ADEC Modeling Review Procedures Manual

June 30, 2013

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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) to the public-domain programs provided by the U.S. Environmental Protection Agency (EPA). ADEC tends to predominately use one of these programs for conducting modeling reviews, and has included specific steps regarding the use of this program as an aid to staff. However, other commercial programs are equally valid and appropriate. Mention of products or services does not convey, and should not be interpreted, as conveying official ADEC approval, endorsement, or recommendation.

This manual was last updated in June 2013 to reflect: EPA’s promulgation of the AERMOD Modeling System, AERSCREEN, and ancillary programs; new ambient air quality standards (e.g., 1-hr NO_2); updated modeling tips; and current regulatory citations. ADEC also revised the overall outline by adding a “quick guide” for more experienced model reviewers.

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1. Quick Guide

This section 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 memorandum 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.

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 AS 46.14.160) to notify the applicant if the application is incomplete and if so, what information is missing.
- If we do not notify the applicant within 60 days, the application is considered complete, leaving only 70 days to issue a final decision.
- If we do notify 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 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.

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 the Air Permit Program 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).

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.

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 include project information, what the requirements for an ambient demonstration, and permit classifications the application triggers in order to confirm what the modeling obligations are.

- Has the applicant described the purpose of the project and its location?

- Is a map in sufficient resolution to identify the source and building locations, ambient air boundaries, nearby terrain features, and any meteorological or air quality monitoring sites used in the analysis?
- Has the applicant clearly and accurately identified the permit classifications for this project?
- 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 (ADEC does not require one), compare the protocol (and any comments by ADEC) to the modeling report to determine if the protocol was followed.

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?
- 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 the results are not correct for the 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 model-ready? If so, how was it obtained and is it approved by ADEC?
  - If the data are not model-ready and need preprocessing, how was it performed? Is there an adequate description of the process (including program options)?
  - **Maybe the most important question**: Are the data representative of the site/sources being modeled? Even model-ready data may not be representative.

  - AERMET, AERSCREEN, and CALMET require information based on land use/land cover (LULC) data. Determine if appropriate data were used. The United States Geological Survey (USGS) is a common source of these data.
  - 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?
  - 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 sources 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.

Emission Units – Inventory, Characterization, and Emission Rates

Depending on the purpose of the modeling and what preliminary modeling shows (such as the significant impact levels), the number of sources and associated parameters could be short or extensive.

- Make a quick determination on the 'depth' of the modeling analysis so when the sources are reviewed, you have an idea if the number, type, and locations of sources are reasonable.

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

- Were appropriate short-term and long-term emission rates modeled for the corresponding short-term and long-term modeling assessments?
- The permit application must present the source type, emission rate, and associated release parameters in a clear and concise manner for each emission unit. Is each emission unit characterized correctly?
- Do the emission rates equal or exceed the emissions rates in the permit application? The applicant can model emission rates higher 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 the information provided in the modeling report.
- Are the units correct for emission rate and source parameter units used for the model used? Typically, metric units of measurement are input to the models, but information from a vendor or other source may be in English units.

  Key point:

  The release parameters and emission rates can vary by model and source type. Some models may allow you to control the input units through a modeling option. Be sure there is consistency throughout the modeling for all the emission units.

- Are intermittent sources 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?
- If sources are grouped, are they properly accounted for in the groups?

Pollutant Specific Modeling

There are important pollutant transformations that may need to be addressed in regulatory dispersion modeling analyses. These include the NO_2 and PM-2.5 modeling.

NO_2

- If annual NO_2 was modeled, what approach (Tier) was used to convert NO to NO_2 (Tier 1 is 100% conversion)?
- If Tier 2 was used, was a national average or a site-specific NO_2-toNO_X value used? If a site-specific value was used, is sufficient justification for the fraction provided? The default national average can be used without further justification.

The following apply to a Tier 3 approach:

- If AERMOD was used for a Tier 3 application, was OLM or PVMRM used?
- Were representative hourly ozone data used?

- Was an appropriate value for the NO_2/NO_X in-stack ratio (ISR) for each emission unit applied?
- If PVMRM was applied, was approval from ADEC obtained?
- If OLM was applied for the 1-hr NO2 modeling was approval obtained from ADEC?
- If a model other than AERMOD was used, is there sufficient detail to determine if the model was applied correctly with the appropriate input parameters?

PM-2.5

- Was an approach used that demonstrates the cumulative impact is conservative and protective of the ambient standard?

Other Pollutants

- Were other pollutants, such as SO_2 modeled? For 1-hr SO2 impacts, were the impacts calculated correctly (i.e., with the probabilistic form of the standard)?
- Did the applicant follow the Interagency Workgroup on Air Quality Modeling and Federal Land Managers' Air Quality Related Values Workgroup (FLAG) guidelines to account for the formation of pollutants that contribute to regional haze? Was CALPUFF used and applied correctly?

Building Information and Downwash

AERMOD

AERMOD uses building dimensions developed by the Building Profile Input Program for PRIME (BPIP-PRIME or BPIPPRM) for every 10° wind direction.

- Review any Good Engineering Practice analyses. Does the analysis agree with the maps and dimensions provided?
- Review the building information to ensure all sources and buildings are accounted for that could impact pollutant dispersion and align with the plot plan.
    - Use of 3rd- party software with a graphical user interface (ADEC uses BEEST) 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)
- 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 sources, receptors, and structures.

CALPUFF

Although the same input structure is used to specify the building information in CALPUFF, there is no indication in the CALPUFF user's manual on how to calculate these values. For CALPUFF modeling, review the procedures used.

Receptors

- Confirm the ambient air boundary is correctly defined and excludes public access. Note: You probably will see the ambient air boundary referred to as the fence line or property boundary and the terms used interchangeably. Be sure the applicant is applying the definition of the ambient air boundary correctly.
- Receptors can be specified in numerous ways, especially for AERMOD. Is the network of receptors sufficient to identify the maximum impact required for the project classification?
- Are there any flagpole receptors?
- Are receptors at locations of sensitive populations?
- Are receptors located at worker housing, if any (inside the ambient boundary)?
- Plotting the receptors in a third-party product specific for dispersion modeling (such as BEEST) or other software (e.g. Golden Sofware's Surfer®) will greatly assist you in visualizing performing this task.

Off-site Contributions and Background Air Quality Data

The use of a significant impact area (SIA) to determine which off-site sources to include in the modeling should be abandoned. The SIA has been replaced by the concept of the significant concentration gradient.

Nearby sources expected to cause a significant concentration gradient in the vicinity of the emission units under consideration should be explicitly modeled. Distant large sources or nearby sources with small emissions may not be required to be included in the modeling.

- Has the applicant identified nearby sources and included them in the source inventory for each applicable analysis (AAAQS, PSD Increment)?
- Did the applicant include an appropriate background air quality value for each pollutant and averaging period (where applicable)?
- Was an average concentration for the "meteorological condition of concern" used?

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 applied properly.

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) – (e)
- If the results were compared to significant impact levels (SILs), were the conclusions correct (to continue with a cumulative impact analysis).

  Note: The applicant can perform a cumulative analysis and bypass a comparison to the SILs.
- Examine the analyses. Was all the necessary modeling performed and the results presented in a format that the reviewer can easily follow and understand?
- Are AAAQS, increments, and other standards clearly identified for comparison to the modeling results?
- Background air quality data are a required part of the applicant's 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 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) should be notified of the application. Did the FLM want to be involved? If so, to what extent?

Note: Class I areas are greater than 300 km from the applicant's stationary source do not require FLM involvement.

- Were emission rates for all nearby, existing sources modeled at current actual emission rates and corresponding stack parameters for a PSD increment analysis?
- Are there any temporary construction activities for which an exclusion applies?
- Was visibility impairment (plume blight/regional haze) addressed? Was an appropriate model used (e.g. VISCREEN)?
- Were impacts on vegetation and soil adequately addressed?
- Was a Class I are 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 is 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 – collect data, surrogate data, or demonstrating that project impacts are less than the significant monitoring concentration(s) (SMC)? The answer to this question may vary by pollutant.

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2. Detailed Discussion

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 and EPA's *Guideline on Air Quality Models* (*Guideline*) [1] – 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/ap/modeling.htm) and the information posted on EPA's modeling web-page (see http://www.epa.gov/ttn/scram/).

This section of the review manual contains the following information. Subsection 2.1 presents suggestions on the reviewer's perspective, and an overview of both EPA and Federal Land Manager (FLM) guidance on conducting modeling analyses. Subsection 2.2 presents an overview of a suggested procedure for performing an efficient review of an ambient air quality assessment. Subsections 2.3 through 2.16 present detailed discussions and "expert tips" on various technical items, such as meteorological data processing and receptor grid generation. Section 3 presents a list of common acronyms.

Appendix A presents information and expert tips on the dispersion models commonly used in New Source Review (NSR) ambient assessments, including VISCREEN, AERSCREEN, AERMOD, Offshore and Coastal Dispersion (OCD) model, and CALPUFF. Appendix B now contains some frequently asked questions about dispersion modeling. Appendix C is a past example of determining the average concentration for the meteorological condition of concern under Section 8.2 of the *Guideline*.

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

[1] http://www.epa.gov/scram001/guidance/guide/appw_05.pdf

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 its 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, EPA Region 10*

2.1.2 ADEC Regulatory Requirements

ADEC's air quality control regulations are in 18 AAC 50.[2] Various sections in Article 3 (Major Stationary Source Permits) and Article 5 (Minor Permits) pertain to the air quality permit program and requirements to conduct ambient assessments. 18 AAC 50.215 contains additional specific requirements for the Ambient Air Quality Analysis Methods. The State's Air Quality Standards 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 in Figure 1. ADEC does not routinely require applicants to model air toxics.

In addition to standard ambient assessments, major source PSD applicants must also conduct an analysis of the impact from the source and associated growth on visibility, vegetation and soil. PSD applicants may also need to conduct an Air Quality Related

[2] See http://dec.alaska.gov/air/ap/regulati.htm

Value (AQRV) analysis, consistent with the Class I area Federal Land Manager (FLM) requirements, to assess the impacts within a "nearby" Class I area.

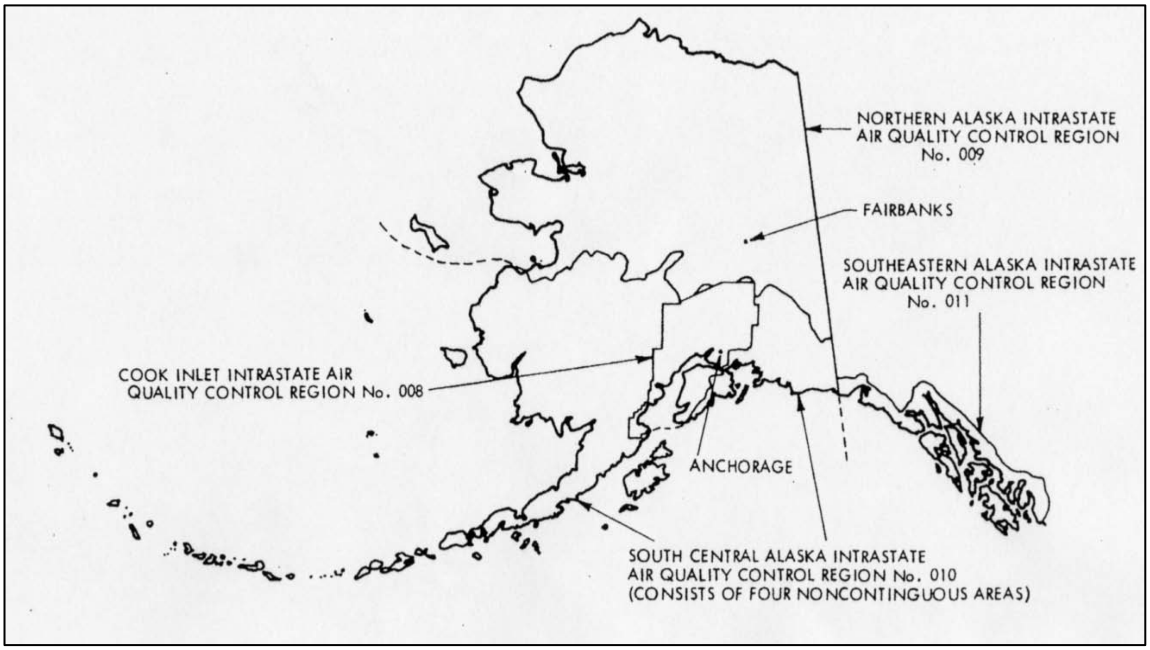

Figure 1. Air Quality Control regions in Alaska

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 CFR 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 and a cumulative impact analysis. In the preliminary analysis, the applicant assesses ambient concentrations resulting from emissions from the proposed project alone (i.e., the emission increases associated with the permit application). For this analysis, the applicant should consider emissions and stack data at the various operating loads that may occur to ensure that project impacts are not underestimated. The results of the preliminary analysis are typically compared to the applicable significant impact level (SIL) in Table 5 of 18 AAC 50.215(d) to determine whether the impacts are significant.[3] If they are, the applicant must perform a cumulative impact analysis to demonstrate compliance with the applicable ambient air quality standard or increment. (Note: Applicants may bypass the project impact analysis if they want – it's not required. This can save them and ADEC time, especially if it's clear that the project impacts will likely exceed the SILs.)

Prior to 2011, if the preliminary analysis indicated that an ambient concentration would exceed the SIL for any pollutant and averaging period, then the applicant would typically determined the extent of the geographical area for which the impacts exceeds the SIL. This was referred to as determining the "significant impact area" (SIA). The applicant

[3] 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.

then performed a cumulative impact analysis in the SIA for the pollutant and averaging time associated with the exceedance of the SIL. The cumulative impact analysis expanded the preliminary analysis by considering emissions from both the proposed source(s) and other existing sources within the SIA. It may also have considered other sources outside of the project's SIA that may have caused significant impacts in the project's SIA.

The SIL and cumulative impact concepts are still valid, but EPA is now saying that the past approach of including all sources within the SIA and large sources beyond the SIA may lead to overly conservative results. EPA now suggests a more literal reading of Section 8.2.3 of the *Guideline*, which says the impacts from most offsite sources could likely be represented through the background data set and that only those sources expected to cause a "significant concentration gradient" in the vicinity of the applicant's source need to be explicitly modeled in a cumulative impact analysis.

The results from the cumulative analysis are used to demonstrate compliance with the Alaska Ambient Air Quality Standards (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 FLAG Guidance on Class I Analysis Procedures

The Federal Land Managers' Air Quality Related Values Work Group (FLAG) was formed to develop a more consistent approach for the Federal Land Managers (FLMs) to evaluate air pollution effects on their resources. Of particular importance is the NSR program, especially in the review of PSD of air quality permit applications. The goals of FLAG are to provide consistent policies and processes both for identifying air quality related values (AQRVs) and for evaluating the effects of air pollution on AQRVs, primarily those in Federal Class I air quality areas, but in some instances, in Class II areas. Federal Class I areas are defined in the Clean Air Act 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 Clean Air Act requires State permitting authorities to notify the FLM if emissions from a proposed PSD project may impact a Class I area. FLM involvement will depend on project size and location relative to the Class I area. Expect FLM involvement for any PSD project located within 50 km of a Class I area. If a proposed PSD project is located within 100 km of a Class I area, or further if the annual emissions[4] divided by distance (in meters), or Q/D, is greater than 10, the FLM should be notified of the project. Class I areas greater than 300 km from the applicant's stationary source do not require FLM involvement.

Guidance on FLM notification can be found Section 2.2.1 of the 2010 FLAG report.

It is important to engage the FLM early in the process, during the pre-application phase. 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.

The FLAG Phase I Report-Revised (October 2010) [5] consolidates the results of the FLAG Visibility, Ozone, and Deposition subgroups. The chapters prepared by these subgroups contain issue-specific technical and policy analyses, recommendations for evaluating AQRVs, and guidelines for completing and evaluating NSR permit applications. These recommendations and guidelines are intended for use by the FLMs, permitting authorities, NSR permit applicants, and other interested parties. The report includes background information on the roles and responsibilities of the FLMs under the NSR program.

2.1.5 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[6], 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 current list includes, but is not limited to AERMOD, OCD, and CALPUFF (used for modeling long-range transport). "Non-guideline" models may be used on a case-by-case basis upon approval by ADEC and EPA, but ADEC must then also allow for public comment regarding the use of the non-

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

[5] Federal Land Managers' Air Quality Related Values Workgroup (FLAG), Phase I Report – Revised (October 2010). U.S. Forest Service. National Park Service, U.S. Fish and Wildlife Service. (http://nature.nps.gov/air/Pubs/pdf/flag/FLAG_2010.pdf)

[6] 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".

guideline model for the given application. The following paragraphs briefly describe the most commonly used air quality models.

The AERMOD Modeling System consists of three components: AERMAP (used to process terrain data and develop elevations for the receptor grid/emission units), 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 the date of this manual) 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/ap/modeling.htm (see the document *Geometric means for AERMET surface parameters (Rev. 2, Revised 6/17/09)*).

The OCD model[7] 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.

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 AERMOD, AERMOD-COARE, which may someday replace OCD for open water conditions. Check the *Guideline*, EPA's Support Center for Regulatory Atmospheric Modeling (SCRAM), or the Regional modeling contact for the current status of these models.

The Plume Visual Impact Screening Model (VISCREEN)[8] is used to assess plume coloration and contrast (referred to as plume blight), but not regional haze. It can model

[7] 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 http://www.epa.gov/ttn/scram/dispersion_prefrec.htm#ocd

[8] U.S. Environmental Protection Agency. September 1988, with Revisions 1992. Workbook for Plume Impact Screening and Analysis. Appendix B: The Plume Visual Impact Screening Model (VISCREEN).

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.

CALPUFF [9] may be used to quantify pollutant concentrations, regional haze, and acid deposition impacts. It is currently used for Long Range Transport (LRT) assessments (at distances greater than 50 km from the emission source), but may also be used at shorter distances on a case-by-case basis, with ADEC and EPA Region 10 approval. 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 is typically used to assess impacts at Class I areas.

EPA-450/4-88-015. Office of Air Quality Planning and Standards Research Triangle Park, NC. http://www.epa.gov/scram001/userg/ntisinfo.txt, revisions - http://www.epa.gov/scram001/userg/screen/viscrdu.pdf

[9] Scire, J.S., D.G. Strimaitis, and R.J. Yamartino, 2000: A User's Guide for the CALPUFF Dispersion Model (Version 5). Earth Tech, Inc. Concord, MA

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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 memorandum. 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 does not notify the applicant within 60 days, the application is considered complete, leaving only 70 days to issue a final decision. If ADEC does notify 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 memorandum is the ultimate work product associated with ADEC's review of an ambient demonstration, begin writing the modeling memo at the onset of the review.

Key points:

- ***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 memo.***

A modeling protocol is not required by ADEC. 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 and will be accepted. In addition, the modeling protocol is a valuable tool in identifying and resolving potential areas of concern early in the process, as well as assisting the applicant in preparing the modeling analysis.

Figure 1 illustrates the steps involved in a modeling review. At the onset of the review, gather together the following documents or files:

1. air quality modeling checklist,
2. the modeling review memo template,
3. a blank document to record deficiencies,
4. the modeling protocol and ADEC comments and correspondence,[10]
5. the modeling report, and
6. the 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 modeling report, and the template for the modeling review memorandum.

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 modeling report 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 analysis in detail.

The applicant should provide a short summary at the beginning of the modeling analysis document, 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 into the modeling review memo.

Step 2 As you go through the document in detail, use the applicable air quality modeling checklist as a guide. Each item in the checklist (e.g., site location, model selection, meteorological data, etc.) is indicated in the flow diagram (Figure 1) as item N, representing each item that must be reviewed. 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 that presented in the modeling report

[10] 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.

and permit application. Also make certain the modeling report is technically complete.

- Document the finding in the modeling review memo 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.
- Once a section is completed, document the results in the modeling review memo or the deficiency letter and begin review of the next section.

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

By 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, thereby enhancing efficiency of permit review and issuance.

