corresponding modeled NOx concentration, the formation of NO_2 is limited by the ambient O_3 concentration. In this case, the NO_2 concentration is set equal to the O_3 concentration plus a correction factor, which accounts for in-stack and near-stack thermal conversion of NOx to NO_2.

The OLM option in AERMOD allows the user to specify which sources are to be modeled as "combined plumes" – i.e., where the NOx within the plumes competes for the available ambient ozone. The selection is specified through the OLMGROUP keyword in the SO pathway. EPA recommends using the "OLMGROUP ALL" option "be routinely applied and accepted for all approved applications of the OLM option in AERMOD." [79]

As with OLM, when using PVMRM, the user must specify the ISR for each EU. To specify this ratio for all EUs, use the keyword NO2STACK on the CO pathway. To specify the ratio on an EU-by-EU basis, use the keyword NO2RATIO on the SO

[79] *Applicability of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard*, June 28, 2010. (https://www3.epa.gov/ttn/scram/guidance/clarification/ClarificationMemo_AppendixW_Hourly-NO2-NAAQS_FINAL_06-28-2010.pdf)

pathway. See the AERMOD User's Guide and Section 2.10.1.2 (NO_2/NO_X In-stack Ratios) below for additional information.

2.10.1.2 Additional Discussion re NO_2/NOx In-stack Ratios

ISR data is becoming more readily available for use in NO_2 modeling assessments. While source test or vendor data should be used, if available, that from similar EUs are potentially another option. APP has developed an ISR spreadsheet for various combustion turbines, reciprocating engines, and heaters and boilers, which it has posted on the modeling web-page.[80] These ratios are for specific EUs, but could be applicable for similar EUs.

EPA also has provided an NO_2/NOx in-stack ratio database on their website.[81] A template for submitting new or updated values of the in-stack ratio is included on this site. EPA expects to update the database monthly, although the frequency of updates will depend on the number of submissions. For those rare situations where there is no data, EPA's March 2011 NO_2 modeling guidance states that an ISR of 0.5 could be used, since "[t]his value appears to represent a reasonable upper bound based on the available in-stack data." [6]

ADEC notes that Shell used a number of illustrative ISR in their 2011 outer continental shelf (OCS) permits issued by EPA. Here, Shell used a value of 0.176 to represent the ratio for reciprocating engines with catalyzed diesel particulate filters (CDPF) – including reciprocating engines with both CDPF and oxidation catalysts. They used a ratio of 0.066 for reciprocating engines without catalyzed diesel particulate filters, 0.041 for heaters/boilers, and 0.023 for incinerators.

2.10.1.3 Additional Comments re Ozone Data

The ambient O_3 concentration in Alaska varies on a seasonal basis. Applicants should therefore either use the highest representative hourly O_3 concentration (in order to obtain an upper bound estimate of the NO_2 concentration), or representative hourly O_3 data that reflects the temporal variations. Most applicants use hourly data.

The O_3 data used in an OLM/PVMRM analysis must also represent the ambient O_3 concentrations prior to mixing with a NOx plume. Once mixed, NOx scavenging reduces the measured O_3 concentrations. The O_3 dataset must therefore be carefully selected since low O_3 values can lead to less NO to NO_2 conversion than high O_3 values – i.e., NOx scavenging can lead to underestimated NO_2 concentrations in a modeling analysis. Scavenging can be easily spotted by comparing traces of the measured NOx and O_3 concentrations, as seen in Figure 17.

80 http://dec.alaska.gov/air/air-permit/dispersion-modeling/

81 https://www.epa.gov/scram/nitrogen-dioxidenitrogen-oxide-stack-ratio-isr-database

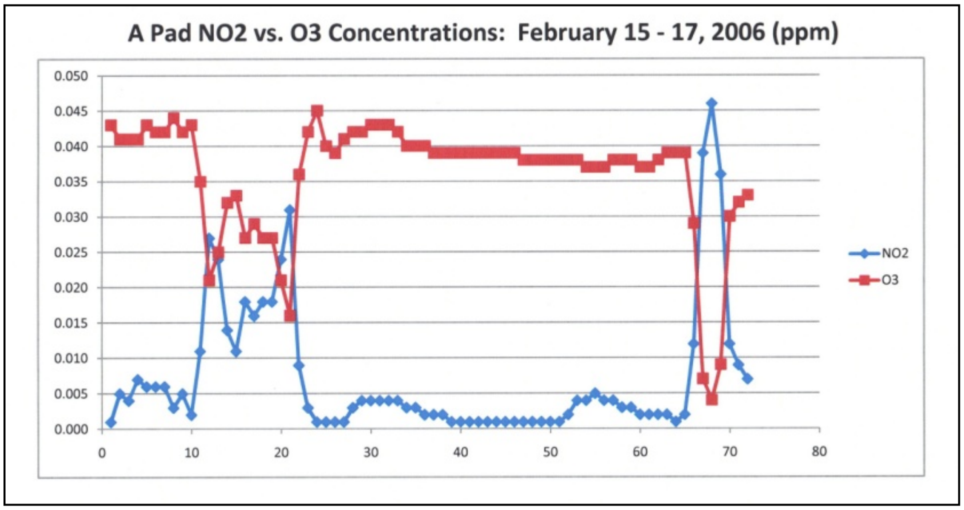

Figure 17. NO_2 to O_3 Comparison to Detect NOx Scavenging

There are numerous ways to counter the NOx scavenging effects. Possibilities include: 1) substitute scavenged values with a monthly maximum value; 2) create an upper bound of what the true ambient O_3 concentration could have been by adding the measured NOx concentration to the O_3 concentration during the periods of concern (after making the appropriate adjustments for molecular weight if the data is recorded by mass); 3) if scavenging is infrequent and there is a multi-year dataset, create a worst-case dataset by selecting the highest O_3 concentration measured during a Julian day/hour. (Note: ADEC does not require concurrent O_3 and meteorological data, but both need to be representative.)

> Note: *Ambient O_3 concentrations are fairly consistent across the North Slope. Therefore, regional O_3 data may be used in a North Slope NO_2 analysis rather than "local" O_3 data. A worst-case compilation of three years of hourly ozone data from Prudhoe Bay A-Pad that has frequently been used in past NO_2 modeling assessments of sources located in the greater Prudhoe Bay area may be found on the Juneau network at: G:\AQ\PERMITS\Modeling\Approved Ozone data.*

2.10.2 PM-10

Applicants may compare the High-N+1-High value over N years of meteorological data to the 24-hour PM-10 AAAQS. For example, when using five years of concatenated meteorological data, applicants may use the modeled high sixth-high (H6H) concentration. EPA's AERMOD User's Guide provides additional information as to how this provision can be implemented when using AERMOD.

The above provision may not be used to demonstrate compliance with the 24-hour PM-10 increment. The PM-10 increments are "deterministic" rather than "statistical." Therefore, the highest of the H2H concentrations should be compared to the increment when using multiple years of meteorological data. A copy of EPA's guidance regarding this issue may be found on ADEC's modeling page (see http://dec.alaska.gov/air/air-permit/dispersion-modeling/).

The effects of gravitational settling and deposition may be included in a PM-10 analysis per Section 7.2.1.3 of the Guideline. AERMOD will even automatically include these effects when provided with the necessary data, unless the user specifies the NODRYDPLT and/or NOWETDPLT options in the CO pathway. See Section 2.10.6 of this manual for additional details. The offshore counterpart to AERMOD, OCD, does not treat settling and deposition.

2.10.3 PM-2.5

PM-2.5 is either directly emitted from a source or formed through chemical reactions in the atmosphere (secondary formation) from other pollutants (NOx and SO_2).[82] AERMOD and OCD are acceptable models for performing near-field analyses of the direct emissions, but EPA has not yet developed a near-field model that includes the necessary chemistry algorithms for estimating secondary impacts.

EPA describes the various options within AERMOD for modeling *direct* PM-2.5 impacts in the AERMOD User's Guide. For example, in order for AERMOD to correctly calculate the 24-hr impact within the form of the standard, the pollutant must be identified as "PM25", "PM-2.5", "PM2.5" or "PM-25" (without the quotes) on the POLLUTID keyword. This approach should not be used, however, for modeling the direct 24-hour PM-2.5 increment concentration (see Section 2.1.4.4). Condensable PM-2.5 emissions should also be included in all PM-2.5 emission estimates submitted after January 2, 2011 (per EPA's May 2008 PM-2.5 Rulemaking).[83]

EPA's recommended approach for assessing the *secondary* PM-2.5 impacts from a proposed source/modification has evolved over time. They also developed new language in Section 5.4.2 of the 2016 version of the Guideline to address the issue. As summarized in a subsequent August 4, 2017 EPA memorandum regarding secondary formation:[84]

> The EPA recently revised the *Guideline on Air Quality Modeling* [sic], also referred to as Appendix W or the *Guideline*, to recommend a two tiered screening approach for permit related program demonstrations rather than establishing a single preferred model [reference]. As detailed in Section 5 of the Guideline, both of these tiers involves the use of chemical transport models (e.g., photochemical grid models). The recommended approach for Tier I demonstrations would utilize such models to provide sensitivity estimates (either through existing modeling work or new projects) of responsiveness to precursor emissions in developing screening tools or methods [reference]. The recommended approach for Tier 2 demonstrations would directly utilize such models to estimate the impacts of the new or modifying sources [reference].

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82 The NOx and SO_2 emissions are also referred as "precursor emissions" in a PM-2.5 assessment.

83 Federal Register, Vol. 73, No. 96, May 16, 2008.

84 EPA Memorandum; *Use of Photochemical Grid Models for Single-Source Ozone and secondary $PM_{2.5}$ impacts for Permit Program Related Assessments and for NAAQS Attainment Demonstrations for Ozone, $PM_{2.5}$ and Regional Haze*, Tyler Fox to EPA Regional Modeling Contacts; August 4, 2017.

EPA is also developing guidance on how States can develop Modeled Emission Rates for Precursors (MERPs) from existing data (e.g., results from existing photochemical grid modeling). The MERPs would essentially provide a ton per year threshold for determining when a Tier 2 analysis may be warranted. They could conversely be used to estimate the secondary impact by prorating the MERP value with the applicant's potential emissions. EPA released a draft of the MERP guidance in December 2016,[85] but the finalized version is still pending as of October 8, 2018.

EPA's secondary formation guidance presumes that States already have existing photochemical modeling analyses and supporting datasets that could readily be used for developing MERPS and/or for assessing a source-specific impact. That's not the case within Alaska. Therefore, the effort needed to develop a photochemical analysis could "create an undue and unnecessary burden on many of our [NSR] permit applicants," as expressed in ADEC's comments on EPA's draft MERP guidance.[86] Many of our stationary sources are also located in isolated areas (i.e., hundreds of kilometers from both the nearest metropolitan area and nearest PSD major stationary source) whereby the lack of competing sources minimizes the potential for adverse secondary formation.

EPA noted in their 2014 PM-2.5 modeling guidance[87] that the maximum direct impacts and the maximum secondary impacts from a stationary source "*…are not likely well-correlated in time or space*", i.e., they will likely occur in different locations and at different times. This difference occurs because secondary PM-2.5 formation is a complex photochemical reaction that requires a mix of precursor pollutants in sufficient quantities for significant formation to occur. As such, it is highly unlikely that there is sufficient time for the reaction to substantively occur within the immediate near-field, which is where the maximum direct impacts from project EUs generally occur.

In an email discussion with R10 regarding the secondary formation issue, R10 replied:[88]

> The EPA continues to emphasize photochemical modeling for Tier 1 and Tier 2 demonstrations for secondary pollutants are **not required** under Appendix W ***but recommended***, as emphasized in the past correspondence highlighted in [ADEC's] email… Therefore has been a lot of concern and confusion in the modeling community regarding this issue, and OAQPS has been attempting to emphasize photochemical modeling is recommended and not required for these demonstrations. (Emphasis added by ADEC)

R10's response clarifies that EPA does not routinely expect a photochemical modeling analysis from NSR applicants. However, applicants that trigger a PM-2.5 modeling

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[85] EPA Memorandum; *Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier I Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program*, Richard A. Wayland to Regional Air Division Directors; December 2, 2016.

