UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, Washington 98101-3140

Exhibit B-55

JUL 20 2011

MEMORANDUM

SUBJECT: Calculation of No. 2 Diesel Fuel Usage Restriction for Condition D.4.6 in Draft Permit to Shell for Operation of Conical Drilling Unit Kulluk in Beaufort Sea

FROM: Dan Meyer, E.I.T.
Office of Air, Waste and Toxics

TO: Permit File

This memorandum presents the calculations supporting the annual No. 2 diesel fuel usage restriction of 7,011,323 gallons presented in Condition D.4.6 of draft OCS Permit No. R10OCS030000.

A. Calculation to Determine CO_2e Available for No. 2 Diesel Fuel Consumption

Calculation to Determine CO_2e Available for No. 2 Diesel Fuel Consumption	
80,000 tons CO_2e	Annual CO_2e Emission Limitation Requested by Shell
-835 tons CO_2e	Waste Incineration CO_2e PTE
- 17 tons CO_2e	Mud Degassing CO_2e PTE
79,148	Remaining CO_2e Available for Fuel Combustion

Waste Incineration CO_2e PTE of 835 Tons

Calculation to Determine Waste Incineration CO_2e PTE				
Emission Unit	Kulluk Incinerator	IB1 Incinerator	IB2 Incinerator	OSRV Incinerator
Rating	276 lb/hr	154 lb/hr	154 lb/hr	125 lb/hr
Conversion	X 1 ton/2000 lb	X 1 ton/2000 lb	X 1 ton/2000 lb	X 1 ton/2000 lb
Operating Schedule	X 12 hr/day	X 24 hr/day	X 24 hr/day	X 24 hr/day
	X 120 days/season	X 120 days/season	X 120 days/season	X 120 days/season
EF	X 2033 lb CO_2e/ton	X 2033 lb CO_2e/ton	X 2033 lb CO_2e/ton	X 2033 lb CO_2e/ton
PTE	202 ton CO_2e	225 ton CO_2e	225 ton CO_2e	183 ton CO_2e
TOTAL	835 ton CO_2e			

- See Shell's June 29, 2011 application for rating of incinerators and operating schedule. Shell has requesting EPA to limit the Kulluk incinerator to just 12 hours of operation each day.
- CO_2e EF = CO_2 EF + [(CH_4 EF)(GWP CH_4)] + [(N_2O EF)(GWP N_2O)]
  (1990 lb CO_2/ton) + [(0.702 lb CH_4/ton)(21 ton CO_2e/ton CH_4)] +[(0.092 lb N_2O)(310 ton CO_2e/ton N_2O) = 2033 lb CO_2e/ton

- See 40 CFR 98, Tables C-1 and C-2 to Subpart C of Part 98 for emission factors
- See 40 CFR 98, Table A-1 to Subpart A of Part 98 for global warming potential of CH_4 and N_2O

<u>Mud Degassing CO_2e PTE of 17 Tons</u>

17 tons CO_2e/season = (399 lb CH_4 / well) x (4 wells / season) x (ton/2000 lb) x (21 tons CO_2e / ton CH_4)

- See May 4, 2009 technical memorandum from Shell's Keith Craik and October 22, 2010 engineering calculations from Air Sciences to support assumption that up to 399 pounds of CH_4 are released through mud degassing per well.
- See Section 3.2.1 of June 29, 2011 OCS Permit Application Supplement to support assumption that up to 4 wells can be drilled in a season.
- See 40 CFR 98, Table A-1 to Subpart A of Part 98 for global warming potential of CH_4

B. Calculation to Determine 12-Month Rolling Limitation on No. 2 Diesel Fuel Consumption

Calculation to Determine 12-Month Rolling Limitation on No. 2 Diesel Fuel Consumption	
79,148 tons CO_2e	Tons CO_2e Available for Fuel Combustion
X 2,000 lb CO_2e / ton CO_2e	Converting Tons to Pounds
X 1 gallon No. 2 diesel / 22.58 lb CO_2e	Converting Pounds CO_2e to Gallons No. 2 Diesel Fuel
7,011,323 gallons	**12-Month Rolling Limitation on No. 2 Diesel Fuel Consumption**

- CO_2e EF = CO_2 EF + [(CH_4 EF)(GWP CH_4)] + [(N_2O EF)(GWP N_2O)]
  (22.5 lb CO_2/gal) + [(0.0009 lb CH_4/gal)(21 ton CO_2e/ton CH_4)] +[(0.0002 lb N_2O/gal)(310 ton CO_2e/ton N_2O) = 22.58 lb CO_2e/gal
  - See 40 CFR 98, Tables C-1 and C-2 to Subpart C of Part 98 for emission factors
  - See 40 CFR 98, Table A-1 to Subpart A of Part 98 for global warming potential of CH_4 and N_2O

The White House
Office of the Press Secretary

For Immediate Release
September 02, 2011

Statement by the President on the Ozone National Ambient Air Quality Standards

Over the last two and half years, my administration, under the leadership of EPA Administrator Lisa Jackson, has taken some of the strongest actions since the enactment of the Clean Air Act four decades ago to protect our environment and the health of our families from air pollution. From reducing mercury and other toxic air pollution from outdated power plants to doubling the fuel efficiency of our cars and trucks, the historic steps we've taken will save tens of thousands of lives each year, remove over a billion tons of pollution from our air, and produce hundreds of billions of dollars in benefits for the American people.

At the same time, I have continued to underscore the importance of reducing regulatory burdens and regulatory uncertainty, particularly as our economy continues to recover. With that in mind, and after careful consideration, I have requested that Administrator Jackson withdraw the draft Ozone National Ambient Air Quality Standards at this time. Work is already underway to update a 2006 review of the science that will result in the reconsideration of the ozone standard in 2013. Ultimately, I did not support asking state and local governments to begin implementing a new standard that will soon be reconsidered.

I want to be clear: my commitment and the commitment of my administration to protecting public health and the environment is unwavering. I will continue to stand with the hardworking men and women at the EPA as they strive every day to hold polluters accountable and protect our families from harmful pollution. And my administration will continue to vigorously oppose efforts to weaken EPA's authority under the Clean Air Act or dismantle the progress we have made.

ADEC Modeling Review Procedures Manual

September 14, 2011

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.

This manual references several commercial modeling programs that provide a Graphical User Interface 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.

NOTE: ADEC developed this manual to teach staff how to conduct an efficient air quality modeling review. 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).

There are numerous sections that need to be updated. The topics that need updating include: model references (e.g., AERMOD has replaced ISCST3 as the typical, onshore new source review dispersion model); regulatory citations; the inclusion of new ambient air quality standards and thresholds; and inclusion of new EPA guidance. There are also a number of topics that need clarification as to when the given suggestion may be applicable.

ADEC is in the process of conducting a major rewrite of this manual to incorporate the above changes and to make the manual more "user-friendly." In the mean-time, ADEC has issued this September 14, 2011 update to the previous October 13, 2006 release in order to acknowledge the dated content, and non-regulatory basis of this review manual. ADEC has also included a limited number of revisions that were previously developed in support of the major rewrite.

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List of Appendices:

1. Introduction

The Alaska Department of Environmental Conservation (ADEC) Air Permits Program (program) developed this Modeling Review Procedures Manual to provide staff some of the *background* information they 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 the U.S. Environmental Protection Agency's (EPA's) *Guideline on Air Quality Models* (Guideline) – which is adopted by reference in 18 AAC 50.040(f). Staff should also utilize the guidance documents posted on the Air Permit Program'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 review manual contains the following information. Section 1 presents some frequently asked questions about dispersion modeling, some suggestions on the reviewer's perspective, and an overview of both EPA and Federal Land Manager guidance on conducting modeling analyses. Section 2 presents an overview of the procedures for performing a review of an ambient air quality assessment. Sections 3 through 9 present specific review procedures and "expert tips" on various technical items, such as meteorological data processing and receptor grid generation. Section 10 discusses the criteria that the ambient assessment is compared against. Section 11 discusses the role of ADEC in reviewing and coordinating any Class I assessments. Section 12 provides specific guidance on the format of content of the electronic data submittal from the permit applicant. Section 13 presents a list of common acronyms.

Appendix A presents information and expert tips on the dispersion models commonly used in ambient assessments, including SCREEN3, VISCREEN, ISCST3, AERMOD, OCD, and CALPUFF. Appendix B presents examples of ADEC correspondences regarding modeling protocols. Appendix C provides examples of deficiency notices. Appendix D provides examples of a modeling review memorandum. Appendix E is reserved for future use. The modeling review template that was in Appendix E may now be found in the Title I portion of the Quality Management System (QMS) library. Appendix F provides ADEC guidance memos on specific issues.

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

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 can not distinguish between impacts from these sources as a function of date and source category.

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.

Often, the errors do not result in significant conclusions that would affect the issuance of a permit, or result in a permit condition. In many circumstances, 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.

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*

1.2 ADEC Regulatory Requirements

ADEC's air quality control regulations are in 18 AAC 50[1]. 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 respectively listed in 18 AAC 50.010 and 18 AAC 50.020. 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 Value (AQRV) analysis, consistent with the Class I area Federal Land Manager (FLM) requirements, to assess the impacts within a "nearby" Class I area.

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

1.3 EPA Guidance on General Modeling Procedures

EPA's guidance for performing air quality analyses is set forth in the "Guideline on Air Quality Models" (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 analysis and a full impact analysis. In the preliminary analysis, the applicant assesses ambient concentrations resulting from emissions from the proposed project alone (for those pollutants with emission increases above the PSD significant emission levels or are otherwise required by ADEC to have a modeling analysis). 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 an indication of whether the applicant must perform a full impact analysis. (Note: There have been times when ADEC has asked an applicant to bypass the preliminary analysis and instead conduct a full impact analysis. This is especially true if there have been numerous modifications over time.)

If the preliminary analysis indicates that ambient concentrations will exceed the PSD Significant Impact Levels (SILs) for any pollutant and averaging period, then the applicant must determine the extent of the geographical area for which the impacts exceeds the SIL. This is referred to as determining the "significant impact area" (SIA). The applicant must then perform a full impact analysis in the SIA for that pollutant and averaging interval. The full impact (aka "cumulative impact") analysis expands the preliminary analysis by considering emissions from both the proposed source(s) and other existing sources in the SIA. It may also consider other sources outside of the project's SIA that may cause significant impacts in the project's SIA. 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, as 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.

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 New Source Review (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 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. FLM involvement will depend on project size and location relative to the Class I area. Expect FLM involvement for any PSD project located within 100 kilometers (km) of a Class I area.

The FLAG Phase I Report (December 2000)[2] 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] Federal Land Managers' Air Quality Related Values Workgroup (FLAG), Phase I Report (December 2000). U.S. Forest Service. National Park Service, U.S. Fish and Wildlife Service. (http://www2.nature.nps.gov/ard/flagfree/FLAG--FINAL.pdf)

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[3], 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 (when 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-guideline model for the given application. The following paragraphs briefly describe the most commonly used air quality models.

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

The Offshore and Coastal Dispersion (OCD) model[4] was developed by the US Department of Interior - Minerals Management Service (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. Alaskan applicants have used OCD to model offshore platforms located in either Cook Inlet or the Beaufort Sea during open water periods. ISCST3 is often used when the water is frozen. 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.

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[3] 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”.

[4] 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. Herdon, VA http://www.epa.gov/scram001/userg/regmod/ocd5ug.exe

The Plume Visual Impact Screening Model (VISCREEN)[5] is used to assess plume coloration and contrast (referred to as plume blight), but not regional haze. It can model plume blight from an individual emission point, for both forward and backscattering viewing situations against a sky and terrain background. It calculates plume blight for a user-defined meteorological condition. Typically, the model is run with worst-case short-term emission rates because the visibility guidelines do not have specified averaging periods. VISCREEN may be run at one of two levels of refinement: referred to as 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[6] 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 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.