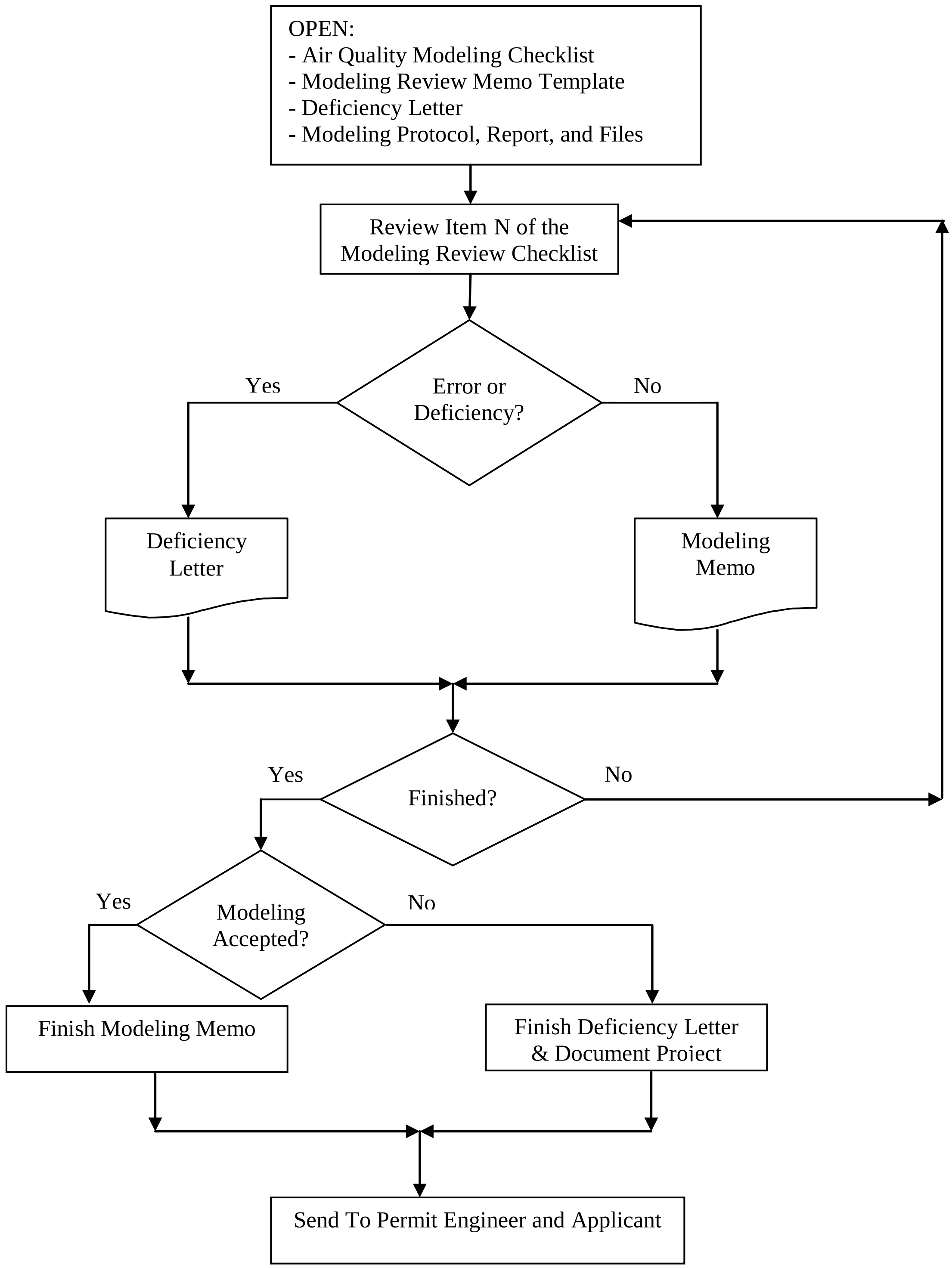

Figure 2. Modeling Review Procedures

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 memorandum and on the form, to keep track of changes. The background section of the modeling memorandum 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 definition of the area of impact, the cumulative NAAQS 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 NAAQS 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 the modeling review memorandum.

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 Memo

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 utilizes a modeling review memorandum to communicate the findings of the modeling review, which is submitted to the lead permit engineer and can be included as an attachment to the TAR. The modeling review memorandum is discussed in detail in this section.

The modeling review memorandum 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 memorandum should not repeat everything in the modeling report. Instead, the memorandum 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 memorandum at the onset of the project.

Templates of a modeling review memorandum are available electronically in QMS. 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 memo. While some of the language provided in a template is useful and often common to many projects, much of a memo will be unique to each project. The modeling review memorandum can also be abridged if the applicant is only revising a portion of a previously approved analysis. In these cases, reference the previous memorandum and only note those items that have changed or otherwise warrant discussion. In all cases, state whether ADEC concurs 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.

The following section provides guidance regarding the typical sections of the modeling review memorandum. Where applicable, check that the report includes where or how the data were obtained and a description of the data used in the modeling (e.g., meteorology, terrain).

Header:

- ✓ The modeling review document is typically submitted as a memorandum from you to the file. It may also need to go through a seasoned modeler or the supervisor. Check with the supervisor to determine who will be reviewing your work. Follow the format for a memorandum provided in the example.

Introduction:

- ✓ Provide a one paragraph summary of the contents of the memo. Be certain to mention the applicant, the project, the associated permit application, the relationship to previous permit applications, if any, and whether or not the project will be in compliance with the Alaska Ambient Air Quality Standards (AAAQS) provided in 18 AAC 50.010, or the maximum allowable increases (increments) listed in 18 AAC 50.020.

Background:

- ✓ Describe the project, the project location, the current construction permit, operating permit and/or consent decree the facility is currently operating under (as applicable), the facility and project classification, and the regulatory basis as to why the modeling analysis was conducted. State whether the project did or did not trigger PSD review.

Approach:

- ✓ The models, pollutants, and methods should briefly be described. Mention whether or not the modification was modeled solely, or if a cumulative impact analysis was performed.

Facility Layout:

- ✓ Identify the location of emission sources, buildings, and structures. A figure may be helpful. Identify the coordinate system and datum (e.g., UTM NAD27 meters) and if this was the same coordinate system used to identify the receptors.

Meteorological Data:

✓ Identify which stations were used for both surface and upper air observations and the corresponding period. Discuss any data processing issues and how they were resolved. Note whether the data is temporally representative.

Terrain Data:

✓ Provide a description of the land use around the stationary source. Discuss how terrain is handled. Identify the sources of data used and how the terrain was processed (e.g., a model's preprocessor). If terrain is not included, provide a justification for excluding terrain.

Emission Rates and Stack Parameters:

✓ Identify which emission units were included in the modeling analysis and their emission rates of each pollutant modeled, expressed in annual average emission rate (tpy) and short-term maximum emission rates (lbs/hr). Note any discrepancies between the emission rates as calculated by or provided to the modeler and the emission rates in the modeling files and how these were resolved. Document whether or not the revisions affected the conclusions of the modeling analysis. Document any sources not modeled because they were considered insignificant or for some other reason.

Load Screening Analysis:

✓ Discuss whether the applicant conducted a part-load analysis, and if so, summarize the results. For turbines, note whether the applicant included various ambient temperatures in the load analysis. Note any discrepancies and how these were resolved.

Ambient NO_2 Modeling:

✓ Document the method employed to convert from NO to NO_2, including 100% conversion. As applicable, note whether the applicant calculated the 1-hour averages according to EPA guidance (see the Addendum AERMOD User's Guide[11] (*AERMOD Addendum*)).

Ambient SO_2 Modeling:

✓ Document the basis for the SO_2 emission calculations for fuel combustion. As applicable, note whether the applicant calculated the 1-hour averages according to EPA guidance (see the *AERMOD Addendum*).

Ambient PM-10 Modeling:

✓ Document the basis for the emission calculations, including fugitive emissions. As applicable, note whether the applicant compared the high sixth-high (h6h) concentration over a five-year modeled period to the 24-hour AAAQS/Increment.

[11] Addendum User's Guide for the AMS/EPA Regulatory Model - AERMOD (EPA-454/B-03-001), September 2004

Ambient PM-2.5 Modeling:

✓ Document the basis for the emission calculations, including fugitive emissions. As applicable, note whether the applicant calculated the 24-hour and annual averages according to EPA guidance (see *AERMOD Addendum*). PM-2.5 is either directly emitted from a source (primary emissions) or formed through chemical reactions in the atmosphere (secondary formation). Since AERMOD does not include the necessary chemistry to account for secondary formation, EPA issued guidance on recommended approaches to account for this formation. Document whether the applicant followed the guidance.

Building Downwash Analysis:

✓ Document if a downwash analysis was conducted and whether or not EPA's Building Profile Input Program for PRIME (BPIPPRM) was used. Note any discrepancies and how these were resolved.

Ambient Air Boundary:

✓ Discuss whether a physical barrier is present, such as a fence, which prevents public access, and where the barrier is located. If not present, discuss what was used to delineate the ambient air boundary.

Receptor Grid:

✓ State whether the applicant's receptor grid was adequate for this analysis or whether you included additional receptors during your review. If this is a facility that has been modeled before, document any changes to the previous grid. Document any discrepancies from ADEC's guidance and any modifications that may be necessary for future applications. Document whether receptors were included at on-site worker housing, if applicable.

Off-site Impacts:

✓ Document if and how impacts from off-site facilities were addressed and whether any off-site sources were eliminated from the analysis.

Background Concentrations:

✓ Discuss the data source and time period that was used to establish the background concentration for each modeled pollutant and averaging time. Note any discrepancies and how they were resolved.

Results and Discussion:

✓ If the applicant conducted a project impact assessment (e.g., a load analysis to ensure that project impacts are not underestimated), provide a summary table of the project impacts for each pollutant modeled and applicable averaging time. Compare these values with the significant impact levels. For those pollutants and averaging periods that exceed the SIL, provide a separate table comparing the impacts from the facility, off-site sources, background concentration and combined total for comparison with the ambient standards. Similarly, present the maximum modeled increment concentration from the facility and off-site sources.

Compare the total increment impact with the applicable increment standard. Provide a brief discussion of each table and any issues associated with the compliance demonstration, if deemed helpful for future analyses.

Conclusions:

- ✓ Restate the project and whether or not the project will comply with the applicable ambient standards and increments. State whether the modeling was consistent with EPA's *Guideline on Air Quality Models*.
- ✓ State any special conditions that were modeled or arose from the review of the modeling analysis that should be included in the permit (e.g., limits on operating schedule).

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.

- ✓ You must ensure that the emission units/processes, pollutants, and discharge rates used in the modeling compliance demonstration 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 emission sources 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 8760 may be necessary to demonstrate compliance with the annual AAQS/ increments. It is not necessary to impose restrictions for purposes of complying with the AAAQS/increments if the applicant is able to demonstrate compliance with potential emissions greater than actual emissions (Note, the actual emission rate is always less than or equal to the potential emission rate). Recommended restrictions should be documented in the conclusions of the modeling review memo.

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, emission units, and methods of operation. Without a good general understanding of the project, it is possible that certain emission units or operating scenarios may not be properly accounted for. It is recommended that you have a general discussion with the permit engineer on the proposed project before the modeling review has initiated.

The air quality analysis requires specific information on the physical characteristics of emission sources (such as information for point sources including emission rate, stack height, stack diameter, and exit velocity and temperature) and the location of emission sources, nearby structures, ambient air boundaries, and receptors (in a consistent coordinate system). The review of this project information is discussed in this section.

There are some software programs available that serve as Graphical User Interfaces (GUI) with several regulatory dispersion models, and which allow you to graphically review project data. These programs include BEEST by Bowman Environmental Software, 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 are useful in modeling review. SURFER® graphics by Golden Software is one such commonly used general graphics and mapping program.

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

An application for a construction permit must include a project location map in sufficient resolution to identify the source and building locations, ambient air boundaries, nearby terrain features, 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 application must also contain a scaled site plan or plot plan in sufficient resolution to identify the sources and buildings, property and fence lines, and roads. The coordinates and site plan orientation must be identified. A consistent coordinate system must be used for the map and site plan. Rather than plant coordinates, the Universal Transverse Mercator (UTM) coordinate system is strongly recommended.

ADEC 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 on the submitted modeling CD-ROM. The topographical map should be a geo-referenced (aligning a place to a known coordinate system in physical space) file such as a GeoTIFF or Surfer file, and the site plan should be submitted as a geo-referenced CAD or Surfer file. This will expedite the review of this information.

Topographical data and base elevations of emission sources can be reviewed and verified using either topographical maps and/or graphical plots of USGS 24k Digital Elevation Model (DEM) data files. The GUI modeling systems previously described can be efficiently used to load digital DRG and/or DEM data for the topographical review.

A land use analysis is not required in Alaska unless the facility is located in the greater Anchorage area (all other areas of the state are rural), and so land use data does not typically need to be supplied with a modeling analysis. However, there are two cases when land use data is required; when the facility is located in the greater Anchorage area, or when AERMOD is used. AERMOD's meteorological preprocessor (AERMET) requires user's to specify the surface roughness height, Bowen ratio, and surface albedo of the project site. These parameters are often determined as a function of land use classification (e.g., urban, forested, etc.), and may even be specified by directional sectors, seasons, or months of the year. If there are significant differences in land use by direction within a few kilometers of the project (e.g., ocean in one direction, mountains in the other direction), then sector-specific parameters should be selected. Additionally, if these parameters change as a function of season (e.g., ice in winter, water in summer), then seasonal or monthly values should be utilized. Land use data is available from EPA and USGS in ArcGIS formats.[12]

2.3.2 Layout of Emission Units and Structures

- ✓ Verify that the applicant has correctly located all emission units, structures, and receptor grids on a consistent coordinate system.

The relative stack height to building height is a critical parameter for simulating downwash in AERMOD/AERSCREEN and OCD. The stack location relative to a structure must also be characterized for simulating downwash in AERMOD/ AERSCREEN. Stack and building coordinates, and heights, must therefore be checked for accuracy. The GUI modeling systems previously described can be efficiently used to load model and BPIPPRM input files, and overlay this information on DRG, DOQQ, and CAD files for review of consistency.

- ✓ Make a 3-D plot of the buildings/stacks using the graphical software of your choice (e.g. BEEST) 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).

For an AERMOD analyses, the current modeling staff typically uses the BEEST software program (Oris Solutions). BEEST will graphically display the building, stack and receptor locations, and includes options for showing the stack and building labels. Reviewers can also easily import USGS Quad map in the background. (Other commercial programs also allow background maps, but at least in some cases, you have to mark opposite corners using the cursor and then manually enter the coordinates. This extra step is cumbersome and inaccurate). The following discussion is based on BEEST version 10.07.

- ✓ Double click on the BEEST icon from the windows screen to launch the program. From the File menu, click on the Import command, then the "Generic AERMOD DTA…" file import command. Locate the directory and file name from the

[12] Land use information may be available at the following web sites: http://edg.epa.gov/metadata/catalog/search/searchpage and http://eros.usgs.gov.

applicants model input file and open the file. You may have to click on the down arrow under the file type sub-window to allow the program to recognize all file types (*.*). Once loaded, click on the Show Current Data Graphically icon listed across the top of the window. You should now be able to see a two dimensional (2-D) plot of the sources (and the receptor grids, as discussed further below).

(Note: importing an ISCST3 input file is still available as of version 10.07.)

✓ If you only have the output file (with a default file extension of .LST in BEEST), you will have to create the input file before you can load the BPIPPRM file. To do so, load the output file. You will need to change the file type from the default .DTA or display all file types (*.*). Highlight the output file. Click on "Open", and finally click on "Import" in the Import File window. For large output files, the import process can take several minutes and many invalid pathway messages are generated. Click on "Close" to close the import window. From the Pathway menu, select the second tab on the Control Option submenu. On the right side, click on the 'Not Run' option. Return to the main menu, and click on RUN AERMOD. You will have the option to save the current data to a BEEST project file (.BST). You can elect to save it now or later. On the AERMOD Setup dialog, the Model Data Input File [DTA] may need to change, depending on how BEEST displays the filename. To change the name, click on File to open the dialog box, enter a new file name, and click Save. Click 'No Downwash'. A summary of the input is displayed (notice the NORUN option is noted on the right side. Click "Run AERMOD" to create the input file. Once the input file is created, you can load the building information from the BPIPPRM file, as described next.

An alternate method, which may be quicker as well, is to copy and rename the output file (changing the file extension to .DTA), edit the file and delete all records after the "OU FINISHED" record, save the resulting file. This file can then be imported as an AERMOD input file (using "Generic AERMOD DTA…" under the "File .. Import" menu).

✓ From the File menu, click on the Import command, then the Generic BPIP/ BPIP-Prime Input File command. If you did not save the project earlier, you will be prompted to do so now. You can elect to save the project now or later. Locate the directory and file name from the applicants BPIPPRM input file and open the file. You may have to click on the down arrow under the file type sub-window to allow the program to recognize all file types (*.*). Make certain to read any warning messages in detail as they may provide helpful clues to errors, for example "building base elevations are non-zero, while source base elevations are zero". [Note: In BEEST, the AERMOD file needs to be imported *prior* to the BPIPPRM file, in order for the buildings to be seen with the stacks.]

✓ Once loaded, click on the Show Current Data Graphically icon listed across the top of the window. You should now be able to see a 2 dimensional (2-D) plot of the building and stack layout of the facility. From the list of icons on the right side of your screen, click on the right

most icon on the top row that says "3D" to create and display a 3 dimensional image of the buildings. Confirm that the layout and location is consistent with submitted plot plans and photographs.

- ✓ If a digital map (24k Digital Raster Graphic (DRG))[13] or aerial photograph (Digital Orthophoto Quarter Quads (DOQQ)) is available, this can be overlaid on the BPIPPRM plot to ensure the sources and buildings are located correctly. The digital map or photo must be in one of the following formats to be compatible with BEEST: *.tif, *.bmp, or *.jpg. From the graphics icon list on the right side of the BPIPPRM plot, click on the first icon on the top row that says MAP. Use the browse feature to identify and open the appropriate file. The map will appear on screen. If a geo-referenced map file is not used, the user must provide coordinates for the lower left (southwest) and upper right (northeast) corners.

Fugitive emissions from area or volume sources require special 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 model.

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

The air quality modeling assessment must be performed in all locations of "ambient air", which has been defined by EPA as 'that portion of the atmosphere, external to buildings, to which the general public has access' (40 CFR 50.1(e)).[14] In order to limit public access to a source's property, EPA and ADEC have generally required that a fence or some other barrier must be present, and so the fence line, not the property line, is used to define the ambient air boundary.[15] In limited circumstances and on a case-by-case basis, geographical barriers such as a cliff or river may preclude public access and be used to define the ambient air boundary. Alaska also has some stationary sources where the use of a fence or similar physical barrier is impractical or creates a safety concern (e.g., in some areas, fences can become hazards during whiteout conditions). In these rare cases, ADEC has allowed applicants to establish an access control plan for their ambient air boundary.[16]

Facility fence lines and property boundaries must be shown on the required site plan, and the model receptor grid must start on the fence line or ambient air boundary. You should graphically review the receptor grid to ensure the ambient air boundary has been correctly represented. Refer to Section 2.12 for details on reviewing receptor grids.

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[13] On USGS's EROS web site (http://eros.usgs.gov), click on "Find Data" followed by "Digitized Data" and finally "Digital Raster Graphics". Proceed with the download at the bottom of the page using the EarthExplorer link.

[14] Adopted by reference in AS 46.14.990(2)

[15] Refer to the Ambient Air policy memorandum on EPA's SCRAM Website under Generic/Recurring Issues, notably memorandum AMA-3 at http://www.epa.gov/scram001/guidance/mch/ama3.txt .

[16] Applicants who desire to use an Access Control Plan must also show that they have a legal right to preclude public access at the proposed ambient air boundary.

2.4 Pre-construction Monitoring

40 CFR 52.21(m)(1) requires PSD applicants to submit ambient air monitoring data describing the air quality in the vicinity of the project, unless the existing concentration or the project impact is less than the significant monitoring concentration (SMC) provided in 40 CFR 52.21(i)(5). The requirement only pertains to the pollutants subject to PSD review. If monitoring is required, the data are to be collected prior to construction. Hence, these data are referred as "pre-construction monitoring" data.

There are three possible methods for meeting the obligation for preconstruction monitoring. The first is by collecting PSD-quality ambient data at a location and in a manner that is consistent with EPA's *Ambient Monitoring Guidelines for Prevention of Significant Deterioration*, which is adopted by reference in 18 AAC 50.035(a)(5). 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 the state and PSD quality assurance requirements per 18 AAC 50.215(a).

The second method is to provide existing ambient data as a surrogate of the expected maximum concentration at the project site. This data should also be current PSD-quality data that reflects an upper bound of the criteria described in EPA's monitoring guidelines. (See additional discussion later in this section.)

The third method is to submit a modeling analysis that shows the project impacts are below the SMC for each of the PSD-triggered pollutants. . 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. However, 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-2.5 must include d pre-construction PM-2.5 data, regardless of the project impacts.

In situations where there is no existing ambient air monitor in the modeled area, monitors located outside the areas of maximum impact may be used. A determination of this option is on a case-by-case basis. 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. The intent of this is to allow use of a 'regional' site in remote areas and not in multi-source areas.

Another consideration for pre-construction monitoring is the length of the monitoring period. EPA and ADEC require monitoring to be conducted for at least one year (and meet all PSD quality requirements) prior to submitting the application to construct. However, under some circumstances, EPA may accept less than one year of monitoring data with four (4) months being the minimum period. The length of the period varies by pollutant. For all pollutants, EPA accepts less than one year if the applicant demonstrates through historical data or dispersion modeling that the data are obtained during a period when maximum concentrations can be expected. Special attention must be given to ozone since maximum concentrations are generally season-dependent.

- ✓ ADEC rarely allows less than 12-months of data though, due to seasonal variations in ambient concentrations. If a specific request arises, staff should discuss the issue with the Air Division's Monitoring & Quality Assurance (M&QA) supervisor.

A person who submits ambient monitoring data under AS 46.03, AS 46.14, or 18 AAC 50.215(a)(1) 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, total suspended particulates (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 is used in an application.

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*.[17] 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.

Surrogate Pre-Construction Data

Surrogate pre-construction data refers to existing ambient data that an applicant proposes to use in lieu of establishing a monitoring program to collect pre-construction data. The surrogate data must have been collected consistent with EPA's *Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)*, adopted by reference in 18 AAC 50.035(a)(5). Per Section 2.1 of the ambient monitoring guidelines, applicants may use either "existing representative air quality data" or collect ambient data. The request and data must be evaluated on a case-by-case basis.

In determining whether the pre-existing data are representative the data quality, data age, and monitor location must be considered. The data must meet all PSD quality assurance requirements and the data must be representative of the current emission activities.

With regard to location, the data must be representative of the location of the maximum project impact, the location of the existing maximum concentration, and the location of the combine impact from existing plus proposed sources.

2.4.1 Comparison of Project Impacts to Pre-Construction Monitoring Thresholds

Most PSD applicants compare their project impacts to the pre-construction monitoring thresholds in an effort to demonstrate that pre-construction monitoring is not required.[18] As in the case of the significant impact analysis, 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 be used.

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

[18] This approach is not currently allowed for PM-2.5 under the January 22, 2013 decision by the District of Columbia Circuit Court of Appeals

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

Applicants must compare the highest, first-highest (H1H) impact to the monitoring thresholds.