[86] Letter from Denise Koch (ADEC Air Quality Director) to George Bridgers (EPA Air Quality Modeling Group); *Modeled Emission Rates for Precursors Proposal*; March 15, 2017.

[87] *Guidance for $PM_{2.5}$ Permit Modeling*; EPA-454/B-14-001; May 2014.

[88] Email from Jay McAlpine (R10) to Alan Schuler (ADEC); *RE: new EPA clarification memo release – photochemical modeling alternative model demo.*; August 7, 2017.

analysis will still need to address the secondary formation aspect. Key considerations in reviewing non-Tier 2 assessments are:

1) the potential for adverse impact from secondary formation is dependent "on the magnitude of emissions," as indicated in Section 5.4.2(a) of the Guideline; and

2) the applicant should base their assessment on what "existing technical information is available," as suggested by Section 5.4.2(b) of the Guideline.

EPA previously addressed the magnitude aspect in a two-by-two matrix where the direct emissions and precursor emissions are either above or below the PSD significant emission rate (SER) for those pollutants.[87] They then provided their suggested approach, or range of approaches, for each cell of the matrix. While this guidance has been superseded by the 2016 revision to the Guideline, it may nevertheless provide ideas for addressing the magnitude issue. For example, emissions that are less than a SER for a given pollutant are probably not a concern since they would not otherwise trigger review under the PSD program.

The existing margin of compliance with the PM-2.5 AAAQS could also be a consideration *in some cases*. This could be especially true if the existing precursor emissions within the airshed greatly exceed the proposed precursor emissions. Representative ambient monitoring data could also likely be used to address the secondary formation that occurs from existing sources in the ambient standard demonstration.

You will need to check for subsequent guidance and past approaches in your review of an applicant's assessment of the potential impacts from secondary PM-2.5 formation. This manual can only provide background information that may or may not be applicable for a given situation: it cannot develop new or additional guidance (as stated in the Notice section). It's also being written at a time when the 2016 version of the Guideline is still relatively new and the subsequent EPA guidance is still be developed and refined.

2.10.4 SO_2

Some pollutants can decay in the atmosphere, such as sulfur dioxide (SO_2). The rate of decay may be a function of the concentration of other oxidants in the atmosphere. In urban environments, SO_2 can decay at a significantly faster rate than in rural environments. AERMOD can account for this by specifying the pollutant name - SO_2 - and invoking the URBANOPT option, simultaneously. Although this feature was available in ISCST3 (AERMOD's predecessor), it was never used in support of a construction permit application in Alaska.

2.10.5 Ozone

Tropospheric O_3 (as opposed to stratospheric O_3) is a PSD regulated pollutant. However, it is not usually emitted directly into the air. It is instead created in the atmosphere through chemical reactions between NOx and VOC in the presence of sunlight. It is inherently a regional pollutant, the result of chemical reactions between emissions from many NOx and VOC sources over a period of hours or days, and over a large area.

EPA developed new language in Section 5.3.2 of the 2016 version of the Guideline regarding possible approaches for assessing the potential O_3 impacts from a stationary source. The wording and approach is analogous to the wording and approach previously discussed in Section 2.10.3 (PM-2.5) of this manual. EPA once again *recommends* a two-tiered approach for assessing the potential impacts. The pending MERP guidance discussed in Section 2.10.3 of this manual would also be applicable for Tier 1 O_3 assessments.

The opening sentence of Section 5.3.2(a) of the Guideline states the O_3 assessment is dependent on "the magnitude of emissions." The discussion sets the stage for subsequent guidance or regionally-specific findings whereby emission thresholds could be set. Alaska does not currently have set emissions thresholds for ambient O_3 demonstrations. However, the PSD rules include a note to 40 CFR 52.21(i)(5)(i)(*f*) that essentially sets 100 tpy of NOx/VOC as the lower bound for when an ambient O_3 demonstration would be required. The note states, in reference to the significant monitoring concentrations established in 40 CFR 52.21(i)(5)(i):

> No *de minimis* air quality level is provided for ozone. However, any net emissions increase of 100 tons per year or more of volatile organic compounds or nitrogen oxides subject to PSD would be required to perform an ambient impact analysis, including the gathering of ambient air quality data.

ADEC encouraged EPA to develop even higher emission floors in its comments on EPA's draft MERP guidance,[86] but EPA has not done so as of October 8, 2018.

R10 clarified that EPA does not routinely expect a photochemical modeling analysis from NSR applicants.[88] However, applicants that trigger PSD for O_3 will still need to provide an ambient demonstration if the NOx and VOC emissions exceed 100 tpy. Key considerations in reviewing non-Tier 2 assessments are:

1) the potential for adverse impact from secondary formation is dependent "on the magnitude of emissions," as indicated in Section 5.3.2(a) of the Guideline; and

2) the applicant should base their assessment on what "existing technical information is available," as suggested by Section 5.3.2(b) of the Guideline.

The existing margin of compliance with the O_3 AAAQS could be a consideration *in some cases*. This could be especially true if the existing precursor emissions within the airshed greatly exceed the proposed precursor emissions. It may also be important to note that since O_3 is a regional pollutant, the ambient O_3 concentrations are fairly consistent throughout the airshed – i.e., they do not rapidly increase near the NOx or VOC source of emissions.

You will need to check for subsequent guidance and past approaches in your review of an applicant's assessment of the potential O_3 impacts. This manual can only provide background information that may or may not be applicable for a given situation: it cannot develop new or additional guidance (as stated in the Notice section). It's also being written at a time when the 2016 version of the Guideline is still relatively new and the subsequent EPA guidance is still be developed and refined.

2.10.6 Deposition

Deposition of gases and particulates can occur due to gravitational settling, plume-ground interactions, and scavenging by rain or snow. This level of detail is not needed in most applications. However, it may be worth the effort when modeling stationary sources with large amounts of fugitive dust (e.g., mines). It is also required in AQRV assessments of acid-deposition.

Deposition can be calculated directly, or included as a physical process which depletes mass from a plume, thereby lowering ambient concentrations (i.e., plume depletion). Within Alaska, the most frequent use of deposition is in an AERMOD PM-10/PM-2.5 analysis. The rest of this discussion will therefore focus on that context.

Section 4.2.2.1(e) the Guideline notes that the state-of-the-science for modeling deposition is evolving. You should therefore check SCRAM to see if EPA has provided any updated guidance prior to reviewing an applicant's deposition parameters.

Section 3.3.4 of the April 2018 *AERMOD User's Guide* describes two methods for handling dry and/or wet deposition of particulate emissions. "Method 1" can be applied under the regulatory option and requires the user to define a particle size distribution and a mass fraction and particle density for each particle size category. The particle size distribution must be known reasonably well to use Method 1. For surface coal mining operations and similar emission processes, this information could potentially be obtained from EPA's *Modeling Fugitive Dust Impacts from Surface Coal Mining Operations – Phase II Model Evaluation Protocol.*[89]

Method 2 is considered non-DFAULT in AERMOD. This method may be used if the particle distribution is not well known or less than about 10 percent of the mass is in particles with an aerodynamic diameter of 10 microns or larger. To use this method, the user defines the fraction of the particle mass in the fine particle category (less than 2.5 microns) and a representative mass mean diameter for the particles. This information can be found for selected pollutants in Appendix B of the Argonne National Laboratory (ANL) report.[90]

Most Alaskan applicants use the Method 1 approach. Either way, you will need to carefully check their deposition parameters since the PM-10/2.5 concentration can be substantially underestimated if inappropriate values are used (e.g., the mass fraction is

[89] *Modeling Fugitive Dust Impacts from Surface Coal Mining Operations – Phase II Model Evaluation Protocol*; EPA-454/R-94-025; October 1994. Available at https://nepis.epa.gov/ or on the Juneau server at: G:\AQ\PERMITS\Modeling\Documents\Haul Roads - Coal Mines.

[90] Wesley, M., P. Doskey, and J. Shannon, June 2002: *Deposition Parameterizations for the Industrial Source Complex (ISC3) Model*. ANL Report ANL/ER/TR-01/003, Argonne National Laboratory, Argonne, IL 60439.

weighted more heavily toward the larger particle sizes than what the underlying data supports). If the applicant used Method 1:

- ✓ Check the particle size distribution against the supporting data provided by the applicant, the above referenced study (surface coal mining operations), the AP-42 size distribution data, or stack test size distribution data (as applicable), to ensure the distribution is reasonable. The applicant should not include data regarding particulates that are larger than the particulate that they're modeling (e.g., they should not include data that represents particulates that are larger than 10 microns in diameter in a PM-10 analysis). The sum of the mass fractions for each EU should also equal 1.0.

- ✓ Check the particle diameter and density values as well. Comparing the applicant's values to the values that we previously accepted for a similar source can be a good starting place. However, just be aware that values are case-specific and that deviations could be very appropriate.

- ✓ If the applicant is incorporating deposition in both their PM-10 and PM-2.5 analysis, make sure that they used the appropriate values for the given pollutant. They should not be using identical parameters for both sets of PM runs since the PM-2.5 analysis should not include values for particulates that are larger than 2.5 microns in diameter. The applicant will instead need to select the subset that applies to particulates that are less than or equal to 2.5 microns in diameter, and then recalculate the mass fractions so that the total still equals 1.0.

AERMOD also needs select meteorological parameters in the surface meteorological data file in order to run the deposition algorithms in AERMOD. The additional variables include the precipitation code, precipitation rate, relative humidity, surface pressure, and cloud cover. These additional variables appear after the standard variables for each hour. You should review the source of the precipitation data to ensure it is representative of the project location. NWS or site-specific data are viable options, as long as they are representative. You may discuss the applicant's precipitation data with the AM&QA meteorologist if you need assistance in determining whether the data are adequately representative. Refer to Section 2.6 of this manual to ensure the meteorological data is processed correctly.

Note: *Depletion can significantly increase the modeling time and should be used with caution for runs with many sources and large modeling domains.*[91]

[91] APP does not generally track run times, but staff once noted a five-fold increase in the run time when adding Method 1 deposition to a PM-10 sensitivity analysis.

2.11 Ambient Air Boundary and Worker Housing

2.11.1 Ambient Air Boundary

As discussed in Section 2.3.3, ambient air is defined as "that portion of the atmosphere, external to buildings, to which the general public has access" (40 CFR 50.1(e), adopted by reference in AS 46.14.990(2)). Onshore applicants may, therefore, exclude areas that they own or lease from their modeling analysis if public access is precluded by a fence or other physical barrier.[92] Conversely, they will need to model that portion of their property/lease that has no such restriction. Natural features, such as dense vegetation or topographical features, can provide adequate barriers, although the adequacy of the given features must be evaluated on a case-specific basis. On the North Slope, the edge of the 5-foot high gravel pad is routinely used as the ambient air boundary.

The ambient air boundary may differ from the stationary source's property boundary. For example, a publicly-assessable parking area within the property boundary should be treated as ambient air. Public roads/trails that cut through the property, or designated right-of-ways that grant some entity (e.g., a utility or even the land owner) access rights, are other examples of areas that need to be treated as ambient air. Please note that it is not your responsibility to search property records for these provisions, but the applicant should note and properly treat these types of areas in their air quality modeling analysis.

Applicants with stationary sources located on leased, unfenced property will need to obtain the land owner's permission to restrict access. You may need to ask the applicant to provide a copy of that portion of the lease (or a subsequent written agreement) that provides this authorization. The determination as to what's ambient air when a stationary source is located within another stationary source can be complicated. EPA's June 22, 2007 memorandum, *Interpretation of "Ambient Air" in Situations Involving Leased Land Under the Regulations for Prevention of Significant Deterioration (PSD)*, provides guidance for this situation.

The applicant's method for precluding public access may need to be incorporated into the permit as an ambient air condition. Work with the permit engineer and supervisor to determine the best method for ensuring the ambient boundary is adequately established and maintained.