[5] 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). 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

[6] 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 http://www.src.com/calpuff/calpuff1.htm

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 memorandum. Each of these phases is described in more detail below. Modeling reviews can become time consuming if you conduct each phase separately, including corresponding with the applicant and waiting for a response. A few weeks (or months) might pass before a response is received from the applicant, and you must get reacquainted with the project status before the next phase of review can be conducted.

The key to efficiently reviewing the modeling analysis is to conduct all phases of the review concurrently, as much as possible. The modeling review memorandum should be prepared concurrently with the various phases of review. Since the modeling memo is the ultimate work product associated with the technical review, begin writing the modeling memo at the onset of the review.

***Key points*:**

- ***Conduct reviews concurrently.***
- ***Begin documentation at the onset of the project.***
  - ✓ ***If you are reviewing a protocol, begin preparing a letter providing comments on the acceptability of the protocol (examples are included in Appendix B of the manual).***
  - ✓ ***If you are reviewing a modeling analysis, begin preparing either a deficiency notice or a modeling review memo (examples are included in Appendices C and D, respectively).***

The steps involved for reviewing a modeling protocol are nearly the same as for reviewing the modeling analysis. The primary difference is that the protocol will not present results and also different documentation will be prepared in response to a modeling protocol, compared with the modeling analysis.

Figure 1 illustrates the steps involved in a modeling or protocol 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's comments,
5. the modeling report (usually a hard copy), and
6. the electronic modeling files.

When reviewing a modeling protocol, you need only open the protocol and a blank document to create the protocol completeness letter. The purpose of having all these documents open is to encourage you to document your comments as you go, while the information is fresh in your mind. When reviewing a modeling analysis, open the protocol, ADEC's comments, 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. Then 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.

Hopefully, the applicant has provided a short summary at the beginning of the 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.

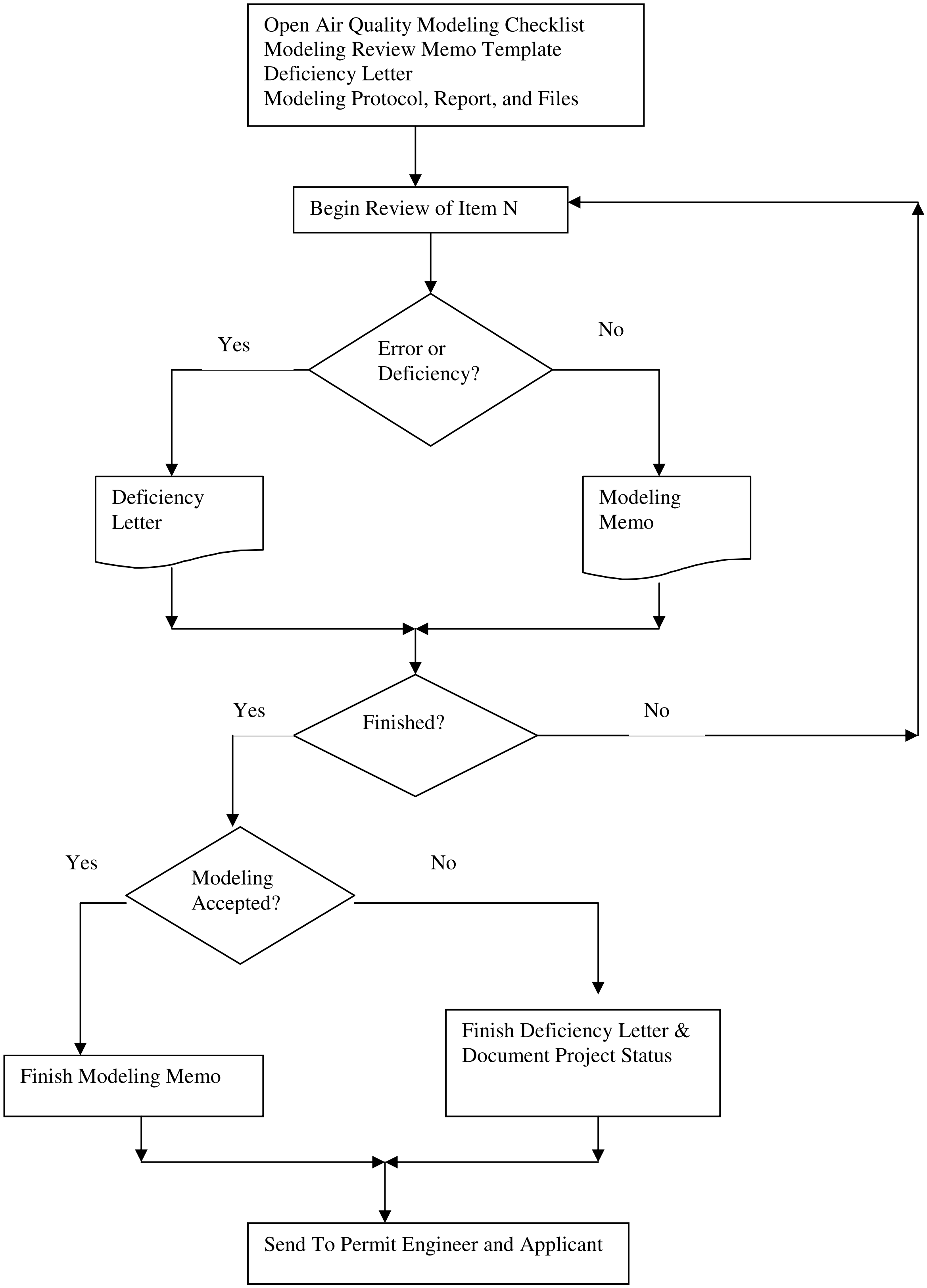
Step 2 As you go through the document in detail, use the air quality modeling checklist as a guide. Each item in the checklist (e.g., site location, model selection, meteorological data, etc.) is indicated in the flow diagram (Figure 1) as item N, representing each item that must be reviewed. See Section 3 of this manual for how to review project information.

- Open the corresponding modeling files and make certain the information is consistent with that presented in the modeling report and permit application. Also make certain it 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 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 1. Modeling Review Procedures



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2.1 Submittal and Approval of Modeling Protocols

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.

Modeling protocols are reviewed on a case-by-case basis for specific projects at a facility. Therefore, the protocol and ADEC comments may or may not apply to other modeling applications. ADEC reserves the right to alter its findings if there is a notable change to the project scope or approach.

- ✓ Review the protocol to ensure consistency with federal and state modeling guidance.
- ✓ After completion, construct a letter conveying any areas of concern and suggested revisions to the protocol.
- ✓ Include a statement of acceptance or denial in the letter.

Often, a conditional statement of acceptance is communicated. Examples of modeling protocol review and acceptance letters are provided in Appendix B.

2.2 Completeness and Technical Review Phase

The completeness review is intended as a first level review of the modeling analysis, to ensure all components of the modeling analysis have been addressed. AS 46.14.160[7] requires the completeness review to be completed within 60 days.

- ✓ Use the air quality checklist to keep track of the review.

ADEC has developed an air quality modeling checklist (included in the appendix) 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. The form may be kept within and at the top of the model review folder as a summary document. 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 tends to happen a lot 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

[7] Alaska Department of Environmental Conservation, Air Quality Statute AS 46.14.160 http://www.state.ak.us/local/akpages/ENV.CONSERV/dawq/aqm/as46.14.pdf

(both direct and indirect) are unclear; so much time is spent identifying these, along with how it impacts what has already been reviewed.

- ✓ 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.

Upon receipt of a revised analysis, 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, 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.

- ✓ 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 creditable. 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.

2.3 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.

A template of a modeling review memorandum has been provided electronically in Appendix E. This may be used as a starting point for developing the project-specific memo. While some of the language provided in the template is useful and often common to many projects, much of the 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 review memorandum.

Header:

✓ The modeling review document is typically submitted as a memorandum from you to the file, through the Construction Permits Supervisor. 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 and whether the applicant compared the h1h or h2h concentration to the short-term AAAQS/increments.

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.

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.

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 in emission rates 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.

Building Downwash Analysis:

✓ Document if a downwash analysis was conducted and whether or not EPA's Building Profile Input Program (BPIP) was used or not. Document if a cavity analysis was performed, if applicable. Note any discrepancies and how these were resolved.

Ambient NO_2 Modeling:

- ✓ Document the method employed to convert from NO to NO_2.

Ambient SO_2 Modeling:

- ✓ Document the basis for the SO_2 emission calculations for fuel combustion.

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.

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, 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 arose from the review of the modeling analysis that should be included in the permit.

2.4 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/activities, 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 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 AAQS/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.

3. Review of 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, ISC-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.

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 file such as a geo-TIFF 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.

As further discussed in Section 4.5, 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 ArcView formats[8].

3.2 Layout of Emission Units and Structures

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

Since this information is processed and used as input to the modeling files (and any required BPIP building downwash analysis files), the best method to QA the modeling analysis is to graphically plot information from the modeling and BPIP input files themselves to verify the applicant's processing. The GUI modeling systems previously described can be efficiently used to load model and BPIP 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.

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).

✓ 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 ISCST3 dta

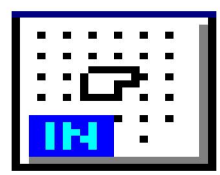
[8] Land use information is available at the following web sites: http://www.epa.gov/ngispgm3/spdata/EPAGIRAS/ and http://edc.usgs.gov/geodata/.

file import command to import the ISCST3 input file. BEEST will convert this file into a BEEST format file.

✓ If you only have the output file, you will have to create the input file before you can load the BPIP file. To do so, load the output file, as described above. Then, from the Pathway menu, select page 2 of the Control Option submenu. In the upper right corner, click on the no-run option. Then go back to the main menu, and RUN ISCST3 to create the input file. Once the input file is created, you can load the building information from the BPIP file.

✓ From the File menu, click on the Import command, then the Generic BPIP or BPIP-Prime input file command. Located the directory and file name from the applicants BPIP 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 ISC file needs to be imported *prior* to the BPIP 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 4th icon on the right, 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 DRG) or aerial photograph (DOQQ) is available, this can be overlaid on the BPIP 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 BPIP 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.

✓ The GUI programs can also be used to load an ISCST3 or AERMOD input file and verify the locations of the sources. From the File menu, click on the Import command, then the input file command. Located the directory and file name from the 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 2 dimensional (2-D) plot of the sources (and the receptor grids, as discussed further below).

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. See further discussion in Section 4.3.

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))[9]. 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[10]. 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.[11]

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 7.3 for details on reviewing receptor grids.

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

[10] 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 .

[11] 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.

4. Emissions and Source 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 4.1 provides general information regarding emission rates and stack parameters. Section 4.2 provides more specific information regarding the most common types of emission units in Alaska. Sections 4.3 through 4.6 provide additional comments regarding operating scenarios, part load assessments, off-site sources, and source groups.

4.1 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. 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 and review the source emission rate and release parameters 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.

Many dispersion models (including ISCST3 and 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, the 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.

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 ISCST3/AERMOD, individual area sources may be represented as rectangles with aspect ratios (length/width) of up to 10 to 1. 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. Irregular shaped sources may be represented by a series of smaller rectangles, or a polygon (in ISCST or AERMOD).

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) 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.

Volume Sources

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), 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, 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.

Open Pit Sources

The open pit source algorithm is available only in ISCST3. 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. 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 their "*AERMOD Implementation Guide*."[12] 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 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.

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

- **SCREEN**: Use the following procedure:
    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 very large.*)

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

[12] The AERMOD Implementation Guide may be found on EPA's SCRAM web-site at: http://www.epa.gov/ttn/scram/7thconf/aermod/aermod_implmtn_guide_19March2009.pdf

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 --

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

where

d_{eq} = the equivalent stack diameter in meters (m), and
$\dot{V}$ = stack flow rate in cubic meters per second (m^3/s).

For situations in which multiple point sources are modeled and not all stacks are discharged horizontally, applicants are still free to make separate runs (or modify the source code), but this would be decided on a case-by-case basis. Most applicants prefer to make a single model run to avoid the post-processing effort of combining results on a receptor-by-receptor basis.