- ✓ Determine whether existing ambient data are representative of the vicinity of the proposed new emission unit or modification.

A discussion of representativeness of the monitoring data is discussed in EPA's *Ambient Monitoring Guidelines for the Prevention of Significant Deterioration*. The document discusses the relevancy of monitoring locations, data quality, and use of current data.

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."

For situations in which the proposed source or modification will be constructed in an area that is generally free from the impact of other point sources and area sources associated with human activities, then monitoring data from a "regional" site may be used as representative data. Such a site could be outside of the maximum impact area, but must be similar in nature to the impact area. This site would be characteristic of air quality across a broad region including that in which the proposed source or modification is located.

- ✓ Under such circumstances (i.e., the proposed source or modification will be constructed in an area that is generally free from the impact of other point sources and area sources associated with human activities), representative background monitoring, which is representative of non-modeled and distant sources, may be representative of pre-construction monitoring data. However, for areas of multisource emissions, representative background monitoring data from other locations may not be used as substitute for preconstruction monitoring data.

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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-hp engine may only require a screening analysis to confirm impacts are less than AAAQS and 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. However, a refined model that requires detailed input data (most importantly, representative hourly meteorological data) should not be used when such data are unavailable. In general, assuming that representative meteorological data are adequate, the use of AERMOD is generally preferred so that the analysis will result in accurate estimates of air quality impacts.

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 to 50 kilometers, as the dispersion algorithms and model evaluations have been conducted for these distances. Common near-field models included AERSCREEN, AERMOD, OCD, and 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 is the preferred long-range transport model.

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 and can be found in the *AERMOD Addendum*[11]. Some options that were available in ISCST3 are not options for AERMOD and cannot be overridden, e.g., buoyancy-induced dispersion. Gradual plume rise is always 'on' in AERMOD, whereas in ISCST3, the user had to specify the option GRDRIS to invoke it in the model.

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

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[19] land use analysis is not required, except possibly for analyses in the greater Anchorage area.

2.5.3 Averaging Periods

Averaging periods should correspond to the appropriate pollutant-specific significant impact levels, ambient air quality standards, and PSD increments. For example, if SO_2 is being modeled, the 3-hour, 24-hour, and annual averaging periods should be employed.[20]

- ✓ Verify that the appropriate short-term or long-term emission rates are used for the appropriate averaging periods.

Often, separate modeling files are necessary for pollutants with different short-term and annual average emission rates. With the recent introduction probabilistic standards (e.g., 98^{th} percentile for the 1-hr 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 1-hr averages will not give the 98^{th} percentile value to compare to the standard. The model run for the 1-hr NO_2 standard must be a separate run.

For screen-level modeling applications, some models only provide 1-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 1 automatically convert 1-hour concentration estimates from AERSCREEN to other averaging periods. Refer to Appendix A for AERSCREEN[21] modeling tips.

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

[20] Note that 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, but are still part of the AAAQS

[21] U.S. Environmental Protection Agency. March 2011. AERSCREEN User's Guide. EPA-454/B-11-001 Office of Air Quality Planning and Standards, Research Triangle Park, NC.

Table 1. Point Source Scaling Factors for AERSCREEN

Averaging Period	EPA Scaling Factor for Point Sources[a]
3 hour	1.0
8 hours	0.90
24 hours	0.60
Annual	0.10

[a] AERSCREEN User's Guide

2.5.4 Geographical Projection Information

A consistent coordinate system should be used for the identification of receptors, building locations, and emission units. 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, 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, as in Figure 3.[22]

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

Figure 3. 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 meters 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 data set 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. The applicant must identify the source and time period of the meteorological data, describe the rationale for using the proposed data set, and demonstrate that it is spatially and temporally representative.

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. They do not require actual meteorological data. AERSCREEN develops a set of screening meteorology based on user input for minimum wind speed, surface characteristics, and several other parameters. The AERSCREEN users guide describes the input required to develop the meteorology for a screening analysis.

For more refined analyses, actual hourly meteorological data sets are required. Meteorological parameters are routinely measured at major airports by the NWS. The military also measures meteorological data that are equivalent to NWS data in accuracy and detail. Meteorological parameters may also be measured by applicants at the stationary source, which is generally referred to as site-specific data.

The data used in a modeling analysis must represent the meteorological conditions at the applicant's stationary source. The concept of "representative meteorological data" is critical to obtaining reasonable estimates of pollutant impacts, and is a concept that many, including meteorologists and dispersion modelers, struggle with.

2.6.1 What is Representative Meteorological Data?

Section 8.3 of the *Guideline* states that the meteorological data used in a dispersion modeling application 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. 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 of the earth's surface can play an important role in how the wind field develops.

The representativeness of the data is 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. According to the *Guideline*, in the case of AERMOD, this means "utilizing data of an appropriate type for constructing realistic boundary layer profiles. Of paramount importance is the requirement that all meteorological data used as input to AERMOD must be both laterally and vertically 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 spatial representativeness of the data can be adversely affected by large distances between the source and receptors of interest and the differing topographic characteristics of the source and meteorological data areas. 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 factor, that the emission releases would experience.

Temporal representativeness is a function of the year-to-year variations in weather conditions. If you look at wind roses (a frequency diagram that displays both wind speed and wind direction in a single plot) from two different years for the same location, overall you will likely see similarities but there will be variations that . Section 3 of EPA's *Meteorological Monitoring Guidance for Regulatory Modeling Applications*[23] provides a general discussion for determining the representativeness of meteorological data.

Representativeness of the data should be evaluated on a parameter-by-parameter basis. The ADEC Division of Air Quality's Monitoring and Quality Assurance Group has a meteorologist that can be contacted to help work through issues of representativeness.

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. EPA's meteorological monitoring guidance discusses the requirements for collecting data for various meteorological instruments.

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 can't 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 tight 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.

[23] "Meteorological Monitoring Guidance for Regulatory Modeling Applications". EPA Publication No. EPA–454/R–99–005. Office of Air Quality Planning & Standards, Research Triangle Park, NC. (PB 2001–103606) (http://www.epa.gov/scram001/) and the ADEC monitoring information at http://dec.alaska.gov/air/am/index.htm.

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 (10m – 2m) height should be used, unless there is a locally compelling reason otherwise.

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. Either five years of adequately representative NWS meteorological data, or one year or more, up to five years, of site specific data, are the minimum required when estimating concentrations of criteria pollutants with an air quality model. For NWS data, consecutive years from the most recent, readily available 5-year period are preferred. For long-range transport or complex wind situations and the application involves a non-steady state dispersion model, five years of NWS data or at least three years of mesoscale meteorological data are required (Section 8.3.1.2.d of the *Guideline*). Section 8.3 of the *Guideline* has additional details and recommendations regarding meteorological data.

2.6.3 Quality Assurance Requirements for Meteorological Data

The quality and completeness of a site specific data set is critical to its use in air dispersion modeling. The data must be collected under an ADEC-approved QAPP. Before using the data, it must also be reviewed and approved as PSD-quality. If NWS data are used, it is assumed that the data meet their (NWS) quality assurance requirements. However, that does not mean the applicant should not review the NWS 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*, adopted by reference in 18 AAC 50.035(a). 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 be of PSD quality. 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.

However, "site specific" data collected by applicants must meet minimum EPA requirements for accuracy, sensitivity, and completeness, as described in ADEC guidance and EPA's *Meteorological Monitoring Guidance for Regulatory Modeling Applications*[23].

While 90 percent recovery should be obtained for parameters required for a model such as AERMOD, 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 is also calculated from the vertical wind speed measurements. However, it is difficult to collect, 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 reviewed by the Air Division's Monitoring and Quality Assurance group 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*.[24] 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. Applicants may use the State's Freedom of Information Act (FOIA) provisions to request previous data reviews along with the site-specific data.

2.6.4 Meteorological Data Processing

Using representative meteorological input for the modeling domain is critical in refined dispersion modeling to identify the impacts to both the public and to the environment. AERMOD and CALPUFF each have their own preprocessors for this purpose, namely, AERMET and CALMET [25], respectively.

2.6.4.1 AERMET Data Processing

AERMET develops hourly boundary layer parameters and profiles for AERMOD using representative hourly meteorological observations (NWS or site-specific) and land use data. AERMET is designed to be run as a three-stage process (with a single executable) and operate on three types of data – National Weather Service (NWS) hourly surface observations, NWS twice-daily upper air soundings, and data collected from an on-site measurement program such as from an instrumented tower. 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.

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

[25] The Mesoscale Model Interface (MMIF) Program may one day be an alternative to CALMET in generating three-dimensional meteorological input fields for long-range transport assessments in support of regulatory air quality impact analyses.

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[26] for a complete description of these programs and data requirements.

National Weather Service

Although most NWS measurements typically are made at a standard height of 10 meters, the actual anemometer height should be used as input to the preferred model. NWS wind direction data are reported to the nearest 10 degrees (e.g., 23 for 230, 08 for 80). A specific set of randomly generated numbers has been implemented in AERMET and should be used with NWS data to ensure a lack of bias in wind direction.

- ✓ The option to randomize the wind direction must be included in the stage 3 input control file (i.e., METHOD WIND_DIR RANDOM) since the default is not to randomize.

Since 1996, NWS data at many stations have been collected by the ASOS, instead of the manual observations performed before that time. The ASOS data report cloud cover data in a different format, which could affect stability class calculations. Therefore, when the most recent five years of data include ASOS data (now the typical situation), discretion should be used. Where judgment indicates ASOS data are inadequate for cloud cover observations, the most recent five years of NWS data that are observer-based may be approved for use (*Guideline* Section 8.3.1.2(a)).

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) web site 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

A program that assists in developing the meteorological input with NWS data for AERMOD is AERMINUTE. 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".[27] AERMINUTE reads 2-minute average ASOS winds (reported every minute) that are available from the NCDC in the TD-6405 format.[28] AERMINUTE calculates hourly average wind speeds and directions to supplement the hourly winds processed in AERMET, reducing the number of calm winds provided to AERMOD. The

[26] U.S. EPA. User's Guide for the AERMOD Meteorological Preprocessor (AERMET); EPA-454/B-03-002; OAQPS, Research Triangle Park, NC, plus addendum

[27] U.S. EPA, Use of ASOS Meteorological Data in AERMOD Dispersion Modeling. Memorandum from Tyler Fox to Regional Modeling Contacts, March 8, 2013.

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.

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.

An important keyword that is mandatory in stage 1 is the wind speed threshold value. This value, when specified on the ONSITE pathway in stage 1 with the THRESHOLD keyword, is the minimum valid wind speed for site-specific measurements. This may be particularly important with the use of sonic anemometers whose detection limits are generally lower than the detection limits of cup anemometers. There is no default value and the value cannot exceed 1.0 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. The value set in the AERMET input control file when site-specific data are used must be checked.

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 from stage 3 since the direction of the

[28] 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)

sensible heat flux at the surface would be reversed from normal, which is upward (positive) during the day and downward (negative) at night.

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 has two additional parameters: a beginning date to start processing and an end date. With either option, the start year for the meteorological data still needs to be included on the SURFDATA keyword for AERMOD, even though there are no NWS data being processed. The start date is used by AERMOD for various internal processing decisions.