A 1980 letter to the US Senate's Committee on Environment and Public Works indicated that "… the exemption from ambient air is available only for atmosphere *over land* owned or controlled by the source and to which public access is precluded by a fence or other physical barriers" (emphasis added). Offshore sources are not expected to use a fence or physical barrier to exclude public access – alternative means for controlling

[92] EPA has written a number of guidance documents regarding ambient air issues which may be found in their Modeling Clearinghouse Information Storage and Retrieval System (MCHISRS) or EPA Region 7's "Title V, NSR/PSD Policy and Guidance Database" (see http://cfpub.epa.gov/oarweb/MCHISRS/ and https://www.epa.gov/home/advanced-search). The documents routinely use the phrase "fence or other physical barrier" when discussing an acceptable means for precluding public access at onshore locations. The phrase originated in a December 19, 1980 letter from EPA Administrator Douglas Costle to Senator Jennings Randolph.

access for overwater scenarios is warranted.[93] Stationary sources located within Cook Inlet typically use a 100 m set-back distance as their ambient air boundary. Cook Inlet has strong tidal currents which can cause substantive drifting. The 100 m range represents a common sense set-back distance for safely navigating around objects in this type of situation.

2.11.2 Worker Housing

Off-duty workers are typically treated as members of the public. Therefore, on-site housing areas should generally be treated as ambient air locations. Applicants should clearly identify all areas within the stationary source boundary where off-duty employees have access in their plot plan. The limited situations where on-site housing accommodations are not treated as ambient air locations are described in Policy and Procedure 04.02.108 (see http://dec.alaska.gov/media/10238/whg.pdf). In this situation, the applicant should clearly describe how they meet the stated criteria for not treating the worker housing as ambient air.

93 The Ninth Circuit Court of Appeals confirmed in August 2012 (REDOIL v. EPA), that Costle's 1980 letter was "clearly written with overland situations in mind." They further stated that an Environmental Appeal Board's assessment that EPA requires some leeway in determining how to apply the ambient air regulation to an overwater situation "is just common sense."

2.12 Receptors

A dispersion model will calculate the concentration of the modeled pollutant at locations defined by the user. These locations are called receptors. Screening models such as AERSCREEN allow the user to define the receptor distance from the source, but assumes all receptors are located directly downwind from the source. Refined models, such as AERMOD or OCD, which use hourly observations of meteorology to determine the direction of plume transport and dispersion, allow the user to define multiple receptor locations. These multiple receptor locations are referred to as receptor grids.

Receptor grids play a critical part of the compliance demonstration because they determine where pollutant concentrations will be calculated. Receptor grids are also one of the most common places for errors in the modeling analysis. Errors are typically caused by incorrect identification of horizontal receptor locations or inadequate grid density, i.e., the distance between receptors is too large, thus missing the point of maximum concentration impact. There can also be errors in the digital elevation data obtained from the USGS.

AERMOD accepts either Cartesian (rectangular) or polar coordinate systems. Cartesian grids define each receptor location using an x, y, z coordinate system. Polar grids define each receptor location as a function of angle and distance from a center (i.e., source) location. Cartesian grids are preferred for both individual and multiple sources because it simplifies overlaying other features (e.g., terrain data) which are often defined in Cartesian coordinates, as well. Polar grids are often based on a user-defined coordinate system where the source is the origin of the grid. A polar grid should only be used for single source evaluation, when terrain features need not be considered.

Polar grids typically work well for an OCD run of an offshore platform since the ambient boundary is usually circular. However, rectangular grids are typically better suited for onshore AERMOD runs where the ambient boundary is non-circular.

2.12.1 Terrain Description, Terrain Treatment and AERMAP

Terrain is typically identified through the use of topographic maps or digital elevation data. Paper topographic maps are helpful for an initial indication of the surrounding terrain, but digitized topographic maps are extremely helpful for ensuring the source is accurately located with respect to the surrounding terrain. AERMOD’s terrain preprocessor, AERMAP, utilizes digital terrain data to obtain source base and receptor elevations and is discussed below.

- ✓ Ensure that terrain is adequately addressed.
- ✓ If the applicant has not included elevated terrain in the modeling analysis, review the location of the stationary source and surrounding terrain to ensure that elevated terrain should not influence pollutant impacts.

Terrain is entered into each dispersion model in a unique manner. Hence, each model has its unique methods and likely errors.

- ✓ A quick way to review the receptor terrain data is to create a three-dimensional plot showing the stationary source location and the surrounding terrain.

This may be accomplished with a graphical interface program such as SURFER graphics.

- ✓ Compare the terrain entered into the model with a topographic map to ensure it is reasonably represented.

AERMOD uses a terrain processor called AERMAP to process gridded digital data – either National Elevation Data (NED) in a Geographic Tagged Image File Format[94] (GeoTIFF) or Digital Elevation Model (DEM) data. AERMAP extracts EU base elevations and receptor elevations from the digital data for use in AERMOD. This approach of using digital data provides consistency in extracting and processing terrain data. For example, errors in the modeling results have occurred when the applicant didn't specify the correct source base elevations.

AERMAP also calculates a scale height, within a user-specified domain or the entire extent of all elevation data if a domain is not specified, for each receptor location. This scale height characterizes the height of the surrounding terrain that most dominates the flow in the vicinity of the receptor and influences pollutant impact at a receptor.

However, the calculation of scale height is independent of direction (i.e. the scale height can be in any direction from the receptor), and therefore errors can occur by using a scale height that is not appropriate for the receptor. This is particularly true when individual large terrain features are included in domain. Although the AERMAP User's Guide suggests including all terrain features exceeding a 10 percent elevation slope from any given receptor, this can lead to excessively large domains with many terrain features. Judgment must be used on how to specify an appropriate domain extent.

There are two options to help avoid this problem. In rare situations involving prominent terrain features which would be selected as the hill height scale beyond a reasonable range of influence, the user can specify the domain options to exclude such features from the analysis. Alternatively, the user could limit the receptor grid in AERMAP to a specific terrain feature, and then assemble the individual AERMAP output files for use in AERMOD.

- ✓ A scale height can never be below a receptor height.

- ✓ No matter which dispersion model is used, if elevated terrain is present, also ensure that the proper model switches were selected and not overridden by flat terrain modeling options.

[94] TIFF is a tag-based file format for storing raster images and is independent of computer architecture. Additional cartographic tags are added to the TIFF format to tie a raster image to a known space model or map projection (from http://www.gisdevelopment.net/technology/ip/mi03117pf.htm).

Several output files are produced by AERMAP. These include:

- AERMAP.OUT – standard output with input echoed, summary of setup options, and warning messages;
- DOMDETAIL.OUT – domain information and whether or not the corners that define the domain are inside or outside the digital terrain file;
- MAPDETAIL – some additional details;
- MAPPARAMS – map parameters;
- Receptor and/or source output file(s) with terrain heights and for the receptors, the scale height.

✓ Review each of these output files, looking for signs that a problem existed with the AERMAP run. Confirm that the input parameters that are echoed to an output file are appropriate for the modeling demonstration.

2.12.2 Receptor Grid Location and Density

Receptor placement is discussed in Section 9.2.2 of the Guideline. You will need to evaluate the applicant's receptor placement to determine whether it has sufficient range and density to find the maximum impacts. Increasing the receptor range and density will obviously lead to greater confidence that the maximum impacts are found, but an excessive number of receptors can substantially slow down the computer run-time without providing significantly different results. We therefore want to be reasonable when evaluating the receptor grid.

Applicants should provide a site plan that shows the EU locations, structures, fence lines, property boundaries, and ambient boundary (as applicable). The receptor grid must start at the ambient air boundary, not beyond it. Applicants are not required to include receptors at non-ambient air locations and doing so actually makes it harder for us to review their modeling results, since the model summary tables may include non-applicable values. The receptor grid should also be limited to just the modeling domain (see Section 2.1.3) rather than extending beyond it.

✓ Create a plot of the receptor grid to make certain that the ambient air boundary has been correctly represented, and that the receptor range and density is reasonable. The BEEST program, or a similar GUI, can be used to accomplish this task when reviewing an AERMOD analysis.

By creating a plot of the receptor grid, ambient boundary, and EU locations, errors in receptor grid definitions or EU locations will immediately become evident; e.g., if the grid is located too far away from the facility, if the grid is incomplete, if the EUs are located outside of the facility boundary. The ambient boundary shown in the grid should accurately represent the ambient boundary as shown in figures in the modeling report.

If the receptor spacing is not sufficiently dense, the location of the maximum model-predicted concentration may not be identified. Judgment is required in determining the sufficiency of receptor density. An area with a steep concentration gradient (i.e., the concentration varies rapidly with distance) requires a denser receptor grid than an area with a more gradual concentration gradient. Steep concentration gradients typically occur near point sources subject to downwash, and in nearby complex terrain. For non-buoyant emissions released at ground-level, concentrations are always highest adjacent to the source, and decrease with distance downwind. For elevated sources (e.g., stacks), the plume must disperse to the ground before any impact at the receptors is realized. Consequently, downwind concentrations may at first increase with distance until the maximum is reached, and thereafter, decrease with distance. For an elevated plume, the concentrations may be relatively low, until the terrain extends upward, thereby intercepting the plume. This will be more pronounced for elevated terrain close to the source (e.g., within 1 km of the source), rather than many kilometers downwind.

As a general rule, receptors should be denser at the ambient air boundary, and generally decrease in density with distance from the applicant's stationary source. Similarly, for elevated terrain close to the source, a denser receptor grid should also be used.

> *Helpful tip:*
> *A grid spacing of 25 m is commonly used when modeling impacts within one to two hundred meters of a stationary source that is "down-wash dominated." However, a larger spacing may be acceptable when modeling a "tall" stack or EUs located well within the ambient boundary (e.g., some mine scenarios). In all cases, judgment must be used to balance the need for sufficient density and a desire to minimize the run time. Inadequate grid spacing could overlook maximum impacts that occur between receptors. Overly tight spacing could lead to extended run-times with no benefit. When in doubt, run sensitivity tests with various grid spacings within the area that the applicant shows the maximum impact(s) to be. Reviewing the steepness of the concentration gradients can also be helpful.*

✓ Verify that the grid extends sufficiently outward from the stationary source to ensure the maximum concentration has been identified.

This is easy to do by reviewing contour plots of pollutant-specific concentration isopleths for each averaging period. The contour plots should show that isopleths decrease in concentration toward the edges of the plot. If they continue to increase in any direction, the maximum concentration may not have been identified.

When conducting the modeling review, you may add receptors to an applicant's modeling analysis if the range or density appear inadequate. However, avoid "fishing expeditions" where you repeatedly place additional individual receptors in an attempt to find "the" maximum concentration. That approach can greatly lengthen the review time without providing worthwhile benefits. As noted in Section 9.2.2(d) of the Guideline, "… the EPA neither anticipates nor encourages that numerous iterations of modeling runs be made to continually refine the receptor network."

2.12.3 Determining Receptor Elevations

Digital terrain data can be obtained in a number of data formats and at map scales from the U.S. Geological Survey and from commercial businesses. One format that is widely used and supported in AERMAP is the NED format (a seamless raster product) available from *The National Map* website.[95] NED data can be obtained in 1/9 (3 meter), 1/3 (10 meter), 1 (30 meter), and 3 (90 meter) arc-second resolutions. NED data are binary files that include data descriptors and geo-referencing information that aid AERMAP in determining the type and structure of the elevation data. To use the NED data, it must be downloaded in the GeoTIFF format. According to the website, NED "resolution for Alaska is primarily of 2 arc-seconds (approximately 60 meters) but is rapidly being replaced with 5-meter resolution ifsar[96] data State-wide and lidar over select areas."

With NED data, the user can specify the area of interest and download one or more files of digital terrain data (the number of files will depend on the area selected) to process.

DEM data may still be available in both 30 meter spacing and 90 meter spacing for parts of Alaska. Typically, 90 meter spacing is used for larger grids (1 degree) and 30 meter spacing is used for smaller grids (7.5 minute). Alaska is covered by 15 minute DEM data. Thirty-meter spaced data is more accurate, especially for situations in which terrain heights may vary greatly over shorter distances. Errors in using DEM data may arise from not accurately defining the receptors locations of interest where elevations should be calculated, or by using the 90 meter spaced data, where 30-meter data (if available) would be more accurate.

Early versions of AERMAP could only process 1-degree (90 meter) and 7.5-minute (30 meter) DEM data. The current version can process a mix of DEM files in a single AERMAP run, including all types of Alaska DEMs, as well as non-Alaskan 1-Degree and 7.5-Minute DEMs. AERMAP also allows "mixed" resolution NED files. However, AERMAP cannot process a mix of DEM and NED files.