The same EPA memo 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 off set 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.

Treatment of Cooling Towers

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 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).

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

4.2 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.

4.2.1 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.[13] Please note that these assumptions may not be appropriate for other permitting aspects, such as PSD avoidance caps. See Section 4.3 for additional information regarding the modeling of partial load conditions.

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

Background Information – IC Engines

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 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.

4.2.2 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".[14] An F-factor is the ratio of the combustion gas volume to the heat content of the fuel, expressed as standard cubic feet per million Btu (scf/MMBtu).[15] 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 Section 1.1 presents coal-fired emission data, Section 1.2 oil-fired emission, and Section 1.3 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, 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.

[14] 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.

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

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When vendor or source test data is not available, applicants may assume that the actual flow rate varies linearly with load when there are no SO_2 scrubbing systems used for pollution control (i.e., multiply the vendor's 100 percent load data by 0.75 for the 75 percent load scenario, and by 0.50 for the 50 percent load scenario). In the absence of vendor or source test data, applicants may assume the exhaust temperature is constant with load (when there are no SO_2 scrubbing systems used for pollution control).[16] Please note that these assumptions may not be appropriate for other permitting aspects, such as PSD avoidance caps. See Section 4.3 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-

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

diameter watertubes, which are inherently stronger. As a consequence, firetube boilers are typically small and are used primarily where boiler loads are relatively constant. Nearly all firetube boilers are sold as packaged units because of their relatively small size.

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

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

The capacity of a boiler or heater is usually expressed 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.

4.2.3 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. The Army has developed a helpful resource manual: Electrical Power Plant Design (http://www.usace.army.mil/publications/armytm/tm5-811-6/) which provides helpful insight into equipment operation, design, and the rationale for selection.

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.

$$H_2S + 1 | O_2 \rightarrow SO_2 + H_2O$$

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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 (Molecular Weight of SO_2)]

Note: The "standard" condition of the 359 scf per lb-mole molar volume is at 32^{o}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. [17] Please note that these assumptions may not be appropriate for other permitting aspects, such as PSD

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

avoidance caps. See Section 4.3 for additional information regarding the modeling of partial load conditions.

4.2.4 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 BPXA, 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 **temperature, stack height** and **“stack” diameter**.

SCREEN3 has a source category for flares, and makes these adjustments internally. ISCST3 and AERMOD do not have a source category for flares, and therefore, need to have the adjustments made by the modeler. The approach consistent with SCREEN3 is as follows:

1. Compute the adjustment to stack height (H) as a function of total heat release Q in MMBtu/hr:[18]

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

where H has units of meters;

[Please note the following: 1) some flares are rated in calories per second and the conversion factor is 14.3 Btu/hr for every cal/s; and 2) the adjustment is to account 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 ISCST3– see discussion below];

Equivalent 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 emissions** from flares is not straight forward. Section 13.5 of AP-42 presents guidance on calculating emissions from industrial flares. Table 13.4-1 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.).

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

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.

4.3 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, presented in Appendix F.

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 someway, thereby causing in 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 deminimis size for modeling is 400 hp.

4.4 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 (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 next to last paragraph in Section 4.1.3 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 corresponding 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.

4.5 Off-site Sources

Off-site sources must be accounted for in a cumulative impact analysis. The required approach is described in Section 8.2 of the Guideline.

***September 14, 2011 Note**: the following discussion is based on ADEC's understanding of EPA guidance available as of the October 2006 release of this manual. That understanding may lead to overly conservative results. ADEC intends to rewrite the following discussion based on more recent EPA guidance.*

The [cumulative impact] analysis expands the preliminary analysis in that it considers emissions from the (1) proposed source, (2) existing sources (both on- and off-site), and (3) residential, commercial, and industrial growth that accompanies the new activity at the new source or modification (i.e., secondary emissions).

Off-site sources to be included are dependent upon the distance from the SIA. The SIA is the geographical extent in which the impacts exceed the SIL. The highest modeled pollutant concentration for each averaging time is the "design concentration" used to determine whether the source will have a significant ambient impact for that pollutant (see discussion in Section 6.1 on length of meteorological data set and the design concentration). The SIA is a circular area with a radius extending from the source to either the most distant point where modeling predicts a significant ambient impact, or a distance of 50 km, whichever is less. Initially, the SIA is determined for every relevant averaging time for a particular pollutant, and the final SIA for that pollutant is the largest of the various averaging time areas.

A cumulative modeling analysis must then be performed in the SIA for that pollutant and averaging interval.

> *Key point:*
>
> *Sources within 50 km of the SIA must be included in the cumulative source inventory, if they cause significant impacts within the project's SIA. (See Figure C-5 in the NSR Workshop manual for an illustration.)*

A significant impact is an impact that exceeds the PSD modeling significance levels. The selection of other sources and emission rates may require different criteria for the NAAQS and PSD increment analyses, as described below.

<u>Cumulative NAAQS Analysis Requirements</u>
ADEC and EPA require that all nearby sources be explicitly modeled as part of the NAAQS 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 location of such nearby sources could be anywhere within the SIA or an annular area extending 50 kilometers beyond the SIA. The number of nearby sources is expected to be small except in unusual circumstances. 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 (see Section 7.0 for a discussion on background concentration data).

Key point:

In general, the emissions from nearby sources that are modeled in the cumulative short-term NAAQS analysis are based on <u>maximum allowable</u> 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 NAAQS analysis, emissions from nearby sources are based on the short-term emission rates multiplied by the actual operating factor averaged over the most recent 2 year period.

<u>Cumulative PSD Increment Analysis Requirements</u>
Analogous to the NAAQS cumulative analysis, only "nearby sources" within 50 km of the SIA 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 <u>actual</u> 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.*

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.

Review of 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 SIA criteria. 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 permits on file with ADEC.

Once all sources are identified that are within 50 km of the project's SIA, sources may be excluded or "screened out" based on the Q/d technique. The Q/d method was developed as a tool to eliminate distant, insignificant emission sources from ambient assessments; it's use is limited to sources located outside the SIA. Refer to ADEC's guidance regarding the use of the Q/d screening method on ADEC's modeling webpage (see http://www.dec.state.ak.us/air/ap/modeling.htm).

4.6 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 ISCST3 and 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.

The simplest way to do this is to open the model output file and look for the source group identification and the list of sources included in that 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 can not use the EVENT model to perform a culpability analysis of annual impacts. The EVENT model has been incorporated into ISCST3 and AERMOD. Refer to the User's Guide for each manual 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 and correcting an error, you reran the model, and it was now predicting exceedances of the 24-hour PSD increment. You wanted to know to 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 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. Remember, the number of source groups is limited by the size of the initial array dimensions specified in the model code. Hence, running the EVENT model, overcomes this limitation.

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?

5. Review of 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 1000-hp IC engine may only require a SCREEN3 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 ISC. 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 ISC or 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 SCREEN3, ISC, AERMOD, and VISCREEN. Long-range transport models are designed to assess impacts between 50 and a few hundred km. They are most often used in Class I area impact assessments. CALPUFF is the preferred long-range transport model.

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. For example, the regulatory default option of ISCST3 invokes the following modeling parameters:

- Final Plume Rise on
- Stack-tip Downwash on
- Buoyancy-induced Dispersion.
- Use Calms Processing Routine.
- Missing Data Processing Routine off (*Note: current Guideline says this setting should now be on*)
- Default Wind Profile Exponents.
- Default Vertical Potential Temperature Gradients.
- "Upper Bound" Values for Supersquat Buildings.
- No Exponential Decay for RURAL Mode

In some limited situations, it may not be appropriate to select the regulatory default option. For example for situations in which plume-terrain interaction may occur before the plume has risen to its final height, the gradual plume algorithm is preferred over the final plume rise algorithm. The SCREEN3 model may be used to determine distance to final plume rise for a given meteorological scenario. The topographic map may be used to evaluate whether intermediate or complex terrain is present within this distance of the emission source. If so, then the model should be run with the gradual plume rise option.

For ISCST3 modeling applications, the non-default option for processing missing meteorological data should be selected such that hours with missing meteorological data are calculated 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. Note: the term "regulatory default" is a bit misleading for this situation).

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 in urban sources

5.2 Treatment of Chemical Transformations

Regulatory air quality models can simulate the transport and dispersion of pollutants in the atmosphere, and to a limited degree can also simulate chemical 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 chemical transformations that need to be addressed in regulatory dispersion modeling analyses.

Emissions of nitric oxides (NOx) from combustion sources are primarily in the form of NO (even though the mass emission rate for NOx is typically based on the molecular weight of NO_2). However, the NAAQS was developed for NO_2. Therefore, a methodology to convert from NOx concentrations to NO_2 concentrations is required. Three approaches have been developed for use in regulatory modeling, ranging from the simple assumption that 100 percent of the NOx emitted is converted to NO_2 to other more complex methods. These methods are discussed in more detail in the Guideline, and are summarized below.

As an initial assumption, the applicant may assume that 100 percent of the emitted NOx is converted to NO_2. Should this be overly conservative, the applicant may employ the ambient ratio method (ARM) adopted in Supplement C to the Guideline (EPA, 1995). ARM allows applicants to develop a site-specific NO_2-to-NOx ratio using local monitoring data that meet strict quality assurance (QA) requirements. Unfortunately there are currently no NOx monitoring stations in Alaska that meet these requirements. However ARM also allows applicants to use a default 0.75 NO_2-to-NOx ratio in rural areas. ADEC allows applicants to use the default 0.75 ratio for near-field impacts, but questions whether it is appropriate for assessing impacts beyond 10 km.

EPA and ADEC also allow the use of the Ozone Limiting Method (OLM) for refining the modeled NO_2 concentration.[19] 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. Available models are EPA's ISC3-OLM model (version 96113) and AERMOD.

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. If the O_3 concentration is greater than nine-tenths 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 nine-tenths of its corresponding modeled NOx concentration, the formation of NO_2 is limited by the ambient O_3 concentration. In this case, the NO_2 concentration is set equal to the O_3 concentration plus a correction factor, which accounts for in-stack and near-stack thermal conversion of NOx to NO_2.

The Plume Volume Molar Ratio Method (PVMRM)[20 21] is a new approach that offers a less conservative (more accurate) approach for calculating ambient NO_2 concentrations than OLM. PVMRM is currently a non-regulatory option in AERMOD. However, EPA Region 10 has authorized the State of Alaska to use PVMRM on a case-by-case basis (with their additional approval). An updated agreement is currently in the works that will allow ADEC to use PVMRM at our discretion, in exchange for an annual usage report. PVMRM uses the same representative, hourly ozone data as used in OLM. There is also an option for revising the in-stack NO_2/NOx ratio from the default 0.10 value.

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. ISCST3 can account for this by specifying the pollutant name SO_2 and invoking the urban dispersion coefficient option, simultaneously. Although this feature is available in ISCST3, it has never been used in support of a construction permit application in Alaska.

Troposphere ozone (as opposed to stratospheric ozone) is a PSD regulated pollutant, and an air quality analysis is typically required in the lower 48 states if the applicant is proposing to emit greater than 100 tpy of volatile organic compounds (VOCs). However, given the remote, non-urban nature of Alaska, an ozone impact analysis is not required for sources of VOC.

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 for Air Quality

[19] 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.
[20] 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.
[21] 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.

Modeling (IWAQM)[22] and FLAG 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.

5.3 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 ISCST3, AERMOD or CALPUFF, or manually calculated using model-predicted ambient concentrations and “deposition velocities”. The IWAQM Phase I modeling report[23] provides an example of this methodology on page 5-6 for calculating deposition of sulfur and nitrogen.

- ✓ 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.

Deposition velocities are pollutant specific.