Output Review

Figure 5 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.

```
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 4. 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

Another source of errors can be found in Stage 3 processing. AERMET requires several parameters for the modeling domain that characterize conditions at the surface of the earth (hence the name surface characteristics). These characteristics are: surface roughness length, Bowen Ratio, and noontime surface albedo. Each can be specified as a function of season or month or annually and directional sector. For a complete description of these characteristics, see the AERMOD Implementation Guide.[29] Using incorrect values can lead to unrealistic estimates of 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.

Continuing the discussion of data representativeness, the *Guideline* states that "data that were collected off-site should be judged, in part, by comparing the surface characteristics in the vicinity of the meteorological monitoring site with the surface characteristics that generally describe the analysis domain."

There are several sources or methods to obtain these values.

AERMET User's Guide[26] 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*

[29] AERMOD Implementation Guide (March 19, 2009) at http://www.epa.gov/ttn/scram/7thconf/aermod/aermod_implmtn_guide_19March2009.pdf

Boundary Layer Meteorology[30] contains a figure for surface roughness for typical terrain types.

The Department is considering posting approved surface/profile files for applicants to use. This will make the data assessable, provide consistency between regional sources, and minimize the possible gaming that could occur by an applicant altering approved meteorological data.

AERSURFACE

Although AERMET is a single program, there is an ancillary programs in the AERMOD Modeling System to assist the user in developing the input meteorology for AERMOD.

Before the digital age, topographic maps, aerial photos, and professional judgment were used to determine the albedo, Bowen ratio, and surface roughness (known collectively as the surface characteristics). EPA developed a program, AERSURFACE[31], to assist the user in prescribing these values 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 EPA's SCRAM can only process 1992 USGS land cover data, which does NOT include Alaska. A future update to AERSURFACE will include the capability to process 2001 and 2006 USGS land cover data, which does include coverage in Alaska.

ADEC has posted a guidance document[32] on how to calculate these values manually. 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 surface parameters for tundra. A literature search by a permit applicant led to values that were approved by ADEC for the application and are shown in Table 2. 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

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

[31] AERSURFACE User's Guide, EPA-454/B-08-001, January 2008 (Revised 01/16/2013)

[32] Geometric means for AERMET surface parameters (Rev. 2, Revised 6/17/09)

surface characteristics (note that AERMET can process up to 12 non-overlapping sectors).

Table 2. Surface Parameters 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

2.6.4.3 Missing Data Substitution

Most regulatory models are capable of handling missing data. For example, as part of the DFAULT option in AERMOD, processing hours with missing meteorological data are treated in a method similar to the calms processing routine (i.e., it sets the concentration value to zero for that hour, and calculates the short-term averages according to EPA's calms policy). As long as the reasonable valid data capture requirements have been met (90% capture per quarter for a site specific program, and reasonable data capture for multi-year NWS data sets) and the quality of the data have been assessed, it is generally preferred to "ignore" missing data versus the alternative of filling in missing data with questionable data interpolations or non-representative data from other locations [per the *Guideline*, missing wind data should not be filled in (unless there are collocated sensors, etc)].

Some applicants may be able to use NWS temperature data to substitute for missing site-specific temperature data, but there is no way to substitute temperature data alone through the substitution option in AERMET. Using the SUBNWS option in AERMET will substitute missing wind data as well, which in most cases, is not representative of the site. All other NWS parameters (e.g., station pressure) are auto automatically substituted even without the specification of this option.

- ✓ AERMET should NOT be run so that NWS surface data is substituted for missing site-specific data, i.e., the METHOD REFLEVEL SUBNWS should not be included in the stage 3 input control file.

The applicant should follow Section 8.3.3.2 (c) of the *Guideline*, which refers to Section 5.3 of the EPA Meteorological Monitoring Guidance.

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-dimensonsal 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 is not an ASCII file that is easily opened with a text editor.

Another point that a user needs to be aware of is the regulatory status of the CALPUFF modeling system. The current regulatory version of CALMET is 5.8, level 070623 (as of June 30, 2013). Refer to the EPA’s SCRAM website to check the current status and if there have been any updates.

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 Meteorological Data Summaries

The applicant should provide summaries of the meteorological data to aid in the review and approval of the data. Wind roses and joint frequency tables describe typical wind flow patterns and help in assessing the representativeness of the data. Distributions of stability class and wind speeds are other useful summaries that can be used to evaluate the reasonableness of the data.

2.6.7 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.

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2.7 Emissions and Emission Unit Data

This section provides some general information on common types of sources in Alaska and helpful tips for reviewing the emission rates and source release characteristics. In addition to verifying the correct model input data was used, the section also reminds you to obtain a larger perspective on the project. After becoming familiar with the project, you should ensure that all operating scenarios have been considered and that all sources have been included in each operating scenario. Section 2.7.1 provides general information regarding emission rates and stack parameters. Section 2.7.2 provides more specific information regarding the most common types of emission units in Alaska. Sections 2.7.3 through 2.7.6 provide additional comments regarding operating scenarios, part load assessments, off-site sources, and source groups.

2.7.1 Emission Rates and Stack 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 99^{th} percentile for the 1-hr SO_2 standard. Some sources may not operate continuously throughout a day, or throughout the year. If the applicant does not know specific times or dates of operation, then they may use a time-averaged emission rate modeled 8,760 hours per 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 permit application must present the source emission and stack parameter data in a clear and concise format for each emission unit. Tables or spreadsheets provide the best format for reviewing and crosschecking this information. This is especially true when there are several identical or similar emission units. 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 stack parameter data, and to provide an electronic copy of any spreadsheet used to calculate the modeled emission rates and stack 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 source. 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 $\frac{kN-m}{gmole-K}$

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 emission units that exhaust through stacks, chimneys, exhaust fans, 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 is manufacturer specific information, followed by general AP-42 equations and mass-balance calculations.

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 emissions associated with construction activities. 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.

PM-10 impacts from vehicle traffic (e.g., road dust) in which an initial wake behind the vehicle is created should be characterized using multiple volume or area sources. The number of volume sources, N, should be calculated as described above. The vertical dimension of the source used in the calculation of Szinit is typically equivalent to the height of the vehicles generating the emissions, commonly 1.5 to 3.0 meters.

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. In the Fall 2011, the workgroup issued its final report with a draft recommendation to EPA. The report provided a variety of approaches for characterizing haul roads. These approaches included modeling the roads as volume sources or as area sources. The workgroup, however, did not forward any recommendation to model the haul roads as (a series of) point sources, indicating that more study is needed. A memorandum summarizing the workgroup's efforts is on EPA's web site.[33]

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 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

If horizontal stacks or raincaps are present on a point source stack, the vertical component of the exit velocity is effectively removed. Consequentially, a unique approach may be needed to characterize these stacks. The approach varies by model, as discussed below.

- **AERMOD**: EPA's suggested method is described in the *AERMOD Addendum* [11] EPA has also incorporated this procedure as a "beta" option in AERMOD. The use of this option requires the model user to designate the horizontal and capped stacks in the Source (SO) pathway. Use of this option ensures the correct adjustments are made to the stack characteristics. ADEC has therefore allowed permit applicants to use this option. The use of this option is actually preferred, since it eliminates the possible errors that could occur by manually making the stack adjustments.

  While the use of an equivalent stack diameter with an exit velocity of 0.001 m/s (as described next for OCD) could be employed in AERMOD for these source types, it should not be employed for sources subject to building downwash. As noted in the AERMOD Implementation Guide:

  > "Capped and horizontal stacks that are subject to building downwash should not be modeled using an effective stack diameter to simulate the restriction to vertical flow since the PRIME algorithms use the stack diameter to define the initial plume radius which, in turn, is used to solve conservation laws."

Another way to prevent precipitation from falling into an emission unit is to use a flapper valve. These obstructions do not hinder vertical momentum and should be treated as an uncapped stack. Figure 5 shows an example of flapper valves.

[33] http://www.epa.gov/ttn/scram/reports/Haul_Road_Workgroup-Final_Report_Package-20120302.pdf

Figure 5. Example of Open and Closed Flapper Valves

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

  1. Assume the exit velocity = 0.001 meters per second
  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) $$\mathbf{d_{eq} = d}\sqrt{\frac{v}{0.001}} = \mathbf{31.6\ d}\ \sqrt{v}$$

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[21] 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 "beta" option described above to invoke the algorithms for horizontal and capped stacks.

  For situations in which multiple point sources are modeled and not all stacks are discharged horizontally or there are multiple sources, applicants are still free to make separate runs, but AERSCREEN has the alternative option to run AERMOD with screening meteorology generated by MAKEMET. This would be decided on a case-by-case basis.

  The *AERMOD Implementation Guide*[29] also states that for vertical stacks that are capped, turn off stack-tip downwash and reduce the stack height by three times the actual diameter. ADEC considers this option (i.e., turning off stack-tip downwash and reducing the stack height by three times the actual diameter) as a surrogate for stack-tip downwash and approves of the method.

  Another case arises where stacks are not vertical, but are offset from vertical by up to 45 degrees. In this case, the vertical momentum of the plume is reduced 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 should also be adjusted in the same manner to preserve the vertical volumetric flow rate. Temperature is the same as that provided by the applicant.

<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 BPIP).

<u>Non-buoyant Plumes</u>

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 Combustion Sources

There are three common types of combustion sources that are modeled in Alaska: internal combustion (IC) engines, boilers/heaters, and 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 the combustion source which may be helpful.

2.7.2.1 Internal Combustion Engines

The compression of the fuel/air mixture in an internal combustion engine leads higher combustion temperatures and NOx emission rates than what is found in a boiler/heater.

In calculating emissions, applicants may use a combination of data sources. The preferred data source is source test data (if it represents the desired load), manufacturer specific information, followed by general AP-42 equations. Mass-balance should be used for calculating SO_2 emissions. For example, an applicant may use manufacture's data for estimating the emissions of NOx and CO, mass-balance for SO_2, and AP-42 for PM-10 and VOCs.

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 hp, and Section 3.4 is used for larger engines. If the engine or generator set package identified in the permit application is not identified in units of hp, the reviewer should convert the units to make certain the applicant used the correct section of AP-42. Errors are often made when the applicant refers to the performance of the generator, rather than the engine, in determining engine size.

Per the *Guideline*, applicants should assess the IC engine's partial load operation to determine the load scenario with the greatest ambient impact. A reasonable load screening analysis would consider operations at 100 percent, 75 percent, and 50 percent load points. Part-load vendor or source test data should be used when available. When vendor or source test data is not available, as a reasonable rule-of-thumb, 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). 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.[34] Please note that these assumptions may not be appropriate for other permitting aspects, such as PSD avoidance caps. See Section 2.7.4 for additional information regarding the modeling of partial load conditions.

<u>Background Information – IC Engines</u>

Diesel-fired IC engines are commonly used in Alaska for electrical generation and to support oil and gas operations. All IC 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, 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. Because the combustion process occurs at relatively high temperatures, there is a relatively high concentration of thermally-formed NOx in

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

the exhaust of IC engines. 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 IC engine is used for electricity generation, the shaft of the IC 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 IC engine may be under- or over-sized with respect to the generator. The distinction between the power rating of the IC engine and output electrical capacity of the generator is important, especially in calculating emissions and stack parameters.

Engine capacities are commonly stated in terms of the mechanical shaft power output (which can be stated in English units of brake horsepower [bhp] or metric units of kilowatts (kW) [1 bhp equals 0.746 kW]), and sometimes by the engine heat input rate in units of MMBtu/hr (fuel input rate times heat content of fuel). The approximate overall efficiency of IC engines varies according to size and design, but is roughly 35-40 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). Specific manufacturer data on heat (fuel) input rates and power output should be used for any specific analysis.

Generator capacities are stated in terms of electrical power output capacity, usually expressed in terms of kW-hr. The efficiency of generators when converting shaft mechanical power output to electrical output power varies according to the generator design, but is typically about 95 percent efficient. As an example, in a matched engine/generator system, an engine may be rated at 900 bhp (equal to about 660 kW of mechanical power output), and the generator output would be approximately 625 ekW.

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”.[35] An F-factor is the ratio of the combustion gas volume to the

[35] 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.

heat content of the fuel, expressed as standard cubic feet per million Btu (scf/MMBtu).[36] 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

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

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 ranges between 460 – 500 K. However, values within 30 K of this range may be seen and could be acceptable.

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 manufacture'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 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 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.

Per the *Guideline*, applicants should assess the partial load operation to determine the load scenario with the greatest ambient impact. According to the *Guideline* (Section 8.1.2), a reasonable load screening analysis would consider operations at 100 percent, 75 percent, and 50 percent load points. 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

[36] The standard temperature used with "F-factors" is 20^{o}C (68^{o}F) or 293K.

for pollution control).[37] Please note that these assumptions may not be appropriate for other permitting aspects, such as PSD avoidance caps. See Section 2.7.3 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 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.

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

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 as the heat input rate (MMBtu/hr). However, at times the horsepower output of the boiler (in units of bhp) or the steam output rate are used to define the boilers capacity. Some conversion factors include 0.045 to convert boiler horsepower output (in units of bhp) to heat input rate (in MMBtu/hr), and 34.5 to convert boiler horsepower output (in units of bhp) into steam generation (i.e., output) rate in units of lbs-steam/hr. It should be noted that the power output of a boiler used primarily for heating may be expressed in units of MMBtu/hr, but this is for the output heat rate, not the heat input rate. 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.

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 actual temperature, but short-term emissions and stack parameters should 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 "air chilling" will also affect the turbine emissions and stack parameters. In order to calculate the worst-case air quality impacts, the screening analysis needs to analyze multiple operating scenarios (based on operating load and atmospheric conditions) to predict the highest ambient impacts on a pollutant-specific basis.

Turbine start up presents another operating scenario that must be considered. Because emissions of CO can significantly increase during startups and shutdowns, a separate load screening analysis for CO should be performed for startup/shutdown.

ADEC strongly recommends that applicants 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.[37] Please note that these assumptions may not be appropriate for other permitting aspects, such as PSD avoidance caps. See Section 2.7.4 for additional information regarding the modeling of partial load conditions.

2.7.2.4 Flares

Flares can be tricky emission units 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 British Petroleum Exploration Alaska, 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 in expressed in calories/second):

1. Compute the adjustment to stack height ($H_{equiv.}$) as a function of total heat release Q in MMBtu/hr:[38]

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

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

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

Note the following: 1) some flares are rated in MMBtu per hour 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

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

[Note: 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 EPA Region 10 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 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

(Reserved)

2.7.3 Additional Comments Regarding Operating Scenarios

✓ Ensure that emissions (and stack parameters) for each proposed operating scenario are evaluated, and that the "worst-case" ambient impacts have been determined.

Each operating scenario may require its own unique modeling analysis to demonstrate compliance with the AAQS, and PSD increments.

✓ Confer with the permit engineer to ensure all reasonable operating scenarios are addressed in the modeling analysis.

For sources using backup fuels, the fuel that produces the highest emission rate for each pollutant must be used when determining emission rates for modeling. For example, if a boiler primarily uses natural gas as a fuel but uses No. 2 diesel as a backup fuel, then the fuel which produces the highest emission rate for each pollutant-specific averaging period should be used.

If the project is associated with oil field construction or operation, be aware that specific guidance has been developed by ADEC to address the modeling requirements for construction and intermittently used oil field equipment. Refer to Policy and Procedures 04.02.104 and 04.02.105 for guidance. These, and other air permit policy documents, can be found at http://dec.alaska.gov/air/ap/policy.htm.

In some circumstances, a modification to an existing facility 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 emission units within the facility. Applicants must include these associated changes in their modeling analysis.

✓ During the review, make certain you have identified if the modification "debottlenecks" the facility in some way, thereby causing an increase of potential emissions at other emission sources at that facility.

Some facilities may have emission units 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-by-case determination regarding a minimal size-threshold for the modeling analysis. For example, ADEC allowed the U.S. Air Force to exclude emission units rated at less than 50 hp from a modeling analysis they conducted in 2003 for Eielson Air Force Base. For North Slope sources complying with Policy and Procedure 04.02.104 or 04.02.105, the de minimis size for modeling is 400 hp.

2.7.4 Additional Comments Regarding Part Load Assessments

Part of the operating scenario analysis should include an evaluation of various operating loads for the project's emission units. Because emission rates, exit velocity, and temperature may vary as a function of operating load or condition (e.g., MMBtu/hour), modeling is required to determine which load has the potential for the largest ambient impacts.

Section 8.1.2 of the *Guideline* presents guidance on how the "load screening analyses" should be conducted. At a minimum the emission unit 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. It should be noted that while emissions and stack flow rates are relatively linear with load for boilers, emissions and stack flows for combustion turbines are not linear with load and engineering data should be submitted by the applicant to define turbine low load emissions and flow data.

Use judgment in assessing which emission units warrant load screening. The evaluation of part-load conditions for all emission units at a large facility can become burdensome. It is also nearly impossible to evaluate all of the possible combinations of source operations. Therefore, ADEC typically works with the applicant to select the sources/loads for evaluation. In general, we only ask for a load analysis for the larger emission units. It is clear that only emission units that operate for significant amounts of time at less than 100 percent load should be considered. Load screening for emergency and intermittently used equipment is not required. Applicants should describe their proposed part-load approach and assumptions in the modeling protocol.