If a situation should arise where an elevation must be computed manually from DEM files, such as a receptor location falling between the grid nodes in the DEM files, an interpolation scheme must be used. When in doubt, the interpolation scheme used in AERMAP (2-dimensional distance weighted interpolation using the four nearest DEM nodes surrounding the receptor) is consistent with EPA guidance, and may be used. The various GUI systems also offer receptor grid generation capabilities from DEM data files.

2.12.4 Flagpole Receptors

"Flagpole" receptors are receptors located above local ground level. They are useful for determining impacts on balconies, roof-top terraces, and parking garages. However, this type of situation is rare in Alaska. EPA policy states that flagpole receptors should *not* be used to model impacts at open windows and building air intakes. When flagpole receptors are used, the modeled impacts are subject to the ambient air quality standards, but not the increments.[97]

[95] U.S. Geological Survey's The National Map website at http://nationalmap.gov/elevation.html.

[96] ifsar – interferometric synthetic aperture radar

[97] EPA Memorandum; *Applicability of PSD Increments to Building Rooftops,* Joseph Cannon (Air and Radiation Assistant Administrator) to Charles Jeter (EPA Region IV Administrator); June 11, 1984.

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2.13 Model Design Concentrations

The modeled concentration that may be used as the design concentration is generally described in Section 9.2.2 of the Guideline. However, EPA has also provided additional pollutant-specific information in some of their guidance documents.

In summary, EPA allows applicants to use modeled concentrations that are consistent with the form of the standard or increment as their modeled design concentration. However, the highest concentration should be used when modeling with screening meteorological data, or when comparing a project impact to a SIL or SMC.

EPA has developed new air quality standards for several pollutants and averaging times over the past several years. The form of these standards is different from the older (deterministic) standards. These new "probabilistic" standards are based on a percentile of the distribution of the impacts for the averaging period under consideration. For example, EPA's Federal Register notice for the 1-hour NO_2 air quality standard reads: "…1-hour standard at a level of 100 ppb, based on the 3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum concentrations …".[98]

EPA has likewise developed a probabilistic approach for the 1-hr SO_2 and PM-2.5 air quality standards. EPA has also developed modeling guidance for these standards and has a web page with clarification memos that include these new standards.[99]

You should make sure the applicant is selecting the proper value from their modeling files for comparison to the given threshold. Applicants occasionally mistype the modeled results in their modeling reports, or the applicant may have misunderstood which modeled value they should be using for the given demonstration.

The form of an air quality standard and increment can also vary for a given pollutant and averaging period. Currently this is only an issue for PM-2.5 since there are no increments for 1-hour NO_2 or 1-hour SO_2. However, the 24-hour PM-10 AAAQS and increment also have inconsistent approaches for selecting the design concentrations when modeling with multiple years of meteorological data (see Section 2.10.2). As a result PSD applicants may need to submit two sets of 24-hour PM-10 and/or PM-2.5 runs:

- One set where the concentrations are calculated in a manner consistent with the given AAAQS; and
- A second set where the concentrations are calculated in a manner consistent with increments.

With respect to PM-2.5, applicants may not use the multi-year average of the modeled impacts to demonstrate compliance with the PM-2.5 increments, even though multi-year averages may be used to demonstrate compliance with the PM-2.5 AAAQS. Applicants likewise may not use the high eighth-high (H8H) 24-hour PM-2.5 impacts to demonstrate

[98] Federal Register, Vol. 75, No. 26, February 9, 2010.

[99] https://www.epa.gov/scram/clean-air-act-permit-modeling-guidance

compliance with the 24-hour PM-2.5 increments, even though the H8H impact may be used in their AAAQS demonstrations. Applicants must instead compare the H2H 24-hour PM-2.5 impacts to the applicable 24-hour PM-2.5 increment – unless they want to use the more conservative approach of using the H1H impacts.

The modeled concentrations that may be used as the design concentrations for demonstrating compliance with the AAAQS and Class II increments are summarized in Table 4 below.

Table 4. Allowed Design Concentrations

Pollutant	Avg. Period	AAAQS	Class II Increment
NO_2	1-hour	h8h	--
	Annual	HY	HY
PM-10	24-hour	h6h	h2h
	Annual	--	HY
PM-2.5	24-hour	h8h	h2h
	Annual	MA	HY
SO_2	1-hour	h4h	--
	3-hour	h2h	h2h
	24-hour	h2h	h2h
	Annual	HY	HY
CO	1-hour	h2h	--
	8-hour	h2h	--

Table Notes:

h2h = the maximum high, second-high concentration from any year.

h4h = the multi-year average of the high, fourth-high daily maximum 1-hour concentrations.

h6h = the high, sixth-high 24-hour concentration over five years.

h8h = high, eighth-high. For purposes of 1-hour NO_2, the "h8h" is the five-year average of the high, eighth-high of the daily maximum 1-hour NO_2 concentrations. For purposes of 24-hour PM-2.5, the "h8h" is the five-year average of the high, eighth-high of the 24-hour PM-2.5 concentrations.

HY = highest annual average from any year.

MA = highest multi-year average of the annual concentrations at a given receptor.

-- = there is no AAAQS/increment (as applicable) for this pollutant/averaging period.

Another issue that periodically arises regards the number of significant digits that must be used when comparing a modeled impact to a threshold (e.g., an AAAQS or increment). You do not generally need to report a modeling result to a substantially higher level of "accuracy" than the given threshold. You may instead generally limit the number of significant digits reported in your modeling review in order to provide a "cleaner" presentation. However, rounding may not be used if it alters the compliance demonstration. For example, a modeled annual NO_2 impact of 25.0001 $\mu g/m^3$ may not be rounded down to 25 $\mu g/m^3$ in order to demonstrate compliance with the 25 $\mu g/m^3$ Class II increment. See the ADEC modeling Memorandum on Rounding of Modeled Impacts for additional guidance.

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2.14 Ambient Assessment Results

The ambient assessment should be conducted according to 18 AAC 50.215(b) – (d). There are several paths and considerations that lead to showing compliance and obtaining a permit.

2.14.1 Fast-Track Demonstration (Minor Permits Only)

ADEC has a "fast-track" provision for issuing certain types of minor permits. The provision requires a 15-day public *notice* that ADEC intends to issue a minor permit decision under the fast-track procedures, but the notice does not include a preliminary permit and does not ask for comment on any type of draft permit. The fast-track process allows for a final permit to be issued within 30 days of receiving a complete permit application.

The fast-track option is only allowed for minor permits classified under 18 AAC 50.502(b) or (c), except for projects located within the areas listed in 18 AAC 50.542(a)(1). The fast-track option is not allowed for minor permits classified under 18 AAC 50.508, or any permit classified under Article 3 of 18 AAC 50.

Upon receiving a complete application ADEC will give notice using the Alaska Online Public Notice System or other means as identified in 18 AAC 50.542(b)(1). Persons receiving such a notification have 15 days to request the opportunity or review a preliminary permit decision under a 30-day public comment period.

For an air pollutant for which a permit is required under 18 AAC 50.502(c), or for an air pollutant for which the department requests an analysis for a stationary source classified under 18 AAC 50.502(b)(3), the applicant must include a screening ambient air quality analysis in accordance with the requirements of 18 AAC 50.542(c)(1). All predicted air pollutant concentrations must comply with thresholds identified in 18 AAC 50.542(c)(2). The thresholds are based on assumed off-site/background concentrations and are derived on review of past assessments.

A screening analysis is not needed if ADEC makes a finding in writing that the stationary source or modification does not need an ambient air quality analysis to determine that construction and operation will not result in a violation of an ambient air quality standard.

2.14.2 Project Impact Analysis

The project impact analysis[100] is conducted on a pollutant-by-pollutant basis. The analysis is relatively straightforward.

- ✓ Ensure that the highest model-predicted impacts were used for comparison with the significant impact level (SIL), not the H2H concentration.

[100] As previously noted, a "project impact analysis" is called a "single source impact analysis" in Section 9.2.3 of the Guideline.

Emissions should be based upon potential-to-emit emission rates and corresponding stack parameters, unless the source is subject to load screening, in which case the emissions scenario with the maximum ambient impact should have been used.

The SIL for AAAQS and Class II assessments are identified in 18 AAC 50.215(d) – Table 5. While EPA has established SILs for Class II areas, they are only proposed but not yet finalized SILs for Class I areas.[101] Refer to Section 2.15 of this document for a discussion of the proposed Class I area SILs.

2.14.3 Cumulative Impact Analyses

The air quality impact from natural and regional sources, along with long-range transport from far away sources, must be accounted for in a cumulative AAAQS demonstration. The increment consuming impact from off-site anthropogenic sources must likewise be accounted for in a cumulative increment demonstration. The approach for incorporating these impacts are described in Sections 8.2 and 8.3 of the Guideline. The approach must be evaluated on a case-specific basis for each pollutant and averaging period with impacts greater than the SIL. Various aspects of this evaluation are described below.

Cumulative AAAQS Analysis

Section 8.3.3 of the Guideline discusses how the off-site impacts could be incorporated for purposes of demonstrating compliance with an air quality standard. In summary, the off-site impacts must either be represented through ambient monitoring data or through modeling. EPA states in Section 8.3.3(b)(iii) of the Guideline that, "The number of nearby sources to be explicitly modeled in the air quality analysis is expected to be few except in unusual situations." They further state in Section 8.3.3(b) that, "…*sources that cause a significant concentration gradient in the vicinity of the [applicant's source] are not likely to be adequately characterized by the monitored data due to the high degree of variability of the source's impact*."

Once the background concentration is determined (see below), it is added to the modeled concentration to estimate the total ambient concentration. Hence, background concentrations are typically needed for all air pollutants included in an AAAQS compliance demonstration, regardless of whether or not PSD pre-construction monitoring was required. The data used to represent the background concentration may come from the pre-construction monitoring effort or from some other ambient monitoring effort that represents the non-modeled sources.

The modeled emission rate used for the off-site sources may need to be adjusted for the given averaging period. Applicants may also be able to exclude off-site sources that do not concurrently operate within the given averaging period. See Table 8-2 and Section 8.3.3(c) of the Guideline for additional information. Actual emissions may also be used for modeling nearby sources, per Section 8.2.2(c) and Table 8-2 of the Guideline.

[101] The SIL for PM-2.5 was vacated January 22, 2013 by the District of Columbia Circuit Court.

Obsolete Past Practices

Previous guidance defining a fairly rigid circular area to consider can now be disregarded. The use of a "Q/d" analysis for culling the off-site inventory should also be discouraged. Q/d was developed in the 1980's by the North Carolina Department of Natural Resources and Community Development as a screening tool for culling off-site sources from a cumulative impact analysis. The Department obtained permission from R10 in 1997 to use Q/d since strict adherence to EPA's 1990 draft *New Source Review Manual* sometimes led to unmanageably large off-site inventories. However, the Q/d approach is no longer needed. EPA clarified in their March 2011 memorandum, *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour* NO_2*,* that using the concentration gradient approach in Section 8.2.3 of the 2005 Guideline provides a more reasonable means for selecting the off-site inventory than the 1990 draft procedure.

Q/d provides no information regarding concentration *gradients* – i.e., how quickly a concentration changes with distance. It is essentially a crude tool for trying to estimate the *range* of a significant impact area. When the concentration gradient is shallow – i.e., there is little change in ambient concentration with distance – then the concentration within that area can be represented by a single data point – e.g., the concentration measured at a monitoring station. However, single data points cannot generally be used to represent the wide variation that occurs in areas with steep concentration gradients – i.e., where the concentration rapidly changes with distance. Modeling is typically a better approach for assessing the cumulative impact in areas with widely varying concentrations. Within Alaska, steep concentration gradients are generally associated with downwash.

ADEC does not currently maintain a master emissions inventory database that can be used to import modeling-related information for off-site sources based on the applicant's geographical location.[102] However, given the limited number of "nearby sources" in typical Alaska modeling assessments, ADEC has generally provided case-by-case guidance to applicants when identifying sources to be included in the cumulative impact analysis.

✓ If you are uncertain of what other sources may exist in the area, (1) ask the lead permit engineer, (2) review any recent construction permit applications that may have been submitted for other sources, and (3) check aerial photographs, topographic maps, or local agency resources.