ISCST3 and AERMOD can be used to assess the deposition or depletion of particulate matter. The dry deposition algorithm uses predicted ambient concentrations and “deposition velocities” to calculate the deposition flux. The user must provide the model with the size distribution information for emitted particulate matter, and the mass fraction and particle density corresponding to each particle size category. 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[24]. Additional meteorological parameters must also be processed when using ISCST3 or AERMOD for deposition and depletion analyses. The user must specific boundary layer parameters including surface roughness length, Bowen ratio, albedo, anthropogenic heat flux, and fraction of net radiation absorbed by the ground.

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

[23] 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/scram001/7thconf/calpuff/phase1.pdf)

[24] 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. (http://www.epa.gov/scram001/guidance/reports/fugdust.zip).

ISCST3 uses a scavenging ratio approach to model wet deposition and removal. In this approach, the flux of material to the surface through wet deposition is the product of the ambient concentration times the "scavenging ratio", integrated in the vertical. If wet deposition is to be modeled, observations of hourly precipitation are also required. The precipitation data source should be reviewed to ensure it is representative of the project location. National Weather Service data processed with PCRAMMET can be used to create the necessary meteorological data. Representative site-specific meteorological data may also be used, if sufficient parameters are collected as required for deposition. The MPRM program should be used to process user-collected meteorological data. Refer to Section 8 of this manual to ensure the meteorological data is processed correctly.

- ✓ Check the particle size distribution calculations against the above referenced study, AP-42 size distribution data, or stack test size distribution data to ensure they are reasonable.

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.

Additionally, at least for one study, wet deposition results have been found to be very sensitive to scavenging coefficients[25]. ISCST3 distinguishes between both liquid and frozen scavenging coefficients. As a conservative estimate, the frozen scavenging coefficient is set equal to the liquid scavenging coefficient, even though research has shown it to only one third as effective. Scavenging coefficients and ground-interaction variables can be found on a limited basis in the Addendum to the ISC User's Guide[26] or more extensively in the species library of the CALPUFF graphical user's interface under the deposition input screen.

- ✓ Refer to the CALPUFF information for determining appropriate wet deposition input information into ISCST3.

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.

5.4 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.

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

[25] Model Parameter Sensitivity Analysis. US. EPA Region 6 Center for Combustion Science and Engineering. May 1997. http://www.epa.gov/earth1r6/6pd/rcra_c/protocol/analysis.pdf

[26] US EPA. Addendum to the Industrial Source Complex (ISC) Dispersion Models. Volume I – User's Instructions. June 1999. US EPA Office of Air Quality Planning and Standards. Research Triangle Park, NC.

Often, separate modeling files are necessary for pollutants with different short-term and annual average emission rates.

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, applicants should use the U.S. EPA scaling factors shown in Table 1 to convert 1-hour concentration estimates from SCREEN3 to other averaging periods. The ±factors should be applied following the guidance. Refer to the SCREEN3 modeling tips contained in Appendix A for a discussion of how to obtain time-averaged pollutant concentrations for complex terrain applications.

Table 1. Point source scaling factors to convert 1-hour average concentration estimates from the SCREEN3 model to longer averaging periods.

Averaging Period	EPA Scaling Factor for Point Sources[a]
3 hour	0.9 (±0.1)
8 hours	0.7 (±0.2)
24 hours	0.4 (±0.2)
annual	0.08 (±0.02)
[a] Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised[27]	

5.5 Selection of Dispersion Coefficients (urban/rural)

In the models SCREEN3 and ISCST3, the applicant must select whether to use the rural or urban dispersion coefficients (other models, such as OCD and AERMOD, use surface characteristics that are a function of land use classification and so do not require the specification of "rural versus urban" characteristics).

> *Key point:*
>
> *With the exception of certain parts of Anchorage, the applicant should select the rural dispersion coefficient for Alaska regulatory modeling analyses.*

A more rigorous demonstration using the Auer Land Use analysis[28] is not required, except for analyses in the greater Anchorage area.

[27] U.S. Environmental Protection Agency. October 1992. Screening Procedures for Estimating the Air Quality Impact of Stationary Sources. EPA-454/R-92-019 Office of Air Quality Planning and Standards, Research Triangle Park, NC, page 4-16. http://www.epa.gov/scram001/guidance/guide/scrng.pdf

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

6. Downwash Analyses and Merged Stacks

Wind flows are disrupted by aerodynamic forces in the vicinity of buildings and other solid structures. Figure 2 illustrates the downwind zones associated with building downwash. The stack is illustrated on the left side of the figure A “cavity” region, extending a distance of 3 times the variable “L” downwind, is produced in the lee of the structure that has circulating eddies and a highly turbulent flow. ” L is defined as the lesser dimension of building height or building width. The turbulent wake extends between the cavity region and 10L downwind. The plume is thought to “reattach” i.e., exhibit behavior uninfluenced by the building or structure beyond 10L from the stack. 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 ISCST3, AERMOD, and SCREEN 3 all make calculations of pollutant concentrations in the building wake zone, but not all models (e.g. ISCST3) make calculations of pollutant concentrations in the cavity region. If the cavity region extends beyond the fenceline, an alternative model, such as SCREEN3 should be used for the cavity region.

```
                              Wind direction
                          ---------------->

_
||
||
||    CAVITY     3L              WAKE              10L      REATTACHMENT
---------------------|----------------------------------------|---------------------------
```

Figure 2. Side View of Stack and Downwind Zones.

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. 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 3. Most stacks in Alaska are below formula GEP.

```
                  Wind direction
                 --------------->

 _______________________________________________  __
|             _____  _ _ _ _ _ _ _ _ _ _ _ |  __ 1/2 L
|          ___|    |___                    |
|          |          |                    |
|          |Building|                      |
|          |______    |                    |
|                 |___| _ _ _ _ _ _ _ _ _ _ |  __
|__________________________________________|  __ 1/2 L

|<--2L->|          |<--------5L------->|
```

Figure 3 - Plan View of Area of Influence of Building Wake Effects

6.1 Review of GEP and BPIP Analyses

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 (BPIP) for use with ISCST3 and AERMOD.[29] The input data to BPIP 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 (BPIP 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 SCREEN3, ISCST3, AERMOD and CALPUFF. SCREEN3 contains the most simplistic downwash algorithm. AERMOD and CALPUFF contain the most sophisticated algorithm – the Plume Rise Model Enhancement (PRIME).

For ISCST3 and AERMOD, direction specific building dimensions are used in the model input files. Since SCREEN3 does not explicitly address direction specific effects, the most conservative dimensions should be used for a SCREEN3 downwash analysis. These dimensions can be obtained from a plot plan, or in complex building situations, can be obtained from a BPIP analysis.

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

[29] The BPIP program used with AERMOD is sometimes referred as BPIP-PRIME.

The following review steps are recommended:

✓ Using the BPIP 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.

The applicant may omit small buildings/structures from the BPIP input file as these structures may not contribute to downwash effects. Also note that if plant north is different than true north, the BPIP input file must include a rotation angel. 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.

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

✓ Check the base elevations of the buildings and stacks in the BPIP 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 BPIP. Both approaches provide identical results when running the SCRAM version of BPIP. 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 ISC/AERMOD input file, rather than the stack base elevations provided in the BPIP file. ***For this reason, ADEC encourages applicants to use the actual building and stack elevations in the BPIP analysis.***

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

- Approach 1 – enter the actual building base elevations in the BPIP input file (copy the BPIP input file first – do not edit original files!) and use BEEST to rerun the BPIP analysis; or
- Approach 2 – run the SCRAM version of BPIP using DOS.

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 BPIP 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 4 below.

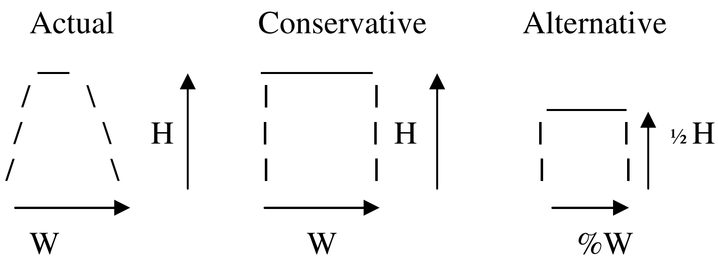


Figure 4. Illustration of Pitched Roof Representations in BPIP.

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

- ✓ After reviewing the BPIP or BPIP-PRIME input/output files, check to ensure that the direction specific building downwash parameters were included in the ISCST3 or AERMOD input files.

BPIP output data with the keywords "BUILDHGT", "BUILDWID" (and BUILDLEN", "XBADJ", and "YBADJ" if BPIP-PRIME is used) should exactly match the same keywords in the ISCST3 or AERMOD source data input files.

6.2 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, or (3) removing a rain cap, or merging 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 <u>at existing stacks</u> 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. This technique should be distinguished from the stack merging procedures used when modeling with SCREEN3.

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.

7. Receptor Grids

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 SCREEN3 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 ISCST3 and 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. There can also be errors in the digital elevation data obtained from the USGS.

7.1 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.

- ✓ Ensure that terrain is adequately addressed.

- ✓ If the applicant has not included elevated terrain in the modeling analysis, review the location of the facility and surrounding terrain to ensure that elevated terrain is not present within three km of each emission source.

Three km was selected as a general approximation. Taller stacks with buoyant plumes may require looking as far as 10 km away, whereas near ground-level sources with non-buoyant plumes may require looking only within one km. If terrain does not rise greater than 10 percent of the stack height, then flat terrain may be assumed.

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 facility 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.

CTSCREEN and CTDM require the user to digitize a controlling terrain feature such as a nearby hill. Often the terrain feature is not in the shape required by the model (idealized hill), so a subjective interpretation must be made to enter the feature into the model.

AERMOD uses a terrain processor called AERMAP. AERMAP processes digital data – either National Elevation Data (NED) or Digital Elevation Model (DEM) data – to calculate a scale height, from within the grid, for each receptor location. However, the calculation of scale height is not dependent upon direction, and therefore errors can occur. To avoid this problem, the user should limit the receptor grid in AERMAP to a specific terrain feature, and then assemble the individual AERMAP output files for use in AERMOD.

AERMAP can also provide the source base elevations and receptor elevations to AERMOD. This approach provides consistency (i.e., eliminates the potential errors that can occur with the use of different elevation datum).

- ✓ When reviewing AERMAP files, create 3-D plot of the receptor scale heights and compare this with a plot of the receptor elevations.

Errors have occurred when the applicant didn't specify the correct source base elevations.

- ✓ No matter which 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.

7.2 Geographical Projection Information

A consistent coordinate system should be used for the identification of receptors, building locations, and emission sources. 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 earth onto a 2-dimensional field. Consequently, each coordinate system has distortions associated with it.

Either Cartesian or polar coordinate system may be used. 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.

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 analysis. [Note that UTM coordinates will need to be adjusted if the off-site sources are located in a neighboring UTM zone.]

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.

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. Care must be taken when specifying a receptor which extends across a UTM zone, as the easting values are not the same. In such a case, the eastings of one UTM zone must be converted to the neighboring zone to ensure a consistent frame of reference. The

- ✓ When using the UTM coordinate system, make certain that the receptors, building, and source information is specified in the same datum and zone (i.e., equations used to describe the shape of the earth).

Two of the most common datum are the North American datum of 1927 (NAD27) and the more recent North American Datum of 1983 (NAD83). Conversion systems are available to convert between these two datum such as the Army Corps of Engineering program CORPSCON (available at www.corpscon.com). 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.

UTM coordinates are also specified by zones.

7.3 Description of Receptor Grids and Boundary Receptors

Stationary source fence lines and property boundaries must be shown on the required site plan, and the model receptor grid must start on the fence line (i.e., 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 3.2 of how to import the ISCST3 or AERMOD input file. Then, 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 sources 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 source 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 (fence line) and emission sources overlaid.

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 sources are located outside of the facility boundary. The property boundary shown in the grid should accurately represent the boundary as shown in figures in the modeling report.