If modeled emission rates are based upon stack test results, the applicant should take care that corresponding stack parameters, i.e., measured concurrently with the emission rates (e.g., exit velocity and temperature) are used in the modeling. Applicants commonly use the maximum measured emission rate and maximum exit velocity, which may not be concurrent in time.

In addition to partial load screening, an analysis should be conducted for turbines as their emissions change as a function of ambient temperature. Refer to the second to last paragraph in Section 2.7.2.3 for a discussion of the basis for this phenomenon and recommended conditions for screening.

- ✓ Use judgment in assessing which emission units warrant load screening.
- ✓ Verify load screening was done in a method consistent with section 8.1.2 of the *Guideline*.
- ✓ If modeled emission rates are based upon stack test results, care should be taken that concurrently measured stack parameters (e.g., exit velocity and temperature) are used in the modeling.
- ✓ Make certain the applicant has conducted a screening analysis for turbines as a function of ambient temperature.
- ✓ Verify worst-case scenario was selected for each pollutant, and applicable averaging period.

- ✓ Verify the results of the load-screening analysis were carried forward in the preliminary and full impact analyses, i.e., the scenario that yielded the worst-case impacts.

2.7.5 Off-site Sources, Cumulative Analyses, and Background Data

A cumulative impact analysis expands the preliminary analysis in that it considers the total impact from all sources. Input requirements and the required approach for AAAQS compliance and PSD demonstrations are described in Sections 8.1 and 8.2 of the *Guideline*.

To adequately address a comprehensive analysis, the off-site inventory and background air quality data must be evaluated on a case-by-case basis and must be done for each pollutant with impacts greater than the SIL.

<u>Off-site Sources</u>

Per Section 8.2.3b of the *Guideline*, "[a]ll sources expected to cause a significant concentration gradient in the vicinity of the source or sources under consideration for emission limit(s) should be explicitly modeled." Since the number of such sources is expected to be small, guidance in EPA's March 1, 2011 clarification memo[39] "cautioned against the literal and uncritical application of very prescriptive procedures for identifying which background sources should be included in the modeled emission inventory for NAAQS compliance demonstrations".

Previous guidance defining a fairly rigid circular area to consider can now be disregarded. With this guidance, EPA makes no attempt to define "significant concentration gradient", but defers to professional judgment. As noted above, "all sources expected to cause a significant concentration gradient" should be considered. This does not mean EVERY source. Larger, substantive sources should be considered initially. Impacts from sources with small emissions that have steep but localized gradients are likely to have a far less impact on the larger scale. The clarification memo provides guidance on criteria for defining the significant concentration gradient and may provide additional insights for you.

> *Key point:*
>
> *Refer to EPA's March 1, 2011 1-hour NO_2 clarification memo for guidance on determining which sources to include in the analysis.*

<u>Cumulative AAAQS Analysis</u>

ADEC and EPA require that all nearby sources be explicitly modeled as part of the AAAQS analysis, including other existing emission units at the applicant's facility. The *Guideline* defines a "nearby" source as any point source expected to cause a significant concentration gradient in the vicinity of the proposed new source or modification. The number of nearby sources is expected to be small except in unusual circumstances.

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[39] US EPA, Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2, National Ambient Air Quality Standard (March 1, 2011) http://www.epa.gov/ttnnaaqs/aqmguide/collection/nsr/appwno2_2.pdf

In addition, nearby sources that do not run concurrently with the proposed sources do not need to be modeled. A non-concurrent source is a source (i.e., emission unit) that does not operate at the same time as the subject source, such as a backup diesel engine/ generator in support of a primary power combustion turbine. The exclusion only applies to emission units located at other stationary sources and that it is incumbent upon the applicant to demonstrate to our satisfaction that the emission units are not operated concurrently.

The emissions from "other sources" (e.g., natural sources, minor sources and distant major sources) do not need to be explicitly modeled, and their contribution to the total ambient concentration can be determined through the use of background concentration data.

Once the background concentration is determined (see below), it is added to the modeled concentration (for the proposed, existing, and nearby sources) 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.

> *Key point:*
>
> *In general, the emissions from nearby sources that are modeled in the cumulative short-term AAAQS analysis are based on maximum allowable short-term emission rates (or if the nearby source does not have a permit or enforceable restriction, the short-term emission rate is based on the sources maximum physical capacity to emit).*
>
> *For the cumulative long-term AAAQS analysis, emissions from nearby sources are based on the short-term emission rates multiplied by the actual annual emissions averaged over the most recent 2 year period.*

Cumulative PSD Increment Analysis

Analogous to the AAAQS cumulative analysis, only "nearby sources" expected to cause a significant concentration gradient in the vicinity of the source or sources under consideration for emission limit(s) need to be considered in the cumulative PSD increment analysis. In general, the sources for the increment inventory are 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 affect the increments.

For the PSD increment cumulative impact analysis, the appropriate emissions that must be modeled for nearby sources are the actual emission changes that have occurred since the applicable baseline date.

Key point:

ADEC guidance is to first model increment consumption using allowable emissions for nearby sources. If modeling with allowable emissions produces exceedances, actual emissions for nearby sources may be used according to guidance in Alaska's State Implementation Plan.

All increments are currently deterministic, *even if* the associated air quality standard is probabilistic. 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.

As a result PSD applicants need to submit two sets of PM-2.5 runs for each averaging period (24-hr & annual):

- One where the concentration is calculated in a manner consistent with the probabilistic AAAQS; and
- A second set where the concentration is calculated in manner consistent with the deterministic increment.

The modeled impacts without background concentrations added are compared to the maximum allowable increase, which are found in Table 2 in 18 AAC 50.020.

The applicant should 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 emission units 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, care must be taken with AERMOD to not overestimate the credit if the non-DFAULT PVMRM option is used. As noted in the *AERMOD Addendum*:[11]

> "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 the PVMRM option.

Applicant's Cumulative Source Inventories

Currently ADEC does not maintain a master emission inventory database that can be used to select source data based on geographical location. 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.

Source emission rates and stack parameters may be obtained by their existing permit documents (permits, TARs, permit applications) on file with ADEC.

Background Air Quality Data

Background air quality data is needed to supplement a cumulative AAAQS analysis.

> *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. Ambient monitoring data may ***not*** be used to "calibrate" a modeled result [reference *Guideline* Section 7.2.9].

Section 8.2 of the *Guideline* offers guidance in determining background concentrations. Currently, the *Guideline* offers a distinction between background concentrations for (1) single isolated sources, and (2) multi-source areas.

- ✓ Make certain that these procedures (as specified in section 8.2 of the *Guideline*) are followed for determining the background concentration.

Two options are available to determine the background concentration near isolated sources: (a) use air quality data collected in the vicinity of the source or (b) if there are no monitors located in the vicinity of the source, use a "regional site". For a multi-source area, the background monitored value should be added to model-predicted impacts from "nearby sources".

Applicants should propose background concentration data for case-by-case approval by ADEC. ADEC maintains a spreadsheet on the Juneau server (*G:\AQ\Permits\Monitoring\QAPP and Data Review)* that has the maximum concentration measured at each industry operating a monitoring station with PSD-quality data. These data can be used for estimating the background concentration within a nearby area. The data is the true max concentration of the given averaging period, rather than the max within the form of the standard. However, it eliminates the concern about underestimating the total impact if the values calculated within the form of the standard occur at different times. It essentially provides an upper bound of the background concentration in that area.

There is no discussion or provision in the *Guideline* for removing “exceptional events” from the ambient monitoring data set. That provision is a concept allowed under other air quality programs (e.g., area designations under Section 107 of the Clean Air Act). However, the *Guideline* does allow applicants to use the average concentration for the “meteorological conditions of concern” (Section 8.2.2.b of the *Guideline*). Appendix C provides an example (for Nuiqsut) of how this approach was used for PM-10. In addition to the approach for Nuiqsut, the Alaska Industrial Development and Export Authority (AIDEA) used a similar approach during the pre-application phase of the Healy Clean Coal Restart Project. However, in this case, ADEC slightly revised the resulting average PM-10 concentration. The AIDEA version of this project never developed into a permit, but the files associated with developing the PM-10 background concentration may be found in the AIDEA\HCCP folder in the Juneau AirFacs directory.

2.7.6 Source Groups

Source groups are useful in quantifying the air quality impacts from a pre-defined group of sources. They are identified in the SO option 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 emission sources, from different facilities. 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 exceedances of the 24-hour PSD increment. You want to know the contribution from the proposed project.

In the CO options, 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 highest, second-highest (H2H) 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 6 (reprinted by permission of Taylor and Francis) [40] 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 EPA's SCRAM web site http://www.epa.gov/ttn/scram/dispersion_prefrec.htm#aermod. 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.

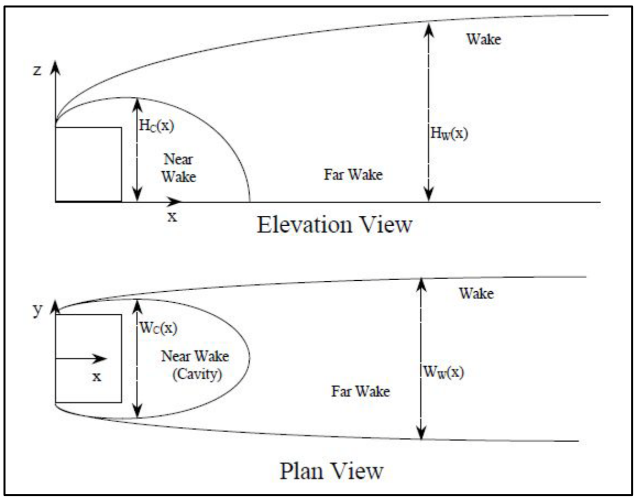

Figure 6. Near and Far Wake in AERMOD
(Schulman *et al.*, 2000; reprinted by permission of Taylor and Francis)

EPA has developed guidelines 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 7. Most stacks in Alaska are below formula GEP.

[40] 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)

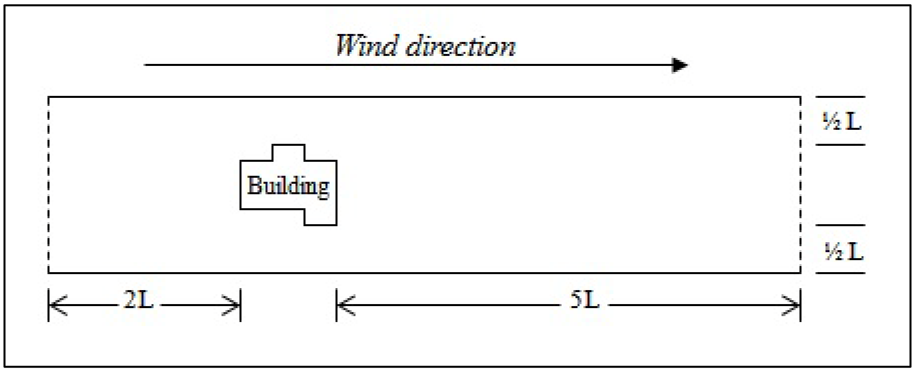

Figure 7. Plan View of Area of Influence of Building Wake Effects

2.8.1 GEP and BPIPPRM Analyses

The following discussion provides additional aspects of the building and emission unit 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[41]) for use with AERMOD.[42] 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.

[41] User's Guide to the Building Profile Input Program, U.S. EPA Office of Air Quality Planning and Support, Research Triangle Park, NC. EPA-454/R-93-038 (Revised April 21, 2004)

[42] The BPIP program used with ISCST 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. Third party dispersion modeling software with a graphical user interface, such as BEEST, can help visualize the spatial relationships between buildings and stacks. See Figure 8 and Figure 9 for an example of an aerial photograph and the representation in third-party dispersion modeling software.

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 8. Aerial View of an Applicant's Stationary Source

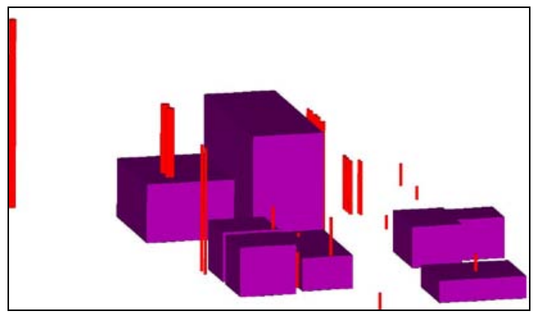

Figure 9. Visualization of the Applicant's Characterization of the Structures and Emission Units using a 3rd-Party Dispersion Modeling Software Package

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 BEEST 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 10 below.

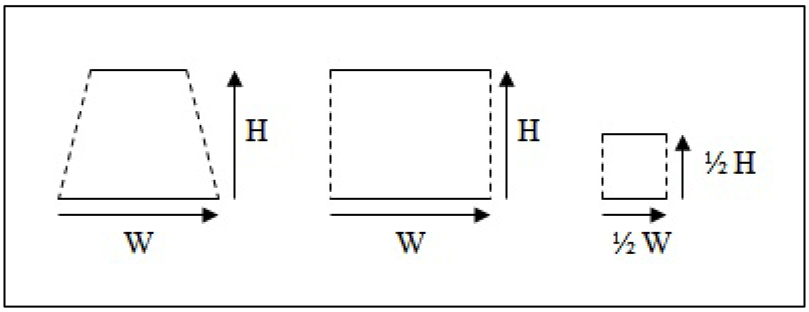

Figure 10. Illustration of Pitched Roof Representations in BPIPPRM

- ✓ 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 EPA Region 10 (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.

According to Mr. Bray, "*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."

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 tpy, the use of stack merging is allowed for SO_2 modeling analyses.

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.

The EPA guidance memorandums "Questions and Answers on Implementing the Revised Stack Height Regulation," G. T. Helms dated October 10, 1985, provides guidance on how merged stacks should be treated in a modeling analysis when merging is not creditable. EPA recommends that each emission unit 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 exit velocity and the volumetric flow from the individual emission units. 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 emission unit's flow).

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

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 oxides of nitrogen (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. The NAAQS and increment were developed for NO_2. Therefore, a methodology to estimating how much of the released NO is converted to NO_2 is needed in order to compare a modeled concentration to an NO_2 standard or increment.

2.10.1.1 Estimating Annual Average Impacts

The *Guideline* discusses a tiered approach for use in regulatory modeling of ***annual average*** NO_2 impacts, ranging from the simple assumption that 100 percent of the NO is converted to NO_2 to other more complex methods. These methods are discussed in more detail in the *Guideline*, and are summarized here. Figure 11, from Section 5.2.4 of the *Guideline*, shows each of the tiers.

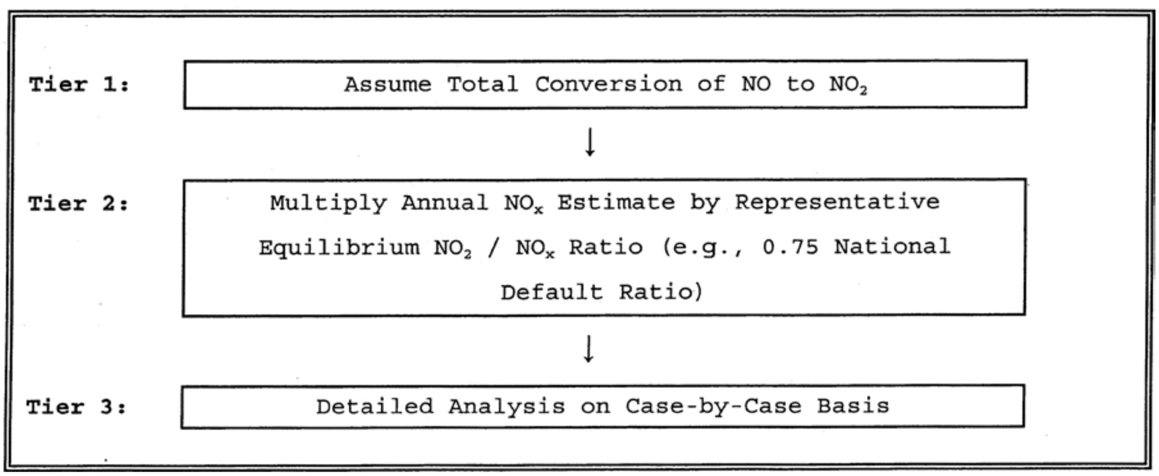

Figure 11. Tier Approach to Modeling Annual NO_2 Impacts

<u>*Tier 1*</u>

In Tier 1, the simplest approach and sometimes used as a first 'cut', the applicant may assume that 100 percent of the emitted NO is converted to NO_2. Applicants may use this approach without justification or request, since it provides the worst-case scenario for atmospheric conversion of NO to NO_2.

Tier 2

Should Tier 1 be overly conservative, the 2nd tier approach employs the method frequently known as the ambient ratio method (ARM). Tier 2 allows applicants to develop a site-specific ambient NO_2-to-NOx ratio using local monitoring data that meet strict quality assurance (QA) requirements. The ambient monitoring station must be located far enough away from local NOx sources to represent "quasi-equilibrium" atmospheric conditions. Unfortunately there are currently no NOx monitoring stations in Alaska that meet these requirements. However Tier 2 also includes a default 0.75 NO_2-to-NOx ratio.

The 0.75 NO_2-to-NOx ratio may be used in all parts of Alaska for estimating near-field annual average NO_2 impacts. However, ADEC questions whether it is appropriate for assessing impacts beyond 10 km. The *Guideline* states: " … default NO_2/NOx ratios, including the 0.75 national default value, can underestimate long range NO_2 impacts and should be used with caution in long range transport scenarios."

Tier 3

For a Tier 3 analysis, a detailed screening method, such as the Ozone Limiting Method (OLM) may be selected on a case-by-case basis.[43] This method limits the conversion of NO to NO_2 on an hourly basis based upon the amount of ozone (O_3) in the lower atmosphere. The applicant must use representative, hourly ozone data.

The OLM algorithm 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/NO_X in-stack ratio (ISR) for each emission unit (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.

AERMOD also includes the Plume Volume Molar Ratio Method (PVMRM) as an optional method for estimating ambient NO_2 concentrations.[44,45] PVMRM is currently a non-regulatory option. However, EPA Region 10 has authorized the State of Alaska to use PVMRM for estimating annual average NO_2 concentrations on a case-by-case basis

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[43] 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.

[44] 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.

[45] 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.

(with their additional approval). PVMRM uses the same representative, hourly ozone data as used in OLM.

As with OLM, when using PVMRM, the user must specify the ISR for each emission unit. To specify this ratio for all emission units, use the keyword NO2STACK on the CO pathway. To specify the ratio on an emission unit-by-emission unit basis, use the keyword NO2RATIO on the SO pathway. See the AERMOD Addendum[11] and Section 2.10.1.3 (NO_2/NO_X In-stack Ratios) below for additional information.

For PVMRM and 1-hr NO_2 modeling with OLM, the applicant would need to obtain EPA/ADEC approval, per 18 AAC 50.215(c)(2), for use of any non-*Guideline* method, as applicable for the given technique and averaging period. OLM is a *Guideline* algorithm for *annual* average NO2 modeling and approval under 18 AAC 50.215(c)(2) is not needed from EPA or ADEC.

2.10.1.2 Estimating 1-hr Impacts

In 2010, EPA approved a 1-hour standard for NO_2. A June 28, 2010 memorandum from EPA to regional air division directors[46] states that "[i]n general, the Appendix W recommendations regarding the annual NO_2 standard are also applicable to the new 1-hour NO_2 standard, but additional issues may need to be considered in the context of a 1-hour standard, depending on the characteristics of the emission sources, and depending on which tier is used". The memorandum summarizes those issues.

A follow-up clarification memorandum for the new 1-hour standard for NO_2 dated March 1, 2011 addresses, among other issues, the use of a default ambient ratio of 0.80 for Tier 2 as well as acceptance of 0.50 as a "default" in-stack ratio of NO_2/NO_X for input to OLM and PVMRM.[47] The applicant can use other ratios with adequate justification.

In the March 2011 EPA memorandum clarifying guidance on the 1-hr NO_2 standard using the Tier 2 approach described above, EPA recommends use of 0.80 as a default ambient ratio applied to the maximum cumulative hourly NOx concentration to compare to the 1-hour NO_2 standard under Tier 2 without additional justification by applicant.[47]

2.10.1.3 NO_2/NO_X In-stack Ratios

A spreadsheet of in-stack NO_2/NO_X ratios for various combustion turbines, reciprocating engines, and heaters and boilers is available on APP's modeling web-page.[48] These ratios are for specific emission units, but could be applicable for similar emission units.

Additionally, Shell used ratios in their 2011 outer continental shelf (OCS) permits issued by EPA. 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

[46] "Applicability of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard", dated June 28, 2010. (http://www.epa.gov/region7/air/nsr/nsrmemos/appwno2.pdf)

[47] "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard", dated March 1, 2011. (http://www.epa.gov/ttnnaaqs/aqmguide/collection/nsr/appwno2_2.pdf)

[48] http://www.dec.alaska.gov/air/ap/modeling.htm

CDPF and oxidation catalysts. A ratio of 0.066 was used for reciprocating engines without catalyzed diesel particulate filters; 0.041 for heaters/boilers, and 0.023 for incinerators.

EPA also has provided an NO_2/NO_X in-stack ratio database on their website.[49] 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.

2.10.1.4 Ozone Data

NO_X scavenging reduces the measured O_3 concentrations. Since low O_3 values can lead to less NO to NO_2 conversion than high O_3 values, scavenging can lead to underestimating the NO_2 concentration in a modeling analysis. Scavenging can be easily spotted by comparing traces of the measured NO_X and O_3 concentrations, as seen in Figure 12. NO_2 to O_3 Comparison to Detect NO_X Scavenging

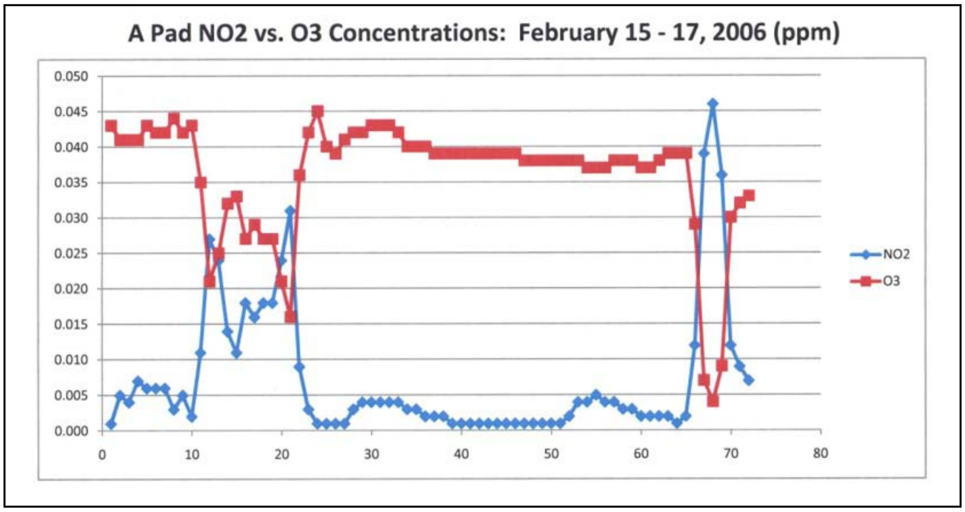

Figure 12. NO_2 to O_3 Comparison to Detect NO_X Scavenging

There are numerous ways to address this issue. 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 that ambient O_3 is fairly consistent across the North Slope. Therefore, "local" data isn't needed for a North Slope NO_2 analysis.

[49] http://www.epa.gov/ttn/scram/no2_isr_database.htm

2.10.2 PM-2.5

PM-2.5 is either directly emission from a source, as primary emissions, or formed through chemical reactions in the atmosphere, as secondary formation. AERMOD and OCD are acceptable models for performing near-field analyses of the primary emissions, but EPA has not yet developed a near-field model that includes the necessary chemistry algorithms for estimating secondary impacts.

EPA proposed draft guidance for dealing with this deficiency in March 2013. They expect to finalize their guidance in fall 2013. In the mean-time, for modeling PM-2.5, the applicant should use the same general approach as used to model other criteria pollutants. For AERMOD to correctly calculate the 24-hr impact for comparison to the standard, the pollutant must be identified as "PM25" (without the quotes) on the POLLUTID keyword. Condensable PM-2.5 emissions should be included in all submittals that are sent for public notice after January 2, 2011 (per EPA's May 2008 Rulemaking).

For comparison to the AAAQS, an appropriate background value must be selected to account for impacts from secondary formation. The applicant should provide sufficient justification for the value used in the analysis. The value must be adequately conservative to reflect emissions from sources not modeled as well as to account for the secondary formation of PM-2.5. Local data is preferred over non-local data, but only if it is representative of the non-modeled impacts. If local data are not available, state-wide averages are available for rural/small community settings. At the time this document was prepared, these values are 18 micrograms per cubic meter ($\mu g/m^3$) for the 24-hr maximum concentration and 4 $\mu g/m^3$ for the annual average.

If the applicant followed EPA's March 23, 2010 guidance for demonstrating compliance with the AAAQS, confirm that the applicant used an approach that demonstrates the cumulative impact is conservative and protective of the ambient standard for PM-2.5. An internal guidance document[50] provides key points regarding background concentrations and approaches that may be used to demonstrate compliance with the PM-2.5 AAAQS.

2.10.3 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.

2.10.4 Ozone

Tropospheric ozone (as opposed to stratospheric ozone) is a PSD regulated pollutant. No *de minimis* air quality level is provided for ozone, and if ozone is a triggered PSD-pollutant, a source impact analysis is required per 40 CFR 52.21(k). Since ozone is not

[50] General Concepts to Consider When Reviewing a PM-2.5 Modeling Assessment Submitted in Support of a Permit Application, November 30, 2010

usually an emitted pollutant, but instead is created in the atmosphere through chemical reactions, an air quality analysis is required if the applicant is proposing to emit greater than 100 tpy of volatile organic compounds (VOCs) or NOx. EPA does not have a recommended modeling approach for assessing the impact of an individual source on ozone. However, in practice, it is very rare for states or EPA to require ozone modeling for individual sources.

2.10.5 Regional Haze

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 the CALPUFF model. Applicants are encouraged to follow the Interagency Workgroup on Air Quality Modeling (IWAQM)[51] and FLAG[5] 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.