[102] ADEC did develop and store the NO_2, PM-10 and SO_2 PSD baseline emissions and stack parameters for the Unalaska area, which are located in the City of Unalaska AIRFACS folder on the Juneau server at: G:\AQ\PERMITS\AIRFACS\Unalaska_City of\Dutch Harbor Power Plant\PSD Baseline Inventories.

Source emission rates and stack parameters may frequently be obtained from existing permit documents (permits, TARs, permit applications) or previously submitted modeling files.

Cumulative PSD Increment Analysis

Background data has not been generally used in past cumulative increment analysis since it typically overstates the offsite increment consumption – i.e., it reflects the total air quality concentration rather than the *change* in concentration subsequent to the applicable baseline date (see related discussion in Section 2.1.4). Applicants have instead typically modeled the offsite increment consuming, and when warranted – the offsite increment expanding, sources of concern. The cumulative impacts were then compared to the applicable maximum allowable increase, which are found in Table 2 of 18 AAC 50.020.

While Section 8.3.1(a) of the 2016 Guideline implies that background data can now be used to represent the increment consumption from offsite sources, this approach should be used with caution since it likely provides overly conservative results. Section 9.2.3 of the Guideline is a better reference for conducting a cumulative increment assessment. This section continues to endorse the past practice by stating in paragraph (d), "… the applicant should *model* the existing or permitted nearby increment-consuming and increment-expanding sources…" (emphasis added). Note: the rest of the sentence indicates that applicants should utilize on a *current* modeling analysis of the off-site sources rather than a previous modeling analysis, in order to incorporate newly acquired data or improved modeling techniques "if such data and/or techniques have become available…."

The details regarding a cumulative increment analysis will need to be worked through on a case-specific basis. Section 9.2.1 of the Guideline encourages the use of modeling protocols to work through the various aspects of a PSD modeling analysis. The use of a modeling protocol provides an excellent opportunity to work through increment modeling issues.

The offsite inventory can generally be limited to those stationary sources with actual emission (or stack parameter) changes that have occurred since the minor source baseline date. However, it should be remembered that certain actual emissions changes occurring before the minor source baseline date (i.e., at major stationary point sources) can also affect the increment. Within this increment-consuming/expanding subset, the applicant will likely need to model those nearby sources that are expected have a significant concentration gradient in the vicinity of their stationary source. The applicant will also likely need to model other off-site sources if the increment is threatened and it appears that the off-site source could cause or contribute to a violation. Past modeling assessments, if available, or simple sensitivity modeling assessments, can be used to help assess which off-site sources should be included in a cumulative PSD increment analysis.

Per Section 8.2.2(c) of the Guideline, applicants may use actual emissions, rather than allowable emissions, for characterizing the off-site increment consuming sources. ADEC has nevertheless allowed applicants to use allowable/maximum emission rates if they so desired since that is generally easier to obtain. However, actual emissions must always be used when modeling increment *expanding* sources, since the use of allowable emissions would likely overstate the amount of available increment. In many cases, applicants could alternatively model the *change* in actual emissions that have occurred since the applicable baseline date. However, modeling the change in emissions (rather than the current actuals and the baseline actual) should not be used if the release/stack parameters have changed over time.

> *Key point:*
>
> *A commonly used approach is to first model increment consumption using allowable emissions for nearby stationary sources. However, the applicant may need to refine their analysis by obtaining the actual emissions for each EU at the nearby stationary sources if this conservative approach leads to modeled violations.*

Per Section 8.2.2(c) of the Guideline, applicants should generally use the most recent two-year averaging period for determining current actual emissions. The cumulative PSD increment modeling analysis sometimes also requires modeling "increment expansion" due to the shutdown of EUs that were operational in the baseline period. This increment expansion is modeled using the estimated actual emissions that occurred during the baseline year, modeled as negative rates.

If the increment analysis is for NO_2, additional care must be taken with AERMOD to not overestimate the credit if the PVMRM option is used. As noted in Section 3.3.7 of the AERMOD User's Guide:

> Due to the ozone-limiting effects of the PVMRM option, the predicted concentrations of NO_2 are not linearly proportional to the emission rate. Therefore, the approach of modeling NO_2 increment consumption with PSD credits through the use of a negative emission rate for credit sources cannot be used with the PVMRM option. However, the draft PSDCREDIT option allows modeling PSD increment credits for NO_2 when the PVMRM option is specified.

The PSDCREDIT option is only valid with PVMRM. As further stated by EPA in Section 3.3.7 of the AERMOD User's Guide, "[The PSDCREDIT] option is not valid if the OLM option is specified, and no comparable option is available for modeling increment credits with the OLM option."

<u>Additional Discussion Regarding Background Data</u>

As previously discussed, background air quality data is needed to supplement a cumulative AAAQS analysis. Section 8.3.2(b) of the Guideline states, "If there are no monitors located in the vicinity of the new or modifying source, a 'regional site' may be used to determine background concentrations. A regional site is one that is located away from the area of interest but is impacted by similar or adequately representative sources."

> *Key point:*
>
> *The background concentration should be representative of the impacts from sources not included in the modeling analysis. Typical examples include (1)*

> *natural sources, (2) nearby, non-modeled sources, and (3) unidentified sources of air pollution (e.g., long-range transport).*

Once the background concentration is determined, it is added to the modeled concentration to estimate the total ambient concentration. Hence, background concentrations are typically needed for all air pollutants included in a cumulative AAAQS compliance demonstration, regardless of whether or not PSD pre-construction monitoring is required.

Section 8.3.2(b) of the Guideline states the data used to represent the background concentration should be recent and quality assured. The quality assured aspect is also required under State rule per 18 AAC 50.215(a).

The 2016 version of the Guideline contains numerous options for deriving a background concentration from an ambient dataset. The goal is to avoid double-counting the impact from modeled, or non-representative, sources. Most of the options and concepts are too new to meaningfully discuss at this point, other than saying:

- ADEC does not need to maintain the past-practice of encouraging applicants to use the true maximum measured concentration, rather than the measured design concentration, as the initial background concentration.
    - As stated in Section 8.3.2(c) of the Guideline, the measured design concentration provides "the best starting point."

- You will likely need to request AM&QA assistance for working through the details of any request to derive a background concentration from any type of ambient data subset. Since many of the options are relatively new, we need to make sure that we are:
    1) approving technically sound and justifiable approaches, and
    2) not inadvertently setting an unwarranted precedent.

ADEC has compiled the design concentrations from the most recent 10 years of ambient monitoring data submitted by industry and approved as "PSD quality" under 18 AAC 50.215(a). The compilation is posted as a spreadsheet titled ***Industrial Data Summary*** in several places, including the APP page at: http://dec.alaska.gov/air/air-permit/. The posting of this data does not establish any type of pre-approval regarding the use of any dataset, but it may help staff and applicants to know what existing datasets are available for possible consideration. As noted in the spreadsheet, "Applicants who desire to use a reported concentration for their project need to demonstrate to ADEC's satisfaction that the monitoring site and data adequately meet the given regulatory requirements for their project."

2.14.4 Additional Impact Analyses (PSD Sources Only)

PSD applicants must provide an analysis "*…of the impairment to visibility, soils and vegetation that would occur as a result of the source or modification and general commercial, residential, industrial and other growth associated with the source or modification*" under 40 CFR 52.21(o). The focus is on potential impacts within the general area of the stationary source, rather than the Class I AQRV analyses which a

FLM may request under 40 CFR 52.21(p). 40 CFR 52.21(o) also clarifies that the applicant "*need not provide an analyses of the impact on vegetation having no significant commercial or recreational value*."

Neither EPA nor ADEC has adopted a formal methodology for actually conducting the analyses required under 40 CFR 52.21(o). There are also no formally established "impairment" thresholds, other than the ambient air quality standards.

Congress established "primary" NAAQS and "secondary" NAAQS in Section 109(b) of the CAA. The primary NAAQS protect public health, while the secondary NAAQS protect public welfare. Congress further stated in Section 302(h) of the CAA, "*All language referring to the effects of **welfare** includes, but is not limited to, effects on **soils**, water, crops, **vegetation**, manmade materials, animals, wildlife, weather, **visibility**…*" (emphasis added). Therefore, an analysis that demonstrates compliance with the secondary NAAQS may generally be considered as adequate for demonstrating that the visibility, soils, and vegetation will not be adversely impacted within the general project area. However, there may be additional considerations in some circumstances.

This manual cannot predict, nor address, all scenarios that could arise during a PSD review. However, there is an additional assessment that has been historically conducted for projects with significant SO_2 emissions: comparing the annual SO_2 impacts to the 13 $\mu g/m^3$ worst-case sensitivity threshold reported by the U.S. Forest Service for some types of southeast Alaska lichens (*Air Quality Monitoring on the Tongass National Forest – Methods and Baselines Using Lichens*; Forest Service Alaska Region; R10-TB-46; September 1994). The additional comparison to the lichen threshold is for the following reason: lichens are more sensitive to air pollutants than vascular plants since they lack roots and derive all growth requirements from the atmosphere. While it is not known whether all species of lichens found in Alaska have the same sensitivity as what the U.S. Forest Service found for some lichens in the Tongass National Forest, the reported value provides a surrogate measure of the potential sensitivity threshold.

HAVE YOU DOCUMENTED THE RESULTS OF YOUR REVIEW SO FAR?

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2.15 Class I Air Quality Related Values (PSD Sources Only)

As discussed in Section 2.1.5 of this Manual, the Department must notify the FLM of any PSD project within 100 km of the Class I area that they manage, or "very large [PSD] sources" located beyond 100 km. The FLM will then determine whether the PSD applicant needs to submit an AQRV analysis for the Class I area under 40 CFR 52.21(p). The FLM will likely expect the AQRV analysis to comply with the current FLAG guidance.

Your responsibility is to keep the FLM informed of the modeling and AQRV stages of the project. The following actions should be taken if a proposed project may affect a Class I area.

- ✓ You should notify the FLM to ensure receipt of the application, including the modeling analysis.
- ✓ Provide an occasional reminder to the FLMs about upcoming deadlines for comments.
- ✓ Be certain to copy the FLM with significant communication such as completeness determinations, deficiency notices, changes in emission scenarios, etc.
- ✓ Incorporate/reference the FLM's assessment of the AQRV analyses in the modeling review.
- ✓ Work with the permit engineer to ensure that the operational restrictions needed to protect the AQRVs are incorporated into the permit, if warranted.

Visibility is an AQRV that the FLMs manage. Visibility impairment means any humanly perceptible change in visibility, i.e. visual range, contrast, or coloration, from that which would have existed under natural conditions; see the definition of *Visibility Impairment* under 40 CFR 51.301. Impacts to visibility can occur in the form of visible plumes as 'plume blight', or in a general, area-wide reduction in visibility as 'regional haze'

The FLM will likely ask for a plume blight analysis if the stationary source is located within 50 km of the Class I area. The typical tool used to assess plume blight is EPA's VISCREEN model. The User's Guide for this tool is contained within the October 1992 EPA document, *Workbook For Plume Visual Impact Screening and Analysis (Revised)*, EPA-454/R-92-023.[103]

The FLM will likely ask for a regional haze analysis if the stationary source is located 50 km or more from the Class I area. CALPUFF is the typical tool for assessing regional haze.

[103] EPA's visibility workbook (VISCREEN User's Guide) may be found in the "Screening Models" section of SCRAM (see https://www.epa.gov/scram/air-quality-dispersion-modeling-screening-models).

Note:

> Ammonium nitrate and ammonium sulfate are two pollutants which can be a significant component of regional haze and fine particulates. The transformation of SO_2 and NOx emissions into these fine particulate species can be assessed using a chemical transport model. Applicants are encouraged to follow the Interagency Workgroup on Air Quality Modeling (IWAQM)[104] and FLAG[105] guidance documents in selecting proper input parameters to correctly account for the formation of these two pollutants. The FLMs will have the lead on the review of modeling assessments performed for Class I areas.

Changes in air quality may affect other AQRVs in addition to visibility. The 2010 version of the Flag Phase I Report states AQRVs can include flora, fauna, odor, water, soils, geologic features, and cultural resources. The details regarding additional AQRV assessments should be determined under the provisions described in 40 CFR 52.21(p)(2).

Applicant with PSD sources that may impact a Class I analysis will also need to provide a Class I increment analysis under 40 CFR 52.21(k)(1)(ii). The review of the Class I increment analysis is our responsibility.