Errors sometimes occur when the receptor spacing is not sufficiently dense to identify the location of the maximum model-predicted concentration. Judgment is required in determining the sufficiency of receptor density. Large concentration gradients (i.e., the change in concentration per distance) require a denser receptor grid than an area with a low concentration gradients. High concentration gradients typically occur near the source, and in nearby complex terrain. For a ground-level source release, 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 ground-level concentration 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 ground-level concentration 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 a 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 a couple hundred meters of a 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 allow the maximum impact to be overlooked. 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.

- ✓ Check adequacy of the grid spacing. In situations with steep concentration gradients, feel free to add receptor and rerun the model to ensure the maximum concentration has been identified.

- ✓ Verify that the grid extends sufficiently outward from the emission 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.

7.4 Determination of Receptor Elevations and DEM Processing Procedures

USGS 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.

Often, the receptor location falls between the grid nodes in the DEM files and an interpolation scheme must be used. When in doubt, the interpolation scheme used in AERMAP (2-dimensional distance weighted interpolation) is consistent with EPA guidance, and may be used. The various GUI systems also offer receptor grid generation capabilities from DEM data files.

7.5 Flagpole and Sensitive Receptors

"Flagpole" receptors are receptors located above the ground. They are useful for determining impacts on balconies and roof-top terraces. 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.[30]

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.

[30] 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.

8. Review of Meteorological Data

Models require meteorological data or assumptions to estimate plume dispersion. Screening models, such as SCREEN3 and CTSCREEN, use an internal matrix of assumed wind speed, stability class, and other parameters to estimate worst-case ambient impacts. They do not require actual meteorological data. The SCREEN3 users guide describes the procedures and meteorological conditions used for screening analysis. In some cases, applicants may also use these screening procedures with more refined models, such as ISCST3. However, there are limitations, as described in the ISCST3 Modeling Tips section contained in Appendix A.

For more refined analyses, actual hourly meteorological data sets are required. Meteorological parameters are routinely measured at major airports by the National Weather Service (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. However, "site specific" data collected by applicants must meet minimum EPA requirements for accuracy, sensitivity, and completeness, as described in ADEC guidance and the EPA Meteorological Monitoring Guidelines[31]. *In all cases, the data used in a modeling analysis must be representative of the meteorological conditions at the applicant's facility.*

Section 8.3 of the Guideline provides additional details regarding acceptable meteorological data sets. The Guideline states that the meteorological data 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. 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. 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 met data areas. Temporal representativeness is a function of the year-to-year variations in weather conditions. Section 3 of the EPA Meteorological Monitoring Guidelines also provides a general discussion for determining the representativeness of meteorological data.

8.1 Length of Data Record and Model Design Concentrations

The applicant should use enough 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 of site specific data, are the minimum required when estimating concentrations with an air quality model. Consecutive years from the most recent, readily available 5-year period are preferred – see further discussion in Section 6.2 on NWS Automated Surface Observing

[31] Refer to "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://www.dec.state.ak.us/air/am/index.htm.

System (ASOS) data. For long-range transport or complex wind situations, five years of NWS data or at least three years of mesoscale meteorological data are required (Guideline 9.3.1.2.d).

If the air quality analyses are conducted using the minimum periods of meteorological data described above, then the “design concentration” (the modeled ambient concentration that is compared to the NAAQS and PSD increments) is the highest, second-highest (h2h) short term concentration, or the highest long term average. (Note, EPA allows the h6h over five-years to be used for the 24-hr PM-10 NAAQS analysis). When sufficient and representative data exist for less than a five-year period from a representative NWS site, when it has been determined that a one year site specific data set is not temporally representative, then the highest concentration estimate should be considered the design value. This 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. The highest value is then a surrogate for the concentration that is not to be exceeded more than once per year (the wording of the deterministic standards). Also, the highest concentration should be used whenever selected worst-case conditions are input to a screening technique, and to determine if the proposed source’s impacts exceed the SILs or the pre-construction monitoring thresholds.

8.2 Meteorological Data Description and Rationale

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. Site specific data must also be demonstrated to meet EPA requirements for representativeness, accuracy, sensitivity, and completeness. Typically, a site specific monitoring program requires the submittal and approval of a Quality Assurance Project Plan, regular audit and calibration reports that document system accuracy and sensitivity, and a data report that presents all data collected and compiles data capture rates or “completeness” information.

The completeness of a site specific data set is a very important parameter, especially when the site specific data set is for a one year period (as contrasted with multi-year periods). The EPA Meteorological Monitoring Guidelines 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).

8.3 Meteorological Data Processing and Missing Data

8.3.1 NWS Data Processing Procedures

PCRAMMET is the recommended meteorological preprocessor for use in applications employing hourly NWS data. Although most NWS measurements 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. A specific set of randomly generated numbers has been implemented in PCRAMMET and should be used with NWS data to ensure a lack of bias in wind direction.

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 includes 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.

If the applicant is using representative NWS data, the modeling submittal should describe the data processing performed with PCRAMMET. Alternately, ADEC has pre-approved some NWS-based data sets, and as long as the applicant demonstrates that the data is representative, they do not need to discuss the data processing steps.

8.3.2 Site Specific Data Processing Procedures

Don't use PCRAMMET to process site-specific meteorological data.

MPRM is a general purpose meteorological data preprocessor which supports regulatory models requiring PCRAMMET formatted (NWS) data. MPRM is available for use in applications employing site specific meteorological data. The latest version (MPRM 99349) has been configured to implement the SRDT method for estimating P–G stability categories. It is recommended that applicants use MPRM for all site specific data processing. 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.

The current release of MPRM (version 99349) can not be used to process meteorological data collected above the Arctic Circle (this limitation is even noted in the User's Guide, Appendix B; page B-11; Parm2,3). EPA has developed (but not released on SCRAM) a patch, but there are indications it doesn't work properly.

8.3.3 AERMET Data Processing Procedures

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

It is beyond the scope of this manual to describe the details of how to use AERMET, the expected data files, and formats. Refer to the AERMET User's Guide[32] for a complete description of these programs and data requirements.

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 are required to run AERMET, these optional parameters create unnecessary warning messages, and could have been avoided by using the non-default QA specification parameters. Additionally, AERMOD can make pollutant calculations using "calm winds"; consequently, the calm wind warning message is not significant.

Figure 5. Example of Messages Generated From Stage 1 Processing of Surface Data

```
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
```

Due to the thousands of error messages generated in AERMET, a difficult situation arises.

- ✓ While many of the error messages aren't significant, you must make certain that you're not missing a error significant message.

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, AERMOD offers the user summary QA files which provide an additional means of quickly assessing the validity of the data. See the User's Guide for additional details.

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

Another source of errors can be found in Stage 3 processing. AERMET requires boundary layer parameters of surface roughness length, Bowen Ratio, and surface albedo for the modeling domain. These can be specified as a function of season and directional sector.

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

The AERMOD manual presents appropriate values of each of these as a function of land use classification (e.g., forest, snow, grassland, etc.) Additional values may be found in other literature sources, as well.

8.3.4 Missing Data Substitution

Some regulatory models are capable of handling missing data. For example, the option for processing missing meteorological data in ISCST3 can be selected so that 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), 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 Rob Wilson & Guideline, missing wind data should not be fill in (unless there are collocated sensors, etc)].

The applicant should follow Section 9.3.3.2 (c) of the Guideline, which refers to Section 5.3 and 6.8 of the EPA Meteorological Monitoring Guidance.

8.4 Meteorological Data Summaries

The applicant should provide some 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.

9. Background Air Quality Data

Background air quality data is needed to supplement a cumulative AAQS 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 AAQS 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 8.2.9].

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 multi-source area, the background monitored value should be added to model-predicted impacts from "nearby sources".

ADEC can provide pre-approved regional background air quality values for a given region. Using pre-approved values, applicants may simply identify the region for which their project is located and download the appropriate value. If this regional background concentration is believed not to be representative, applicants may propose alternate background concentration data for case-by-case approval by ADEC.

10. Review of Ambient Assessment Results

The ambient assessment should be conducted according to 18 AAC 50.215(b) – (e). The ambient assessment should include the following elements:

- Significant impact analysis
- Comparison with pre-construction monitoring thresholds (if PSD)
- A AAQS Compliance analysis
- PSD Increment Consumption analysis

Each of these is discussed in the following sections.

10.1 Significant Impact Analysis & Determination of Significant Impact Area (SIA)

The significant 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 significant impact levels (SILs) for Class II areas, they have only proposed, but not yet finalized SILs for Class I areas. Refer to Section 11 of this document for a discussion of the proposed Class I area SILs.

Determining the significant impact area (SIA) is also relatively straightforward. The methodology is discussed in Section 4.5 Off-Site Sources, of this manual. 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.

10.2 Comparison of Project Impacts to Pre-Construction Monitoring Thresholds

"Preconstruction monitoring may be required for sources subject to PSD to determine whether emissions from a source will result in exceeding the NAAQS."

-EPA's PSD Monitoring Guidelines[33]

Significant Deterioration (PSD). Office of Air Quality Planning and Standards, Research Triangle Park, NC http://www.epa.gov/ttn/amtic/files/ambient/criteria/reldocs/4-87-007.pdf

Further the data could be used to verify the accuracy of the modeling estimates since modeling will be the principal mechanism to determine whether emissions from the proposed source or modification will result in exceeding allowable increments."

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. 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.

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

As discussed in Section 7.1, applicants must compare the h1h impact to the monitoring thresholds.

- ✓ Determine whether existing ambient data is representative of the vicinity of the proposed emission source, 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 currentness of the 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 locations 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 out 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.

10.3 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).

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

Refer to Section 3.7: Review of 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. The document is available at http://www.dec.state.ak.us/air/ap/docs/roumemo.pdf.

10.4 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. 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).

10.5 Additional Impact Analyses (PSD Sources Only)

PSD applicants must provide an analysis "of the impairment to visibility, soils and vegetation that would occur as a result of the source or modification and general commercial, residential, industrial and other growth associated with the source or modification." 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 9.1.2(k).

10.5.1 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(x)). 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.

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.

10.5.2 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.[34] 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.

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*

[34] ADEC previously recommended that applicants compare their maximum modeled impacts to the sensitive vegetation thresholds listed in EPA's *A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals*. ADEC is no longer pursuing this practice since the document is out of print and appears to be no longer used by EPA.

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?

11. Class I Air Quality Related Values (PSD Sources Only)

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 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 point:

   The Federal Land Manager (FLM) has responsibility for reviewing and providing comments on air quality impacts inside Class I areas.

Class I areas of the State are presented in Table 1 of 18 AAC 50.015.

Consequently, your responsibility is to keep the FLM informed of other 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 US EPA has proposed criteria indicated the circumstances 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. The EPA has proposed significant impact levels (SILs) for Class I areas (61 FR 38292, July 23, 1996), but these have yet to be fully promulgated (i.e., finalized). 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
Nitrogen Dioxide (NO_2)	Annual	0.1

12. Data Submittal Requirements

The modeling analysis should include (1) a technical report describing the analysis (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
- Digital Elevation Model (DEM) 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.

13. List of Acronyms

AAAQS: Alaska Ambient Air Quality Standards

AAQS: Ambient Air Quality Standards

AQRV: Air Quality Related Value

NAAQS: National Ambient Air Quality Standards

NSR: New Source Review

Guideline: Guideline on Air Quality Models

SIL: Significant Impact Level

SIA: Significant Impact Area

ROI: Radius of Impact

IWAQM: Interagency Workgroup on Air Quality Modeling

FLAG: Federal Land Managers' Air Quality Related Values Workgroup

FLM: Federal Land Manager

LRT: Long Range Transport (distances greater than 50 km from a source)

GEP: Good Engineering Practice (stack heights)

Appendix A

Modeling Tips

SCREEN3

Although SCREEN3 is a screening model, it is not necessarily easy to obtain correct results. Complications arise from errors in providing the model with the intended input data such as: correctly representing the controlling building, using proper merged stack parameters, properly identifying simple and complex terrain, and converting output data for the correct averaging periods.

- ✓ Refer to the SCREEN3 user's guide and the EPA publication "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised" for current guidance.