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 appropriate when modeling stationary sources with large amounts of fugitive dust (e.g., mines), and is 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). As stated in the *Guideline*, the state-of-the-science for modeling deposition is evolving. Consequently, the approach taken for a deposition modeling analysis must be proposed by the applicant and approved by ADEC.

Deposition can be modeled directly with AERMOD or CALPUFF, or manually calculated using model-predicted ambient concentrations and “deposition velocities”. The IWAQM Phase I modeling report[52] provides an example of this methodology on page 5-6 for calculating deposition of sulfur and nitrogen. Deposition velocities are pollutant specific.

- ✓ In addition to ensuring time-averaged concentrations of NOx and SO_2 were modeled correctly, ensure that the appropriate conversion factors and deposition velocities were used.

Two methods are available for modeling dry and wet deposition/depletion of particulate emissions. “Method 1”, as it is known in AERMOD, can be applied under the regulatory option and requires the user to define a particle size distribution and a mass fraction and

[51] U.S. EPA. December 1998. Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary report and Recommendations for Modeling Long-Range Transport Impacts.

[52] Interagency Workgroup on Air Quality Modeling (IWAQM) Phase I Report: Interim Recommendation for Modeling Long Range Transport and Impacts on Regional Visibility. April 1993. US EPA, National Park Service, USDA Forest Service, USFWS (http://www.epa.gov/scram001/models/calpuff/phase1.pdf)

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 can be obtained from Modeling Fugitive Dust Impacts from Surface Coal Mining Operations – Phase II Model Evaluation Protocol.[53]

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.[54]

Wet and dry deposition of gaseous emissions is also available in AERMOD. The algorithms are based on an ANL report and modified based on peer review of the report. Gaseous deposition is considered to be non-DFAULT options in AERMOD. Gaseous dry deposition requires the user to assign a seasonal descriptive category for each calendar month. Additionally, a land use category for each of the 36 direction sectors (every 10 degrees) and three pollutant-specific physical parameters (see the AERMOD User's Guide Addendum for a complete description of these physical parameters) are required.

A table summarizing the dry and wet deposition of both particulate and gaseous emissions options in AERMOD can be found in the AERMOD Addendum[11] to the AERMOD User's Guide.

AERMET includes additional meteorological parameters in the surface file that are needed to support application of 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. The precipitation data source should be reviewed to ensure it is representative of the project location. National Weather Service data can be used. Representative site-specific meteorological data may also be used, if sufficient parameters are collected as required for deposition. Refer to Section 2.6 of this manual to ensure the meteorological data is processed correctly.

- ✓ Check the calculations requiring a particle size distribution against the above referenced study (surface coal mining operations), AP-42 size distribution data, or stack test size distribution data to ensure they are reasonable.

[53] US EPA. Modeling Fugitive Dust Impacts from Surface Coal Mining Operations – Phase II Model Evaluation Protocol. October 1994. Office of Emissions Inventory Branch, Research Triangle Park, NC. EPA-454/R-94-025. Available at (http://nepis.epa.gov).

[54] Wesley, M., P. Doskey, and J. Shannon, 2002: Deposition Parameterizations for the Industrial Source Complex (ISC3) Model. ANL Report ANL/ER/TR-01/003, DOE/xx-nnnn, Argonne National Laboratory, Argonne, IL 50439.

If the mass is weighted more heavily toward the larger particle sizes than the stack test indicates is appropriate, deposition and depletion could be significantly over-predicted.

Two things to note with regard to deposition in AERMOD: 1) no longer required are the scavenging coefficients for wet deposition familiar in ISCST3; and 2) depletion is automatically included when deposition is modeled unless the NODRYDPLT and/or NOWETDPLT options are enabled to override depletion. Depletion can significantly increase the modeling time and should be used with caution for runs with many sources and large modeling domains.

If the applicant used CALPUFF in performing calculations of deposition, be aware of the many complexities involved. Refer to the CALPUFF-specific guidance at the end of this document.

2.11 Ambient Air Boundary and Worker Housing

2.11.1 Ambient Air Boundary

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)). Ambient air typically excludes that portion of the atmosphere within a stationary source's boundary. This boundary may differ from the stationary source property boundary in that a fence or physical barrier restricts public access to a particular area. For example, if a fence surrounds a stationary source but not the associated parking area, the parking area is considered ambient air since the public has unrestricted access. Another example is if a road passes through a stationary source, allowing access by the public to locations near the facility that would not typically be accessible if there were no road.

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." The use of fences/physical barriers only pertaining to over land situations was confirmed by the 9th Circuit Court of Appeals in August 2012. Alternative means for controlling access for overwater scenarios is warranted.

Whether over land or over water, the ambient air boundary should be clearly identified on a map or plot plan.

Note: If the stationary source is located on leased, unfenced land, a copy of the land-owner's permission should be included with the application to control access (including their own access) within the proposed ambient boundary.

2.11.2 Worker Housing

Off-duty workers are typically treated as members of the public. If on-site housing is provided for the workers, then this area may need to be treated as ambient air. All areas within the stationary source boundaries where off-duty employees have access should be identified on a stationary source plot plan. The limited situations where on-site housing accommodations are not treated as ambient air is described in Policy and Procedure 04.02.108 (see http://dec.alaska.gov/air/ap/docs/whg.pdf). If the stationary source is not treating worker housing as ambient air, justification as to why it should not be treated as such should be provided.

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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 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.

2.12.1 Terrain Description and Terrain Treatment

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[55] (GeoTIFF) or Digital Elevation Model (DEM) data. AERMAP extracts emission unit

[55] 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).

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% 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.

AERMAP 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 or 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.

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.

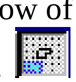
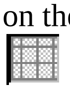
✓ Review each of these output files, looking for signs that a problem existed with the AERMAP run. Confirm that the input parameters that are echoed to an output file are appropriate for the modeling demonstration.

2.12.2 Receptor Grid Location and Density

According to Section 7.2.2 of the *Guideline*, "receptor sites for refined modeling should be utilized in sufficient detail to estimate the highest concentrations and possible violations of [an ambient air quality standard] or PSD increment." You will need to determine whether the applicant's receptor grid meets this objective.

Applicants should provide a site plan that shows the emission unit locations, structures, fence lines, property boundaries, and ambient boundary (as applicable). The receptor grid must start at the ambient air boundary.

✓ Create a plot of the receptor grid to make certain that the ambient air boundary has been correctly represented.

The BEEST program can be used to accomplish this task. Refer to the discussion in [Section 2.3.2](#) of how to import the AERMOD input file. From the row of icons shown in the top of the screen, select on Show Current Data Graphically icon.  Use the icons on the left side of the image to overlay graphic lines showing the coordinate locations.
 Fugitive emission activities and other area sources should be displayed on the same plot as the receptors, as well. It is not uncommon for applicants to develop the emission unit locations from a plant coordinate system and to obtain receptor coordinates from a topographic map or NED/DEM data file. The overlay will ensure that receptors aren't located on the facility or far beyond the plant boundary.

✓ Create a 2-dimensional plot of the receptor grid with the ambient air boundary and emission units overlaid.

By creating a plot of the receptor grid, ambient boundary, and emission units, errors in receptor grid definitions will immediately become evident; e.g., if the grid is located too far away from the facility, if the grid is incomplete, if the emission units 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 meters 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 emission units 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.

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* web site.[56] 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.

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

According to the web site, NED "resolution for Alaska is primarily of 2 arc-seconds (approximately 60 meters) but is rapidly being replaced with 5-meter resolution ifsar[57] 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.

USGS continues to make available DEM data is the preferred method of defining receptor elevations. DEM data is available in both 30 meter spacing and 90 meter spacing. 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. DEM data may not be available for all locations. 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 and Sensitive 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 construction/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.[58]

Sensitive receptors may include locations where people more sensitive to air pollution may be located, including hospitals, nursing homes, and schools. These locations should be included and highlighted in the receptor grid.

When doing the modeling review, you may add receptors to an applicant's modeling analysis if the modeled receptors appear inadequate to detect the maximum impacts.

[57] ifsar – interferometric synthetic aperature radar

[58] 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

If the air quality analyses are conducted using the minimum periods of meteorological data described above, then the classic form of a "design concentration" (the modeled ambient concentration that is compared to the AAAQS and PSD increments) is the highest, second-highest (H2H) short term concentration[59], or the highest long term average. (Note, EPA allows the h6h over five-years to be used for the 24-hr PM-10 AAAQS analysis).

Also, the highest concentration should be used whenever selected worst-case conditions are input to a screening technique, or to determine if the proposed source's impacts exceed the SILs or pre-construction air quality monitoring.

For an increment analysis, all increments are currently deterministic, *even if* the associated air quality standard is probabilistic. 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.

As a result PSD applicants need to submit two sets of PM-2.5 runs for each averaging period (24-hr & annual):

- One where concentration is calculated in manner consistent with probabilistic AAAQS; and
- A second where concentration is calculated in manner consistent with deterministic increment.

The modeled impacts without background concentrations added are compared to the maximum allowable increase, which are found in Table 2 in 18 AAC 50.020.

EPA has developed new standards for several pollutants and averaging times. The form of these standards is different from the older (deterministic) standards such as H2H. These new standards are based on a percentile of the distribution of the impacts for the averaging period under consideration. You may see these forms of the standards referred to as "probabilistic" standards. For example, a rule for the new 1-hr NO_2 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 …".[60] In addition to the rule, EPA has developed guidance on the applicability of these standards.[61,39]

[59] If sufficient and representative data exist for less than a five-year period from a representative NWS site, or when it has been determined that a one year site specific data set is not temporally representative, the highest concentration estimate should be considered the design value. The reason is because the length of the data record may be too short to assure that the conditions producing worst-case estimates have been adequately sampled.

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

[61] US EPA, http://www.epa.gov/ttn/scram/guidance/clarification/ClarificationMemo_AppendixW_Hourly-NO2-NAAQS_FINAL_06-28-2010.pdf

Additional standards were developed for 1-hr SO_2 and 24-hr PM-2.5. EPA has also developed guidance for these standards and has a web page with clarification memos that include these new standards.[62]

2.13.1 Demonstrating Compliance with the 24-hr PM-2.5 AAAQS

The following is from ADEC's internal document of concepts to consider when reviewing a PM-2.5 modeling assessment. Applicants may, but are not required to, use the following approaches for the 24-hour PM-2.5 ambient air quality standard:

• Add the multi-year average of the first high modeled concentration (*per EPA's March 23, 2010 guidance*) to the 3-year average of the 98th percentile 24-hour average monitored concentration;

or

• Add the multi-year average of the eighth-highest 24-hour modeled concentration (*per Section 2.1.5.1 of EPA's October 2009 Addendum to the AERMOD User's Guide*) to the maximum monitored concentration (e.g., the state-wide average).

2.13.2 Demonstrating Compliance with the 1-hr NO_2 AAAQS

The following is from EPA's March 1, 2011 memorandum "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard".

For a full compliance demonstration for the 1-hr NO_2, add the highest multiyear impact to the NO_2 background concentration (3-year average of the 8^{th}-highest daily maximum 1-hour NO_2 monitoring concentrations) to the modeled multiyear average of the 98^{th} percentile of the annual distribution of daily maximum 1-hour values. Note that the 8^{th}-highest of the daily maximum 1-hour values across a year is an unbiased surrogate for the 98^{th} percentile.

2.13.3 Demonstrating Compliance with the 1-hr SO_2 AAAQS

The following is from EPA's August 23, 2010 memorandum "Guidance Concerning the Implementation of the 1-hour SO_2 NAAQS for the Prevention of Significant Deterioration Program".

For the 1-hour SO_2 standard, the modeled contribution to the cumulative ambient impact assessment should follow the form of the standard based on the 99th percentile of the annual distribution of daily maximum 1-hour concentrations averaged across the number of years modeled. A "first tier" assumption that may be applied without further justification is to add the overall highest hourly background SO_2 concentration from a representative monitor to the modeled design value, based on the form of the standard, for comparison to the AAAQS. Additional refinements to this "first tier" approach based on some level of temporal pairing of modeled and monitored values may be considered on a case-by-case basis, subject to approval by ADEC, with adequate justification and documentation.

[62] http://www.epa.gov/ttn/scram/guidance_clarificationmemos.htm

2.14 Ambient Assessment Results

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

2.14.1 Fast-Track Demonstration

A fast-track demonstration allows an applicant to receive a minor permit within 30 days of submitting an application if certain procedures are followed. Fast-track procedures are available for a permit classification if the application qualifies under 18 AAC 50.502 (b) and 18 AAC 50.502 (c). However, several areas within the state are excluded from using fast-track procedures; these areas are listed in 18 AAC 50.502(a)(1).

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 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 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.

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.[63] Refer to Section 2.15 of this document for a discussion of the proposed Class I area SILs.

[63] The SIL for PM-2.5 was vacated January 22, 2013 by the District of Columbia Circuit Court.

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.

A discussion of the significant concentration gradient that is used to determine which ‘nearby’ sources are to be included in a cumulative impact analysis is discussed in Section 2.7.5 for off-site sources of this manual.

2.14.3 AAAQS Cumulative Analyses

- ✓ Ensure that (1) all sources are included [as applicable], (2) the emission rates and stack parameters for both the stationary source and other emission units are correct, and (3) the proper statistical model output was used (e.g., high vs. highest second-high, 98th percentile).

Table 8-2 in the *Guideline* presents information on the correct emission limit, operating level, and operating factor for point source modeling for the NAAQS compliance demonstration. Guidance is provided for the proposed source(s), nearby sources, and other sources.

Refer to Section 2.7.5: Applicant’s Cumulative Source Inventories, for a discussion of sources to be included in the cumulative source inventory. Certain sources may be considered for exclusion from the AAAQS inventory. Refer to the June 19, 1997 Q/D screening method memo (see http://www.dec.state.ak.us/air/ap/modeling.htm). Following this method, sources may be excluded on a case-by-case basis, depending upon professional judgment.

- ✓ Make certain that sources included in the AAAQS inventory are modeled at their federally-enforceable potential-to-emit emission rates and corresponding stack parameters.

If the compliance demonstration shows impacts within one microgram/cubic meter ($\mu g/m^3$) of AAAQS, refer to the ADEC modeling memorandum on numerical rounding for additional guidance.

2.14.4 PSD Increment Cumulative Analyses (Class I and Class II)

The review of the cumulative PSD increment analysis is similar to the review of the cumulative AAAQS analysis, with the following exceptions. Emission rates for all nearby, existing sources may be modeled at their current actual emission rates and corresponding stack parameters. Sources to be included are dependent upon their emission rates (i.e., major or minor sources) and whether the minor source baseline date has been triggered. Refer to 18 AAC 50.020, Table 2 for the list of baseline dates, listed by area and pollutant.

2.14.4.1 Temporary Construction Activities

An exclusion is allowed for temporary construction activities, 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."

2.14.5 Additional Impact Analyses (PSD Sources Only)

Per 40 CFR 52.21(o), 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." Although this portion of the modeling analysis does not typically receive much effort by applicants for Class II areas, it must still be addressed. The *Guideline* addresses the impacts of growth in Section 8.1.2(k).

A Federal Land Manager could request a regional haze analysis. If the FLM is involved, note the extent of the involvement in the modeling review memorandum.

2.14.5.1 Visibility Impacts

PSD applicants must assess whether the emissions from their stationary source, including associated growth, will impair visibility. Visibility impairment means any humanly perceptible change in visibility (visual range, contrast, or coloration) from that which would have existed under natural conditions (40 CFR 51.301 *Visibility impairment*). Visibility impacts can be in the form of visible plumes ("plume blight") or in a general, area-wide reduction in visibility ("regional haze").

A visibility analysis, separate from the Class I area analysis, is required as part of the additional impacts analysis. These should be conducted for sensitive Class II areas (places of interest). The most likely place for an observer within 50 km of the source should be identified (the maximum assessment distance for EPA's VISCREEN model) and the visibility analysis conducted for that observer.

The typical tool for assessing plume blight is EPA's VISCREEN model. VISCREEN provides results for impacts located inside a Class I area and for impacts located outside a Class I area. The latter is 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 and "out of the park" values can be ignored.[64] Alaska only has two integral vistas, both of which are associated with the Denali National Park Class I area.

As noted above, there are two levels of analysis available in VISCREEN. 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

[64] Email from Alan Schuler dated February 24, 2000 regarding a visibility analysis by Westward Seafoods.

worst-case meteorological conditions obtained from local (representative) hourly meteorological data.

The most important input in a Level 2 analysis is determining the meteorological conditions – winds and stability – that lead to a worst-case scenario. The joint frequency of these parameters measured at or near the location of the emission source or Class I area and the persistence of these conditions should be considered in making this determination. As the VISCREEN User's Manual says: "Any assessment of plume visual impacts is limited by the availability, representativeness, and quality of the meteorological data."

Another consideration for VISCREEN is accounting for complex terrain and its influence on determining the worst-case meteorological conditions. Accounting for elevated terrain can be a complex process. EPA suggests a simpler approach as outlined in the User's Manual.

Background visual ranges have not been established in Class II areas of Alaska. ADEC recommends using a value of 258 km, unless otherwise justified. The 258 km value is based upon measurements at Denali National Park for the 90^{th} percentile of visibility observations.

Background ozone concentration is also a required model input parameter. Ozone is used to calculate NO to NO_2 conversion. ADEC recommends to use the model default background ozone concentration of 40 parts per billion (ppb).

Currently, there are no visibility thresholds for Class II areas. In the absence of such information, applicants often compare the results to the Class I area thresholds. However, there is no requirement to demonstrate impacts less than these thresholds, only to report whether or not the plumes will be visible.

2.14.5.2 Soil and Vegetation Impacts

Neither EPA nor ADEC has adopted a formal methodology for actually conducting the soil and vegetation analysis. If modeling is used (the typical approach), it must comply with the *Guideline* per 18 AAC 50.215(b). However, there are no formal standards or thresholds for evaluating whether the modeled impacts are acceptable.

If applicants ask for suggestions on how to comply with this requirement, staff should suggest that they compare their modeled impacts with the "secondary" air quality standards. This is the approach used by the other EPA Region 10 states (Washington, Oregon and Idaho). Unlike the "primary" standards which were developed to protect public health, the secondary standards were developed to protect public welfare. The primary and secondary designations are indicated in 40 CFR 50.

Although the annual average SO_2 NAAQS standard was revoked in 2010, EPA indicated states should not drop the standard until no earlier than a year after EPA approves their SO_2 State Implementation Plan (SIP) for the 1-hr SO_2 standard. Alaska has adopted the 1-hour SO_2 standard, but has not yet fully developed its SIP.

ADEC staff should also recommend that applicants compare their annual average SO_2 impacts (when SO_2 is a triggered pollutant) 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. This value is based on a study of some Alaskan lichens, and therefore, it is appropriate to use this threshold for Alaska projects. 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)

Specific requirements for sources impacting a Federal Class I area are identified in 40 CFR 52.21(p). The FLM is "charged with direct responsibility for management of such lands have an affirmative responsibility to protect the air quality related values (including visibility) of such lands and to consider … whether a proposed source or modification will have an adverse impact on such values."