There are no Class I SILs in federal or State rule. However, EPA developed recommended SILs for Class I PM-2.5 increment demonstrations in an April 17, 2018 guidance document.[106] The recommended values are reiterated in Table 5 below.

Table 5. EPA Recommended SILs for Class I PM-2.5 Increment Demonstrations

Pollutant	Avg. Period	Class I SIL (µg/m³)
PM-2.5	24-hour	0.27
	Annual	0.05

EPA previously proposed Class I SILs for the other increment-consuming pollutants in 1996, but they never finalized the proposal. ADEC is nevertheless providing the 1996 proposed values for the NO_2, SO_2, and PM-10 Class I SILs in Table 6 below.

[104] *Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts*; EPA-454/R-92-019; December 1998.

[105] See https://www.nature.nps.gov/air/Permits/flag/index.cfm

[106] EPA Memorandum, *Guidance on Significant Impact Levels for Ozone and Fine Particulates in the Prevention of Significant Deterioration Permitting Program*, Peter Tsirigotis to Regional Air Division Directors; April 17, 2018.

Table 6. EPA's 1996 Proposed SILs for Class I Areas

Pollutant	Avg. Period	Proposed Class I SIL ($\mu g/m^3$)
SO_2	3-hour	1.0
	24-hour	0.2
	Annual	0.1
PM-10	24-hour	0.3
	Annual	0.2
NO_2	Annual	0.1

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2.16 [Reserved]

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3. List of Acronyms

AAAQS: Alaska Ambient Air Quality Standards (see 18 AAC 50.010)

AAC: Alaska Administrative Code

ADEC: Alaska Department of Environmental Conservation

AM&QA: Air Monitoring & Quality Assurance (a program within ADEC's Air Division)

APP: Air Permit Program (a program within ADEC's Air Division)

AQRV: Air Quality Related Value

AS: Alaska Statute

ASOS: Automated Surface Observing System (meteorology)

AWOS: Automated Weather Observing Station

BOEM: Bureau of Ocean Energy Management

BPIP: Building Profile Input Program

BPIPPRM: Building Profile Input Program for PRIME

CAD: Computer-aided Design

CFR: Code of Federal Regulations

CO: Carbon Monoxide

DEM: Digital Elevation Model

DOQQ: Digital Orthophoto Quarter Quadrangle

DRG: Digital Raster Graphic

EPA: Environmental Protection Agency

EU: Emissions Unit

FAA: Federal Aviation Administration

FLAG: Federal Land Managers' Air Quality Related Values Workgroup

FLM: Federal Land Manager

GEP: Good Engineering Practice (stack heights)

GPS: Global Positioning System

GUI: Graphical User Interface

H1H: High First-High

H2H: High Second-High

H6H: High Sixth-High

H8H: High Eighth-High

ISR: In-Stack Ratio (of the NO_2 to NOx concentrations in exhaust effluent)

IWAQM: Interagency Workgroup on Air Quality Modeling

LRT: Long Range Transport (distances greater than 50 km from a source)

LULC: Land Use/Land Cover

MM5: 5th Generation Penn State/NCAR Mesoscale Model

MMIF: Mesoscale Model Interface Program

MLLW: Mean Lower Low Water

MSL: Mean Sea Level

NAAQS: National Ambient Air Quality Standards

NEI: National Emissions Inventory

NED: National Elevation Data

NO_2: Nitrogen Dioxide

NOx: Oxides of Nitrogen

NSR: New Source Review

NWS: National Weather Service

OCD: Offshore and Coastal Dispersion

PM: Particulate Matter

PM-2.5: Particulate Matter with an aerodynamic diameter of 2.5 microns or less

PM-10: Particulate Matter with an aerodynamic diameter of 10 microns or less

PRIME: Plume Rise Model Enhancements

PSD: Prevention of Significant Deterioration

QAPP: Quality Assurance Project Plan

R10: The Region 10 Office of EPA

SCRAM: Support Center for Regulatory Atmospheric Modeling

SIL: Significant Impact Level

SIP: State Implementation Plan

SIA: Significant Impact Area

SMC: Significant Monitoring Concentration

SO_2: Sulfur Dioxide

SRDT: Solar Radiation and Delta-Temperature

TAR: Technical Analysis Report

TSP: Total Suspended Particulates

USGS: United States Geological Survey

UTM: Universal Transverse Mercator

VISCREEN: Plume Visual Impact Screening Model

VOC: Volatile Organic Compounds

WRF: Weather Research and Forecasting model

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Appendix A

Modeling Tips

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AERSCREEN

AERSCREEN is significantly more complex with regard to user input requirements and user setup compared to its predecessor SCREEN3. Unlike SCREEN3, AERSCREEN is not a stand-alone program. During a single model run, AERSCREEN may interface with each of the following programs: 1) MAKEMET, to generate a matrix of meteorological conditions; 2) AERMAP, to process source and receptor elevations; 3) BPIPPRM, to derive building parameters for building downwash; and 4) AERMOD which is run in screening mode to obtain maximum 1-hour concentrations.

Because AERSCREEN will potentially interface with each of these programs, the user should become familiar with each of these programs and consult the following guidance, most of which are available on EPA's Support Center for Regulatory Atmospheric Modeling (SCRAM) website:

- *AERSCREEN User's Guide* (EPA-454/B-16-004)
- *AERMAP User's Guide* (EPA-454/B-18-004)
- *AERMET User's Guide* (EPA-454/B-18-002)
- *BPIP User's Guide* (EPA-454/R-93-038) and the 2004 Update
- *Addendum to the ISC3 User's Guide* (The PRIME Plume Rise and Building Downwash Model)
- *Guideline on Air Quality Models* (40 CFR 51, Appendix W)
- *AERSURFACE User's Guide* (EPA-454/B-08-001; Revised 01/16/2013)
- *AERMOD Implementation Guide* (EPA-454/B-18-013)
- *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources* (EPA-454/R-92-019)

When running AERSCREEN, it is important to ensure all of the required program executable files and input files are accessible to AERSCREEN. The following executable files should be copied to the same directory where the AERSCREEN executable is located (AERSCREEN.EXE):

- MAKEMET.EXE
- AERMAP.EXE
- BPIPPRM.EXE
- AERMOD.EXE

The user should ensure the most recent versions of AERSCREEN, MAKEMET, AERMAP, BPIPPRM, and AERMOD have been obtained from the SCRAM website.

If terrain processing is required, the user input file "demlist.txt" is required and must reside in the same directory where the AERSCREEN executable is stored. In addition, one or multiple elevations file in the USGS DEM format or one or multiple National Elevation Dataset (NED) files in GEOTIFF format is required, as well as the North American Data (NAD) conversion files are required. Elevation and NAD conversion files do not have to reside in the same directory with AERSCREEN. Path and filename information for these files should be specified in "demlist.txt." Refer to the AERSCREEN User's Guide for guidance on the contents and format of "demlist.txt."

AERSCREEN also requires surface characteristics for input to MAKEMET. This information can be input into AERSCREEN by the following methods:

1. single values for albedo, Bowen ratio, and surface roughness without temporal or spatial variation (annual values for a single sector)
2. AERMET seasonal tables (seasonal surface characteristics derived within AERSCREEN for a single sector)
3. values read by AERSCREEN from either an AERSURFACE output file or an AERMET Stage 3 input file (temporal and spatial variation)

When method #3 is used, the path and filename of the AERSURFACE output file or AERMET Stage 3 input file are required user entries, and the file is not required to reside in the same directory where the AERSCREEN executable is located.

Like SCREEN3, AERSCREEN supports only a single emission source and a single building approximated by a simple rectangular box. Multiple point sources with similar parameters that are within about 100m of each other may be analyzed by treating all of the emissions as coming from a single representative stack. This technique of combining stacks is described in Section 2.2 of the Screening Procedures (EPA-454/R-92-019). If more than one building influences the plume, the user may create a BPIPPRM input file which can be read by AERSCREEN to process downwash parameters from multiple buildings. However, there may only be one source defined in the BPIPPRM input file or AERSCREEN will abort.

Under some cases, applicants may model impacts from multiple sources, not adjacent to each other. Multiple sources have been modeled in a very conservative manner by assessing the maximum impact from each individual source, and adding the results to quantify the total impact. This method is conservative because it assumes maximum impacts from individual sources occur at the same location and time.

As an alternative screening approach in cases where there are multiple sources and/or buildings, AERMOD can be run in screening mode, apart from AERSCREEN, using screening meteorology with all sources, building parameters and a receptor grid specified. This requires pre-processing and model set-up similar to refined modeling with AERMOD. Performing screening modeling in this way requires the user to develop an AERMOD control file including source parameters and a receptor grid which will require setting up and running AERMAP and BPIPPRM to obtain source and receptor elevations and building downwash parameters. Screening meteorology can be generated using MAKEMET as a stand-alone program, and AERMOD can be run with the SCREEN option specified on the CO MODELOPT card in the AERMOD control file. Refer to the AERSCREEN User's Guide (EPA-454/B-16-004) for more information on running MAKEMET as a stand-alone program. Refer to the AERMAP, BPIPPRM, and

AERMOD User's Guides and the modeling tips provided in this appendix for more information on these programs.

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VISCREEN

The VISCREEN model is used to assess plume blight within Class I areas, but not regional haze. Plume blight is a visual impairment of air quality that manifests itself as a coherent plume. It is an instantaneous parameter that should be assessed using peak short-term emission rates. Regional haze is defined as a cloud of aerosols extending up to hundreds of miles across a region promoting noticeably hazy conditions. It is a condition of the atmosphere in which uniformly distributed aerosol obscures the entire vista irrespective of direction or point of observation. The haze is not easily traced visually to a single source. Regional haze is regulated in Class I areas by mandating the maximum allowable change which may occur. Since the change is based upon projected impacts compared to a 24-hour averaged "natural condition", the 24-hour averaged emission rate is often used in the regional haze analysis. This manual does not discuss the tools and approach for running a regional haze assessment instead of a plume blight analysis. Those details should be worked out with the FLM.

VISCREEN requires the user to input values for particulate and NOx emission rates, along with several distances. As stated in Section 3 of EPA's *Workbook for Plume Visual Impact Screening and Analysis* *(Revised)* – (EPA-454/R-92-023), "*[t]he emission rates should be the maximum short-term rates expected during the course of the year.*" The required distances are discussed on page 24 of EPA's Workbook.

VISCREEN also requires the user to input a background ozone concentration, used to calculate NO to NO_2 conversion, and the background visual range (BVR). A default background ozone concentration of 40 ppb should be used within Alaska unless otherwise justified. The assumed BVR, however, can vary by location. A typical BVR used by applicants located in non-arctic coastal areas, e.g. Aleutians, Western Alaska, and Cook Inlet, has been 250 km. Interior and North Slope applicants have used a BVR of 258 km, which is based upon past measurements at Denali National Park for the 90th percentile of visibility observations.

VISCREEN provides results for impacts located both inside and outside a Class I area. According to page 27 of EPA's Workbook, the model results for impacts located outside a Class I area are used in situations where there is an "integral vista." In situations where there are no integral vistas, applicants only need to use the results for impacts located inside a Class I area. Alaska has two integral vistas, both of which are associated with the Denali National Park Class I area. There are no integral vistas associated with the other three Class I areas within the State.

VISCREEN includes Class I visibility thresholds to denote when plume blight could occur. While non-binding, most applicants endeavor to demonstrate that their modeled impacts will not exceed these thresholds within a Class I area. When running VISCREEN under its default "Level 1" analysis, the model uses a worst-case stability class (F) and wind speed (1 meter/sec) to generate estimated results. VISCREEN can also be run under a slightly less conservative regime to help refine the estimates of plume blight. In a "Level 2" analysis, the modeler uses more representative plume travel times and actual local meteorological conditions.

The most important step in a Level 2 analysis is determining the meteorological conditions, i.e. wind speed and stability class, that lead to a worst-case scenario. The joint frequency of these parameters measured at or near the stationary source or Class I area and the persistence of these conditions should be considered in making this determination. As cited in the Workbook, "*Any assessment of plume visual impacts is limited by the availability, representativeness, and quality of the meteorological data.*"

Plume travel time can also be a factor in determining the worst-case scenario. The Workbook states that "*[f]or the Level-2 screening analysis, we assume it is unlikely that steady-state plume conditions will persists for more than 12 hours.*" The user may, therefore, determine and use the minimum wind speed needed for the plume to travel to the Class I area within 12 hours.