When SCREEN3 is run for building downwash calculations, the program prompts the user for the building height, the minimum horizontal building dimension, and the maximum horizontal building dimension. The downwash screening procedure assumes that the building can be approximated by a simple rectangular box. If more than one building influences the plume, the user may run BPIP to determine the controlling building, and enter these parameters into the SCREEN3 program, rather than perform this exercise manually, as specified in the Screening Procedures document.

On occasion, a user may use screen to assess impacts from multiple sources, including but not limited to nearby stacks. Sources that emit the same pollutant from several stacks 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 is described in Section 2.2 of the Screening Procedures.

Under some cases, applicants may model impacts from multiple sources, not adjacent to each other. SCREEN3 has been used in some cases 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.

Modeling impacts in simple and complex terrain can sometimes be complicated. If elevated terrain above stack height occurs within 50km of the source, then the procedure in Section 4.5.2 should be applied in addition to the procedures in this section. Additional and helpful information is available in Sections 2.4.2 and 2.4.3 of the Screen3 Model's User's Guide (EPA-454/B-95-004).

Section 2.3.3 of the Screen3 User's Guide provides the following guidance for (1) relatively uniform elevated terrain, (2) isolated terrain features, and (3) where terrain heights vary with distance from the source.

"For relatively uniform elevated terrain, or as a "first cut" conservative estimate of terrain effects, the user should input the maximum terrain elevation (above stack base) within 50 km of the source, and exercise the automated distance array option out to 50 km."

"For isolated terrain features a separate calculation can be made using the discrete distance option for the distance to the terrain feature, with the terrain height input as the maximum height of the feature above stack base."

"*Where terrain heights vary with distance from the source, then the SCREEN model can be run on each of several concentric rings using the minimum and maximum distance inputs of the automated distance option to define each ring, and using the maximum terrain elevation above stack base within each ring for terrain height input. As noted above, the terrain heights are not allowed to decrease with distance in SCREEN. If terrain decreasing with distance (in all directions) can be justified for a particular source, then the distance rings would have to be modeled using separate SCREEN runs, and the results combined. The overall maximum concentration would then be the controlling value. The optimum ring sizes will depend on how the terrain heights vary with distance, but as a "first cut" it is suggested that ring sizes of about 5 km be used (i.e., 0-5 km, 5-10 km, etc.).*"

Be aware that "*if the plume is at or below the terrain height for the distance entered, then SCREEN will make a 24-hour concentration estimate using the VALLEY screening technique. If the terrain is above stack height but below plume centerline height for the distance entered, then SCREEN will make a VALLEY 24-hour estimate (assuming E or F and 2.5 m/s), and also estimate the maximum concentration across a full range of meteorological conditions using simple terrain procedures with terrain "chopped off" at physical stack height. The higher of the two estimates is selected as controlling for that distance and terrain height (both estimates are printed out for comparison). The simple terrain estimate is adjusted to represent a 24-hour average by multiplying by a factor of 0.4, while the VALLEY 24-hour estimate incorporates the 0.25 factor used in the VALLEY model*."

SCREEN3 can also calculate ambient pollutant concentration during an inversion break-up fumigation and shoreline fumigation. Reviewers and applicants not be familiar with these meteorological processes are offered the following explanation so as to know under what conditions these options are to be employed.

Fumigation occurs when a plume that was originally emitted into a stable layer is mixed rapidly to ground-level when unstable air below the plume reaches plume level. Fumigation can cause very high ground-level concentrations. Typical situations in which fumigation occurs are:

1. Breaking up of the nocturnal radiation inversion by solar warming of the ground surface;

2. Shoreline fumigation caused by advection of pollutants from a stable marine environment to an unstable inland environment; and

3. Advection of pollutants from a stable rural environment to a turbulent urban environment.

The option for fumigation calculations is applicable only for rural inland sites with stack heights greater than or equal to 10 meters (scenario 1, above) or within 3km onshore from a large body of water (scenario 2, above). Procedures for estimating concentrations during the third type, rural/urban, are not discussed in the Screening Procedures manual or Screen3 User's guide. The fumigation algorithm also ignores any potential effects of elevated terrain.

Be aware that SCREEN3 has large discontinuities for low buoyancy plumes with stack to building height ratios around 1.5 and 2.5. However, this is not a issue for most Alaskan sources since most Alaskan sources have fairly buoyant plumes.

SCREEN3 is further discussed on pages: 7, 35, 36, 41, 46, 49, 52-54, 59.

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. 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 <u>inside</u> a Class I area *and* for impacts located <u>outside</u> 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 <u>inside</u> 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.

VISCREEN is further discussed on pages: 7, 9, 41, 68, and 69.

ISCST3

ISCST3 was the primary NSR model during the 1990's through 2005. However, EPA replaced ISCST3 (along with the ISC-meteorological processors, MPRM and PCRAMMET) with the AERMOD Modeling System in a November 9, 2005 Guideline revision.

***September 14, 2011 Note*: ADEC has adopted by reference post-2005 versions of the Guideline which means AERMOD is now the primary model for NSR permitting. ADEC has therefore deleted much of the following discussion in the September 2011 release. However, ADEC has kept the screening-level discussion in case portions can be transferable to AERSCREEN. ADEC intends to review and revise all of Appendix A in the major rewrite**.

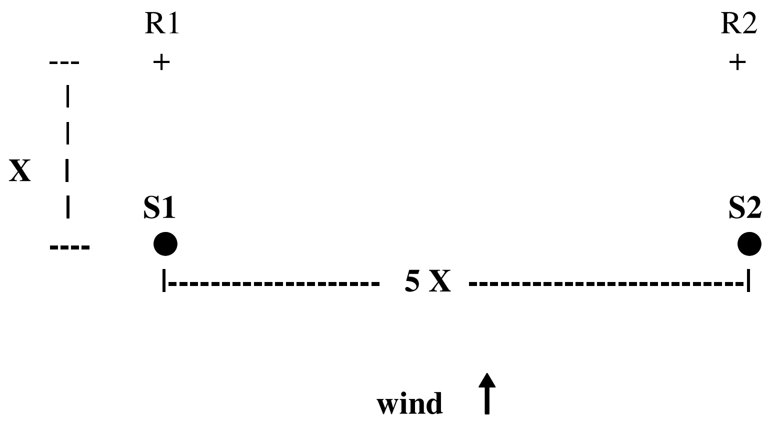
Because ISCST3 has been the most widely used regulatory dispersion model, most of the tips for running ISCST3 are incorporated in the main document as general guidance.

Oregon DEQ has developed a screening meteorological data set for use with ISCST3 for multiple source situations without hourly observations of representative meteorology. The data set consists of the 54 potential combinations of wind speed and stability class scenarios that are used in the SCREEN3 model, and is repeated for every user defined increment of wind direction. Using this screening meteorology, the user can obtain maximum 1-hour pollutant concentrations.

ADEC allows applicants to use ISCST3 with screening meteorology in cases where the emission units are essentially clustered and have similar stack characteristics. However, ADEC may require a more refined approach for situations where the distance between emission units exceeds the distance between an emission unit and the nearest receptor. A similar concept lies behind the 100 meter threshold for merging sources in EPA's *Screening Procedures for Estimating the Air Quality Impact from Stationary Sources* (US EPA, October 1982, EPA-454/R-92-019).

Consider the following example shown in the figure below. Two receptors: R1 and R2 are located due north of two emission units: S1 and S2. R1 and R2 are located a distance X north of S1 and S2 respectively. The sources are located 5X apart, on the east-west plane. The wind is blowing from the south to the north. Under this configuration, R1 is impacted by S1, but not S2. Similarly R2 is impacted by S2 but not S1.

Assume ISCST3 is predicting the maximum 1-hour SO_2 concentration at R1 under this configuration. The modeler desires to quantify the 24-hour SO_2 concentration. Therefore, he or she applies the SCREEN3 conversion factor of 0.4, multiplied by the 1-hour maximum SO_2 concentration to obtain the maximum predicted 24-hour SO_2 concentration. This effectively assumes that R1 is impacted by S1 40-percent of the 24-hour period. It also assumes that during the remaining 60-percent of the period, it is not impacted by S2. Consequently, the maximum predicted 24-hour SO_2 concentration may be underestimated using this approach, since S2 could be impacting R1 during part of the remaining 60-percent.



To address this concern, ISCST3 should be ran for each emission unit, or emission unit cluster (with similar stack characteristics). Modelers may then take the conservative approach of adding the highest impact from each run, regardless of location and meteorological condition. Modelers may also take a somewhat more refined approach of adding the highest impact (regardless of meteorological condition) on a receptor-by-receptor basis. Using the later approach, modelers would use the largest sum as the maximum 1-hour concentration. Once the maximum 1-hour concentration is combined, modelers could then use the standard conversion factors to estimate the maximum impacts during other averaging periods. In all cases regarding the use of screening meteorological data, modelers must use the high first-high (h1h), rather than the high second-high (h2h) modeled concentration, for demonstrating compliance with the air quality standards and increments.

ISCST3 is further discussed on pages: 7-9, 20, 21, 31-35, 37, 41-46, 48, 49, 51, 53, 54, 56, 59, 63.

AERMOD

EPA promulgated the AERMOD Modeling System (which includes AERMOD, AERMAP and AERMET) as a preferred GAQM model on November 9, 2005. The effective date of EPA's promulgation is December 9, 2005. The AERMOD Modeling System is a replacement to ISCST3 and the ISC-meteorological processors, MPRM and PCRAMMET.

EPA has posted additional guidance regarding the AERMOD Modeling System on their SCRAM web-site. This additional guidance is currently entitled, "AERMOD Implementation Guide" (September 27, 2005).

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 is discussed further on pages 54, 56, and 58.

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. 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 selected surface parameters should reflect the conditions within a 3 km radius of the meteorological tower.
  - ✓ The FAA web-site (http://www.alaska.faa.gov/fai/airports.htm) 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.*

AERMET is further discussed on pages 20, and 61-63.

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 (OCD)

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. Discreet, 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.

MODEL OPTIONS

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. 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. Mr. Herkhof instead recommended that the building height and width should be based on the nearest solid structure on the platform. 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. 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.

OCD is discussed further on pages: 3, 8, 36, and 46.

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.

CALPUFF is discussed further on pages: 7, 9, 41, 43-45, and 54.

Appendix B

Examples of ADEC Correspondence Modeling Protocols

[ADEC intends to provide updated examples in the major rewrite.]

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Appendix C

Examples of ADEC Correspondence Deficiency Notices

[ADEC intends to provide updated examples in the major rewrite.]

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Appendix D

Example Modeling Review Memorandums

[ADEC intends to provide updated examples in the major rewrite.]

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Appendix E

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Appendix F

ADEC Policy and Procedure Documents

ADEC Policy and Procedure Documents

1. Policy and Procedure 04.02.104 “Construction Phase Air Emissions at Oil Fields”
2. Policy and Procedure 04.02.105 “Intermittently Used Oilfield Support Equipment”
3. Policy and Procedure 04.02.108 “Ambient Air Quality Issues at Worker Housing”

State of Alaska Department of Environmental Conservation **Policy and Procedure** **Policy**		POLICY AND PROCEDURE NUMBER **04.02.104**	PAGE **1 of 3**
		EFFECTIVE DATE **November 20, 2006**	
SUBJECT **Construction Phase Air Emissions at Oil Fields**		SUPERSEDES **All Previous Editions**	
SECTION **Air Quality Division**	CHAPTER **Permit Processing**	APPROVED BY	

PURPOSE

Clarify policy direction for air quality management for North Slope oil field related emissions that occur during project construction phase. This policy establishes a procedure by which small construction equipment can be managed through fuel sulfur levels, rather than ambient air quality assessments.

The guidance is presented as an overall policy direction followed by specific questions and direction to clarify the issues and policy decision.