The FLM review of a PSD application for a proposed project that may impact a Class I area generally consists of three main analyses:

1. An air quality impact analysis to ensure that the predicted pollutant levels in Class I areas do not exceed the AAAQS or Class I PSD increments;

2. Air Quality Related Value (AQRV) impact analysis to ensure that the Class I area resources (i.e., visibility, flora, fauna, etc.) are not adversely affected by the proposed emissions; and

3. Best Available Control Technology (BACT) analysis to help ensure that the source installs the best control technology to minimize emission increases from the proposed project.

Key points:

The Federal Land Manager has responsibility for reviewing and providing comments on air quality impacts inside Class I areas per 40 CFR 52.21 (p) – Sources impacting Federal Class I areas-additional requirements.

The Federal Land Manager should be contacted early in the process to determine their level of interest and involvement in the project.

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.

The Class I areas of the State are presented in Table 1 of 18 AAC 50.015 and are illustrated in Figure 13.

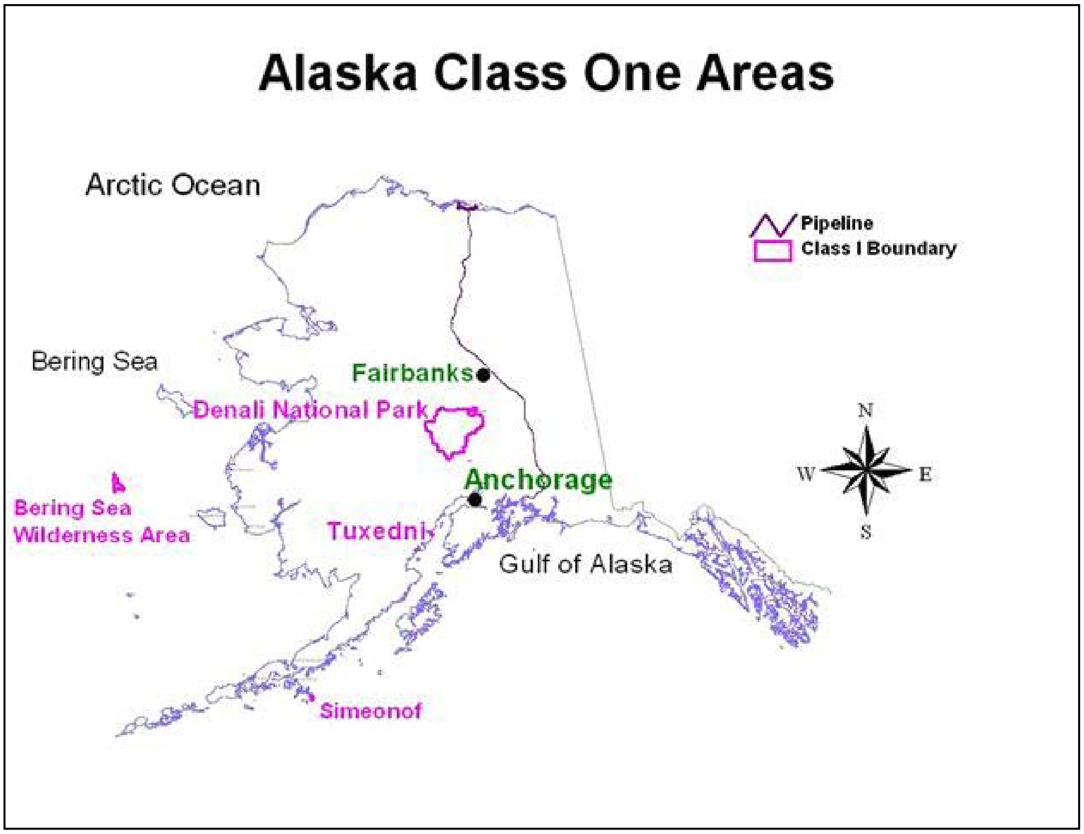

Figure 13. Class I Areas within Alaska

EPA proposed criteria in 1996 in which a proposed source's projected contribution to ambient concentrations in a Class I area may be considered de minimis for certain planning requirements. EPA never finalized the proposal. Nevertheless, States and applicants often use these numbers for screening purposes. That is to say, if the applicant can demonstrate that model-predicted impacts from their facility in the Class I area are less than the proposed Class I area SILs, then a cumulative impact analysis is not needed. However, an impact below the proposed Class I SILs does not necessarily indicate that the proposed source also has an insignificant impact on AQRVs. The proposed Class I area SILs are presented in Table 3 below.

Table 3. Proposed Significant Impact Levels for Class I Areas

Pollutant	Averaging Period	Proposed Class I SIL ($\mu g/m^3$)
Sulfur Dioxide (SO_2)	Annual	0.1
	24-hour	0.2
	3-hour	1.0
Particulate Matter (PM-10)	Annual	0.2
	24-hour	0.3
Particulate Matter (PM-2.5)	Annual	0.06 [a]
	24-hr	0.07 [a]
Nitrogen Dioxide (NO_2)	Annual	0.1

(a) Federal standard, rule adopted October 20, 2010; vacated on January 22, 2013 by the District of Columbia Circuit Court

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2.16 Data Submittal Requirements

The modeling analysis should include (1) a technical report describing the analysis and (2) computer files containing the model and related programs input and output files. The technical report should assist you by describing the nature of the project, the rationale for performing modeling, the rational for selecting the selected model, a discussion of all model input data, assumptions, and results.

The Air Quality Checklist provides a list of expected contents to be included in the data report. In addition to the data report, the following data files should be submitted with an application, if applicable:

- Readme.txt file: describes the modeling files used in the analysis,
- Meteorological data files,
- Non-EPA meteorological or terrain data processing files (code and executables),
- Plot plan of facility, to scale
- A topographic map of the project area
- Terrain data files,
- Model input and output files,
- Non-EPA models used (code and executables),
  - ✓ If any of the applicable files are missing, do not hesitate to request them from the applicant.

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3. List of Acronyms

AAAQS: Alaska Ambient Air Quality Standards (see 18 AAC 50.010)

AAC: Alaska Administrative Code

AIDEA: Alaska Industrial Development and Export Authority

APP: Air Permit Program

AQRV: Air Quality Related Value

ASOS: Automated Surface Observing System (meteorology)

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

DEM: Digital Elevation Model

DOQQ: Digital Orthophoto Quarter Quad

DRG: Digital Raster Graphic

EPA: Environmental Protection Agency

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

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

MLLW: Mean Lower Low Water

MSL: Mean Sea Level

NAAQS: National Ambient Air Quality Standards

NED: National Elevation Data

NSR: New Source Review

NWS: National Weather Service

OCD: Offshore and Coastal Dispersion

PRIME: Plume Rise Model Enhancements

PSD: Prevention of Significant Deterioration

QAPP: Quality Assurance Project Plan

SCRAM: Support Center for Regulatory Atmospheric Modeling

SIL: Significant Impact Level

SIP: State Implementation Plan

SIA: Significant Impact Area

SMC: Significant Monitoring Concentration

SRDT: Solar Radiation and Delta-Temperature

TAR: Technical Analysis Report

USGS: United States Geological Survey

VISCREEN: Plume Visual Impact Screening Model

Appendix A

Modeling Tips

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, most of which are available on EPA's Support Center for Regulatory Atmospheric Modeling (SCRAM) website:

- AERSCREEN User's Guide (EPA-454/B-11-001)
- AERMAP User's Guide and Addendum (EPA-454/B-03-003)
- AERMET User's Guide and Addendum (EPA-454/B-03-002)
- BPIP User's Guide (EPA-454/R-93-038)
- Addendum to the ISC3 User's Guide (The PRIME Plume Rise and Building Downwash Model
- Guideline on Air Quality Models (40 CFR Appendix W to Part 51)
- AERSURFACE User's Guide (EPA-454/B-08-001)
- AERMOD User's Guide and Addendum (EPA-454/B-03-001)
- AERMOD Implementation Guide
- 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 EPA's Support Center for Regulatory Atmospheric Modeling (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-11-001) 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.

VISCREEN

The VISCREEN model is used to assess "plume blight", 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.

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), "The 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 the "background visual range." The background visual range measured at Denali National Park is 258 km. This value should be used for sources located in the interior. It has also been used in North Slope applications. The typical background visual range used by sources located in the non-arctic coastal areas (e.g., Aleutians, Western Alaska, Cook Inlet) is 250 km.

The background visual range can also be estimated using the formula presented on page 36 of the FLAG document. This approach requires conversion of light extinction (Bext) values, expressed in units of inverse megameters (Mm^{-1}). Appendix 2.B of the FLAG document provides reference levels for light extinction.

A background ozone level of 40 ppb should always be used, unless otherwise justified.

VISCREEN provides results for impacts located inside a Class I area *and* for impacts located outside a Class I area. According to page 27 of EPA's workbook, the results for impacts located outside a Class I area are used in situations where there is an "integral vista." In situations where there no integral vistas, applicants only need to use the results for impacts located inside a Class I area.

Alaska only 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.

AERMOD

EPA promulgated the AERMOD Modeling System (which includes AERMOD, AERMAP and AERMET) as a preferred *Guideline* model on November 9, 2005. The AERMOD Modeling System is a replacement to ISCST3 and the ISC-meteorological processors, MPRM and PCRAMMET.

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.

EPA has posted additional guidance regarding the AERMOD Modeling System on their SCRAM web-site. This additional guidance is currently entitled, "AERMOD Implementation Guide" (March 19, 2009). 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 web site 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.

AERMAP

Section 2.2.4 of the AERMAP user's manual (page 2-7) presents a nice discussion of horizontal datum (NAD27 vs. NAD83). The most recent release of 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 http://nationalmap.gov/viewer.html.

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 an option within Alaska (at the time of this writing) since the format of the land use data that can be processed by AERSURFACE is not available for Alaska. Check EPA's Support Center for Regulatory Atmospheric Modeling (SCRAM) website to see if software updates are available that are capable of processing land use data for Alaska.

Check the ADEC website at http://dec.alaska.gov/air/ap/modeling.htm[32] for guidance on calculating these parameters manually.

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 (http://www.alaska.faa.gov) provides aerial pictures of airports, which can be helpful when trying to determine the local surface conditions.

- ✓ 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 4.7.7 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 looses their leaves (i.e., autumn).

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.*

Data processing in AERMET has undergone several significant changes, although not all may necessarily affect modeling applications in Alaska. Some changes, which are explained in more detail in the Model Change Bulletin #2, include:

1) Modification to the procedure for calculating hourly averages to use the "hour-ending" convention in accordance with Section 7.3 of "Meteorological Monitoring

Guidance for Regulatory Modeling Applications," EPA-454/R-99-005, February 2000; previous versions used the "hour-beginning" convention.

2) Several enhancements to provide more flexibility in selecting the most appropriate upper air sounding; these enhancements also provide better support for applications of AERMOD beyond the U.S.

3) Adjustment of ASOS-based wind speeds (including winds derived from 1-minute ASOS data) by +0.5 knot to account for the bias in reported ASOS wind speeds due to winds being truncated (rather than rounded) to whole knots.

4) Enhancement to allow the use of hourly-averaged winds derived from 1-minute ASOS wind data (TD-6405), generated by the new AERMINUTE program.

5) A new option/requirement incorporated in Stage 3 to specify a secondary set of surface characteristics for use when NWS winds are substituted for missing on-site winds using the SUBNWS option.

6) New keywords, AERSURF and AERSURF2, were added to the METPREP pathway to allow users to specify external files to read for surface characteristics.

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) form shoreline fumigation. Often, resolutions of 100 meters or greater (i.e. 50 meter) is sufficient. Discrete, polar, and Cartesian receptors can be used in OCD. Often, Cartesian receptors in UTM coordinates are the most easily used as modeled impacts can be reviewed on a topographical map.

OCD Version 5 has the ability to view the shoreline geometry maps, source locations, and the receptor fields. This should be used to review the modeling input files.

OVERWATER METEOROLOGICAL DATA

The OCD model 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. No defaults are assumed for these four variables in the OCD model.

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.

<u>MODEL OPTIONS</u>

The OCD Version 5 modeling options for plume dispersion are similar to those of AERMOD. The model can calculate impacts from point, area, and line sources. These options should be checked for consistency. 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 emission unit). OCD Version 5 will not accept data from BPIP or BPIPPRM.

Some applicants have used the platform diagonal as the building width. However, ADEC has learned through conversations with Dirk Herkhof of the *Mineral Management Service* (the agency that developed OCD) that OCD estimates lower concentrations with wider building widths. Therefore, Mr. Herkhof recommended *against* the use of the platform diagonal as the building width.

The current guidance for characterizing building parameters is based on wind tunnel studies. Petersen[65] concluded that the effects of downwash from an elevated platform can be approximated by taking the maximum platform height as the building height, relative to the base of the platform, and the height of the stack relative to the local sea surface. He also defined the lateral scale W as the total platform width. This approach accounts 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.

The applicant can obtain the appropriate downwash parameters from a plot plan (or similar) and should provide the plot plan with the application.

The relative height of an offshore platform varies with the tide. Therefore, the point of measurement must 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 MLLW need to be converted to MSL when modeling platforms located in Cook Inlet.

[65] Petersen, R. L. 1986. "Wind Tunnel Investigation of the Effect of Platform-Type Structures on Dispersion of Effluents from Short Stacks." J. Air Poll. Control Assoc., 36, 1347-1352.

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 GUI will not install or operate properly under 32-bit Windows 7 operating system nor is the GUI compatible with a 64-bit system. BOEM is currently working on a resolution to these problems. Check SCRAM for a possible update.

CALPUFF

Because of its higher level of sophistication, CALPUFF inherently has more model options to be employed. Two post-processing tools are also need to obtain time-averaged calculations of deposition and visibility: POSTUTIL and CALPOST, but only CALPOST is needed to obtain time-averaged pollutant concentrations. A helpful document is included which describes the steps and options to be incorporated to run CALPUFF and its associated post-processors in a screening mode.

EPA recently approved using version 6.221 of CALPOST (level 080724). Version 6.221 includes "Method 8," which utilizes the revised IMPROVE equation per the October 2010 - FLAG Phase 1 Report. This update only effects CALPOST and no other program in the CALPUFF System of programs.

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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 can not 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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Appendix C

Example of Average Concentration

SHORT-TERM PM_{10} BACKGROUND CONCENTRATION DETERMINATION FOR THE PROPOSED ALPINE CDN & CDS SATELLITE DRILLING PADS COLVILLE RIVER UNIT, ALASKA

Prepared for:

PHILLIPS ALASKA, INC.
Anchorage, Alaska

Submitted to:

Alaska Department of Environmental Conservation
Air Quality, Permitting Branch
410 Willoughby Avenue Suite 303
Juneau, Alaska 99801-1795

Prepared by:

SECOR INTERNATIONAL INCORPORATED
Fort Collins, Colorado

March 2002

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EXECUTIVE SUMMARY

This document presents the determination of a 24-hour PM_{10} background concentration from the monitoring data collected from May 1999 through October 2001 at the Nuiqsut Ambient Air Quality Monitoring Station (Nuiqsut Station) using Section 9.2 of the *Guideline on Air Quality Models* (USEPA 2000)(Guideline Background Determination Method). Following the Guideline Background Determination Method, Phillips Alaska, Inc. (PAI) proposes to use this background concentration in the first part of a four-step process used to compare modeled impacts from Colville River Unit (CRU) satellite drilling facilities Colville Delta North (CDN) and Colville Delta South (CDS) to the National Ambient Air Quality Standards (NAAQS).

The 24-hour PM_{10} background concentration is presented separately from all other pollutants and averaging periods [NO_x (annual), PM_{10} (annual), and SO_2 (annual, 24-hour and 3-hour)] determined from the Nuiqsut Station monitoring data because it was the only background concentration that had to be determined using the Guideline Background Determination Method. All other background concentrations were determined using a simpler, more conservative approach recommended by the Alaska Department of Environmental Conservation and outlined in *Background Pollutant Concentration Determination for the Proposed Alpine CDN and CDS* (SECOR 2002). When applied to 24-hour PM_{10} measurements, the simpler, more conservative approach produced a background concentration of 113.4 $\mu g/m^3$. This concentration is close to the NAAQS, and leaves little room for modeled facility contributions and that is why a less conservative approach was used to determine a lower background concentration. When looking for a less conservative method, PAI was directed to use the Guideline Background Determination Method by the Alaska Department of Environmental Conservation and EPA Region 10.

Based on the interpretation and application of the Guideline Background Determination Method to the PM_{10} data collected at the Nuiqsut Station, the 24-hour background PM_{10} concentration PAI proposes to use is 33.6 $\mu g/m^3$. This value will be applied to all model predicted impacts to conduct the first part of a four-step compliance demonstration. The remaining steps will be conducted in the air quality impact analysis report after modeled impacts are available.

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1.0 INTRODUCTION

1.1 Purpose

Phillips Alaska, Inc. (PAI) is submitting this document to establish a 24-hour average PM_{10} background pollutant concentration based on significant measured PM_{10} concentrations and accompanying meteorological conditions identified in the Nuiqsut ambient air quality monitoring station (Nuiqsut Station) monitoring data. This background determination is the first step in a four step process followed for comparing modeled impacts from Colville River Unit (CRU) satellite drilling facilities Colville Delta North (CDN) and Colville Delta South (CDS) to the National Ambient Air Quality Standards (NAAQS). This process is based on Section 9.2 of the *Guideline on Air Quality Models* (USEPA 2000). The complete four-step process is discussed in this document, but only Step 1 will be conducted since the other steps are performed after modeling results are obtained. The remaining steps will be conducted as part of the air quality impact analysis.

1.2 Background

At the request of the Alaska Department of Environmental Conservation (ADEC), background concentrations to be used for comparing modeled impacts from CRU satellite drilling facilities CDN and CDS to the NAAQS should be derived from Prevention of Significant Deterioration (PSD) monitoring data collected at the Nuiqsut Station. The Nuiqsut Station is located in the City of Nuiqsut in the Colville River Delta on the North Slope of Alaska. The Nuiqsut Station is located approximately 8 kilometers south of CRU CDS operations and 24 kilometers south of the CRU CDN operations. Figure 1-1 presents a regional map of the Colville Delta showing the relationship between the Nuiqsut Station and CRU CDN and CDS operations. Both PAI and ADEC consider the Nuiqsut Station monitoring data representative temporally and spatially to conditions near the CRU CDN and CDS operations in the Colville Delta. A complete description of the Nuiqsut Station monitoring program can be found in the project monitoring plan (SECOR 2001a) as well as the project quarterly and annual data reports.

In most cases, ADEC recommends that short-term background pollutant concentrations be determined by finding the maximum period average for the averaging period of interest. This

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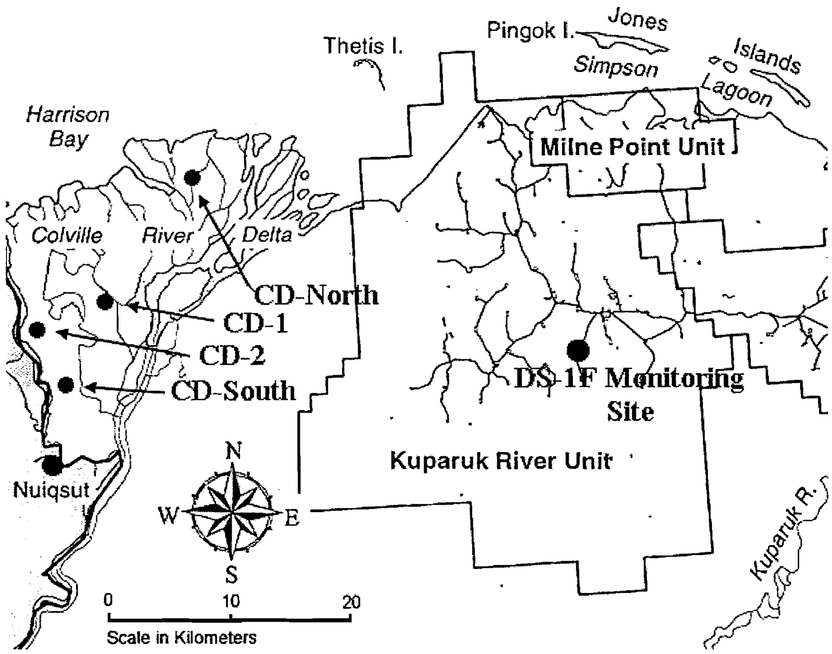

FIGURE 1-1: REGIONAL MAP SHOWING THE COLVILLE DELTA AND KUPARUK RIVER UNIT

PAI: PM_{10} Background Pollutant Level Determination for CRU Satellite Operations 012.11461.009 1-2 March 2002 method is simple and requires very little documentation, but can yield overly conservative results. This is the case with the 24-hour PM_{10} background concentration determined from data measured at the Nuiqsut Station. PM_{10} concentrations measured at the Nuiqsut station have been influenced by several days of naturally-occurring high wind events which have caused daily particulate measurements as high as 222.9 $\mu g/m^3$ (see Appendix B of SECOR 2000). Using conservative ADEC guidance, this data set results in a background concentration of 113.4 $\mu g/m^3$ (SECOR 2002). For most applications, this background concentration is overly conservative and an alternate, less conservative, approach for determining the 24-hour PM_{10} background concentration was needed. Following ADEC guidance, in July 2001, PAI submitted to ADEC the first attempt to establish a less conservative 24-hour background PM_{10} concentration using the framework of a Natural Events Action Plan (NEAP) (SECOR 2001c). In December 2001, ADEC decided that the NEAP was not the proper vehicle for determining background PM_{10} concentrations.

On December 21, 2001 a telephone conversation was held between members of ADEC, members of EPA Region 10, and SECOR to discuss an acceptable approach. At the close of the conversation all agreed that the background PM_{10} determination should be based on guidance outlined in Section 9.2 of *Guideline on Air Quality Models* (USEPA 2000) (Guideline Background Determination Method). As presented, the Guideline Background Determination Method is ambiguous, so it was discussed and interpreted by Rob Wilson of EPA Region 10. ADEC agreed that Mr. Wilson's interpretation of the Guideline Background Determination Method provided an acceptable methodology for determining the background PM_{10} concentration in the CRU. His interpretation is summarized in Section 1.3 and detailed in Section 2.0.

1.3 Methodology Summary

According to the Guideline Background Determination Method, the application of a background concentration to modeled concentrations, and the subsequent compliance demonstration, is a four-step process. In the first step, background concentrations are determined from data collected during specific sets of meteorological conditions shown to produce high measured concentrations. These background concentrations are determined in advance of modeling and independent of it. Next, the modeling is conducted for the facility of interest to obtain a set of high impacts. Third, background concentrations are determined from the monitoring data collected during specific meteorological conditions which produced the highest modeled impacts. In the last step, the background concentrations determined in Steps 1 and 3 are applied to the appropriate model-predicted impacts and a compliance determination is made. The entire four-step method will be discussed in this document, but only the background concentrations from the first step will be determined since they can be found independent of the modeling. The remaining three parts, and the compliance demonstration, will be presented as part of the impact analysis. A compliance demonstration requires showing compliance with the NAAQS using the highest background concentrations determined using the method.

Background concentrations will be determined from the data collected at the Nuiqsut Station from May 1999 through October 2001. This time frame encompasses all complete months of PM_{10} monitoring from the commissioning of the Nuiqsut Station through the most recent summer of monitoring. Since the determination of the background concentration is highly dependent on meteorological conditions, the final determination will only use PM_{10} concentrations for which there are concurrent wind speed and wind direction measurements.

NO_x and SO_2 are also monitored at the Nuiqsut Station and this data is also to be used to establish background concentrations for operations in the Colville River Delta. Because these two data sets are not plagued by a small number of hours of high concentrations, the most conservative and simple approach for the determination of background concentrations approved by ADEC was used to determine background concentrations for these two pollutants. This determination is presented in a separate document (SECOR 2002) submitted concurrently with this document.

1.4 Document Overview

The remainder of this document will:

- present and discuss the Guideline Background Determination Method (Section 2.0);
- discuss how the method will be applied to the Nuiqsut Station data (Section 3.0); and
- apply the method and determine the 24-hour background PM_{10} concentration from the Nuiqsut Station data (Section 4.0).

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2.0 DESCRIPTION AND INTERPRETATION OF THE GUIDANCE

Section 9.2 of the *Guideline on Air Quality Models* (USEPA 2000) does not specifically detail how background concentrations will be determined; it only offers a general approach which needs to be interpreted based on the monitoring program and the modeling being conducted. Section 9.2.2b of the guidance directs:

> …….For shorter averaging periods, the meteorological conditions accompanying the concentrations of concern should be identified. Concentrations for meteorological conditions of concern, at monitors not impacted by the source in question, should be averaged for each separate averaging time to determine the average background value…….

Though it is not obvious from reading the above section from the Guideline Background Determination Method, a compliance demonstration is a four-step process. These are as follows:

1. The monitoring data are examined to determine the meteorological conditions that produced the highest pollutant concentration(s) of interest for all appropriate averaging periods. Once the conditions that lead to high monitored concentrations are found, the data are examined to find all periods when these meteorological conditions occurred, then the mean concentration that occurred under these conditions is found. Note that it is possible that there is more than one set of meteorological conditions that lead to high monitored concentrations, so several different potential background concentrations may be found. The mean value (or highest mean value, if several sets of conditions were found to cause high monitored concentrations) becomes the potential background concentration. A potential background concentration is determined for each pollutant and averaging period of interest. In the present case, the only pollutant/averaging period of interest is the 24-hour PM_{10} concentration.

2. An appropriate dispersion model is run for the facility(ies) of interest. The model results are examined to determine the meteorological condition(s) that produced the highest modeled impacts for each of the pollutant(s) and averaging period(s) of interest.

3. The monitoring data are re-examined to determine the mean monitored concentration (mean 24-hour PM_{10} average, for example) that occurred during periods when the meteorological conditions were similar to those found to produce high modeled impacts. Again, it is

possible that there is more than one set of conditions that lead to high modeled impacts, so several different potential background concentrations may result from this process. The mean value (or highest mean value, if several sets of conditions were found to cause high modeled impacts) becomes the potential background value. A potential background concentration is determined for each pollutant and averaging period of interest.

4. The background concentrations are applied to the appropriate modeled impacts. This can be a simple process of applying the highest of all background concentrations determined in Steps 1 and 3 to all modeled impacts, or a very complex process of applying different background concentrations to selected predicted impacts based on similar meteorological conditions. In either case, a compliance demonstration requires showing that the sum of modeled impacts plus the background concentration(s) determined in this step do not exceed applicable NAAQS.

The potential background concentrations determined in Step 1 is made in advance of modeling and is independent of any modeling results. However, the potential background concentrations found in Step 3 can be determined only after modeling is completed. Only the first part of the method (Step 1) will be presented in this document. Steps 2 through 4 will be presented as part of the impact analysis.

To summarize, background concentrations are determined in two basic ways:

- Background Concentrations Dictated by Monitoring Data - the meteorological conditions of concern are based on significant concentrations found in the monitoring data in advance of the modeling.

- Background Concentrations Dictated by Modeling Data - the meteorological conditions of concern are based on significant concentrations found through modeling and can only be determined after the modeling has been conducted.

Both background determinations require the determination of significant concentrations. The significant concentrations are not formally defined since they only have meaning in the context of the monitoring data and the modeling results. In the monitoring data, significant concentrations are groups of elevated concentrations attributable to a source or group of sources not explicitly modeled. From the modeling results, significant concentrations are an appropriate number of the highest concentrations necessary to establish a correlation to meteorological parameters. In the end, the definition and identification of these significant concentrations is subjective.

Meteorological conditions of concern are key meteorological parameters which are correlated with the significant concentrations. The particular meteorological parameters of interest will vary depending on the nature of the sources responsible for the significant concentrations. For example, impacts due to fugitive sources are strongly correlated with wind speed and direction, so meteorological conditions of concern will be dominated by wind characteristics, and less by stability class or temperature. Once meteorological conditions of concern are identified, all measured concentrations (not just significant concentrations) associated with the meteorological conditions of concern are averaged to obtain the background pollutant estimate.

This document will only determine the Background Concentrations Dictated by Monitored Data for PM_{10}. These concentrations do not depend on the modeled-predicted results and are applicable to any project. The remaining three-steps of the compliance demonstration will be conducted after the model predicted results are available, and will be presented in the air quality impact analysis report.

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3.0 APPLICATION OF THE GUIDANCE TO NUIQSUT DATA

3.1 Discussion of the Monitoring Data

This background determination will use all available PM_{10} and concurrent meteorological data collected at the Nuiqsut Station from May 1999 through October 2001. This period encompasses data collected starting with the first full month of PM_{10} monitoring at the station through the most recent summer month of monitoring at the station.

A seasonal variation in PM_{10} concentration exists in the Nuiqsut Station monitoring data (SECOR 2001d). This seasonal variation will help to determine significant concentrations. For this determination, the definition of seasons is consistent with the description presented in the Nuiqsut Station annual data report for the 2000 monitoring year (SECOR 2001b), which follows guidance from the Barrow, Alaska National Weather Service office. According to the latter source the Colville River Delta area experiences two seasons, winter and summer, separated by a month of rapid transition in May and October. Therefore, for the Nuiqsut Station monitoring program, winter is defined as November through May, and summer as June through October. The seasons of spring and fall are ignored.

At the Nuiqsut Station, PM_{10} concentrations are reported hourly by a continuous particulate monitor. Rather than reduce the Nuiqsut Station hourly data to 24-hour average PM_{10} concentrations and concurrent daily average meteorological conditions, PAI will use the hourly measurements to identify significant concentrations and corresponding meteorological conditions of concern. Since meteorological conditions of concern are determined from hourly data, the average of 1-hour PM_{10} measurements matching the meteorological conditions of concern will define the 24-hour background concentration, not the average of 24-hour average concentrations. This deviation from the Guideline Background Determination Method is being used to take full advantage of the hour-by-hour correlation of the PM_{10} concentrations to the meteorological conditions rather than obscure the correlation through an averaging process. The approach also simplifies processing and technical review of the background concentrations determined, since the assignment of daily average meteorological conditions is a subjective procedure.

Application of the method requires a correlation between meteorological data and measured concentration, so hours of data collected which are missing wind direction, wind speed, or PM_{10} concentration are eliminated from the data set prior to any analysis.

3.2 Determination of Significant Concentrations

As previously discussed, significant concentrations must be identified to determine meteorological conditions of concern. There is no guidance on what constitutes a significant concentration. For this application of the guidance, measured concentrations above the 95th percentile PM_{10} concentration of a particular data set will be considered significant concentrations. Groups of significant concentrations found this way will be refined based on knowledge of the sources generating them. The 95th percentile level was arbitrarily chosen because it could be applied objectively and it is a level that clearly defines groups of elevated PM_{10} concentrations known to exist in the data set.

4.0 24-HOUR PM_{10} BACKGROUND CONCENTRATION DETERMINATION

4.1 Identifying Groups of Significant Concentrations

4.1.1 Limiting the Monitoring Data by Season

Quarterly and annual data trends discussed in the Nuiqsut Station data reports clearly show that the highest PM_{10} concentrations are caused by fugitive sources. Measured concentrations drop to nearly undetectable values in the winter (November through April) when the fugitive sources become inactive. The sources are inactive because the ground becomes frozen and snow covered. Figure 4-1 demonstrates the stark difference between hourly concentrations measured during the summer as opposed to those measured during the winter. This figure clearly shows that maximum hourly concentrations measured during the summer are nearly an order of magnitude higher than winter. Based on this graphical comparison, the search for significant concentrations was limited to data collected during the summer months only.

4.1.2 Determination of Groups of Significant Concentrations from the Summer Monitoring Data

Figure 4-2 shows the distribution of hourly PM_{10} concentrations over all wind directions measured during the summer months for the years for 1999 through 2001. Also included on this plot is a horizontal line at the concentration representing the 95th percentile of all hourly concentrations measured over this data set (34 $\mu g/m^3$). As discussed, the 95th percentile is a level set to help identify significant concentrations. Examining concentrations above the 95th percentile, two groups of significant concentrations are shown to be dependent on wind direction. Figure 4-3 presents a map of the area surrounding the Nuiqsut Station with known PM_{10} sources highlighted in red. Using the wind directions associated with the significant concentrations and the source locations shown in Figure 4-3, significant concentrations are clearly associated with fugitive sources from the Nechelik Channel to the east and anthropogenic PM_{10} sources in the City of Nuiqsut to the south through west.

The most significant grouping of concentrations above the 95th percentile occurs when wind directions are from 60 degrees through 100 degrees inclusively (Nechelik Channel Bank Impacts).

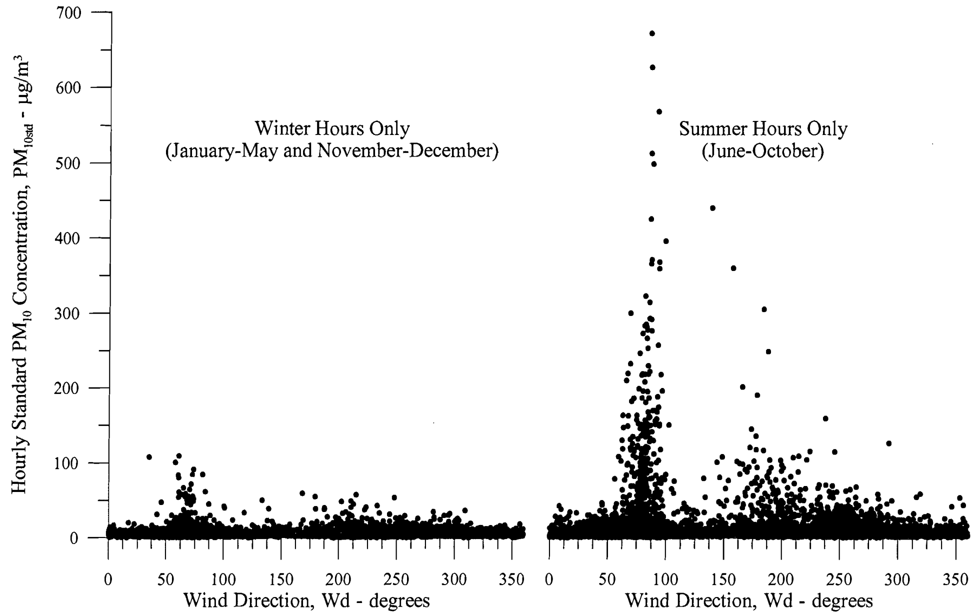

FIGURE 4-1: DISTRIBUTION OF HOURLY PM_{10} CONCENTRATIONS BY WIND DIRECTION AND SEASON

SECOR

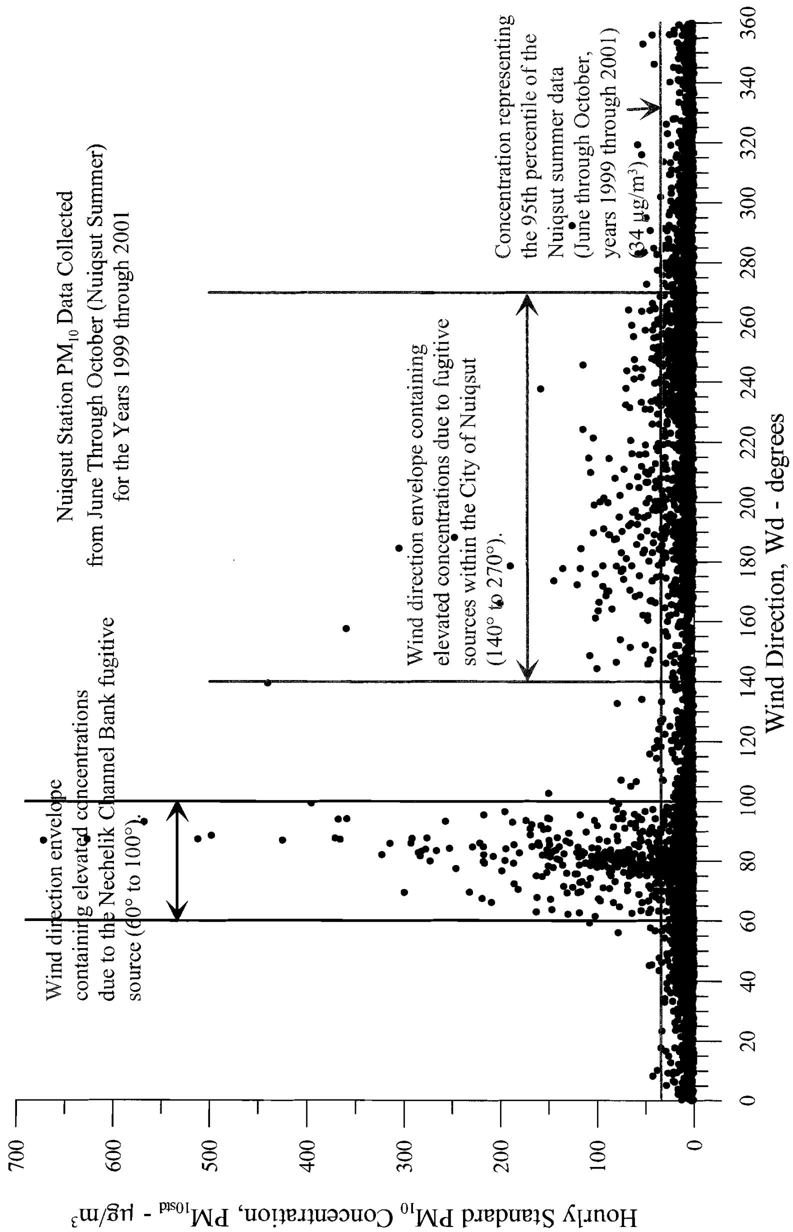

FIGURE 4-2: NUIQSUT SUMMER 1999-2001 DISTRIBUTION OF HOURLY PM_{10} CONCENTRATIONS OVER ALL WIND DIRECTIONS

PAI: PM_{10} Background Pollutant Level Determination for CRU Satellite Operations 012.11461.009

4-3

March 2002

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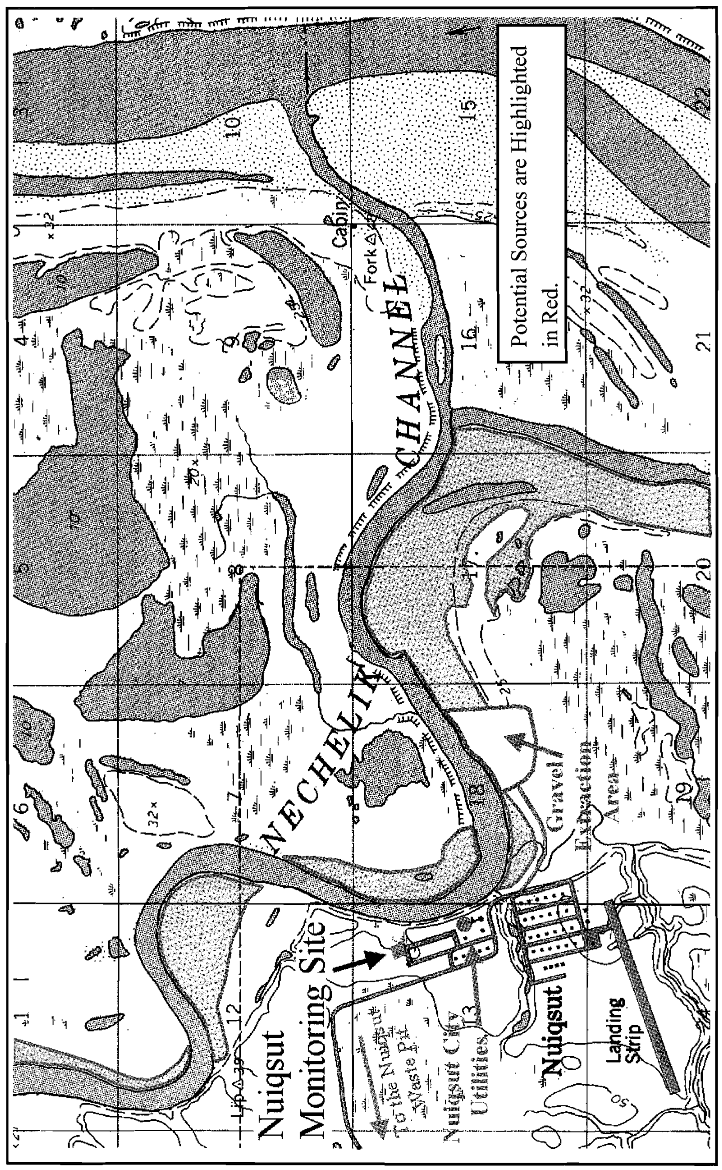

FIGURE 4-3: POTENTIAL PM_{10} SOURCES IN THE AREA SURROUNDING THE NUIQSUT STATION

4-4

PAI: PM_{10} Background Pollutant Level Determination for CRU Satellite Operations
012.11461.009

March 2002

From Figure 4-3, these measured concentrations are associated with wind blown dust generated from the exposed banks of the Nechelik Channel. These measured concentrations are caused by a single type of fugitive source and have a very strong correlation to wind speed.

The next grouping of significant concentrations above the 95th percentile occurs when winds are from 140 degrees through 270 degrees inclusively (City of Nuiqsut Impacts). From Figure 4-3, these measured concentrations can be generally classified as sources associated with the City of Nuiqsut. These sources are predominately fugitive, but may include some combustion sources. This group of measured concentrations is generated by many different sources, each becoming active under specific sets of conditions. Some of the sources are anthropogenic and some naturally-occurring. Though it would be ideal for this analysis to break this grouping of impacts down into individual sources, it is not possible due to the overlap of contributing sources. Grouping impacts from many sources would make the identification of a specific set of meteorological conditions to associate with them more difficult, but not impossible, since most of the sources are dominantly fugitive and will have a similar correlation to wind speed.

To continue the analysis, the summer data set is now split into two sets of significant concentrations. Within these subsets, the significant concentrations will be further refined to determine the meteorological conditions of concern used to determine the background concentration.

4.2 Determination of a 24-Hour PM_{10} Background Concentration for Nechelik Channel Bank Impacts

For all hourly concentrations associated with the Nechelik Channel Bank Impacts, the 95th percentile of this data is again used to identify a group of significant concentrations within this data subset. Figure 4-4 shows the distribution of summertime hourly PM_{10} concentrations from 60 degrees through 100 degrees inclusively. A horizontal line on the plot shows the concentration representing the 95th percentile of this data subset (80 $\mu g/m^3$). All concentrations greater than or equal to the 95th percentile are considered significant concentrations for this data subset and were used to define the meteorological conditions of concern for this group of concentrations.

Correlating hourly concentrations above the 95th percentile with concurrent meteorological data shows that significant concentrations are associated with the following meteorological conditions of concern:

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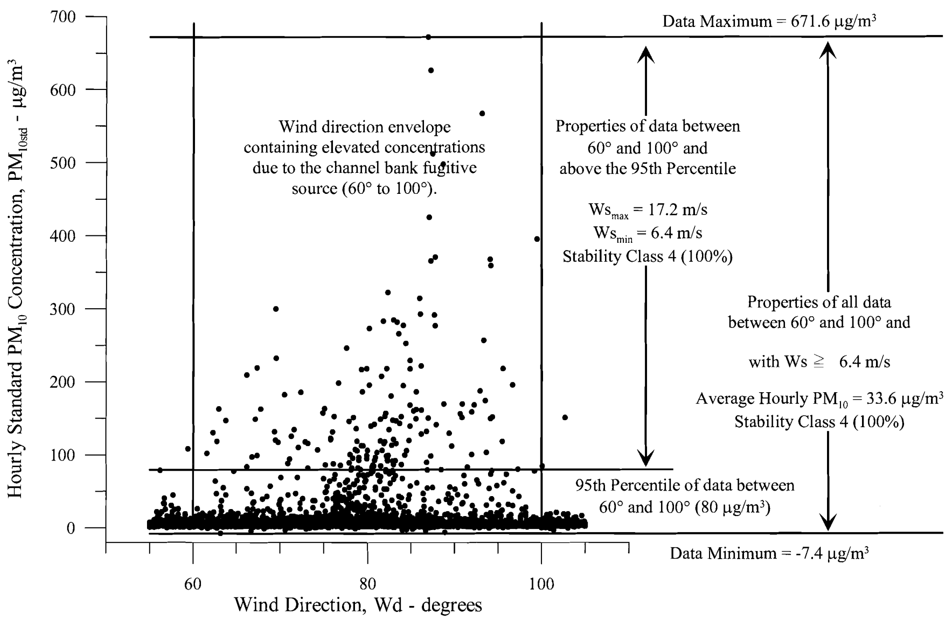

FIGURE 4-4: NUIQSUT SUMMER 1999-2001 DISTRIBUTION OF HOURLY PM10 CONCENTRATIONS BY WIND DIRECTION FROM THE NECHELIK CHANNEL SOURCE (60° <= WD <= 100°)

PAI: PM$_{10}$ Background Pollutant Level Determination for CRU Satellite Operations
012.11461.009

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March 2002

- summer months;
- $60° \leq$ (wind directions) $\leq 100°$;
- wind speeds ≥ 6.4 m/s; and
- neutral stability (Pasquill-Gifford Stability Class 4).

Averaging all hourly PM_{10} concentrations for these meteorological conditions yields a concentration of 33.6 μg/m^3. This hourly averaged value represents the 1-hour background concentration for significant concentrations associated with the Nechelik Channel Bank Impacts. As discussed in Section 3.1, the 24-hour background concentration is set equal to the mean 1-hour concentration.

Note that the wind direction limits used to define the significant concentrations only apply to the specific source-monitor relationship that exists for the Nuiqsut Station. High impacts could occur under different wind directions if the source/monitor relationship was changed and the wind speeds remain elevated. In this case, the source is a land feature that occurs randomly throughout the Colville River Delta, so the application of this background concentration should not be limited to specific wind directions.

4.3 Determination of a 24-Hour PM_{10} Background Concentration for the City of Nuiqsut Impacts

For all hourly concentrations associated with City of Nuiqsut Impacts, the 95th percentile of this data is again used to identify significant concentrations within this data subset. Figure 4-5 shows the distribution of hourly PM_{10} concentrations for wind directions from 140° through 270° inclusively. A horizontal line on the plot shows the concentration representing the 95th percentile of this data subset (40 μg/m^3). All concentrations greater than or equal to the 95th percentile are considered significant concentrations for this data subset and were used to further refine the meteorological conditions of concern for this group of concentrations.

Correlating hourly concentrations above the 95th percentile with the concurrent meteorology shows that significant concentrations are generated by wind speeds from 0.8 to 17.5 m/s inclusive, and under a wide range of stability conditions. A close examination of this wind speed range shows that a single hour is responsible for the lower wind speed limit. The overwhelming majority of concentrations measured for wind speeds between 0.8 and 1.2 m/s are very low, and if included, would skew the background concentration low. To keep from biasing

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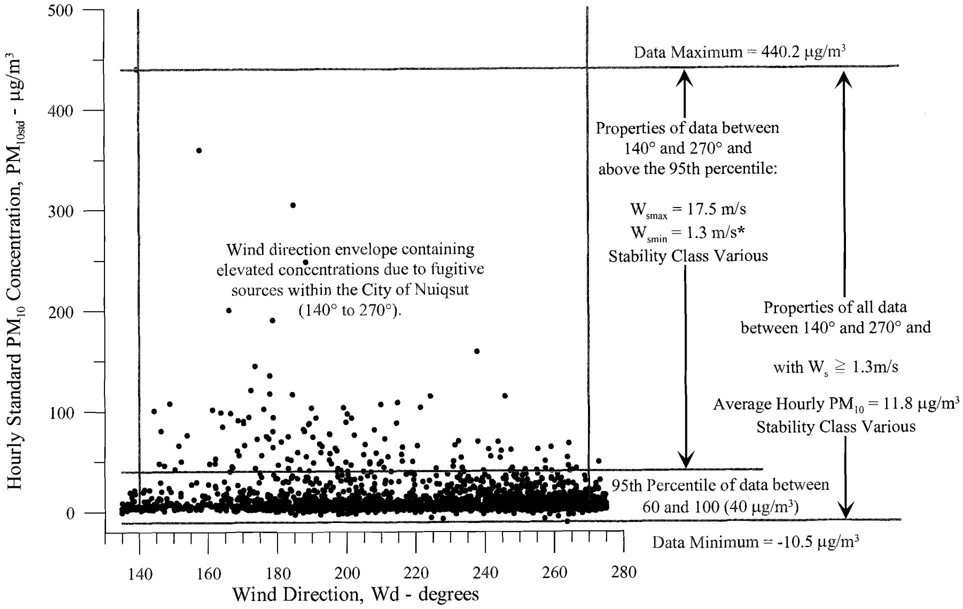

*Actual W_{smin} = 0.8 m/s (1999 day 185 hour 23) was eliminated because it biased final background concentrations low.

FIGURE 4-5: NUIQSUT SUMMER 1999-2001 DISTRIBUTION OF HOURLY PM_{10} CONCENTRATIONS BY WIND DIRECTION FOR THE CITY OF NUIQSUT SOURCES (140° <= WD <= 270°)

the data set low by the contribution of one hour, the lower wind speed limit defining the meteorological conditions of concern was increased to 1.3 m/s. Averaging all hourly PM_{10} concentrations obtained under the following meteorological conditions of concern:

- summer months;
- 140° ≤ (wind directions) ≤ 270°;
- wind speeds ≥ 1.3 m/s; and
- various stability classes.

yields an average hourly concentration of 11.8 μg/m^3. This hourly average value represents the 1-hour background concentration for significant concentrations associated with the City of Nuiqsut sources impacts. As discussed in Section 3.1, the 24-hour background concentration is set equal to the mean 1-hour average concentration. Note, again, the wind direction limits used to define significant concentrations only apply to the specific source-monitor relationship that exists for the Nuiqsut Station. High impacts could occur under different wind directions if the source/monitor relationship were changed and the wind speeds remain elevated.

As expected, the meteorological conditions of concern for this group of significant concentrations are not as specific and easy to define because, as discussed earlier, concentrations are generated by many sources, each becoming active under specific conditions.

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5.0 CONCLUSIONS

Using the Guideline Background Determination Method, two sets of meteorological conditions of concern were identified which cause significant hourly PM_{10} concentrations. The first set is responsible for high measured concentrations produced by the Nechelik Channel Bank fugitive source. The second set is responsible for high concentrations produced by predominantly fugitive sources within the City of Nuiqsut. Averaging hourly PM_{10} concentrations for all measurements associated with meteorological conditions for concern for the Nechelik Channel Bank Impacts yields a background concentration of 33.6 $\mu g/m^3$. Doing the same for concentrations from the City of Nuiqsut Impacts yields a background concentration of 11.8 $\mu g/m^3$. The higher of the two (33.6 $\mu g/m^3$) is the proposed 24-hour PM_{10} background concentration. For conservatism and simplicity, this background concentration will be applied to all modeled impacts regardless of the meteorological conditions that produced them. This is a conservative approach because the higher background concentration will be applied to predicted impacts that are associated with meteorological conditions that would normally generate a lower background concentration.

Both 24-hour background PM_{10} concentrations were determined using a correlation between hourly PM_{10} concentrations and hourly meteorological data rather than 24-hourly averaged data. In both cases, the PM_{10} 24-hour background concentration was set equal to the average of hourly concentrations associated with meteorological conditions of concern, not average 24-hour concentrations over the meteorological conditions of concern. This was done to:

- take advantage of the hourly PM_{10} data available from the Nuiqsut Station,
- clearly establish a correlation between concentrations and conditions that might otherwise be obscured by averaging the data into 24-hour blocks, and
- simplify the analysis and review.

In both cases, background concentrations were associated with a specific set of wind directions. These wind directions are only applicable to the unique source/monitor orientation of the Nuiqsut Station and should not be used to limit the application of the background concentrations to the modeled impacts.

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6.0 REFERANCES

SECOR International Incorporated (SECOR). 2000 Phillips Alaska Inc. Nuiqsut Ambient Air Quality Monitoring Project Quarterly Data Report - October through December 1999. February 2000.

_____. 2001a Phillips Alaska Inc. Nuiqsut Ambient Air Quality Monitoring Project Addition of Federal Reference Method Particulate Monitoring - Final Addendum. January 2001.

_____. 2001b Phillips Alaska Inc. Nuiqsut Ambient Air Quality Monitoring Project Annual Data Report - April through March 2001. May 2001.

_____. 2001c Phillips Alaska Inc. Air Quality Construction Permit Application for the Proposed Alpine CDN and CDS Satellite Drilling Pads. July 2001.

_____. 2001d Phillips Alaska Inc. Nuiqsut Ambient Air Quality Monitoring Project Quarterly Data Report - July through September 2001. November 2001.

_____. 2002 Phillips Alaska Inc. Air Quality Construction Permit Application for the Proposed Alpine CDN and CDS Satellite Drilling Pads - Revised. February 2002.

United States Environmental Protection Agency (USEPA). 2000. Guideline on Air Quality Models CFR Title 40, Part 51, Appendix W, January 2000

APPENDIX A

DIGITAL POLLUTANT DATA COLLECTED
AT THE NUIQSUT AIR QUALITY MONITORING STATION

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***************************************
Nuiqsut Air Quality Monitoring Station
April 1, 1999 through October 31, 2001
3 Disks
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This diskette contains validated data from the Nuiqsut Air Quality Monitoring station in Nuiqsut, AK, which is operated and maintained by SECOR International Incorporated (SECOR).

Validated data for the period from April 1, 1999 through October 31, 2001 are included on this diskette. Data are arranged in 3 files by monitoring year. The name of the files are:

- nuq_1999.prd
- nuq_2000.prd
- nuq_2001_partial.prd

The naming convention for SECOR ".PRD" file, or processed data file is three letters describing the site (i.e. nuq) followed by the monitoring year the data was collected in: (i.e. _2000, the April 2000 through March 2001).

One line of descriptive text is included at the beginning of each month for the sake of clarity, and the subsequent lines contain hourly sequential data in the following format:

For data collected from April 1999 through June 2001

COLUMNS	PARAMETER	UNITS	MISSING FLAG
01-02	YEAR		
03-05	JULIAN DAY		
06-07	HOUR ENDING		
08-18	10 M HORIZ. WIND SPEED	M/S	-999.
19-28	10 M HORIZ. WIND DIR.	DEGREES	-999.
29-38	HORIZ. WIND DIR STD DEV	DEGREES	-999.
39-48	2 M TEMPERATURE	DEGREES C	-999.
49-58	OXIDES OF NITROGEN (NOx)	PPM	-999.
59-68	NITROGEN DIOXIDE (NO2)	PPM	-999.
69-78	NITROGEN OXIDE (NO)	PPM	-999.
79-88	SULFUR DIOXIDE (SO2)	PPM	-999.
89-98	STANDARD PM10	μg/m3	-999.
99-108	ACTUAL PM10	μg/m3	-999.

For data collected from July 2001 through October 2001

COLUMNS	PARAMETER	UNITS	MISSING FLAG	START DATE
01-02	YEAR			
03-05	JULIAN DAY			
06-07	HOUR ENDING			
08-17	10 M HORIZ. WIND SPEED	M/S	-999.	04-09-1999
18-27	10 M HORIZ. WIND DIR.	DEGREES	-999.	04-09-1999
28-37	HORIZ. WIND DIR STD DEV	DEGREES	-999.	04-09-1999
38-47	10 M VERTICAL WIND SPEED	M/S	-999.	07-24-2001
48-57	10 M SIGMA W	M/S	-999.	07-24-2001
58-67	10 M TEMPERATURE	DEGREES C	-999.	07-24-2001
68-77	2 M TEMPERATURE	DEGREES C	-999.	04-09-1999
78-87	10-2 M TEMP. DIFFERENCE	DEGREES C	-999.	07-24-2001
88-97	TOTAL SOLAR RADIATION	WATTS/M^2	-999.	07-24-2001
98-107	OXIDES OF NITROGEN (NOx)	PPM	-999.	04-09-1999
108-117	NITROGEN DIOXIDE (NO2)	PPM	-999.	04-09-1999
118-127	NITROGEN OXIDE (NO)	PPM	-999.	04-09-1999
128-137	SULFUR DIOXIDE (SO2)	PPM	-999.	04-09-1999
138-147	STANDARD PM10	µg/m3	-999.	04-25-1999
148-157	ACTUAL PM10	µg/m3	-999.	04-25-1999