The maximum range of VISCREEN is 50 km. A common approach for using VISCREEN when the nearest Class I area lies beyond this range is to use the 50 km maximum range as the source to observer distance. The approach provides the "upper bound" of the plume blight impacts at more distant locations. 50 km is also used as the "nearest" source to boundary distance (see page 24 of the Workbook). For the "farthest" distance, applicants typically just added the approximate width of the nearest Class I area to the 50 km range.

AERMOD

EPA promulgated the AERMOD Modeling System (which includes AERMOD, AERMAP, and AERMET) as a preferred Guideline model for on-shore, near-field assessments, on November 9, 2005. As stated in Section A.1 of the Guideline:

> AERMOD is a steady-state plume dispersion model for assessment of pollutant concentrations from a variety of sources. AERMOD simulates transport and dispersion from multiple point, area, or volume sources based on an up-to-date characterization of the atmospheric boundary layer. Sources may be located in rural or urban areas, and receptors may be located in simple or complex terrain.

EPA has posted additional guidance regarding the AERMOD Modeling System on their SCRAM website. This additional guidance is entitled, "*AERMOD Implementation Guide*" (April 2018). This document provides many recommendations and requirements for conducting dispersion modeling with AERMOD.

Model Change Bulletins, issued with each release, should be checked for important information about bug fixes, updates and enhancements, and other miscellaneous items (note that each component in the AERMOD Modeling System has its own set of model change bulletins).

The EPA website has many documents that can be examined that describe some of the science, development, and evaluation of AERMOD. These documents may provide some insight into model results if there is something that may not seem correct.

Allocatable arrays have been implemented in AERMOD for most arrays. This means the user does not have to be (too) concerned about the number of receptors, sources, source groups, etc. The only limitation is based on the amount of available random access memory (RAM). If the input exceeds the available RAM, AERMOD will issue an error message and not perform the model run.

The repeatable keyword INCLUDED can be specified on several pathways in the AERMOD input control file. With this keyword, the user identifies an external file to 'include' in the control file. Each INCLUDED file must contain only information for the pathway under which it appears. Sources and associated parameters and building information (SO pathway), receptors (RE pathway), event data (EV pathway) can be included in the model run with this keyword. Since the keyword can be repeated on each pathway, the user could divide the content into multiple files to better control, for example, which sources to include in a particular model run.

Using INCLUDED files can help reduce the size of the control file, as well as the output file from AERMOD since the content of the INCLUDED files is NOT printed in the output file. Confirm that the applicant included the correct INCLUDED files with the submittal. Since the content of INCLUDED files is not printed in the AERMOD output file, care must be used to ensure the same files were used in the modeling as submitted with the application.

AERMAP

Section 2.1.1 of the AERMAP User's Guide presents a nice discussion of horizontal datum. AERMAP allows for coordinate conversion between NAD27 and NAD83. Fourteen conversion files must be loaded in the same file directory as the executable version of AERMAP. These files are identified by their file name extensions (*.las and *.los). AERMAP will not run without these files, even if no coordinate transfer is requested. AERMAP can now process elevation data files from the National Elevation Dataset (NED) in GeoTIFF format. The use of NED data is now preferred over USGS DEM files because they are updated regularly. NED data can be obtained from the USGS via the National Map Viewer at https://www.usgs.gov/core-science-systems/ngp/tnm-delivery/.

As noted above, AERMAP can process a mix of resolutions of the same data type (DEM or NED), but cannot process a mix of DEM and NED files.

AERMET

AERMET requires hourly cloud cover or measurements of solar radiation and delta temperature (SRDT) data to calculate hourly turbulence parameters. It will not work with hourly measurements of sigma theta to calculate Pasquill-Gifford stability categories.

There are 3 stages of processing the data. Stage 3 processing allows the user to specify boundary layer parameters (surface roughness length, Bowen ratio, and surface albedo) as a function of directional sector and time of year.

The ancillary program, AERSURFACE, can calculate these parameters from land use data available from the United States Geological Survey (USGS). However, use of this program is not currently an option within Alaska since the format of the land use data that can be processed by AERSURFACE is not available for Alaska. Check SCRAM to see if EPA has issued an update that is capable of processing land use data for Alaska. If not, the ADEC website http://dec.alaska.gov/air/air-permit/dispersion-modeling/[55] provides guidance on how the surface parameters may be manually calculated.

AERMOD tends to be very sensitive to the surface roughness length. It tends to not be very sensitive to the albedo and Bowen ratio. Often these parameters are specified as a function of land use classification. Consequently, make certain that the boundary layer parameters are correct.

- ✓ The surface roughness should reflect the land cover and usage within a 1 km radius of the meteorological tower, while albedo and Bowen ratio should be based on the land cover and usage of a 10 km x 10 km area centered on the meteorological tower.

- ✓ The FAA web-site FAI FSS – Airport Photographs provides aerial pictures of Alaskan airports, which can be helpful when trying to determine the local surface conditions around an airport meteorological tower.

- ✓ Select the surface parameters by month – do not use the default seasons. (Alaskan winters run much longer than the December through February assumption used in AERMET.)

- ✓ See Section 4.7.8 of the AERMET User's Guide for additional guidance

    - "Winter conditions apply to snow-covered surfaces and subfreezing temperatures"

- ✓ Use the National Climatic Data Center (NCDC) Local Climatic Data (LCD) summaries to help determine the actual seasons for the area of interest.

    - The temperature and snowfall summaries provided in Tables A-1 and A-2 may also helpful.

    - However, also look at the mean and max temperatures for defining "winter."

- ✓ Local knowledge should also be used in regards to when vegetation starts emerging (i.e., start of spring) and when the vegetation loses their leaves (i.e., autumn).

AERMET contains an option for adjusting the surface friction velocity (ADJ_u*) parameter. EPA developed this option to correct AERMOD's tendency to overpredict impacts under stable, low wind conditions. It is a regulatory option when used *without* turbulence measurements, such as standard deviation of horizontal wind direction (sigma-theta) data and/or standard deviation of vertical wind speed (sigma-w) data. However, it is an alternative modeling technique that requires case-specific EPA and ADEC approval under 18 AAC 50.215(c) when used *with* turbulence measurements.

AERMET requires time zone information for the surface meteorological station, the upper air meteorological station, and the applicant's stationary source. However, AERMET uses a different reference point in regards to the stationary source information than it does for the meteorological data. AERMET uses local standard time as the reference point for processing the meteorological data. However, it uses Greenwich Mean Time (GMT) as the reference point for the location of the applicant's source. This inconsistency in reference points can lead to errors when running AERMET, and therefore, should be closely checked by the reviewer.

Surface data is generally recorded in local standard time, which means the conversion factor between recorded time and local time will usually be zero. Upper air data is generally recorded in GMT. Therefore, AERMET needs to know the number of hours required to convert the time of each data record (e.g., GMT) to local standard time.

In regards to the applicant's source, AERMET wants to know the relation between the applicant's time zone and GMT. Therefore, the modeler must enter the number of hours required to convert from local time to GMT. In most cases, this value will be the same value as used for the upper air station. *It will never be zero (as may be used for processing the surface data) when modeling sources located in Alaska.*

AERMOD WITH SCREENING MET DATA

ADEC has occasionally allowed applicants to run AERMOD with AERSCREEN/MAKEMET-generated meteorology. However, AERMOD with screening meteorological data should only be used to estimate 1-hour impacts. The AERSCREEN scaling factors should be used to convert the 1-hour concentrations to other averaging periods. In all cases regarding the use of screening meteorological data, modelers must also use the high first-high concentration, rather than a ranked concentration (e.g., the high second-high or high x-high modeled concentration), for demonstrating compliance with the air quality standards and increments.

Table A-1: Mean Number of Days with a Minimum Temperature of 32^{O}F or Less

As Reported by the National Climatic Data Center through 2004. Formatted by ADEC on 2/14/06

DATA THROUGH 2004	YRS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
ANCHORAGE, AK	40	31	27	29	20	3	0	0	*	3	20	28	30	191
ANNETTE, AK	44	17	13	12	4	*	0	0	0	0	2	10	14	71
BARROW, AK	84	31	28	31	30	31	24	14	15	25	31	30	31	321
BARTER IS.,AK	41	31	28	31	30	31	23	9	11	25	31	30	31	310
BETHEL, AK	46	30	28	31	27	16	1	*	*	6	26	28	30	223
BETTLES,AK	52	31	28	31	29	14	*	*	2	15	30	30	31	240
BIG DELTA,AK	59	31	28	30	26	8	*	*	1	10	28	30	31	222
COLD BAY,AK	61	24	23	25	21	8	*	0	0	*	9	19	24	154
FAIRBANKS, AK	41	31	28	31	27	6	0	0	0	9	29	30	31	223
GULKANA,AK	56	31	28	31	29	15	1	*	3	14	27	30	31	239
HOMER, AK	63	28	25	27	22	9	*	0	*	4	18	25	28	184
JUNEAU, AK	60	25	22	23	14	3	*	0	*	1	8	18	23	137
KING SALMON, AK	41	28	25	27	24	11	*	0	*	6	21	25	28	196
KODIAK, AK	42	22	20	21	13	3	*	0	0	1	12	19	23	134
KOTZEBUE, AK	61	31	28	31	30	25	6	*	*	8	28	30	31	247
MCGRATH, AK	62	31	28	31	28	11	*	0	1	11	28	30	31	229
NOME, AK	38	31	28	31	29	19	3	*	1	10	25	29	31	237
ST. PAUL ISLAND, AK	87	26	26	29	27	18	3	*	*	2	11	19	25	186
TALKEETNA, AK	64	31	28	31	28	13	*	0	1	8	25	29	31	222
UNALAKLEET, AK	30	31	28	31	29	18	2	*	1	8	27	30	31	236
VALDEZ, AK	32	30	27	29	16	1	*	0	*	1	12	26	30	172
YAKUTAT, AK	40	25	23	24	20	8	*	0	*	5	11	22	25	163

Table A-2: Snowfall (Including Snow Pellets and Sleet) – Average Total in Inches

As Reported by the National Climatic Data Center through 2004. Formatted by ADEC on 2/14/06

DATA THROUGH 2004	*YRS*	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	*ANN*
ANCHORAGE, AK	*61*	10.3	11.5	9.8	4.3	0.5	0	0	T	0.4	7.5	11.2	15.7	*71.2*
ANNETTE, AK	*57*	11.8	10.8	8.5	2.3	0.1	T	0	0	0	0.2	3.6	10.6	*47.9*
BARROW, AK	*84*	2.4	2.2	1.9	2.2	1.9	0.6	0.5	0.7	3.7	7.5	3.8	2.6	*30*
BARTER IS.,AK	*40*	4.6	2.5	2.5	2.3	2.9	1.6	0.5	1.6	5.7	9.5	5.1	3.3	*42.1*
BETHEL, AK	*46*	6.9	6.3	8	5.7	2.1	0.1	T	0	0.5	4.2	9.8	10.2	*53.8*
BETTLES,AK	*53*	12.3	10.7	10	6.6	1.3	T	T	0.1	2.5	12.2	13.7	15	*84.4*
BIG DELTA,AK	*50*	5.7	5.4	4.5	2.8	0.7	T	0	T	1.6	9.5	8.6	6	*44.8*
COLD BAY,AK	*54*	12.2	11.8	11.1	6.1	1.7	T	T	T	T	3.2	8	11.5	*65.6*
FAIRBANKS, AK	*53*	10.4	8.6	6	3.1	0.9	T	T	T	1.6	11	13.4	12.7	*67.7*
GULKANA,AK	*56*	7.5	7.4	5.4	2.6	0.6	0	T	0.1	1.1	8.3	8.9	10.3	*52.2*
HOMER, AK	*54*	10.3	12	9.4	3.1	0.4	T	0	0	T	2.4	7.2	13	*57.8*
JUNEAU, AK	*60*	25.5	18.6	14.8	3.3	T	T	0	0	T	1	11.8	21.5	*96.5*
KING SALMON, AK	*55*	8.6	6.7	6.7	4.4	1	T	0	T	T	3.1	6.3	9.3	*46.1*
KODIAK, AK	*42*	15.6	17.2	13.3	7.6	0.7	T	0	T	T	2.1	6.9	14.8	*78.2*
KOTZEBUE, AK	*61*	7	6	5.4	5.4	1.6	0.1	T	0	1.2	6.4	9.2	8.5	*50.8*
MCGRATH, AK	*61*	14.7	12.5	11.3	6.8	0.9	T	T	T	1.2	10.1	16.9	18.5	*92.9*
NOME, AK	*58*	10.7	8.2	7.4	7.1	2.3	0.1	0	0	0.5	4.8	11.3	10.6	*63*
ST. PAUL ISLAND, AK	*79*	12.3	10.1	9.1	5.7	2.1	0.1	0	0	0.1	2.6	6.7	9.9	*58.7*
TALKEETNA, AK	*67*	19.4	18.9	17.7	8	0.8	T	0	T	0.2	10.5	17.9	22	*115.4*
UNALAKLEET, AK	*25*	5.1	5.5	5.6	3.6	1	0	0	T	0.8	3.9	7.1	5.4	*38*
VALDEZ, AK	*33*	65.8	59.4	52	22.7	1.9	0	0	0	0.5	11.6	40.3	73	*327.2*
YAKUTAT, AK	*56*	36.8	37	35.9	15.9	1.5	T	0	T	T	5.4	22.2	37.9	*192.6*