In 2004, the department undertook significant reforms for the new source review program to more closely mimic the federal new source review regulations. The department also decided to manage the air impacts from construction activities through fuel sulfur restrictions rather than explicit pre-permit modeling demonstrations. The department will rely more upon in-field inspections, observation and compliance verification and less upon pre-permit technical reviews, where those reviews are not clearly mandated by federal law or rules and where practices employed by EPA and other states have generally not gone to the level of detail that Alaska has done in recent years.

POLICY

Action:

Construction activities are considered "temporary construction activities" if they are completed within 24 months from the date construction begins – see 18 AAC 50.990(107). Temporary construction activities are not required to demonstrate compliance with the air quality increment standards.

Air permits staff should recognize that certain activities do not trigger the onset of the construction phase. Such an example would be an ice road construction that would support further stationary source construction. The ice road does not itself trigger an air permitting requirement nor is it part of the permanent stationary source. Therefore, it would not be considered the onset of the construction phase. While some project specific analysis may be required, construction is generally believed to commence once construction of the permanent facility begins – the facility, or its permanent appurtenances, that contains or relies upon the permitted stationary source(s).

Development drilling is considered part of the stationary source construction. In some situations, early transition to high-line power for tasks like development phase drilling can provide a way to enable drilling to proceed beyond the 24 month construction window since the construction source is replaced by a permitted permanent source. Yet, this particular approach should be examined with respect to the potential changes in the emission characteristics of the permitted source (electrical generator).

Applicability: Do construction phase emission units/activities need to be specifically listed in the permit?

Action: The department can provide for air quality management of construction phase units/activities without having the units/activities listed in the permit.

In such cases, the applicant must provide the department an adequate listing of units/activities and their projected operations and associated emissions prior to permit issuance in order for a) the department to concur with any modeling required in order to assure demonstrated compliance with NAAQS, b) enable an on-site department inspector to assess likely compliance with ambient standards via comparison with actual operating units to modeling analyses, and c) enable the company and the department to adequately correlate emissions from operating units during construction phase with any concurrent ambient monitoring that is ongoing at the time of construction. It is appropriate to require the permittee to make updates to the listing for any significant changes for construction phase related operations and to require periodic reports of actual construction phase units. Any such reporting regarding insignificant sized units and units less than 400 bhp equivalent should be lumped in some fashion to avoid individual unit reporting.

Applicability: What modeling demonstration is necessary for construction phase emission units?

Action: At the discretion of the supervisor for construction permitting, it is appropriate to require a modeling demonstration for construction phase emissions.

The purpose of the modeling would be to assure compliance with NAAQS. An increment demonstration may only be required if there is a regulatory basis for the demonstration (e.g., PSD requirement), and if the construction activities are expected to last more than 24-months per 18 AAC 50.990(107). The modeling request should be designed to examine the potential worst case phase for construction emissions, not all construction phase operations. Furthermore, it is recognized that characterizing small close to the ground emission units/activities, such as those common to earth moving, small electrical generators and heat plants, can be difficult and the modeling results can be questionable. Therefore, applicants who agree to the fuel sulfur limits listed below do not need to include construction-related internal combustion units rated at less than 400 bhp, and construction-related boilers/heaters with a heat input rating of less than 2.8 MMBtu/hr, in their construction phase modeling analysis.

Applicants who wish to rely on fuel sulfur restrictions must agree to use only fuel that meets the following fuel sulfur limits in all diesel-fired construction equipment:

- ≤ 1000 parts per million by weight (ppmw) through January 31, 2009; and
- ≤ 15 ppmw after January 31, 2009.

Air permits staff may include the above fuel sulfur limits as permit conditions applicable to the entire stationary source. For purposes of this policy, the department will assume that all construction equipment will be refueled from the fuel storage tanks used by the stationary source or brought on-site with a portable oil and gas operation (as defined in 18 AAC 50.990), and that any fuel that comes on-site in the construction equipment fuel tanks is inconsequential. Permittees can demonstrate compliance with this policy by retaining records related to sulfur content of the fuel delivered to the stationary source. Department staff may request these records in supporting their compliance reviews.

Nothing in this policy prevents the department from conducting it's own ambient monitoring adjacent to a construction phase operation.

AUTHORITY

IMPLEMENTATION RESPONSIBILITY

The Division Director and Air Permits Program Manager.

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State of Alaska Department of Environmental Conservation **Policy and Procedure** **Policy**		POLICY AND PROCEDURE NUMBER **04.02.105**	PAGE **1 of 4**
		EFFECTIVE DATE **November 20, 2006**	
SUBJECT **Intermittently Used Oilfield Support Equipment**		SUPERSEDES **All Previous Editions**	
SECTION **Air Quality Division**	CHAPTER **Permit Processing**	APPROVED BY	

PURPOSE

This policy establishes a procedure by which small, intermittently used oilfield support equipment can be managed through fuel sulfur levels, rather than ambient air quality assessments. This policy is limited to North Slope emission units.

Intermittent oilfield support equipment are typically used for two primary categories of work: oil well servicing and maintenance, and general oilfield maintenance for pipelines, roads and other existing infrastructure. Generally the emission units include diesel powered internal combustion engines for mechanical and electrical power, portable heaters, vehicle engines, and small electrical generators for light plants. Additional examples can include:

- Slickline units, well wireline units, coil tube units, fractionation units, hot oil units, and associated equipment related to well servicing
- Welding, brazing, cutting, and soldering equipment
- Snow blowers, melters, and general snow removal activities
- Hydraulic lifts
- Cranes
- Portable generators
- Road, pad, camp, pipeline and dock maintenance (grading, repairs, small construction projects, etc.)
- Well tie-ins and piping connects/disconnects related to well servicing.

Drilling rigs used for exploratory and development drilling are not considered as intermittent support equipment.

The guidance is presented as an overall policy direction followed by specific questions and direction to clarify the issues and policy decision.

Background: In 2004, the department undertook significant reforms for the new source review program to more closely mimic the federal new source review regulations. The department also decided to manage the air impacts from small, intermittent well servicing activities through fuel sulfur reductions rather than explicit pre-permit modeling demonstrations. The department will rely more upon in-field inspections, observation and compliance verification and less upon pre-permit technical reviews, where those reviews are not clearly mandated by federal law or rules and where practices employed by EPA and other states have generally not gone to the level of detail that Alaska has done in recent years.

PURPOSE

Applicability: Do air quality increments or National Ambient Air Quality Standards (NAAQS) apply for these operations?

Action: The department is obligated to make reasonable inquiry to assure that emissions from these emission units will not results in violations of the NAAQS.

In recognition of their portable nature, their infrequent intermittent use at any given location and how EPA and other states manage such emission units the department finds that these emissions are not subject to the more restrictive increment standards.

Applicability: Should these activities be managed via a Permit? If so, what type of permit and who is the permittee?

The department finds that these are comparatively small sources of air emissions, especially those used during wireline, hot oil and slickline functions as well as those used for general oil field infrastructure support.

Applicants must list all of the expected intermittent oilfield support equipment in the permit application. This includes emission units that will not be included in any ambient assessment that may be performed. For purposes of this policy, "intermittent" means a portable unit that only operates on an occasional basis at the given stationary source.

Air permits staff may include the fuel sulfur limits listed below as a permit condition applicable to the entire stationary source. For purposes of this policy, the department will assume that all intermittent support equipment will be refueled from the fuel storage tanks used by the stationary source or brought on-site with a portable oil and gas operation (as defined in 18 AAC 50.990) and that any fuel that comes on-site in the support equipment fuel tanks is inconsequential. Permittees are responsible for retaining fuel delivery records to document sulfur content and such records may be requested by DEC air permits staff. Fuel receipts are anticipated to be necessary for the permittee to fulfill their due diligence requirement for annual compliance certification. Unless required by federal law or rule, DEC issued permits will not require periodic reporting of fuel sulfur content for purposes of the equipment addressed by this policy document.

No other use restrictions will be placed on the equipment via the permit unless: 1) the applicant request to use a higher sulfur content fuel; 2) a specifically required modeling analyses provides a reasoned basis to anticipate a violation of a NAAQS; or 3) field measurements of fuel sulfur content, ambient measurements or staff observations provide compelling evidence of a likely violation of a NAAQS.

Notes:
1)The department considered the situation that these well service tasks are generally performed by contractors rather than the company operating the field.

2) The department reviewed ambient air quality measurements performed at PBU Well Pad A and an associated use record for portable and intermittent units that operated on that pad. A multi-year record was provided for ambient NOX. The results demonstrate that these units do not degrade air quality to a measurable extent. In 2003, BP installed an ambient SO2 instrument at the same location to track short term ambient conditions associated with intermittent source activity on this oil field production pad.

3) Nothing in this policy prevents the department from conducting it's own ambient monitoring adjacent to these field support operations.

Applicability: What ambient Air Quality Modeling is appropriate for these smaller units?

Action: After considerable review of the issue and research of practices among EPA and other states, the department concludes that properly characterizing small close to the ground emission units such as small electrical and heat plants, and well service operations, can be difficult and the modeling results can be questionable.

However, coil tubing drilling units and fractionation units normally incorporate larger reciprocating engines. These emission units are easier to characterize and have a greater potential for violating ambient air quality standards. At the discretion of the supervisor of the construction permitting group, the Department may require pre-permit modeling for coil tubing drilling units and well fractionation units to assess compliance with the NAAQS. If requested, such modeling should be adequate if performed for a generic unit of each type for a typical location in the particular oil field or exploration site.

Applicants using intermittent internal combustion units rated at less than 400 bhp or intermittent boilers/heaters with a heat input rating of less than 2.8 MMBtu/hr, who agree to use fuel with a sulfur content listed below, do not need to include these units in a modeling analysis.

Applicants who wish to rely on fuel sulfur restrictions must agree to use only fuel that meets the following sulfur limits in all diesel-fired intermittent units operating at the given stationary source:

- ≤ 1000 parts per million by weight (ppmw) through January 31, 2009; and
- ≤ 15 ppmw after January 31, 2009.

AUTHORITY

IMPLEMENTATION RESPONSIBILITY

The Division Director.

Department of Environmental Conservation **Policy and Procedure** **Policy**		PROCEDURE NUMBER **04.02.108**	**1 of 2**
		EFFECTIVE DATE **October 8, 2004**	
SUBJECT **Ambient Air Quality Issues at Worker Housing**		SUPERSEDES **All Previous Editions**	
SECTION **Air Quality Division**	CHAPTER **Permit Processing**	APPROVED BY	

PURPOSE

Establish a procedure for air quality modeling of worker housing areas.

Many stationary sources in Alaska provide on-site worker housing. In these situations, the Department must decide whether the housing areas should be treated as “ambient air” and included in a permit applicant’s ambient demonstration.

“Ambient air” is defined in Alaska and federal regulations as outside air to which the public has access. Ambient air typically excludes that portion of the atmosphere within a source’s boundary.[35] However, areas within the property boundary that are accessible to the public are treated as ambient air. Typical examples include public roads, rivers, parks and even other sources located within the boundaries of a geographically larger source. EPA has also clearly stated family housing areas within military reservations are ambient air.[36]

POLICY

This policy applies to all Air Permit Program staff who review or conduct an ambient air quality analysis associated with a permit action, a permit-avoidance action, a petition to revise Air Quality Control Regulations, or 18 AAC 50.201.

Action: Staff shall treat all worker housing areas (including areas provided for families and off-duty activities) as ambient air, except when the following conditions are met.

[35] The Alaska Legislature has given the Department of Environmental Conservation responsibility for managing and protecting ambient air. The Legislature has given the Department of Labor responsibility for worker safety, which includes the non-ambient air within a source’s boundary.

[36] EPA Modeling Clearinghouse Information Storage and Retrieval System (McHisrs), “R-II Military Reservation Power Plant – April 83,” April 13, 1983.

1. The worker housing area is located within a secure or remote site, such as military bases with no family housing units, off-shore platforms, etc;

2. The worker housing area is for official business/worker use only; and

3. the operator has a written policy stating that on-site workers are on 24 hour call.