OFFSHORE AND COASTAL DISPERSION MODEL

The Offshore and Coastal Dispersion (OCD Version 5) model was developed to simulate the effects of offshore emissions from point, area, or line sources on the air quality of coastal regions. The model includes special algorithms that account for overwater plume transport and dispersion, as well as changes that take place as the plume crosses the shoreline. Furthermore, the OCD model also includes treatments of plume dispersion over complex terrain and platform downwash. OCD is best applied during generally ice-free conditions as the model takes into account the unique dispersion conditions associated with overwater boundary layers. If most of the water area is covered in ice, AERMOD is better suited to these conditions as ice has similar boundary layer conditions to that of land. The model can simulate impacts from point, area, and line sources. The following steps outline the approach to reviewing the OCD input/output files.

SHORELINE GEOMETRY AND RECEPTORS

OCD requires the specification of shoreline geometry, or land-sea interface. The information is used to determine the change in plume dispersion as the plume crosses the internal boundary layer generated at the shoreline. The traditional approach to preparing the shoreline data required the user to overlay a grid on the area of interest, and then provide digitized information on the distribution of land versus water. Manual preparation of such information is obviously a laborious task, and prone to user errors. Furthermore, the results are not easily reproducible. OCD Version 5 has associated with it a MAKEGEO program that can be used to generate the land-sea interface throughout Alaska. All that is needed is to enter the two latitudes and the two longitudes that define the modeling domain. The modeling domain should be sized such that all possible plume trajectories are within the domain. The resolution of the modeling domain should replicate the shoreline geometry but need not reproduce every “nook and cranny”.

Receptors should be placed within the modeling domain and be of sufficient resolution in order to find the maximum impact(s) from shoreline fumigation. Often, resolutions of 50 meters or greater is sufficient. Discrete, polar, and Cartesian receptors can be used in OCD. OCD Version 5 has the ability to view the shoreline geometry maps, source locations, and the receptor fields. This feature should be used to review the modeling input files.

OVERWATER METEOROLOGICAL DATA

OCD requires the user to provide overwater meteorological data, where the overwater mixing height, the overwater humidity (relative humidity, web bulb temperature, or dew point temperature), the overwater air temperature, and the water surface temperature (or air minus water temperature) must be available. There are no default values for these four variables.

Missing overwater data must be filled in. Missing data of six hours or less can be replaced with the last good hour. Missing data over six hours but less than two days can be replaced by the previous good day's data from the same (missing) time period. For longer days, missing data should be filled in with the following:

Parameter	*Default*
relative humidity	80 %
air temperature	overland air temperature
air minus water temperature	0 C
mixing height	500 m

The default values used above should only be used when all sources of overwater data have been exhausted.

PLATFORM CHARACTERIZATION

OCD Version 5 also has the ability to model downwash and non-vertical stacks. However, the downwash algorithm is fairly simple in that it is based on a single building height and width per EU. OCD Version 5 will not accept data from BPIPPRM.

OCD will account for the open area beneath the platform and the air flow through this area. The elevation of the platform and the airflow under the platform should result in a net reduction in the influence of structure downwash when compared to the downwash influence from a solid structure that extends to the sea surface.

Applicants should generally use the height and width of the dominant structure near each EU in their OCD analysis. They should be able to obtain these dimensions from a scaled plot plan (or similar) of the platform. (They should also provide the plot plan with the permit application.) Some applicants have asked if they can use the platform diagonal as the building width. In investigating the question, ADEC learned through conversations with Dirk Herkhof of the *Mineral Management Service* (the agency that developed OCD)[107] that OCD estimates lower concentrations with wider building widths.[108] Therefore, Mr. Herkhof recommended *against* the use of the platform diagonal as the building width. Mr. Herkhof also noted that underestimating the building height could likewise underestimate the ambient concentration.

The relative height of an offshore platform varies with the tide. Therefore, the point of measurement should be discussed with the applicant. Tide fluctuations within Cook Inlet are on the order of 30-feet. They are on the order of 3-feet in the Beaufort Sea. Platform and receptor elevations should be measured from Mean Sea Level (MSL) for purposes of modeling. However, the traditional reference point for nautical charts and marine surveys is the Mean Lower Low Water (MLLW) level. Therefore, elevations based on

[107] The Department of the Interior split the Mineral Management Service (MMS) into three new federal agencies in 2011. The responsibility for managing OCD currently lies with the Bureau of Ocean Energy Management (BOEM).

[108] The conversations with Mr. Herkhof occurred in March 2000.

MLLW need to be converted to MSL when modeling platforms located in Cook Inlet. When modeling platforms located in the Beaufort Sea, the use of MLLW measurements is adequate. In Cook Inlet, the difference between MLLW and MSL is 3.42 meters.

> Note: *The current OCD GUI will not install or operate properly on a 32-bit Windows 7 operating system, nor is the GUI compatible with a 64-bit system. BOEM is purportedly working on a resolution to these problems. Check SCRAM for a possible update.*

DISPERSION SUBMENU

OCD allows the user to turn the following four dispersion options on and off: terrain adjustments, stack-tip downwash, gradual plume rise, and buoyancy-induced dispersion. Unfortunately, there is not a lot of OCD-specific guidance regarding these options.

EPA provides no guidance regarding these switches in Appendix A.6 of the Guideline (Offshore and Coastal Dispersion Model). The input/output files describe "default" settings for each option, but it's not readily clear why those are the default values or under what circumstances the non-default settings should be used. Section 2.3.4 of the November 1989 User's Guide (Volume I) provides a short discussion regarding gradual plume rise, but the context appears to be limited to the modeling of onshore impacts rather than over water impacts. The discussion includes the statement, "Following the recommendation of the EPA, users are advised not to select the gradual plume rise option since it has been found to occasionally produce large overpredictions close to the stack" but it's not clear whether that finding was with or without downwash. While the concern regards overprediction, APP staff found that gradual plume rise can actually decrease the maximum impact from a turbine by a factor of two when downwash is included.

Given the lack of OCD-specific Guidance, the best option may be to follow the general recommendations within the Guideline, rather than the "default" settings found in the OCD input/output files. Section 7.2.3(g) of the Guideline says buoyancy induced dispersion should be used for fuel combustion sources. Section 7.2.5(b) of the Guideline recommends the general inclusion of gradual plume rise for sources impacted by building downwash. Since most offshore sources in Alaska are combustion related and downwash dominated, the use of buoyancy induced dispersion and gradual plume rise would likely be warranted. The use of stack-tip downwash likewise appears to be generally warranted since that is the default approach used in AERMOD.

The terrain adjustments switch can typically be left off as the greatest impacts tend to be located close to the source, which is generally over open water. However, if the source is located close to shore or there is other reason to be interested in the impacts which occur over land, use of terrain adjustments may be warranted.

The OCD input file would look as shown in Figure A-1 below when using the above settings (including no terrain adjustments).

```
INPUT GROUP 4 -- Main model options (mandatory)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
! IOPT(1)  =             0  !
          IOPT(1)  -- Switch for terrain adjustment (0 or 1)
                      = 0, Do not use terrain adjustment
                      = 1, Use terrain adjustment
          Default = 0
! IOPT(2)  =             0  !
          IOPT(2)  -- Switch for stack-tip downwash (0 or 1)
                      = 0, Use stack-tip downwash
                      = 1, Do not use stack-tip downwash
          Default = 1
! IOPT(3)  =             0  !
          IOPT(3)  -- Switch for gradual plume rise (0 or 1)
                      = 0, Use gradual plume rise
                      = 1, Do not use gradual plume rise
          Default = 1
! IOPT(4)  =             1  !
          IOPT(4)  -- Switch for buoyancy-induced dispersion (0 or 1)
                      = 0, Do not use buoyancy-induced dispersion
                      = 1, Use buoyancy-induced dispersion
          Default = 0
```

Figure A-1. Likely OCD Switch Settings Needed for Regulatory Analysis

CALPUFF

Because of its higher level of sophistication, CALPUFF inherently has more model options to be employed. Two post-processing tools are also needed to obtain time-averaged calculations of deposition and visibility: POSTUTIL and CALPOST, but only CALPOST is needed to obtain time-averaged pollutant concentrations.

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Appendix B

Frequently Asked Questions

The following list of questions is presented to help those unfamiliar with dispersion modeling have a basic understanding.

1. What is dispersion modeling?

- A technique for calculating concentrations of pollutants that are the result of emissions.
- A single equation can be used to estimate an air pollutant concentration at a single receptor from a single uncomplicated source.
- When plume rise must be estimated or there are complications about the source, such as building downwash, then a series of equations are needed.
- These equations, when coded for use by a computer, are usually referred to as a "computer model".
- Repetitive calculations are required to estimate concentrations at a number of receptor locations, or from a number of sources, or for a series of meteorological conditions or over the length of a particular time period.
- A dispersion model usually does a considerable amount of "bookkeeping" to determine averages over multiple hourly simulations or to keep track of highest calculated concentrations for reporting at the end of the simulation period.
- **Why use dispersion modeling instead of monitoring?**
- Monitoring can be used to quantify the concentration of a pollutant at a specific location under actual meteorological conditions.
- Unlike monitoring, modeling can provide estimates of pollutant concentrations from an unbuilt source, at multiple locations.
- Modeling can simulate concentrations under a variety of meteorological conditions.
- Modeling can determine the concentration from individual sources, all of which may be contributing to the concentration of a pollutant at a specific location.

2. What's the difference between a screening model and a refined model?

- Regulatory dispersion modeling is conducted in a series of successive levels of refinements.
- Each successive level often requires additional information and processing to obtain the revised estimate.
- Start with a set of simplified conservative assumptions (Screening-Level Models).

- If compliance with air quality goals can be demonstrated using these simplified assumptions, then no additional refinements are necessary.

- However, if compliance cannot be demonstrated using the simplified set of assumptions, one may elect to refine the input assumptions (i.e., refined-level modeling) until compliance can be demonstrated or modify the source design, until compliance can be demonstrated.

How accurate is dispersion modeling?

- Models are more reliable for estimating longer time-averaged concentrations than for estimating short-term concentrations at specific-locations.

- The models are reasonably reliable in estimating the magnitude of the highest concentration occurring sometime, somewhere within an area.

- Errors in highest estimated concentrations of 10 to 40 percent are found to be typical. Estimates of concentrations that occur at a specific time and site are poorly correlated with actual observed concentrations and are much less reliable.

- However, this inability to pair modeled concentrations with measured concentrations does not indicate that an estimated concentration does not occur, only that the precise time and locations are in doubt.

Why can't you monitor for PSD increment consumption?

- Increment consumption is based upon changes in emissions (and therefore ambient concentration of pollutants) since the applicable baseline date.

- There are different baseline dates for major stationary and minor sources.

- Monitors cannot distinguish between impacts from these sources as a function of date and source category.

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