If the owner/operator allows for family or casual visits, then staff shall treat worker housing areas as ambient air, even if workers are on 24-hour call. Likewise, staff shall treat all worker housing areas that have uncontrolled access as ambient air, even if the workers are on 24-hour call. Staff shall treat worker housing areas at sources with no written 24-hour call policy as ambient air.

Staff shall use and require the following approach for modeling worker housing areas.

- Place receptors in the general area surrounding the worker housing buildings (including mess halls, recreational centers, schools, etc) and all out-door support areas.
- Use a receptor density that is commensurate with the approach used to determine the receptor density at locations beyond the source's boundary.
- Do *not* use flagpole receptors to model impacts at buildings, *unless* the building has a balcony or a flat-roof that is accessible by the public or off-duty worker.[37]

Staff may *not* use flagpole receptors to model impacts at open windows and building air intakes.[38] When flagpole receptors are used, the modeled impacts are subject to ambient air quality standards, but not increments.[39]

AUTHORITY

See the footnotes.

IMPLEMENTATION RESPONSIBILITY

Program Manager and Section Manager.

[37] The approach regarding flagpole receptors differs from past Department practice. However, the approach is consistent with the EPA guidance listed in footnotes 4 and 5.

[38] EPA does not consider air at open windows and air intakes as ambient air, as stated in an April 13, 1992 letter from John Seitz (Director, OAQPS) to Daniel Gutman.

[39] 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.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
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OCTOBER 21, 2011

MEMORANDUM

SUBJECT: Revisions to Emission Factors in Tables D.2.1 and D.2.2 of Draft Permit to Shell for Operation of Conical Drilling Unit Kulluk in Beaufort Sea

FROM: Dan Meyer, E.I.T. */s/*
Office of Air, Waste and Toxics

TO: Permit File

This memorandum presents information supporting revisions to emission factors (EF) presented in Tables D.2.1 and D.2.2 of draft OCS Permit No. R10OCS030000. The revisions to draft EF are presented in the following table:

Permit Condition or Location	Description	Explanation or Response to Comments Discussion
Table D.2.1 – Row for Units K-5A – 5Z. Table D.2.2 – Rows for Units IB1-2A – 2Z and IB2-2A – 2Z.	Revised CO emission factor to 0.007 lb/gal.	See RTC Comment I.3.a-c. See also October 21, 2011 EPA memo. New value reflects worst-case emissions test results for boiler on the Discoverer.
Table D.2.1 – Row for Unit K-6. Table D.2.2 – Row for OSRV WB-1A – 1Z	Revised NO_X and $PM_{10/2.5}$ emission factors to 0.399 lb/gal and 0.038 lb/gal, respectively.	See RTC Comment I.3.a. See also October 21, 2011 EPA memo. New values reflect 90th percentile emissions test result values for engines with output greater than 600 hp on Discoverer and Associated Fleet.
Table D.2.1 – Last Cell	Revised CH_4 emission factor to 1596 lb/month.	See RTC Comment I.3.d. New value assumes that what was projected to be emitted during an entire drilling season is emitted in just one month.

Permit Condition or Location	Description	Explanation or Response to Comments Discussion
Table D.2.2	Exchange emission factor values in columns “N_2O” and “CH_4.”	Corrected typo. See also RTC Comment HH.6.

<u>Carbon Monoxide (CO) EF for Heaters and Boilers</u>

The EF Shell employed in its application and Region 10 proposed in the draft permit for CO was 0.005 lb/gal and reflects AP-42 value. Stack testing of two Noble Discover boilers in 2010 showed a high value of 0.007 lb/gal. [0.007 lb/gal = (0.05 lb/MMBtu) x (MMBtu/1x10^6 Btu) x (131,180 Btu/gal)] See June 16, 2011 email from Rodger Steen to Dan Meyer. To provide an additional measure of conservatism to emissions calculations to be performed by Shell for its operations, I recommend revising draft permit to replace 0.005 lb/gal EF with 0.007 lb/gal EF.

<u>Nitrogen Oxides (NO_X) and Particulate Matter (PM) EF for Large Engines</u>

The uncontrolled EF Shell employed in its application and Region 10 proposed in the draft permit for NO_X was 0.370 lb/gal and reflects 2010 stack test results for Noble Discover and Associated Fleet. See June 16, 2011 email from Rodger Steen to Dan Meyer. The stack test results are presented below in an extracted Microsoft Excel spreadsheet displaying average and 90^{th} percentile test-derived EF values. To provide an additional measure of conservatism to emissions calculations to be performed by Shell for engines Region 10 is not requiring to be tested, I recommend revising draft permit to replace uncontrolled NO_X 0.370 lb/gal EF with the 90^{th} percentile 0.399 lb/gal EF for engines greater than 600 hp.

The uncontrolled EF Shell employed in its application for PM was 0.015 lb/gal, and the uncontrolled EF Shell employed in its application for PM was 0.018 lb/gal. See July 20, 2011 EPA memorandum. Both values reflect 2010 stack test results for Noble Discover and Associated Fleet. See June 16, 2011 email from Rodger Steen to Dan Meyer. The stack test results are presented below in an extracted Microsoft Excel spreadsheet displaying average and 90^{th} percentile test-derived EF values. To provide an additional measure of conservatism to emissions calculations to be performed by Shell for engines Region 10 is not requiring to be tested, I recommend revising draft permit to replace PM 0.018 lb/gal EF with the 90^{th} percentile 0.038 lb/gal EF for engines greater than 600 hp.

NOX for engines > 600 hp	PM for engines > 600 hp
16.29	0.13
5.92	0.12
8.35	0.12
13.74	0.18
8.52	0.1
5.56	0.16
6.41	0.17
5.87	0.19
22.41	1.76
12.62	0.56
7.8	1.28
14.47	0.79
10.1	0.65
7.3	1.18
8.87	0.58
9.09	0.68
9.46	0.97
11.47	0.83
11.83	0.74
9.62	1.41
11.07	0.81
11.93	0.61
7.89	0.28
6.27	0.3
7.32	0.28
5.93	0.16
7.53	avg 0.578462 g/kW-hr
10.94	90th P 1.23 g/kW-hr
8.86	
8.44	
7.02	
6.62	
7.05	
8.26	
8.99	
7.71	
9.97	
7.58	
avg 9.344211 g/kW-hr	
90th P 12.956 g/kW-hr	

PM: Draft Permit 0.578 g/kW-hr

Amend Permit to 1.23 g/kW-hr. or 0.037894 lb/gal
This is a 113% increase.

NOX: Draft Permit 12 g/kW-hr

Amend Permit to 13.0 g/kW-hr. or 0.399153 lb/gal
This is a 7.8% increase.

	NOX for engines < 600 hp			PM for engines < 600 hp				
	2.48			0.04				
	2.18			0.07				
	3.88			0.05				
	3.76			0.03				
	2.6			0.27				
	2.94			0.26				
	6.94			0.35				
	6.89			0.29				
	5.52			0.73				
	4.22			0.4				
	5.18			0.2				
	3.62			0.31				
	3.07			0.26				
	2.23		avg	0.250769	g/kW-hr		Permit	
	11.56		90th	0.39	g/kW-hr		1.2 g/kW-hr	
	12.72							
	10.72		Permit EF already greater than 90th percentile value.					
	12.47							
	10.23							
	9.4							
	7.8							
	7.24							
	9.3							
avg	6.38913	g/kW-hr		Permit				
90th	11.392	g/kW-hr		15 g/kW-hr				
Permit EF already greater than 90th percentile value.								

Methane (CH_4) EF for Mud Degassing

Multiply EF appearing in draft permit by a factor of 4 to make consistent with EF appearing in Noble Discoverer PSD permitting action as an additional measure of conservatism. Assume emissions generated over a 120-day period will occur within a 30-day period.

Nitrous Oxide (N_2O) and CH_4 EF for Mud Degassing

Correct typographical error in Table D.2.2. No further discussion required.

<u>Summary Changes to Tables D.2.1 and D.2.2</u>

Table D.2.1 – Kulluk Emission Factors[1]

EMISSION UNIT ID	Description	Emission Unit Rating	Emission Factor Units[2]	NO_X[3]	CO[4]	PM_{10}[5]	$PM_{2.5}$[6]	CO_2	N_2O	CH_4
K-5A – 5Z	Heaters and Boilers	Various	lb/gal		0.007 ~~0.005~~					
K-6	Emergency Generator	> 600 hp	lb/gal	0.399 ~~0.370~~		0.038 ~~0.018~~	0.038 ~~0.018~~			
K-10	Drilling Mud System	NA	lb/month	NA	NA	NA	NA	NA	NA	1596 ~~399~~

[1] Footnotes in Table D.2.1 also apply to Table D.2.2.

[2] Emission factors are in terms of pounds of emissions per unit of operation except for the drilling mud system which are worst case emission per month; lb/gal means pounds of pollutant emitted per gallon of diesel burned; lb/ton means pounds of pollutant emitted per ton of waste incinerated; lb/month means pounds of pollutant emitted per month.

[3] C = controlled. U = uncontrolled. Controlled NO_X emission factors for emission units K-1A – 1D, IB1-1A – 1Z and IB2-1A – 1Z reflect an SCR control efficiency of 90%.

[4] C = controlled. U = uncontrolled. Controlled CO emission factors for emission units K-1A – 1D, K-2A – 2Z, K-3A – 3Z, K-4A – 4C, IB1-1A – 1Z and IB2-1A – 1Z reflect an oxidation catalyst control efficiency of 80%.

[5] C = controlled. U = uncontrolled. Controlled PM_{10} emission factors for emission units K-1A – 1D, K-2A – 2Z, K-3A – 3Z, K-4A – 4C, IB1-1A – 1Z and IB2-1A – 1Z reflect an oxidation catalyst control efficiency of 50%.

[6] C = controlled. U = uncontrolled. Controlled $PM_{2.5}$ emission factors for emission units K-1A – 1D, K-2A – 2Z, K-3A – 3Z, K-4A – 4C, IB1-1A – 1Z and IB2-1A – 1Z reflect an oxidation catalyst control efficiency of 50%.

Table D.2.2 – Associated Fleet Emission Factors

EMISSION UNIT ID	Description	Emission Unit Rating	Emission Factor Units	NO_X	CO	PM_{10}	$PM_{2.5}$	CO_2	N_2O	CH_4
IB1-1A – 1Z IB2-1A – 1Z	Propulsion Engines and Generator Engines on Icebreakers	Various	lb/gal						0.0002 ~~0.0009~~	0.0009 ~~0.0002~~
IB1-2A – 2Z IB2-2A – 2Z	Heaters and Boilers on Icebreakers	Various	lb/gal		0.007 ~~0.005~~				0.0002 ~~0.0009~~	0.0009 ~~0.0002~~
RV/BT-1A – 1Z OSRV-1A – 1Z OSRV WB 1 - 4	Propulsion Engines and Generator Engines on Resupply Vessel/Barge and Tug, Oil Spill Response Vessel ~~and Oil Spill Response Vessel Work Boats~~	> 600 hp	lb/gal						0.0002 ~~0.0009~~	0.0009 ~~0.0002~~
		< 600 hp	lb/gal						0.0002 ~~0.0009~~	0.0009 ~~0.0002~~
OSRV WB 1A – 1Z	Oil Spill Response Vessel Work Boats	> 600 hp	lb/gal	0.399 ~~0.370~~		0.038 ~~0.018~~	0.038 ~~0.018~~		0.0002 ~~0.0009~~	0.0009 ~~0.0002~~
		< 600 hp	lb/gal						0.0002 ~~0.0009~~	0.0009 ~~0.0002~~
IB1-3A – 3Z IB2-3A – 3Z RV/BT-2A – 2Z OSRV-2A – 2Z	Seldom-Used Sources on Associated Fleet	< 600 hp	lb/gal						0.0002 ~~0.0009~~	0.0009 ~~0.0002~~
IB1-4 IB2-4 OSRV-3	Incinerators on Icebreakers and Oil Spill Response Vessel	Various	lb/ton						0.092 ~~0.702~~	0.702 ~~0.092~~